Measurement of RF Interference from an Orion SE Mobile Transceiver

For : Badger Meter, Inc.
: 4545 W. Brown Deer Road
: Milwaukee, WI

P.O. No. : 555006
Date Received : October 13, 2010
Date Tested : October 13, 2010 through December 15, 2010
Test Personnel : Brandon Lugo, Richard E. King, Daniel Crowder
Specification : FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.207 and 15.247 for Frequency Hopping Spread Spectrum Intentional Radiators Operating within the band 902-928MHz
FCC “Code of Federal Regulations” Title 47, Part15, Subpart 15B, Section 15.107 and 15.109 for Receivers
Industry Canada RSS-210
Industry Canada RSS-GEN

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REVISION HISTORY

Revision	Date	Description
—	1-6-2011	Initial release

Measurement of RF Emissions from an Orion SE Mobile Transceiver

1 INTRODUCTION

1.1 Scope of Tests

This document represents the results of the series of radio interference measurements performed on a Badger Meter, Inc. Orion SE Mobile Transceiver, (hereinafter referred to as the EUT). No serial number was assigned to the EUT. The EUT is a frequency hopping spread spectrum transceiver. The transceiver was designed to transmit and receive in the 902-928 MHz band using a removable magnetic mount monopole antenna. The antenna was an Antenex Laird model B8965C 5dBi closed collinear antenna. The EUT contained a super-heterodyne type receiver. The EUT 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 EUT meets the conducted and radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B, Sections 15.107 and 15.109, for receivers and Subpart C, Sections 15.207 and 15.249 for Intentional Radiators Operating within the 902-928 MHz band.

The test series was also performed to determine if the EUT meets the conducted and radiated RF emission requirements of the Industry Canada Radio Standards Specification, RSS-Gen, Section 7.2.2 and Section 7.2.3 for receivers and the Industry Canada Radio Standards Specification RSS-Gen Section 7.2.2 and RSS-210 Annex 2, section A2.9 for Transmitters.

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 EMC Laboratory Identification

This series of tests was performed by Elite Electronic Engineering Incorporated of Downers Grove, Illinois. The laboratory is accredited by the National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP). NVLAP Lab Code: 100278-0.

1.5 Laboratory Conditions

The temperature at the time of the test was 22°C and the relative humidity was 45%.

2 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, Subparts B and C, dated 1 October 2009
- 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"
- FCC Public Notice, DA 00-705, "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems", Released March 30, 2000
- Industry Canada RSS-210, Issue 7, June 2007, “Spectrum Management and Telecommunications Radio Standards Specification, Low-power License-exempt radio communication devices (All Frequency Bands): Category I Equipment”
- Industry Canada RSS-GEN, Issue 2, June 2007, “Spectrum Management and Telecommunications Radio Standards Specification, General Requirements and Information for the Certification of radio communication equipment”

3 EUT SETUP AND OPERATION

3.1 General Description

The EUT is an Orion SE Mobile Transceiver. A block diagram of the EUT setup is shown as Figure 1.

3.1.1 Power Input

The EUT typically receives 13.8VDC from an automotive battery.

3.1.2 Peripheral Equipment

No peripheral equipment was submitted with the EUT.

3.1.3 Interconnect Cables

The following interconnect cables were submitted with the EUT:

Item	Description
USB Cable	Unterminated 6 foot USB cable connected to the USB port of the EUT
Antenna	Antenex Laird model B8965C antenna was connected to the antenna port of the EUT

3.1.4 Grounding

The EUT was not grounded during the tests.

3.2 Operational Mode

For all tests, the EUT was placed on an 80cm high non-conductive stand. The EUT was energized. The unit was programmed to operate in one of the following modes:

- Transmit at 904.9MHz (Channel 1)
- Transmit at 913.9MHz (Channel 24)
- Transmit at 923.7MHz (Channel 48)
- Receive at 904.9MHz (Channel 1)
- Receive at 913.9MHz (Channel 24)
- Receive at 923.7MHz (Channel 48)
- Frequency Hopping Enabled

3.3 EUT Modifications

No modifications were required for compliance.

4 TEST FACILITY AND TEST INSTRUMENTATION

4.1 Shielded Enclosure

All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined 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. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4-2003 for site attenuation.

4.2 Test Instrumentation

The test instrumentation and auxiliary equipment used during the tests are listed in Table 9-1.

The receiver allows measurements with the bandwidths and detectors specified by the FCC.

4.3 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).

4.4 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 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

5 TEST PROCEDURES

5.1 Receiver

5.1.1 Radiated Measurements

5.1.1.1 Requirements

Per the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B, Section 15.109(a) and Industry Canada RSS-Gen, Section 7.2.3, all radio frequency emissions from a receiver shall be below the limits shown on the following table:

RADIATION LIMITS FOR A RECEIVER

Frequency MHz	Distance between EUT And Antenna in Meters	Field Strength uV/m	Field Strength dBuV/m
30-88	3	100	40
88-216	3	150	43.5
216-960	3	200	46
Above 960	3	500	54

Note: The tighter limit shall apply at the edge between the two frequency bands.

5.1.1.2 Procedures

Testing was performed separately on low, middle, and high channels. The emissions in the frequency range of 30MHz to 5GHz were measured and plotted using a ‘screen-dump’ utility. Testing was performed with the antenna of the EUT in place.

All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. The walls and ceiling of the shielded chamber are lined with ferrite tiles. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4-2003 for site attenuation.

The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the

enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads.

Since a quasi-peak detector and an average detector require long integration times, it is not practical to automatically sweep through the quasi-peak and average levels. Therefore, radiated emissions from the EUT were first scanned using a peak detector and automatically plotted. The frequencies where significant emission levels were noted were then remeasured using the quasi-peak detector or average detector.

The broadband measuring antenna was positioned at a 3 meter distance from the EUT. The frequency range from 30MHz to 1GHz was investigated using a peak detector function with the bilog antenna at several heights, horizontal and vertical polarization, and with several different orientations of the EUT with respect to the antenna. The frequency range from 1GHz to 5GHz was investigated using a peak detector function with the double ridged waveguide antenna at several heights, horizontal and vertical polarization, and with several different orientations of the EUT with respect to the antenna. The maximum levels for each antenna polarization were plotted.

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

1) Measurements from 30MHz to 1GHz were made using a quasi-peak detector and a broadband bilog antenna. Measurements above 1GHz were made using a peak detector and a broadband double ridged waveguide antenna.
2) To ensure that maximum or worst case, emission levels were measured, the following steps were taken:
    a) The EUT was rotated so that all of its sides were exposed to the receiving antenna.
    b) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.
    c) The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.
    d) For hand-held or body-worn devices, the EUT was rotated through three orthogonal axes to determine which orientation produces the highest emission relative to the limit.

5.1.1.3 Results

The preliminary plots are presented on pages 19 through 24. The plots are presented for a reference only, and are not used to determine compliance. The final radiated levels are presented on pages 25 through 27. As can be seen from the data, all emissions measured from the EUT were within the specification limits. Photographs of the test configuration which yielded the highest or worst case, radiated emission levels are shown on Figure 2 and Figure 3.

5.2 Transmitter

5.2.1 20dB Bandwidth

5.2.1.1 Requirements

Per 15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. 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. If the 20dB bandwidth of the hopping channel is less than 250kHz, the system shall use at least 50 hopping channels. If the 20dB bandwidth of the hopping channel is 250kHz or greater (but not greater than 500kHz), the system shall use at least 25 hopping channels.

5.2.1.2 Procedures

The antenna port of the EUT was connected to the input of the spectrum analyzer through 40dB of attenuation.

With the hopping function disabled, the EUT 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 ≥ 1% of the 20 dB BW. The span was set to approximately 2 to 3 times the 20 dB bandwidth.

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.

5.2.1.3 Results

The plots on pages 28 through 30 show that the maximum 20 dB bandwidth was 306.1kHz. The 99% bandwidth was measured to be 290.6kHz. Therefore, since the 20dB bandwidth of the hopping channel is 250kHz or greater, but not greater than 500kHz, the system shall use at least 25 hopping channels.

5.2.2 Carrier Frequency Separation

5.2.2.1 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.

5.2.2.2 Procedures

The EUT was setup inside the chamber. With the hopping function enabled, the EUT 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 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.

5.2.2.3 Results

Page 31 shows the carrier frequency separation. As can be seen from this plot, the carrier frequency separation is 400.3kHz, which is greater than the 20dB bandwidth (306.1kHz).

5.2.3 Number of Hopping Frequencies

5.2.3.1 Requirements

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. If the 20dB bandwidth of the hopping channel is less than 250kHz, the system shall use at least 50 hopping channels. If the 20dB bandwidth of the hopping channel is 250kHz or greater (but not greater than 500kHz), the system shall use at least 25 hopping channels.

5.2.3.2 Procedures

The EUT was setup inside the chamber. With the hopping function enabled, the EUT 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 EUT'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.

5.2.3.3 Results

Page 32 shows the number of hopping frequencies. As can be seen from this plot, the number of hopping frequencies is 48 which is greater than 25 which is the minimum number of required hopping frequencies for systems with a 20dB bandwidth greater than 250kHz.

5.2.4 Time of Occupancy

5.2.4.1 Requirements

Per section 15.247(a)(1)(i), for frequency hopping systems operating in the 902-928MHz band, if the 20dB bandwidth of the hopping channel is 250kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

5.2.4.2 Procedures

The EUT was setup inside the chamber. With the hopping function enabled, the EUT was allowed to transmit continuously. The resolution bandwidth (RBW) was set to 1 MHz. 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. The analyzer's display was plotted using a 'screen dump' utility. Then, the sweep time was expanded to 10 seconds.

5.2.4.3 Results

Pages 33 and 34 show the plots for the time of occupancy (10.6ms). As can be seen from the plots, the time of occupancy can be determined by 10.6ms multiplied by 2 hops. This calculated value is equal to 0.021 seconds, which is less than the 0.4 seconds maximum allowed.

5.2.5 Antenna Conducted Peak Output Power

5.2.5.1 Requirements

Per section 15.247(b)(2), for frequency hopping systems operating in the 902-928MHz band and employing less than 50 hopping channels, but at least 25 hopping channels, the maximum peak output conducted power shall not be greater than 0.25W (24dBm).

5.2.5.2 Procedures

The output of the EUT was connected to the spectrum analyzer through 30dB of attenuation. With the hopping function disabled, the EUT 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 greater than the 20dB bandwidth. The span was set to approximately 5 times the 20 dB bandwidth. The 'Max-Hold' function was engaged. The maximum meter reading was recorded. The peak power output was calculated for the low, middle and high hopping frequencies.

5.2.5.3 Results

The results are presented on pages 35 through 37. The maximum peak conducted output power from the transmitter was 7.2mW (8.6 dBm) which is below the 0.25 Watts limit.

5.2.6 Effective Isotropic Radiated Power (EIRP)

5.2.6.1 Requirements

Per section 15.247(b)(2), for frequency hopping systems operating in the 902-928MHz band and employing less than 50 hopping channels, but at least 25 hopping channels, the maximum peak output conducted power shall not be greater than 0.25W (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). If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below 24dBm by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.2.6.2 Procedures

The EUT 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 EUT. The resolution bandwidth (RBW) of the spectrum analyzer was set to greater than the 20dB bandwidth. The span was set to approximately 5 times the 20 dB bandwidth. The EUT 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, a second dipole antenna was then set in place of the EUT 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 low, middle, and high hopping frequencies.

5.2.6.3 Results

The results are presented on page 38. The maximum EIRP measured from the transmitter was 8.6mW (8.2dBm) which is below the 1 Watt limit.

5.2.7 Antenna Conducted Spurious Emissions

5.2.7.1 Requirements

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.

5.2.7.2 Procedures

The output of the EUT was connected to the spectrum analyzer through 30dB of attenuation. The frequency hopping function was disabled. The resolution bandwidth (RBW) was set to 100kHz. The peak detector and 'Max-Hold' function were engaged. The emissions in the frequency range from 30MHz to 10GHz were observed and plotted separately with the EUT transmitting at low, middle and high hopping frequencies.

5.2.7.3 Results

The results of the antenna conducted emissions levels were plotted. These plots are presented on pages 39 through 47. These plots show that the spurious emissions were at least 20 dB below the level of the fundamental.

5.2.8 Radiated Spurious Emissions Measurements

5.2.8.1 Requirements

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must comply with the radiated emission limits specified in §15.209(a).

Paragraph 15.209(a) has the following radiated emission limits:

Frequency MHz	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30.0-88.0	100	3
88.0-216.0	150	3
216.0-960.0	200	3
Above 960	500	3

5.2.8.2 Procedures

Radiated 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.

Preliminary radiated emissions tests were performed to determine the emission characteristics of the EUT. For the preliminary test, a broadband measuring antenna was positioned at a 3 meter distance from the EUT. The entire frequency range from 30MHz to 10.0GHz was investigated using a peak detector function.

The final open field emission tests were then manually performed over the frequency range of 30MHz to 10.0GHz.

For all emissions in the restricted bands, the following procedure was used:

a) The field strengths of all emissions below 1 GHz were measured using a bi-log antenna. The bi-log antenna was positioned at a 3 meter distance from the EUT. A peak detector with a resolution bandwidth of 100 kHz was used on the spectrum analyzer.

b) The field strengths of all emissions above 1 GHz were measured using a double-ridged waveguide antenna. The waveguide antenna was positioned at a 3 meter distance from the EUT. A peak detector with a resolution bandwidth of 1 MHz was used on the spectrum analyzer.

c) To ensure that maximum or worst case emission levels were measured, the following steps were taken when taking all measurements:

   i) The EUT was rotated so that all of its sides were exposed to the receiving antenna.

   ii) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.

   iii) The measuring antenna was raised and lowered for each antenna polarization to maximize the readings.

   iv) In instances where it was necessary to use a shortened cable between the measuring antenna and the spectrum analyzer. The measuring antenna was not raised or lowered to ensure maximized readings, instead the EUT was rotated through all axis to ensure the maximum readings were recorded for the EUT.

d) For all radiated emissions measurements below 1 GHz, if the peak reading is below the limits listed in 15.209(a), no further measurements are required. If however, the peak readings exceed the limits listed in 15.209(a), then the emissions are remeasured using a quasi-peak detector.

e) For all radiated emissions measurements above 1 GHz, the peak readings must comply with the 15.35(b) limits. 15.35(b) states that when average radiated emissions measurements are specified, there also is a limit on the peak level of the radiated emissions. The limit on the peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test. Therefore, all peak readings above 1 GHz must be no greater than 20 dB above the limits specified in 15.209(a).

f) Next, for all radiated emissions measurements above 1GHz, the resolution bandwidth was set to 1MHz. The analyzer was set to linear mode with a 10Hz video bandwidth in order to simulate an average detector. An average reading was taken. If the dwell time per channel of the hopping signal is less than 100msec, then the reading obtained with the 10 Hz video bandwidth may be further adjusted by a “duty cycle correction factor”, derived from 20*log(dwell time/100msec). These readings must be no greater than the limits specified in 15.209(a).

5.2.8.3 Results

Preliminary radiated emissions plots with the EUT transmitting at low, middle, and high hopping frequencies are shown on pages 48 through 53. Final radiated emissions data are presented on data pages 54 through 59. As

can be seen from the data, all emissions measured from the EUT were within the specification limits. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figure 2 and Figure 3.

5.2.9 Band Edge Compliance

5.2.9.1 Requirements

Per section 15.247(d), the emissions at the band-edges must be at least 20dB below the highest level measured within the band but attenuation below the general limits listed in 15.209(a) is not required.

5.2.9.2 Procedures

5.2.9.2.1 Low Band Edge

1) The output of the EUT was connected to the spectrum analyzer through 30dB of attenuation.
2) The EUT was set to transmit continuously at the channel closest to the low band-edge (hopping function disabled).
3) To determine the band edge compliance, the following spectrum analyzer settings were used:

    a. Center frequency = low band-edge frequency.
    b. Span = Wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, as well as any modulation products which fall outside of the authorized band of operation.
    c. Resolution bandwidth (RBW) ≥ 1% of the span.
    d. The 'Max-Hold' function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined.
    e. The marker was set on the peak of the in-band emissions. A display line was placed 20dB down from the peak of the in-band emissions. All emissions which fall outside of the authorized band of operation must be below the 20dB down display line. (All emissions to the left of the center frequency (band-edge) must be below the display line.)
    f. The analyzer's display was plotted using a 'screen dump' utility.

4) Step 3) was repeated with the frequency hopping function enabled.

5.2.9.2.2 High Band Edge

1) The output of the EUT was connected to the spectrum analyzer through 30dB of attenuation.
2) The EUT was set to transmit continuously at the channel closest to the high band-edge (hopping function disabled).
3) To determine the band edge compliance, the following spectrum analyzer settings were used:

    a. Center frequency = high band-edge frequency.
    b. Span = Wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, as well as any modulation products which fall outside of the authorized band of operation.
    c. Resolution bandwidth (RBW) ≥ 1% of the span.
    d. The 'Max-Hold' function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined.
    e. The marker was set on the peak of the in-band emissions. A display line was placed 20dB down from the peak of the in-band emissions. All emissions which fall outside of the authorized band of operation must be below the 20dB down display line. (All emissions to the right of the center frequency (band-edge) must be below the display line.)
    f. The analyzer's display was plotted using a 'screen dump' utility.

4) Step 3) was repeated with the frequency hopping function enabled

5.2.9.3 Results

Pages 60 through 63 show the conducted band-edge compliance results. As can be seen from these plots, the emissions at the low end band edge and the high end band edge are within the 20 dB down limits.

6 CONCLUSIONS

It was determined that the Badger Meter, Inc. Orion SE Mobile frequency hopping spread spectrum transceiver, Serial No. None Assigned, did fully meet the emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B, Sections 15.107 and 15.109 for receivers and Subpart C, Sections 15.207 and 15.247 for Intentional Radiators Operating within the 902-928 MHz band, when tested per ANSI C63.4-2003.

It was also determined that the Badger Meter, Inc. Orion SE Mobile frequency hopping spread spectrum transceiver, Serial No. None Assigned, did fully meet the emission requirements of the Industry Canada Radio Standards Specification, RSS-Gen, Section 7.2.2 and Section 7.2.3 for receivers and the Industry Canada Radio Standards Specification RSS-Gen Section 7.2.2 and RSS-210 Annex 2, section A2.9 for transmitters, when tested per ANSI C63.4-2003.

7 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 EUT at the test date. Any electrical or mechanical modification made to the EUT subsequent to the specified test date will serve to invalidate the data and void this certification.

8 ENDORSEMENT DISCLAIMER

This report must not be used to claim product endorsement by NVLAP or any agency of the US Government.

9 EQUIPMENT LIST

Table 9-1 Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
APW3	PREAMPLIFIER	PLANAR ELECTRONICS	PE2-35-120-5R0-10-12	PL2924	1GHZ-20GHZ	8/27/2010	8/27/2011
GBR5	SIGNAL GENERATOR	AGILENT TECHNOLOGIES	8648D	4037U00607	0.009-4000MHZ	2/23/2010	2/23/2011
NDQ1	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	313	400-1000MHZ	4/12/2010	4/12/2011
NTA2	BILOG ANTENNA	TESEQ	6112D	28040	25-1000MHz	6/7/2010	6/7/2011
NWH0	RIDGED WAVE GUIDE	TENSOR	4105	2081	1-12.4GHZ	8/31/2010	8/31/2011
RBB0	EMI TEST RECEIVER 20HZ TO 40GHZ	ROHDE & SCHWARZ	ESIB40	100250	20 HZ TO 40GHZ	3/16/2010	3/16/2011
RBD1	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESU40	100009	20Hz-40GHz	8/25/2010	8/25/2011
SES1	24VDC POWER SUPPLY	P TRANS	FS-32024-1M	002	18-27VDC	NOTE 1	
T2DL	20DB, 25W ATTENUATOR	WEINSCHEL	46-20-34	BS0910	DC-18GHZ	8/9/2010	8/9/2011
T2S8	20DB 25W ATTENUATOR	WEINSCHEL	46-20-34	BV3541	DC-18GHZ	1/5/2010	1/5/2011
XPQ2	HIGH PASS FILTER	K&L MICROWAVE	4IH30-1804/T10000-0	3	1.8-10GHZ	10/28/2010	10/28/2011

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.

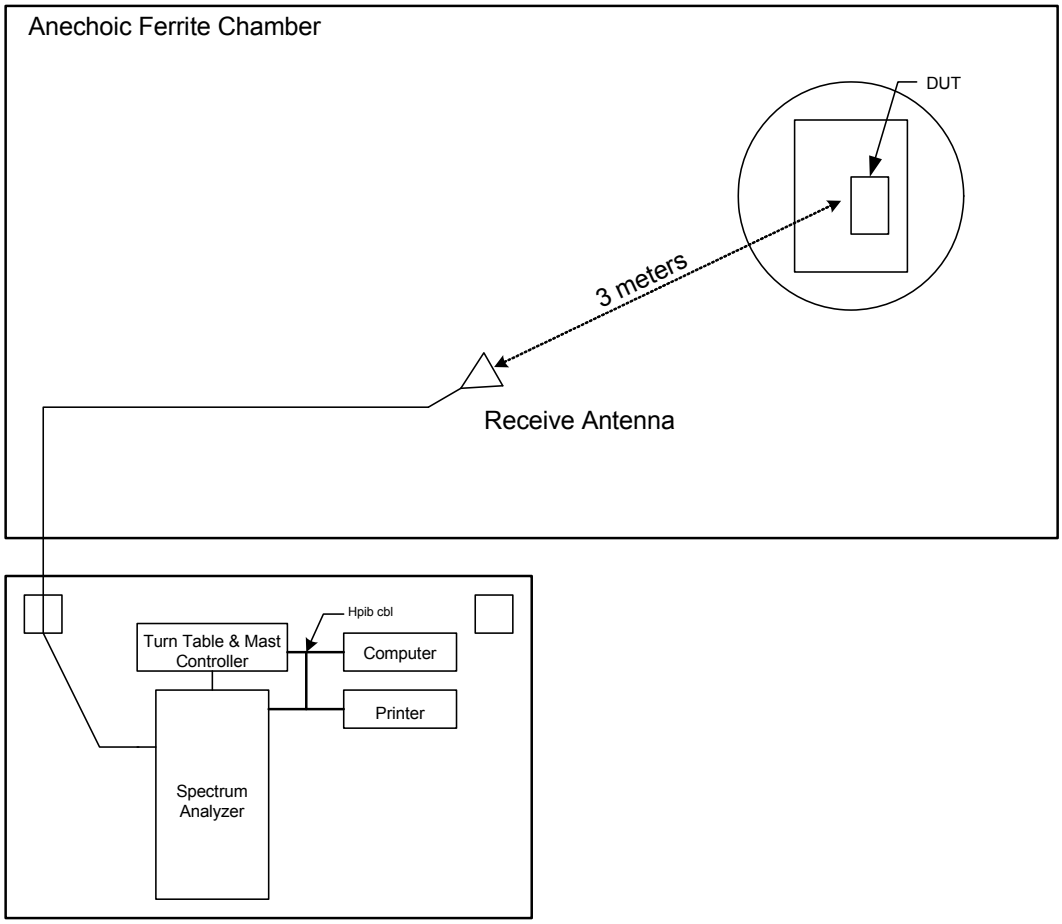
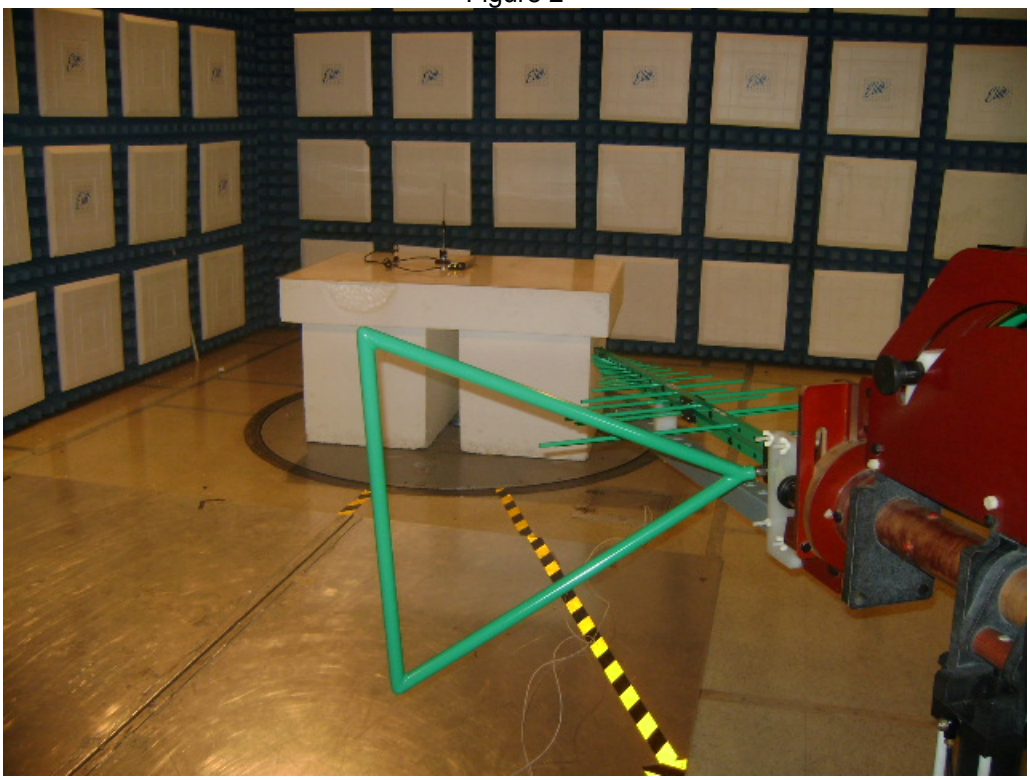
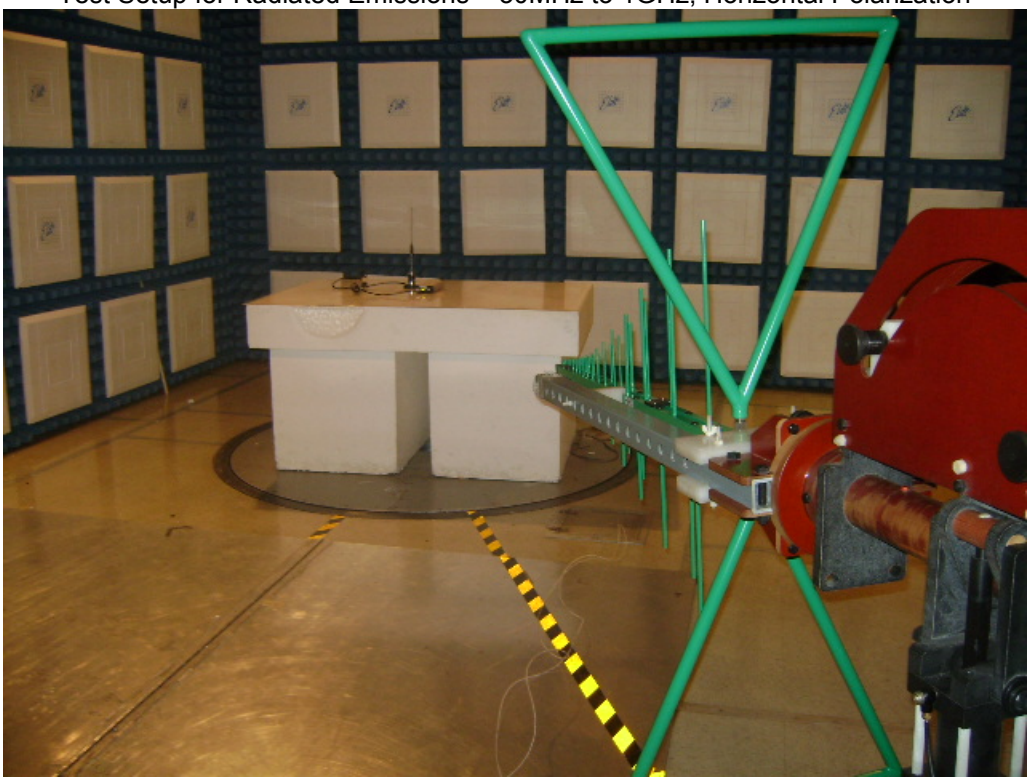


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 2

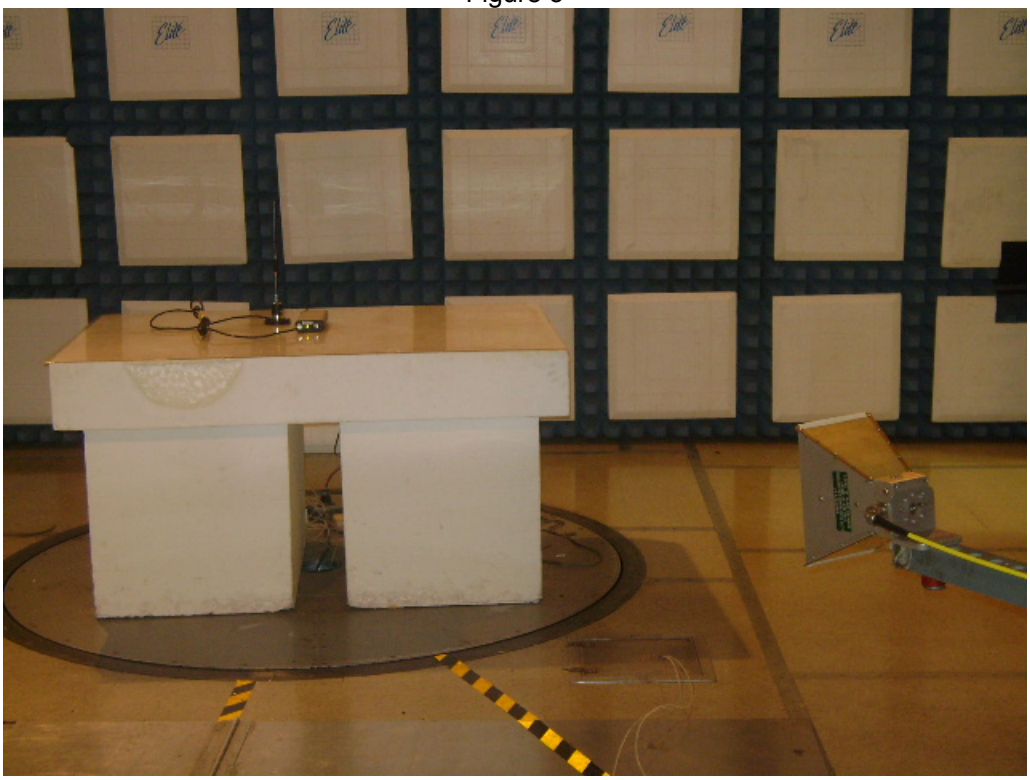


Test Setup for Radiated Emissions – 30MHz to 1GHz, Horizontal Polarization

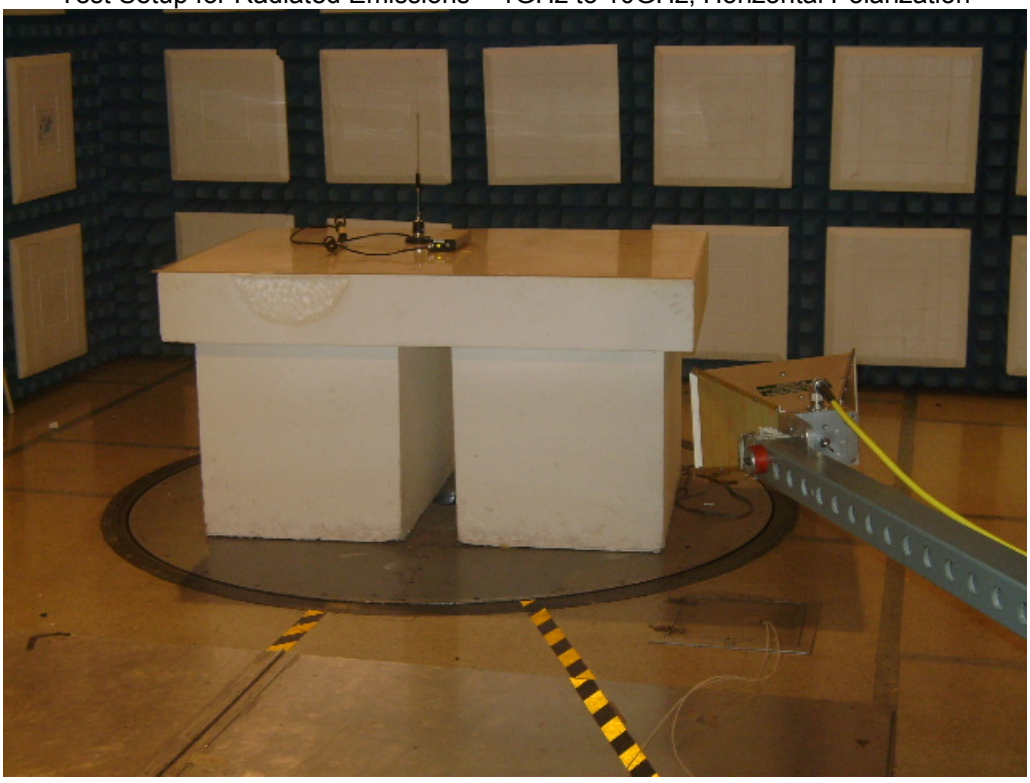


Test Setup for Radiated Emissions – 30MHz to 1GHz, Vertical Polarization

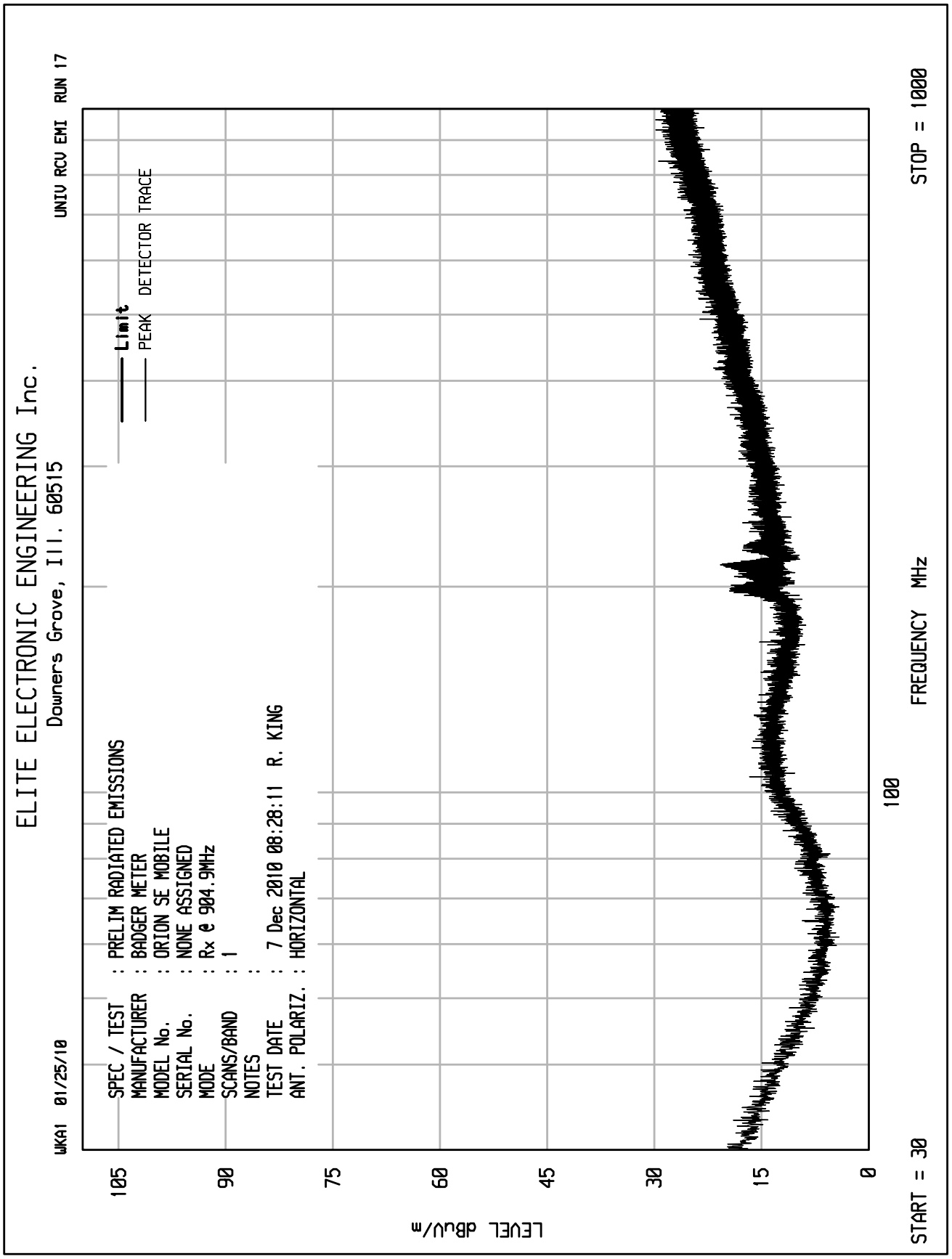
Figure 3

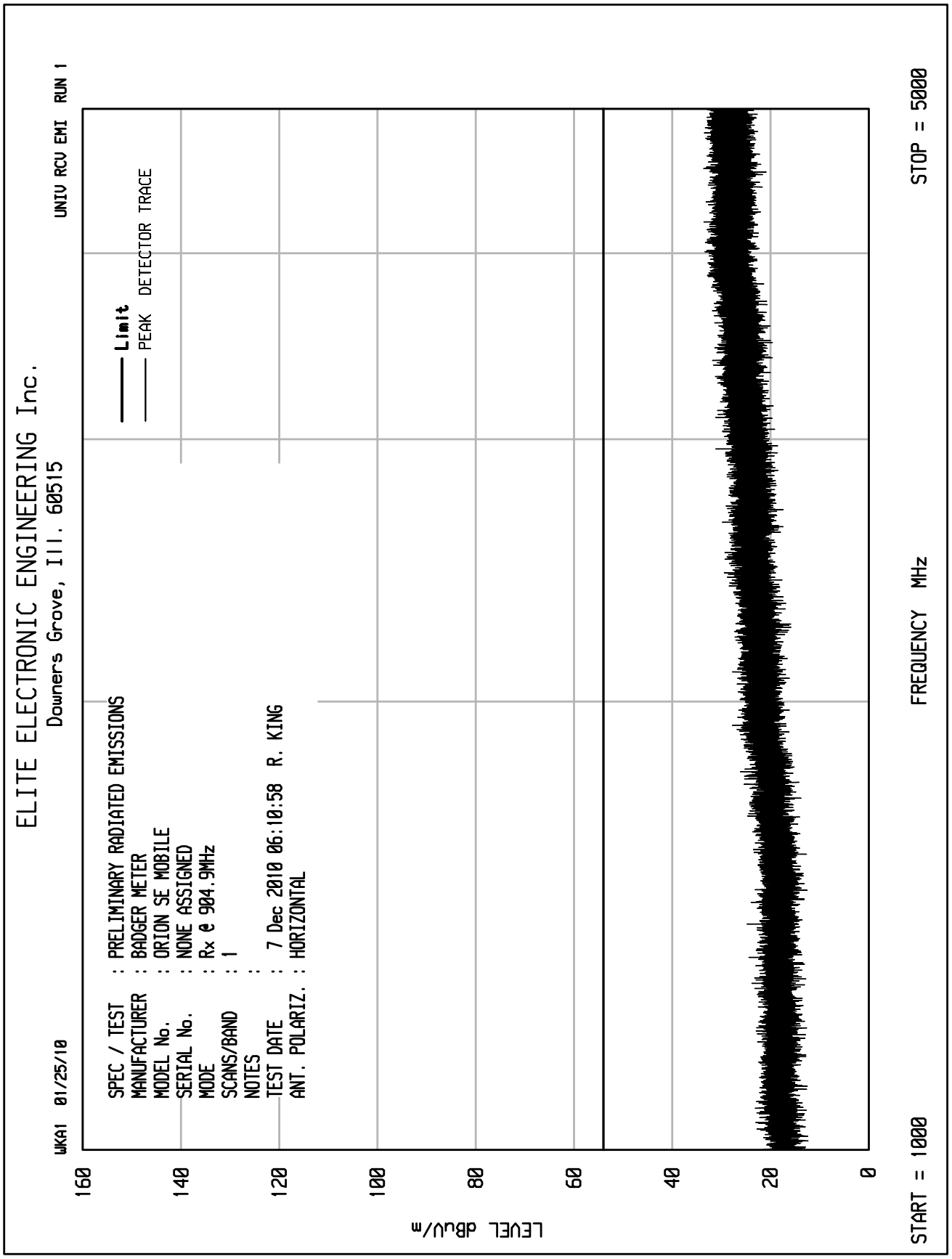


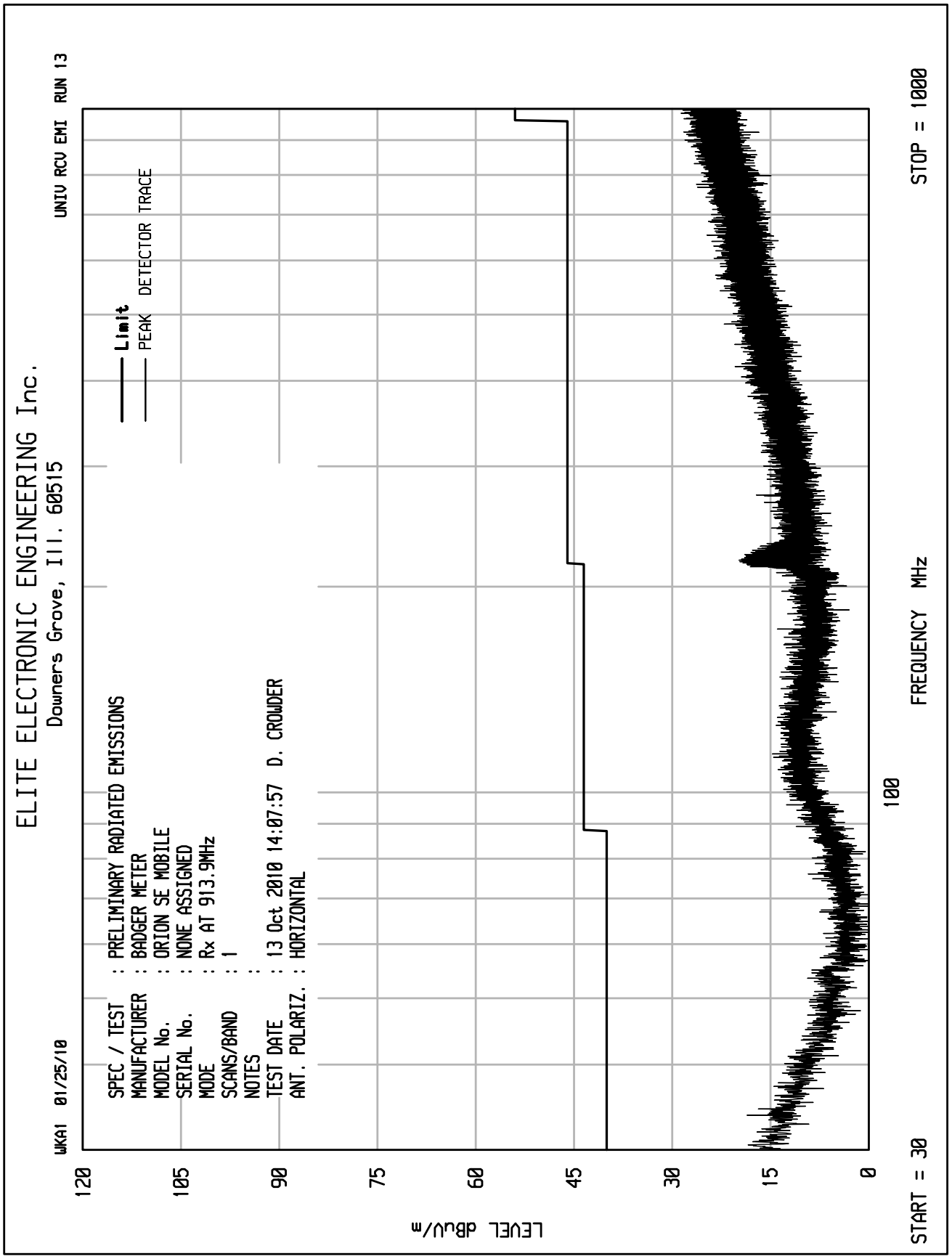
Test Setup for Radiated Emissions – 1GHz to 10GHz, Horizontal Polarization

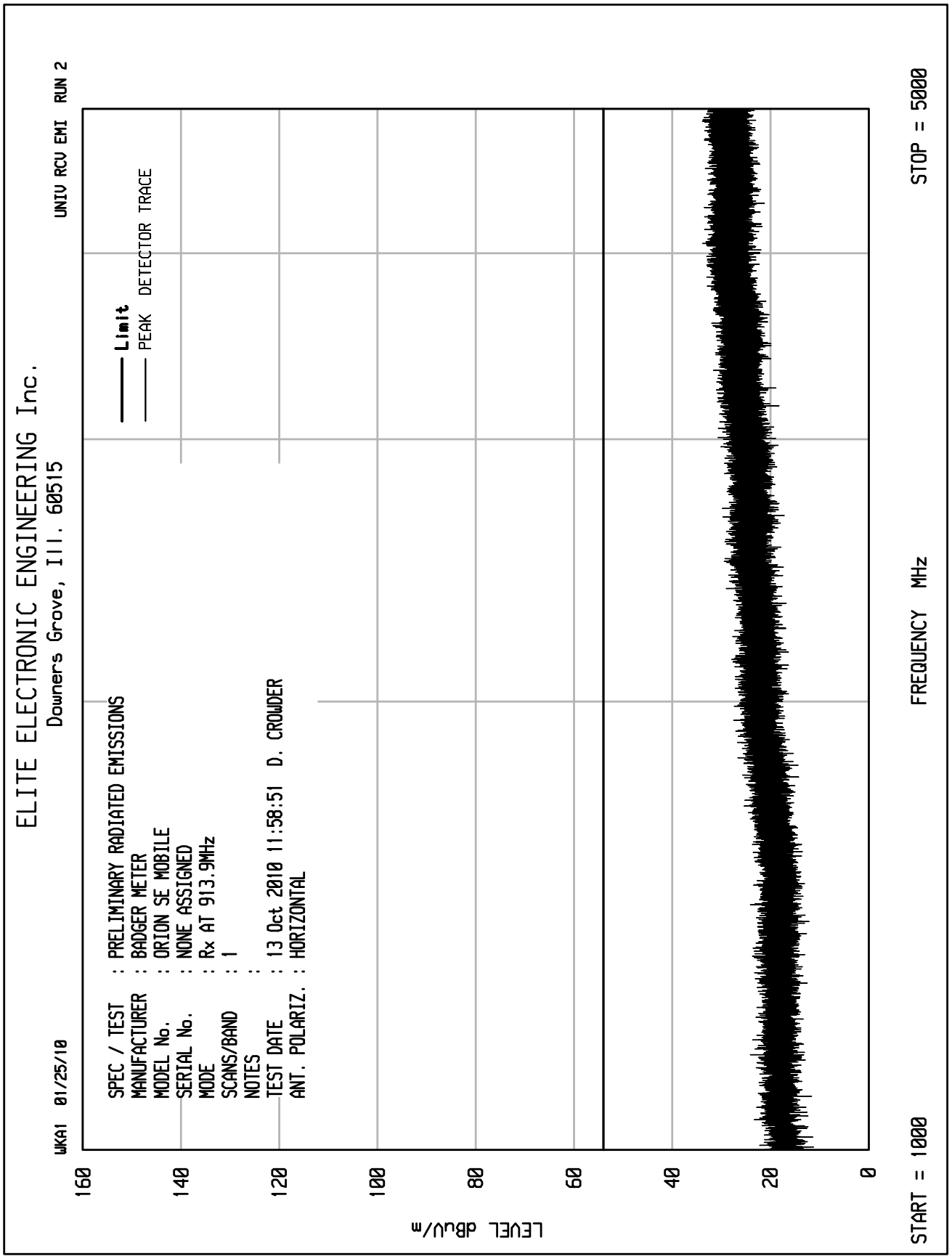


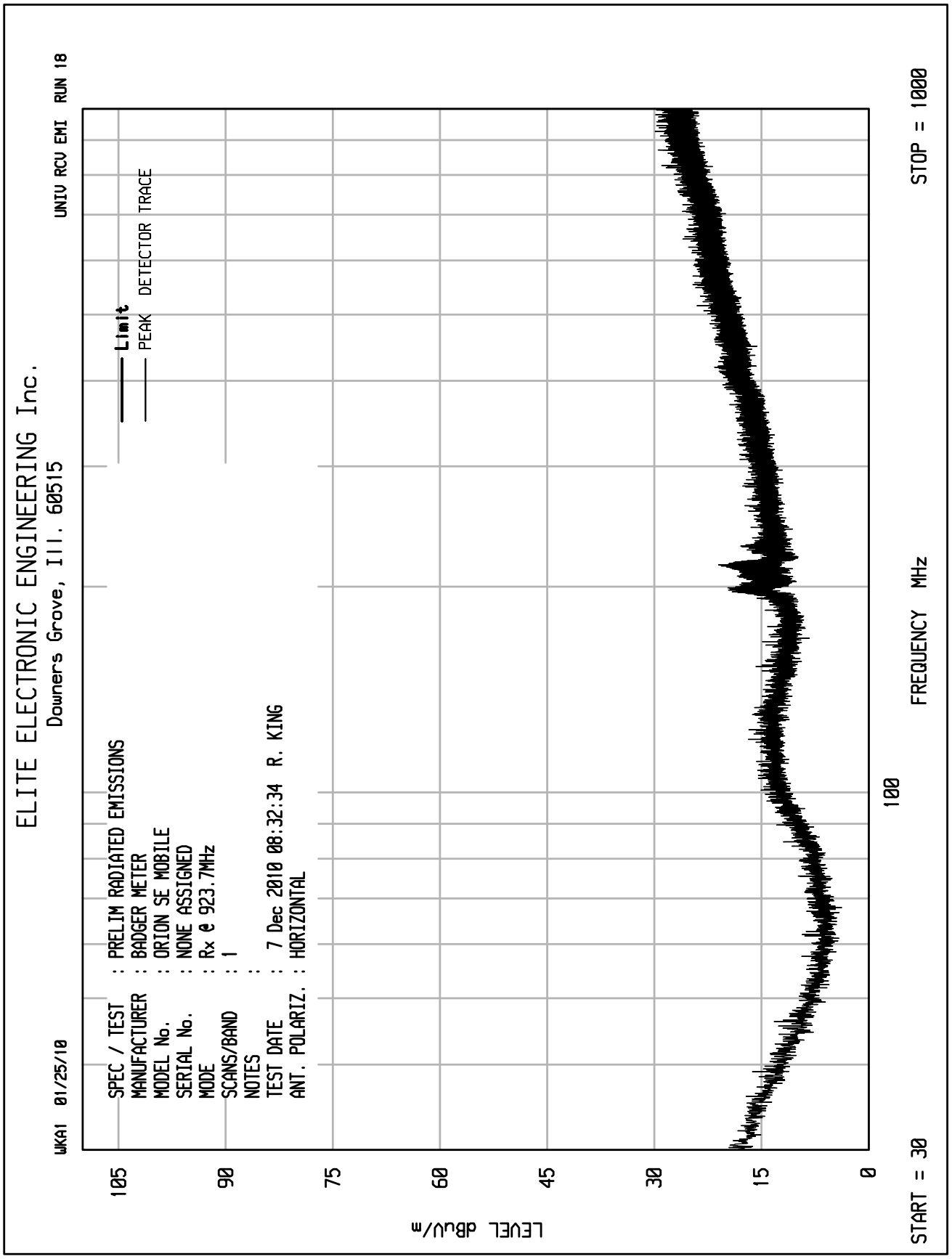
Test Setup for Radiated Emissions – 1GHz to 10GHz, Vertical Polarization

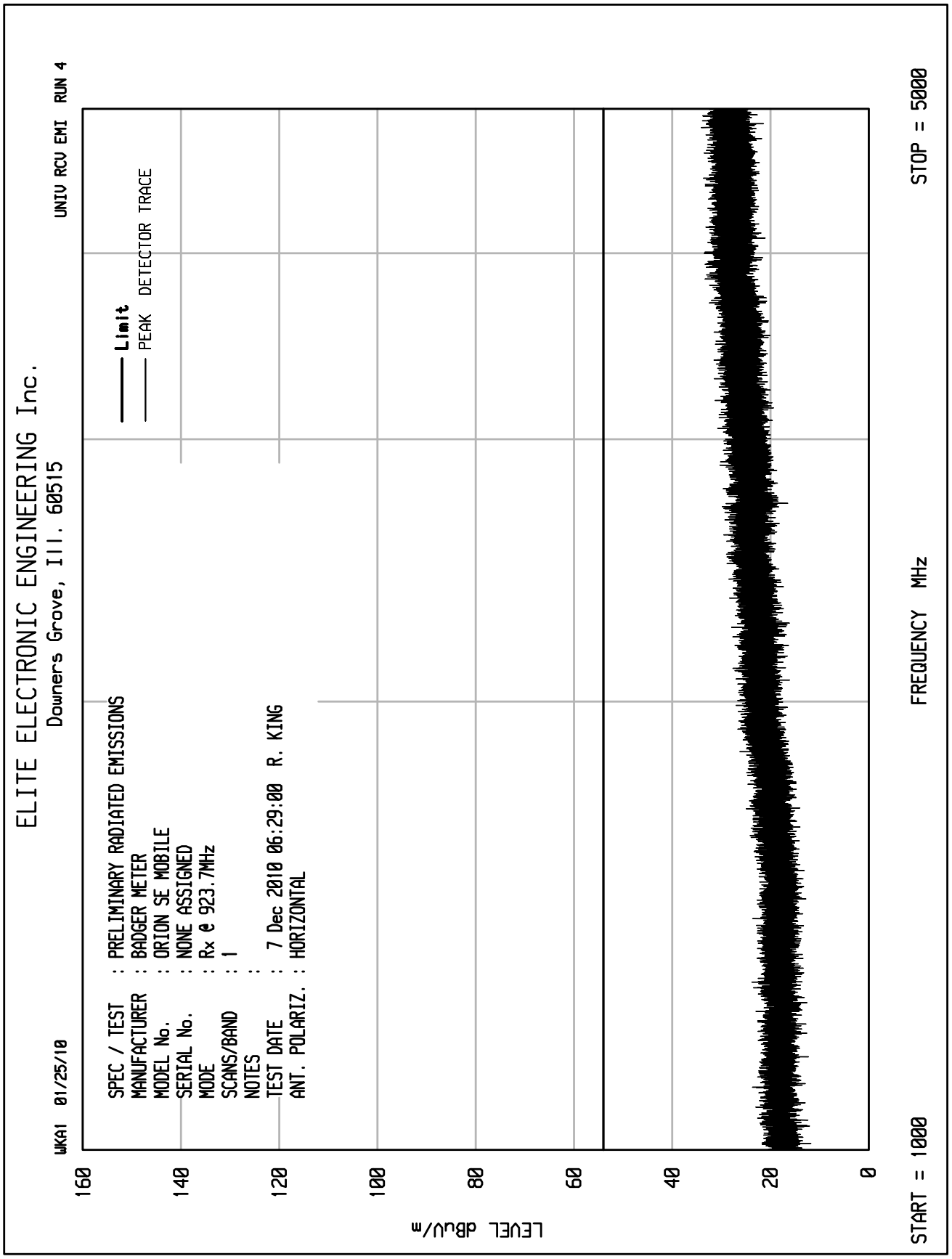

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 17
WKA1 01/25/10
SPEC / TEST : PRELIM RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION SE MOBILE
SERIAL No. : NONE ASSIGNED
MODE : Rx @ 904.9MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 7 Dec 2010 08:28:11 R. KING
ANT. POLARIZ. : HORIZONTAL
Limit
PEAK DETECTOR TRACE
LEVEL dBuV/m
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 1
WKA1 01/25/10
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION SE MOBILE
SERIAL No. : NONE ASSIGNED
MODE : Rx @ 904.9MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 7 Dec 2010 06:10:58 R. KING
ANT. POLARIZ. : HORIZONTAL
Limit
PEAK DETECTOR TRACE
LEVEL dBuV/m
160
140
120
100
80
60
40
20
0
START = 1000
FREQUENCY MHz
STOP = 5000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 13
WKA1 01/25/10
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION SE MOBILE
SERIAL No. : NONE ASSIGNED
MODE : Rx AT 913.9MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 13 Oct 2010 14:07:57 D. CROWDER
ANT. POLARIZ. : HORIZONTAL
Limit
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 2
WKA1 01/25/10
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION SE MOBILE
SERIAL No. : NONE ASSIGNED
MODE : Rx AT 913.9MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 13 Oct 2010 11:58:51 D. CROWDER
ANT. POLARIZ. : HORIZONTAL
Limit
PEAK DETECTOR TRACE
LEVEL dBuV/m
160
140
120
100
80
60
40
20
0
START = 1000
FREQUENCY MHz
STOP = 5000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 18
WKA1 01/25/10
SPEC / TEST : PRELIM RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION SE MOBILE
SERIAL No. : NONE ASSIGNED
MODE : Rx @ 923.7MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 7 Dec 2010 08:32:34 R. KING
ANT. POLARIZ. : HORIZONTAL
Limit
PEAK DETECTOR TRACE
LEVEL dBuV/m
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 4
WKA1 01/25/10
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION SE MOBILE
SERIAL No. : NONE ASSIGNED
MODE : Rx @ 923.7MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 7 Dec 2010 06:29:00 R. KING
ANT. POLARIZ. : HORIZONTAL
Limit
PEAK DETECTOR TRACE
LEVEL dBuV/m
160
140
120
100
80
60
40
20
0
START = 1000
FREQUENCY MHz
STOP = 5000

Manufacturer : Badger Meter
Model No. : Orion SE Mobile
Serial No. : None Assigned
Specification : FCC-15B Spurious Radiated Emissions
Date : October 13, 2010
Mode : Rx @ 904.9MHz (Ch. 1)
Notes : Test Distance is 3 meters

Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Total dBuV/m at 3 M	Total uV/m at 3M	Limit uV/m at 3M	Margin (dB)
904.9	H	6.2	Ambient	2.4	21.8	0.0	30.3	32.9	200.0	-15.7
904.9	V	5.3	Ambient	2.4	21.8	0.0	29.5	29.9	200.0	-16.5
1809.8	H	34.3	Ambient	3.4	27.4	-40.0	25.2	18.2	500.0	-28.8
1809.8	V	34.0	Ambient	3.4	27.4	-40.0	24.9	17.6	500.0	-29.1
2714.7	H	33.7	Ambient	3.9	30.2	-39.3	28.4	26.4	500.0	-25.5
2714.7	V	33.7	Ambient	3.9	30.2	-39.3	28.5	26.6	500.0	-25.5
3619.6	H	32.9	Ambient	4.7	33.1	-38.5	32.1	40.4	500.0	-21.9
3619.6	V	32.9	Ambient	4.7	33.1	-38.5	32.1	40.4	500.0	-21.9
4524.5	H	32.0	Ambient	5.5	33.5	-38.2	32.8	43.6	500.0	-21.2
4524.5	V	31.9	Ambient	5.5	33.5	-38.2	32.7	43.4	500.0	-21.2

FS (dBuV/m) = MTR (dBuV) + AF (dB/m) + CF (dB) + (- PA (dB))
FS (uV/m) = AntiLog [(FS (dBuV/m))/20]

Manufacturer : Badger Meter
Model No. : Orion SE Mobile
Serial No. : None Assigned
Specification : FCC-15B Spurious Radiated Emissions
Date : October 13, 2010
Mode : Rx @ 913.9MHz (Ch. 24)
Notes : Test Distance is 3 meters

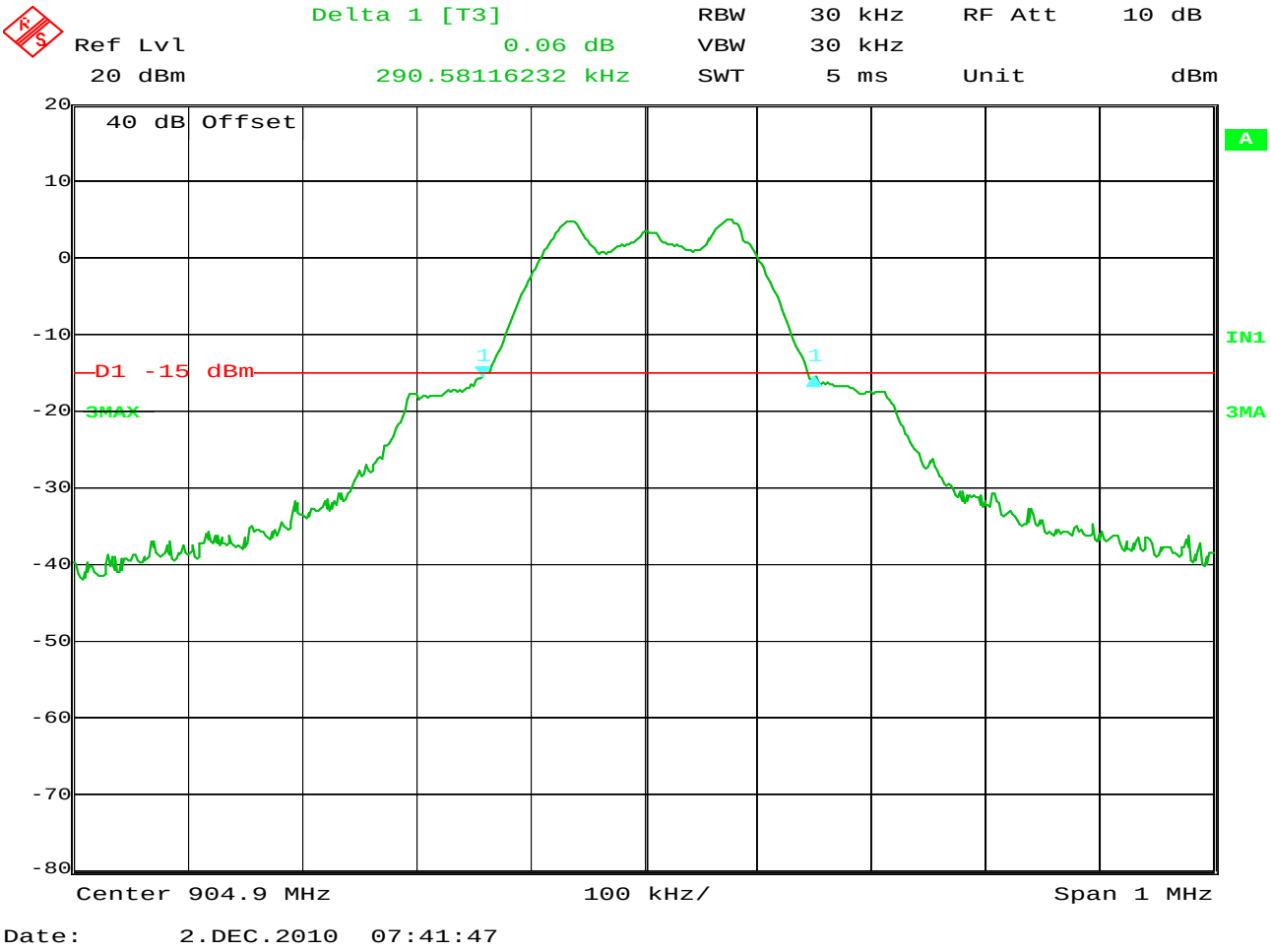
Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Total dBuV/m at 3 M	Total uV/m at 3M	Limit uV/m at 3M	Margin (dB)
913.900	H	1.8	Ambient	2.4	21.8	0.0	26.0	19.9	200.0	-20.0
913.900	V	2.0	Ambient	2.4	21.8	0.0	26.2	20.4	200.0	-19.8
1827.800	H	48.7	Ambient	3.5	27.5	-40.0	39.7	96.2	500.0	-14.3
1827.800	V	49.5	Ambient	3.5	27.5	-40.0	40.5	105.5	500.0	-13.5
2741.700	H	46.5	Ambient	3.9	30.3	-39.3	41.4	117.9	500.0	-12.5
2741.700	V	46.0	Ambient	3.9	30.3	-39.3	40.9	111.3	500.0	-13.0
3655.600	H	45.6	Ambient	4.7	33.2	-38.5	45.0	177.6	500.0	-9.0
3655.600	V	45.8	Ambient	4.7	33.2	-38.5	45.2	181.7	500.0	-8.8
4569.500	H	45.7	Ambient	5.5	33.7	-38.2	46.7	215.7	500.0	-7.3
4569.500	V	45.9	Ambient	5.5	33.7	-38.2	46.9	220.7	500.0	-7.1

FS (dBuV/m) = MTR (dBuV) + AF (dB/m) + CF (dB) + (- PA (dB))
FS (uV/m) = AntiLog [(FS (dBuV/m))/20]

Manufacturer : Badger Meter
Model No. : Orion SE Mobile
Serial No. : None Assigned
Specification : FCC-15B Spurious Radiated Emissions
Date : October 13, 2010
Mode : Rx @ 923.7MHz (Ch. 48)
Notes : Test Distance is 3 meters

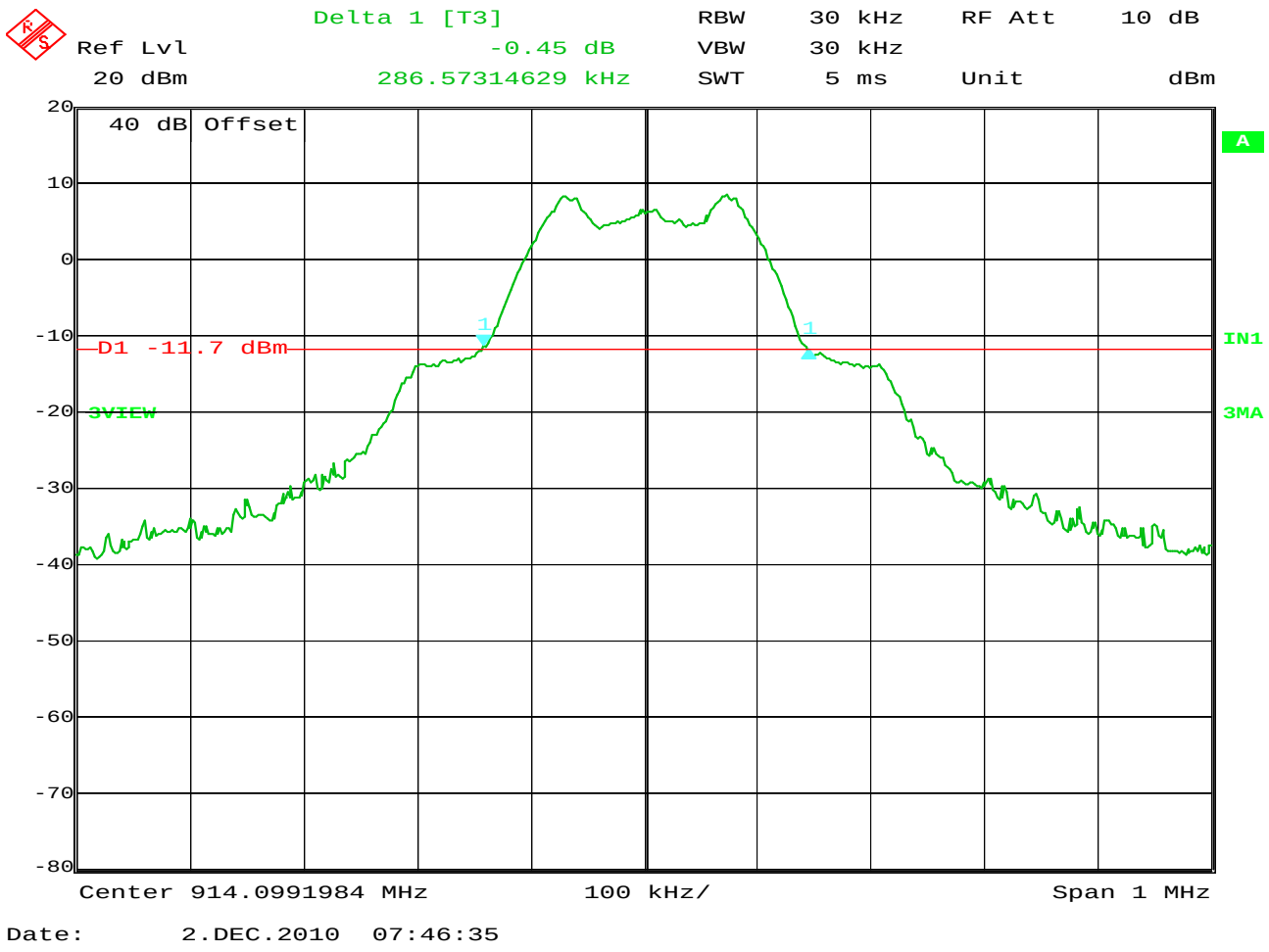
Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Total dBuV/m at 3 M	Total uV/m at 3M	Limit uV/m at 3M	Margin (dB)
923.700	H	5.2	Ambient	2.4	21.8	0.0	29.5	29.8	200.0	-16.5
923.700	V	5.4	Ambient	2.4	21.8	0.0	29.6	30.1	200.0	-16.4
1847.400	H	33.5	Ambient	3.5	27.6	-40.0	24.6	17.0	500.0	-29.4
1847.400	V	33.6	Ambient	3.5	27.6	-40.0	24.7	17.1	500.0	-29.3
2771.100	H	34.0	Ambient	4.0	30.4	-39.2	29.1	28.6	500.0	-24.9
2771.100	V	34.0	Ambient	4.0	30.4	-39.2	29.1	28.5	500.0	-24.9
3694.800	H	32.3	Ambient	4.8	33.3	-38.5	31.8	38.8	500.0	-22.2
3694.800	V	32.3	Ambient	4.8	33.3	-38.5	31.8	39.0	500.0	-22.2
4618.500	H	31.3	Ambient	5.6	33.8	-38.2	32.5	42.1	500.0	-21.5
4618.500	V	31.3	Ambient	5.6	33.8	-38.2	32.5	42.1	500.0	-21.5

FS (dBuV/m) = MTR (dBuV) + AF (dB/m) + CF (dB) + (- PA (dB))
FS (uV/m) = AntiLog [(FS (dBuV/m))/20]



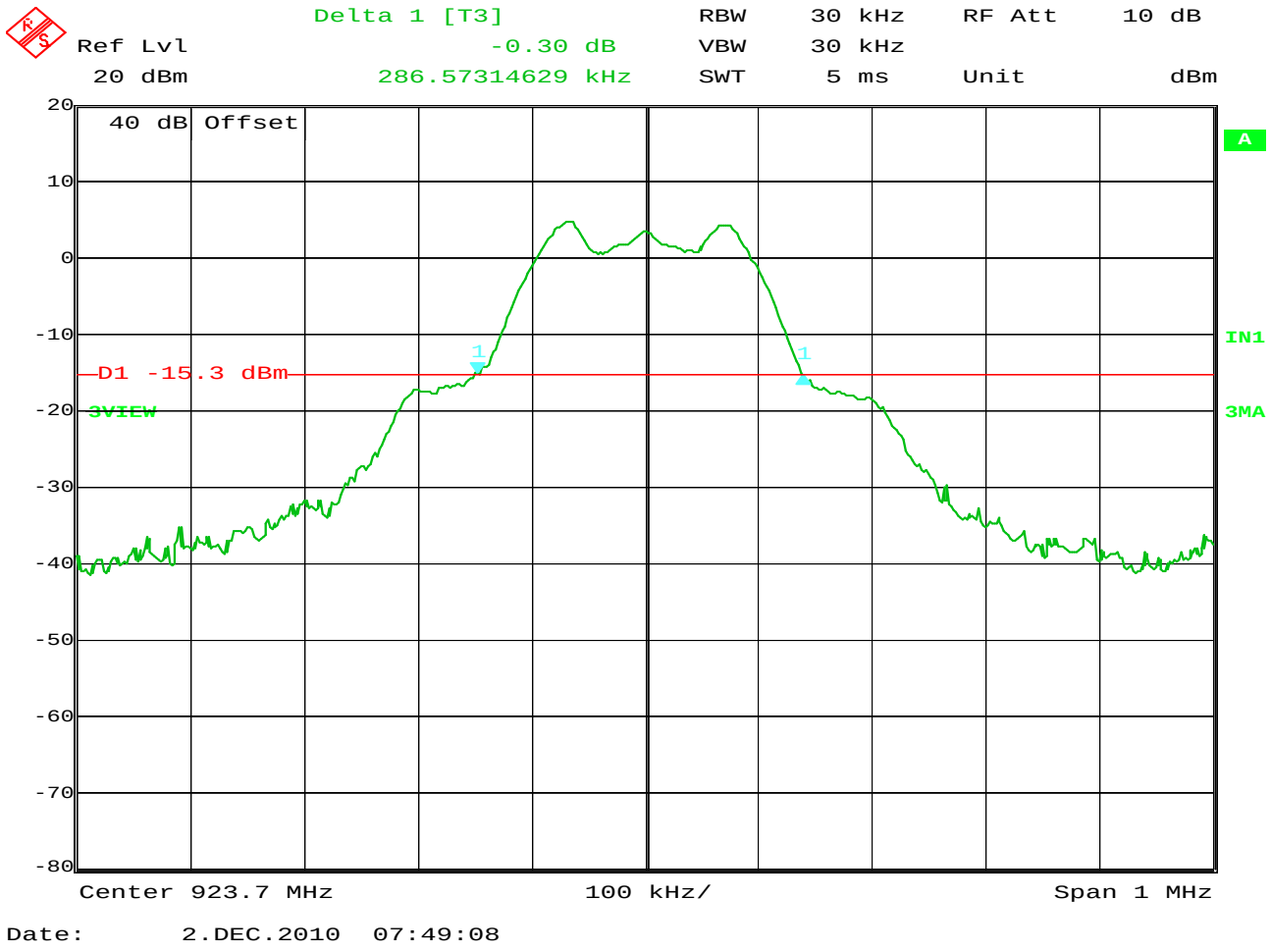
15.247(a) 20dB Bandwidth

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 904.9MHz
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	20dB bandwidth
NOTES	:	20dB bandwidth = 290.6kHz
EQUIPMENT USED	:	RBD1, T2S8, T2DL



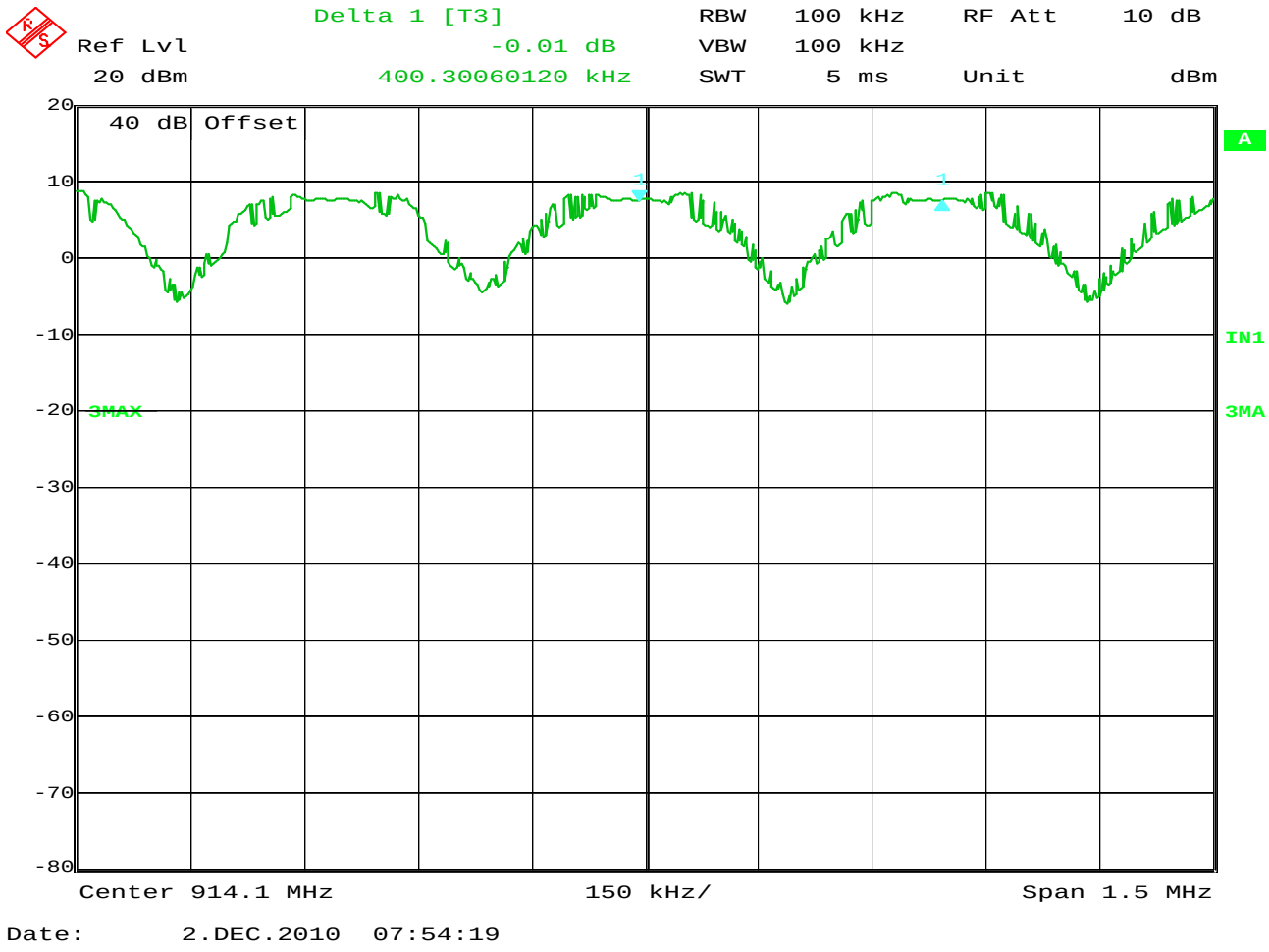
15.247(a) 20dB Bandwidth

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 914.1MHz (Ch. 24)
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	20dB bandwidth
NOTES	:	20dB bandwidth = 286.6kHz
EQUIPMENT USED	:	RBD1, T2S8, T2DL



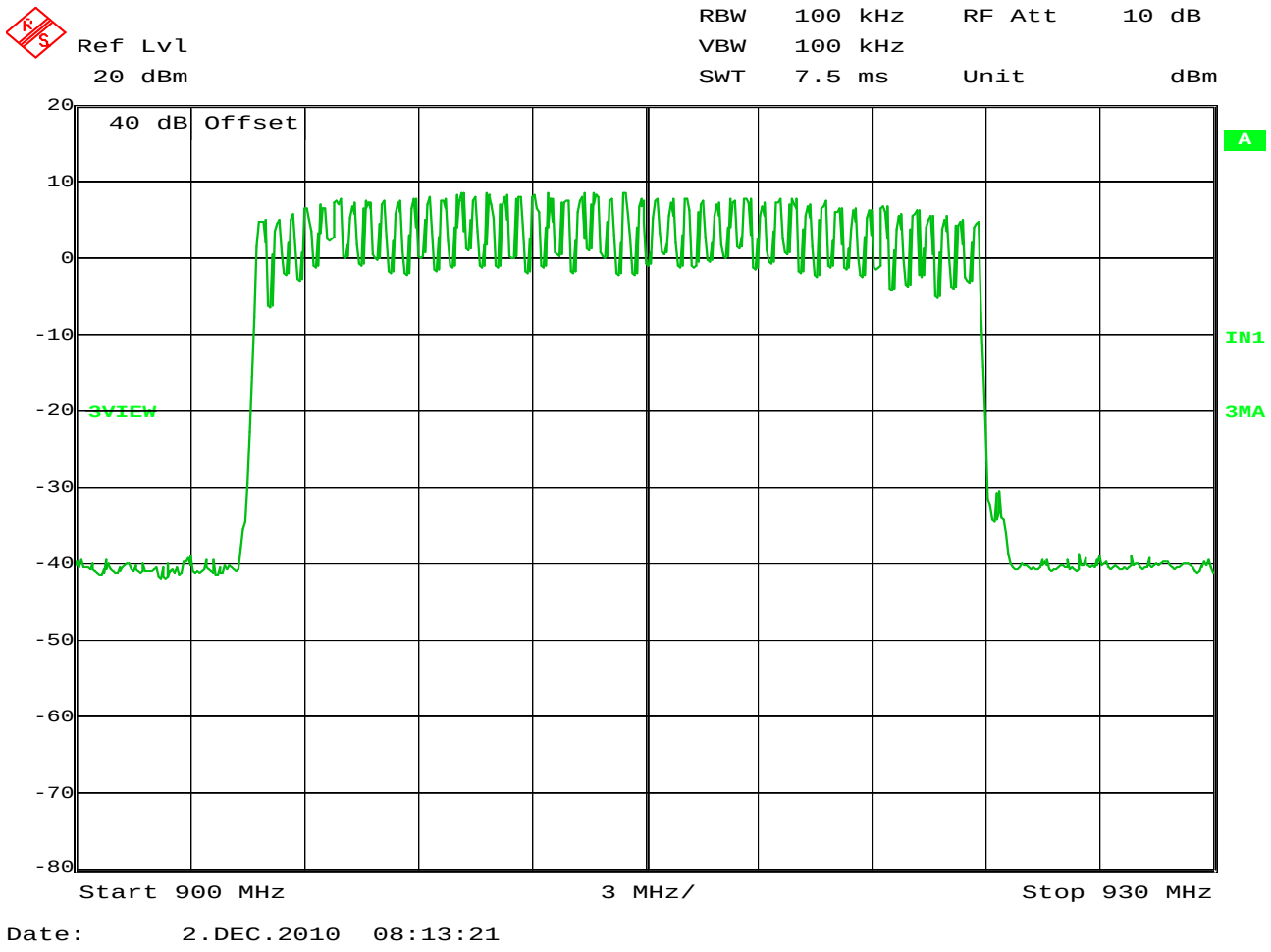
15.247(a) 20dB Bandwidth

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 923.7MHz (Ch. 48)
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	20dB bandwidth
NOTES	:	20dB bandwidth = 286.6kHz
EQUIPMENT USED	:	RBD1, T2S8, T2DL



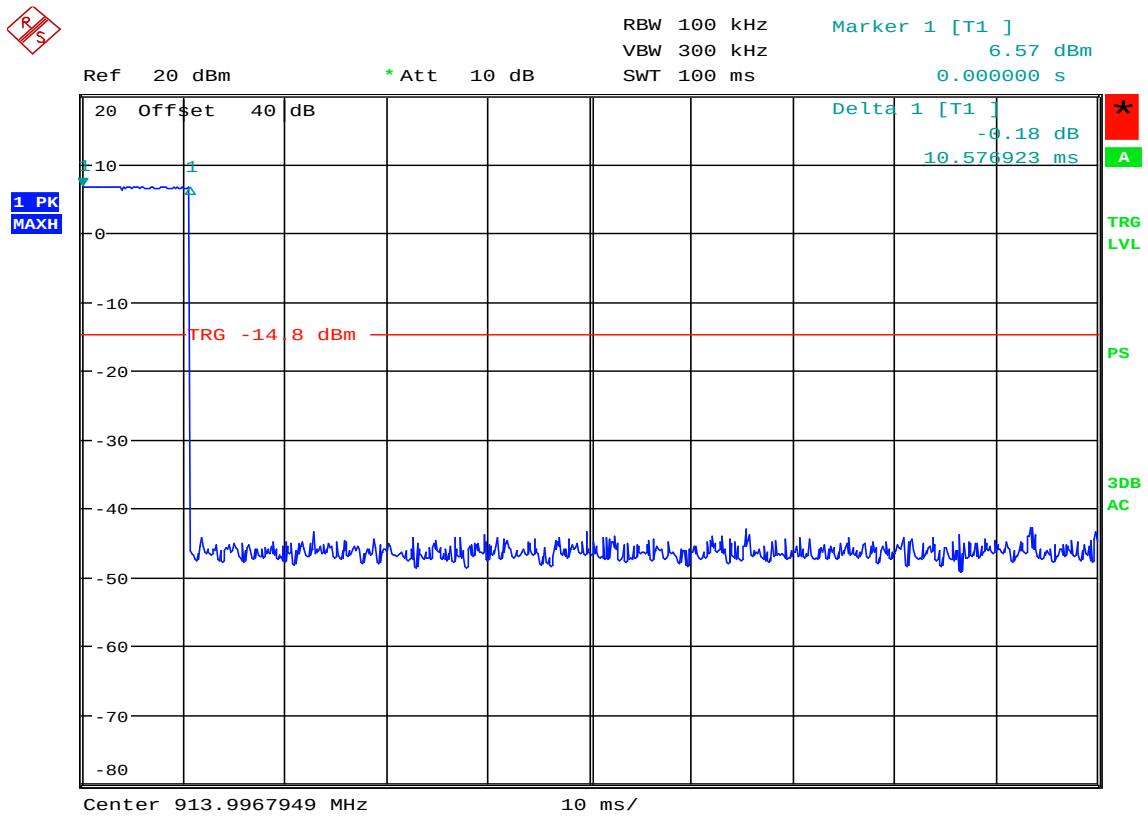
15.247(a) Carrier Frequency Separation

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Hopping Enabled
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	Carrier Frequency Separation
NOTES	:	Carrier Frequency Separation = 400.3kHz
EQUIPMENT USED	:	RBD1, T2S8, T2DL



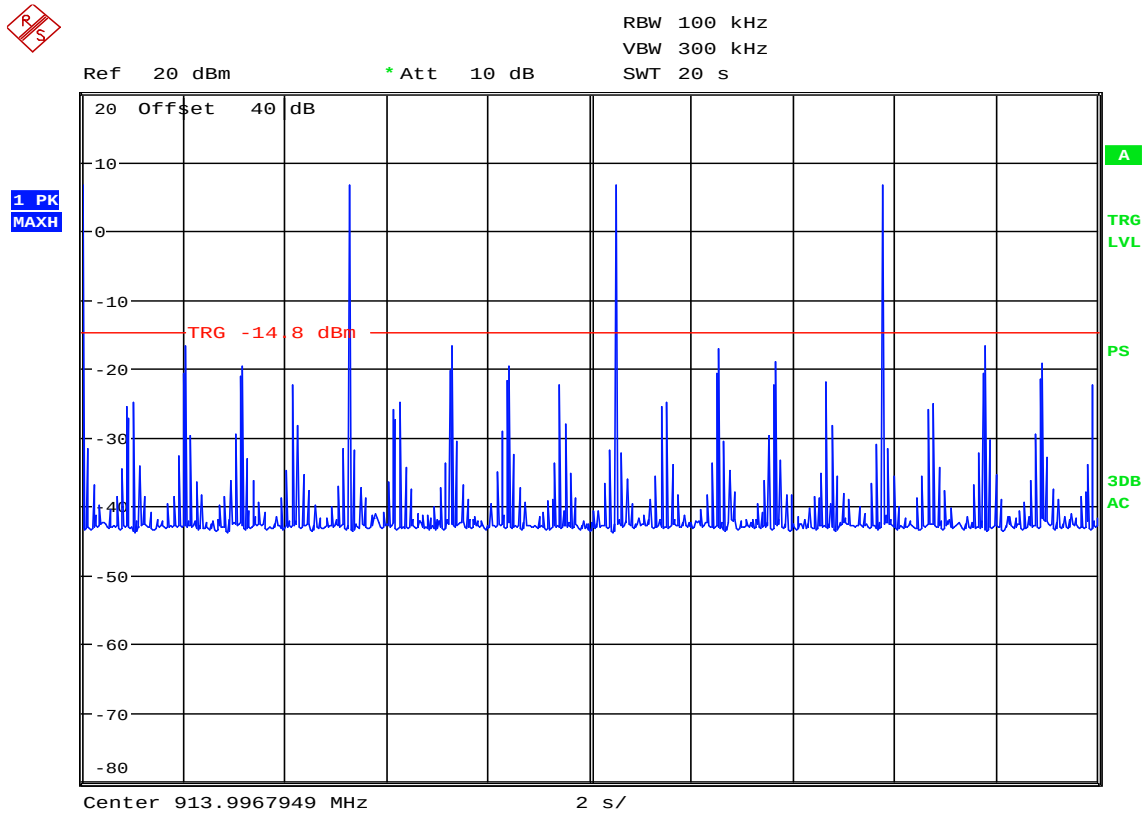
15.247(a) Number of Hopping Frequencies

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Hopping Enabled
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	Number of Hopping Channels
NOTES	:	Number of Hopping Channels = 48
EQUIPMENT USED	:	RBD1, T2S8, T2DL



15.247(a) Time of Occupancy

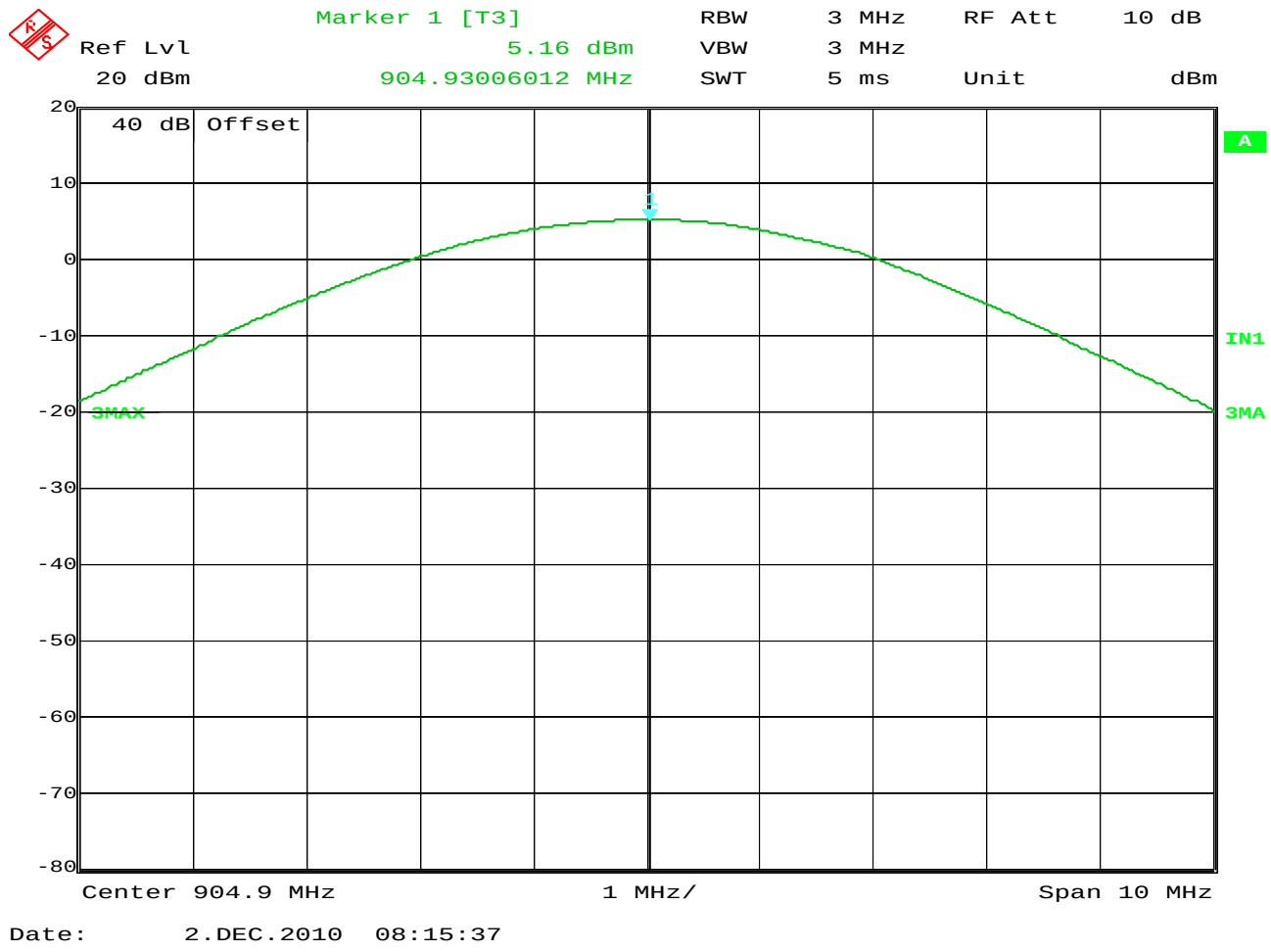
MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Worst Case Data Rate
NOTES	:	
TEST DATE	:	October 14, 2010
TEST PARAMETERS	:	Time of Occupancy
NOTES	:	Worst Case Pulse = 10.6msec.
EQUIPMENT USED	:	RBD1, T2S8, T2DL



Date: 14.OCT.2010 14:06:58

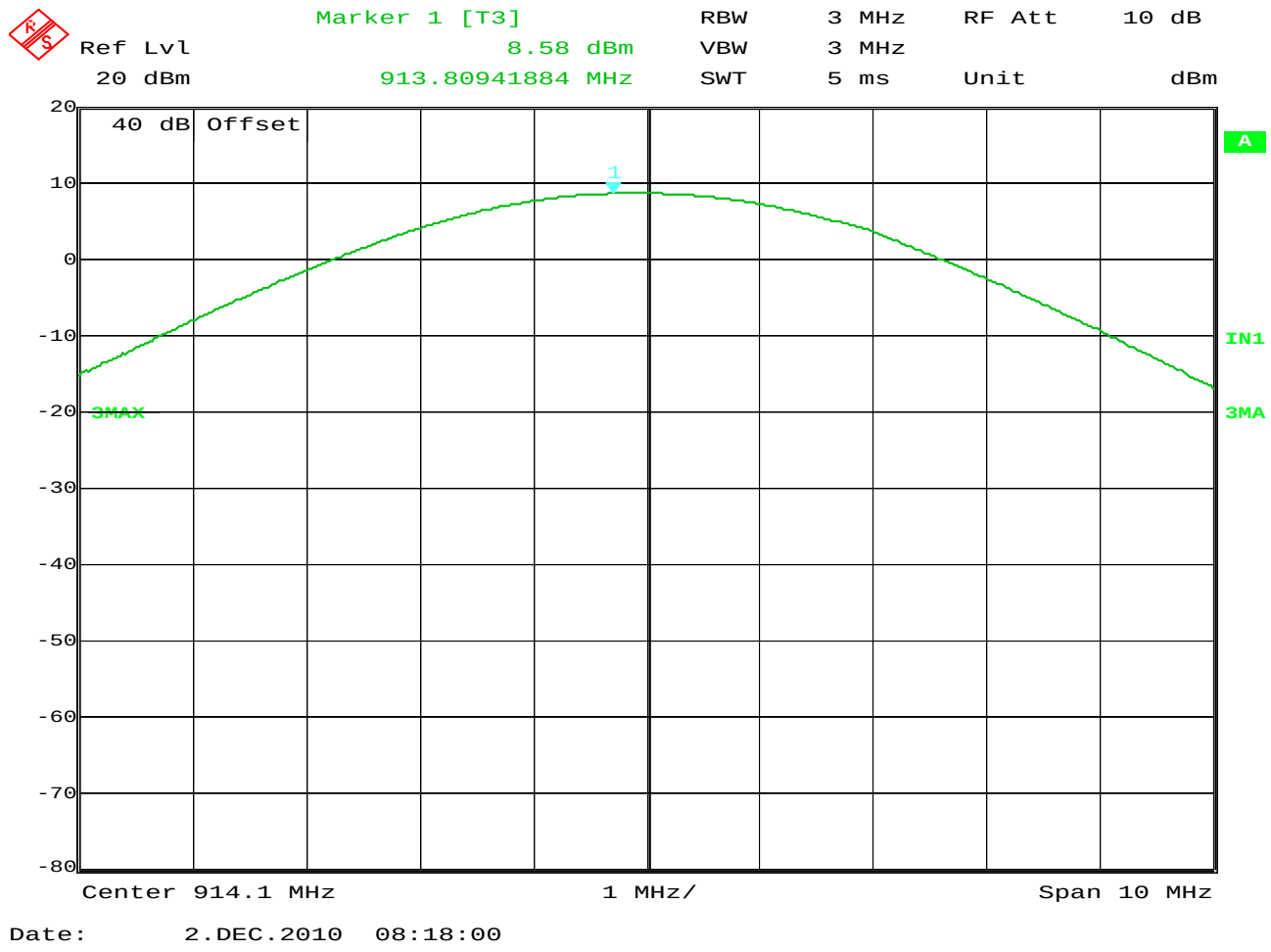
15.247(a) Time of Occupancy

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Worst Case Data Rate
NOTES	:	
TEST DATE	:	October 14, 2010
TEST PARAMETERS	:	Time of Occupancy
NOTES	:	Worst Case Pulse = 10.6msec. Number of times it hits a channel in a 10 second period is 2. Therefore the time of occupancy is 2 x 10.6msec = 21.2msec
EQUIPMENT USED	:	RBD1, T2S8, T2DL



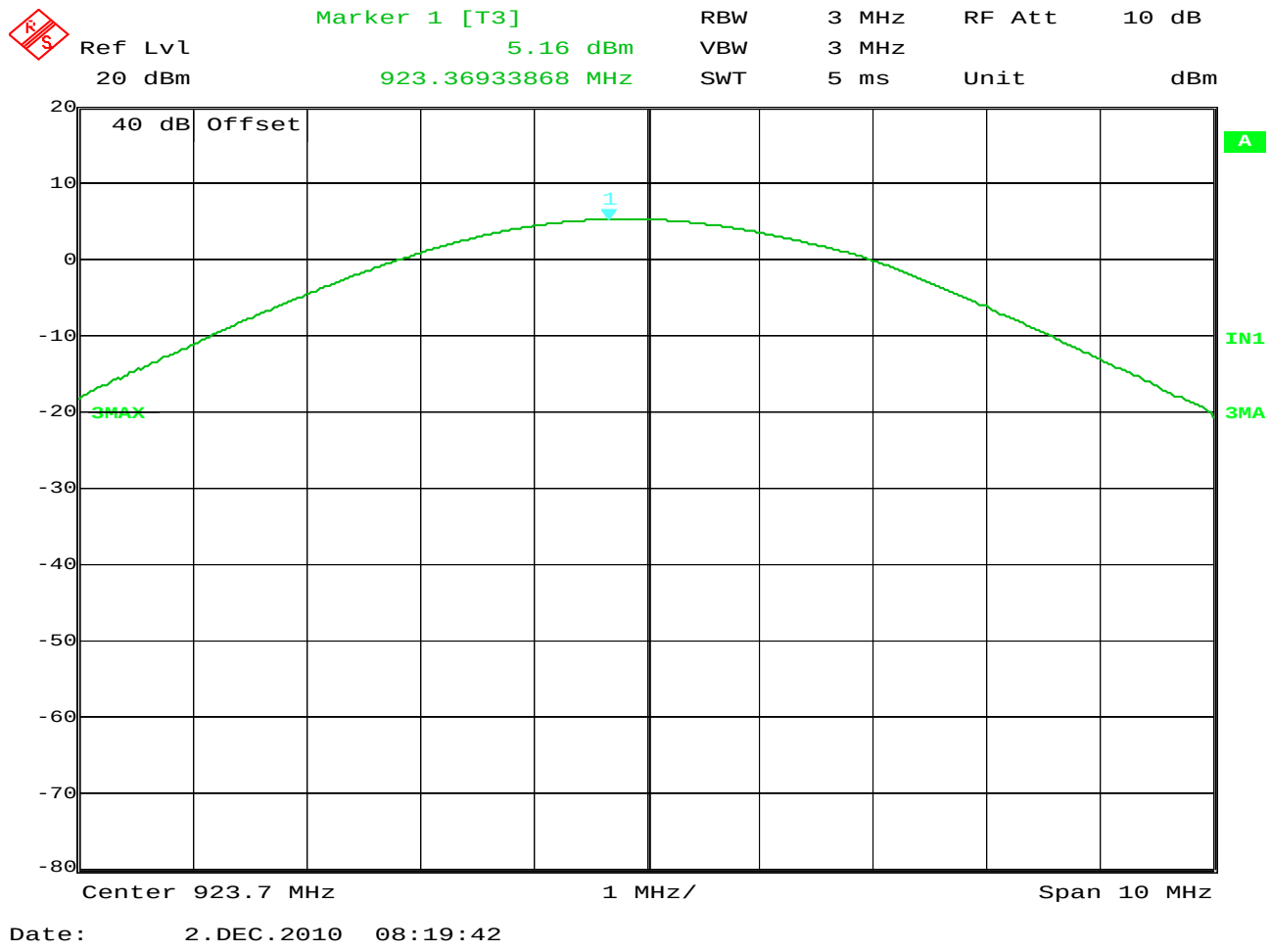
15.247(b) Peak Output Power At Antenna Terminal

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 902.4MHz (Ch. 1)
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	Peak Output Power
NOTES	:	Peak Output Power = 5.16dBm = 3.3mW
EQUIPMENT USED	:	RBD1, T2S8, T2DL



15.247(b) Peak Output Power At Antenna Terminal

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 914.1MHz (Ch. 24)
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	Peak Output Power
NOTES	:	Peak Output Power = 8.6dBm = 7.2mW
EQUIPMENT USED	:	RBD1, T2S8, T2DL



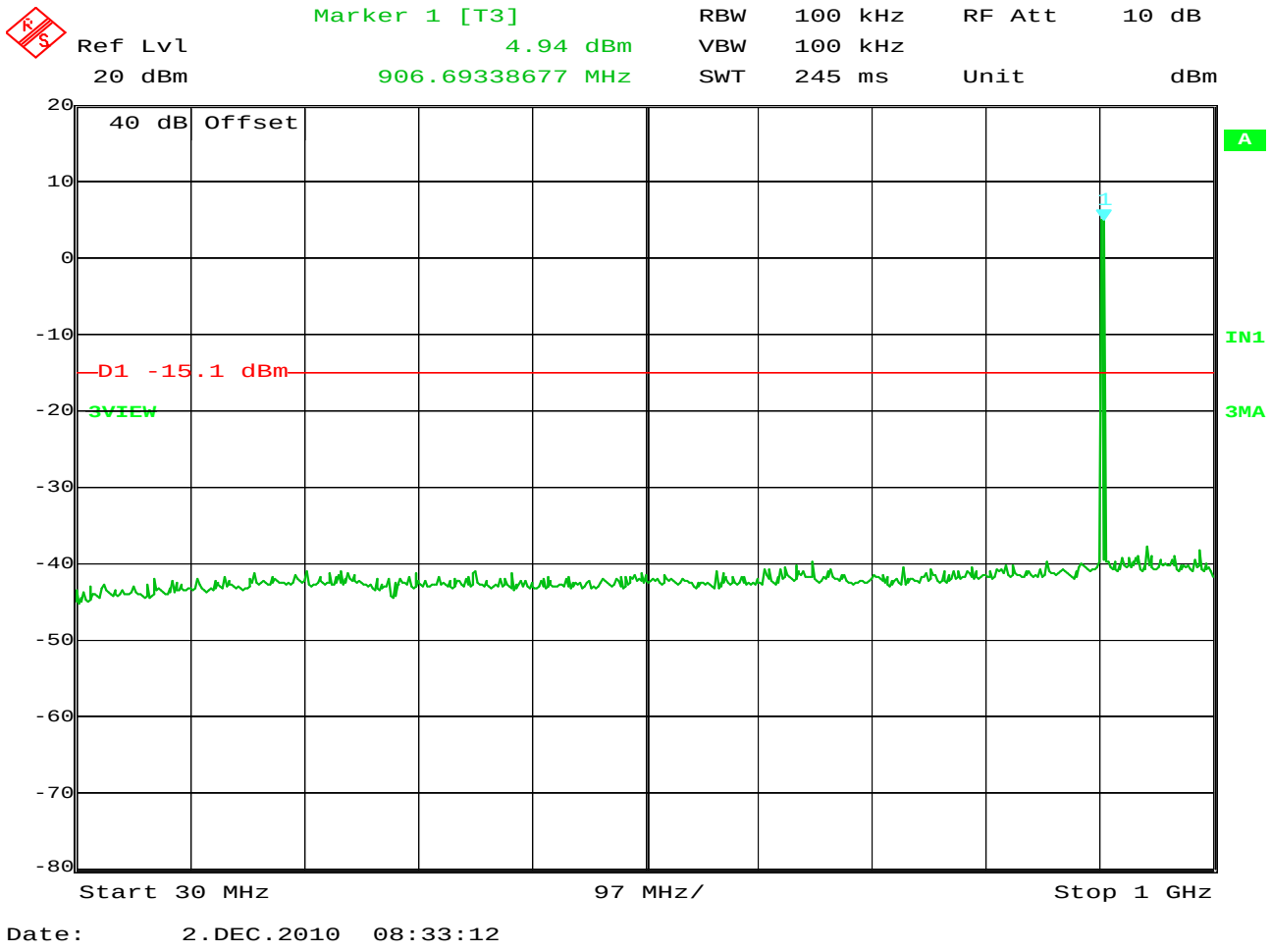
15.247(b) Peak Output Power At Antenna Terminal

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 923.7MHz (Ch. 48)
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	Peak Output Power
NOTES	:	Peak Output Power = 5.2dBm = 3.3mW
EQUIPMENT USED	:	RBD1, T2S8, T2DL

Manufacturer : Badger Meter
MODEL NUMBER : Orion SE Mobile
Serial No. : None Assigned
Specification : FCC-15.247 Effective Isotropic Radiated Power (EIRP)
Date : October 13, 2010
Mode :
Equipment Used : RBB0, NTA2, NDQ1, GBR5
Notes : Test Distance is 3 meters

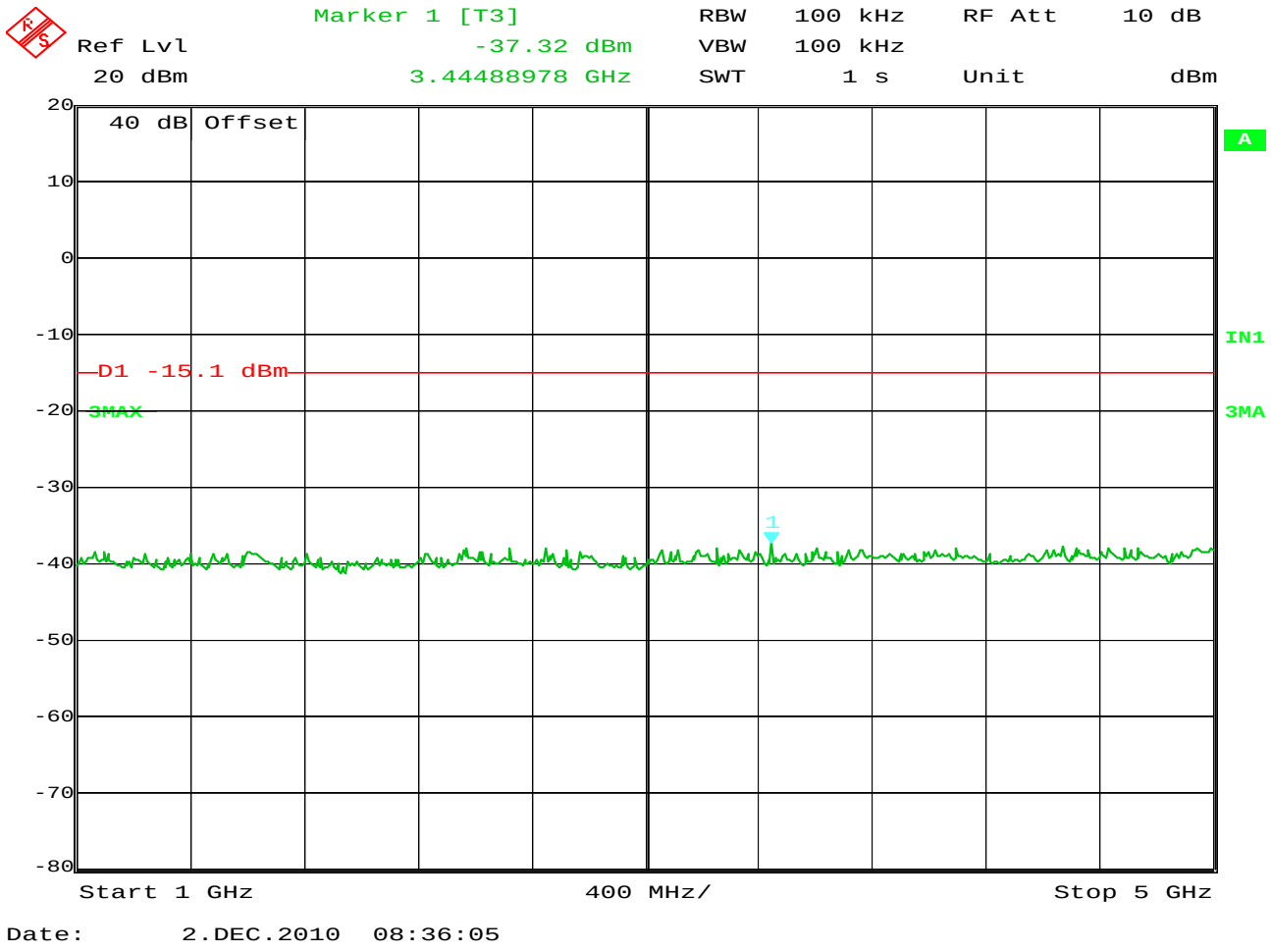
Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	Matched SIG. GEN. (dBm)	Ant Gain (dB)	CBL (dB)	EIRP Total (dBm)	Limit dBm
Transmit at 904.9MHz (Ch. 1)								
904.9	H	70.0		-5.1	2.2	1.9	-4.8	36.0
904.9	V	80.3		6.6	2.2	1.9	6.9	36.0
Transmit at 913.9 (Ch. 24)								
913.9	H	67.8		-7.0	2.2	1.9	-6.7	36.0
913.9	V	81.1		7.9	2.2	1.9	8.2	36.0
Transmit at 923.7MHz (Ch. 48)								
923.7	H	69.8		-4.6	2.2	1.9	-4.3	36.0
923.7	V	79.9		7.3	2.2	1.9	7.6	36.0

EIRP (dBm) = Matched Signal Generator (dBm) + Antenna Gain (dB) – Cable Loss (dB)



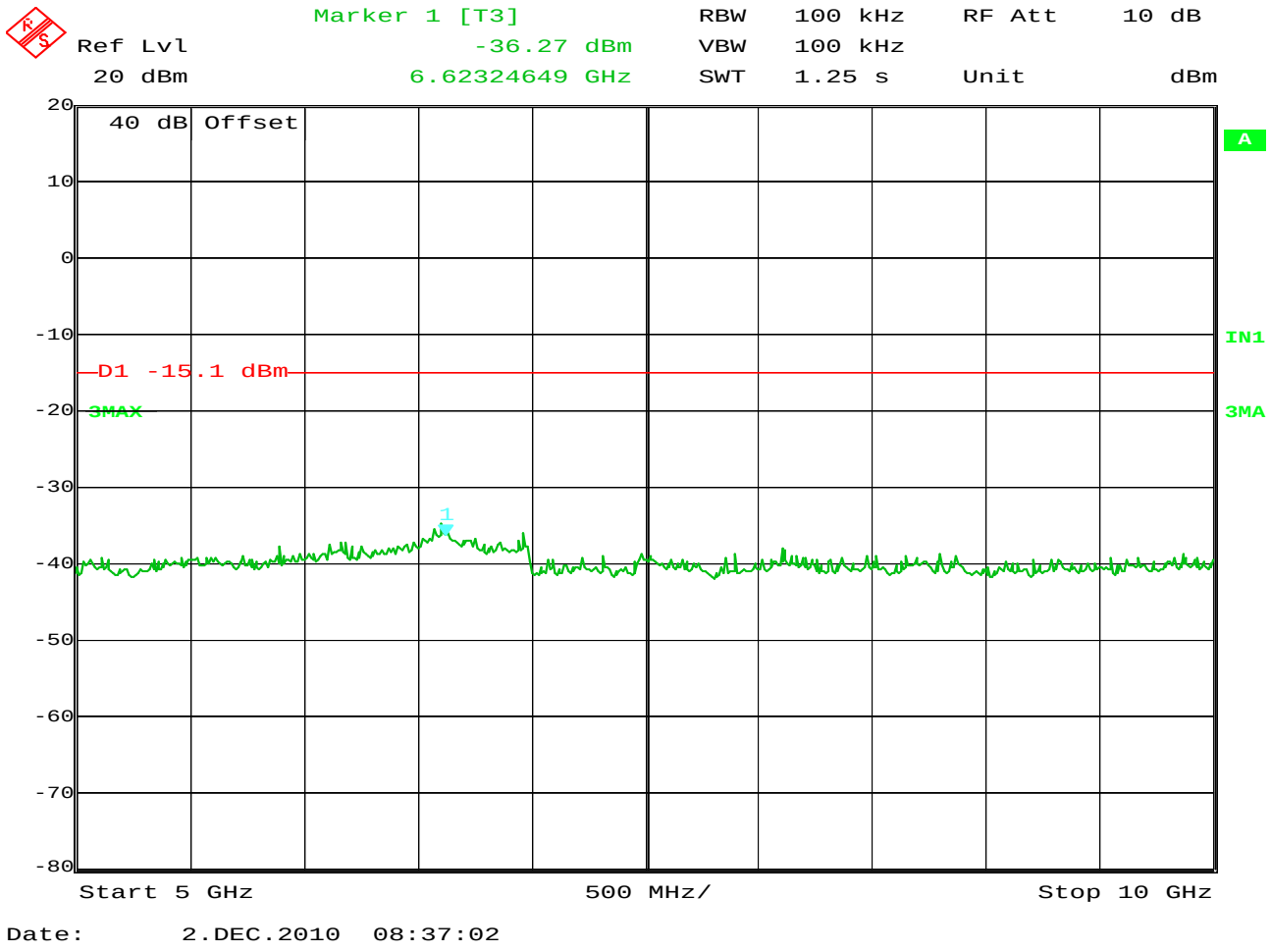
15.247(c) Antenna Conducted Spurious Emissions

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 904.9MHz (Ch. 1)
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	Antenna Conducted Spurious Emissions
NOTES	:	Display Line D1 represents the 20dB down point from the maximum emissions in a 100kHz bandwidth
EQUIPMENT USED	:	RBD1, T2S8, T2DL



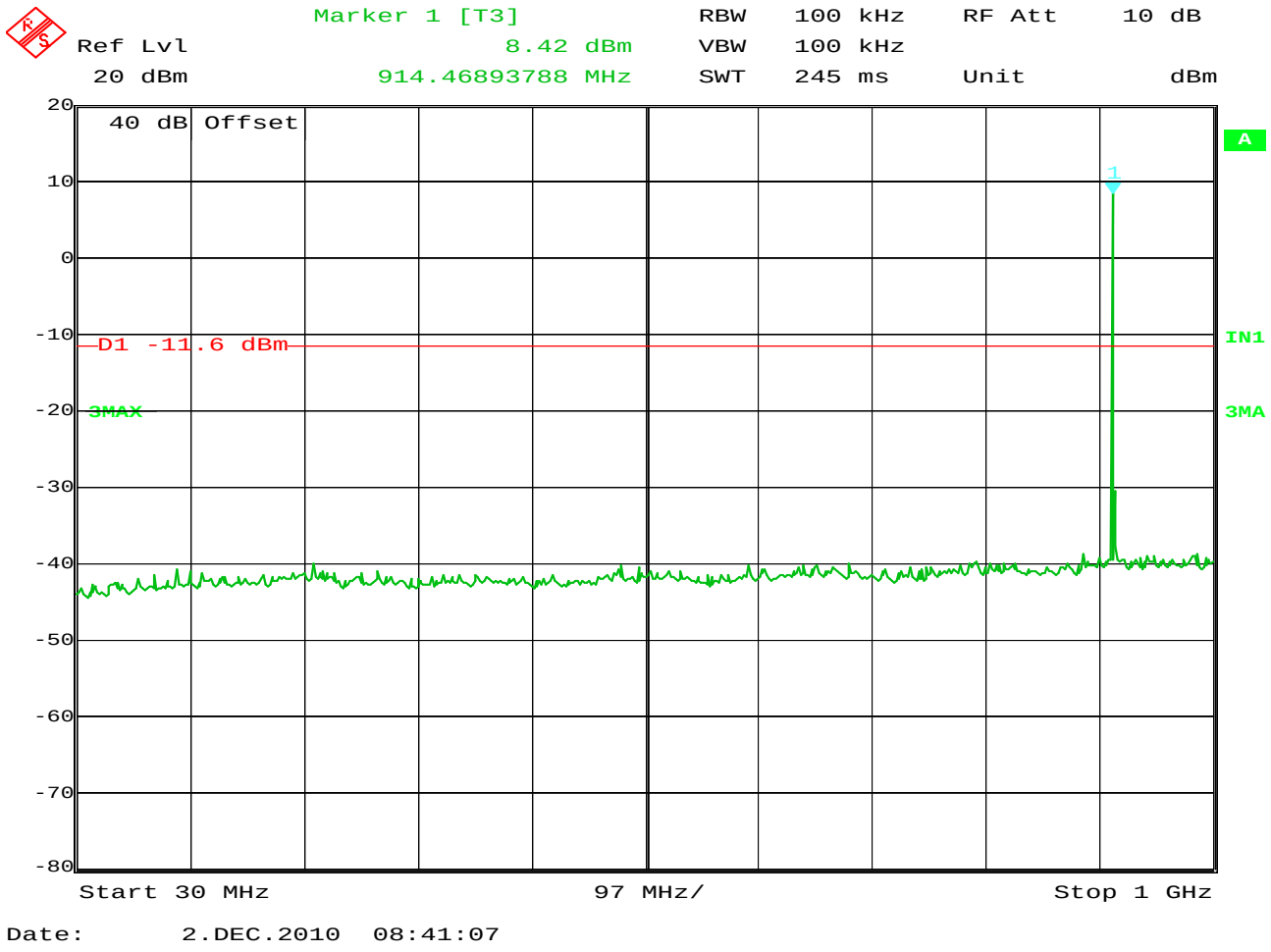
15.247(c) Antenna Conducted Spurious Emissions

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 904.9MHz (Ch. 1)
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	Antenna Conducted Spurious Emissions
NOTES	:	Display Line D1 represents the 20dB down point from the maximum emissions in a 100kHz bandwidth
EQUIPMENT USED	:	RBD1, T2S8, T2DL



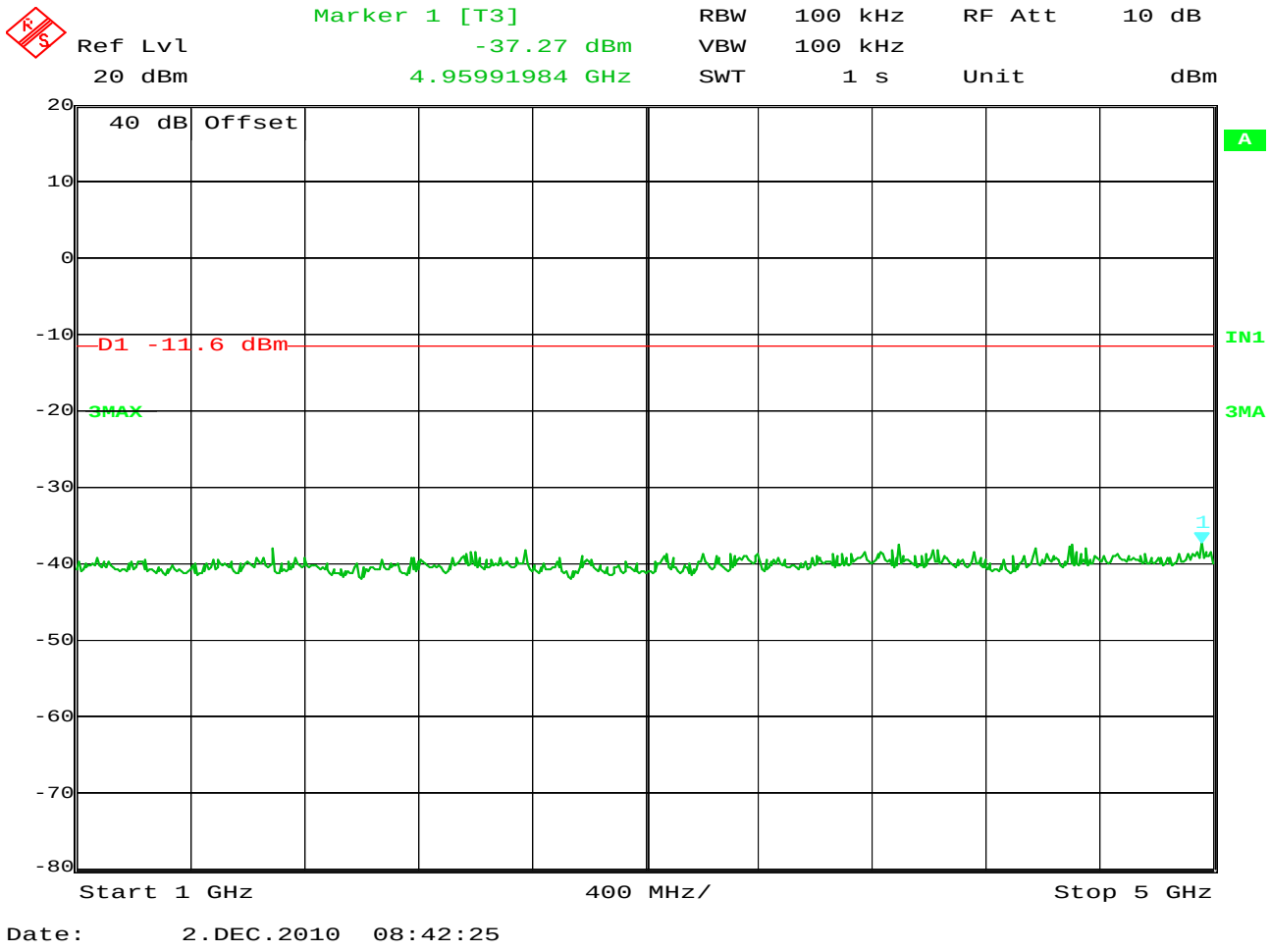
15.247(c) Antenna Conducted Spurious Emissions

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 904.9MHz (Ch. 1)
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	Antenna Conducted Spurious Emissions
NOTES	:	Display Line D1 represents the 20dB down point from the maximum emissions in a 100kHz bandwidth
EQUIPMENT USED	:	RBD1, T2S8, T2DL



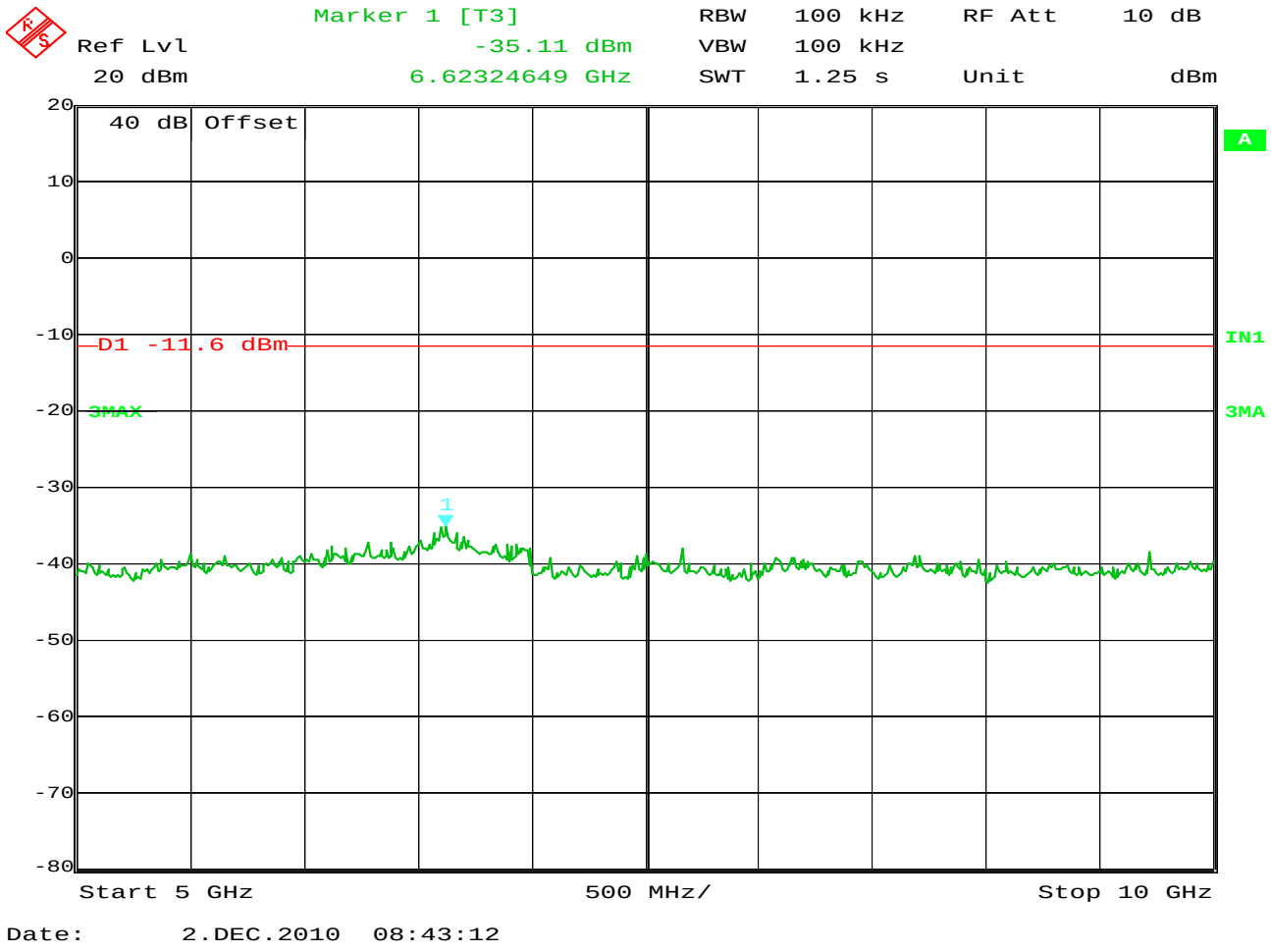
15.247(c) Antenna Conducted Spurious Emissions

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 914MHz (Ch. 24)
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	Antenna Conducted Spurious Emissions
NOTES	:	Display Line D1 represents the 20dB down point from the maximum emissions in a 100kHz bandwidth
EQUIPMENT USED	:	RBD1, T2S8, T2DL



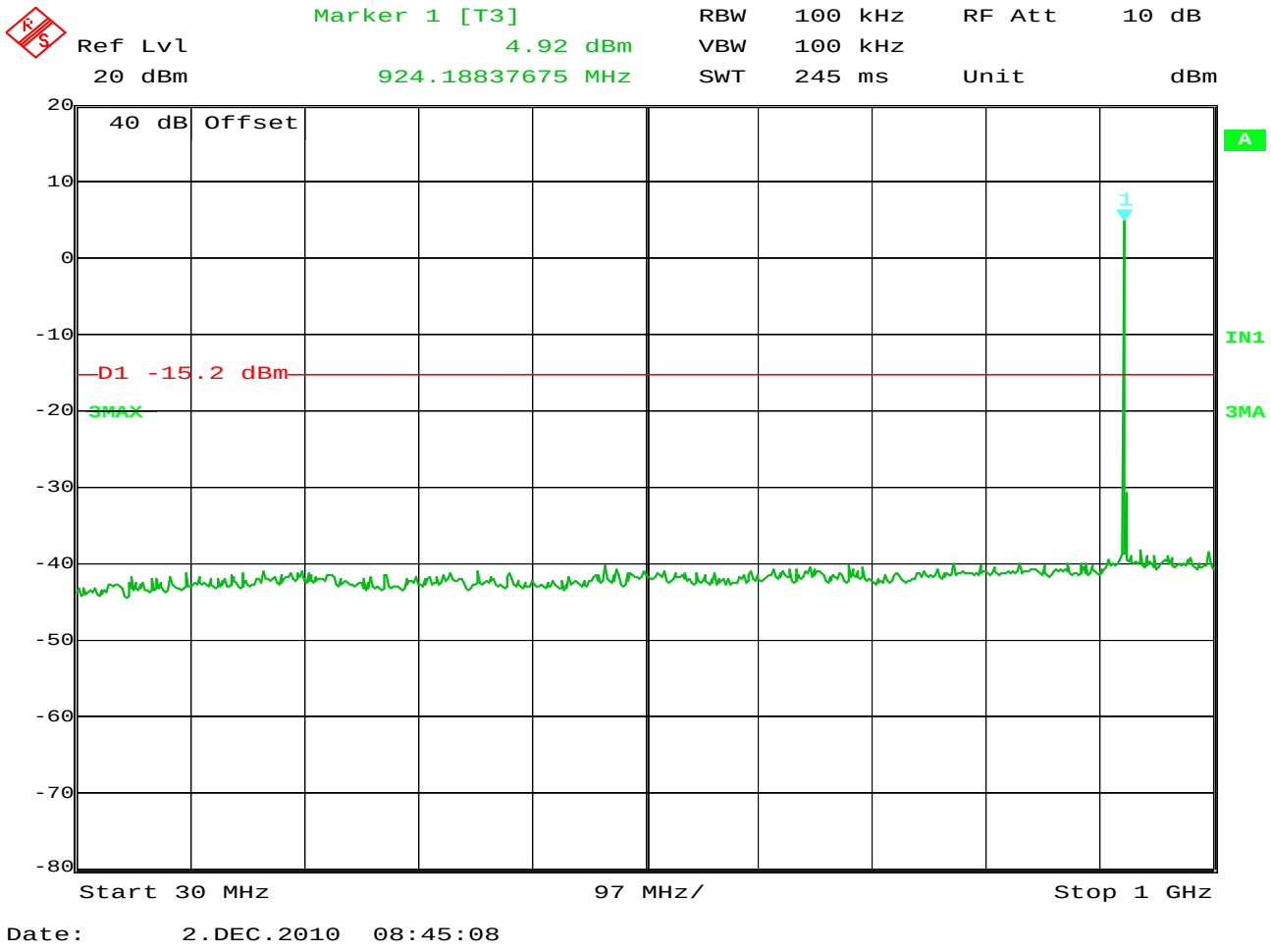
15.247(c) Antenna Conducted Spurious Emissions

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 914MHz (Ch. 24)
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	Antenna Conducted Spurious Emissions
NOTES	:	Display Line D1 represents the 20dB down point from the maximum emissions in a 100kHz bandwidth
EQUIPMENT USED	:	RBD1, T2S8, T2DL



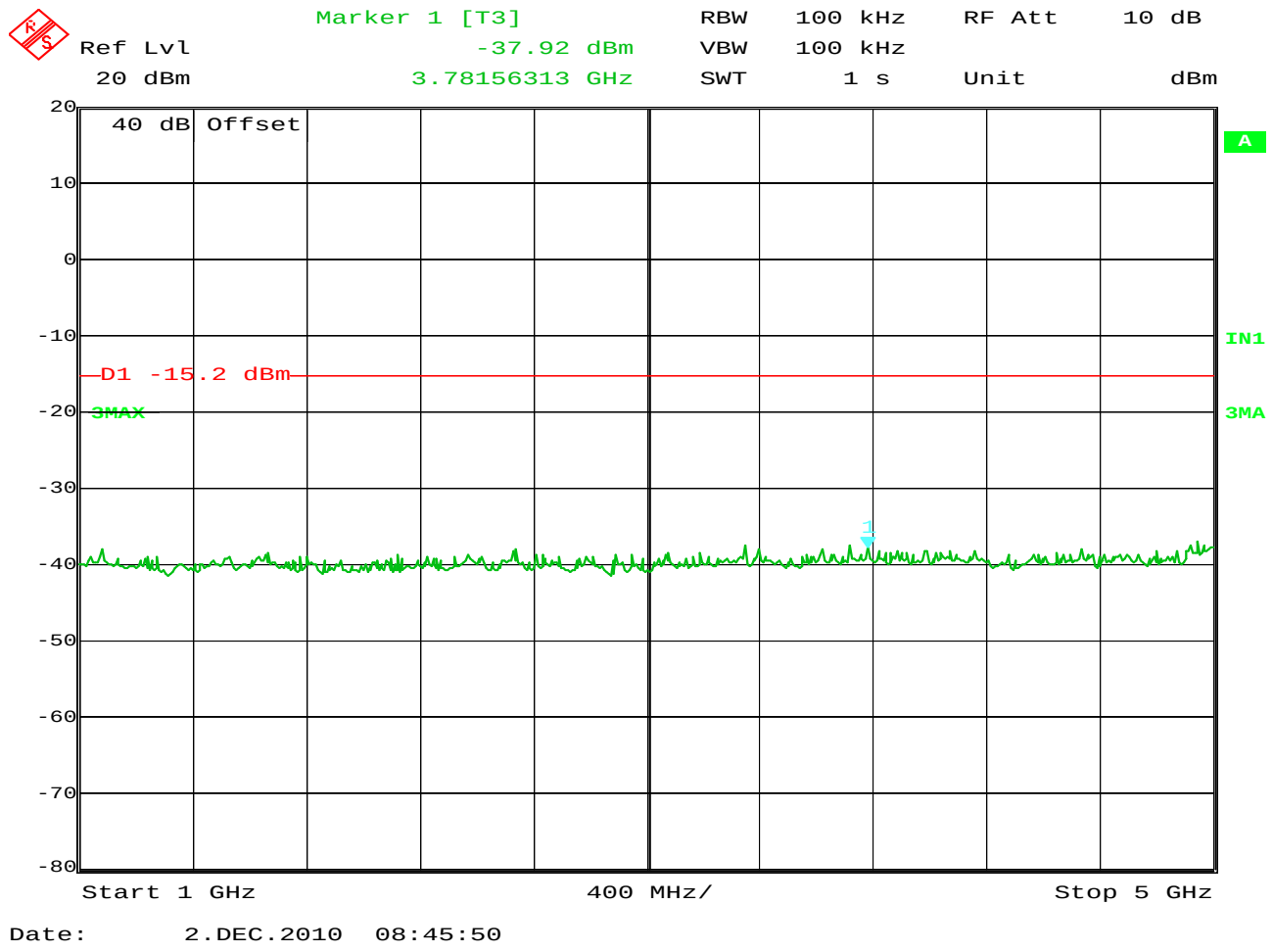
15.247(c) Antenna Conducted Spurious Emissions

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 914MHz (Ch. 24)
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	Antenna Conducted Spurious Emissions
NOTES	:	Display Line D1 represents the 20dB down point from the maximum emissions in a 100kHz bandwidth
EQUIPMENT USED	:	RBD1, T2S8, T2DL



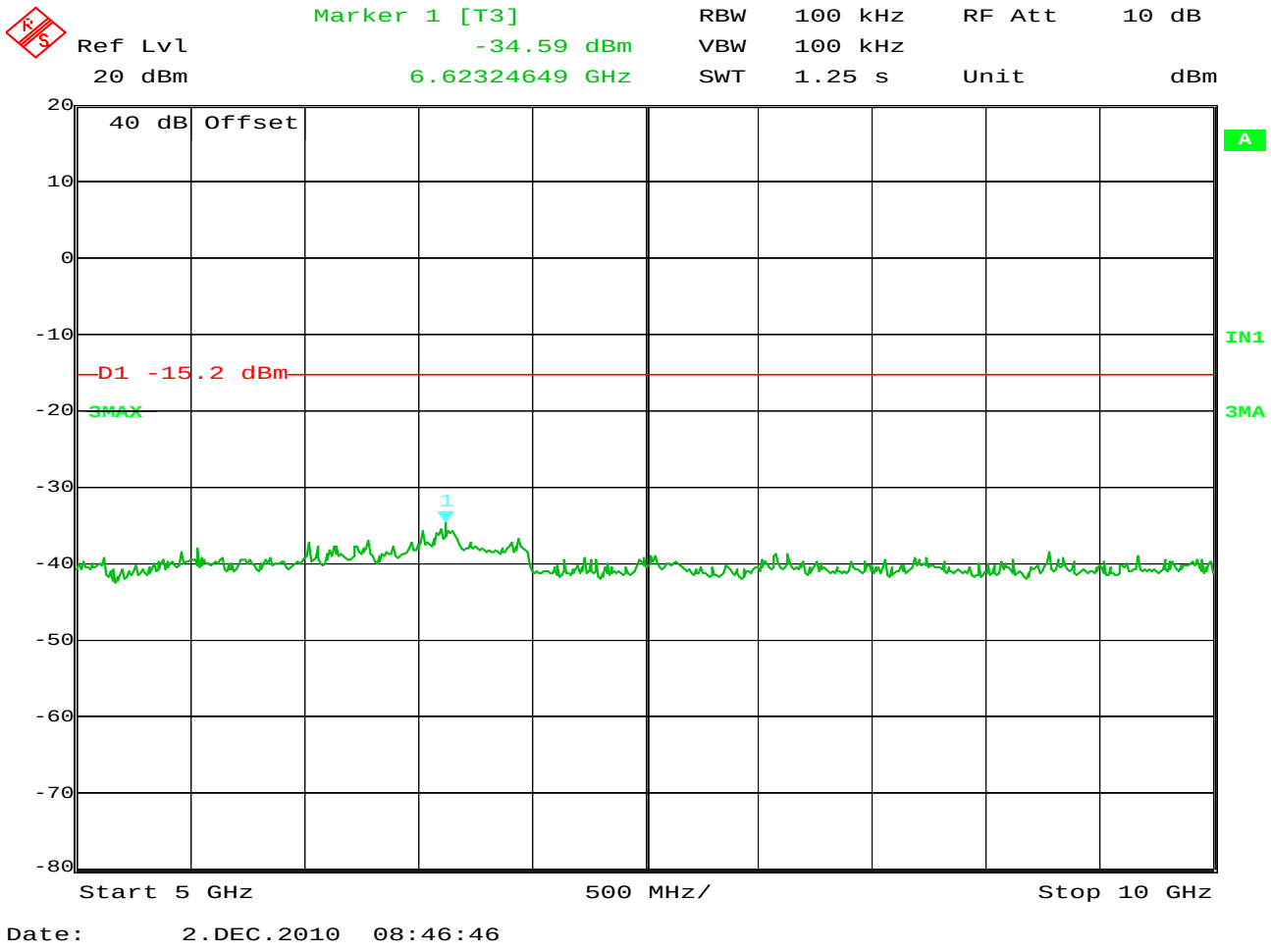
15.247(c) Antenna Conducted Spurious Emissions

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 923.76MHz (Ch. 48)
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	Antenna Conducted Spurious Emissions
NOTES	:	Display Line D1 represents the 20dB down point from the maximum emissions in a 100kHz bandwidth
EQUIPMENT USED	:	RBD1, T2S8, T2DL



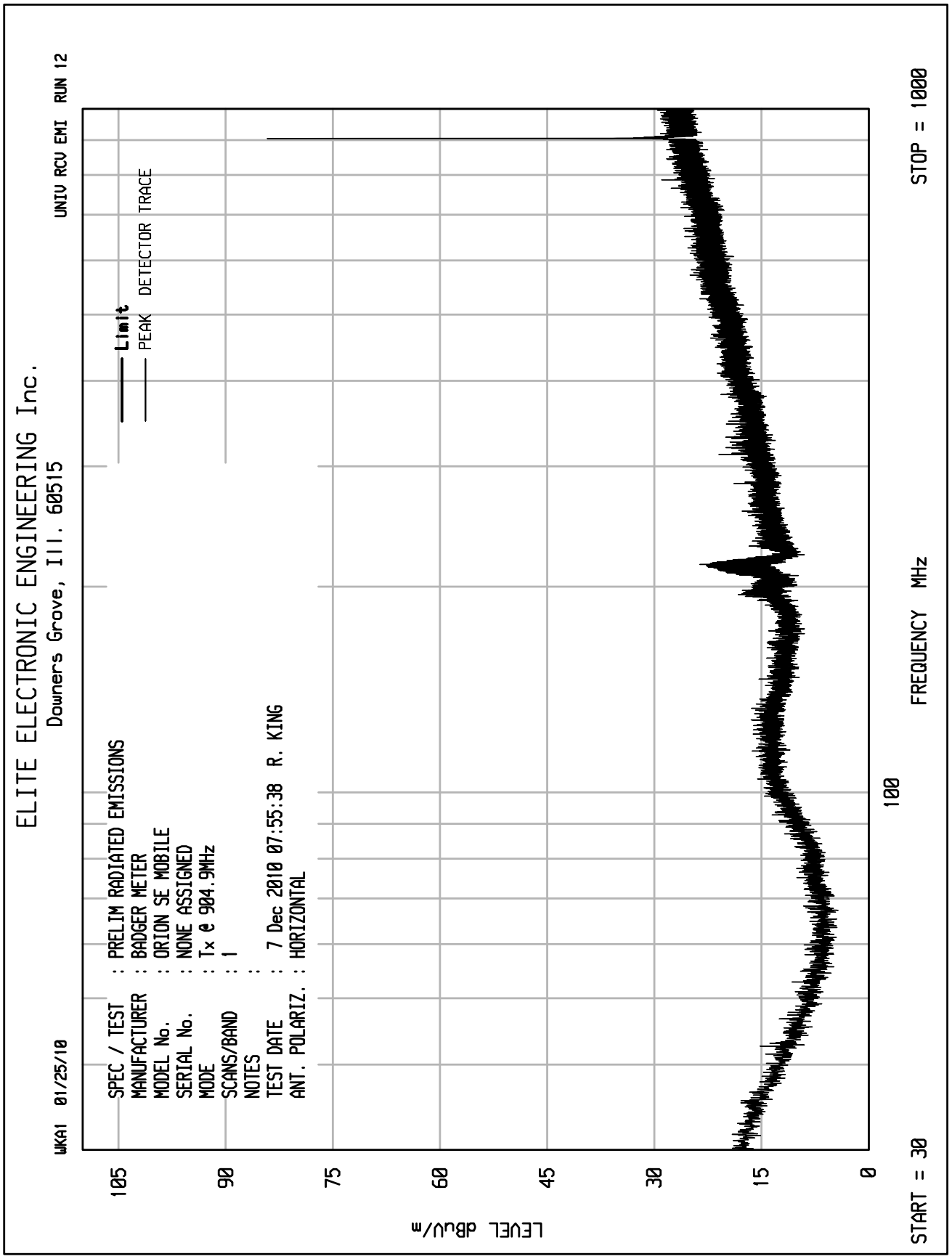
15.247(c) Antenna Conducted Spurious Emissions

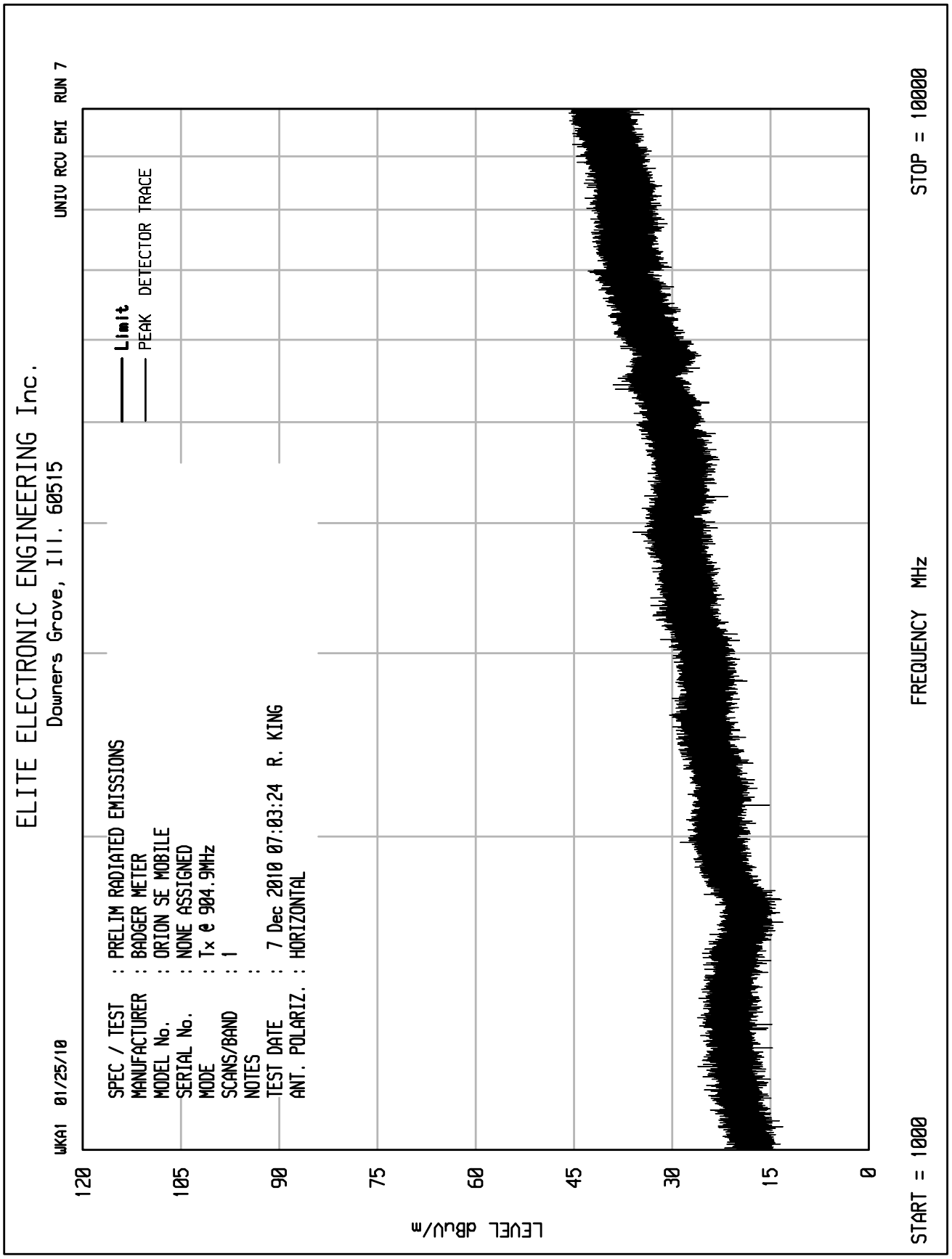
MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 923.76MHz (Ch. 48)
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	Antenna Conducted Spurious Emissions
NOTES	:	Display Line D1 represents the 20dB down point from the maximum emissions in a 100kHz bandwidth
EQUIPMENT USED	:	RBD1, T2S8, T2DL

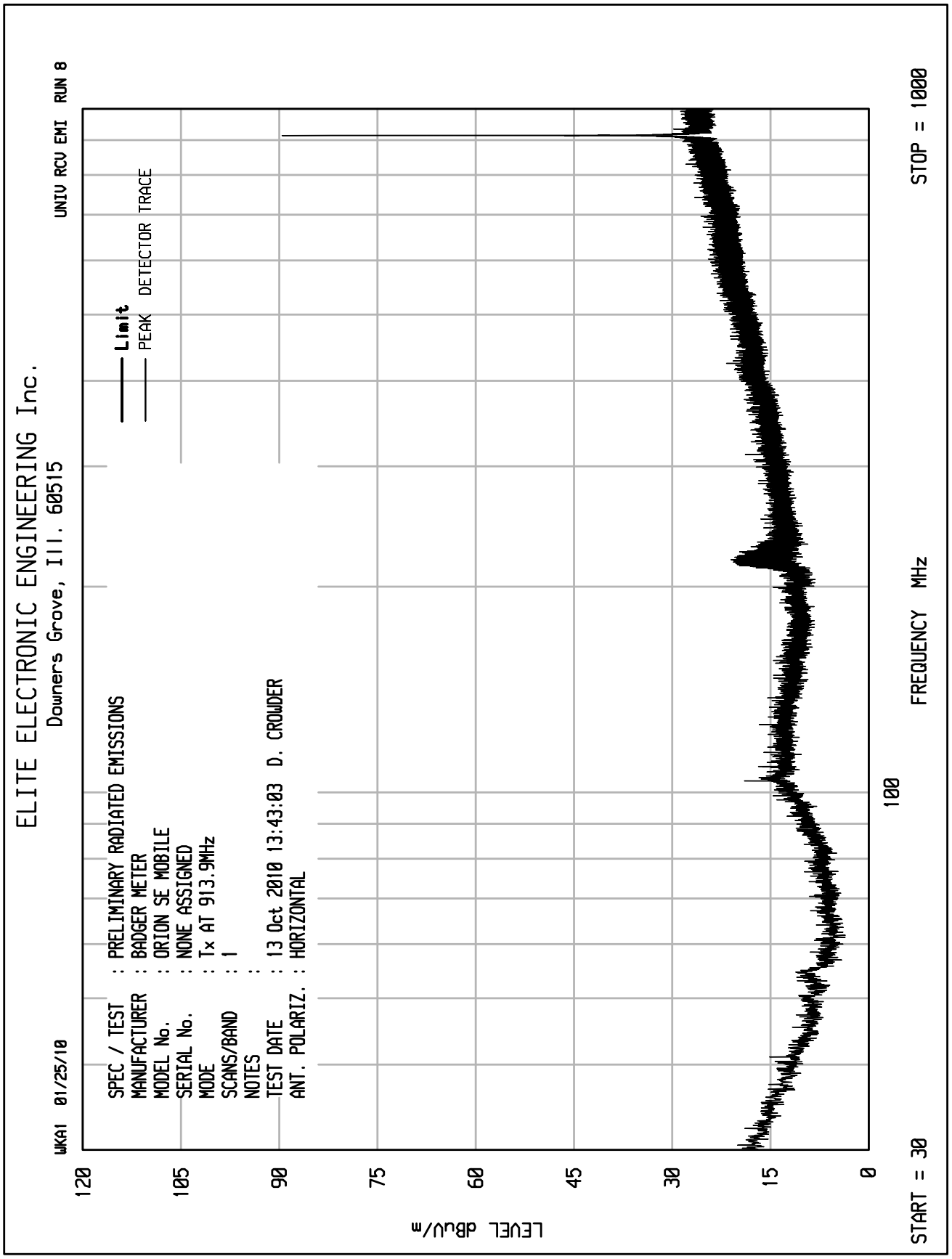


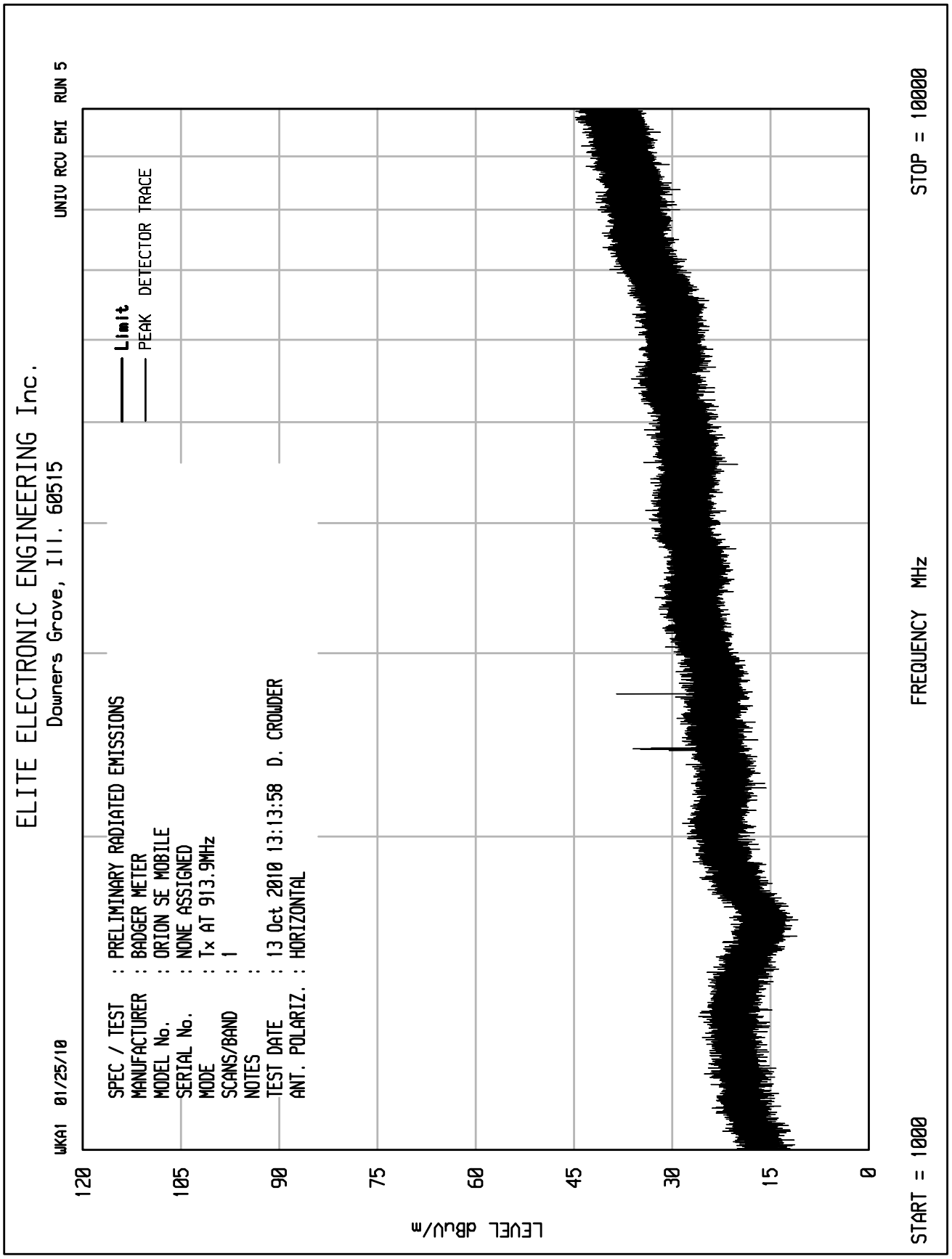
15.247(c) Antenna Conducted Spurious Emissions

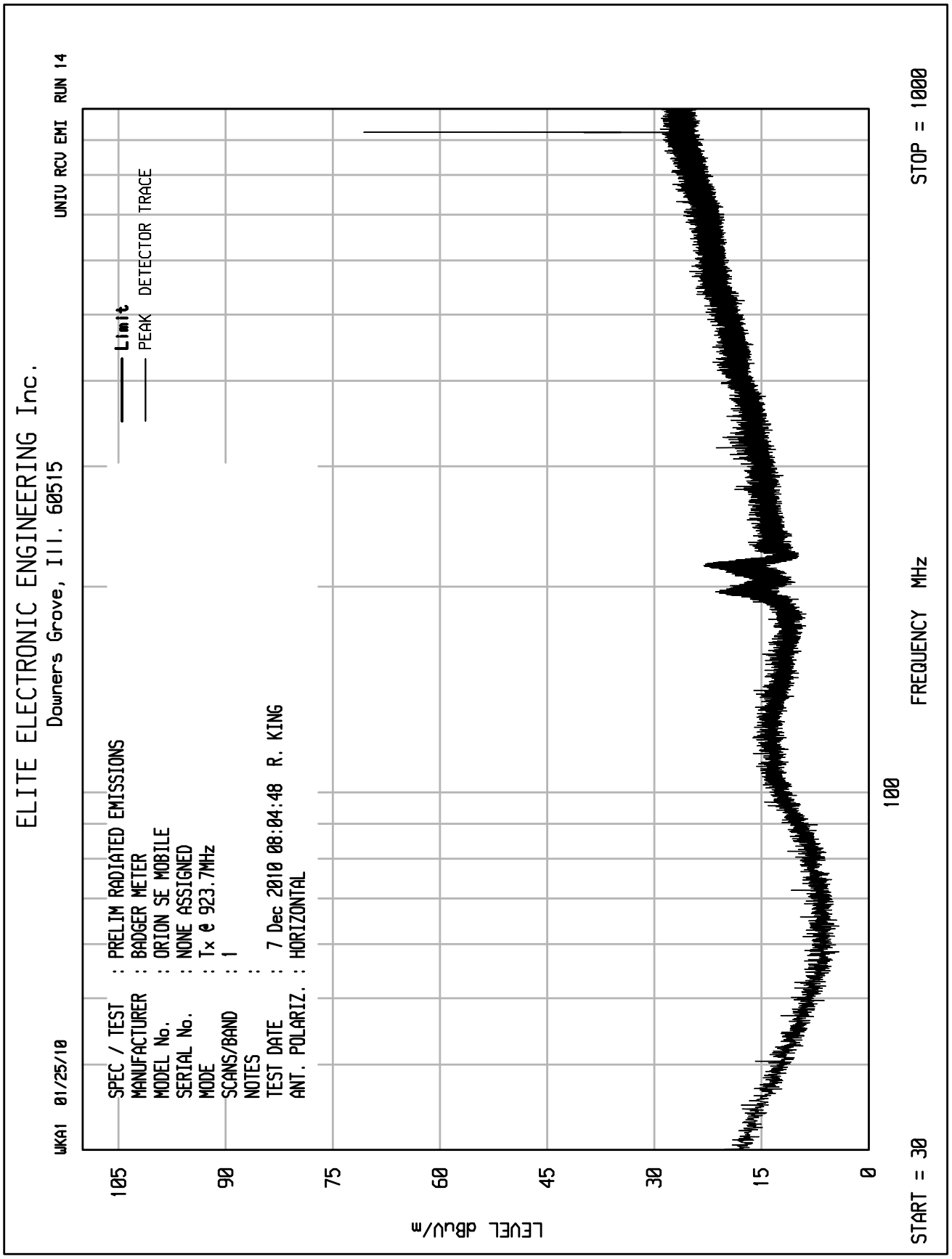
MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 923.76MHz (Ch. 48)
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	Antenna Conducted Spurious Emissions
NOTES	:	Display Line D1 represents the 20dB down point from the maximum emissions in a 100kHz bandwidth
EQUIPMENT USED	:	RBD1, T2S8, T2DL

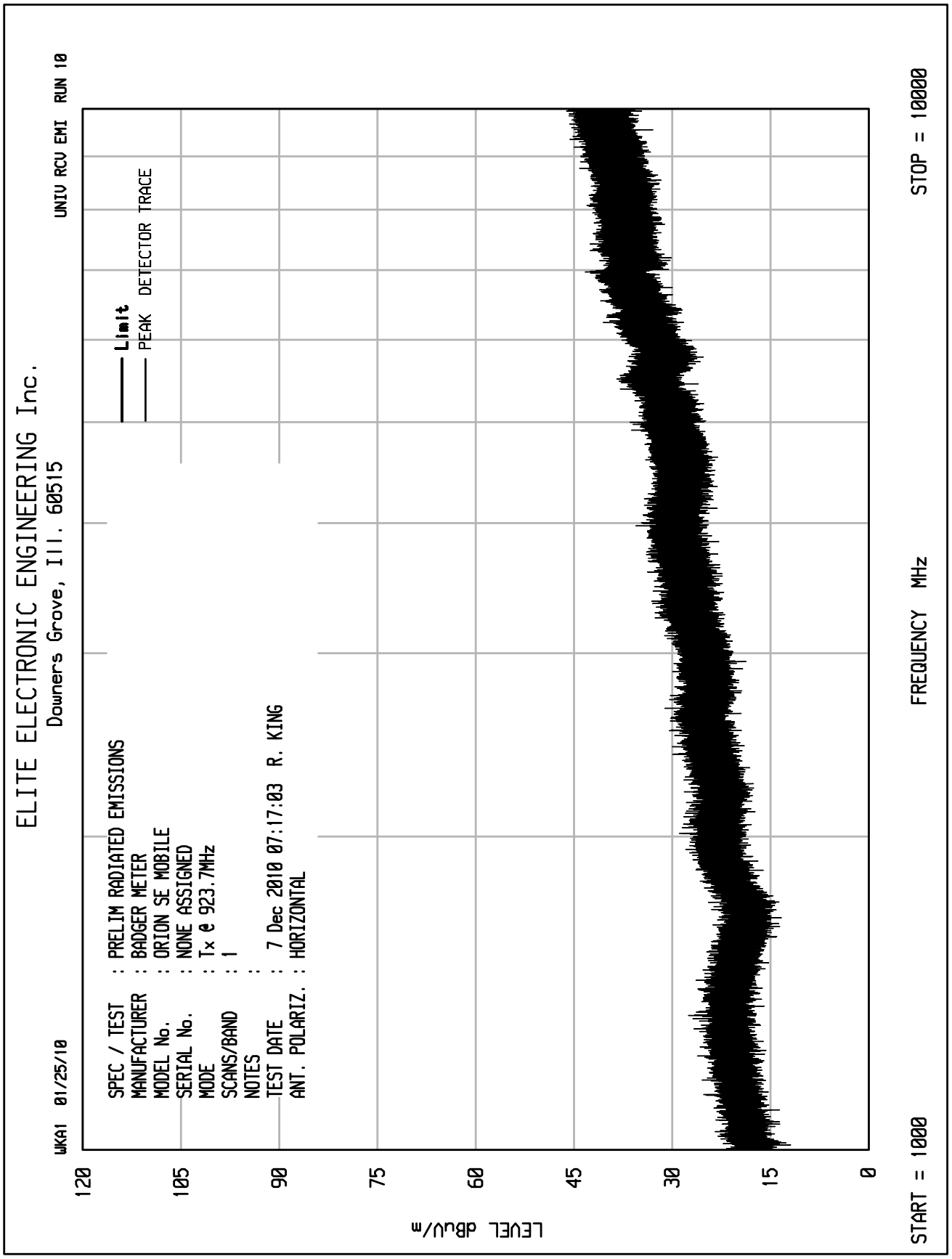

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 12
WKA1 01/25/10
SPEC / TEST : PRELIM RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION SE MOBILE
SERIAL No. : NONE ASSIGNED
MODE : Tx @ 904.9MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 7 Dec 2010 07:55:38 R. KING
ANT. POLARIZ. : HORIZONTAL
Limit
PEAK DETECTOR TRACE
LEVEL dBuV/m
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 7
WKA1 01/25/10
SPEC / TEST : PRELIM RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION SE MOBILE
SERIAL No. : NONE ASSIGNED
MODE : Tx @ 904.9MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 7 Dec 2010 07:03:24 R. KING
ANT. POLARIZ. : HORIZONTAL
Limit
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 10000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 8
WKA1 01/25/10
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION SE MOBILE
SERIAL No. : NONE ASSIGNED
MODE : Tx AT 913.9MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 13 Oct 2010 13:43:03 D. CROWDER
ANT. POLARIZ. : HORIZONTAL
Limit
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 5
WKA1 01/25/10
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION SE MOBILE
SERIAL No. : NONE ASSIGNED
MODE : Tx AT 913.9MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 13 Oct 2010 13:13:58 D. CROWDER
ANT. POLARIZ. : HORIZONTAL
Limit
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 10000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 14
WKA1 01/25/10
SPEC / TEST : PRELIM RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION SE MOBILE
SERIAL No. : NONE ASSIGNED
MODE : Tx @ 923.7MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 7 Dec 2010 08:04:48 R. KING
ANT. POLARIZ. : HORIZONTAL
Limit
PEAK DETECTOR TRACE
LEVEL dBuV/m
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 10
WKA1 01/25/10
SPEC / TEST : PRELIM RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION SE MOBILE
SERIAL No. : NONE ASSIGNED
MODE : Tx @ 923.7MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 7 Dec 2010 07:17:03 R. KING
ANT. POLARIZ. : HORIZONTAL
Limit
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 10000

Manufacturer : Badger Meter
Model No. : Orion SE Mobile
Serial No. : None Assigned
Specification : FCC-15.247 Spurious Radiated Emissions in Restricted Bands
Date : December 7, 2010
Mode : Tx @ 904.9MHz (Ch. 1)
Equipment Used : RBB0, NTA2, NWH0, APW3, XPQ2, SES1
Notes : Test Distance is 3 meters
Notes : Peak Readings in Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Total dBuV/m at 3 M	Total uV/m at 3M	Limit uV/m at 3M	Margin (dB)
2714.7	H	50.6		3.9	30.2	-39.3	45.4	185.6	5000.0	-28.6
2714.7	V	49.2		3.9	30.2	-39.3	43.9	157.2	5000.0	-30.1
3619.6	H	46.6	Ambient	4.7	33.1	-38.5	45.9	197.1	5000.0	-28.1
3619.6	V	47.1	Ambient	4.7	33.1	-38.5	46.3	207.6	5000.0	-27.6
4524.5	H	45.7	Ambient	5.5	33.5	-38.2	46.6	212.9	5000.0	-27.4
4524.5	V	45.5	Ambient	5.5	33.5	-38.2	46.3	207.1	5000.0	-27.7
5429.4	H	46.2	Ambient	6.2	35.5	-38.2	49.7	304.1	5000.0	-24.3
5429.4	V	46.4	Ambient	6.2	35.5	-38.2	49.9	311.2	5000.0	-24.1
8144.1	H	45.8	Ambient	8.0	37.9	-38.7	52.9	442.9	5000.0	-21.1
8144.1	V	45.5	Ambient	8.0	37.9	-38.7	52.7	429.4	5000.0	-21.3
9049.0	H	45.7	Ambient	8.8	38.3	-38.8	54.0	500.4	5000.0	-20.0
9049.0	V	44.7	Ambient	8.8	38.3	-38.8	53.0	447.0	5000.0	-21.0

H – Horizontal V – Vertical

* - Ambient

Total (dBuV/m) = Meter Reading (dBuV) + Cable Factor (dB) + Antenna Factor (dB) + Pre Amp (dB)
FS (uV/m) = AntiLog [(FS (dBuV/m))/20]

Manufacturer : Badger Meter
Model No. : Orion SE Mobile
Serial No. : None Assigned
Specification : FCC-15.247 Spurious Radiated Emissions in Restricted Bands
Date : December 7, 2010
Mode : Tx @ 904.9MHz (Ch. 1)
Equipment Used : RBB0, NTA2, NWH0, APW3, XPQ2, SES1
Notes : Test Distance is 3 meters
Notes : Average Readings in Restricted Bands

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	Margin (dB)
2714.7	H	43.3		3.9	30.2	-39.3	-13.5	24.6	17.0	500.0	-29.4
2714.7	V	39.8		3.9	30.2	-39.3	-13.5	21.1	11.3	500.0	-32.9
3619.6	H	34.8	Ambient	4.7	33.1	-38.5	-13.5	20.5	10.6	500.0	-33.4
3619.6	V	34.8	Ambient	4.7	33.1	-38.5	-13.5	20.6	10.7	500.0	-33.4
4524.5	H	34.0	Ambient	5.5	33.5	-38.2	-13.5	21.3	11.6	500.0	-32.7
4524.5	V	33.9	Ambient	5.5	33.5	-38.2	-13.5	21.2	11.5	500.0	-32.7
5429.4	H	33.7	Ambient	6.2	35.5	-38.2	-13.5	23.7	15.3	500.0	-30.3
5429.4	V	31.7	Ambient	6.2	35.5	-38.2	-13.5	21.7	12.2	500.0	-32.3
8144.1	H	32.3	Ambient	8.0	37.9	-38.7	-13.5	25.9	19.7	500.0	-28.1
8144.1	V	32.3	Ambient	8.0	37.9	-38.7	-13.5	25.9	19.7	500.0	-28.1
9049.0	H	32.7	Ambient	8.8	38.3	-38.8	-13.5	27.5	23.7	500.0	-26.5
9049.0	V	32.6	Ambient	8.8	38.3	-38.8	-13.5	27.4	23.5	500.0	-26.5

H – Horizontal V – Vertical

* - Ambient

Total (dBuV/m) = Meter Reading (dBuV) + Cable Factor (dB) + Antenna Factor (dB) + Pre Amp (dB) + Duty Cycle (dB)
FS (uV/m) = AntiLog [(FS (dBuV/m))/20]

Manufacturer : Badger Meter
Model No. : Orion SE Mobile
Serial No. : None Assigned
Specification : FCC-15.247 Spurious Radiated Emissions in Restricted Bands
Date : October 13, 2010
Mode : Tx @ 913.9MHz (Ch. 24)
Equipment Used : RBB0, NTA2, NWH0, APW3, XPQ2, SES1
Notes : Test Distance is 3 meters
Notes : Peak Readings in Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Total dBuV/m at 3 M	Total uV/m at 3M	Limit uV/m at 3M	Margin (dB)
2741.700	H	51.7		3.9	30.3	-39.3	46.6	214.5	5000.0	-27.3
2741.700	V	49.5		3.9	30.3	-39.3	44.4	166.5	5000.0	-29.5
3655.600	H	46.0	Ambient	4.7	33.2	-38.5	45.4	186.0	5000.0	-28.6
3655.600	V	46.7	Ambient	4.7	33.2	-38.5	46.1	201.6	5000.0	-27.9
4569.500	H	45.7	Ambient	5.5	33.7	-38.2	46.7	215.7	5000.0	-27.3
4569.500	V	45.4	Ambient	5.5	33.7	-38.2	46.4	208.3	5000.0	-27.6
7311.200	H	46.2	Ambient	7.7	37.8	-38.4	53.2	457.7	18372.9	-32.1
7311.200	V	46.0	Ambient	7.7	37.8	-38.4	53.0	447.3	18372.9	-32.3
8225.100	H	45.6	Ambient	8.1	37.9	-38.7	52.8	436.2	5000.0	-21.2
8225.100	V	46.6	Ambient	8.1	37.9	-38.7	53.8	489.4	5000.0	-20.2
9139.000	H	46.7	Ambient	8.7	38.4	-38.7	55.1	568.5	5000.0	-18.9
9139.000	V	47.7	Ambient	8.7	38.4	-38.7	56.1	637.9	5000.0	-17.9

H – Horizontal V – Vertical

* - Ambient

Total (dBuV/m) = Meter Reading (dBuV) + Cable Factor (dB) + Antenna Factor (dB) + Pre Amp (dB)
FS (uV/m) = AntiLog [(FS (dBuV/m))/20]

Manufacturer : Badger Meter
Model No. : Orion SE Mobile
Serial No. : None Assigned
Specification : FCC-15.247 Spurious Radiated Emissions in Restricted Bands
Date : October 13, 2010
Mode : Tx @ 913.9MHz (Ch. 24)
Equipment Used : RBB0, NTA2, NWH0, APW3, XPQ2, SES1
Notes : Test Distance is 3 meters
Notes : Average Readings in Restricted Bands

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	Margin (dB)
2741.7	H	45.9		3.9	30.3	-39.3	-13.5	27.3	23.3	500.0	-26.6
2741.7	V	42.4		3.9	30.3	-39.3	-13.5	23.8	15.5	500.0	-30.1
3655.6	H	34.3	Ambient	4.7	33.2	-38.5	-13.5	20.2	10.2	500.0	-33.8
3655.6	V	34.5	Ambient	4.7	33.2	-38.5	-13.5	20.4	10.5	500.0	-33.6
4569.5	H	33.7	Ambient	5.5	33.7	-38.2	-13.5	21.2	11.4	500.0	-32.8
4569.5	V	33.8	Ambient	5.5	33.7	-38.2	-13.5	21.3	11.6	500.0	-32.7
7311.2	H	34.4	Ambient	7.7	37.8	-38.4	-13.5	27.9	24.9	500.0	-26.1
7311.2	V	34.6	Ambient	7.7	37.8	-38.4	-13.5	28.1	25.4	500.0	-25.9
8225.1	H	34.6	Ambient	8.1	37.9	-38.7	-13.5	28.3	26.0	500.0	-25.7
8225.1	V	34.7	Ambient	8.1	37.9	-38.7	-13.5	28.4	26.3	500.0	-25.6
9139.0	H	35.0	Ambient	8.7	38.4	-38.7	-13.5	29.9	31.2	500.0	-24.1
9139.0	V	35.1	Ambient	8.7	38.4	-38.7	-13.5	30.0	31.6	500.0	-24.0

H – Horizontal V – Vertical

* - Ambient

Total (dBuV/m) = Meter Reading (dBuV) + Cable Factor (dB) + Antenna Factor (dB) + Pre Amp (dB) + Duty Cycle (dB)
FS (uV/m) = AntiLog [(FS (dBuV/m))/20]

Manufacturer : Badger Meter
Model No. : Orion SE Mobile
Serial No. : None Assigned
Specification : FCC-15.247 Spurious Radiated Emissions in Restricted Bands
Date : December 7, 2010
Mode : Tx @ 923.7MHz (Ch. 48)
Equipment Used : RBB0, NTA2, NWH0, APW3, XPQ2, SES1
Notes : Test Distance is 3 meters
Notes : Peak Readings in Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Total dBuV/m at 3 M	Total uV/m at 3M	Limit uV/m at 3M	Margin (dB)
2771.1	H	52.1		4.0	30.4	-39.2	47.2	228.4	5000.0	-26.8
2771.1	V	53.3		4.0	30.4	-39.2	48.4	261.9	5000.0	-25.6
3694.8	H	45.9	Ambient	4.8	33.3	-38.5	45.5	187.4	5000.0	-28.5
3694.8	V	45.3	Ambient	4.8	33.3	-38.5	44.8	173.4	5000.0	-29.2
4618.5	H	45.5	Ambient	5.6	33.8	-38.2	46.7	215.5	5000.0	-27.3
4618.5	V	44.9	Ambient	5.6	33.8	-38.2	46.0	199.5	5000.0	-28.0
7389.6	H	45.5	Ambient	7.7	37.9	-38.5	52.7	431.5	5000.0	-21.3
7389.6	V	45.7	Ambient	7.7	37.9	-38.5	52.8	438.0	5000.0	-21.2
8313.3	H	46.9	Ambient	8.2	37.9	-38.8	54.1	508.5	5000.0	-19.9
8313.3	V	46.9	Ambient	8.2	37.9	-38.8	54.1	508.5	5000.0	-19.9

H – Horizontal V – Vertical

* - Ambient

Total (dBuV/m) = Meter Reading (dBuV) + Cable Factor (dB) + Antenna Factor (dB) + Pre Amp (dB)
FS (uV/m) = AntiLog [(FS (dBuV/m))/20]

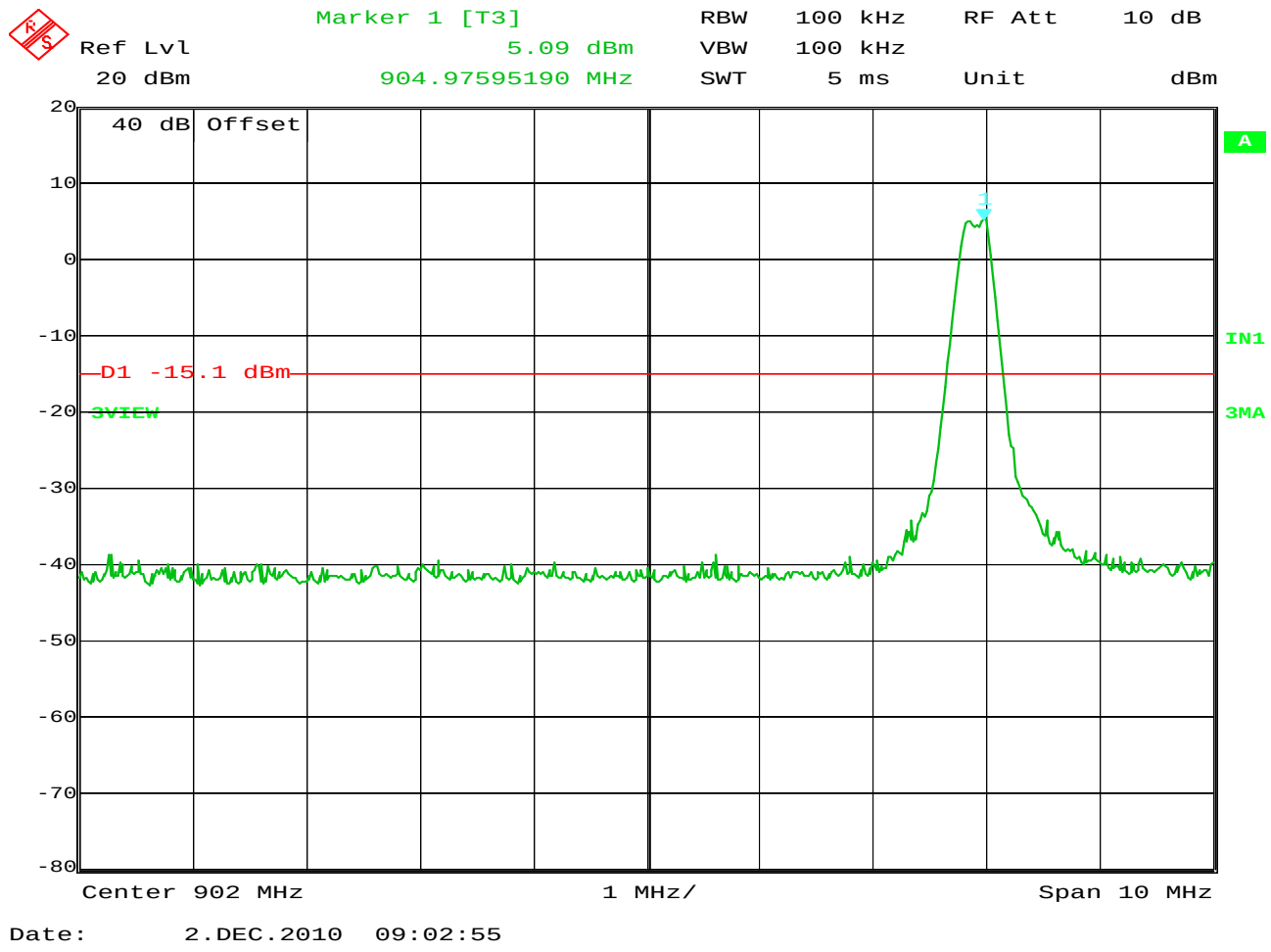
Manufacturer : Badger Meter
Model No. : Orion SE Mobile
Serial No. : None Assigned
Specification : FCC-15.247 Spurious Radiated Emissions in Restricted Bands
Date : December 7, 2010
Mode : Tx @ 923.7MHz (Ch. 48)
Equipment Used : RBB0, NTA2, NWH0, APW3, XPQ2, SES1
Notes : Test Distance is 3 meters
Notes : Average Readings in Restricted Bands

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	Margin (dB)
2771.1	H	47.8		4.0	30.4	-39.2	-13.5	29.4	29.4	500.0	-24.6
2771.1	V	47.5		4.0	30.4	-39.2	-13.5	29.1	28.4	500.0	-24.9
3694.8	H	32.9	Ambient	4.8	33.3	-38.5	-13.5	18.9	8.8	500.0	-35.1
3694.8	V	33.0	Ambient	4.8	33.3	-38.5	-13.5	19.0	8.9	500.0	-35.0
4618.5	H	31.6	Ambient	5.6	33.8	-38.2	-13.5	19.2	9.2	500.0	-34.7
4618.5	V	31.6	Ambient	5.6	33.8	-38.2	-13.5	19.2	9.1	500.0	-34.8
7389.6	H	32.1	Ambient	7.7	37.9	-38.5	-13.5	25.8	19.5	500.0	-28.2
7389.6	V	32.2	Ambient	7.7	37.9	-38.5	-13.5	25.9	19.7	500.0	-28.1
8313.3	H	32.5	Ambient	8.2	37.9	-38.8	-13.5	26.3	20.6	500.0	-27.7
8313.3	V	32.4	Ambient	8.2	37.9	-38.8	-13.5	26.2	20.4	500.0	-27.8

H – Horizontal V – Vertical

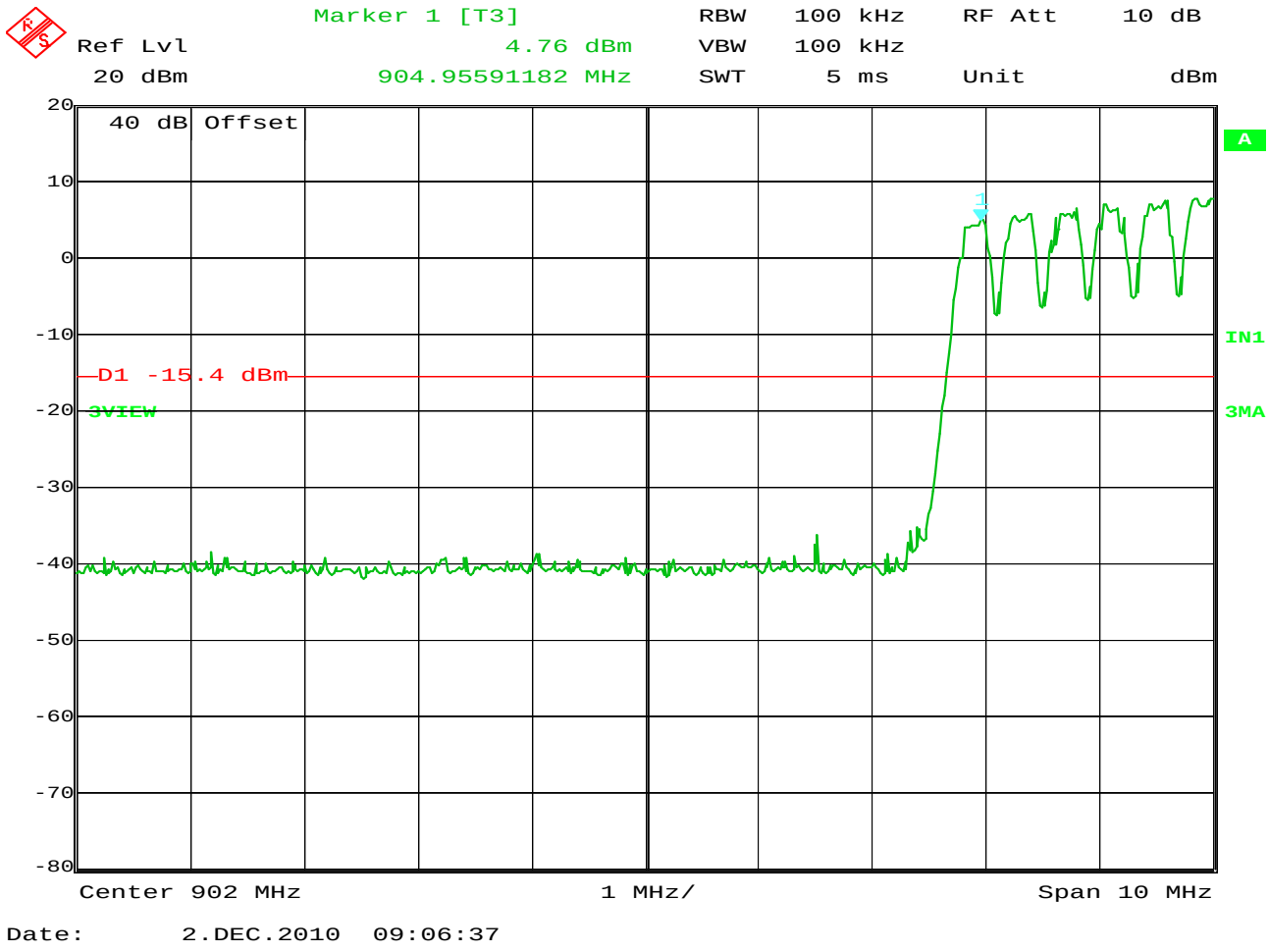
* - Ambient

Total (dBuV/m) = Meter Reading (dBuV) + Cable Factor (dB) + Antenna Factor (dB) + Pre Amp (dB) + Duty Cycle (dB)
FS (uV/m) = AntiLog [(FS (dBuV/m))/20]



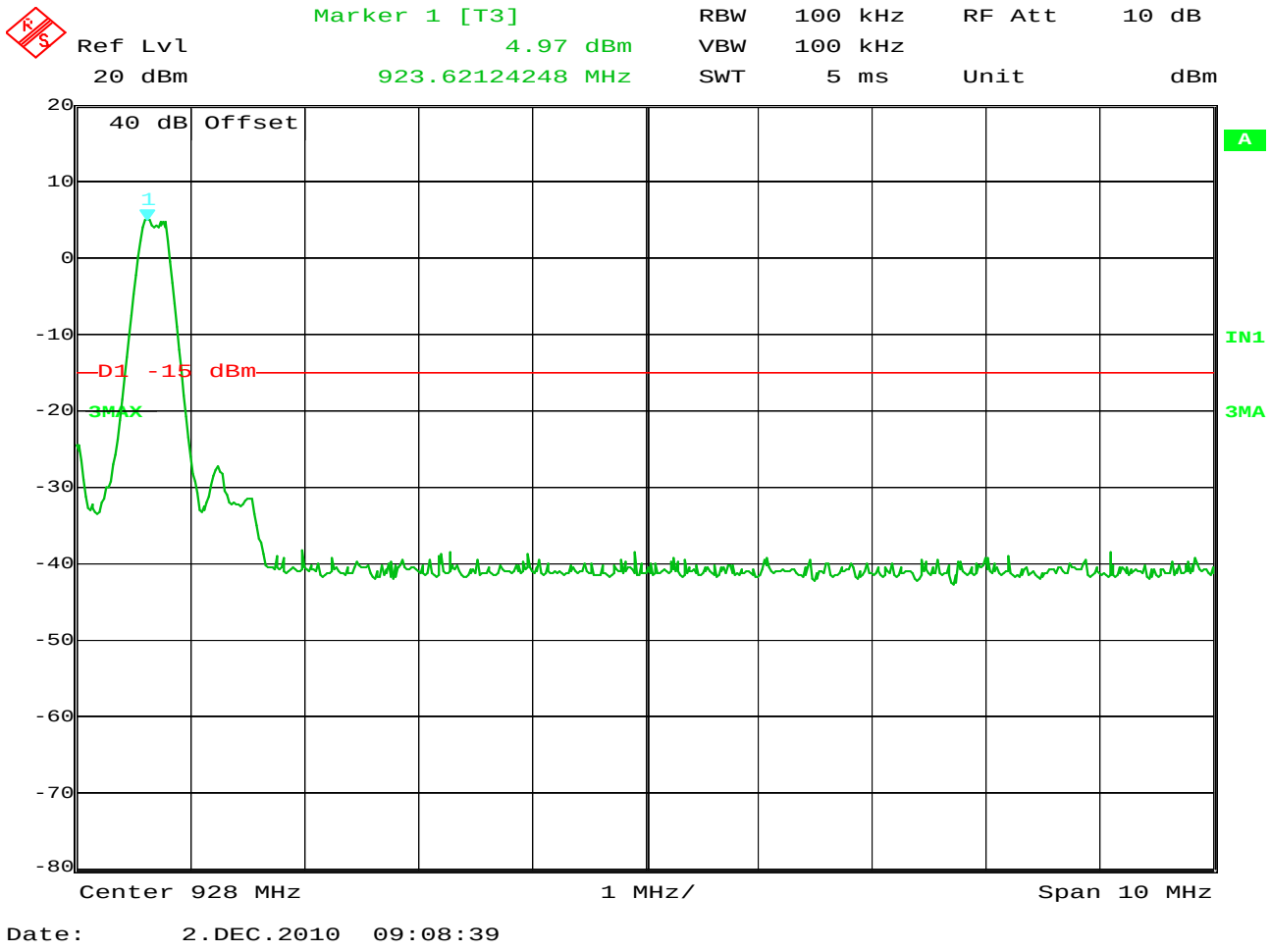
15.247(d) Band Edge Compliance

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 904.9MHz (Ch. 1)
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	Band Edge Test
NOTES	:	Display Line D1 represents the 20dB down point from the peak emissions in a 100kHz bandwidth. The center line represents the band edge (902MHz).
EQUIPMENT USED	:	RBD1, T2S8, T2DL



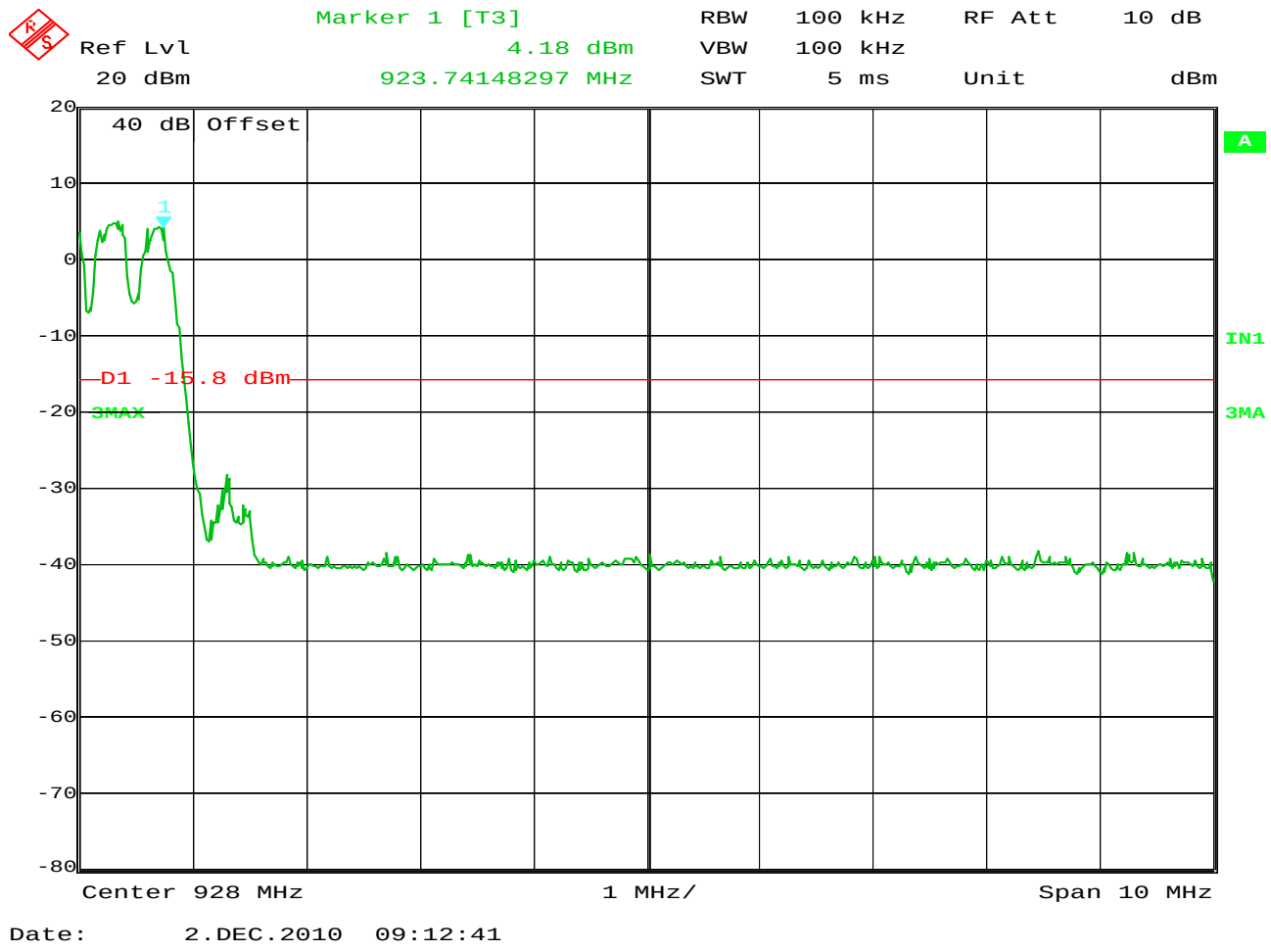
15.247(d) Band Edge Compliance

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Hopping Enabled
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	Band Edge Test
NOTES	:	Display Line D1 represents the 20dB down point from the peak emissions in a 100kHz bandwidth. The center line represents the band edge (902MHz).
EQUIPMENT USED	:	RBD1, T2S8, T2DL



15.247(d) Band Edge Compliance

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 923.7MHz (Ch. 48)
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	Band Edge Test
NOTES	:	Display Line D1 represents the 20dB down point from the peak emissions in a 100kHz bandwidth. The center line represents the band edge (928MHz).
EQUIPMENT USED	:	RBD1, T2S8, T2DL



15.247(d) Band Edge Compliance

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Hopping Enabled
NOTES	:	
TEST DATE	:	December 2, 2010
TEST PARAMETERS	:	Band Edge Test
NOTES	:	Display Line D1 represents the 20dB down point from the peak emissions in a 100kHz bandwidth. The center line represents the band edge (928MHz).
EQUIPMENT USED	:	RBD1, T2S8, T2DL