



Measurement of RF Interference from a Orion Gas Invensys Gas Meter Frequency Hopping Spread Spectrum Transmitter

For : Badger Meter Inc.
Street
Milwaukee WI 53223

P.O. No. :
Date Tested : May 4 through 16, 2007
Test Personnel : Richard King
Specification : FCC "Code of Federal Regulations" Title 47 Part
15, Subpart C, Section 15.247 for Frequency
Hopping Spread Spectrum Intentional Radiators
Operating within the 902-928MHz band.

Test Report By : *Richard E. King*
Richard King

Witnessed by :
John Olsen
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
—	06/1/07	Initial release



**Measurement of RF Emissions from a
Model Gas Meter Orion Gas Invensys F.H.S.S 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 Badger Meter Inc., Part No.Orion Gas Invensys, Serial No.none assigned transmitter, (hereinafter referred to as the test item). The test item is a frequency hopping spread spectrum transmitter used for gas metering applications. It transmits over 902-928 MHz and 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 conducted and radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 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 2006
- 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 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 24.7°C and the relative humidity was 35%.

2.0 TEST ITEM SETUP AND OPERATION:

The test item is a Badger Meter Inc., Part No.Orion Gas Invensys . A block diagram of the test item setup is shown as Figure 1.

2.1 Power Input - The test item obtained 3.0 VDC from 2 lithium thionylchloride internal batteries.

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

2.3 Support Equipment - The test item does require peripheral equipment.

2.4 Interconnect Cables - The test item does not require interconnect cables.

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 could be programmed to operate in one of the following modes: transmit at 911.65MHz, transmit at 916.45MHz, transmit at 921.25MHz, or frequency hopping enabled.

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).

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 required.

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 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 13 and 14. The test item transmits a 1.79 msec pulse every 4.12 seconds. Since a word is greater than 100 msec long, the duty cycle factor was computed over a 100 msec interval. The duty cycle correction factor was calculated to be -35dB ($-35\text{dB} = 20 \cdot \log(1.79\text{msec}/100\text{msec})$).

4.2 Carrier Frequency Separation:

4.2.1 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.

4.2.2 Procedures: The test item was setup inside the chamber. The output of the test item was connected to the spectrum analyzer through a 20dB pad. 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 was 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.

4.2.3 Results: Page 15 shows the carrier frequency separation. As can be seen from this plot, the separation is 396.79 kHz which is greater than the 20dB bandwidth (260.5 kHz).

4.3 Number of Hopping Frequencies

4.3.1 Requirements - Per section 15.247(a)(1)(i), For frequency hopping systems operating in the 902-928MHz band. The frequency hopping system shall use at least 50 hopping frequencies if the 20dB bandwidth is less than 250kHz. If the 20dB bandwidth is greater than 250kHz the frequency hopping system shall use at least 25 hopping frequencies.

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 was 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.

4.3.3 Results - Page 16 shows the number of hopping frequencies. As can be seen from this plot, the number of frequencies is 25 which is equal to the minimum required.

4.4 Time of Occupancy

4.4.1 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 20 second period if the 20dB bandwidth is less than 250kHz. If the 20dB bandwidth is greater than 250kHz, the average time of occupancy shall not be greater than 0.4 seconds within a 10 second period

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 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.

4.4.3 Results - Pages 17 and 18 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 1.79 msec pulse multiplied by 1 hop. This calculated value is equal to .00179 seconds which is less than the 0.4 seconds maximum allowed.

4.5 20dB Bandwidth

4.5.1 Requirement - Per section 15.247(a)(1)(i), For frequency hopping systems operating in the 902-928MHz band. The 20dB bandwidth shall not be greater than 500kHz.

4.5.2 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 \geq 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.

4.5.3 Results - The plots on pages 19 through 21 show that the maximum 20 dB bandwidth was 260.5 kHz. Therefore, the carrier frequency separation must be greater than 260.5 kHz and the number of hopping channels must be at least 25.

4.6 Peak Output Power

4.6.1 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 maximum peak output conducted power shall not be greater than 250mW (24dBm). Per section 15.247(b)(4), this limit is based on the use of antennas with directional gains that do not exceed 6dBi. Since the limit allows for a 6dBi antenna gain, the maximum EIRP can be increased by 6dB to 1 Watt (30dBm).

4.6.2 Procedures - The test item was placed on the non-conductive stand and set to transmit. A dipole 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.

4.6.3 Results - The results are presented on page 22. The maximum EIRP measured from the transmitter was 9.0 dBm or 8 mW which is below the 1 Watt limit.

4.7 Bandedge Compliance

4.7.1 Requirement - Per section 15.247(d), 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 the restricted band beginning at 2483.5 MHz, must meet the general limits of 15.209

4.7.2 Procedures - The test item was setup inside the chamber on a non-

conductive stand. A broadband measuring antenna was placed at a test distance of 3 meters from the test item. With the hopping function disabled, the test item was allowed to transmit continuously. The test item was maximized for worst case emissions at the measuring antenna. The maximum meter reading was recorded. The frequency hopping channel was set separately to low and high hopping channels. The resolution bandwidth (RBW) was set to 300 kHz (greater than or equal to 1% of the span). 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.

4.7.3 Results - Pages 23 through 26 show the band-edge compliance results using the marker-delta method. As can be seen from this plots, the emissions at the band-edge in the restricted band are within the general limits.

4.8 Spurious Emissions

4.8.1 Antenna Conducted

4.8.1.1 Requirement – Since the test item was not equipped with an antenna port antenna conducted emissions measurements were not performed.

4.8.2 Radiated Spurious Emissions

4.8.2.1 Requirement – Per section 15.247(c), the spurious emissions in any 100 kHz BW outside the frequency band must be at least 20dB below the highest 100 kHz BW level measured within the band. In addition, the radiated emissions which fall in the restricted bands must meet the general limits of 15.209.

4.8.2.2 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 18 GHz. Frequency range 18 to 24 GHz was checked manually but not plotted.

Next, the harmonic or spurious emissions falling in the restricted bands were measured up through the 10th harmonic. For these measurements, the measurement bandwidths were 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.

4.8.2.3 Results - The preliminary emissions levels were plotted. These plots are presented on pages 27 through 38. These plots show that the radiated spurious emissions were at least 20 dB below the level of the fundamental.

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 39 through 44. The field intensities levels for the harmonics in the restricted band were within the limit.

A block diagram of the test item orientation position is shown in Figure 1.

5.0 CONCLUSIONS:

It was determined that the Badger Meter Inc. Gas Meter, Part No. Orion Gas Invensys, Serial No. none assigned, did fully meet the radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.205 et seq. for Intentional Radiators, when tested per ANSI C63.4-2003.

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.



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								
XPQ3	HIGH PASS FILTER	K&L MICROWAVE	4IH30-1804/T	4	1.8GHZ-10GHZ		12	
XZG0	ATTENUATOR/SWITCH DRIVER	HEWLETT PACKARD	11713A	3439A02724	---		N/A	
Equipment Type: AMPLIFIERS								
APK0	PRE-AMPLIFIER	HEWLETT PACKARD	8449B	3008A00662	1-26.5GHZ	03/16/07	12	03/16/08
Equipment Type: ANTENNAS								
NDQ0	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	311	400-1000MHZ	03/06/07	12	03/06/08
NDQ1	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	313	400-1000MHZ	03/28/07	12	03/28/08
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								
RAC1	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	3407A08369	100HZ-22GHZ	02/21/07	12	02/21/08
RACB	RF PRESELECTOR	HEWLETT PACKARD	85685A	3506A01491	20HZ-2GHZ	02/21/07	12	02/21/08
RAF3	QUASISPEAK ADAPTER	HEWLETT PACKARD	85650A	3303A01775	0.01-1000MHZ	02/21/07	12	02/21/08
RBB0	EMI TEST RECEIVER 20HZ TO	ROHDE & SCHWARZ	ESIB40	100250	20 HZ TO 40GHZ	09/29/06	12	09/29/07
Equipment Type: SIGNAL GENERATORS								
GBR6	SIGNAL GENERATOR	HEWLETT PACKARD	8648C	3642U02047	9KHZ-3000MHZ	02/20/07	12	02/20/08

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.

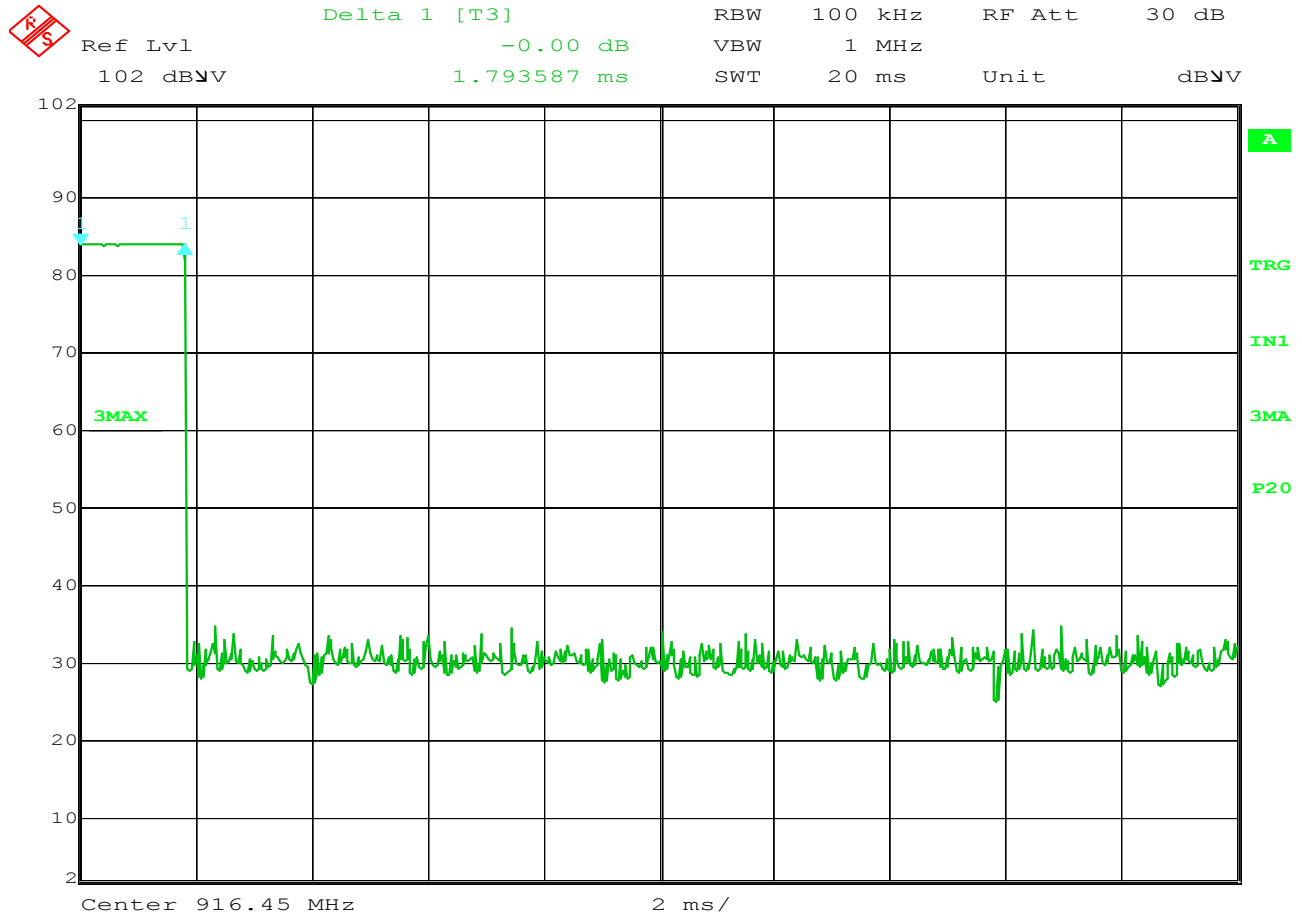
Figure 3



Test Set-up for Radiated Emissions, 911.65MHz to 921.25MHz Horizontal Polarization



Test Set-up for Radiated Emissions, 911.65MHz to 921.25MHz Vertical Polarization



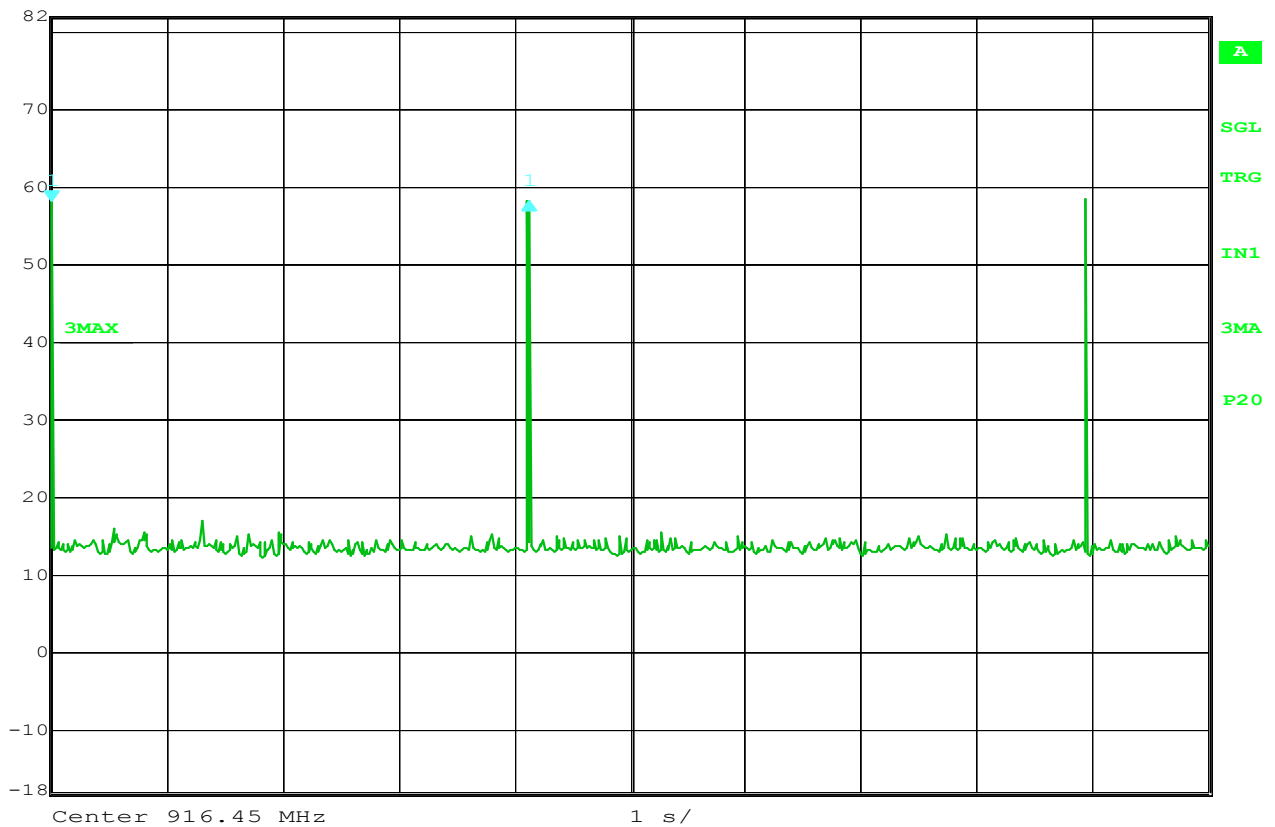
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FCC 15.247 Dwell Time / Duty Cycle

MANUFACTURER : Badger Meter
TEST ITEM : Gas Meter
MODEL NUMBER : Orion Gas Invensys
TEST MODE : Tx @ 916.45 MHz
NOTES : 1.79 mS pulse width



Delta 1 [T3] RBW 100 kHz RF Att 10 dB
Ref Lvl 0.02 dB VBW 1 MHz
82 dBV 4.122725 s SWT 10 s Unit dBV



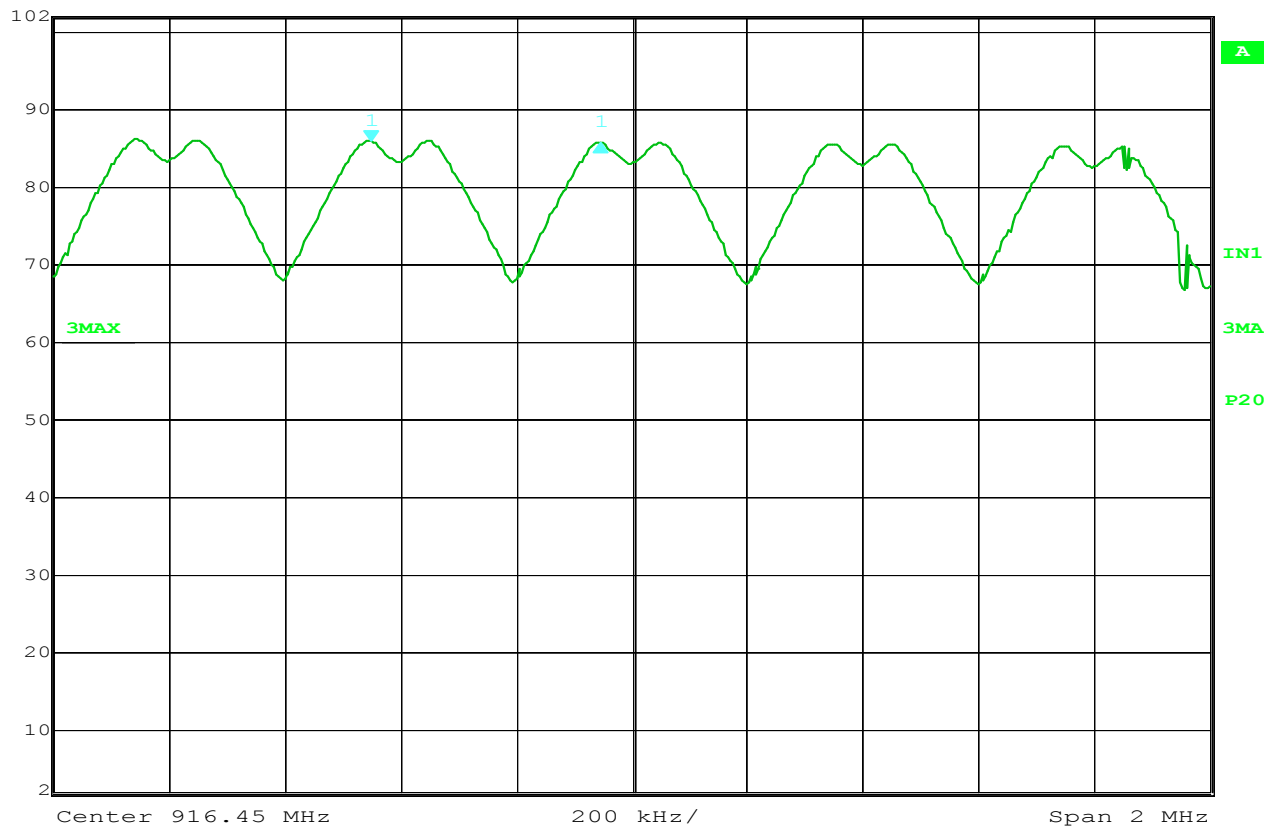
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FCC 15.247 Dwell Time / Duty Cycle

MANUFACTURER : Badger Meter
TEST ITEM : Gas Meter
MODEL NUMBER : Orion Gas Invensys
TEST MODE : Tx @ 916.45 MHz
NOTES : 4.12 Seconds between pulses



Delta 1 [T3] RBW 100 kHz RF Att 30 dB
Ref Lvl -0.28 dB VBW 1 MHz
102 dBμV 396.79358717 kHz SWT 5 ms Unit dBμV



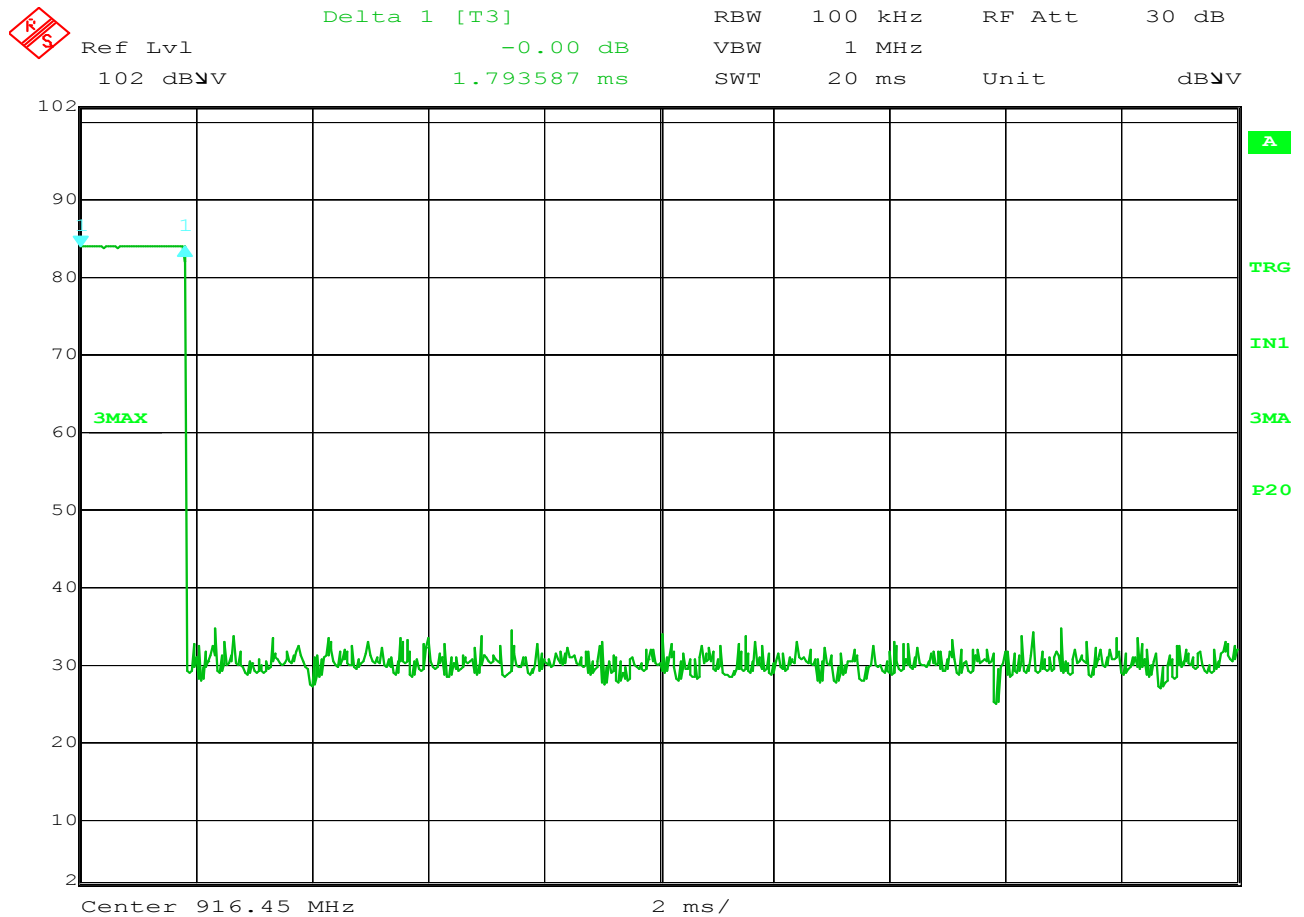
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FCC 15.247 Carrier Frequency Separation

MANUFACTURER : Badger Meter
TEST ITEM : Gas Meter
MODEL NUMBER : Orion Gas Invensys
TEST MODE : Hopping Enabled
NOTES :



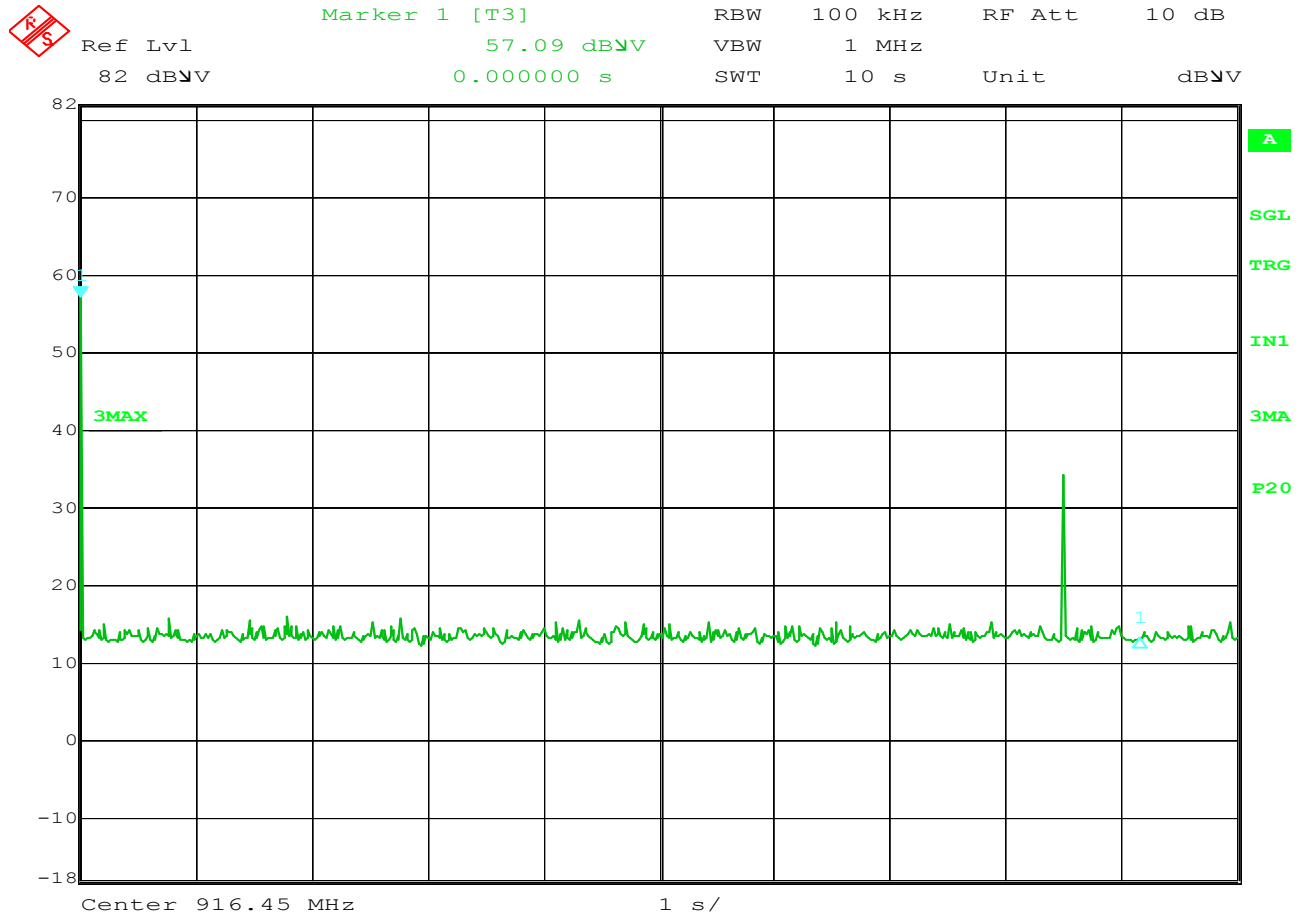
MANUFACTURER : Badger Meter
TEST ITEM : Gas Meter
MODEL NUMBER : Orion Gas Invensys
TEST MODE : Hopping Enabled
NOTES : 25 Hopping Channels



Date: 10.MAY.2007 20:15:09

FCC 15.247 dwell time / duty cycle

MANUFACTURER : Badger Meter
TEST ITEM : Gas Meter
MODEL NUMBER : Orion Gas Invensys
TEST MODE : Hopping Enabled
NOTES : 1.79 mS Pulse width



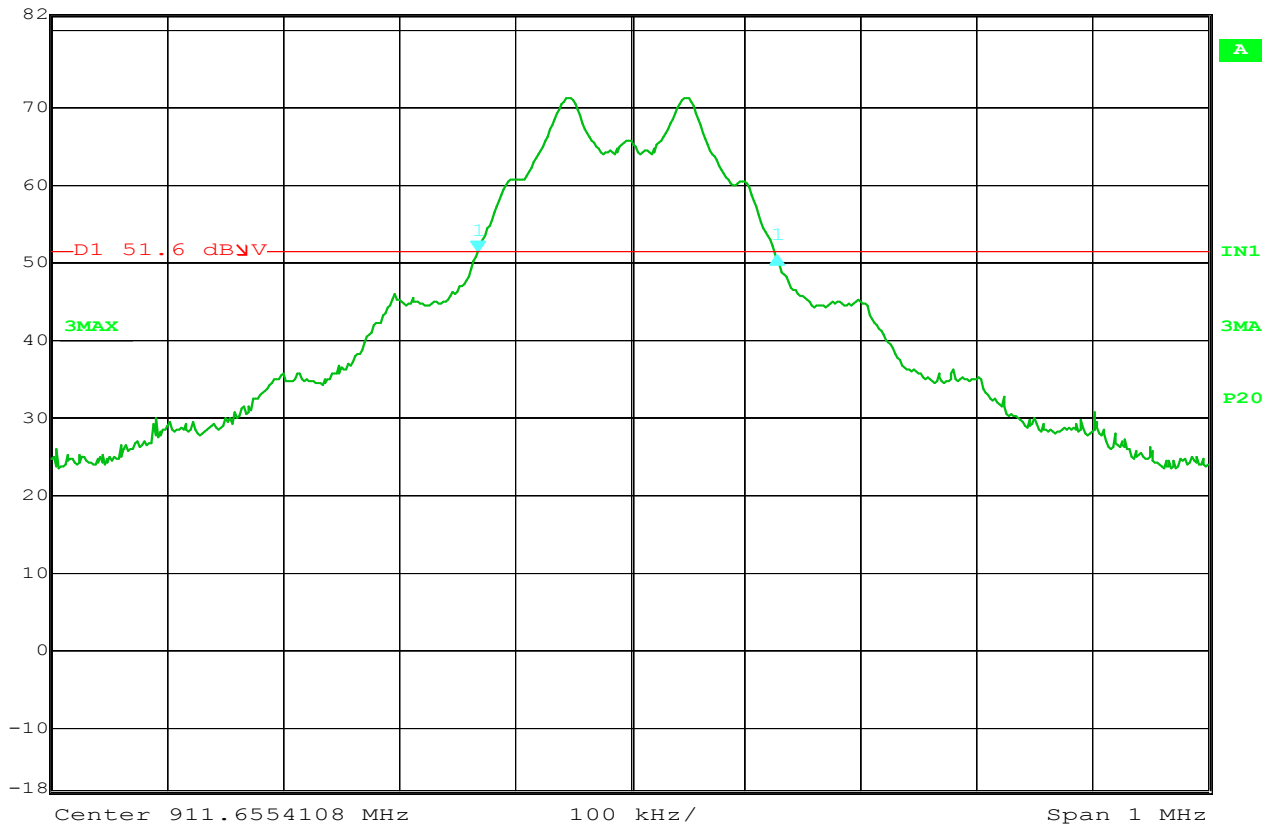
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FCC 15.247 dwell time / duty cycle

MANUFACTURER : Badger Meter
TEST ITEM : Gas Meter
MODEL NUMBER : Orion Gas Invensys
TEST MODE : Hopping Enabled
NOTES : 1 pulse in 10 seconds



Delta 1 [T3] RBW 30 kHz RF Att 10 dB
Ref Lvl -0.43 dB VBW 300 kHz
82 dBμV 258.51703407 kHz SWT 5 ms Unit dBμV



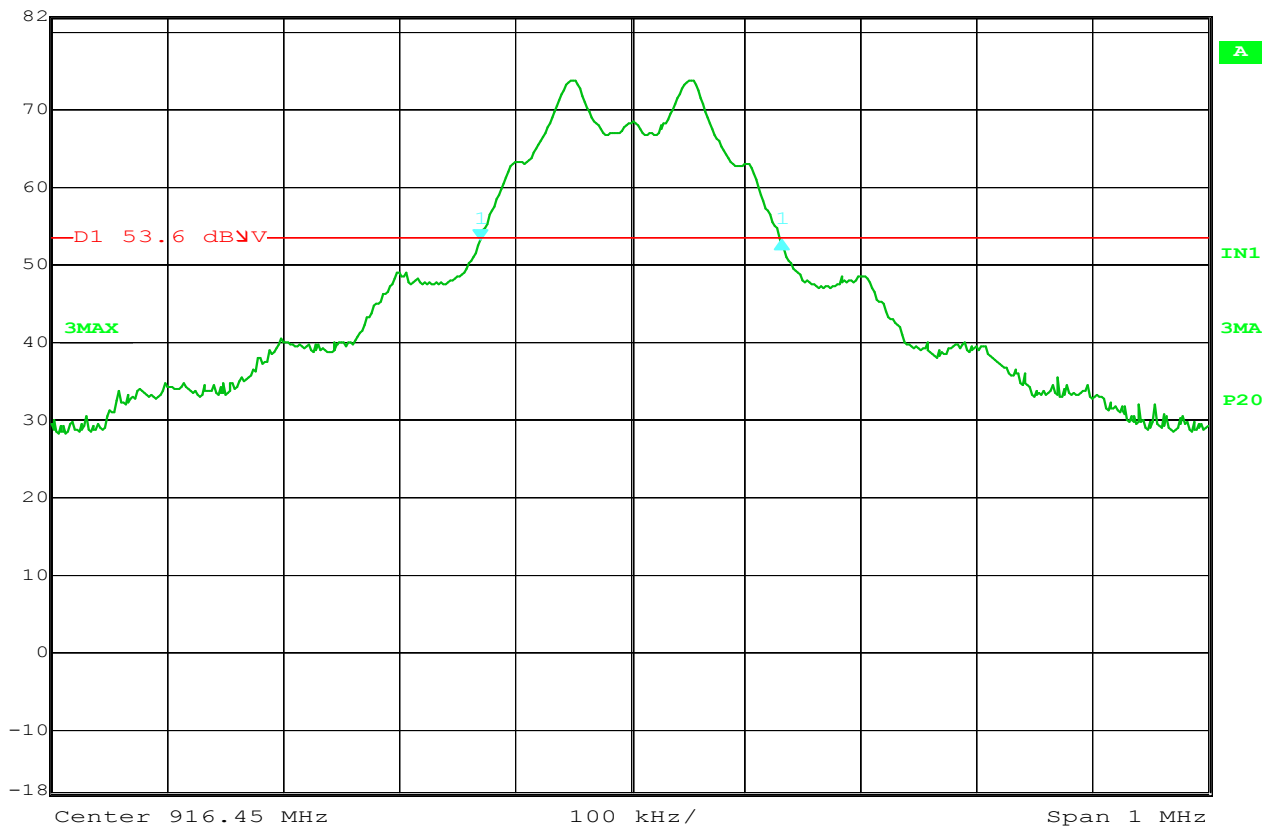
Date: 16.MAY.2007 19:08:50

FCC 15.247 20 dB Bandwidth Measurement

MANUFACTURER : Badger Meter
TEST ITEM : Gas Meter
MODEL NUMBER : Orion Gas Invensys
TEST MODE : Tx @ 911.65MHz
NOTES :



Delta 1 [T3] RBW 30 kHz RF Att 10 dB
Ref Lvl -0.02 dB VBW 300 kHz
82 dBV 260.52104208 kHz SWT 5 ms Unit dBV



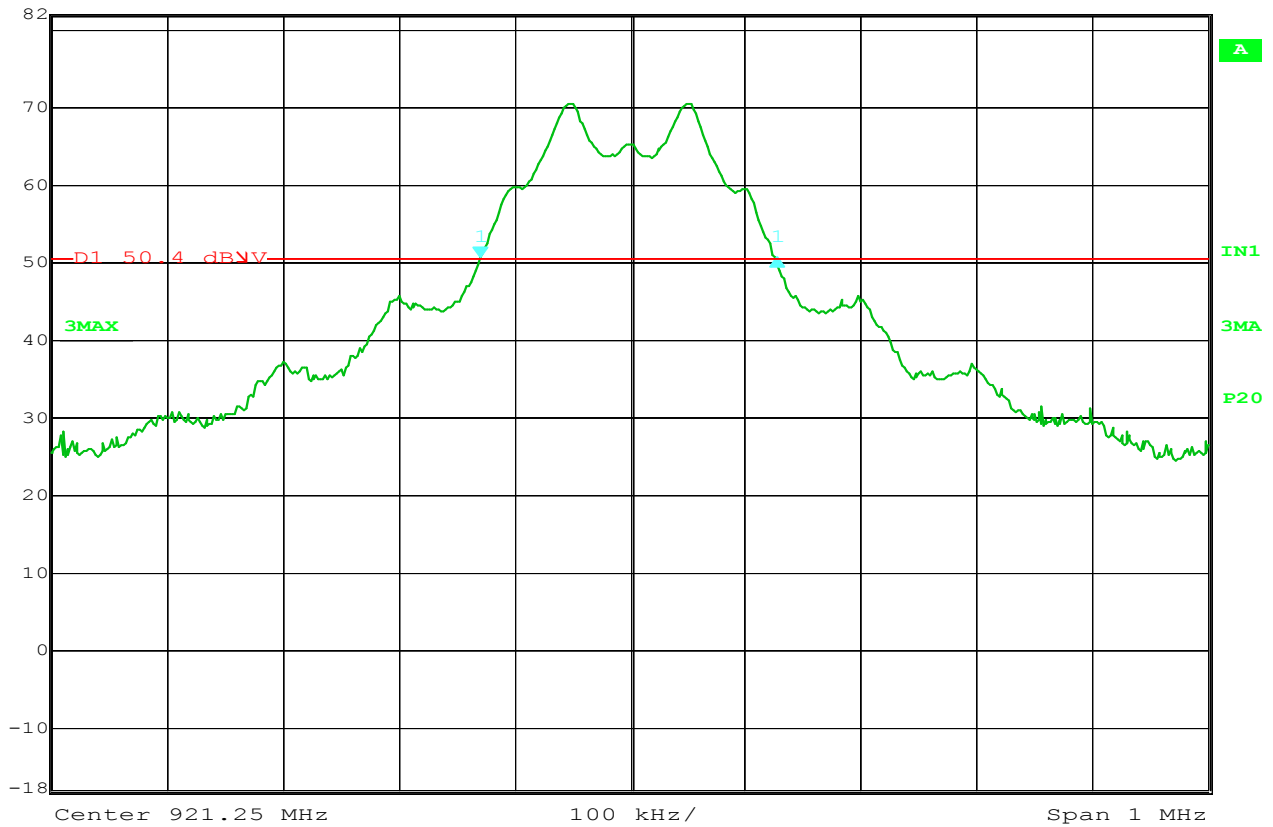
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FCC 15.247 20 dB Bandwidth Measurement

MANUFACTURER : Badger Meter
TEST ITEM : Gas Meter
MODEL NUMBER : Orion Gas Invensys
TEST MODE : Tx @ 916.45MHz
NOTES :



Delta 1 [T3] RBW 30 kHz RF Att 10 dB
 Ref Lvl 0.01 dB VBW 300 kHz
 82 dBV 256.51302605 kHz SWT 5 ms Unit dBV



Date: 16.MAY.2007 19:35:04

FCC 15.247 20 dB Bandwidth Measurement

MANUFACTURER : Badger Meter
 TEST ITEM : Gas Meter
 MODEL NUMBER : Orion Gas Invensys
 TEST MODE : Tx @ 921.25MHz
 NOTES :



Manufacturer : Badger Meter
Model No. : Orion Gas Invensys Transmitter
Serial No. : None Assigned
Test Specification : FCC Part 15, Subpart C, 15.247, Peak Output Power –
: Radiated Measurement
Date : May 16, 2007
Notes : Test Distance is 3 meters

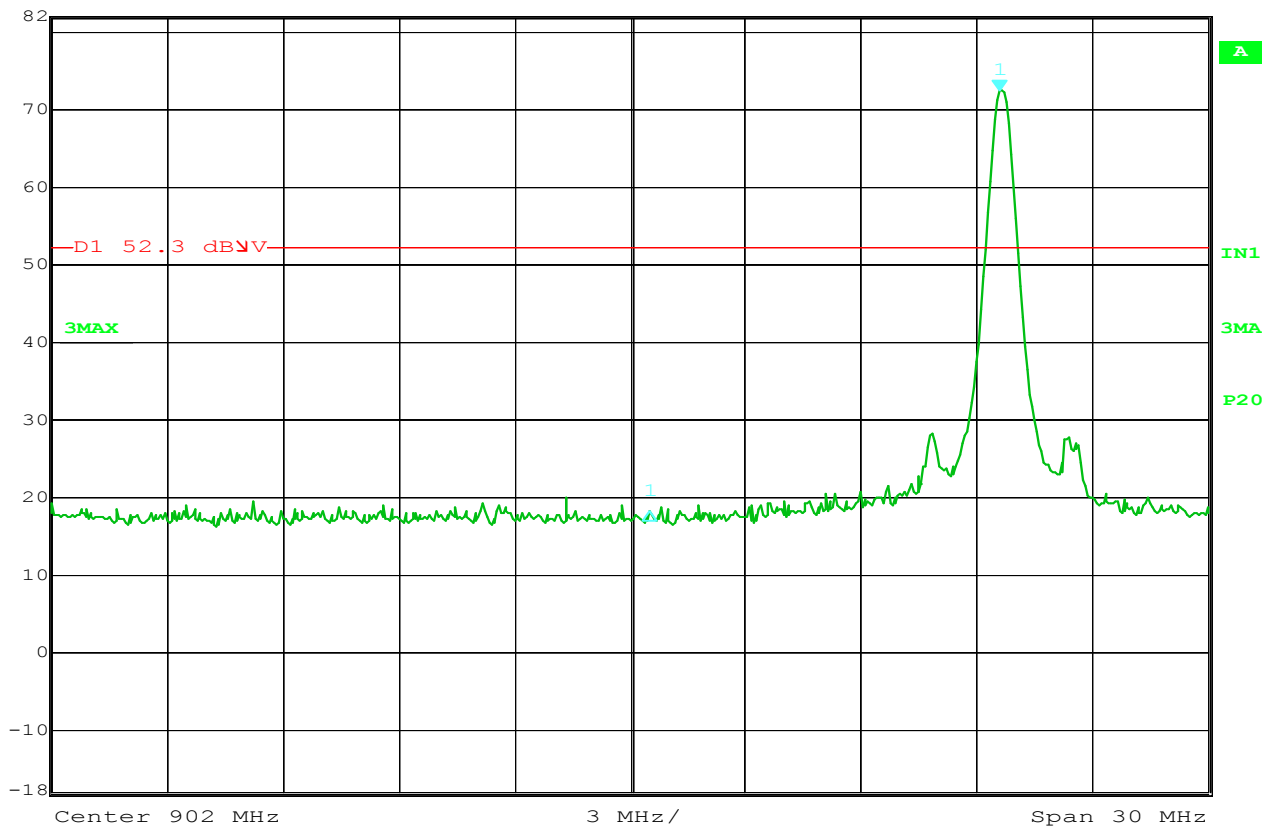
Frequency MHz	Antenna Polarity	Meter Reading dBuV	Matched Signal Generator Reading dBm	Antenna Gain dB	Cable Loss dB	EIRP dBm	Limit dBm
911.65	H	69.5	4.6	1.6	2.1	4.1	30
911.65	V	74.2	9.3	1.6	2.1	8.8	30
916.45	H	67.3	2.4	1.7	2.1	2.0	30
916.45	V	74.3	9.4	1.7	2.1	9.0	30
921.25	H	66.0	1.4	1.6	2.1	0.9	30
921.25	V	70.7	6.1	1.6	2.1	5.6	30

EIRP = Sig. Gen. Reading + Antenna Gain – Cable Loss

Checked By: *RICHARD E. KING*



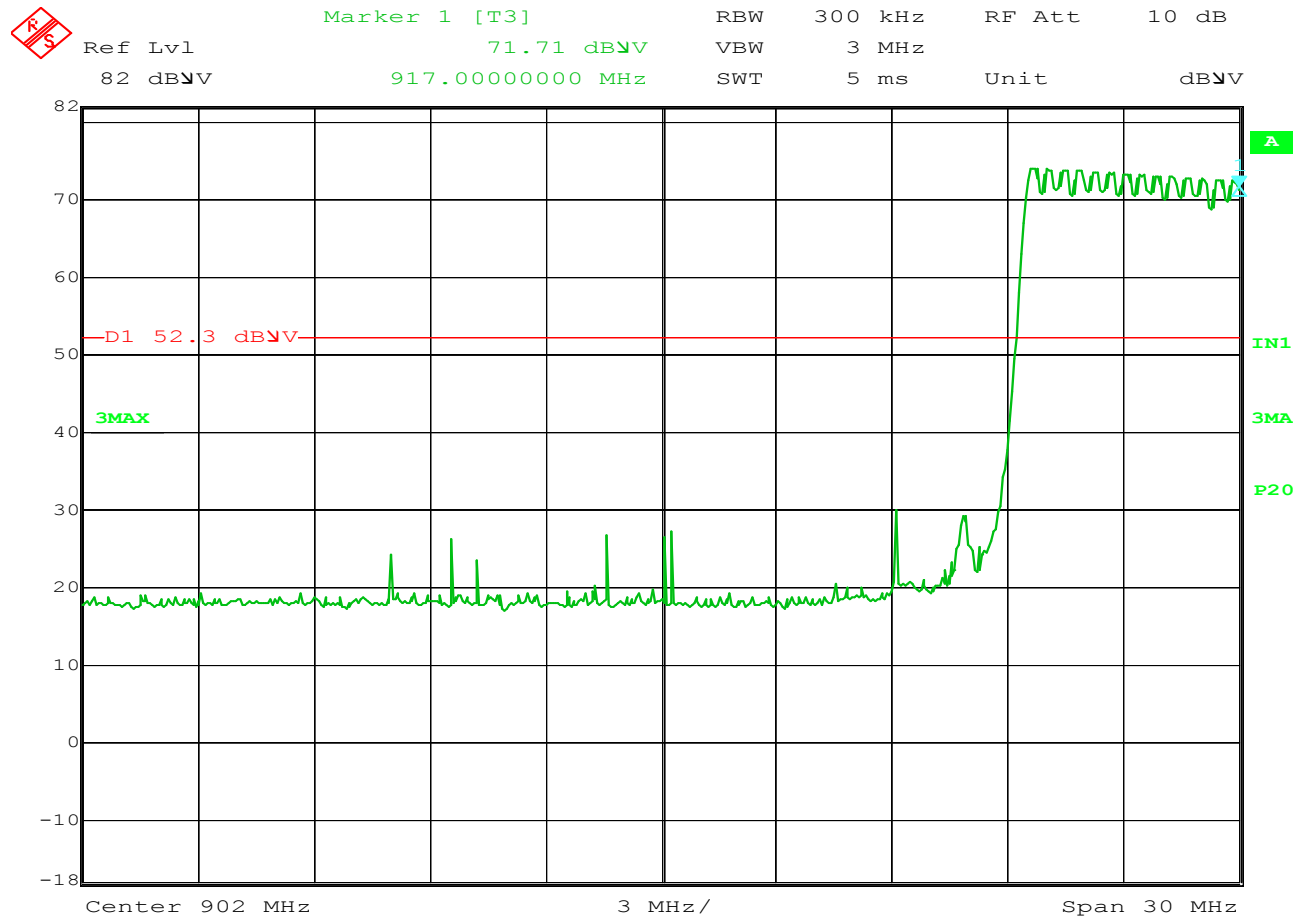
Marker 1 [T3] RBW 300 kHz RF Att 10 dB
Ref Lvl 82 dBμV 72.31 dBμV VBW 3 MHz
911.58917836 MHz SWT 5 ms Unit dBμV



Date: 16.MAY.2007 19:14:00

FCC 15.247 Bandedge Compliance

MANUFACTURER : Badger Meter
TEST ITEM : Gas Meter
MODEL NUMBER : Orion Gas Invensys
TEST MODE : Tx @ 911.65MHz
NOTES : 20 dB down



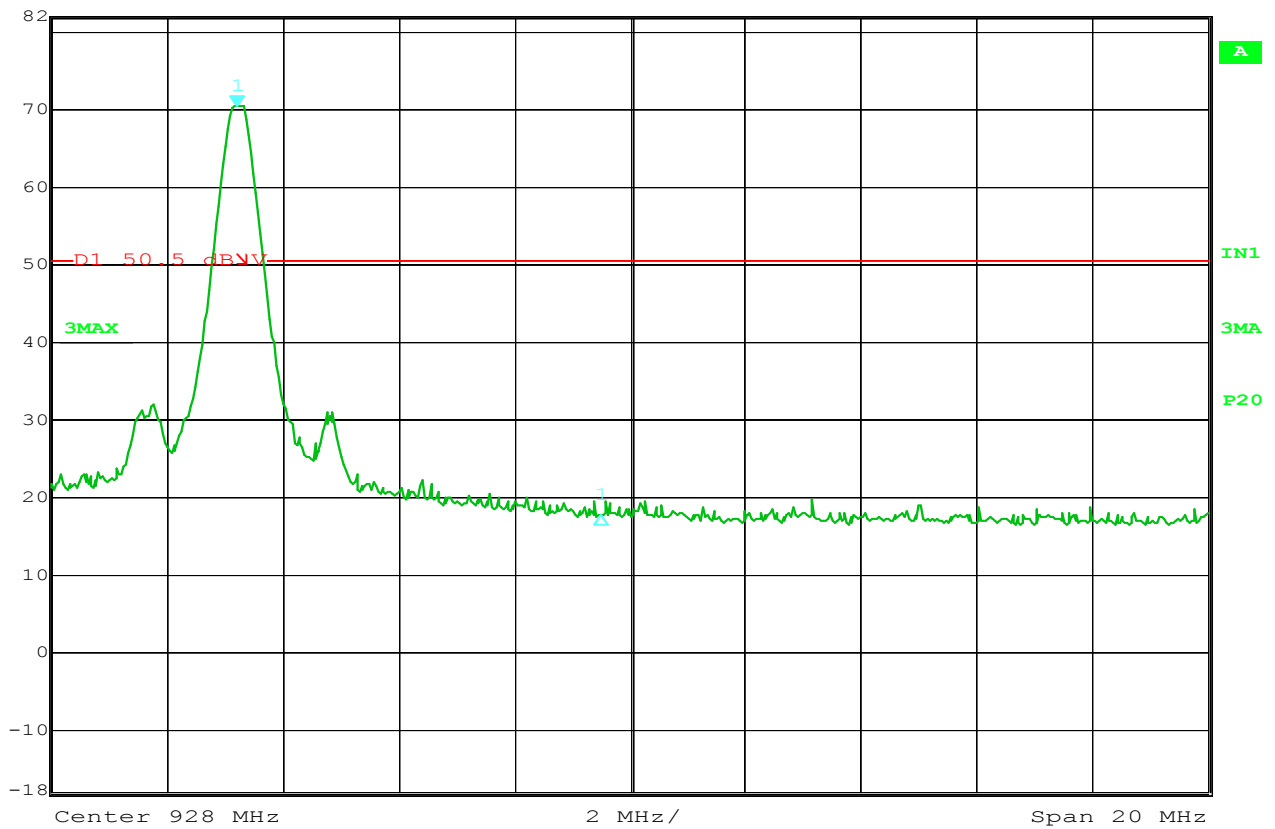
Date: 16.MAY.2007 19:51:07

FCC 15.247 Bandedge Compliance Measurement

MANUFACTURER : Badger Meter
TEST ITEM : Gas Meter
MODEL NUMBER : Orion Gas Invensys
TEST MODE : Hopping Enabled
NOTES :



Marker 1 [T3] RBW 300 kHz RF Att 10 dB
Ref Lvl 82 dBV 70.47 dBV VBW 3 MHz
921.20641283 MHz SWT 5 ms Unit dBV



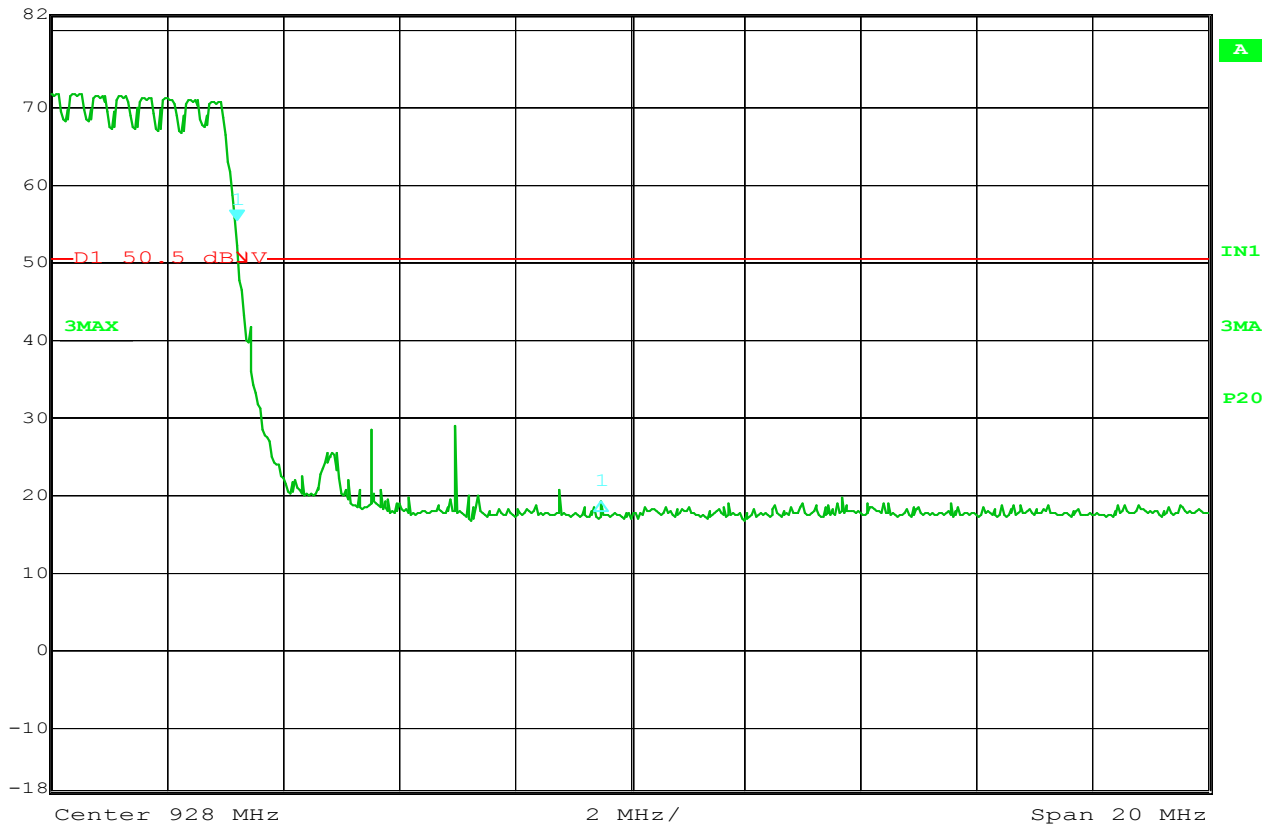
Date: 16.MAY.2007 19:36:57

FCC 15.247 20 dB Bandwidth Measurement

MANUFACTURER : Badger Meter
TEST ITEM : Gas Meter
MODEL NUMBER : Orion Gas Invensys
TEST MODE : Tx @ 921.25MHz
NOTES :



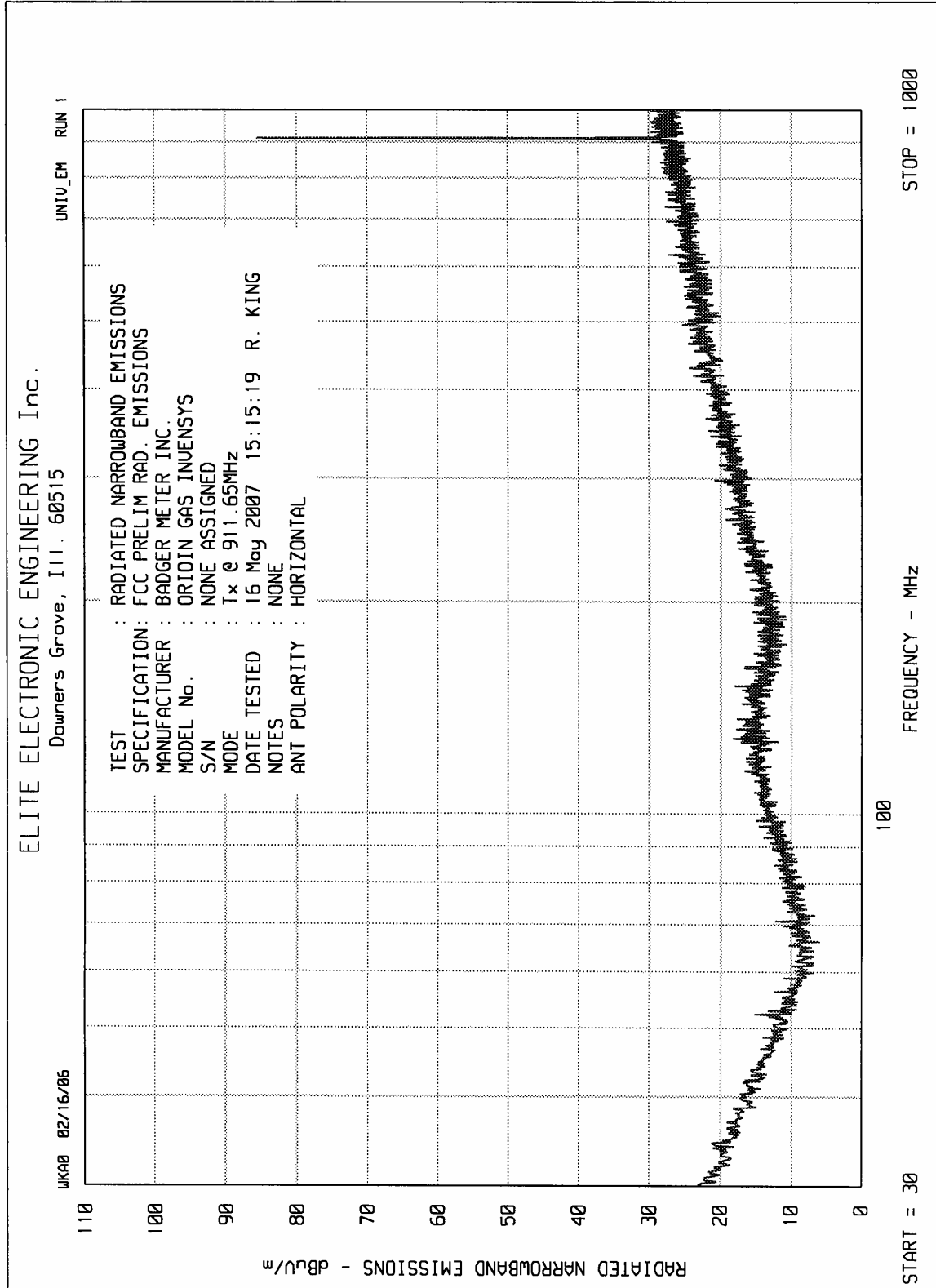
Marker 1 [T3] RBW 300 kHz RF Att 10 dB
Ref Lvl 82 dBV 55.33 dBV VBW 3 MHz
921.20641283 MHz SWT 5 ms Unit dBV

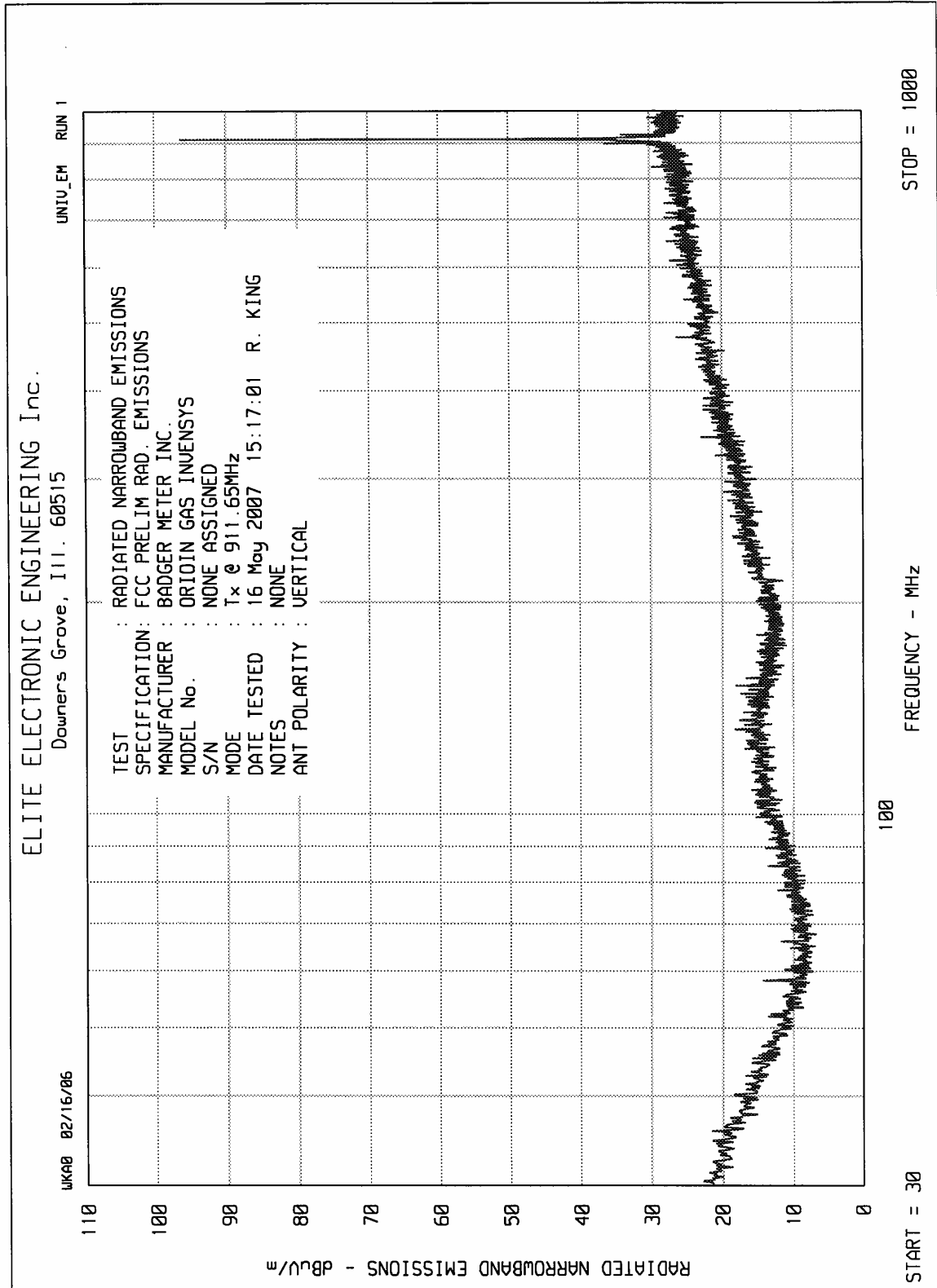


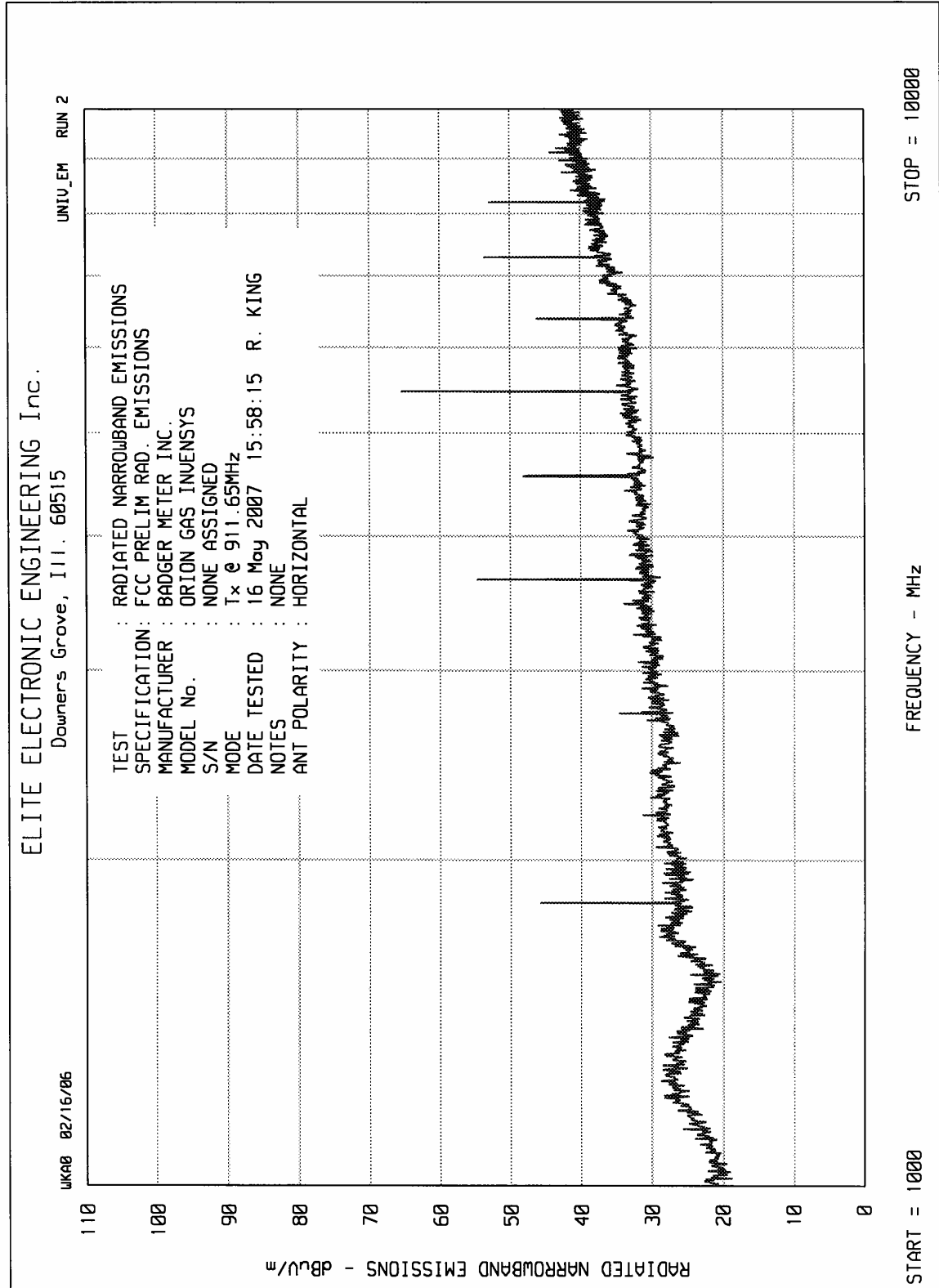
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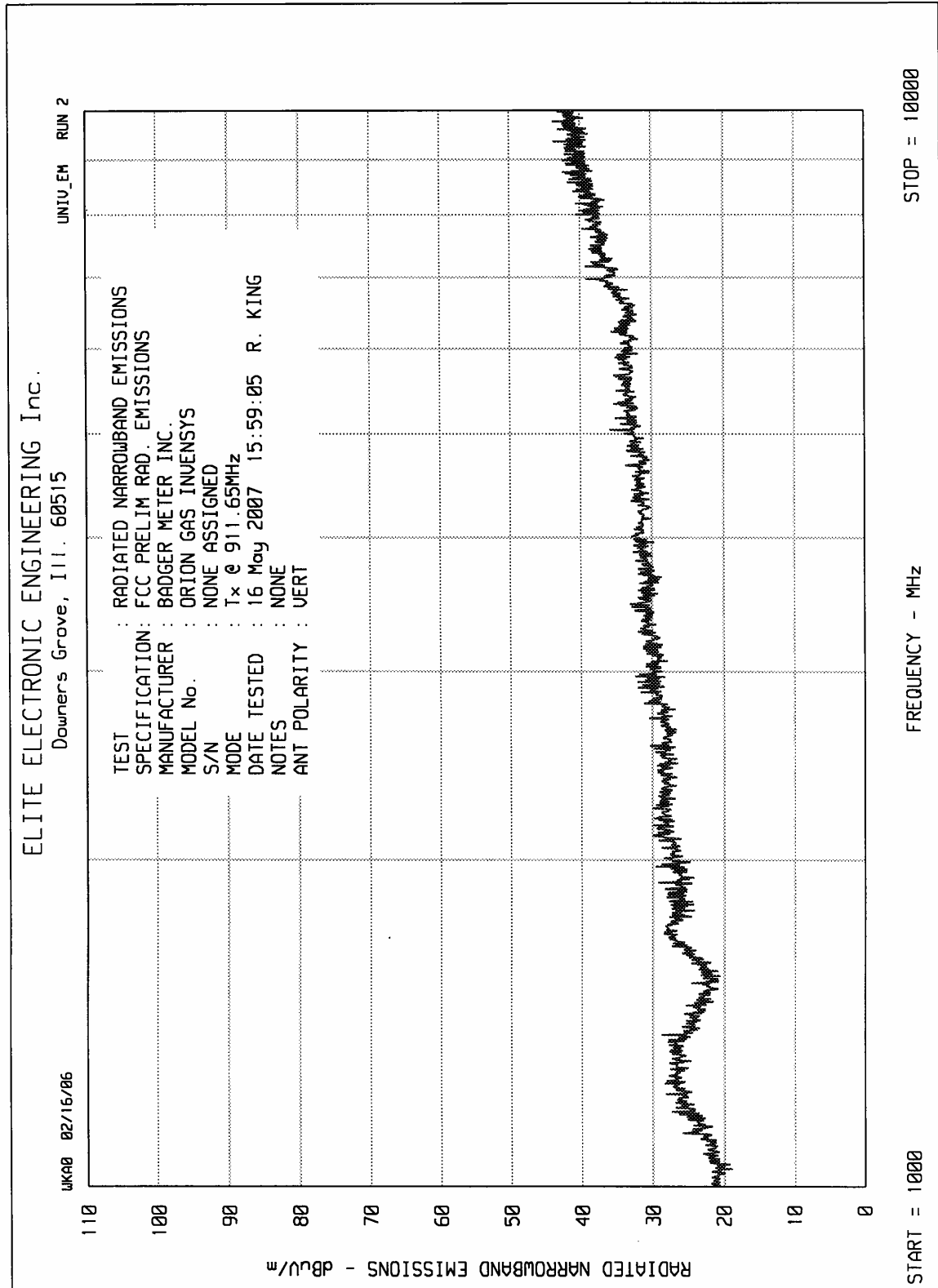
FCC 15.247 Bandedge Compliance Measurement

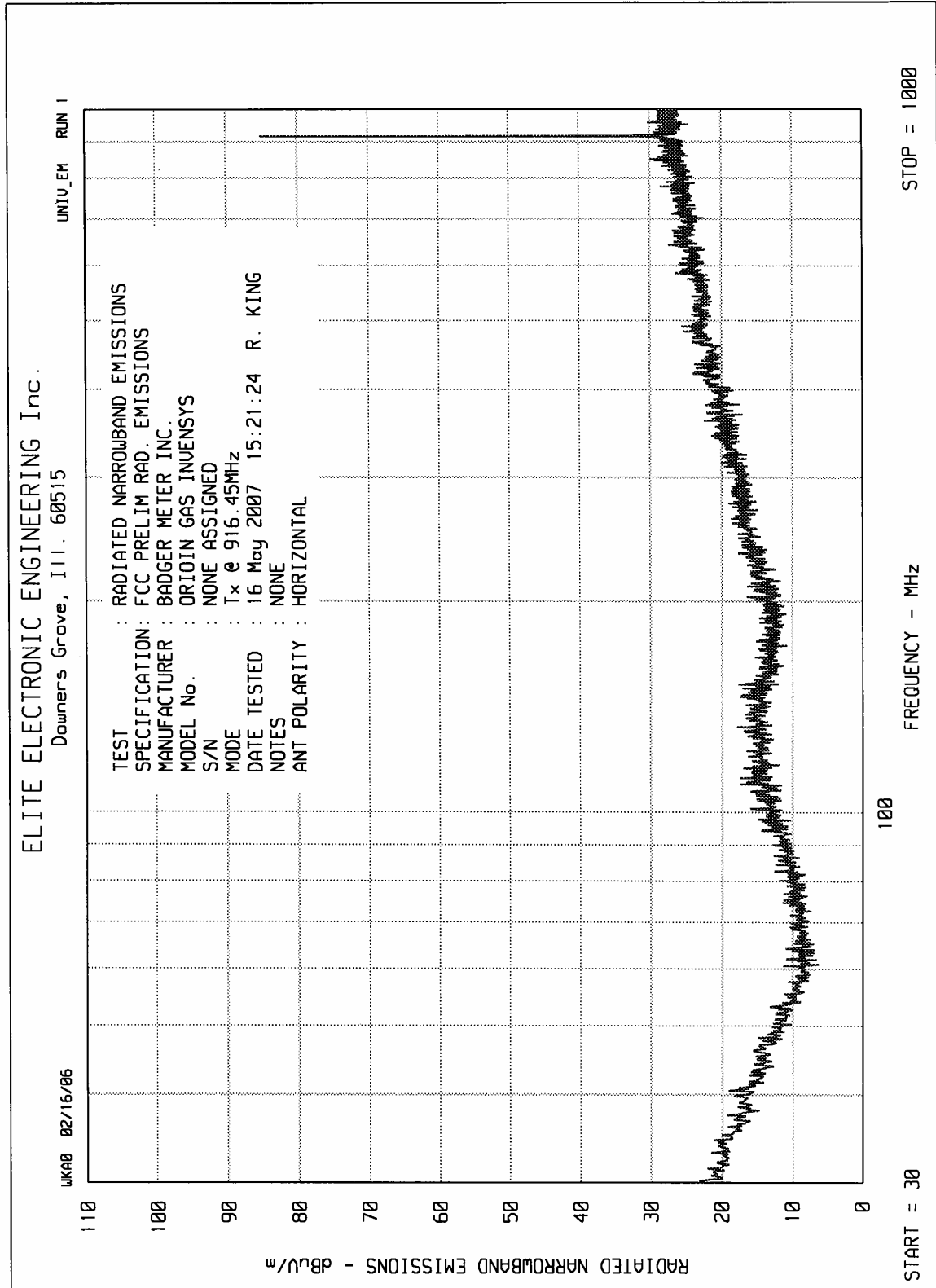
MANUFACTURER : Badger Meter
TEST ITEM : Gas Meter
MODEL NUMBER : Orion Gas Invensys
TEST MODE : Hopping Enabled
NOTES :

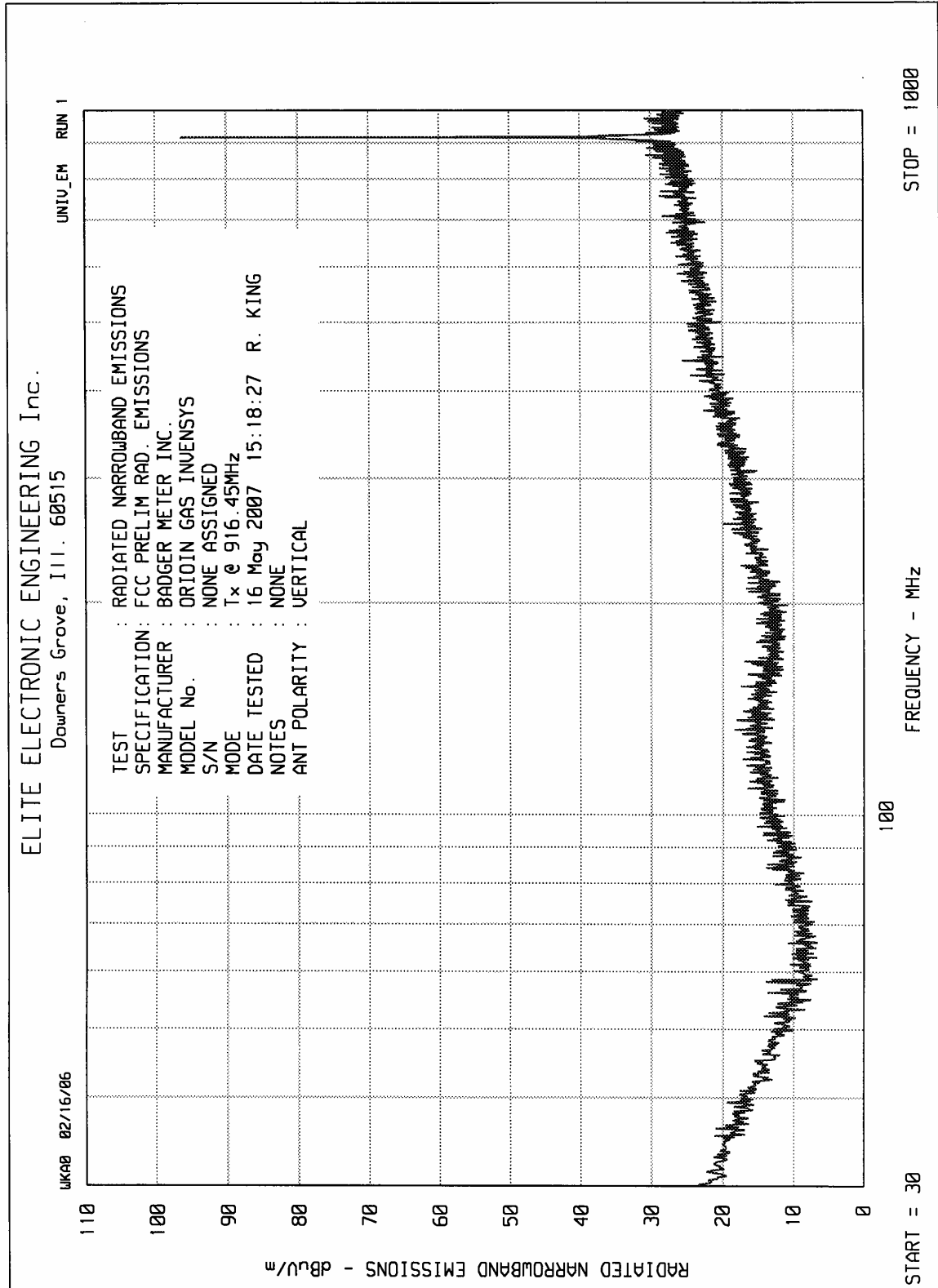


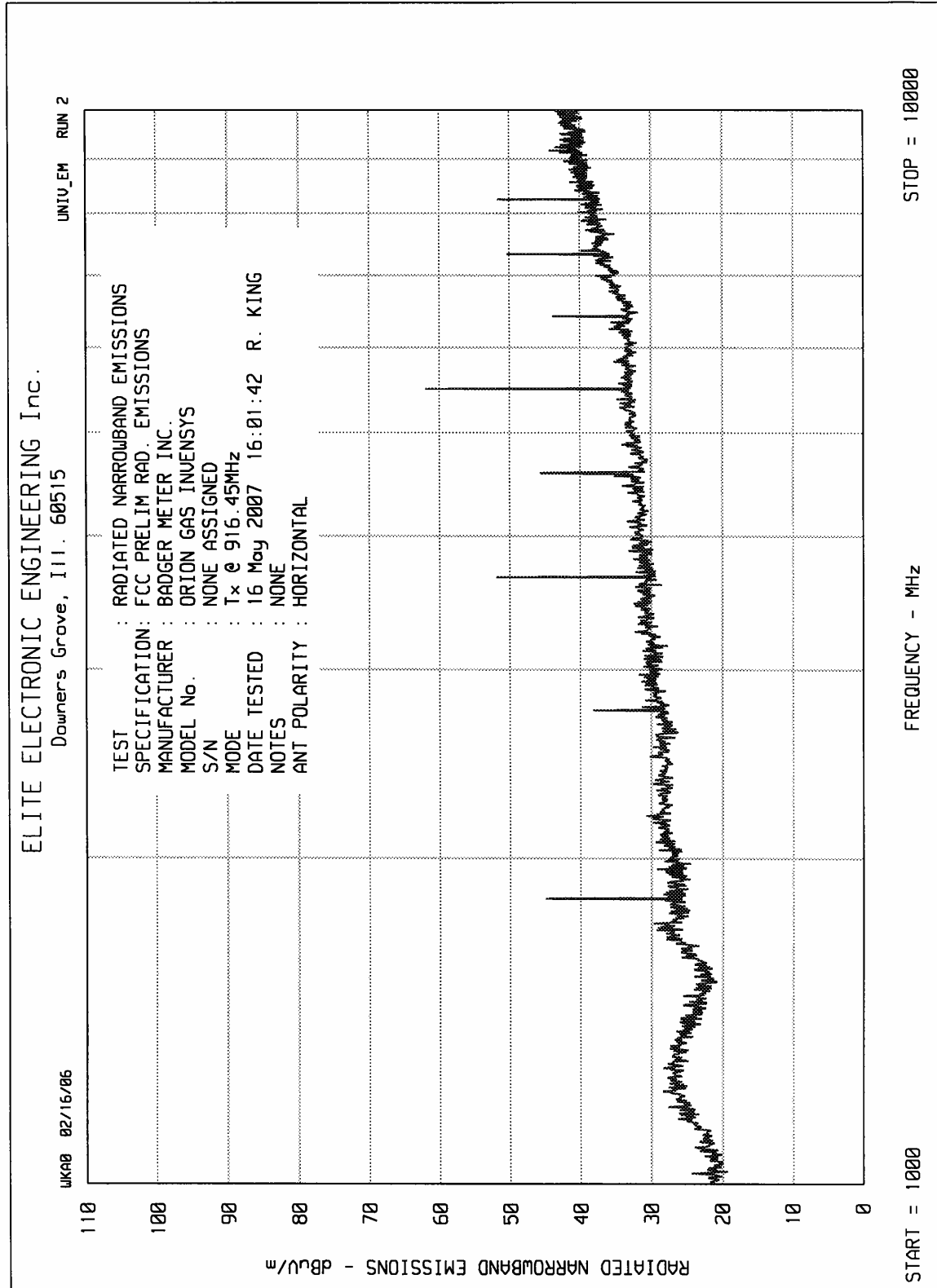


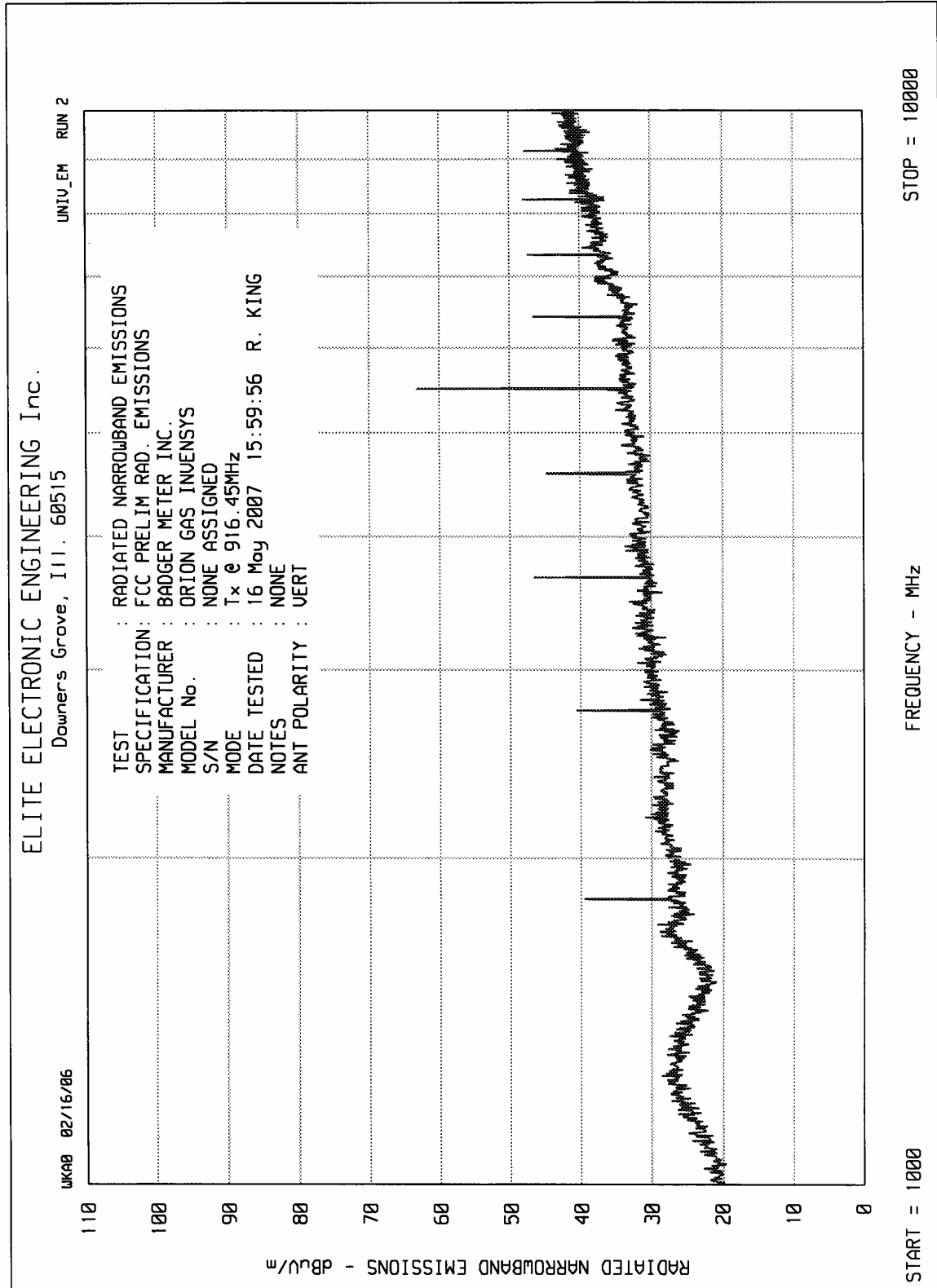


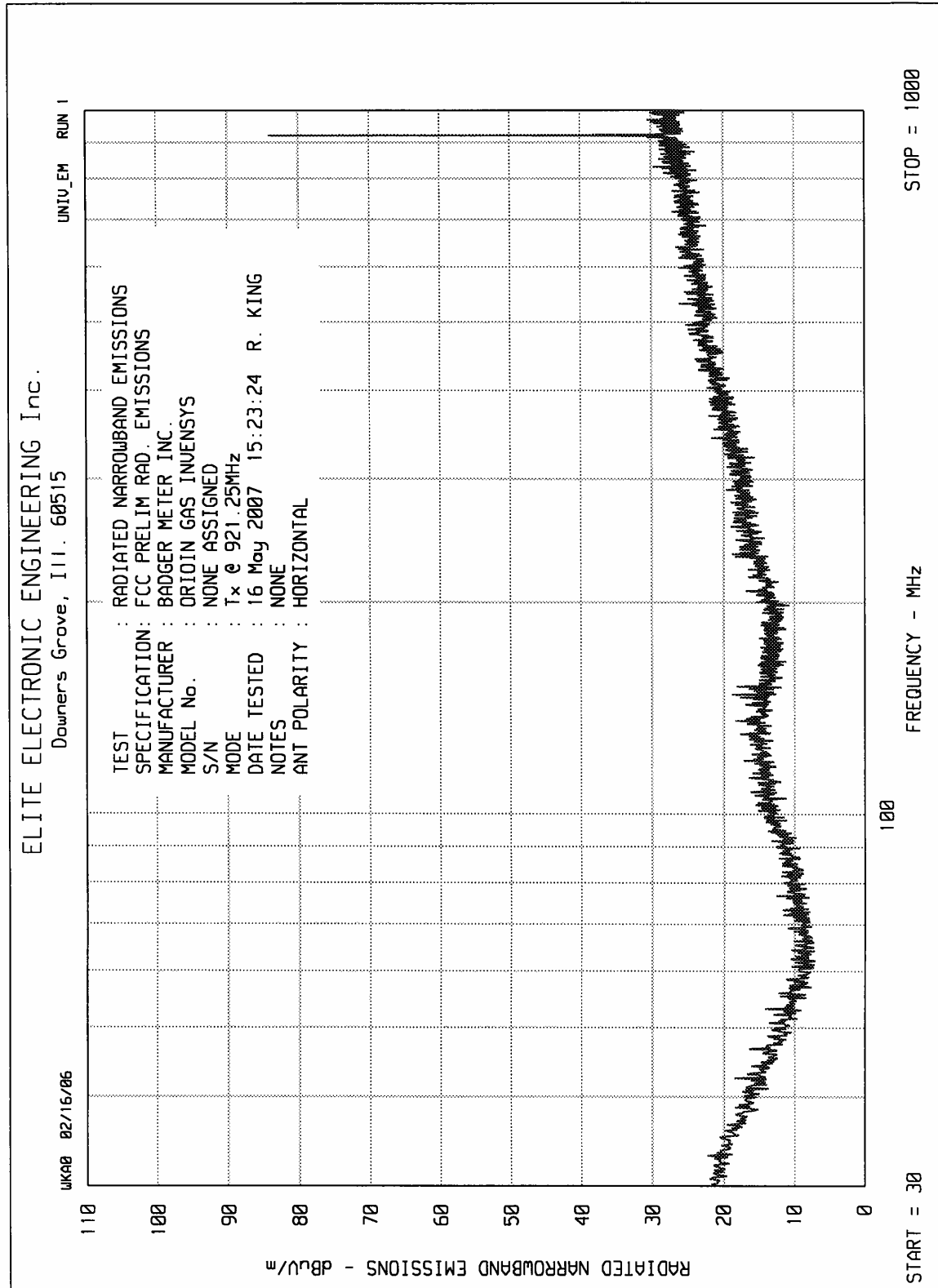


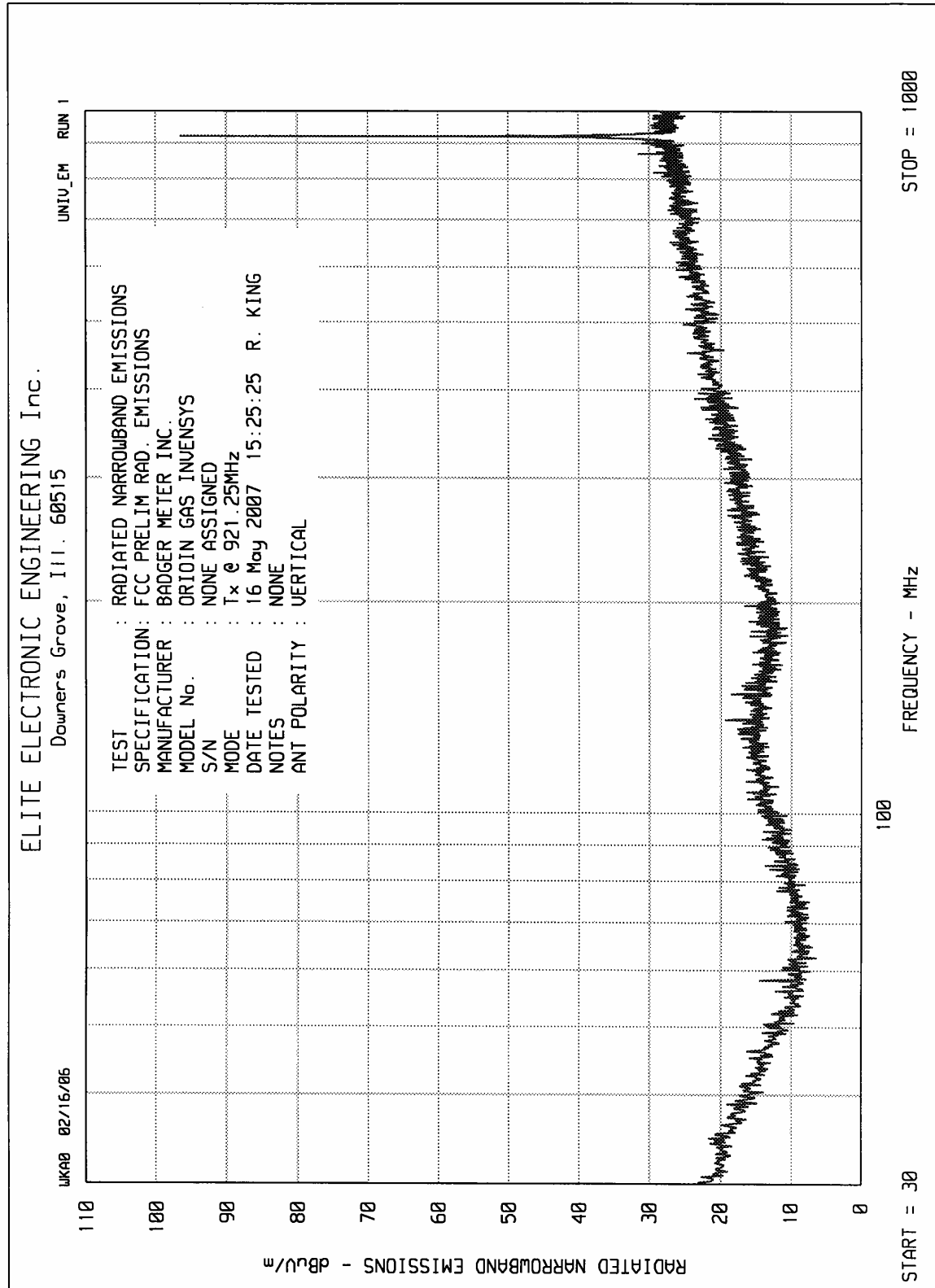


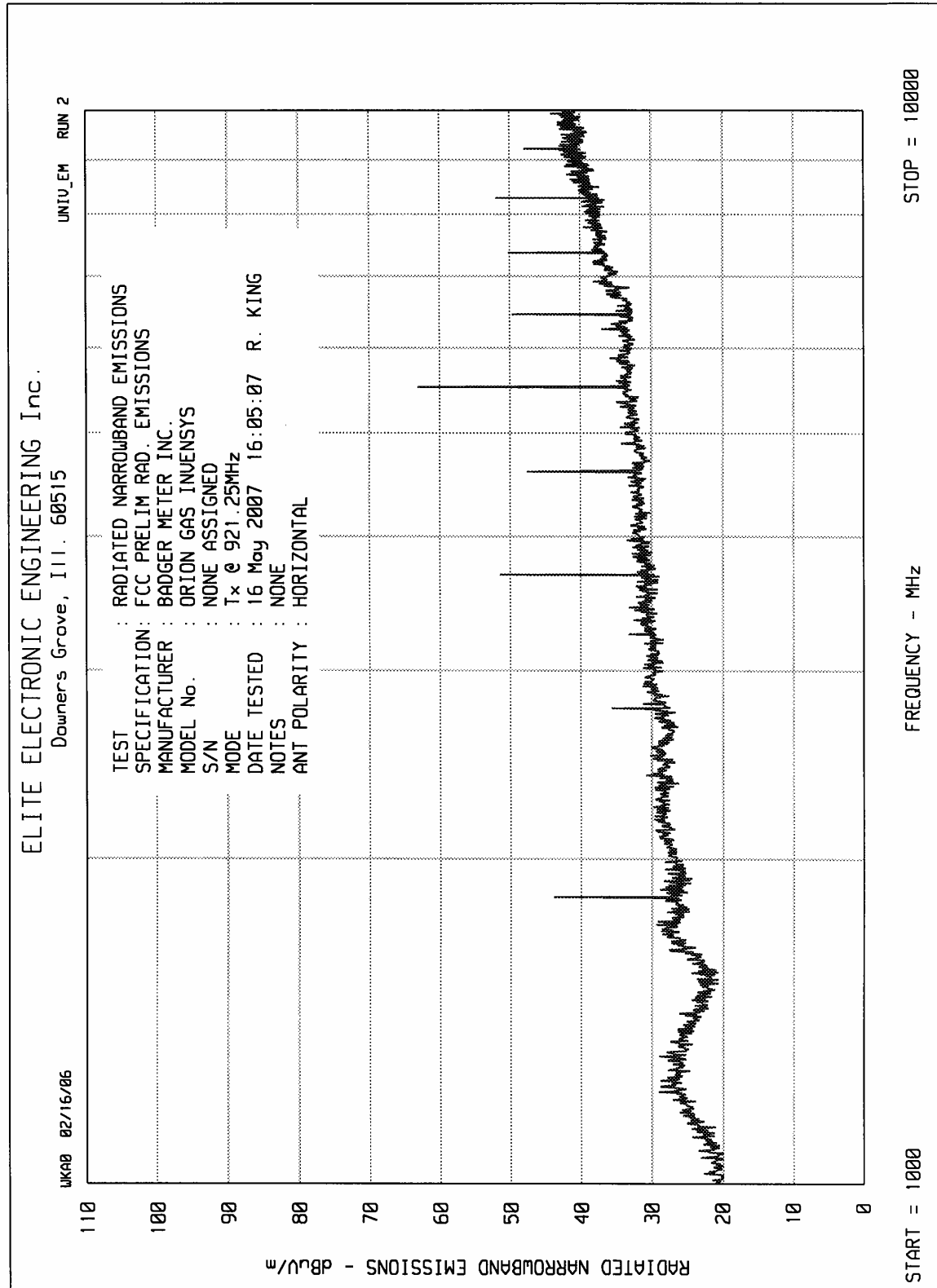


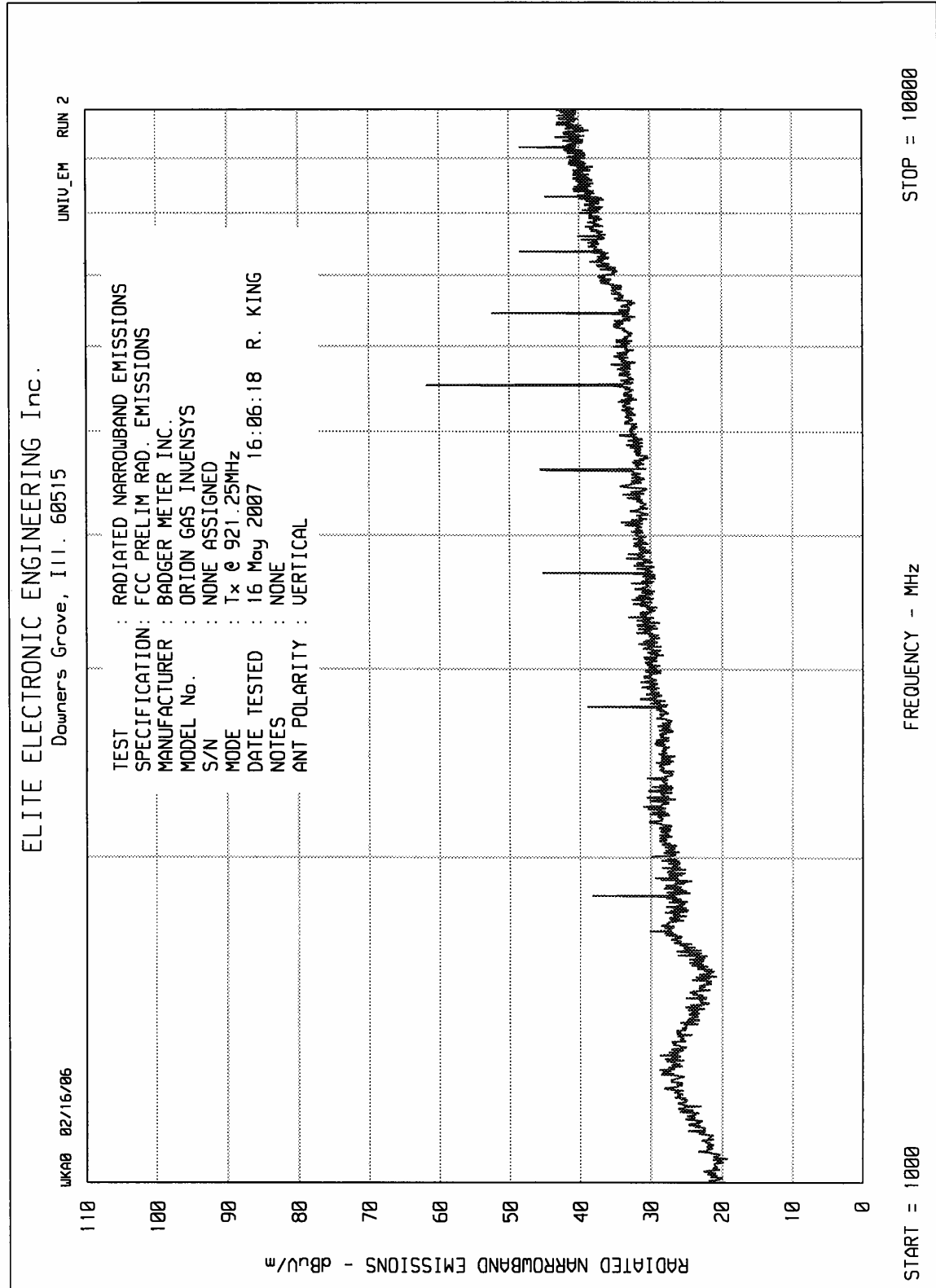














Manufacturer : Badger Meter
Model No. : Orion Gas Invensys Transmitter
Serial No. : None Assigned
Test Specification : FCC Part 15, Subpart C, Section 15.247, Radiated Emissions
Date : May 16, 2007
Mode : Transmit @ 911.65MHz,
Test Distance : 3 meters
Notes : Peak Detector

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
911.65	H	69.5		1.9	27.7	0.0	99.1	90273.1	
911.65	V	74.2		1.9	27.7	0.0	103.8	154902.6	
1823.30	H	52.7		2.9	28.1	-36.3	47.4	233.6	15490.3
1823.30	V	54.4		2.9	28.1	-36.3	49.1	284.0	15490.3
2734.95	H	49.4		3.8	31.4	-35.9	48.7	272.8	5000.0
2734.95	V	45.8		3.8	31.4	-35.9	45.1	180.2	5000.0
3646.60	H	56.6		4.4	32.5	-35.5	58.0	792.4	5000.0
3646.60	V	54.8		4.4	32.5	-35.5	56.2	644.0	5000.0
4558.25	H	50.5		4.8	33.0	-35.3	53.0	446.8	5000.0
4558.25	V	50.6		4.8	33.0	-35.3	53.1	452.0	5000.0
5469.90	H	62.6		5.2	35.4	-35.2	68.0	2519.3	15490.3
5469.90	V	63.5		5.2	35.4	-35.2	68.9	2794.4	15490.3
6381.55	H	53.2		5.9	36.1	-35.3	60.0	995.5	15490.3
6381.55	V	56.3		5.9	36.1	-35.3	63.1	1422.5	15490.3
7293.20	H	48.7		6.7	37.7	-35.6	57.5	750.5	5000.0
7293.20	V	48.6		6.7	37.7	-35.6	57.4	741.9	5000.0
8204.85	H	51.0		7.1	37.7	-35.8	60.0	1000.2	5000.0
8204.85	V	48.8		7.1	37.7	-35.8	57.8	776.4	5000.0
9116.50	H	48.0		7.5	38.0	-36.2	57.3	732.7	5000.0
9116.50	V	46.1		7.5	38.0	-36.2	55.4	588.8	5000.0

Gray rows indicate restricted bands which must meet the general limits
Total = Meter Reading + Cable Loss + Antenna Factor + Preamp Gain

Checked BY RICHARD E. King :

Richard E. King



Manufacturer : Badger Meter
Model No. : Orion Gas Invensys Transmitter
Serial No. : None Assigned
Test Specification : FCC Part 15, Subpart C, Section 15.247, Radiated Emissions
Date : May 16, 2007
Mode : Transmit @ 911.65MHz
Test Distance : 3 meters
Notes : Peak Detector Used
: Peak readings converted to average readings using the duty cycle correction factor

Frequency MHz	Antenna Polarity	Meter Reading dBuV	Amb.	Cable Loss dB	Antenna Factor dB	Pre Amp Gain dB	Duty Cycle Factor dB	Total dBuV/m	Total uV/m	Limit uV/m
911.65	H	69.5		1.9	27.7	0.0	0.0	99.1	90273.1	
911.65	V	74.2		1.9	27.7	0.0	0.0	103.8	154902.6	
1823.30	H	52.7		2.9	28.1	-36.3	0.0	47.4	233.6	15490.3
1823.30	V	54.4		2.9	28.1	-36.3	0.0	49.1	284.0	15490.3
2734.95	H	49.4		3.8	31.4	-35.9	-35.0	13.7	4.9	500.0
2734.95	V	45.8		3.8	31.4	-35.9	-35.0	10.1	3.2	500.0
3646.60	H	56.6		4.4	32.5	-35.5	-35.0	23.0	14.1	500.0
3646.60	V	54.8		4.4	32.5	-35.5	-35.0	21.2	11.5	500.0
4558.25	H	50.5		4.8	33.0	-35.3	-35.0	18.0	7.9	500.0
4558.25	V	50.6		4.8	33.0	-35.3	-35.0	18.1	8.0	500.0
5469.90	H	62.6		5.2	35.4	-35.2	0.0	68.0	2519.3	15490.3
5469.90	V	63.5		5.2	35.4	-35.2	0.0	68.9	2794.4	15490.3
6381.55	H	53.2		5.9	36.1	-35.3	0.0	60.0	995.5	15490.3
6381.55	V	56.3		5.9	36.1	-35.3	0.0	63.1	1422.5	15490.3
7293.20	H	48.7		6.7	37.7	-35.6	-35.0	22.5	13.3	500.0
7293.20	V	48.6		6.7	37.7	-35.6	-35.0	22.4	13.2	500.0
8204.85	H	51.0		7.1	37.7	-35.8	-35.0	25.0	17.8	500.0
8204.85	V	48.8		7.1	37.7	-35.8	-35.0	22.8	13.8	500.0
9116.50	H	48.0		7.5	38.0	-36.2	-35.0	22.3	13.0	500.0
9116.50	V	46.1		7.5	38.0	-36.2	-35.0	20.4	10.5	500.0

Gray rows indicate restricted bands which must meet the general limits

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

Checked BY RICHARD E. KING :

Richard E. King



Manufacturer : Badger Meter
Model No. : Orion Gas Invensys Transmitter
Serial No. : None Assigned
Test Specification : FCC Part 15, Subpart C, Section 15.247, Radiated Emissions
Date : May 16, 2007
Mode : Transmit @ 916.45MHz,
Test Distance : 3 meters
Notes : Peak Detector

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	67.3		2.0	27.8	0.0	0.0	97.0	70786.7
916.45	V	74.3		2.0	27.8	0.0	0.0	104.0	159386.6
1832.90	H	50.3		2.9	28.1	-36.3	0.0	45.0	178.3
1832.90	V	49.2		2.9	28.1	-36.3	0.0	43.9	157.1
2749.35	H	46.0		3.8	31.5	-35.9	0.0	45.4	185.7
2749.35	V	56.7		3.8	31.5	-35.9	0.0	56.1	636.6
3665.80	H	58.4		4.4	32.6	-35.5	0.0	59.8	981.1
3665.80	V	56.1		4.4	32.6	-35.5	0.0	57.5	752.8
4582.25	H	53.0		4.8	33.0	-35.3	0.0	55.6	601.6
4582.25	V	51.9		4.8	33.0	-35.3	0.0	54.5	530.0
5498.70	H	64.1		5.3	35.5	-35.2	0.0	69.6	3024.1
5498.70	V	64.0		5.3	35.5	-35.2	0.0	69.5	2989.4
6415.15	H	52.9		5.9	36.2	-35.3	0.0	59.7	966.5
6415.15	V	56.3		5.9	36.2	-35.3	0.0	63.1	1429.6
7331.60	H	46.9		6.7	37.8	-35.6	0.0	55.8	616.9
7331.60	V	38.7		6.7	37.8	-35.6	0.0	47.6	240.0
8248.05	H	43.0		7.1	37.7	-35.8	0.0	52.0	399.8
8248.05	V	41.3		7.1	37.7	-35.8	0.0	50.3	328.7
9164.50	H	48.0		7.5	38.1	-36.3	0.0	57.3	732.5
9164.50	V	45.8		7.5	38.1	-36.3	0.0	55.1	568.6

Gray rows indicate restricted bands which must meet the general limits
Total = Meter Reading + Cable Loss + Antenna Factor + Preamp Gain

Checked BY RICHARD E. KING :

Richard E. King



Manufacturer : Badger Meter
Model No. : Orion Gas Invensys Transmitter
Serial No. : None Assigned
Test Specification : FCC Part 15, Subpart C, Section 15.247, Radiated Emissions
Date : May 16, 2007
Mode : Transmit @ 916.45MHz
Test Distance : 3 meters
Notes : Peak Detector Used
: Peak readings converted to average readings using the duty cycle correction factor

Frequency MHz	Antenna Polarity	Meter Reading dBuV	Amb.	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	67.3		2.0	27.8	0.0	0.0	97.0	70786.7	
916.45	V	74.3		2.0	27.8	0.0	0.0	104.0	159386.6	
1832.90	H	50.3		2.9	28.1	-36.3	0.0	45.0	178.3	15938.7
1832.90	V	49.2		2.9	28.1	-36.3	0.0	43.9	157.1	15938.7
2749.35	H	46.0		3.8	31.5	-35.9	-35.0	10.4	3.3	500.0
2749.35	V	56.7		3.8	31.5	-35.9	-35.0	21.1	11.3	500.0
3665.80	H	58.4		4.4	32.6	-35.5	-35.0	24.8	17.4	500.0
3665.80	V	56.1		4.4	32.6	-35.5	-35.0	22.5	13.4	500.0
4582.25	H	53.0		4.8	33.0	-35.3	-35.0	20.6	10.7	500.0
4582.25	V	51.9		4.8	33.0	-35.3	-35.0	19.5	9.4	500.0
5498.70	H	64.1		5.3	35.5	-35.2	0.0	69.6	3024.1	15938.7
5498.70	V	64.0		5.3	35.5	-35.2	0.0	69.5	2989.4	15938.7
6415.15	H	52.9		5.9	36.2	-35.3	0.0	59.7	966.5	15938.7
6415.15	V	56.3		5.9	36.2	-35.3	0.0	63.1	1429.6	15938.7
7331.60	H	46.9		6.7	37.8	-35.6	-35.0	20.8	11.0	500.0
7331.60	V	38.7		6.7	37.8	-35.6	-35.0	12.6	4.3	500.0
8248.05	H	43.0		7.1	37.7	-35.8	-35.0	17.0	7.1	500.0
8248.05	V	41.3		7.1	37.7	-35.8	-35.0	15.3	5.8	500.0
9164.50	H	48.0		7.5	38.1	-36.3	-35.0	22.3	13.0	500.0
9164.50	V	45.8		7.5	38.1	-36.3	-35.0	20.1	10.1	500.0

Gray rows indicate restricted bands which must meet the general limits

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

Checked BY RICHARD E. KING :

Richard E. King



Manufacturer : Badger Meter
Model No. : Orion Gas Invensys Transmitter
Serial No. : None Assigned
Test Specification : FCC Part 15, Subpart C, Section 15.247, Radiated Emissions
Date : May 16, 2007
Mode : Transmit @ 921.25MHz
Test Distance : 3 meters
Notes : Peak Detector

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
921.25	H	66.0		2.0	27.9	0.0	95.9	62203.4	
921.25	V	70.7		2.0	27.9	0.0	100.6	107229.5	
1842.50	H	49.1		2.9	28.2	-36.3	43.9	156.3	10722.9
1842.50	V	51.4		2.9	28.2	-36.3	46.2	203.7	10722.9
2763.75	H	49.5		3.8	31.5	-35.9	48.9	279.8	5000.0
2763.75	V	47.2		3.8	31.5	-35.9	46.6	214.7	5000.0
3685.00	H	58.9		4.4	32.6	-35.5	60.4	1045.9	5000.0
3685.00	V	56.3		4.4	32.6	-35.5	57.8	775.3	5000.0
4606.25	H	54.3		4.8	33.1	-35.3	57.0	705.3	5000.0
4606.25	V	53.9		4.8	33.1	-35.3	56.6	673.5	5000.0
5527.50	H	64.3		5.3	35.5	-35.2	69.9	3111.1	10722.9
5527.50	V	68.0		5.3	35.5	-35.2	73.6	4763.3	10722.9
6448.75	H	50.8		6.0	36.2	-35.3	57.6	762.7	10722.9
6448.75	V	57.5		6.0	36.2	-35.3	64.3	1649.5	10722.9
7370.00	H	51.1		6.7	37.9	-35.6	60.1	1011.6	5000.0
7370.00	V	50.0		6.7	37.9	-35.6	59.0	891.3	5000.0
8291.25	H	50.9		7.2	37.7	-35.8	60.0	996.8	5000.0
8291.25	V	48.3		7.2	37.7	-35.8	57.4	739.0	5000.0
9212.50	H	48.2		7.5	38.1	-36.3	57.5	749.3	5000.0
9212.50	V	46.1	*	7.5	38.1	-36.3	55.4	588.4	5000.0

Gray rows indicate restricted bands which must meet the general limits

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

Checked BY RICHARD E. KING :

Richard E. King



Manufacturer : Badger Meter
Model No. : Orion Gas Invenys Transmitter
Serial No. : None Assigned
Test Specification : FCC Part 15, Subpart C, Section 15.247, Radiated Emissions
Date : May 16, 2007
Mode : Transmit @ 921.25MHz
Test Distance : 3 meters
Notes : Peak Detector Used
: 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
921.65	H	66.0		2.0	27.9	0.0	0.0	95.9	62203.4	
921.65	V	70.7		2.0	27.9	0.0	0.0	100.6	107229.5	
1843.30	H	49.1		2.9	27.6	-36.3	0.0	43.3	147.0	10722.9
1843.30	V	51.4		2.9	27.6	-36.3	0.0	45.6	191.6	10722.9
2764.95	H	49.5		3.8	30.4	-35.9	-35.0	12.8	4.3	500.0
2764.95	V	47.2		3.8	30.4	-35.9	-35.0	10.5	3.3	500.0
3686.60	H	58.9		4.4	34.0	-35.5	-35.0	26.8	21.8	500.0
3686.60	V	56.3		4.4	34.0	-35.5	-35.0	24.2	16.2	500.0
4608.25	H	54.3		4.8	34.2	-35.3	-35.0	23.1	14.3	500.0
4608.25	V	53.9		4.8	34.2	-35.3	-35.0	22.7	13.6	500.0
5529.90	H	64.3		5.3	36.5	-35.2	0.0	70.8	3485.2	10722.9
5529.90	V	68.0		5.3	36.5	-35.2	0.0	74.5	5336.1	10722.9
6451.55	H	50.8		6.0	36.1	-35.3	0.0	57.6	756.7	10722.9
6451.55	V	57.5		6.0	36.1	-35.3	0.0	64.3	1636.5	10722.9
7373.20	H	51.1		6.7	38.3	-35.6	-35.0	25.6	19.0	500.0
7373.20	V	50.0		6.7	38.3	-35.6	-35.0	24.5	16.7	500.0
8294.85	H	50.9		7.2	37.8	-35.8	-35.0	25.1	17.9	500.0
8294.85	V	48.3		7.2	37.8	-35.8	-35.0	22.5	13.3	500.0
9216.50	H	48.2		7.5	38.5	-36.3	-35.0	22.9	14.0	500.0
9216.50	V	46.1	*	7.5	38.5	-36.3	-35.0	20.8	11.0	500.0

Gray rows indicate restricted bands which must meet the general limits

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

Checked BY RICHARD E. KING :

Richard E. King