Measurement of RF Interference from an Orion SE Mobile Transceiver

For	Badger Meter Inc. 4545 W. Brown Deer Road Milwaukee, WI 53223
P.O. Number	272783
Date Tested	June 11 – 13, 2014
Test Personnel	Richard King
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 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

Test Report By:

Richard King
EMC Engineer

Requested By:

Kelly Laughlin-Parker
Badger Meter Inc.

Approved By:

Raymond J. Klouda
Registered Professional
Engineer of Illinois - 44894

Elite Electronic Engineering Inc.
1516 Centre Circle
Downers Grove, IL 60515
Tel : (630) 495-9770
Fax: (630) 495-9785
www.elitetest.com

TABLE OF CONTENTS

REVISION HISTORY

Revision	Date	Description
—	17 July 2014	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, No Serial No. was assigned, transceiver (hereinafter referred to as 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 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 7.2.4 and Section 6.1 for receivers and the Industry Canada Radio Standards Specification RSS-Gen Section 7.2.4 and RSS-210 Annex 8, for Transmitters.

Testing was performed in accordance with ANSI C63.4-2009.

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 22.4C and the relative humidity was 34%.

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 2013

- ANSI C63.4-2009, "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 8,December 2010, “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 3, December 2010, “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 and Figure 2.

3.1.1 Power Input

The EUT was powdered by 5VDC over USB cable.

3.1.2 Peripheral Equipment

The following peripheral equipment was submitted with the EUT:

Item	Description
Laptop Computer	Dell Latitude M/N: E6430 with DELL AC Adapter FA90PM111

3.1.3 Interconnect Cables

The following interconnect cables were submitted with the EUT:

Item	Description
USB Cable	36 feet of USB repeater cable was used to connect the EUT to the laptop computer. The cable was used to provide 5VDC power to the EUT and to program the EUT via the laptop computer. The 36 feet of USB repeater cable was used for spurious radiated emissions tests and for peak output power tests (EIRP). The laptop computer was external to the test chamber.
USB Cable	Six feet of standard USB cable was used to connect the EUT to the laptop computer. The cable was used to provide 5VDC power to the EUT and to program the EUT via the laptop computer. The 5 feet of standard USB cable was used for all tests except spurious radiated emissions tests and for peak output power tests (EIRP).
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 Software

For all tests the EUT had Firmware Version M.35 loaded onto the device to provide correct load characteristics.

3.3 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
- Transmit at 914.1MHz
- Transmit at 923.7MHz
- Receive at 904.9MHz
- Receive at 914.1MHz

- Receive at 923.7MHz
- Frequency Hopping Enabled

3.4 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 C63.4-2009 for site attenuation.

4.2 Test Instrumentation

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

Conducted emission tests were performed with a spectrum analyzer in conjunction with a quasi-peak adapter. Radiated emissions were performed with a spectrum analyzer. This receiver allows measurements with the specified bandwidths and with the quasi-peak and average detector functions.

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 Emissions Measurements		
Combined Standard Uncertainty	1.06	-1.06
Expanded Uncertainty (95% confidence)	2.12	-2.12

Radiated Emissions Measurements		
Combined Standard Uncertainty	2.09	-2.09
Expanded Uncertainty (95% confidence)	4.19	-4.19

5. TEST PROCEDURES

5.1 Receiver

5.1.1 Powerline Conducted Emissions

5.1.1.1 Requirements

Per the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B, 15.107(a) and Industry Canada RSS-Gen section 7.2.4, all radio frequency voltages on the power lines of a receiver shall be below the values shown below when using a quasi-peak or average detector:

CONDUCTED LIMITS FOR A RECEIVER

Frequency MHz	RFI Voltage dBuV(QP)	RFI Voltage dBuV(Average)
0.15-0.5	66 decreasing with logarithm of frequency to 56	56 decreasing with logarithm of frequency to 46
0.5-5	56	46
5-30	60	50

Note 1: The lower limit shall apply at the transition frequencies.
Note 2: If the levels measured using the QP detector meet both the QP and the Average limits, the EUT is considered to have met both requirements and measurements do not need to be performed using the Average detector.

5.1.1.2 Procedures

The interference on each power lead of the EUT was measured by connecting the measuring equipment to the appropriate meter terminal of the Line Impedance Stabilization Network (LISN). The meter terminal of the LISN not under test was terminated with 50 ohms.

a) The laptop computer used to power the EUT via power over USB was operated in the Running Windows mode.

b) Measurements were first made on the 115V, 60Hz high line of the Dell M/N: FA90PM111 used to provide 19.5VDC to the laptop computer.

c) The frequency range from 150 kHz to 30 MHz was broken up into smaller frequency sub-bands.

d) Conducted emissions measurements were taken on the first frequency sub-band using a peak detector.

e) The data thus obtained was then searched by the computer for the highest levels. Any emissions levels that were within 10dB of the average limit were then measured again using both a quasi-peak detector and an average detector. (If no peak readings were within 10dB of the average limit, quasi-peak and average readings were taken on the highest emissions levels measured during the peak detector scan.)

f) Steps (d) and (e) were repeated for the remainder of the frequency sub-bands until the entire frequency range from 150kHz to 30MHz was investigated. The peak trace was automatically plotted. The plot also shows quasi-peak and average readings that were taken on discrete frequencies. A table showing the quasi-peak and average readings was also generated. This tabular data compares the quasi-peak and average conducted emissions to the applicable conducted emissions limits.

g) Steps (c) through (f) were repeated on the 115V, 60Hz return line of the Dell M/N: FA90PM111 used to provide 19.5VDC to the laptop computer.

h) Steps (b) through (g) were repeated with the EUT (powered via power over USB from the Dell M/N: FA90PM111 laptop computer) operated in the Receive at 914.1MHz mode.

5.1.1.3 Results

The plots of the peak, quasi-peak, and average conducted voltage levels acquired from each input power line with the EUT to receive at the middle channel mode are shown on pages 25 and 27. The tabular quasi-peak and average results from each input power line with the EUT to receive at the middle channel mode are shown on pages 24 and 26. All power line conducted emissions measured from the EUT were within the specification limits.

Photographs of the test configuration which yielded the highest or worst case, conducted emission levels are shown on Figure 3.

5.1.2 FCC Antenna Power Conducted Emissions

5.1.2.1 Requirements

Per the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B, Section 15.111, receivers that provide terminals for the connection of an external receiving antenna may be tested to demonstrate compliance with the radiated emissions limits with the antenna terminals shielded and terminated with a resistive termination equal to the impedance specified for the antenna, provided these receivers also comply with the following: With the receiver antenna terminal connected to a resistive termination equal to the impedance specified or employed for the antenna, the power at the antenna terminal at any frequency within the range of measurements shall not exceed 2.0 nanowatts..

5.1.2.2 Procedures

The output of the EUT was connected to the spectrum analyzer. The EUT was set to receive continuously. Testing was performed separately on a low, middle, and high channel. The emissions in the frequency range of 30MHz to 5GHz were measured and plotted using a ‘screen-dump’ utility.

5.1.2.3 Results

The results of the antenna conducted measurements are presented on pages 28 through 30. The antenna power conducted limits are shown on the plots. As can be seen from the data, all emissions from the EUT were below the 2 nanowatt requirements. Since the emissions were below the 2 nanowatt limit, the antenna port can be terminated with a shielded load for the radiated emissions measurements.

5.1.3 Industry Canada Antenna Power Conducted Emissions

5.1.3.1 Requirements

Per the Industry Canada, RSS-GEN section 6.2, if a conducted measurement is made, no spurious output signals appearing at the antenna terminals shall exceed 2 nanowatts in the band 30-1000 MHz, or 5 nanowatts above 1 GHz.

5.1.3.2 Procedures

The output of the EUT was connected to the spectrum analyzer. The EUT was set to receive continuously. Testing was performed on a middle channel. The emissions in the frequency range of 30MHz to 3 times the highest tunable or local oscillator frequency, whichever is the higher, were measured and plotted.

5.1.3.3 Results

The results of the antenna conducted measurements are presented on pages 31 through 33. The antenna power conducted limits are shown on the plots. As can be seen from the data, all emissions from the EUT were below the specification requirements.

5.1.4 Radiated Measurements

5.1.4.1 Requirements

Per the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B, Section 15.109(a) and Industry Canada RSS-Gen, Section 6.1, 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.

5.1.4.2 Procedures

For FCC, testing was performed separately on a low, middle, and high channel. 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.

For Industry Canada, testing was performed on a middle channel. The emissions in the frequency range of 30MHz to 3 times the highest tunable or local oscillator frequency, whichever is the higher, were measured and plotted. 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 C63.4-2009 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 an average 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.

5.1.4.3 Results

The preliminary plots for the low-channel are presented on pages 20 through 37. The plots are presented for a reference only, and are not used to determine compliance. The final radiated levels are presented on page 38 and 39. As can be seen from the data, all emissions measured from the EUT were within the specification limits.

The preliminary plots for the mid-channel are presented on pages 40 through 43. The plots are presented for a reference only, and are not used to determine compliance. The final radiated levels are presented on page 44 and 45. As can be seen from the data, all emissions measured from the EUT were within the specification limits.

The preliminary plots for the high channel are presented on pages 46 through 82. The plots are presented for a reference only, and are not used to determine compliance. The final radiated levels are presented on page 50 and 51. 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 Figures 4 and 5.

5.2 Transmitter

5.2.1 Powerline Conducted Emissions

5.2.1.1 Requirements

Per the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Per 15.207(a) and Industry Canada RSS-Gen section 7.2.4, all radio frequency voltages on the power lines of a transmitter shall be below the values shown below when using a quasi-peak or average detector:

Frequency MHz	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 – 0.5	66 decreasing with logarithm of frequency to 56	56 decreasing with logarithm of frequency to 46
0.5 - 5	56	46
5 - 30	60	50

Note 1: The lower limit shall apply at the transition frequencies.
Note 2: If the levels measured using the QP detector meet both the QP and the Average limits, the EUT is considered to have met both requirements and measurements do not need to be performed using the Average detector.

5.2.1.2 Procedures

The interference on each power lead of the EUT was measured by connecting the measuring equipment to the

appropriate meter terminal of the Line Impedance Stabilization Network (LISN). The meter terminal of the LISN not under test was terminated with 50 ohms.

a) The laptop computer used to power the EUT via power over USB was operated in the Running Windows mode.

b) Measurements were first made on the 115V, 60Hz high line of the Dell M/N: FA90PM111 used to provide 19.5VDC to the laptop computer.

c) The frequency range from 150 kHz to 30 MHz was broken up into smaller frequency sub-bands.

d) Conducted emissions measurements were taken on the first frequency sub-band using a peak detector.

e) The data thus obtained was then searched by the computer for the highest levels. Any emissions levels that were within 10dB of the average limit were then measured again using both a quasi-peak detector and an average detector. (If no peak readings were within 10dB of the average limit, quasi-peak and average readings were taken on the highest emissions levels measured during the peak detector scan.)

f) Steps (d) and (e) were repeated for the remainder of the frequency sub-bands until the entire frequency range from 150kHz to 30MHz was investigated. The peak trace was automatically plotted. The plot also shows quasi-peak and average readings that were taken on discrete frequencies. A table showing the quasi-peak and average readings was also generated. This tabular data compares the quasi-peak and average conducted emissions to the applicable conducted emissions limits.

g) Steps (c) through (f) were repeated on the 115V, 60Hz return line of the Dell M/N: FA90PM111 used to provide 19.5VDC to the laptop computer.

a) Steps (b) through (g) were repeated with the EUT (powered via power over USB from the Dell M/N: FA90PM111 laptop computer) operated in the transmit at 914.1MHz mode.

5.2.1.3 Results

The plots of the peak, quasi-peak, and average conducted voltage levels acquired from each input power line with the EUT set to transmit at the mid channel are shown on pages 53 and 55. The tabular quasi-peak and average results from each input power line with the EUT set to transmit at the mid channel are shown on pages 52 and 54. All power line conducted emissions measured from the EUT were within the specification limits.

Photographs of the test configuration which yielded the highest or worst case, conducted emission levels are shown on Figure 2.

5.2.2 20dB Bandwidth

5.2.2.1 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.

5.2.2.2 Procedures

The output of the EUT was connected to 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.

5.2.2.3 Results

The plots on pages 56 through 58 show that the maximum 20 dB bandwidth was 282.56kHz. The 99% bandwidth was measured to be 272.5kHz.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.

5.2.3 Carrier Frequency Separation

5.2.3.1 Requirements

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

5.2.3.2 Procedures

The output of the EUT was connected to the spectrum analyzer through 40dB of attenuation. 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.

5.2.3.3 Results

Page 59 shows the carrier frequency separation. As can be seen from this plot, the carrier frequency separation is 399.79kHz, which is greater than the 20dB bandwidth (282.56kHz).

5.2.4 Number of Hopping Frequencies

5.2.4.1 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.

5.2.4.2 Procedures

The output of the EUT was connected to the spectrum analyzer through 40dB of attenuation. 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.

5.2.4.3 Results

Page 60 shows the number of hopping frequencies. As can be seen from this plot, the number of hopping frequencies is 47 which is greater than 25 which is the minimum number of required hopping frequencies for systems with a 20dB bandwidth greater than 250kHz.

5.2.5 Time of Occupancy

5.2.5.1 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.

5.2.5.2 Procedures

The output of the EUT was connected to the spectrum analyzer through 40dB of attenuation. With the hopping function enabled, the EUT was allowed to transmit continuously.

The resolution bandwidth (RBW) was set to 100kHz. 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 to capture the number of hops in the appropriate sweep time. A single sweep was made. The analyzer's display was plotted using a 'screen dump' utility. The dwell time in the specified time period was then calculated from dwell time per hop multiplied by the number of hops in the specified time period.

5.2.5.3 Results

Pages 61 and 62 show the plots for the time of occupancy. As can be seen from the plots, the time of occupancy can be determined by the dwell time/hop multiplied by the number of hops: 10.8msec/hop x 2 hops/10sec = 21.6msec = 0.0216sec. This calculated value is equal to 0.0216 seconds which is less than the 0.4 seconds maximum allowed.

5.2.6 Antenna Conducted Peak Output Power

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).

5.2.6.2 Procedures

The output of the EUT was connected to 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 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.

5.2.6.3 Results

The results are presented on pages 63 through 65. The maximum peak conducted output power from the transmitter was 0.025W (14.01dBm) which is below the 0.25 Watts limit.

5.2.7 Effective Isotropic Radiated Power (EIRP)

5.2.7.1 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.

5.2.7.2 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.

5.2.7.3 Results

The results are presented on page 66. The maximum EIRP measured from the transmitter was 0.091W (19.6dBm) which is below the 1 Watt limit.

5.2.8 Duty Cycle Factor Measurements

5.2.8.1 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 1msec/div. The amplitude settings are adjusted so that the on/off transitions clear the 4th division from the bottom of the display. The markers are set at the beginning and end of the “on-time”. The trace is recorded.

Next the spectrum analyzer center frequency is set to the transmitter frequency with a zero span width and 10msec/div. This shows if the word is longer than 100msec or shorter than 100msec. If the word period is less than 100msec, the display is set to show at least one word. The on-time and off-time are then measured. The on-time is total time signal level exceeds the 4th division. Off-time is time under for the word period. The duty cycle is then computed as the (On-time/ word period) where the word period = (On-time + Off-time).

5.2.8.2 Results

The plots of the duty cycle are shown on data page 70. The EUT transmits a 10.8msec pulse approximately every 5 seconds. Since a word is greater than 100 msec long, the duty cycle factor was computed over a 100msec interval. The duty cycle correction factor was calculated to be -19.3dB (-19.3dB = 20*log(10.8msec/100msec).

5.2.9 Antenna Conducted Spurious Emissions

5.2.9.1 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

5.2.9.2 Procedures

The output of the EUT was connected to the spectrum analyzer through 40dB 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.

5.2.9.3 Results

The results of the antenna conducted emissions levels were plotted. These plots are presented on pages 67

through 69. These plots show that the spurious emissions were at least 20 dB below the level of the fundamental.

5.2.10 Radiated Spurious Emissions Measurements

5.2.10.1 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

5.2.10.2 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

1) 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).

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).

5.2.10.3 Results

Preliminary radiated emissions plots with the EUT transmitting at 904.9MHz, 914.1MHz, and 923.7MHz are shown on pages 71 through 82. Final radiated emissions data are presented on data pages 83 through 88. 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 4 and Figure 5.

5.2.11 Band Edge Compliance

5.2.11.1 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.

5.2.11.2 Procedures

5.2.11.2.1 Low Band Edge

1) The output of the EUT was connected to the spectrum analyzer through 40dB 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.

5.2.11.2.2 High Band Edge

1) The output of the EUT was connected to the spectrum analyzer through 40dB 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.

5.2.11.3 Results

Pages 89 through 92 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, no serial number assigned, did fully meet the conducted and radiated 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 C63.4-2009.

It was also determined that the Badger Meter Inc. Orion SE Mobile, frequency hopping spread spectrum transceiver, no serial number assigned, did fully meet the conducted and radiated RF emission requirements of the Industry Canada Radio Standards Specification, RSS-Gen, Section 7.2.4 and Section 6.1 for receivers and the Industry Canada Radio Standards Specification RSS-Gen Section 7.2.4 and RSS-210 Annex 8 for transmitters, when tested per ANSI C63.4-2009.

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 certification, approval, or endorsement by NVLAP, NIST or any agency of the Federal Government.

9. EQUIPMENT LIST

Table 9-1 Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
APW11	PREAMPLIFIER	PMI	PE2-35-120-5R0-10-12-SFF	PL11685/1241	1GHZ-20GHZ	3/11/2014	3/11/2015
CDX8	COMPUTER	ELITE	WORKSTATION			N/A	
GRD0	SIGNAL GENERATOR	HEWLETT PACKARD	E4432B	US38080222	250KHZ-3.0GHZ	8/23/2013	8/23/2014
NDQ1	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	313	400-1000MHZ	4/17/2014	4/17/2015
NTA3	BILOG ANTENNA	TESEQ	6112D	28040	25-1000MHz	2/19/2014	2/19/2015
PLF1	CISPR16 50UH LISN	ELITE	CISPR16/70A	001	.15-30MHz	6/5/2014	6/5/2015
PLF2	CISPR16 50UH LISN	ELITE	CISPR16/70A	002	.15-30MHz	6/5/2014	6/5/2015
RAKI	RF SECTION	HEWLETT PACKARD	85462A	3411A00181	0.009-6500MHZ	3/19/2014	3/19/2015
RAKJ	RF FILTER SECTION	HEWLETT PACKARD	85460A	3330A00154	---	3/19/2014	3/19/2015
RBA0	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB26	100145	20HZ-26.5GHZ	3/7/2014	3/7/2015
RBB0	EMI TEST RECEIVER 20HZ TO 40 GHZ.	ROHDE & SCHWARZ	ESIB40	100250	20 HZ TO 40GHZ	3/11/2014	3/11/2015
T1EP	10DB 25W ATTENUATOR	WEINSCHEL	46-10-34	CD6792	DC-18GHZ	6/12/2014	6/12/2015
T2DH	20DB, 25W ATTENUATOR	WEINSCHEL	46-20-34	BN1039	DC-18GHZ	11/7/2013	11/7/2014
T2SK	20DB 25W ATTENUATOR	WEINSCHEL	46-20-34	CD5022	DC-18GHZ	11/7/2013	11/7/2014
VBR8	CISPR EN FCC CE VOLTAGE.exe						
WKA1	SOFTWARE, UNIVERSAL RCV EMI	ELITE	UNIV_RCV_EMI	1	---	I/O	
WQB0	RE_8546A						
WQC0	HF_8546A						
XPQ3	HIGH PASS FILTER	K&L MICROWAVE	4IH30-1804/T10000-0	4	1.8GHZ-10GHZ	11/25/2013	11/25/2014

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.

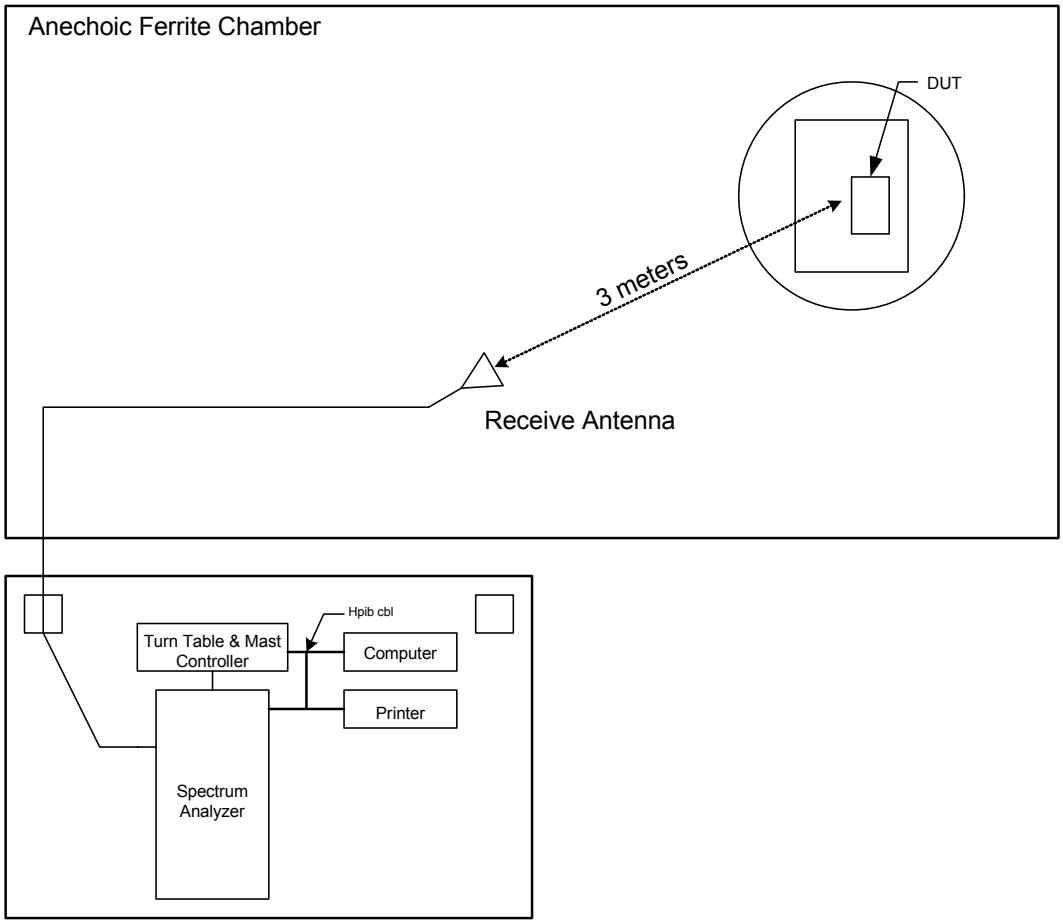
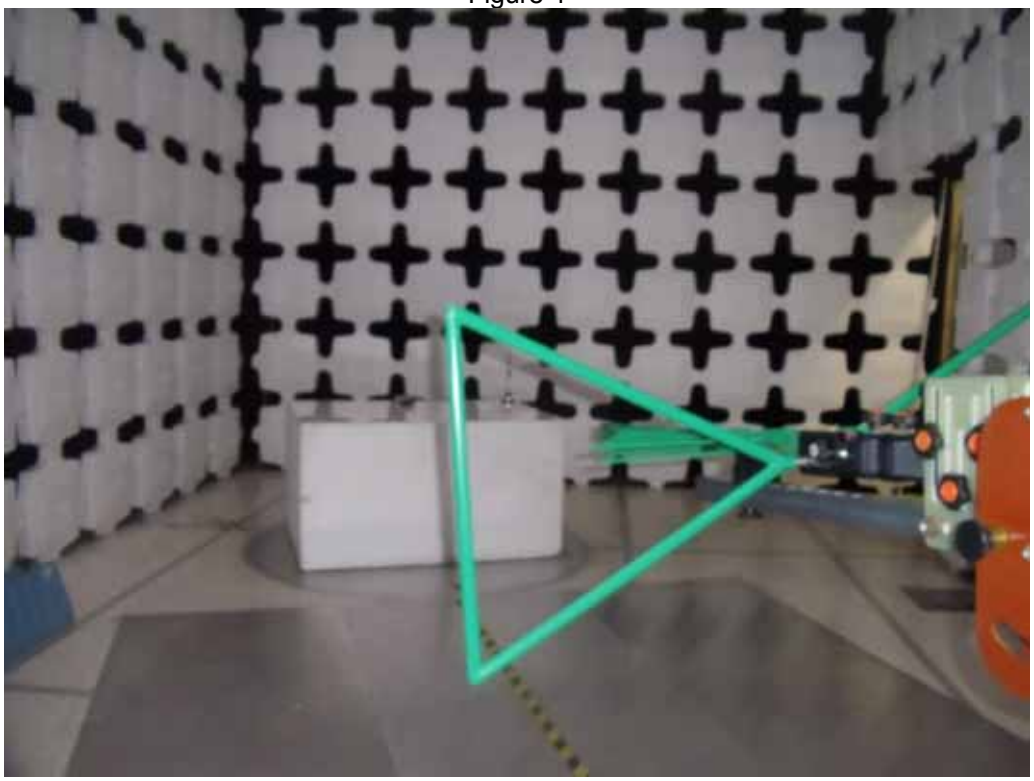


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

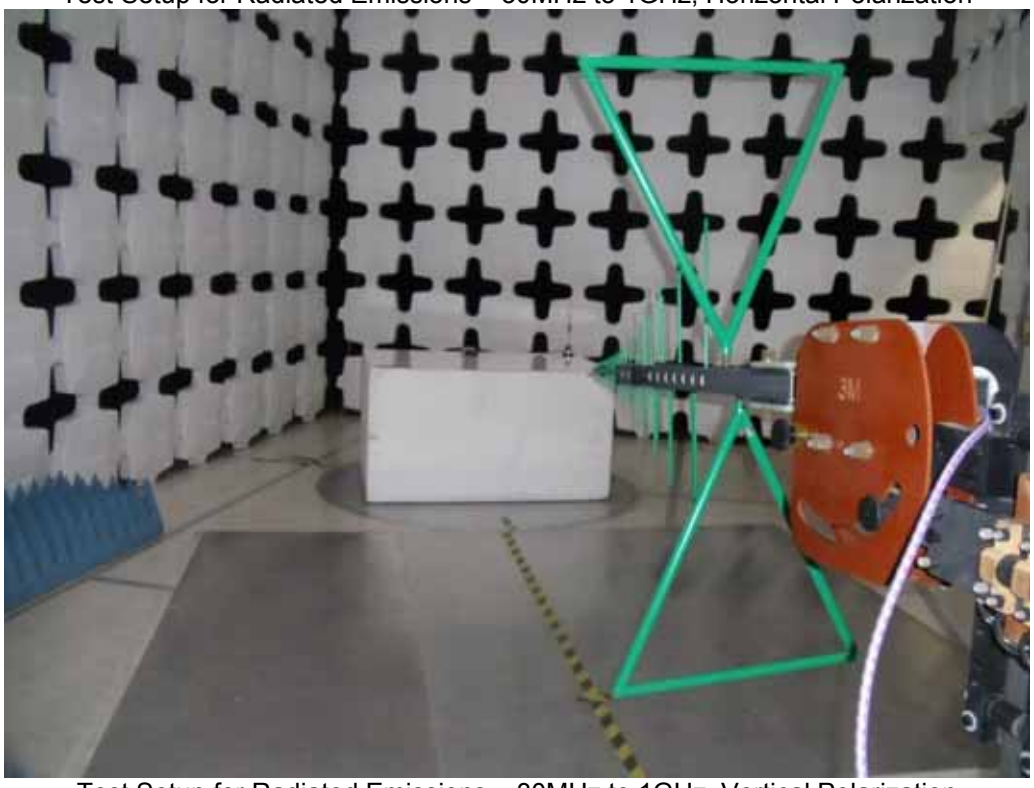
Figure 3

Test Setup for Conducted Emissions

Figure 4



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



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

Figure 5

Test Setup for Radiated Emissions – Above 1GHz, Horizontal Polarization

Test Setup for Radiated Emissions – Above 1GHz, Vertical Polarization

FCC Part 15 Subpart B Conducted Emissions Test

Significant Emissions Data

VB** 02/09/2011

Manufacturer	:	BADGER METER
Model	:	ORION SE MOBILE
DUT Mode	:	Rx @ MID CHANNEL
Line Tested	:	120V 60Hz HIGH
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-10
Notes	:	
Test Engineer	:	R. King
Limit	:	Class B
Test Date	:	Jun 12, 2014 11:33:00 AM
Data Filter	:	Up to 80 maximum levels detected with 6 dB level excursion threshold over 10 dB margin below limit

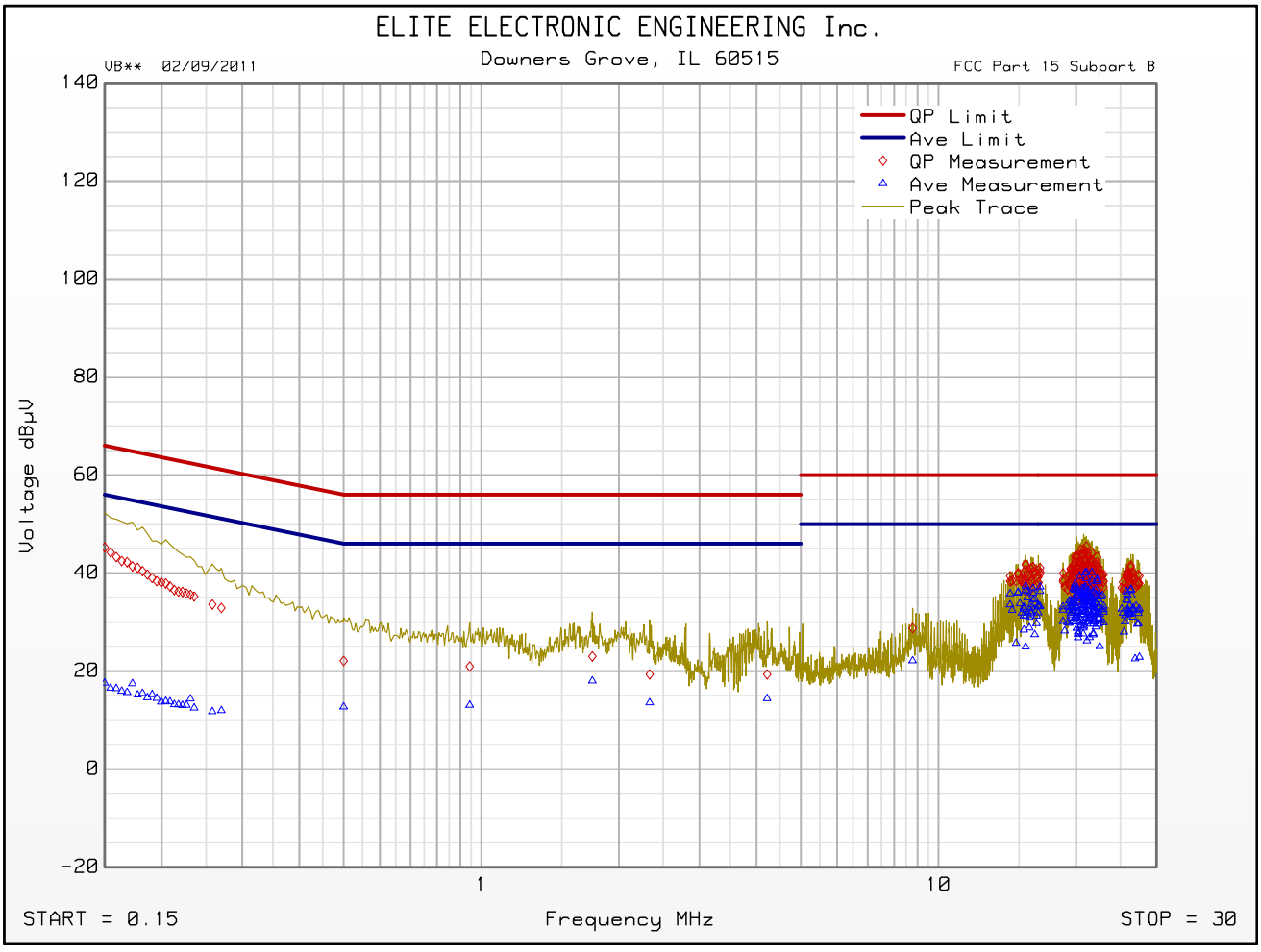
Freq MHz	Quasi-peak Level dBµV	Quasi-peak Limit dBµV	Excessive Quasi-peak Emissions	Average Level dBµV	Average Limit dBµV	Excessive Average Emissions
0.150	45.3	66.0		17.6	56.0	
0.270	32.9	61.1		12.0	51.1	
0.500	22.1	56.0		12.7	46.0	
0.943	21.0	56.0		13.1	46.0	
1.750	23.0	56.0		18.0	46.0	
2.336	19.3	56.0		13.6	46.0	
4.220	19.3	56.0		14.4	46.0	
8.780	28.8	60.0		22.1	50.0	
15.516	41.8	60.0		37.3	50.0	
20.930	44.5	60.0		40.1	50.0	
21.074	45.5	60.0		40.2	50.0	
21.659	44.1	60.0		40.2	50.0	

FCC Part 15 Subpart B Conducted Emissions Test

Cumulative Data

VB** 02/09/2011

Manufacturer	:	BADGER METER
Model	:	ORION SE MOBILE
DUT Mode	:	Rx @ MID CHANNEL
Line Tested	:	120V 60Hz HIGH
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-10
Notes	:	
Test Engineer	:	R. King
Limit	:	Class B
Test Date	:	Jun 12, 2014 11:33:00 AM



Emissions Meet QP Limit
Emissions Meet Ave Limit

FCC Part 15 Subpart B Conducted Emissions Test

Significant Emissions Data

VB** 02/09/2011

Manufacturer	:	BADGER METER
Model	:	ORION SE MOBILE
DUT Mode	:	Rx @ MID CHANNEL
Line Tested	:	120V 60Hz RETURN
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-10
Notes	:	
Test Engineer	:	R. King
Limit	:	Class B
Test Date	:	Jun 12, 2014 11:22:43 AM
Data Filter	:	Up to 80 maximum levels detected with 6 dB level excursion threshold over 10 dB margin below limit

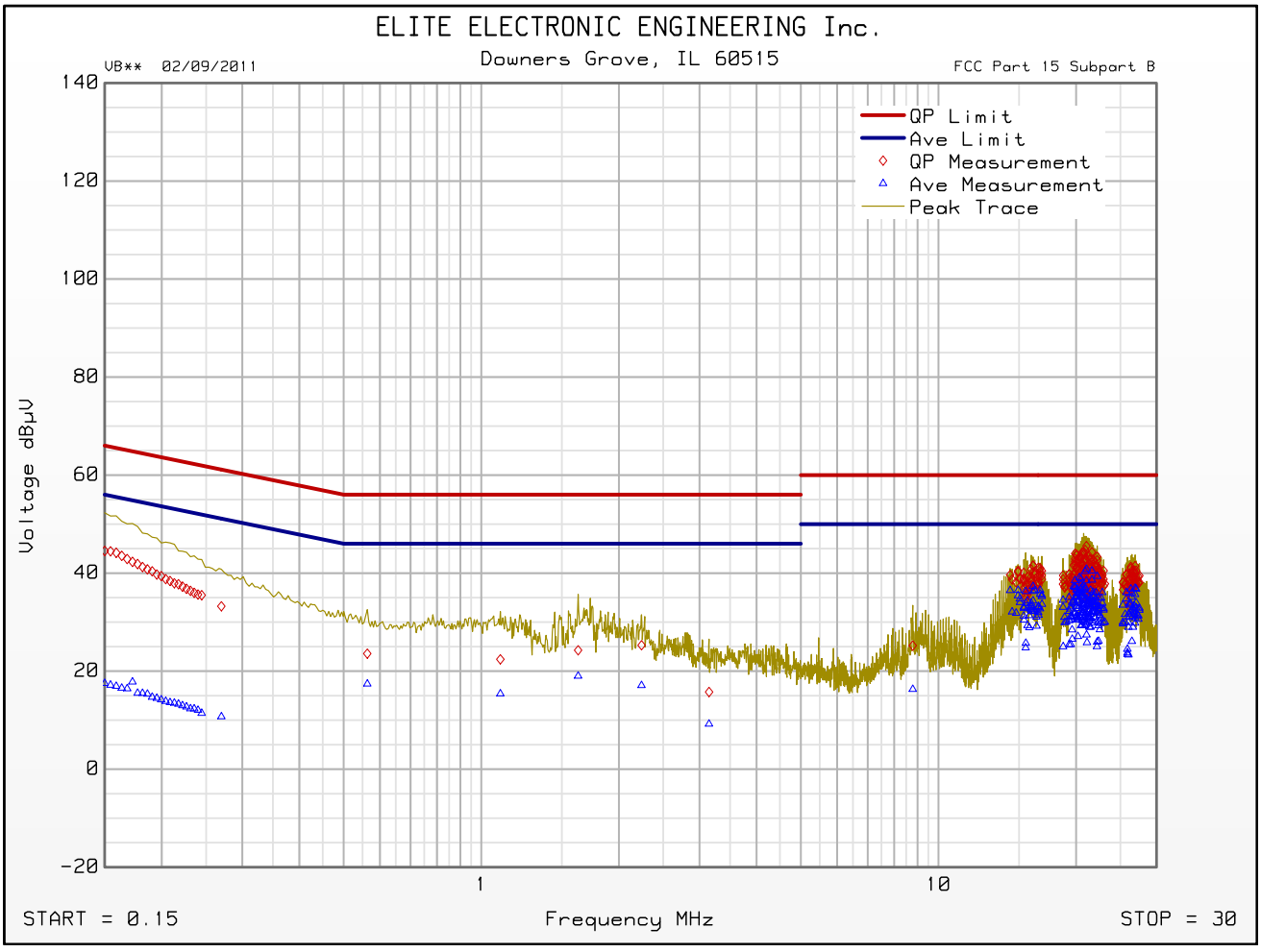
Freq MHz	Quasi-peak Level dBµV	Quasi-peak Limit dBµV	Excessive Quasi-peak Emissions	Average Level dBµV	Average Limit dBµV	Excessive Average Emissions
0.155	44.5	65.8		17.2	55.8	
0.270	33.2	61.1		10.7	51.1	
0.563	23.6	56.0		17.4	46.0	
1.101	22.4	56.0		15.4	46.0	
1.628	24.3	56.0		19.0	46.0	
2.241	25.3	56.0		17.1	46.0	
3.149	15.7	56.0		9.2	46.0	
8.785	25.2	60.0		16.3	50.0	
16.106	41.5	60.0		37.3	50.0	
20.930	44.7	60.0		40.4	50.0	
21.074	45.5	60.0		40.8	50.0	
21.659	44.3	60.0		40.5	50.0	

FCC Part 15 Subpart B Conducted Emissions Test

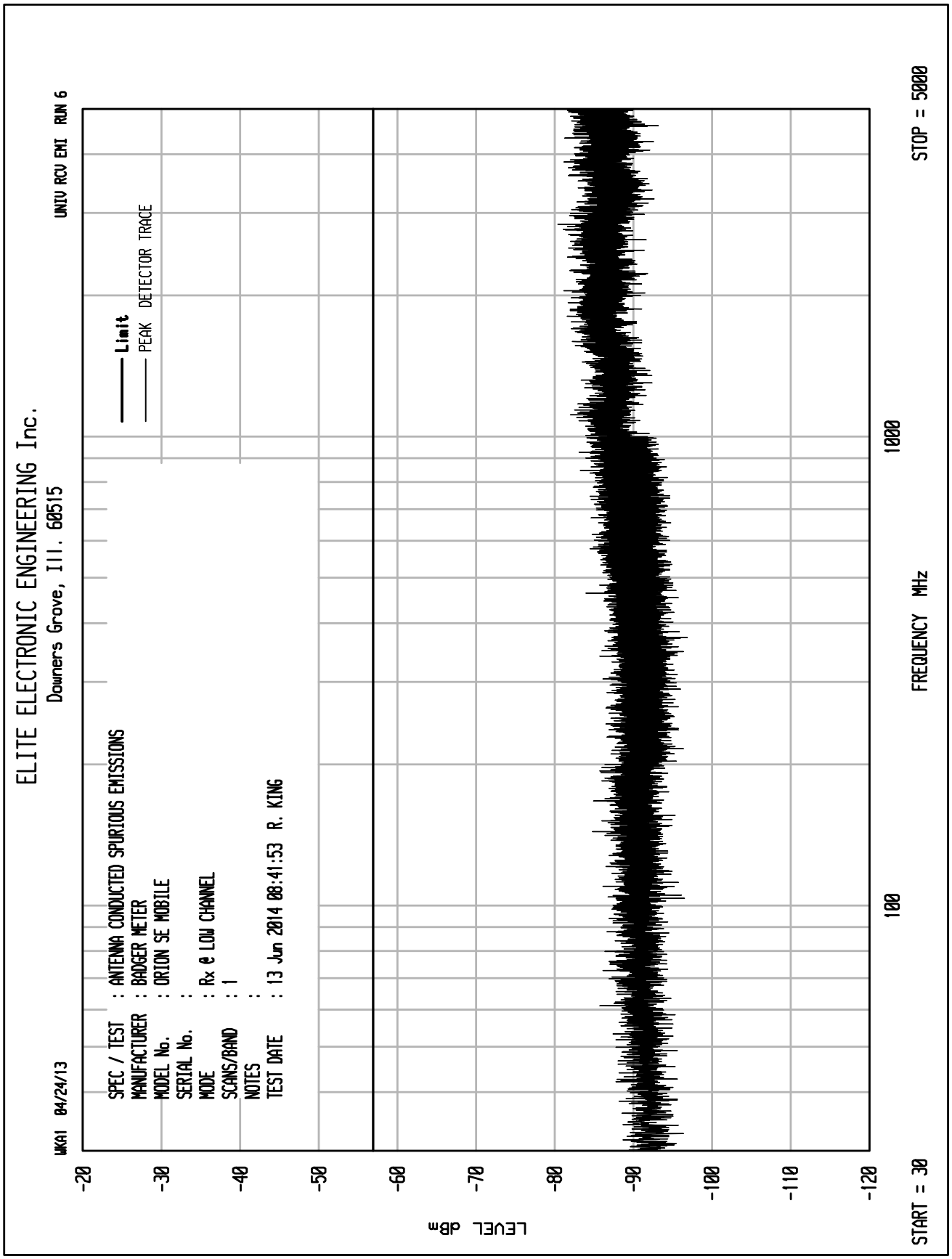
Cumulative Data

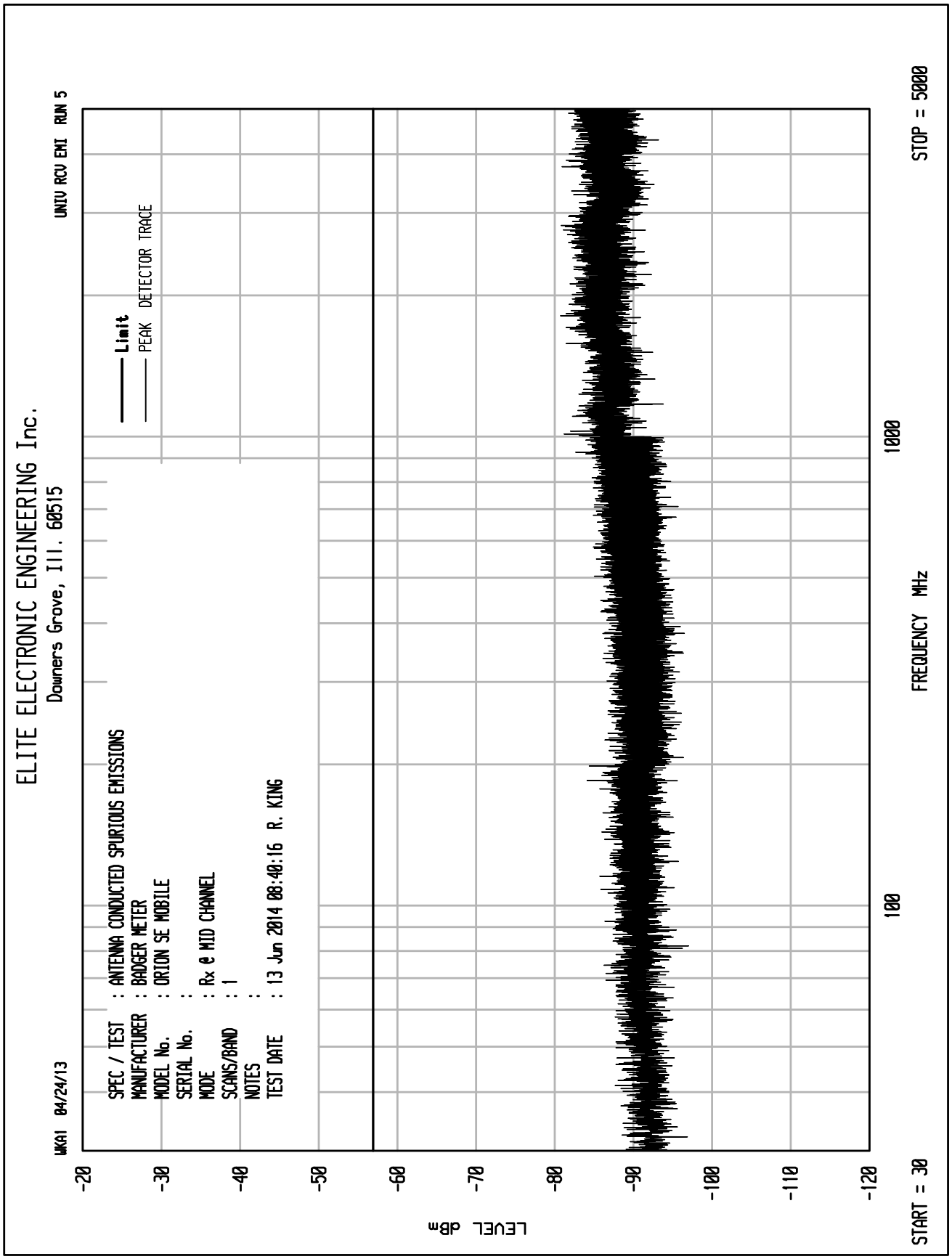
VB** 02/09/2011

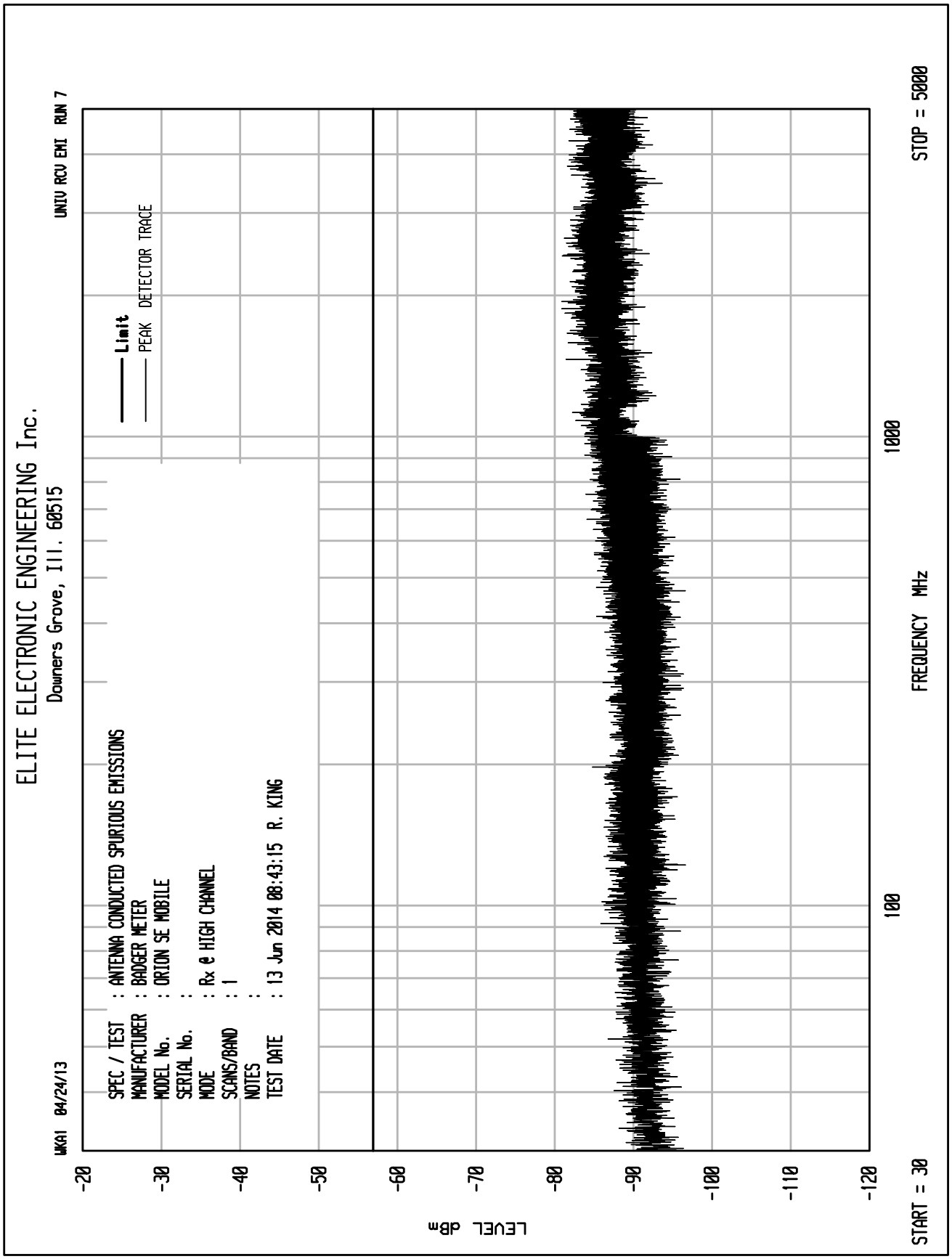
Manufacturer	:	BADGER METER
Model	:	ORION SE MOBILE
DUT Mode	:	Rx @ MID CHANNEL
Line Tested	:	120V 60Hz RETURN
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-10
Notes	:	
Test Engineer	:	R. King
Limit	:	Class B
Test Date	:	Jun 12, 2014 11:22:43 AM

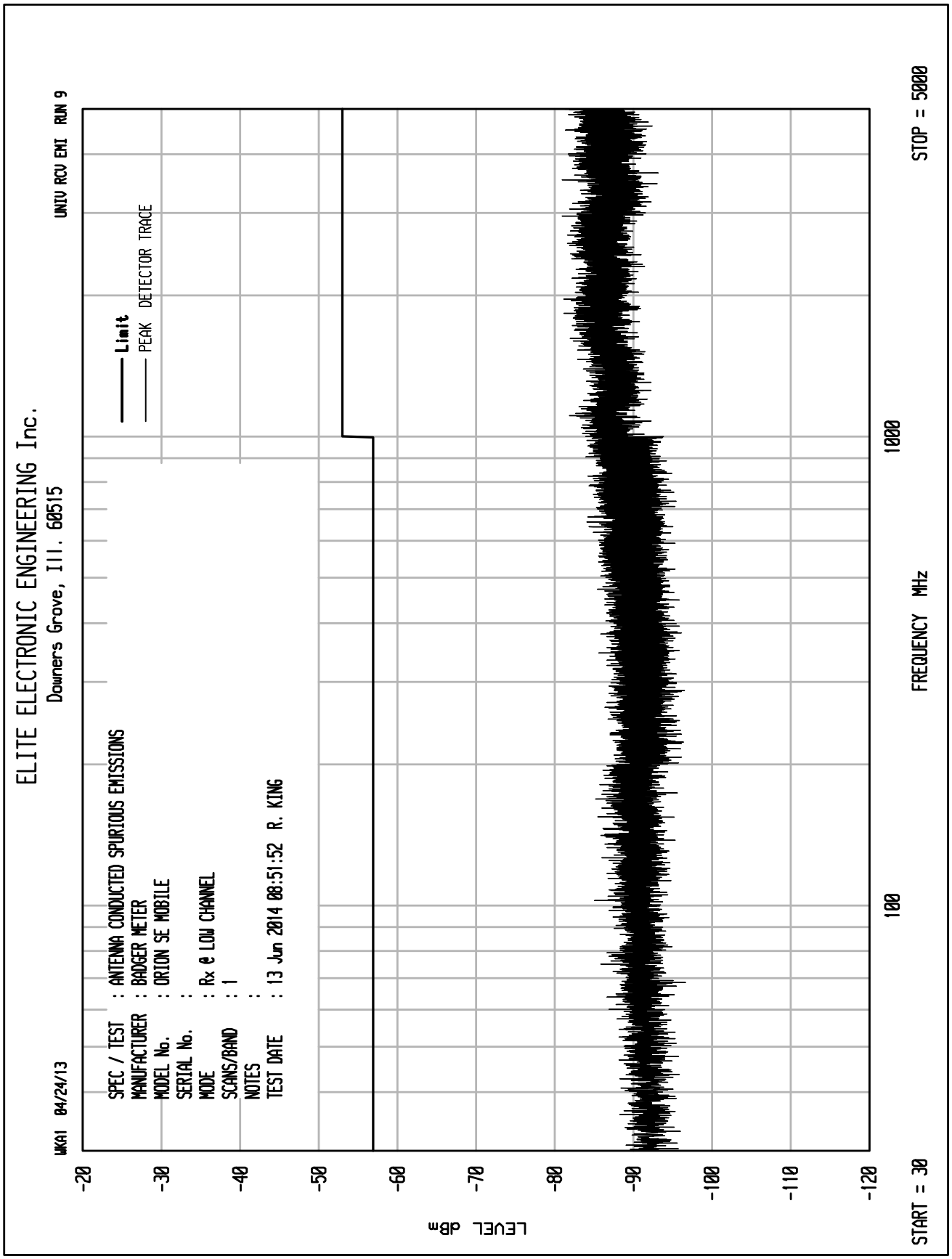


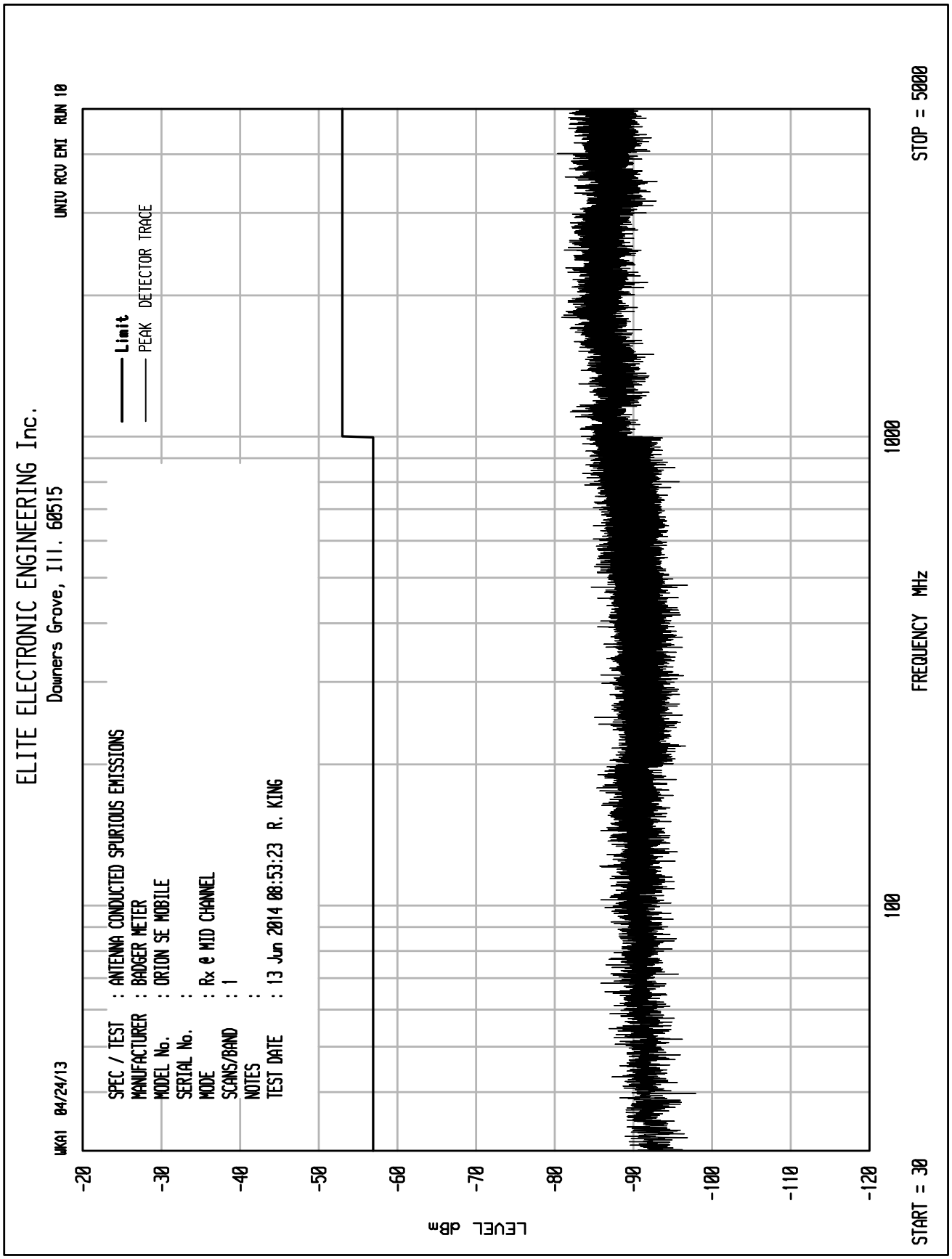
Emissions Meet QP Limit
Emissions Meet Ave Limit

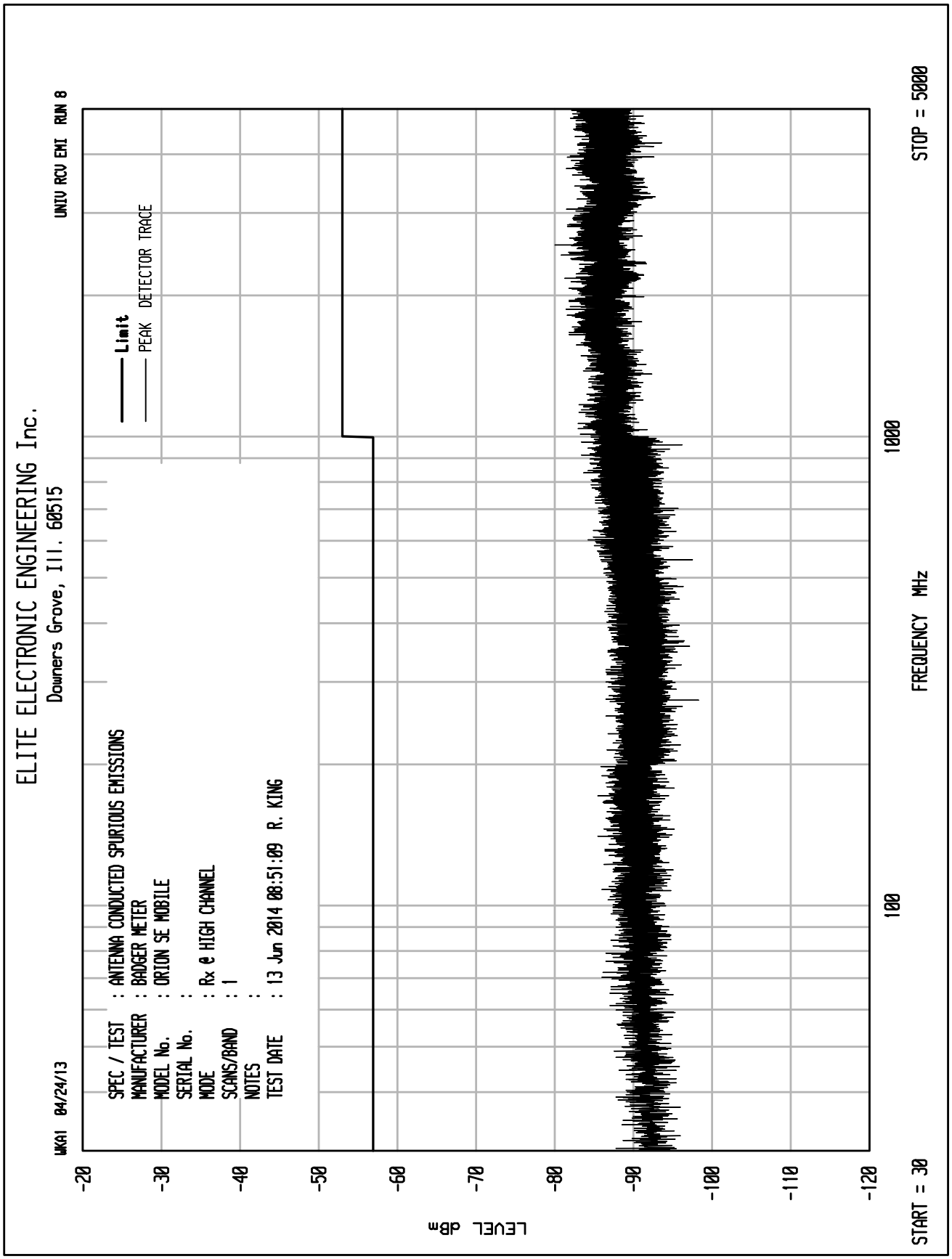

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 6
WKAI 04/24/13
SPEC / TEST : ANTENNA CONDUCTED SPURIOUS EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION SE MOBILE
SERIAL No. :
MODE : Rx @ LOW CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 13 Jun 2014 08:41:53 R. KING
Limit
PEAK DETECTOR TRACE
LEVEL dBm
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
START = 30
100
1000
STOP = 5000
FREQUENCY MHz

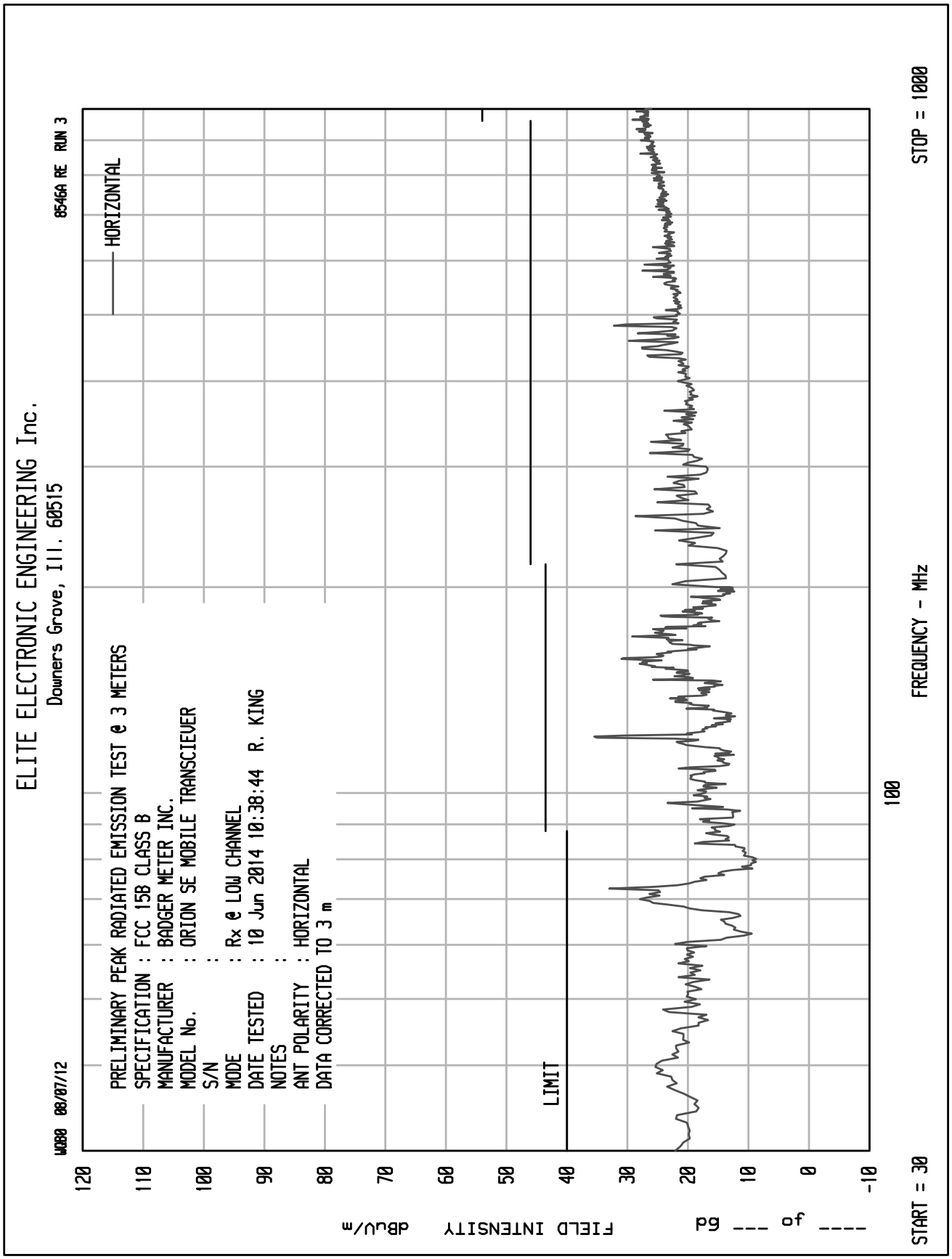

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 5
WKAI 04/24/13
SPEC / TEST : ANTENNA CONDUCTED SPURIOUS EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION SE MOBILE
SERIAL No. :
MODE : Rx @ MID CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 13 Jun 2014 08:40:16 R. KING
Limit
PEAK DETECTOR TRACE
LEVEL dBm
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
START = 30
100
1000
FREQUENCY MHz
STOP = 5000

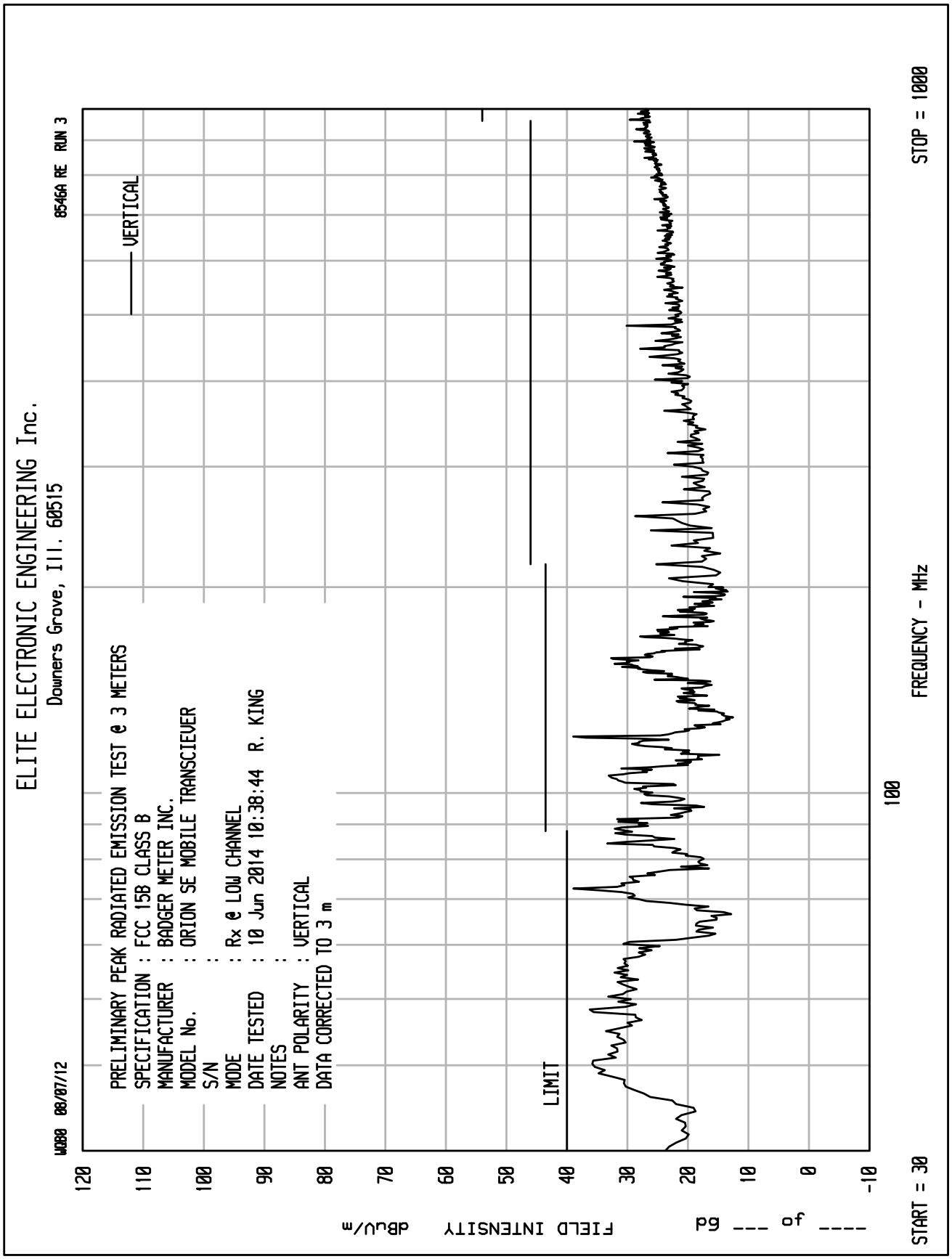

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 7
WKAI 04/24/13
SPEC / TEST : ANTENNA CONDUCTED SPURIOUS EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION SE MOBILE
SERIAL No. :
MODE : Rx @ HIGH CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 13 Jun 2014 08:43:15 R. KING
Limit
PEAK DETECTOR TRACE
LEVEL dBm
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
START = 30
100
1000
FREQUENCY MHz
STOP = 5000

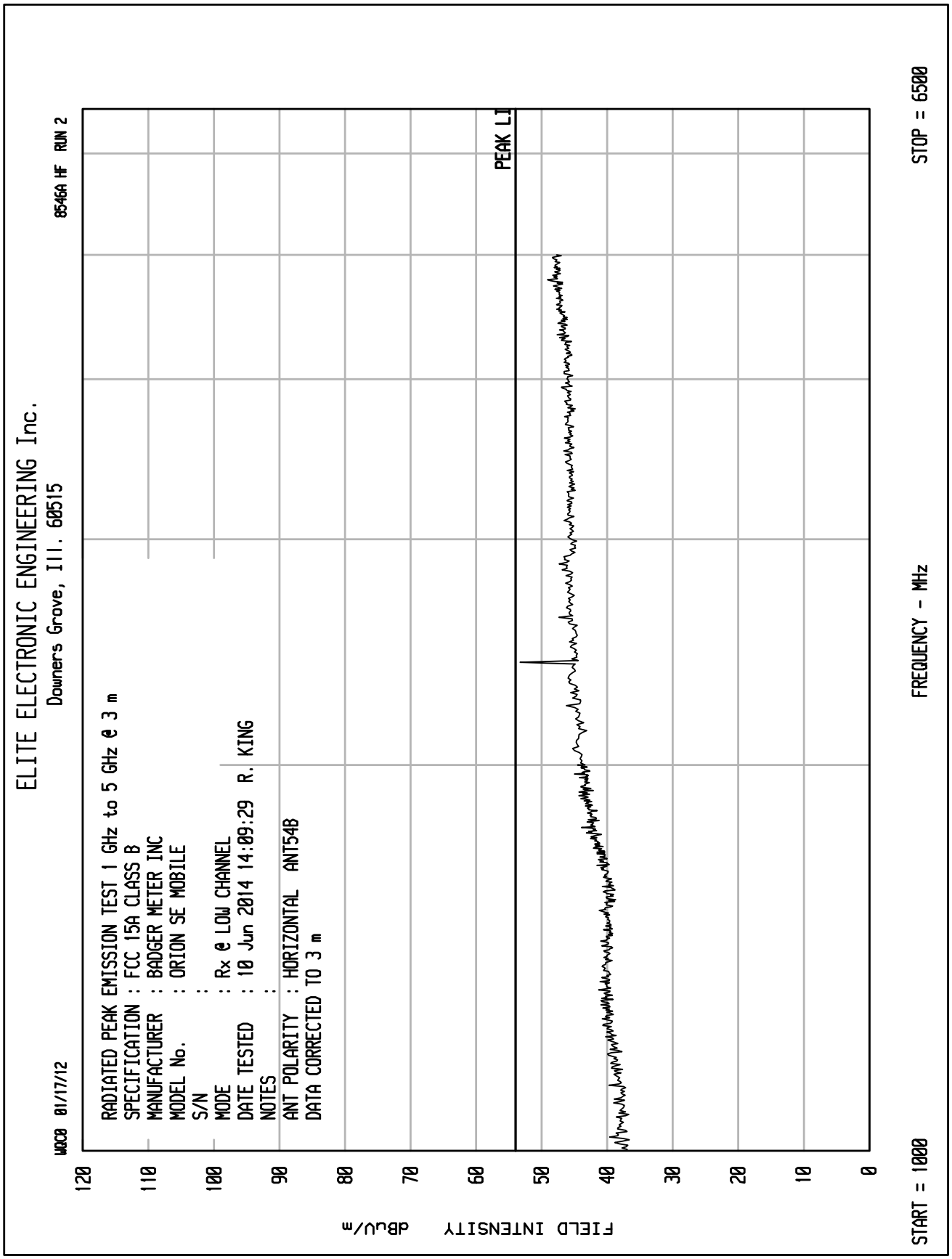

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 9
WKAI 04/24/13
SPEC / TEST : ANTENNA CONDUCTED SPURIOUS EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION SE MOBILE
SERIAL No. :
MODE : Rx @ LOW CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 13 Jun 2014 08:51:52 R. KING
Limit
PEAK DETECTOR TRACE
LEVEL dBm
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
START = 30
100
1000
STOP = 5000
FREQUENCY MHz

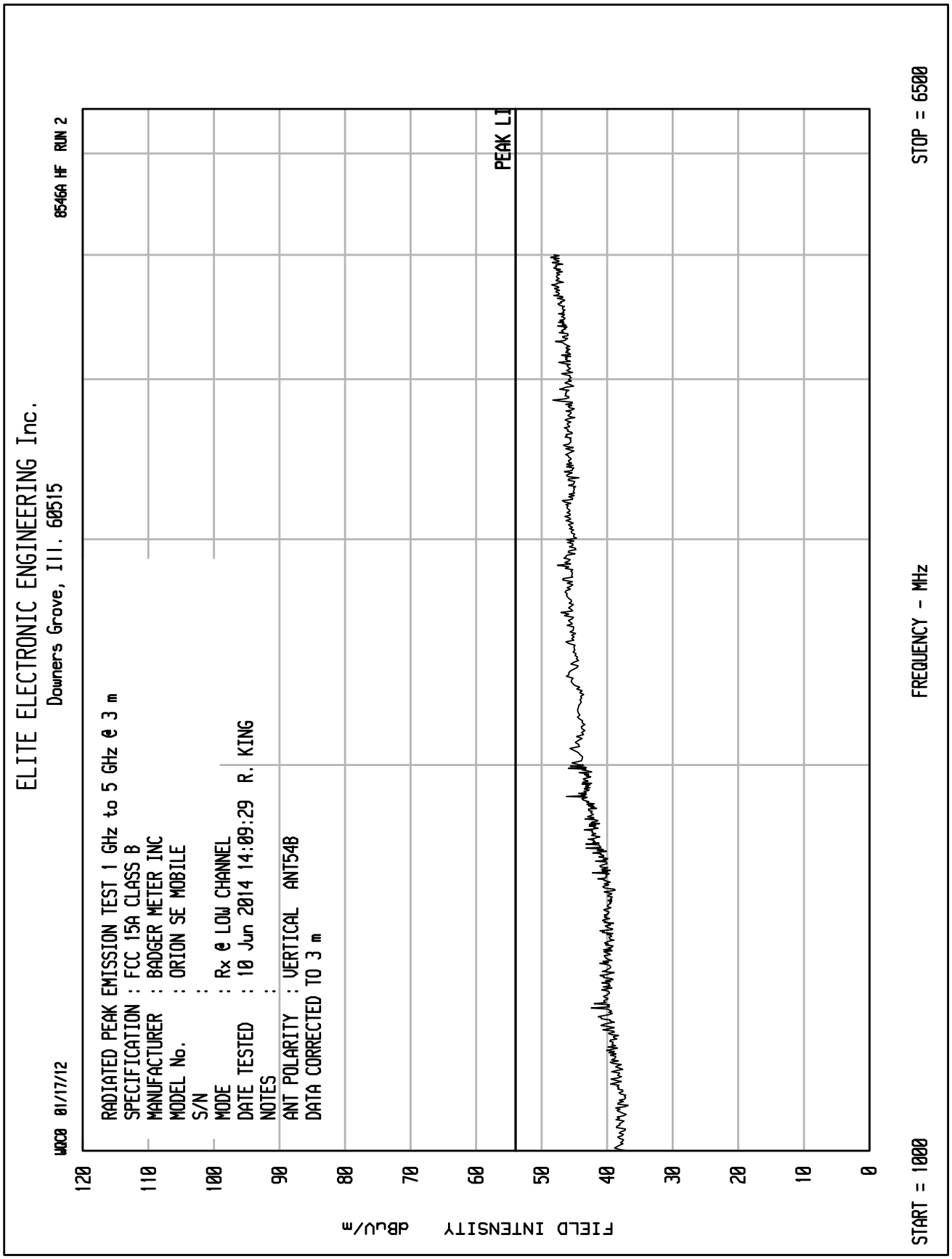

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 10
WKAI 04/24/13
SPEC / TEST : ANTENNA CONDUCTED SPURIOUS EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION SE MOBILE
SERIAL No. :
MODE : Rx @ MID CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 13 Jun 2014 08:53:23 R. KING
Limit
PEAK DETECTOR TRACE
LEVEL dBm
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
START = 30
100
1000
STOP = 5000
FREQUENCY MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 8
WKAI 04/24/13
SPEC / TEST : ANTENNA CONDUCTED SPURIOUS EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION SE MOBILE
SERIAL No. :
MODE : Rx @ HIGH CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 13 Jun 2014 08:51:09 R. KING
Limit
PEAK DETECTOR TRACE
LEVEL dBm
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
START = 30
100
1000
STOP = 5000
FREQUENCY MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
8546A RE RUN 3
HORIZONTAL
PRELIMINARY PEAK RADIATED EMISSION TEST @ 3 METERS
SPECIFICATION : FCC 15B CLASS B
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION SE MOBILE TRANSCIEVER
S/N :
MODE : Rx @ LOW CHANNEL
DATE TESTED : 10 Jun 2014 10:38:44 R. KING
NOTES :
ANT POLARITY : HORIZONTAL
DATA CORRECTED TO 3 m
LIMIT
FIELD INTENSITY dBuV/m
FREQUENCY - MHz
START = 30
100
STOP = 1000
120
110
100
90
80
70
60
50
40
30
20
10
0
-10


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
8546A RE RUN 3
VERTICAL
PRELIMINARY PEAK RADIATED EMISSION TEST @ 3 METERS
SPECIFICATION : FCC 15B CLASS B
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION SE MOBILE TRANSCIEVER
S/N :
MODE : Rx @ LOW CHANNEL
DATE TESTED : 10 Jun 2014 10:38:44 R. KING
NOTES :
ANT POLARITY : VERTICAL
DATA CORRECTED TO 3 m
LIMIT
FIELD INTENSITY dBuV/m
---- of --- dB
FREQUENCY - MHz
START = 30
100
STOP = 1000
120
110
100
90
80
70
60
50
40
30
20
10
0
-10


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WQC9 01/17/12
8546A HF RUN 2
RADIATED PEAK EMISSION TEST 1 GHz to 5 GHz @ 3 m
SPECIFICATION : FCC 15A CLASS B
MANUFACTURER : BADGER METER INC
MODEL No. : ORION SE MOBILE
S/N : :
MODE : Rx @ LOW CHANNEL
DATE TESTED : 10 Jun 2014 14:09:29 R. KING
NOTES : :
ANT POLARITY : HORIZONTAL ANT54B
DATA CORRECTED TO 3 m
PEAK LI
FIELD INTENSITY dBuV/m
120
110
100
90
80
70
60
50
40
30
20
10
0
START = 1000
FREQUENCY - MHz
STOP = 6500


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
8546A HF RUN 2
WDC9 01/17/12
RADIATED PEAK EMISSION TEST 1 GHz to 5 GHz @ 3 m
SPECIFICATION : FCC 15A CLASS B
MANUFACTURER : BADGER METER INC
MODEL No. : ORION SE MOBILE
S/N : :
MODE : Rx @ LOW CHANNEL
DATE TESTED : 10 Jun 2014 14:09:29 R. KING
NOTES : :
ANT POLARITY : VERTICAL ANT54B
DATA CORRECTED TO 3 m
PEAK LI
FIELD INTENSITY dBuV/m
120
110
100
90
80
70
60
50
40
30
20
10
0
START = 1000
FREQUENCY - MHz
STOP = 6500

ETR No. 8546A
DATA SHEET TEST NO. 3

RADIATED QP EMISSION MEASUREMENTS in a 3 m SEMI-ANECHOIC ROOM
SPECIFICATION : FCC 15B CLASS B
MANUFACTURER : BADGER METER INC.
MODEL NO. : ORION SE MOBILE TRANSCIEVER
SERIAL NO. :
TEST MODE : Rx @ LOW CHANNEL
NOTES :
TEST DATE : 10 Jun 2014 10:38:44
TEST DISTANCE : 3 m (DATA EXTRAPOLATED TO 3 m)

FREQUENCY	QP READING	ANT FAC	CBL FAC	EXT ATTN	DIST FAC	TOTAL	QP LIMIT	AZ	ANT HT	POLAR
MHz	dBuV	dB	dB	dB	dB	dBuV/m	dBuV/m	deg	cm	
48.00	26.3	8.9	.5	0.0	0.0	35.7	40.0	90	120	V
72.01	30.1	6.5	.5	0.0	0.0	37.1	40.0	135	200	V
84.01	24.3	7.9	.5	0.0	0.0	32.6	40.0	45	120	V
120.01	28.4	10.7	.6	0.0	0.0	39.7	43.5	135	120	V
120.02	19.3	10.7	.6	0.0	0.0	30.6	43.5	315	340	H
156.01	21.9	10.0	.8	0.0	0.0	32.7	43.5	180	340	V
168.01	17.6	9.8	.9	0.0	0.0	28.3	43.5	270	200	H
252.02	15.2	11.5	1.0	0.0	0.0	27.7	46.0	270	120	V
312.02	11.5	13.4	1.1	0.0	0.0	25.9	46.0	270	120	H
456.03	9.2	16.4	1.5	0.0	0.0	27.1	46.0	315	120	H
480.06	15.6	16.8	1.5	0.0	0.0	33.9	46.0	315	120	H
588.06	3.8	18.5	1.5	0.0	0.0	23.7	46.0	315	200	H
794.69	-6.4	19.8	2.0	0.0	0.0	15.4	46.0	315	120	V
892.75	-5.5	20.7	2.0	0.0	0.0	17.2	46.0	135	340	V
924.97	-5.5	21.0	2.0	0.0	0.0	17.4	46.0	180	120	V

Checked BY Richard E. King :

Richard E. King

DATA SHEET HF TEST NO. 2

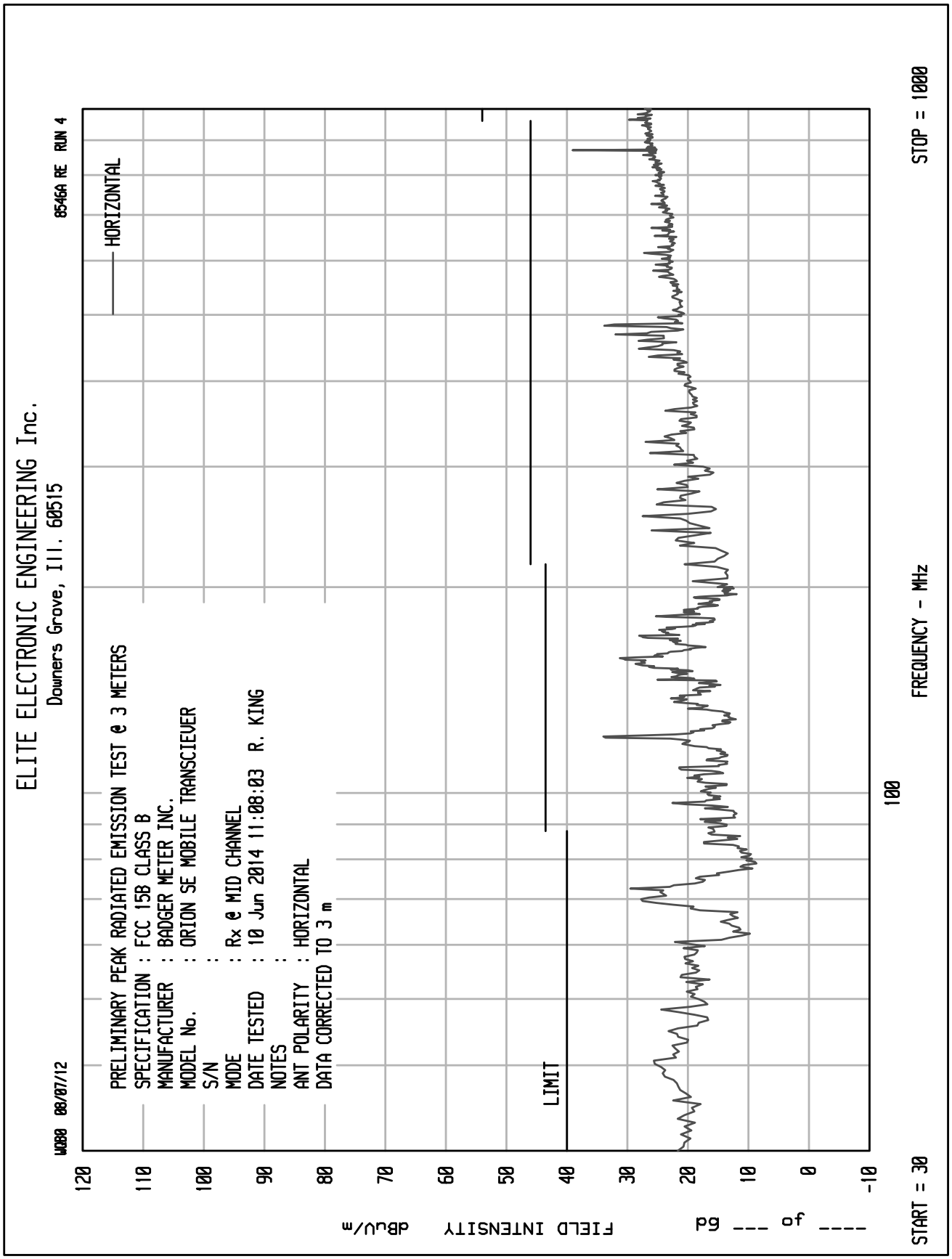
RADIATED AVG EMISSION MEASUREMENTS >=1000 MHz in a 3 m ANECHOIC ROOM

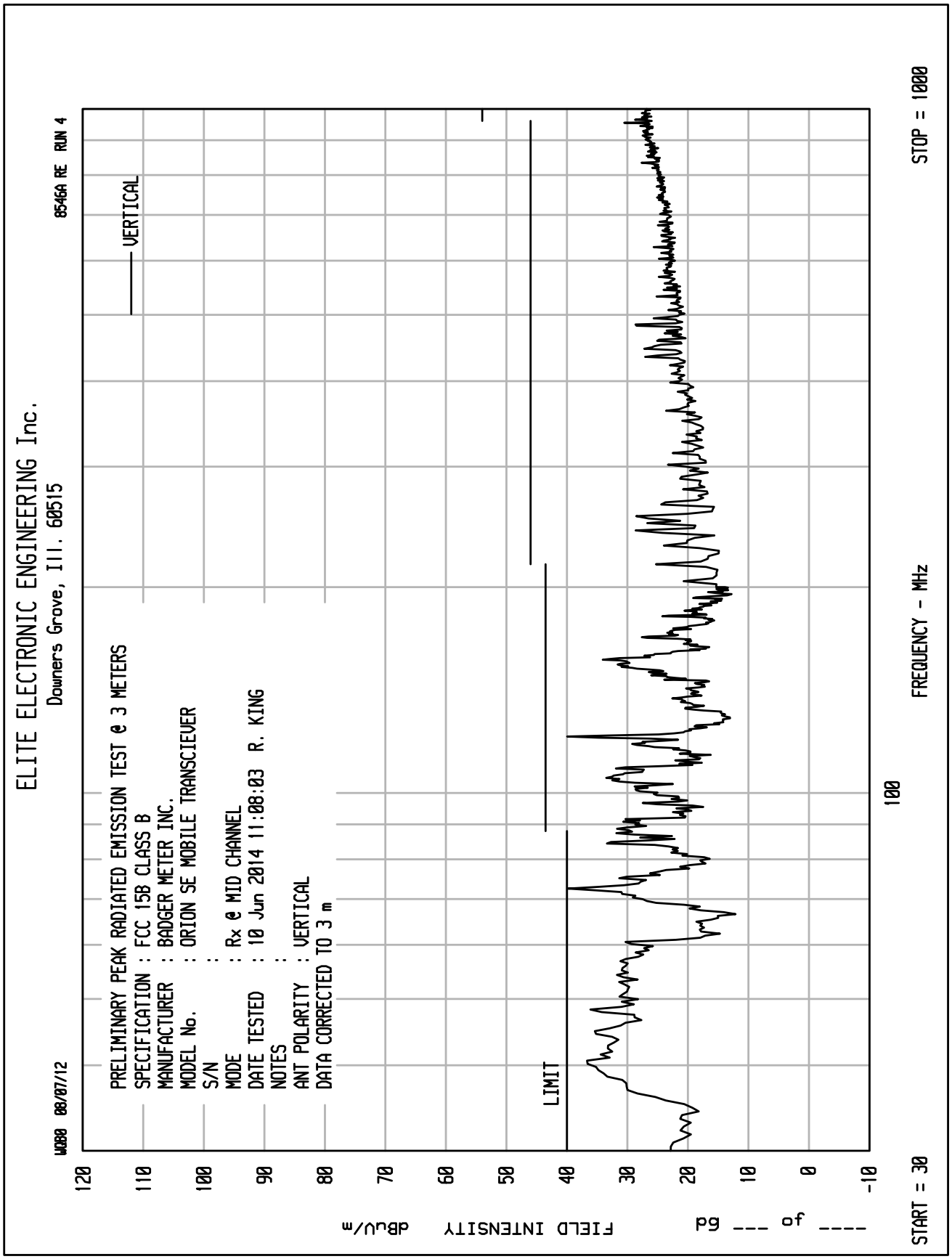
SPECIFICATION : FCC 15A CLASS B
MANUFACTURER : BADGER METER INC
MODEL NO. : ORION SE MOBILE
SERIAL NO. :
TEST MODE : Rx @ LOW CHANNEL
NOTES :
TEST DATE : 10 Jun 2014 14:09:29
TEST DISTANCE : 3 m
ANTENNA : ANT54B

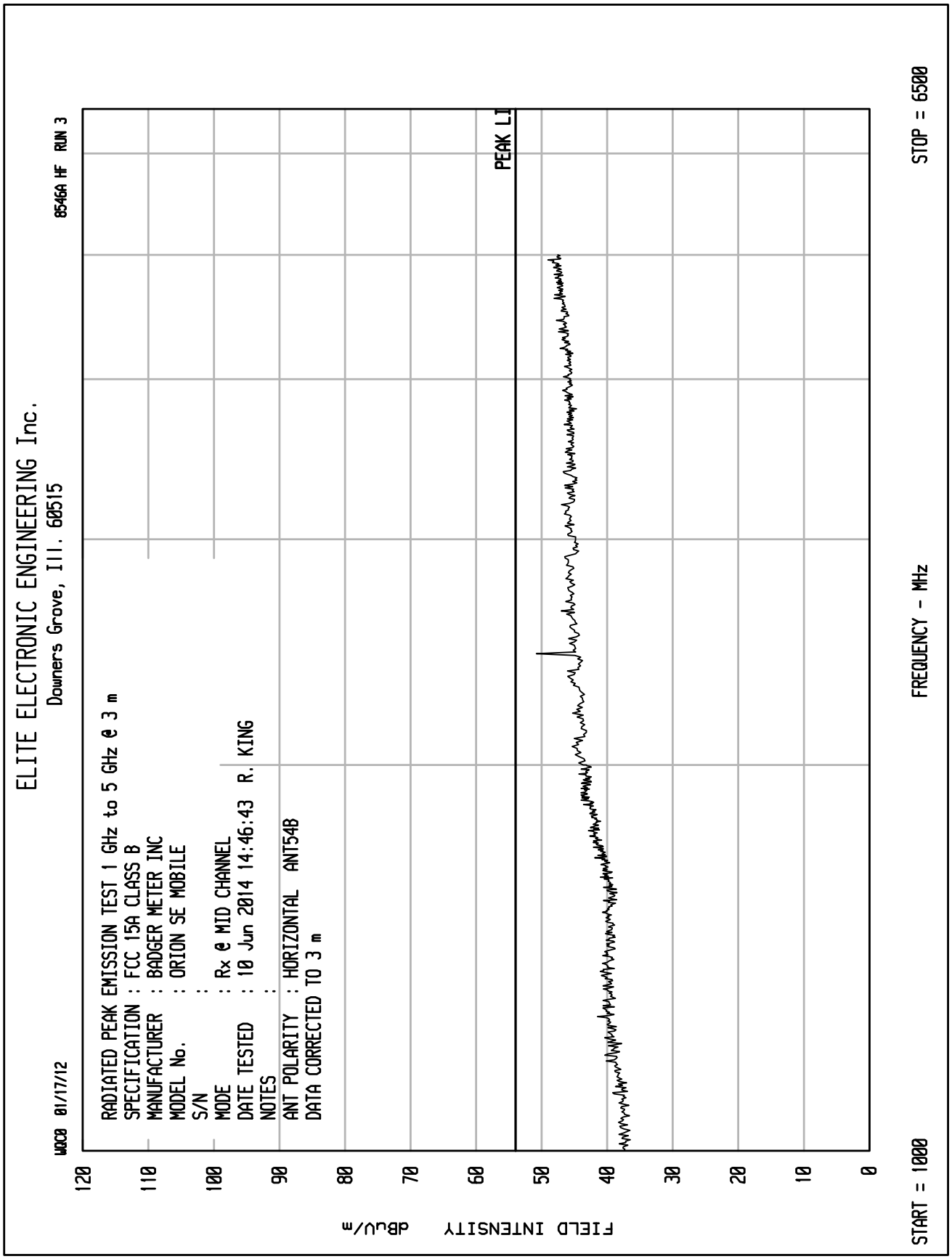
FREQUENCY MHz	AVG READING dBuV	ANT FAC dB	CBL FAC dB	DIST FAC dB	TOTAL dBuV/m	AVG LIMIT dBuV/m	PASS/ FAIL	AZ deg	ANT HT cm	POLAR
1143.65	-4.7	27.6	1.3	0.0	24.3	54.0		135	340	H
1235.35	-4.3	28.7	1.4	0.0	25.8	54.0		90	340	V
1301.14	-3.8	29.2	1.4	0.0	26.9	54.0		180	200	V
1502.21	-3.9	28.3	1.6	0.0	26.0	54.0		135	200	V
1668.41	-3.7	29.0	1.6	0.0	27.0	54.0		225	120	V
1788.56	-3.7	30.5	1.7	0.0	28.5	54.0		135	120	H
1888.64	-3.9	31.5	1.8	0.0	29.4	54.0		270	340	V
1978.57	-4.3	31.7	1.8	0.0	29.3	54.0		0	200	V
2382.01	7.3	32.1	2.0	0.0	41.4	54.0		225	340	H
2874.40	-3.1	32.7	2.3	0.0	31.9	54.0		225	200	V
3232.59	-3.5	32.9	2.4	0.0	31.8	54.0		270	340	V
3536.55	-4.4	33.1	2.5	0.0	31.3	54.0		135	340	V
3867.22	-4.5	33.4	2.7	0.0	31.6	54.0		270	200	V
4638.07	-4.5	34.5	2.9	0.0	32.9	54.0		315	120	V
4789.10	-4.5	34.8	2.9	0.0	33.3	54.0		180	200	H

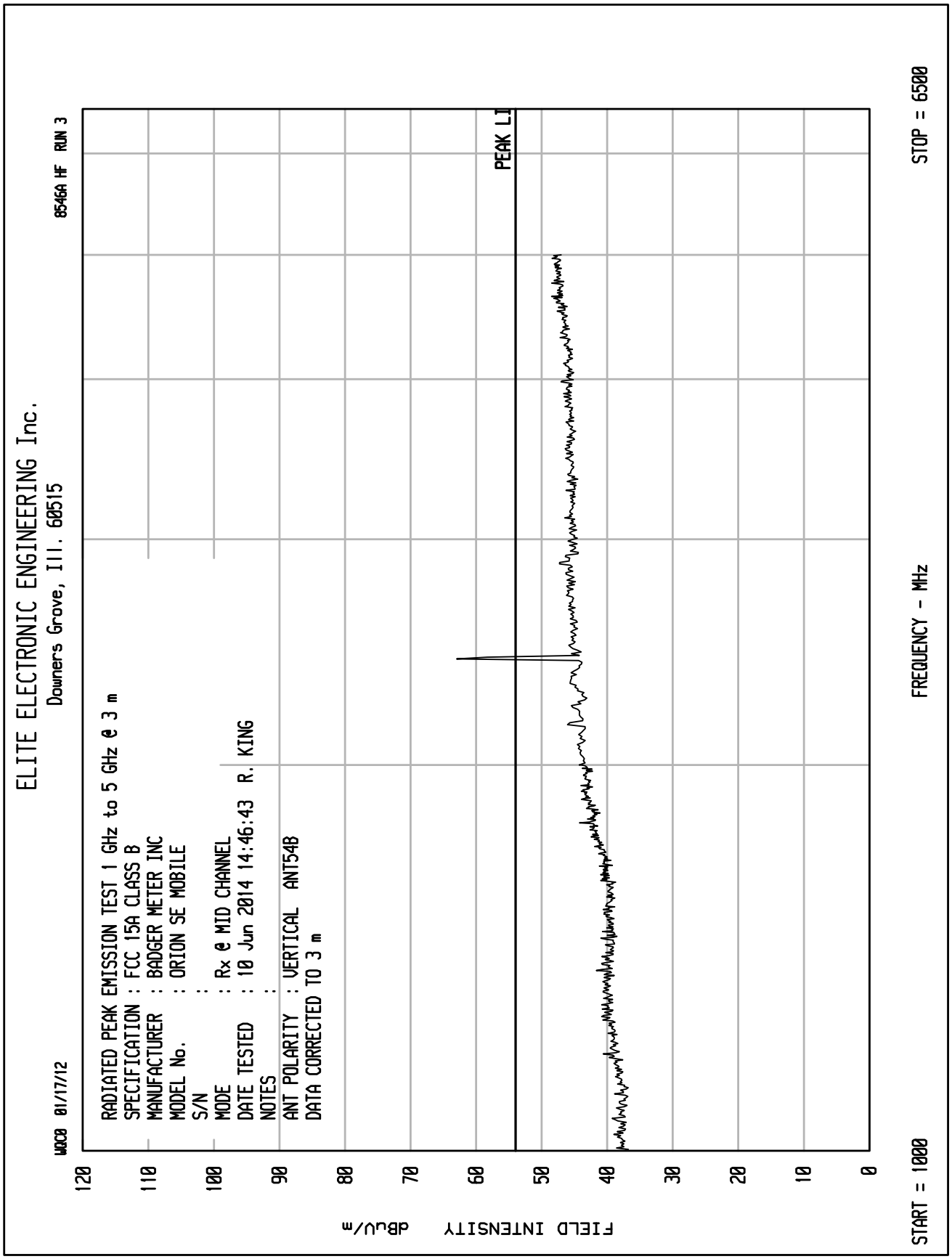
Checked BY Richard E. King :

Richard E. King


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
8546A RE RUN 4
WQ80 08/07/12
PRELIMINARY PEAK RADIATED EMISSION TEST @ 3 METERS
SPECIFICATION : FCC 15B CLASS B
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION SE MOBILE TRANSCIEVER
S/N :
MODE : Rx @ MID CHANNEL
DATE TESTED : 10 Jun 2014 11:08:03 R. KING
NOTES :
ANT POLARITY : HORIZONTAL
DATA CORRECTED TO 3 m
HORIZONTAL
LIMIT
FIELD INTENSITY dBuV/m
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
---- of ---- dB
START = 30
100
FREQUENCY - MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
8546A RE RUN 4
VERTICAL
PRELIMINARY PEAK RADIATED EMISSION TEST @ 3 METERS
SPECIFICATION : FCC 15B CLASS B
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION SE MOBILE TRANSCIEVER
S/N : :
MODE : Rx @ MID CHANNEL
DATE TESTED : 10 Jun 2014 11:08:03 R. KING
NOTES : :
ANT POLARITY : VERTICAL
DATA CORRECTED TO 3 m
LIMIT
FIELD INTENSITY dBuV/m
FREQUENCY - MHz
START = 30
100
STOP = 1000
120
110
100
90
80
70
60
50
40
30
20
10
0
-10


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WQC9 01/17/12
8546A HF RUN 3
RADIATED PEAK EMISSION TEST 1 GHz to 5 GHz @ 3 m
SPECIFICATION : FCC 15A CLASS B
MANUFACTURER : BADGER METER INC
MODEL No. : ORION SE MOBILE
S/N : :
MODE : Rx @ MID CHANNEL
DATE TESTED : 10 Jun 2014 14:46:43 R. KING
NOTES : :
ANT POLARITY : HORIZONTAL ANT54B
DATA CORRECTED TO 3 m
PEAK LI
FIELD INTENSITY dBuV/m
120
110
100
90
80
70
60
50
40
30
20
10
0
START = 1000
FREQUENCY - MHz
STOP = 6500


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WOO3 01/17/12
8546A HF RUN 3
RADIATED PEAK EMISSION TEST 1 GHz to 5 GHz @ 3 m
SPECIFICATION : FCC 15A CLASS B
MANUFACTURER : BADGER METER INC
MODEL No. : ORION SE MOBILE
S/N : :
MODE : Rx @ MID CHANNEL
DATE TESTED : 10 Jun 2014 14:46:43 R. KING
NOTES : :
ANT POLARITY : VERTICAL ANT54B
DATA CORRECTED TO 3 m
PEAK LI
FIELD INTENSITY dBuV/m
120
110
100
90
80
70
60
50
40
30
20
10
0
START = 1000
FREQUENCY - MHz
STOP = 6500

ETR No. 8546A
DATA SHEET TEST NO. 4

RADIATED QP EMISSION MEASUREMENTS in a 3 m SEMI-ANECHOIC ROOM
SPECIFICATION : FCC 15B CLASS B
MANUFACTURER : BADGER METER INC.
MODEL NO. : ORION SE MOBILE TRANSCIEVER
SERIAL NO. :
TEST MODE : Rx @ MID CHANNEL
NOTES :
TEST DATE : 10 Jun 2014 11:08:03
TEST DISTANCE : 3 m (DATA EXTRAPOLATED TO 3 m)

FREQUENCY	QP READING	ANT FAC	CBL FAC	EXT ATTN	DIST FAC	TOTAL	QP LIMIT	AZ	ANT HT	POLAR
MHz	dBuV	dB	dB	dB	dB	dBuV/m	dBuV/m	deg	cm	
40.35	22.7	12.6	.5	0.0	0.0	35.8	40.0	225	120	V
72.00	29.7	6.5	.5	0.0	0.0	36.7	40.0	225	200	V
84.00	23.8	7.9	.5	0.0	0.0	32.2	40.0	90	120	V
120.01	28.1	10.7	.6	0.0	0.0	39.4	43.5	135	120	V
120.01	23.0	10.7	.6	0.0	0.0	34.3	43.5	135	340	V
156.01	21.6	10.0	.8	0.0	0.0	32.5	43.5	180	340	V
168.01	15.8	9.8	.9	0.0	0.0	26.5	43.5	225	200	H
240.02	17.7	11.1	1.0	0.0	0.0	29.8	46.0	225	120	V
324.02	10.7	13.7	1.1	0.0	0.0	25.5	46.0	315	120	H
463.99	.6	16.5	1.5	0.0	0.0	18.6	46.0	135	120	H
480.05	15.1	16.8	1.5	0.0	0.0	33.4	46.0	315	120	H
612.06	2.4	18.6	1.5	0.0	0.0	22.5	46.0	315	200	H
720.72	-6.2	18.8	1.8	0.0	0.0	14.4	46.0	135	120	H
863.95	-5.5	20.5	2.0	0.0	0.0	17.0	46.0	225	200	H
958.31	-5.5	21.2	2.0	0.0	0.0	17.7	46.0	225	340	V

Checked BY Richard E. King :

Richard E. King

DATA SHEET HF TEST NO. 3

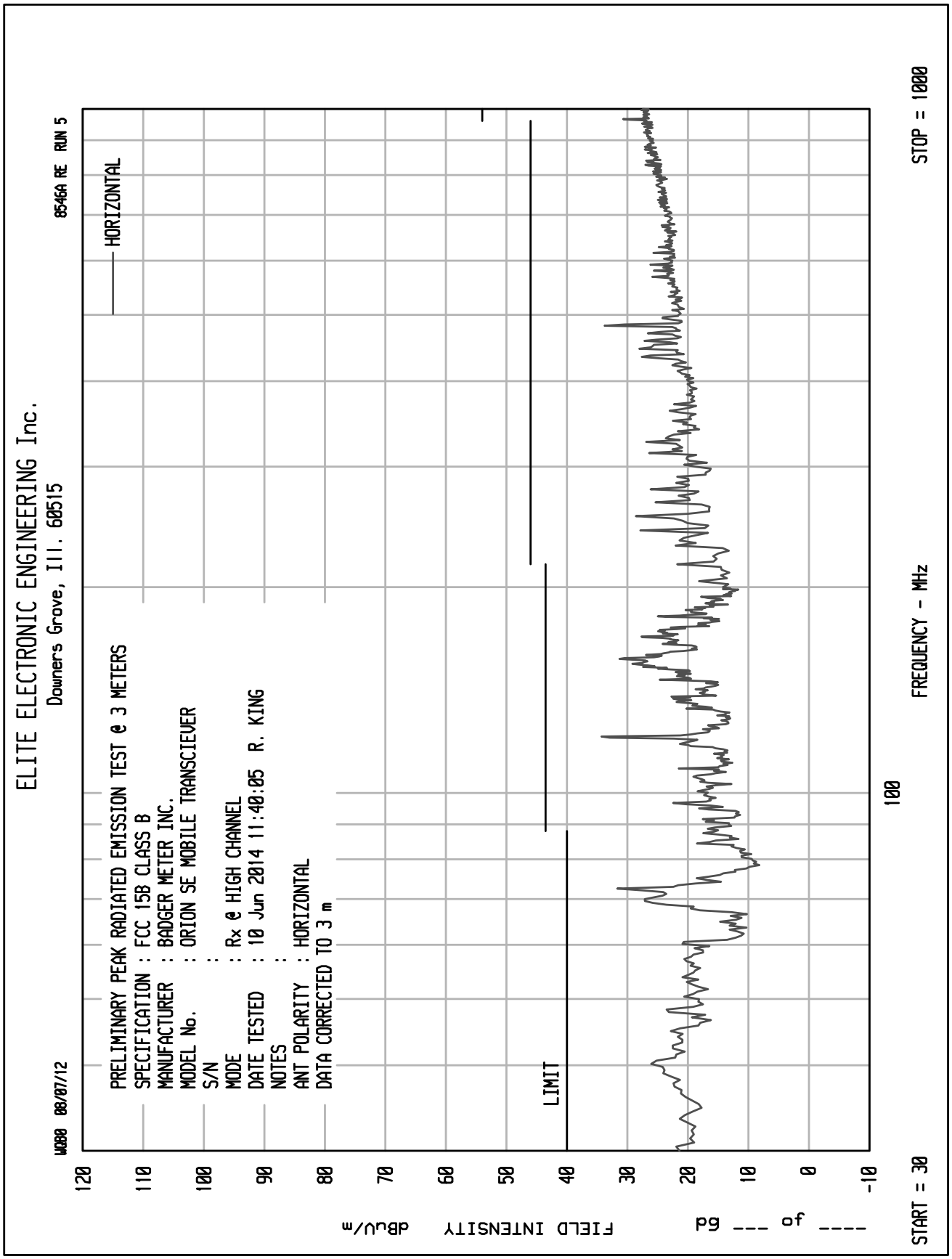
RADIATED AVG EMISSION MEASUREMENTS >=1000 MHz in a 3 m ANECHOIC ROOM

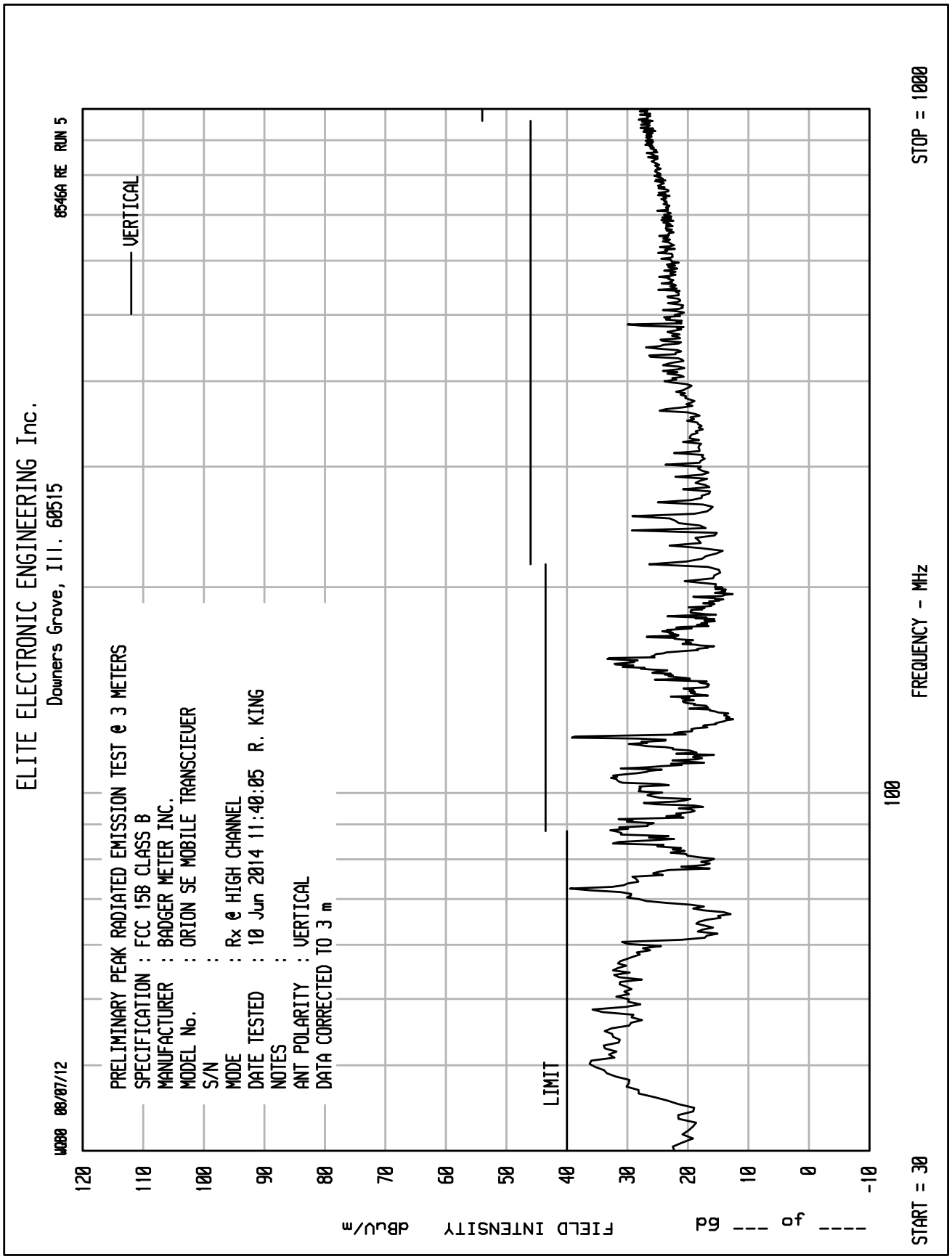
SPECIFICATION : FCC 15A CLASS B
MANUFACTURER : BADGER METER INC
MODEL NO. : ORION SE MOBILE
SERIAL NO. :
TEST MODE : Rx @ MID CHANNEL
NOTES :
TEST DATE : 10 Jun 2014 14:46:43
TEST DISTANCE : 3 m
ANTENNA : ANT54B

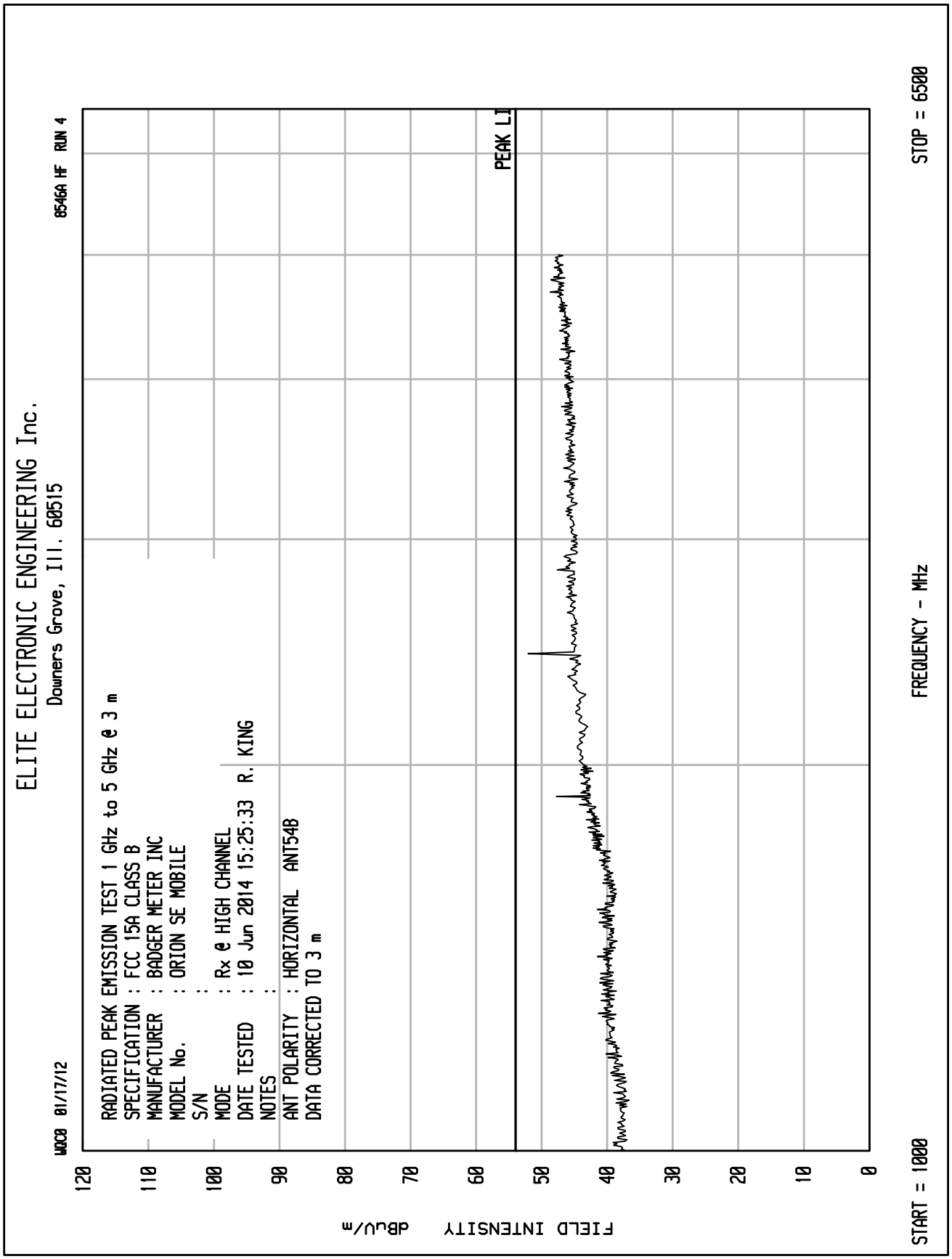
FREQUENCY MHz	AVG READING dBuV	ANT FAC dB	CBL FAC dB	DIST FAC dB	TOTAL dBuV/m	AVG LIMIT dBuV/m	PASS/ FAIL	AZ deg	ANT HT cm	POLAR
1061.29	-3.4	27.1	1.3	0.0	24.9	54.0		135	120	V
1280.52	-3.8	29.1	1.4	0.0	26.7	54.0		225	120	V
1388.43	7.2	29.0	1.5	0.0	37.7	54.0		135	200	V
1464.50	-3.9	28.6	1.5	0.0	26.2	54.0		90	340	V
1678.39	-3.9	29.1	1.6	0.0	26.8	54.0		315	340	V
1805.08	-3.6	30.7	1.7	0.0	28.8	54.0		0	120	V
1917.71	-3.5	31.6	1.8	0.0	29.9	54.0		180	120	V
2169.61	-3.9	31.6	1.9	0.0	29.6	54.0		135	120	V
2420.92	6.6	32.2	2.1	0.0	40.9	54.0		0	200	V
2893.82	-3.0	32.7	2.3	0.0	31.9	54.0		0	340	V
3165.64	-3.8	32.9	2.4	0.0	31.5	54.0		225	200	H
3693.70	-4.6	33.3	2.6	0.0	31.3	54.0		180	200	H
4236.18	-4.5	33.6	2.8	0.0	31.9	54.0		270	120	H
4645.48	-4.6	34.6	2.9	0.0	32.9	54.0		180	120	V
4971.77	-4.3	34.7	3.0	0.0	33.5	54.0		180	120	H

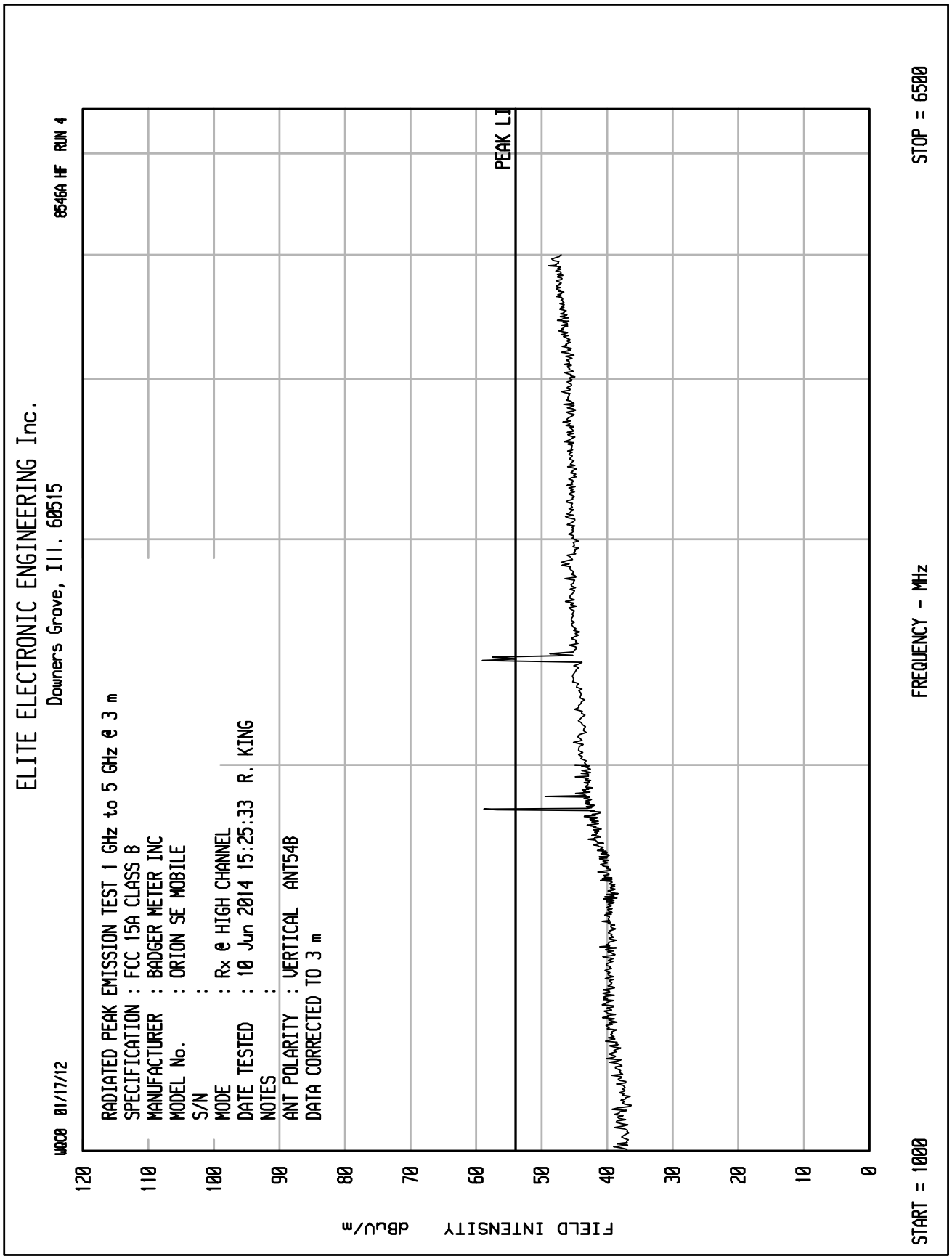
Checked BY Richard E. King :

Richard E. King


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
8546A RE RUN 5
HORIZONTAL
PRELIMINARY PEAK RADIATED EMISSION TEST @ 3 METERS
SPECIFICATION : FCC 15B CLASS B
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION SE MOBILE TRANSCIEVER
S/N :
MODE : Rx @ HIGH CHANNEL
DATE TESTED : 10 Jun 2014 11:40:05 R. KING
NOTES :
ANT POLARITY : HORIZONTAL
DATA CORRECTED TO 3 m
LIMIT
FIELD INTENSITY dBuV/m
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
START = 30
100
STOP = 1000
FREQUENCY - MHz
---- of ---- pg


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
8546A RE RUN 5
VERTICAL
PRELIMINARY PEAK RADIATED EMISSION TEST @ 3 METERS
SPECIFICATION : FCC 15B CLASS B
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION SE MOBILE TRANSCIEVER
S/N :
MODE : Rx @ HIGH CHANNEL
DATE TESTED : 10 Jun 2014 11:40:05 R. KING
NOTES :
ANT POLARITY : VERTICAL
DATA CORRECTED TO 3 m
LIMIT
FIELD INTENSITY dBuV/m
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
START = 30
100
STOP = 1000
FREQUENCY - MHz
---- of ---- pg


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WQC9 01/17/12
8546A HF RUN 4
RADIATED PEAK EMISSION TEST 1 GHz to 5 GHz @ 3 m
SPECIFICATION : FCC 15A CLASS B
MANUFACTURER : BADGER METER INC
MODEL No. : ORION SE MOBILE
S/N : :
MODE : Rx @ HIGH CHANNEL
DATE TESTED : 10 Jun 2014 15:25:33 R. KING
NOTES : :
ANT POLARITY : HORIZONTAL ANT54B
DATA CORRECTED TO 3 m
PEAK LI
FIELD INTENSITY dBuV/m
120
110
100
90
80
70
60
50
40
30
20
10
0
START = 1000
FREQUENCY - MHz
STOP = 6500


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
8546A HF RUN 4
WOC0 01/17/12
RADIATED PEAK EMISSION TEST 1 GHz to 5 GHz @ 3 m
SPECIFICATION : FCC 15A CLASS B
MANUFACTURER : BADGER METER INC
MODEL No. : ORION SE MOBILE
S/N : :
MODE : Rx @ HIGH CHANNEL
DATE TESTED : 10 Jun 2014 15:25:33 R. KING
NOTES : :
ANT POLARITY : VERTICAL ANT54B
DATA CORRECTED TO 3 m
PEAK LI
FIELD INTENSITY dBuV/m
120
110
100
90
80
70
60
50
40
30
20
10
0
START = 1000
FREQUENCY - MHz
STOP = 6500

ETR No. 8546A
DATA SHEET TEST NO. 5

RADIATED QP EMISSION MEASUREMENTS in a 3 m SEMI-ANECHOIC ROOM
SPECIFICATION : FCC 15B CLASS B
MANUFACTURER : BADGER METER INC.
MODEL NO. : ORION SE MOBILE TRANSCIEVER
SERIAL NO. :
TEST MODE : Rx @ HIGH CHANNEL
NOTES :
TEST DATE : 10 Jun 2014 11:40:05
TEST DISTANCE : 3 m (DATA EXTRAPOLATED TO 3 m)

FREQUENCY	QP READING	ANT FAC	CBL FAC	EXT ATTN	DIST FAC	TOTAL	QP LIMIT	AZ	ANT HT	POLAR
MHz	dBuV	dB	dB	dB	dB	dBuV/m	dBuV/m	deg	cm	
39.82	21.1	12.8	.5	0.0	0.0	34.4	40.0	270	120	V
72.00	30.9	6.5	.5	0.0	0.0	37.9	40.0	90	120	V
120.01	27.4	10.7	.6	0.0	0.0	38.7	43.5	180	120	V
120.01	22.0	10.7	.6	0.0	0.0	33.3	43.5	0	120	V
156.01	21.2	10.0	.8	0.0	0.0	32.0	43.5	180	340	V
168.01	15.4	9.8	.9	0.0	0.0	26.1	43.5	225	120	H
240.02	8.8	11.1	1.0	0.0	0.0	20.9	46.0	180	120	V
324.02	9.8	13.7	1.1	0.0	0.0	24.6	46.0	315	120	H
444.01	8.0	16.2	1.5	0.0	0.0	25.7	46.0	315	120	H
480.05	14.9	16.8	1.5	0.0	0.0	33.2	46.0	315	120	H
587.91	1.0	18.4	1.5	0.0	0.0	20.9	46.0	270	200	H
798.34	-6.6	19.9	2.0	0.0	0.0	15.3	46.0	180	335	V
866.97	-5.9	20.5	2.0	0.0	0.0	16.7	46.0	90	200	H

Checked BY Richard E. King :

Richard E. King

DATA SHEET HF TEST NO. 4

RADIATED AVG EMISSION MEASUREMENTS >=1000 MHz in a 3 m ANECHOIC ROOM

SPECIFICATION : FCC 15A CLASS B
MANUFACTURER : BADGER METER INC
MODEL NO. : ORION SE MOBILE
SERIAL NO. :
TEST MODE : Rx @ HIGH CHANNEL
NOTES :
TEST DATE : 10 Jun 2014 15:25:33
TEST DISTANCE : 3 m
ANTENNA : ANT54B

FREQUENCY MHz	AVG READING dBuV	ANT FAC dB	CBL FAC dB	DIST FAC dB	TOTAL dBuV/m	AVG LIMIT dBuV/m	PASS/ FAIL	AZ deg	ANT HT cm	POLAR
1070.97	8.1	27.1	1.3	0.0	36.4	54.0		315	120	V
1226.59	-2.4	28.6	1.4	0.0	27.5	54.0		135	340	V
1282.64	-2.2	29.1	1.4	0.0	28.3	54.0		135	120	H
1396.29	-2.4	29.0	1.5	0.0	28.0	54.0		0	120	H
1556.27	-2.5	28.4	1.6	0.0	27.5	54.0		270	340	H
1814.65	-2.7	30.8	1.7	0.0	29.8	54.0		180	120	V
1880.36	7.9	31.4	1.7	0.0	41.0	54.0		90	340	V
2093.32	-2.6	31.8	1.9	0.0	31.1	54.0		180	340	V
2403.39	-3.0	32.2	2.0	0.0	31.2	54.0		0	120	V
2872.15	-2.0	32.7	2.3	0.0	33.0	54.0		315	120	H
3421.79	-3.6	33.0	2.5	0.0	31.9	54.0		0	200	H
3790.91	-4.1	33.2	2.6	0.0	31.7	54.0		225	120	H
4142.24	-4.0	33.6	2.8	0.0	32.3	54.0		135	340	H
4648.86	-3.7	34.6	2.9	0.0	33.8	54.0		90	120	V
4891.56	-3.7	34.8	3.0	0.0	34.1	54.0		225	120	V

Checked BY Richard E. King :

Richard E. King

FCC Part 15 Subpart B Conducted Emissions Test

Significant Emissions Data

VB** 02/09/2011

Manufacturer	:	BADGER METER
Model	:	ORION SE MOBILE
DUT Mode	:	Tx @ MID CHANNEL
Line Tested	:	120V 60Hz HIGH
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-10
Notes	:	
Test Engineer	:	R. King
Limit	:	Class B
Test Date	:	Jun 12, 2014 11:00:19 AM
Data Filter	:	Up to 80 maximum levels detected with 6 dB level excursion threshold over 10 dB margin below limit

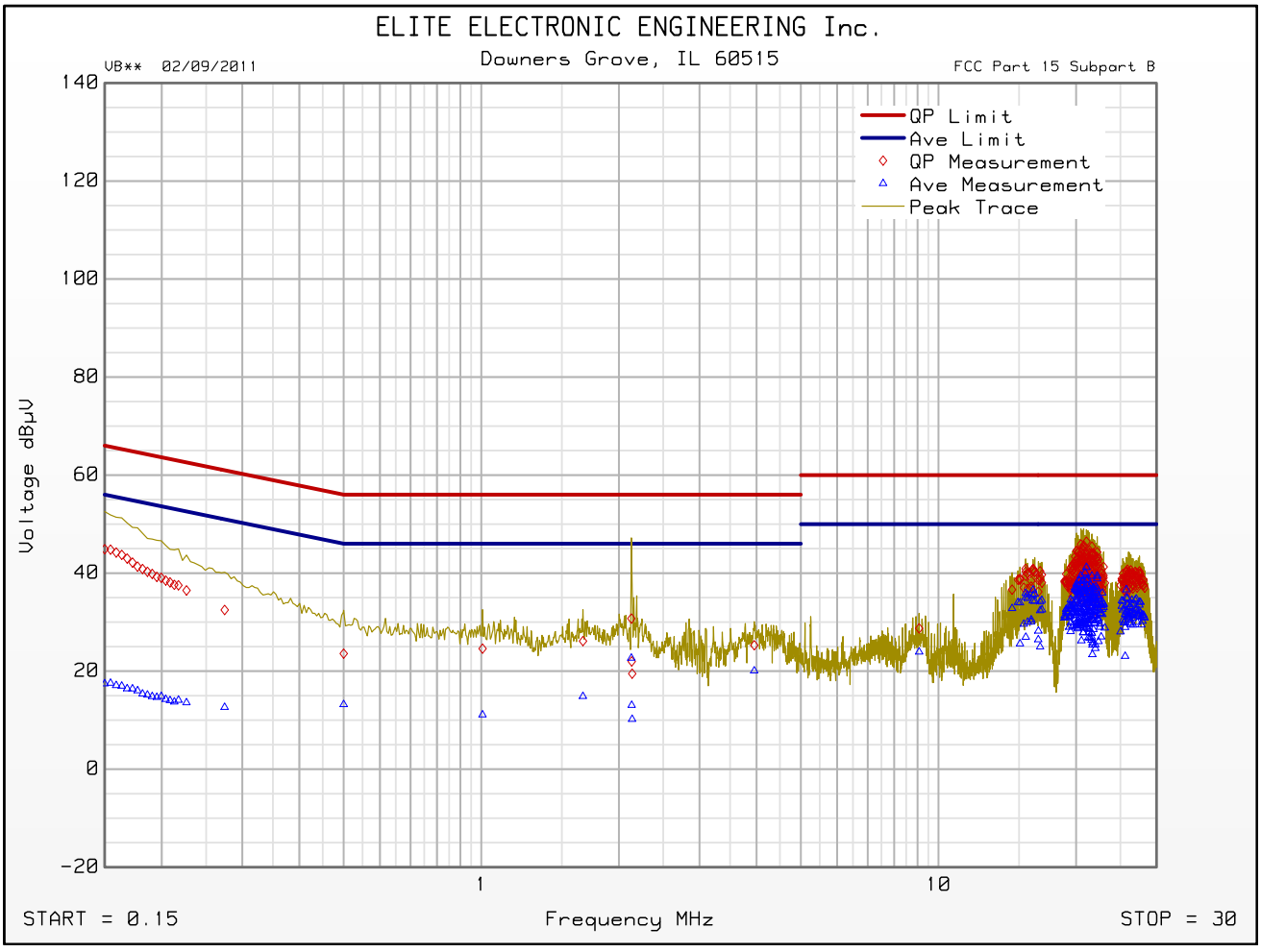
Freq MHz	Quasi-peak Level dBµV	Quasi-peak Limit dBµV	Excessive Quasi-peak Emissions	Average Level dBµV	Average Limit dBµV	Excessive Average Emissions
0.155	44.8	65.8		17.6	55.8	
0.275	32.5	61.0		12.6	51.0	
0.500	23.6	56.0		13.2	46.0	
1.006	24.6	56.0		11.1	46.0	
1.669	26.1	56.0		14.9	46.0	
2.129	30.7	56.0		22.7	46.0	
3.955	25.3	56.0		20.1	46.0	
9.073	28.7	60.0		23.9	50.0	
15.512	40.9	60.0		35.1	50.0	
20.930	44.4	60.0		40.1	50.0	
21.074	46.4	60.0		41.2	50.0	

FCC Part 15 Subpart B Conducted Emissions Test

Cumulative Data

VB** 02/09/2011

Manufacturer	:	BADGER METER
Model	:	ORION SE MOBILE
DUT Mode	:	Tx @ MID CHANNEL
Line Tested	:	120V 60Hz HIGH
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-10
Notes	:	
Test Engineer	:	R. King
Limit	:	Class B
Test Date	:	Jun 12, 2014 11:00:19 AM



Emissions Meet QP Limit
Emissions Meet Ave Limit

FCC Part 15 Subpart B Conducted Emissions Test

Significant Emissions Data

VB** 02/09/2011

Manufacturer	:	BADGER METER
Model	:	ORION SE MOBILE
DUT Mode	:	Tx @ MID CHANNEL
Line Tested	:	120V 60Hz RETURN
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-10
Notes	:	
Test Engineer	:	R. King
Limit	:	Class B
Test Date	:	Jun 12, 2014 11:11:38 AM
Data Filter	:	Up to 80 maximum levels detected with 6 dB level excursion threshold over 10 dB margin below limit

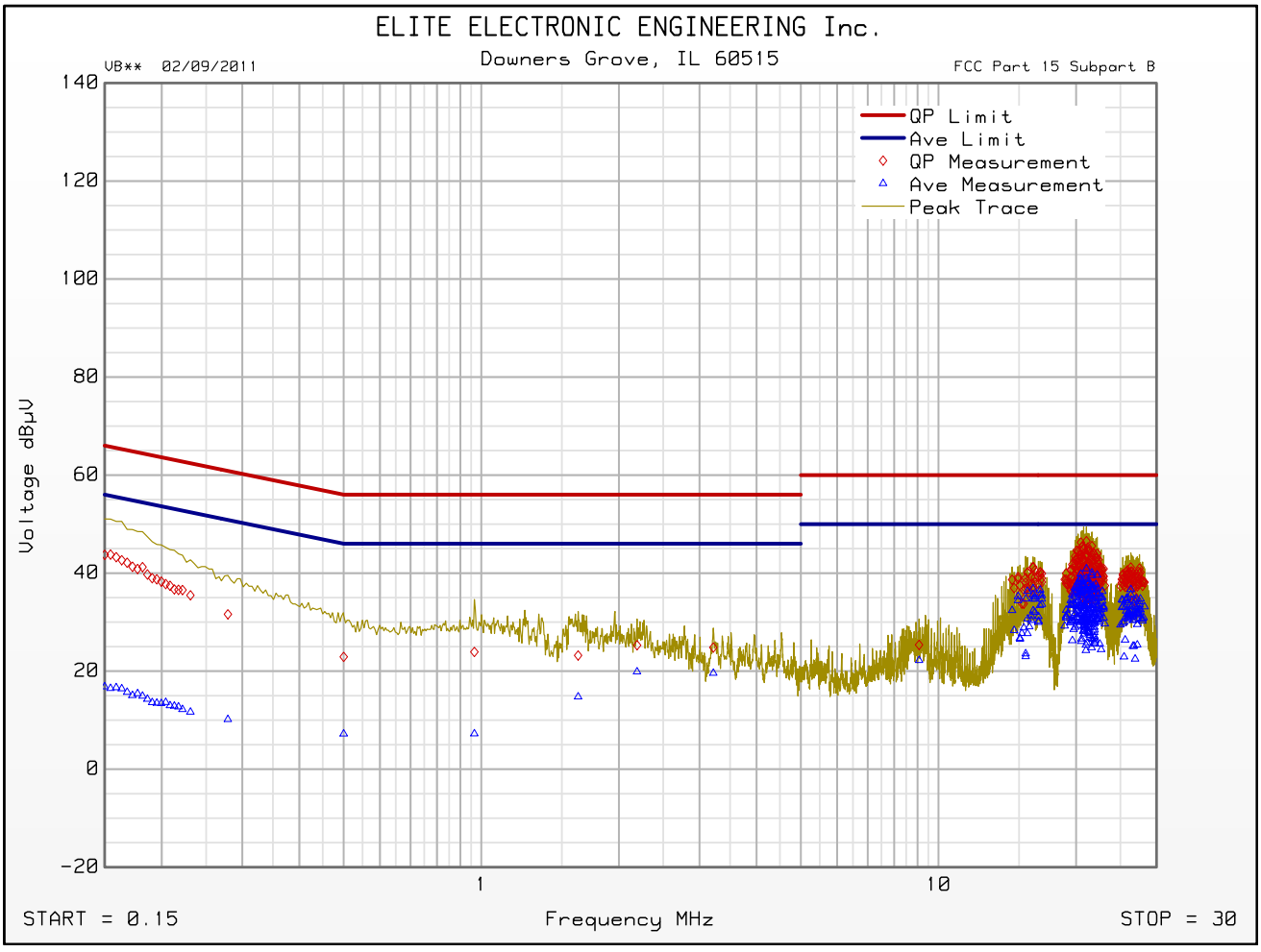
Freq MHz	Quasi-peak Level dBµV	Quasi-peak Limit dBµV	Excessive Quasi-peak Emissions	Average Level dBµV	Average Limit dBµV	Excessive Average Emissions
0.155	43.8	65.8		16.5	55.8	
0.279	31.6	60.8		10.1	50.8	
0.500	22.9	56.0		7.2	46.0	
0.966	23.9	56.0		7.3	46.0	
1.628	23.2	56.0		14.8	46.0	
2.192	25.3	56.0		19.9	46.0	
3.217	24.8	56.0		19.6	46.0	
9.068	25.4	60.0		22.2	50.0	
16.106	41.3	60.0		36.8	50.0	
21.074	46.5	60.0		40.9	50.0	
21.655	43.8	60.0		40.1	50.0	

FCC Part 15 Subpart B Conducted Emissions Test

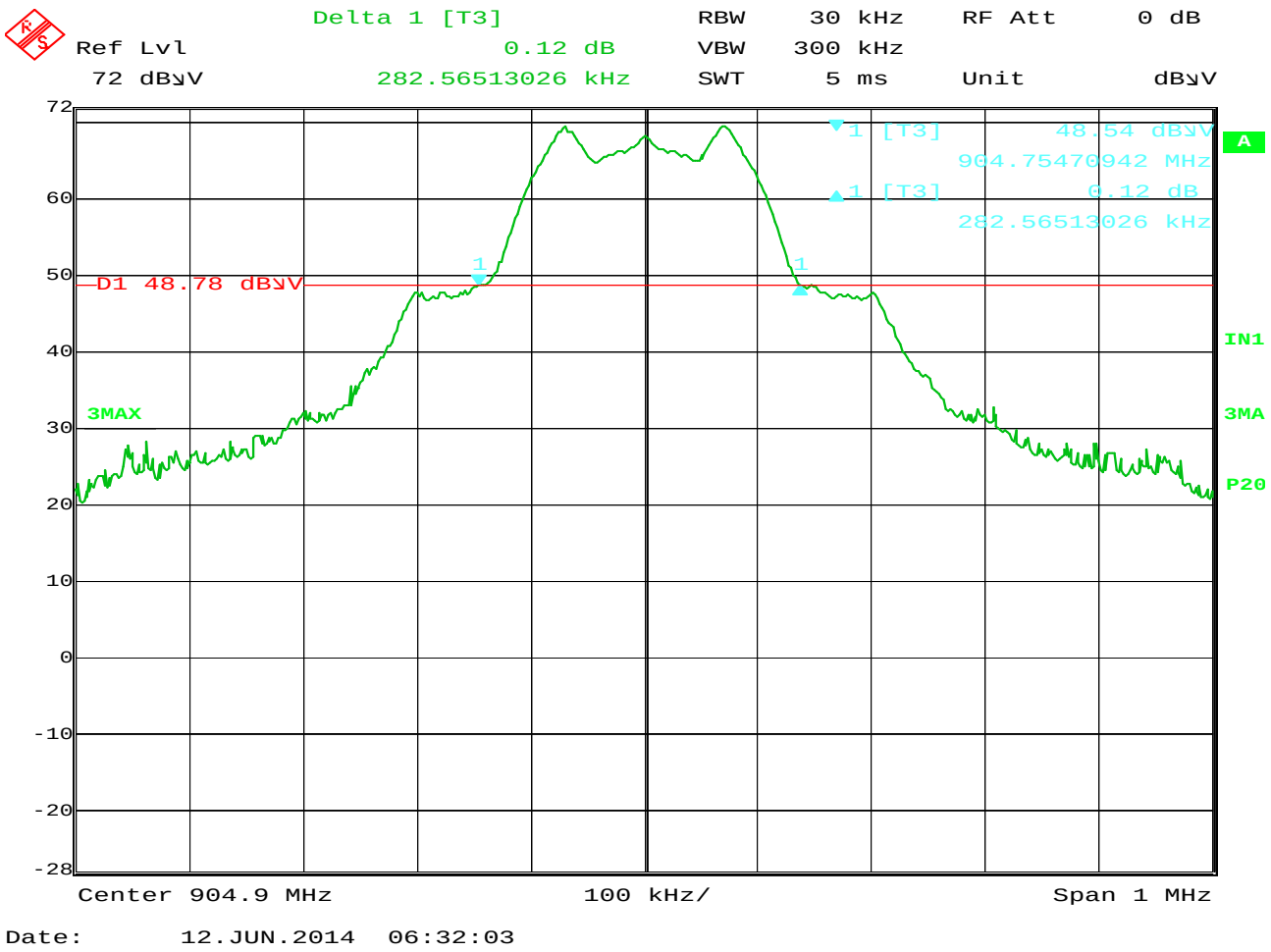
Cumulative Data

VB** 02/09/2011

Manufacturer	:	BADGER METER
Model	:	ORION SE MOBILE
DUT Mode	:	Tx @ MID CHANNEL
Line Tested	:	120V 60Hz RETURN
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-10
Notes	:	
Test Engineer	:	R. King
Limit	:	Class B
Test Date	:	Jun 12, 2014 11:11:38 AM

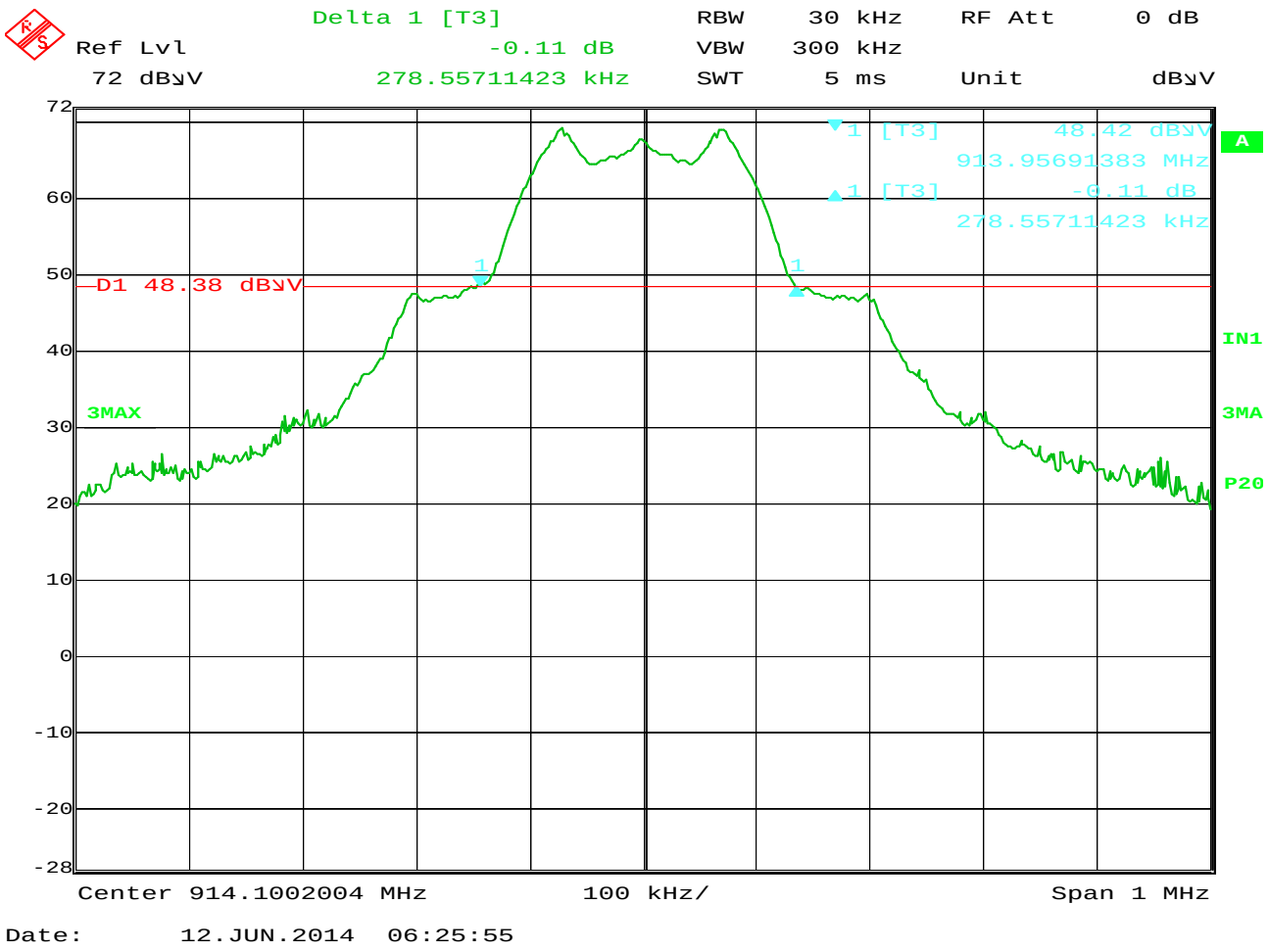


Emissions Meet QP Limit
Emissions Meet Ave Limit



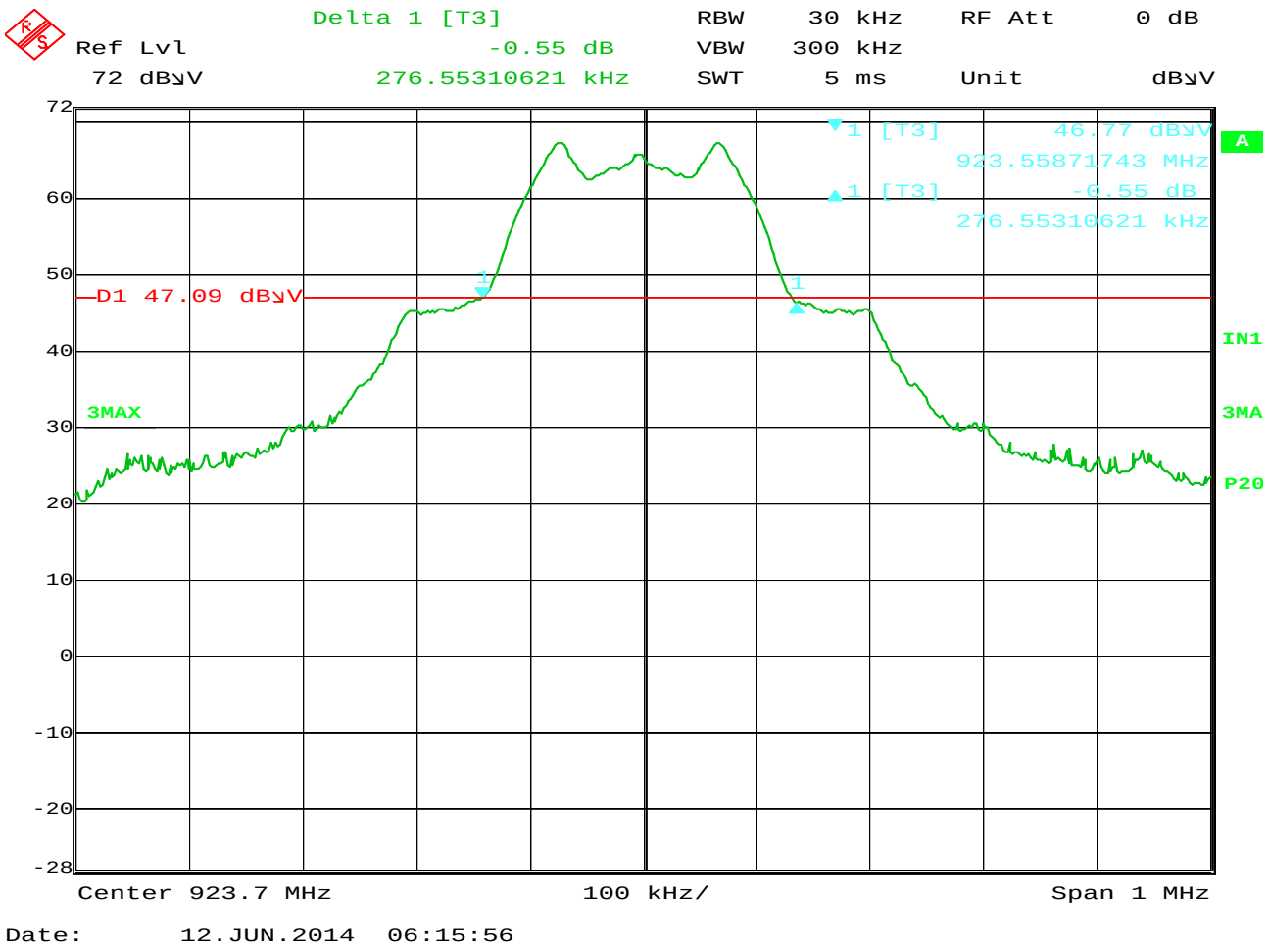
FCC 15.247(a) 20dB Bandwidth

MANUFACTURER	:	Badger Meter Inc.
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	
TEST MODE	:	Tx @ 904.9MHz
TEST PARAMETER	:	20dB Bandwidth = 282.56kHz
NOTES	:	



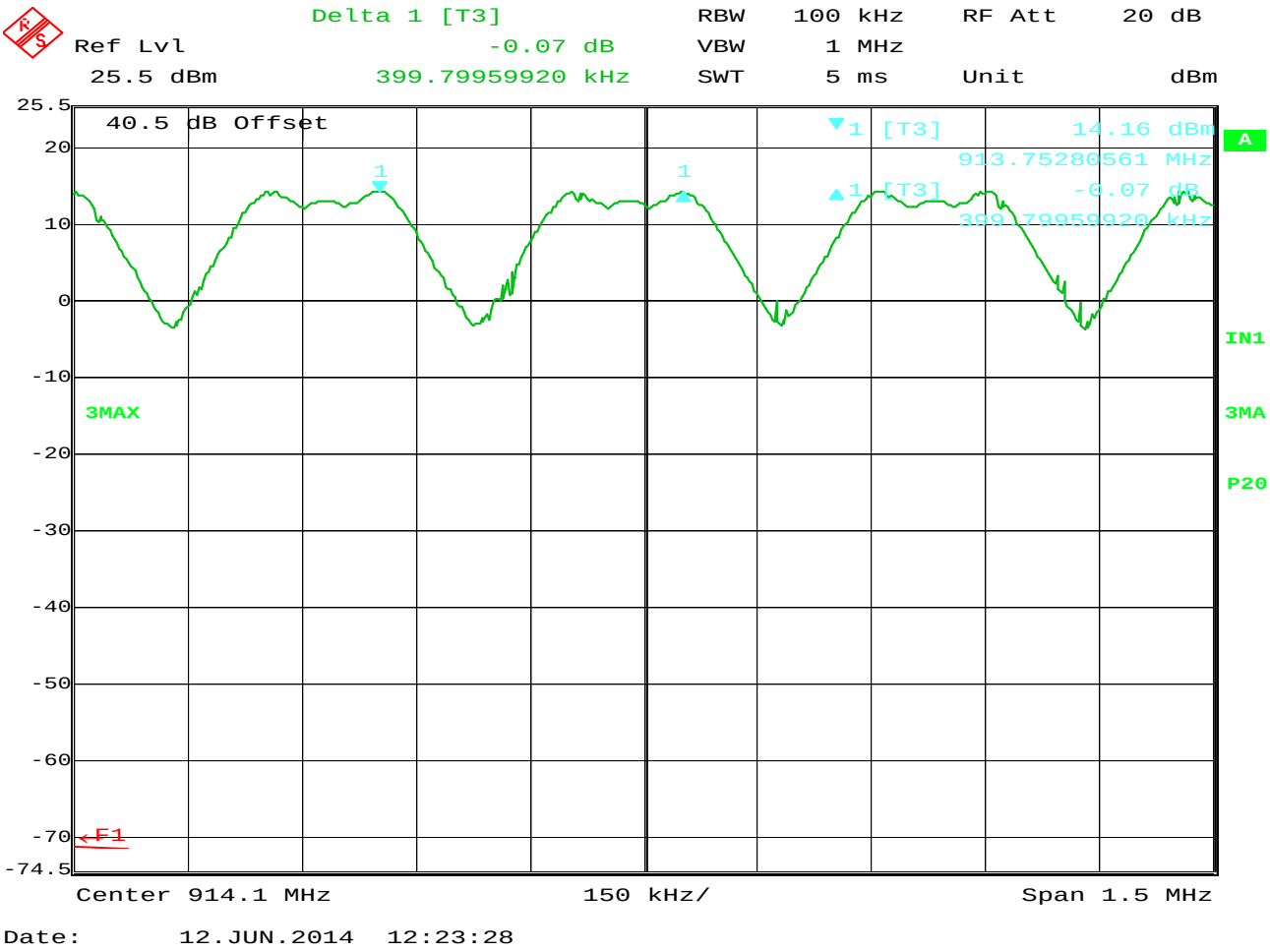
FCC 15.247(a) 20dB Bandwidth

MANUFACTURER	:	Badger Meter Inc.
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	
TEST MODE	:	Tx @ 914.1MHz
TEST PARAMETER	:	20dB Bandwidth = 278.55kHz
NOTES	:	



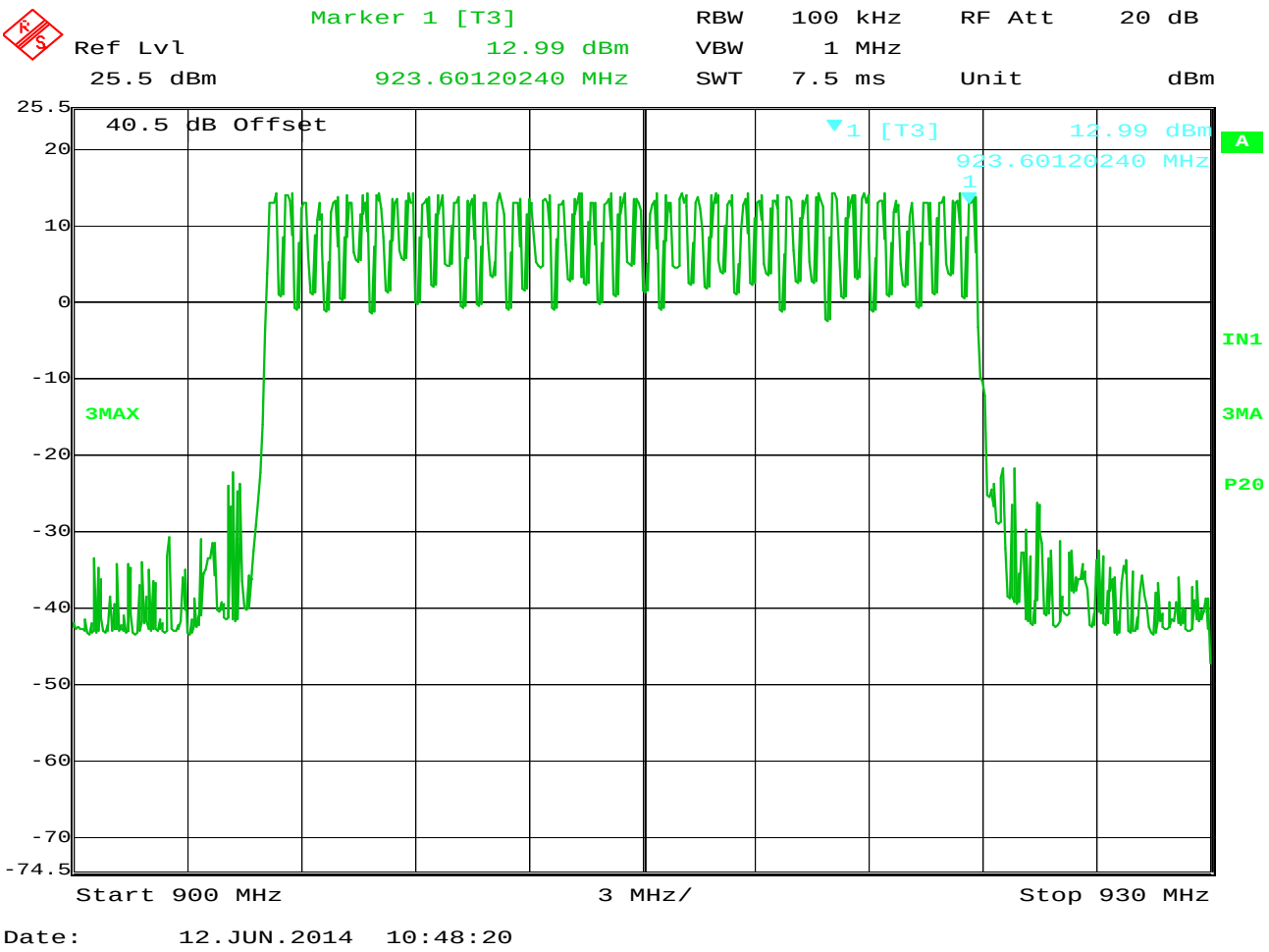
FCC 15.247(a) 20dB Bandwidth

MANUFACTURER	:	Badger Meter Inc.
MODEL NUMBER	:	Orion SE Mobile
SERIAL NUMBER	:	
TEST MODE	:	Tx @ 923.7MHz
TEST PARAMETER	:	20dB Bandwidth = 276.55kHz
NOTES	:	



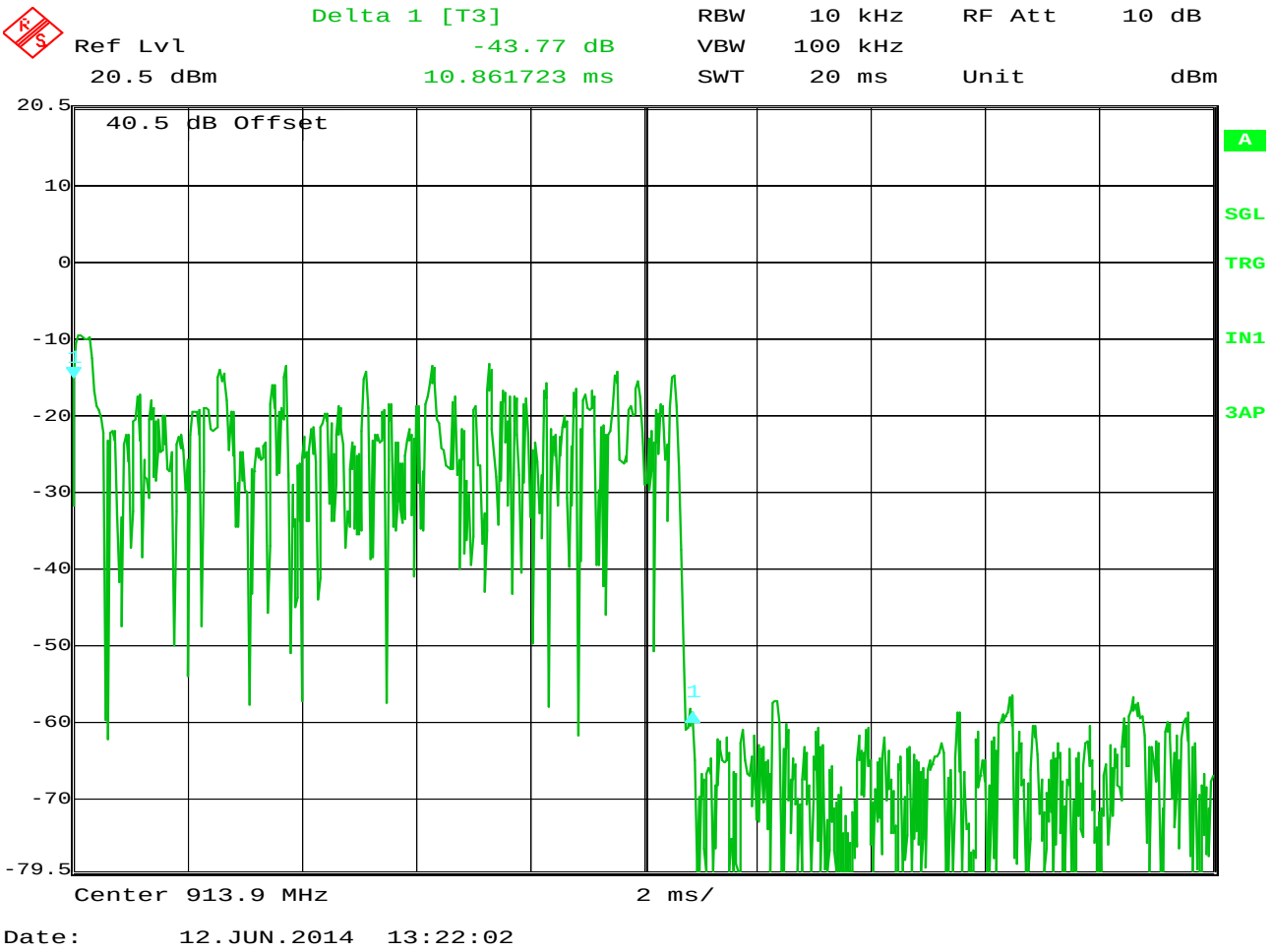
15.247(a) Carrier Frequency Separation

MANUFACTURER : Badger Meter Inc.
MODEL NUMBER : Orion SE Mobile
SERIAL NUMBER :
TEST MODE : Frequency Hopping
TEST PARAMETERS : Carrier Frequency Separation
NOTES : Carrier Frequency Separation = 399.79kHz
EQUIPMENT USED : RBA0, T2SK, T2DH



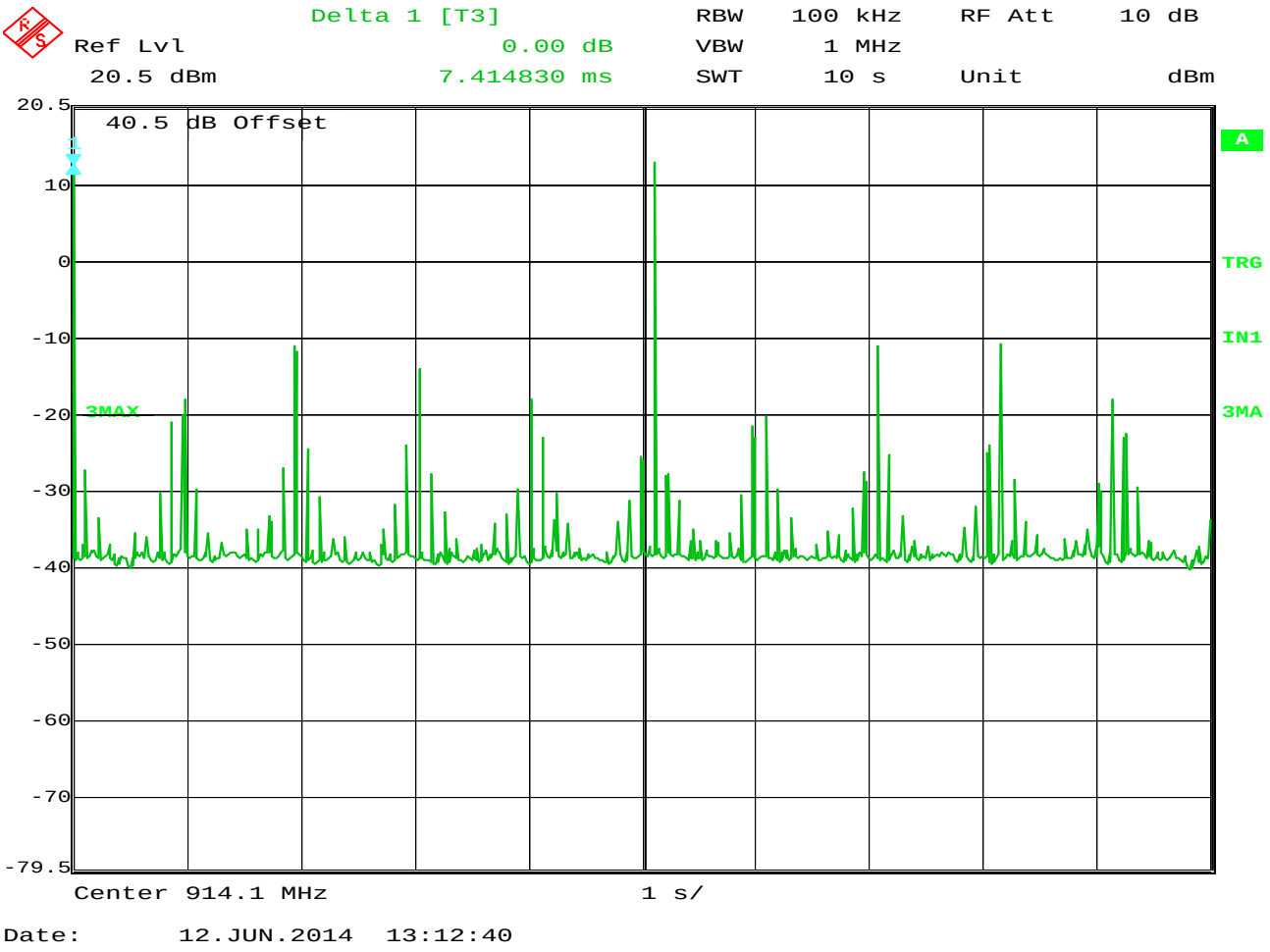
15.247(a) Number of Hopping Frequencies

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile Transceiver
SERIAL NUMBER	:	
TEST MODE	:	Hopping Enabled
TEST DATE	:	June 12, 2014
TEST PARAMETERS	:	Number of Hopping Channels
NOTES	:	Number of Hopping Channels = 47
EQUIPMENT USED	:	RBA0, T2SK, T2DH



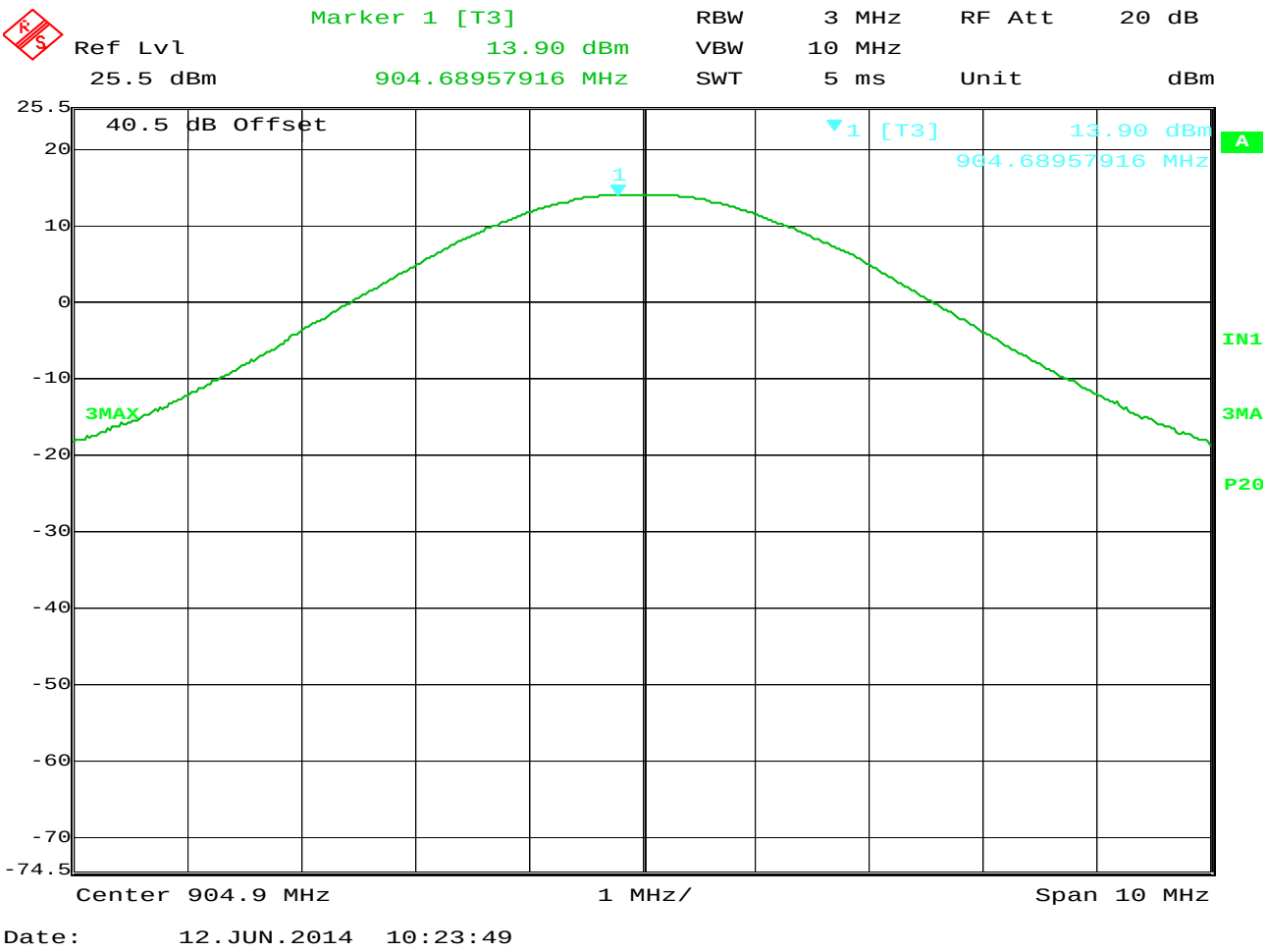
15.247(a) Time of Occupancy

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile Transceiver
TEST MODE	:	Worst Case Data Rate
TEST DATE	:	June 12, 2014
TEST PARAMETERS	:	Time of Occupancy
NOTES	:	Worst Case Pulse = 10.8msec. Number of times it hits a channel in a 10 second period is 2. Therefore the time of occupancy is 2 x 7.4msec = 21.6msec



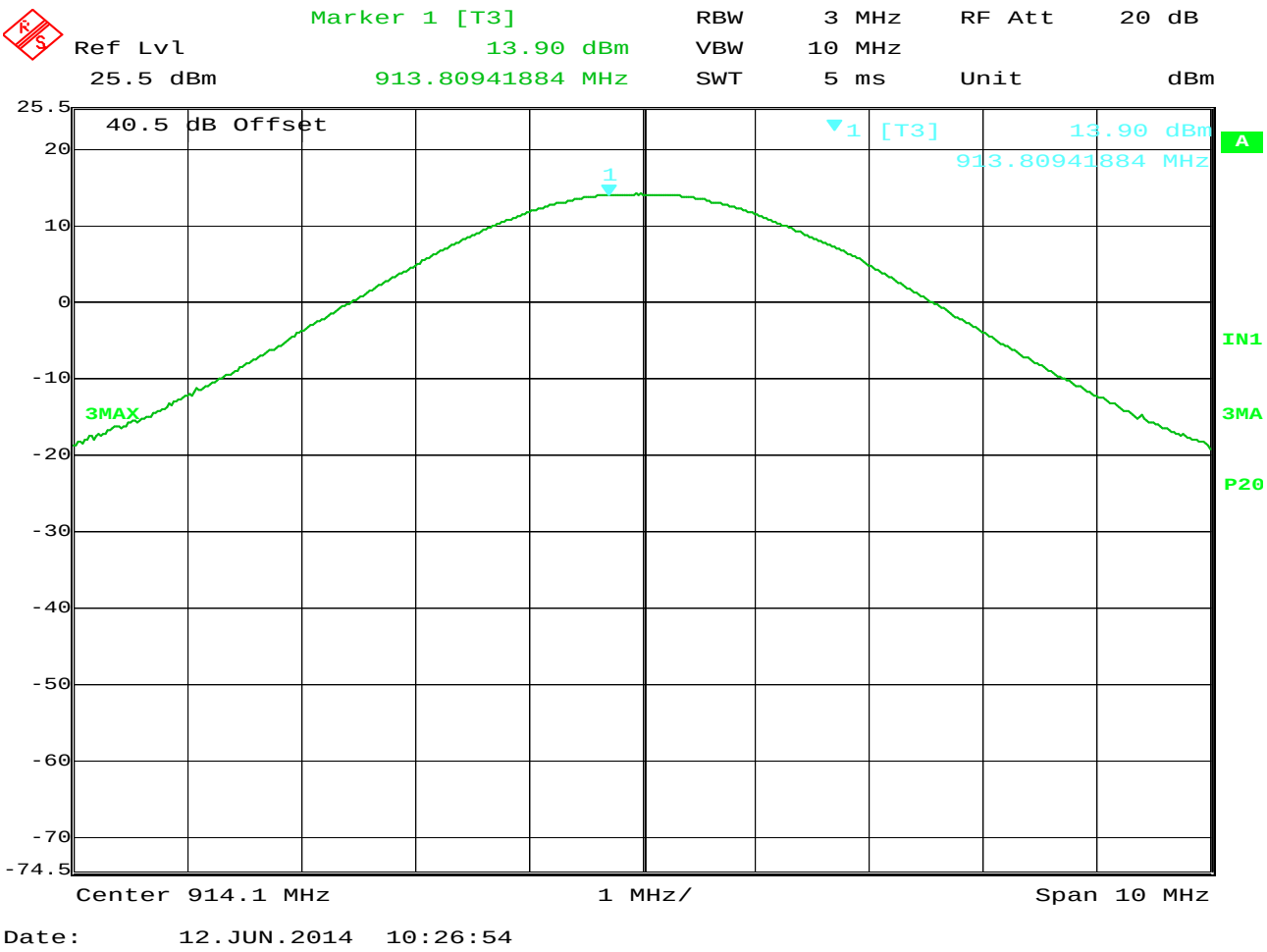
15.247(a) Time of Occupancy

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile Transceiver
TEST MODE	:	Worst Case Data Rate
TEST DATE	:	June 12, 2014
TEST PARAMETERS	:	Time of Occupancy
NOTES	:	Worst Case Pulse = 10.8msec. Number of times it hits a channel in a 10 second period is 2. Therefore the time of occupancy is 2 x 7.4msec = 21.6msec



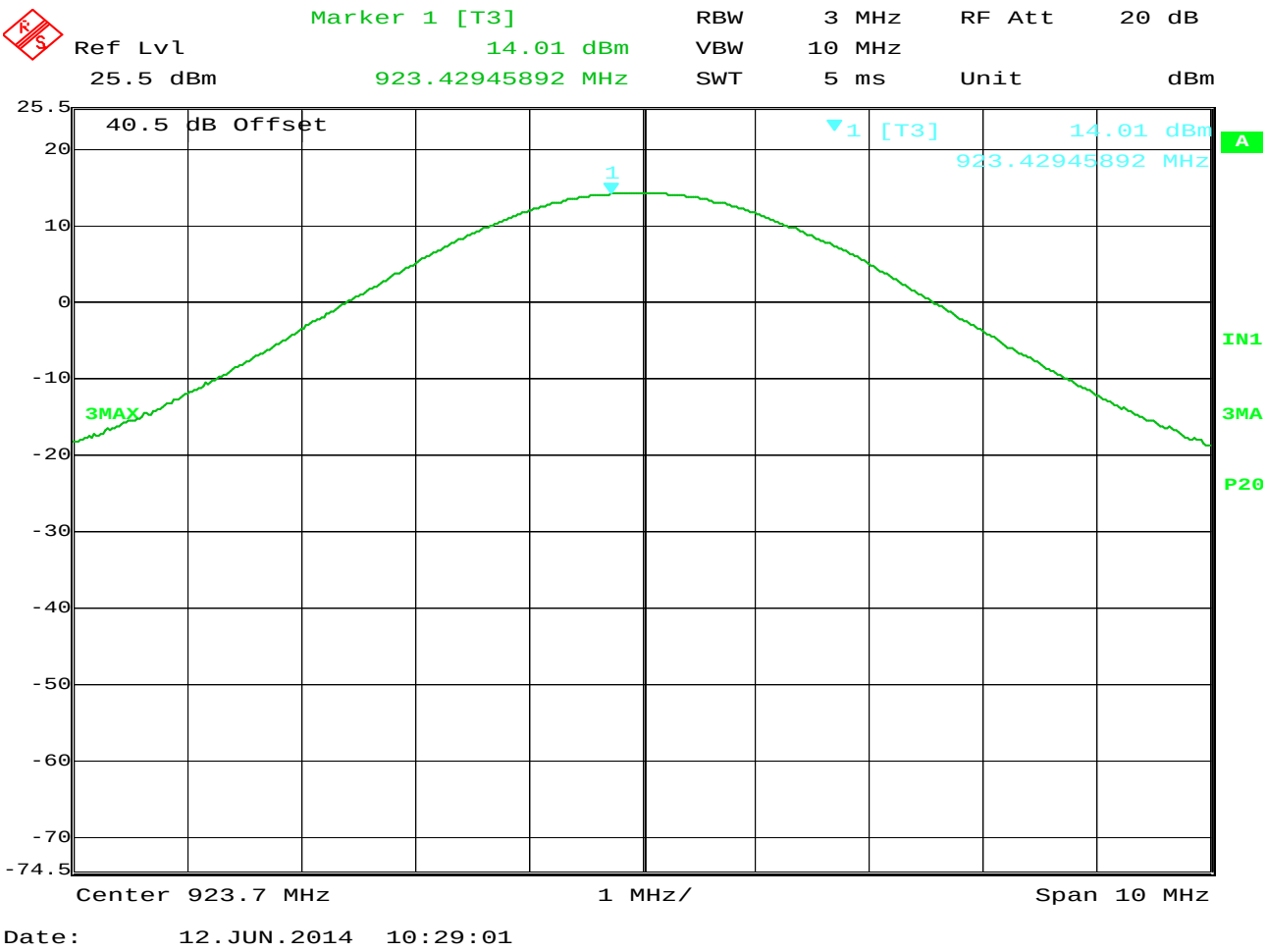
15.247(b) Peak Output Power at Antenna Terminal

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile Transceiver
TEST MODE	:	Tx @ 904.9MHz
NOTES	:	
TEST DATE	:	June 12, 2014
TEST PARAMETERS	:	Peak Output Power
NOTES	:	Peak Output Power = 13.9dBm = 24.5mW
EQUIPMENT USED	:	RBA0, T2SK, T2DH



15.247(b) Peak Output Power at Antenna Terminal

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile Transceiver
TEST MODE	:	Tx @ 914.1MHz
NOTES	:	
TEST DATE	:	June 12, 2014
TEST PARAMETERS	:	Peak Output Power
NOTES	:	Peak Output Power = 13.9dBm = 24.5mW
EQUIPMENT USED	:	RBA0, T2SK, T2DH



15.247(b) Peak Output Power at Antenna Terminal

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile Transceiver
TEST MODE	:	Tx @ 923.7MHz
NOTES	:	
TEST DATE	:	June 12, 2014
TEST PARAMETERS	:	Peak Output Power
NOTES	:	Peak Output Power = 14.01dBm = 25.1mW
EQUIPMENT USED	:	RBA0, T2SK, T2DH

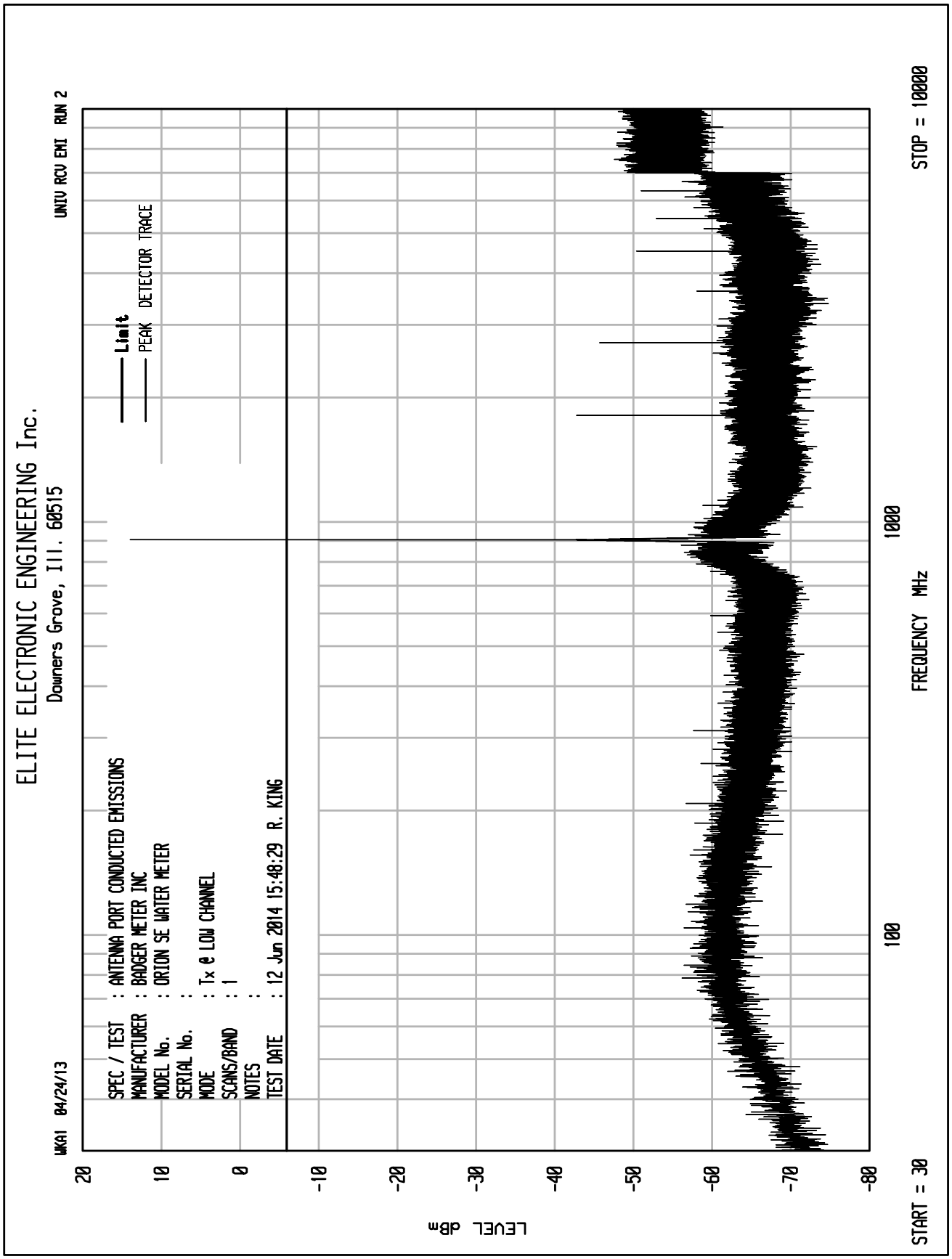
Manufacturer : Badger Meter, Inc.
Model Number : Orion SE Mobile
Serial No. : None Assigned
Specification : FCC-15.247 Effective Isotropic Radiated Power (EIRP)
Date : June 11, 2014
Notes : Test Distance is 3 meters

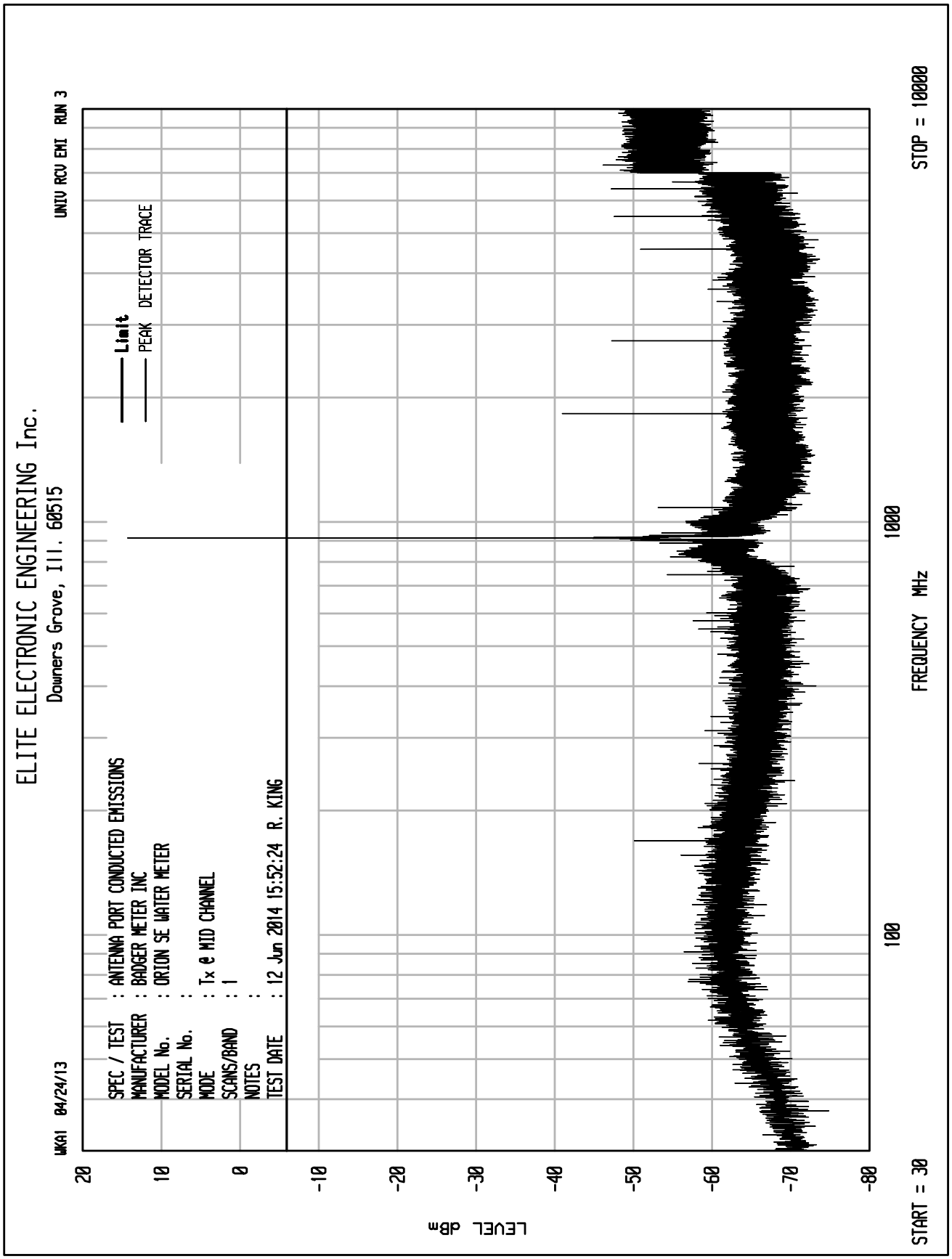
Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Matched SIG. GEN. (dBm)	Equivalent Ant Gain (dB)	Cable Loss (dB)	EIRP Total (dBm)	Limit dBm
904.90	H	74.7	0.6	2.2	2.5	0.3	30.0
904.90	V	90.7	19.9	2.2	2.5	19.6	30.0
913.90	H	75.3	1.3	2.2	2.5	1.0	30.0
913.90	V	92.1	19.6	2.2	2.5	19.3	30.0
923.70	H	73.0	-0.9	2.2	2.5	-1.2	30.0
923.70	V	90.5	17.7	2.2	2.5	17.4	30.0

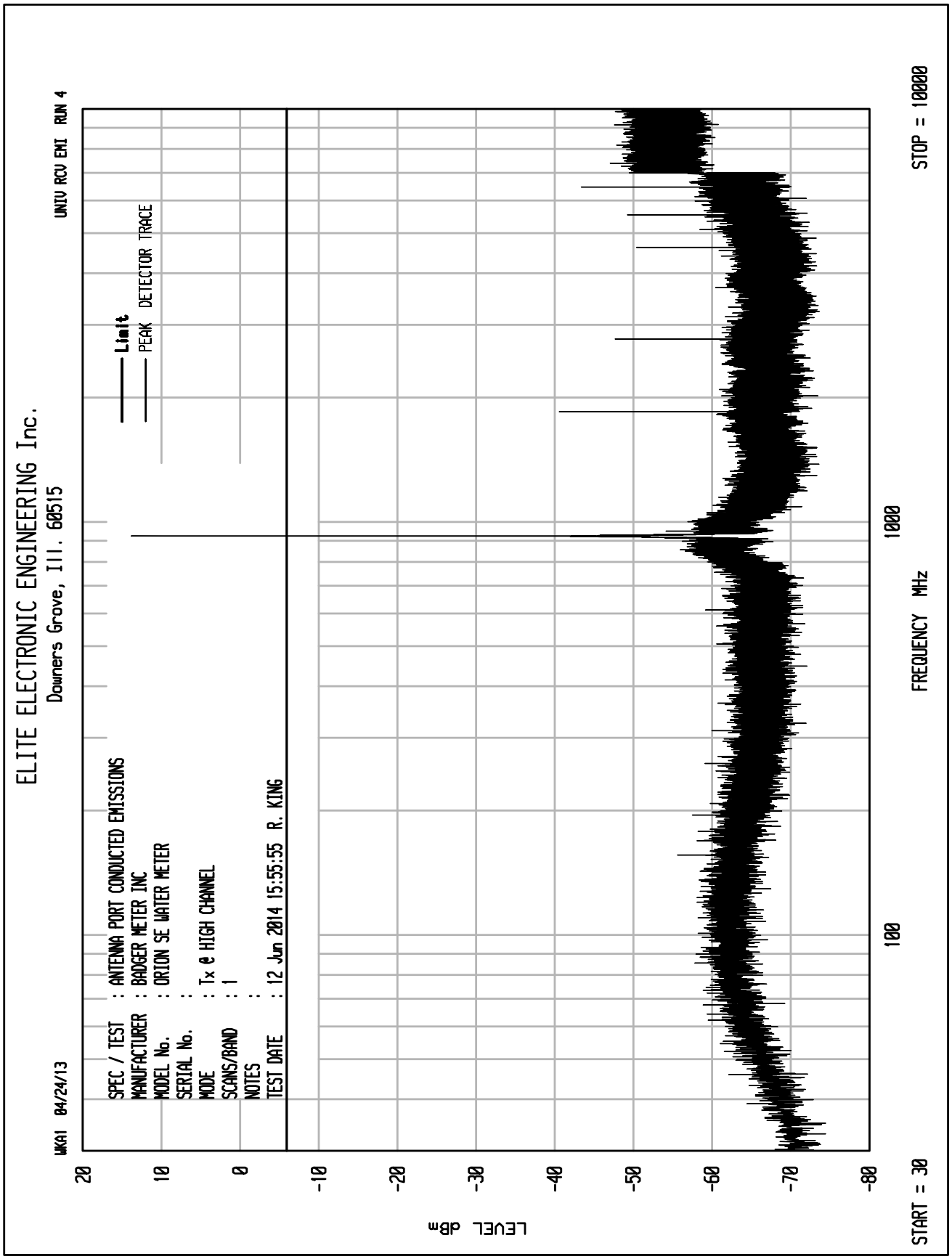
EIRP (dBm) = Matched Signal Generator (dBm) + Antenna Gain (dB) – Cable Loss (dB)

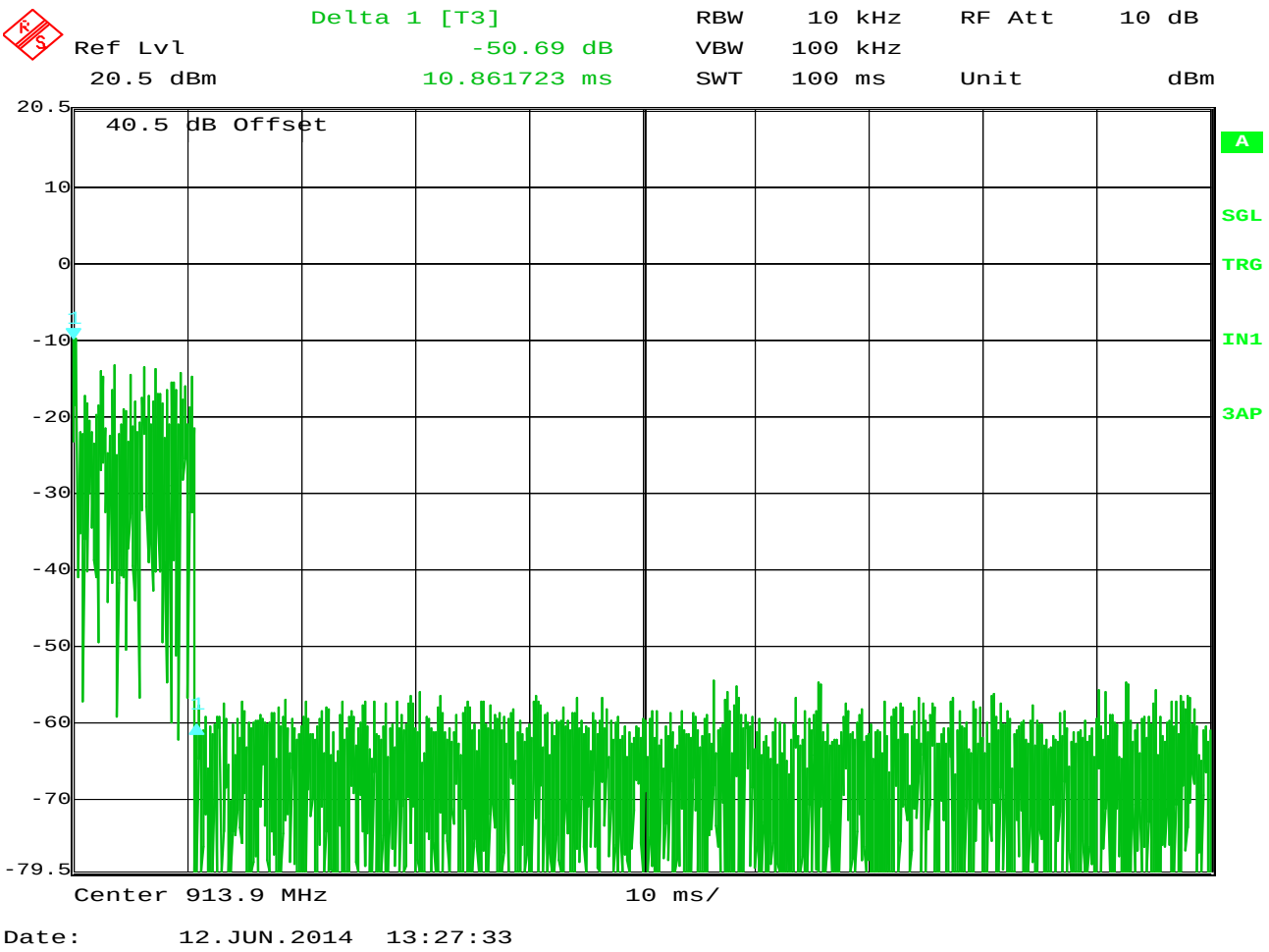
Checked BY Richard E. King :

Richard E. King


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 2
WKAI 04/24/13
SPEC / TEST : ANTENNA PORT CONDUCTED EMISSIONS
MANUFACTURER : BADGER METER INC
MODEL No. : ORION SE WATER METER
SERIAL No. :
MODE : Tx @ LOW CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 12 Jun 2014 15:48:29 R. KING
Limit
PEAK DETECTOR TRACE
LEVEL dBm
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
START = 30
100
1000
STOP = 10000
FREQUENCY MHz

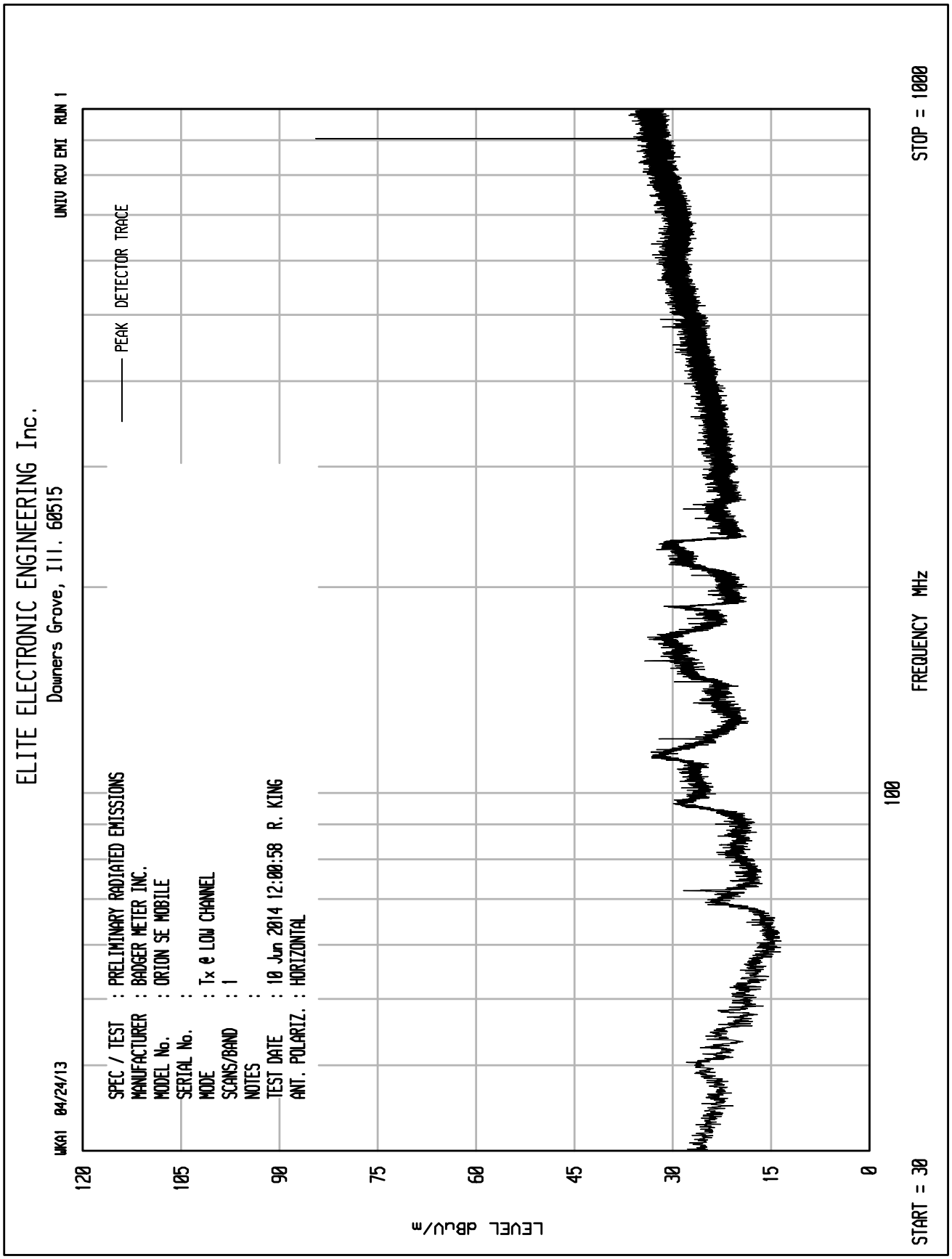

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 3
WKAI 04/24/13
SPEC / TEST : ANTENNA PORT CONDUCTED EMISSIONS
MANUFACTURER : BADGER METER INC
MODEL No. : ORION SE WATER METER
SERIAL No. :
MODE : Tx @ MID CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 12 Jun 2014 15:52:24 R. KING
Limit
PEAK DETECTOR TRACE
LEVEL dBm
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
START = 30
100
1000
STOP = 10000
FREQUENCY MHz

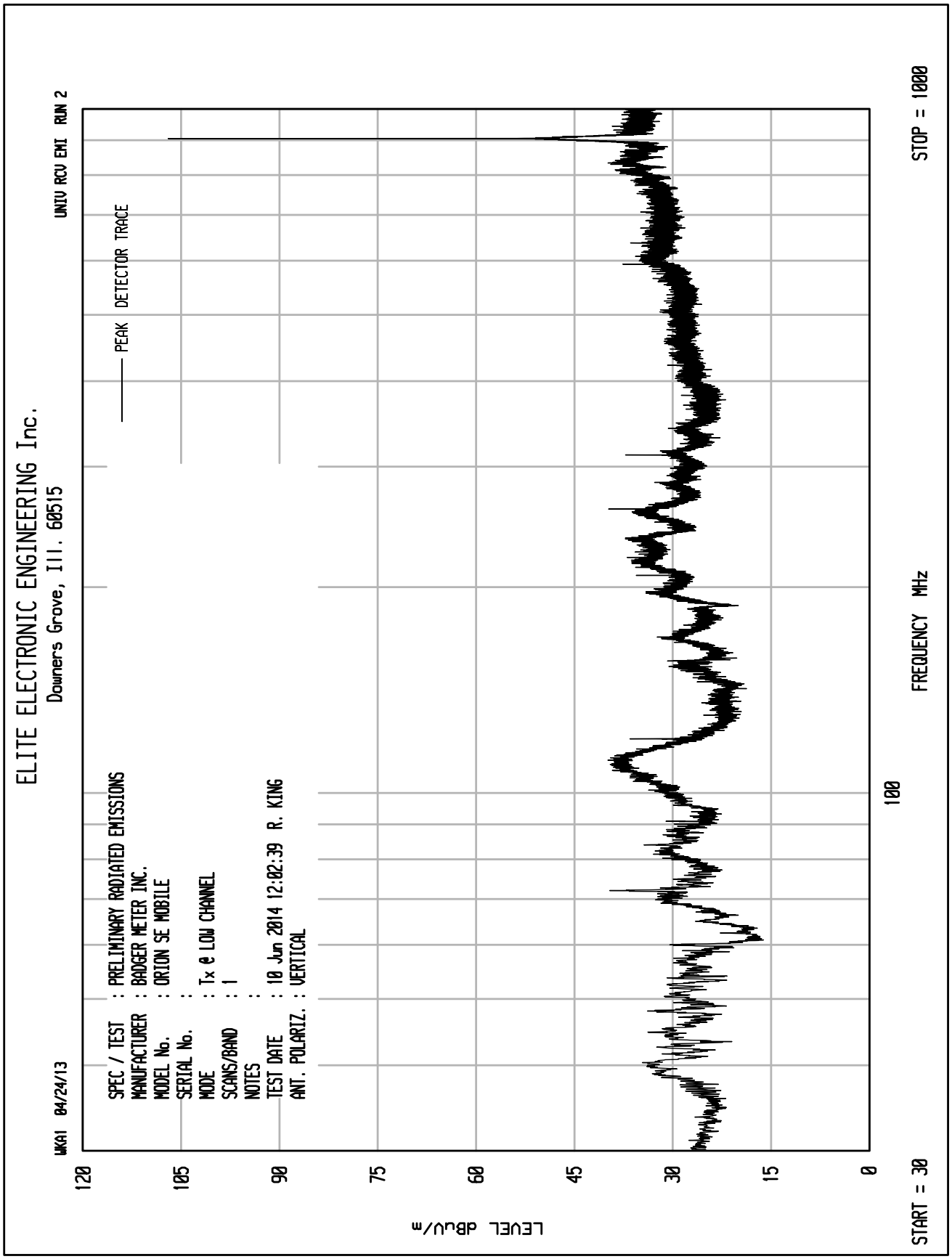

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 4
WKAI 04/24/13
SPEC / TEST : ANTENNA PORT CONDUCTED EMISSIONS
MANUFACTURER : BADGER METER INC
MODEL No. : ORION SE WATER METER
SERIAL No. :
MODE : Tx @ HIGH CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 12 Jun 2014 15:55:55 R. KING
Limit
PEAK DETECTOR TRACE
LEVEL dBm
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
START = 30
100
1000
STOP = 10000
FREQUENCY MHz

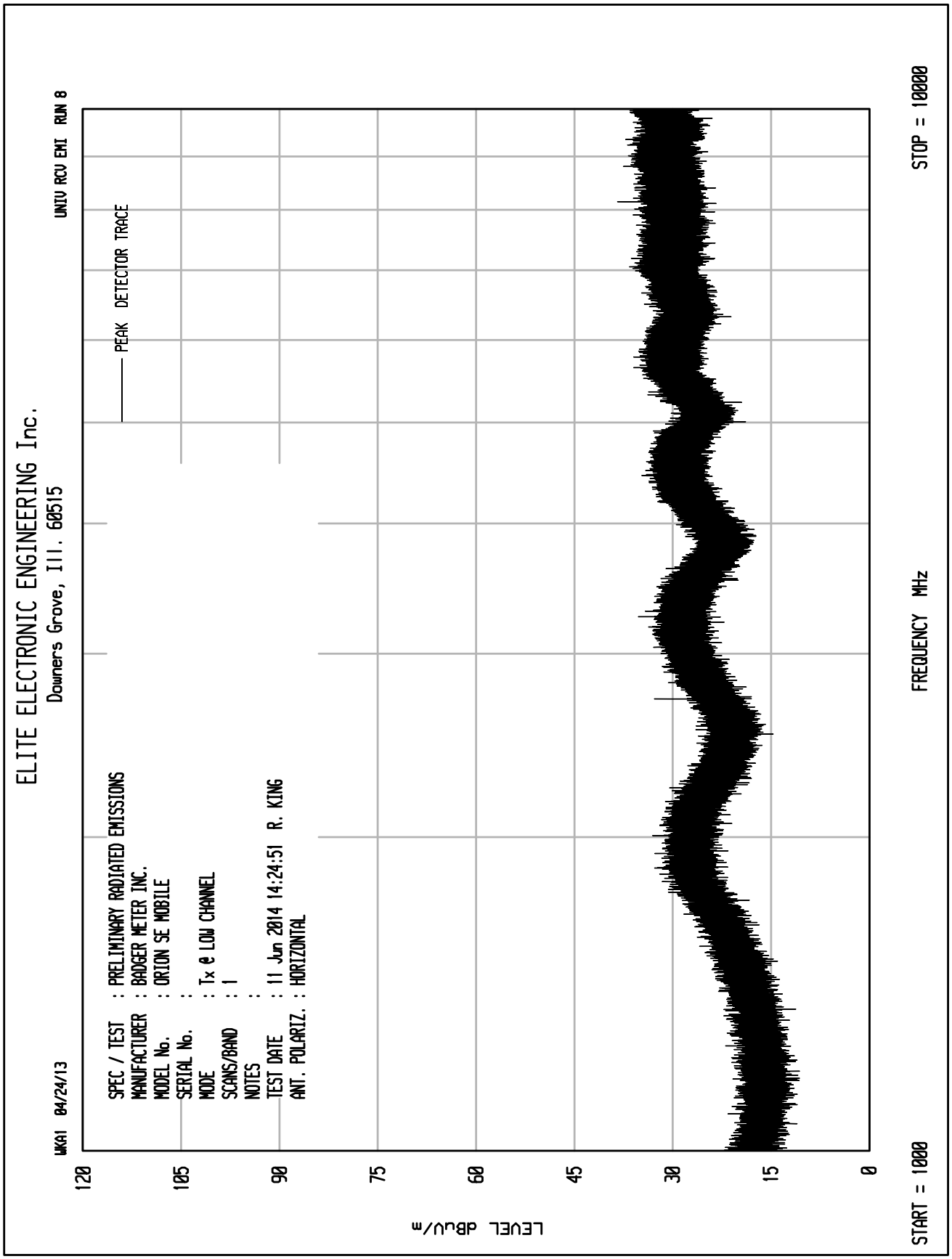


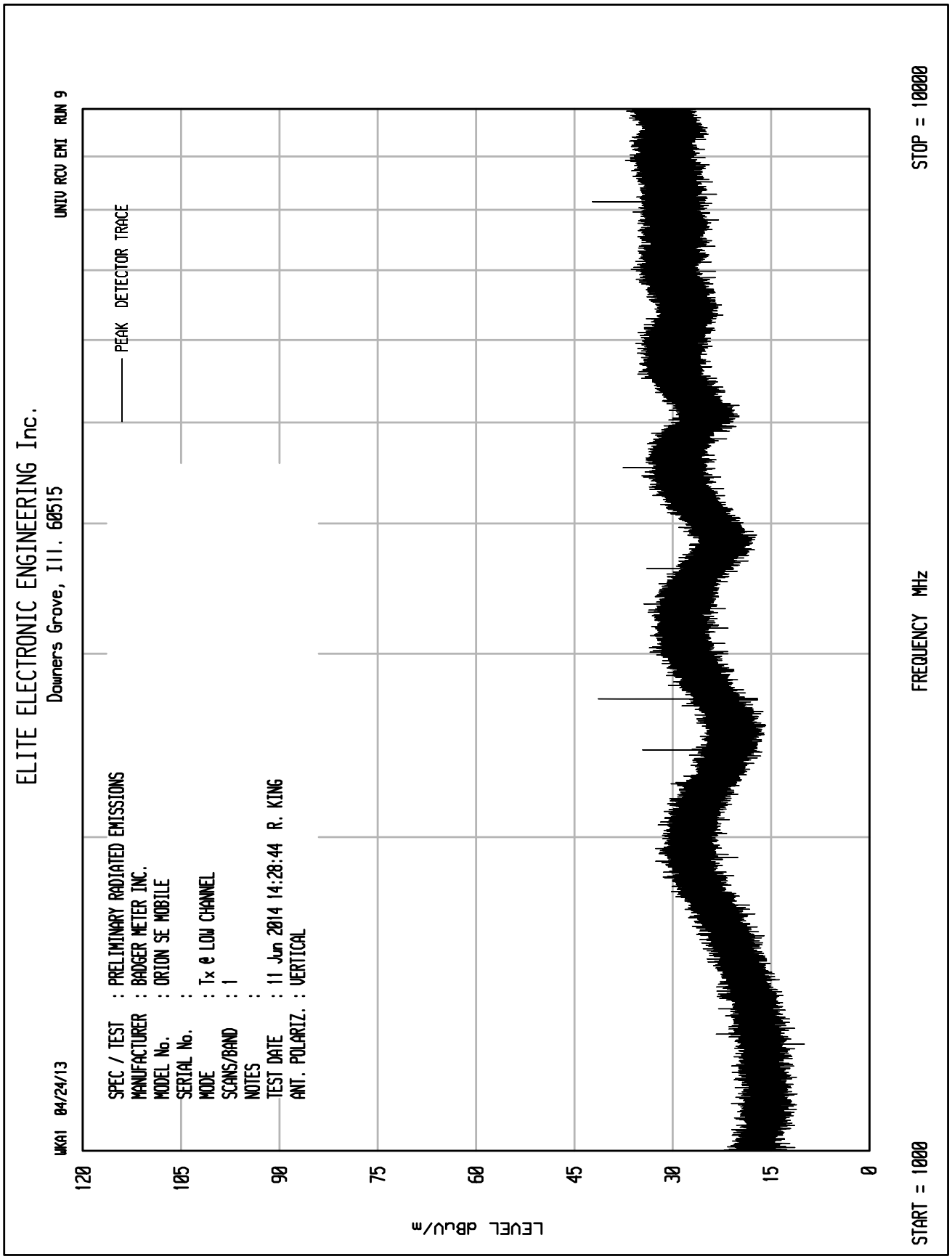
15.35(c) Duty Cycle Factor

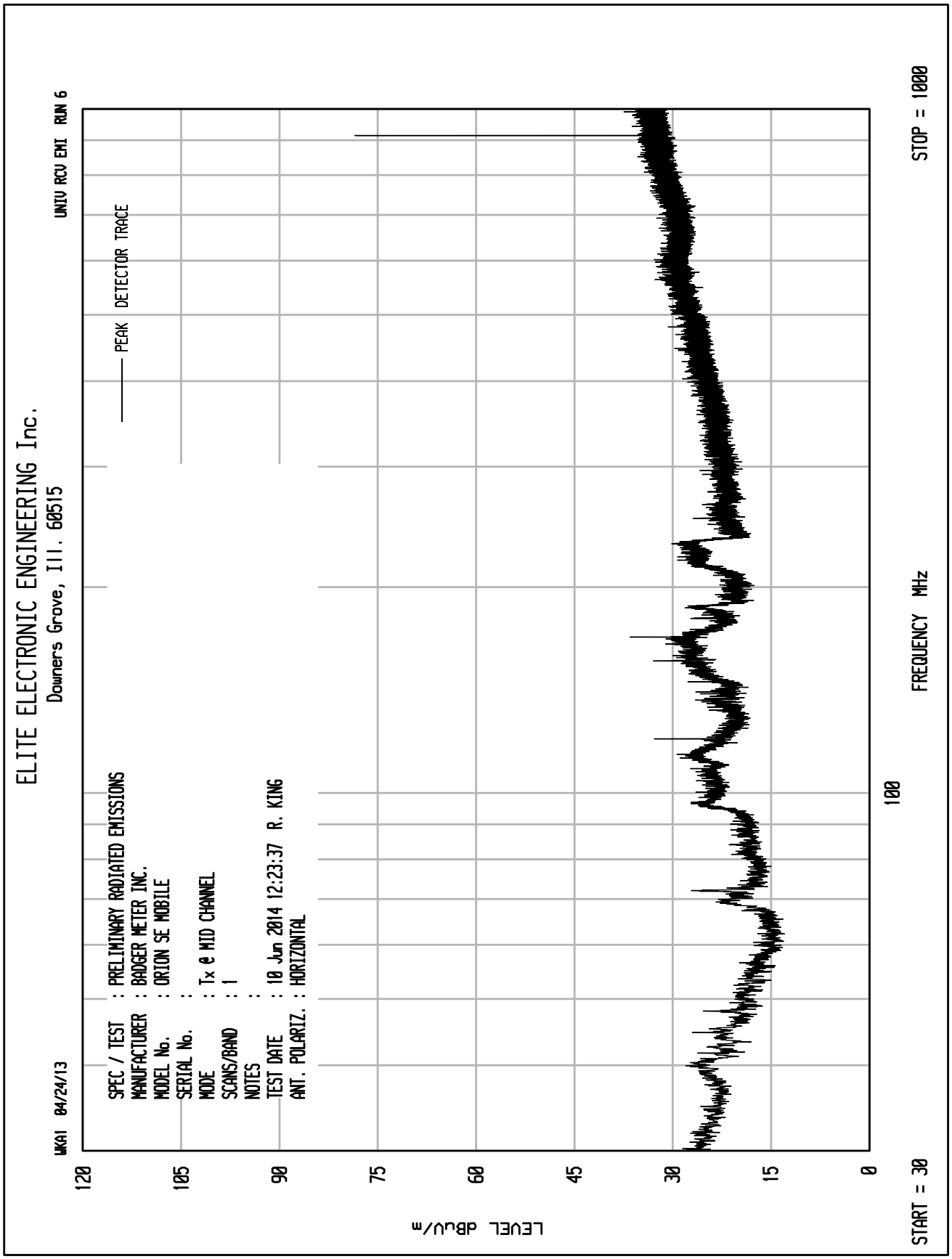
MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile Transceiver
TEST MODE	:	Worst Case Data Rate
NOTES	:	
TEST DATE	:	June 12, 2014
TEST PARAMETERS	:	Duty Cycle Correction Factor
NOTES	:	Duty Cycle Correction Factor = 20*log(10.8msec/100msec) = 20*log(.108) =
	:	-19.3dB
EQUIPMENT USED	:	RBA0, T2SK, T2S3

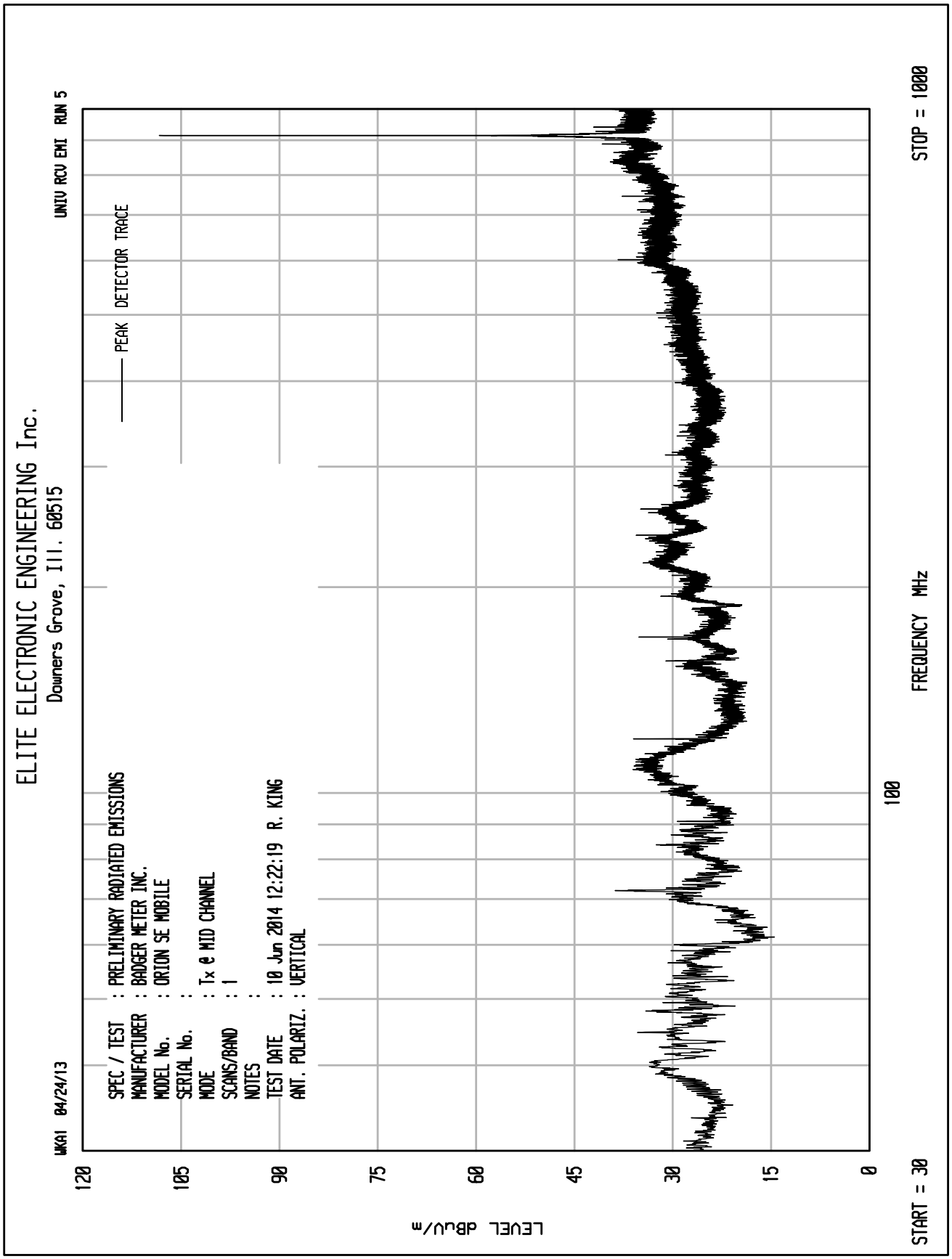

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 1
WKAI 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION SE MOBILE
SERIAL No. :
MODE : Tx @ LOW CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 10 Jun 2014 12:00:58 R. KING
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000

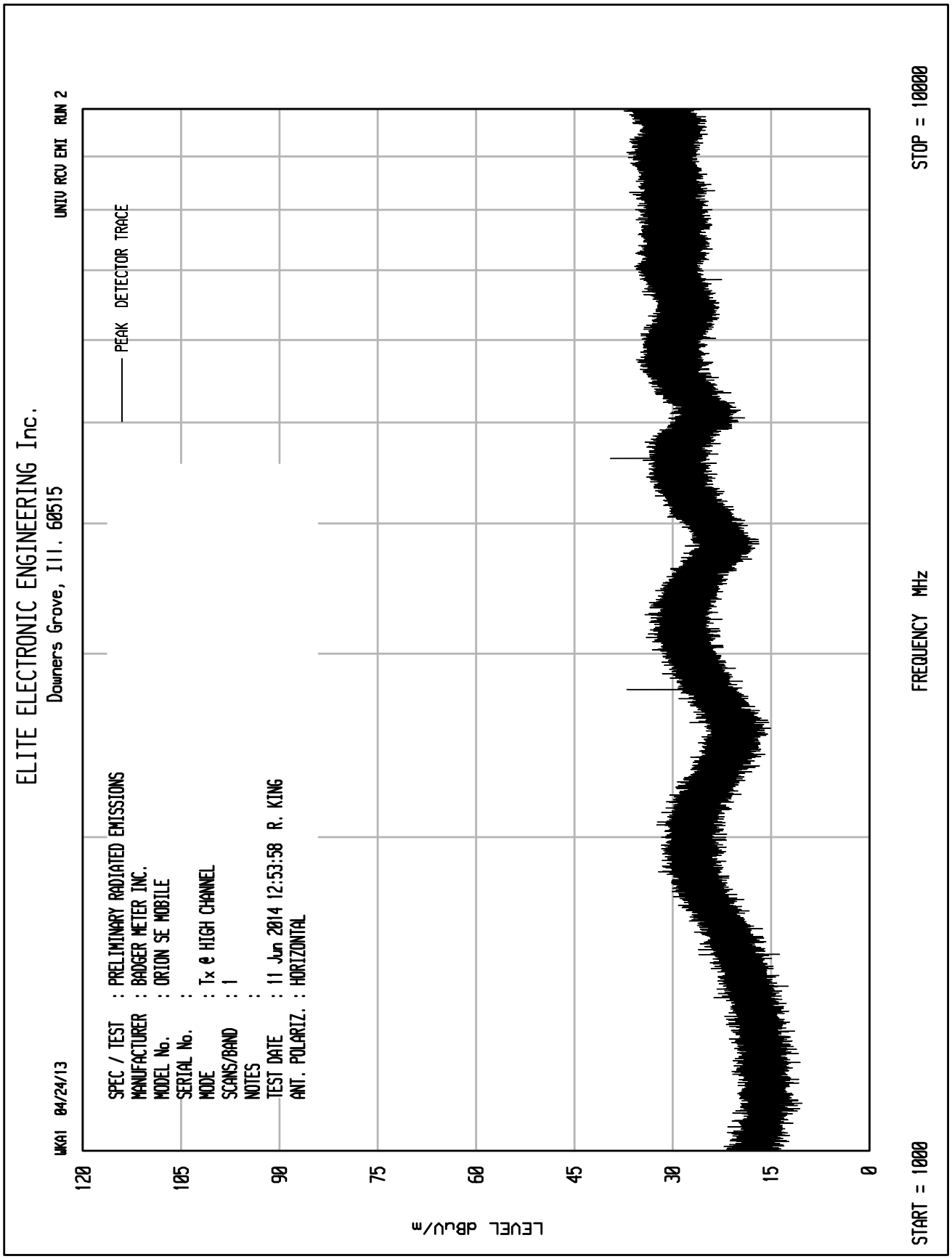

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 2
WKAI 04/24/13
PEAK DETECTOR TRACE
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION SE MOBILE
SERIAL No. :
MODE : Tx @ LOW CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 10 Jun 2014 12:02:39 R. KING
ANT. POLARIZ. : VERTICAL
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000

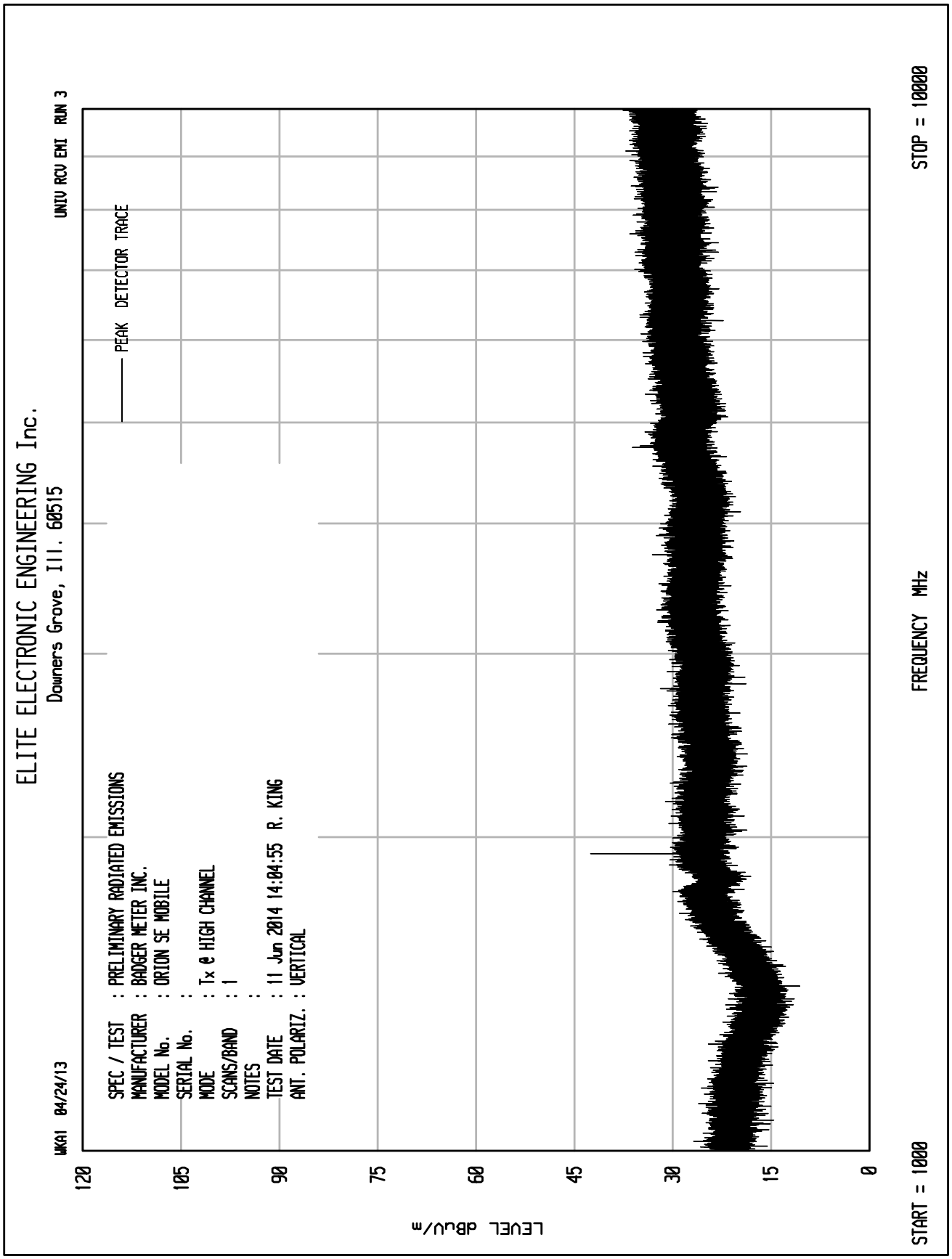

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 8
WKAI 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION SE MOBILE
SERIAL No. :
MODE : Tx @ LOW CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 11 Jun 2014 14:24:51 R. KING
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 10000

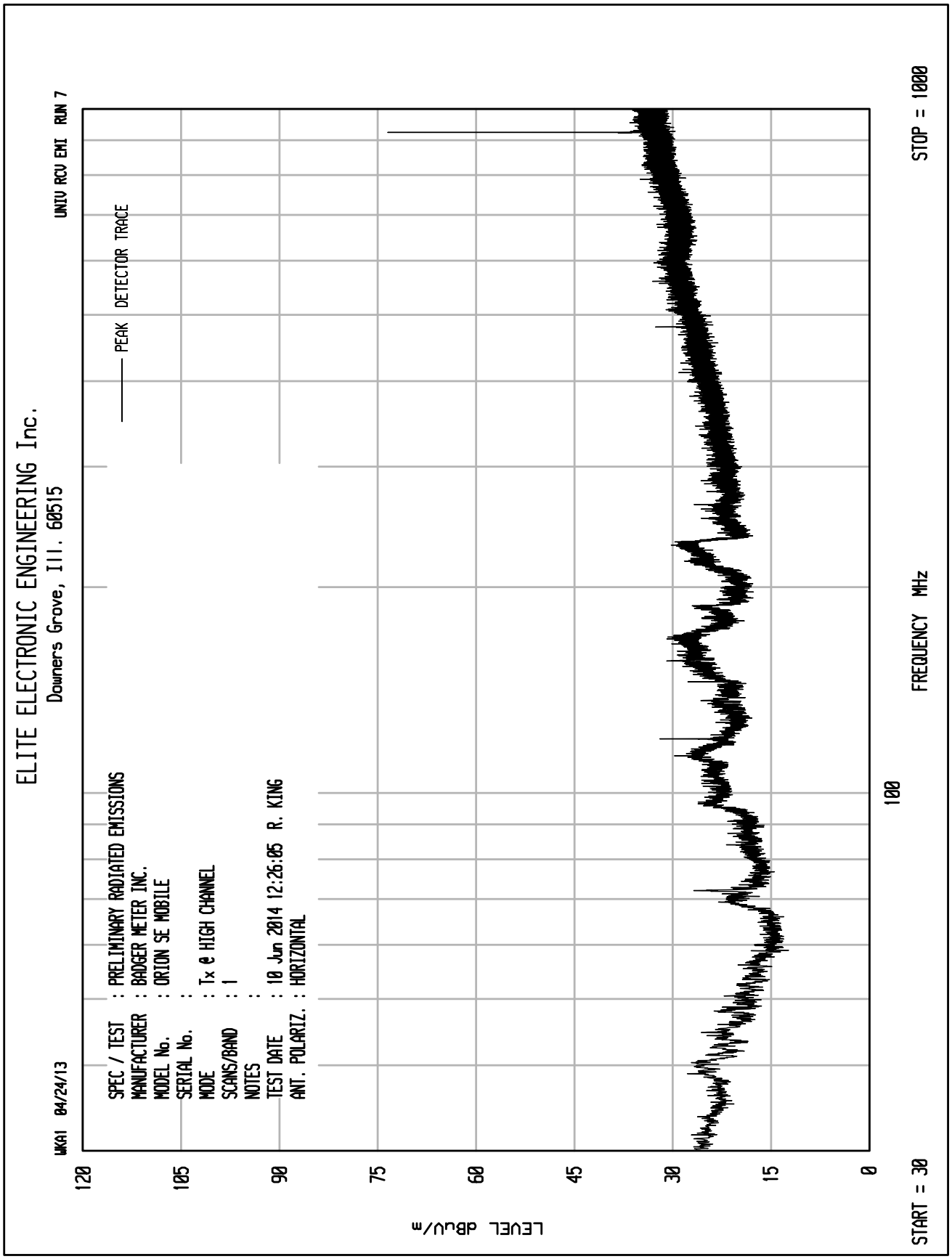

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 9
WKAI 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION SE MOBILE
SERIAL No. :
MODE : Tx @ LOW CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 11 Jun 2014 14:28:44 R. KING
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 10000

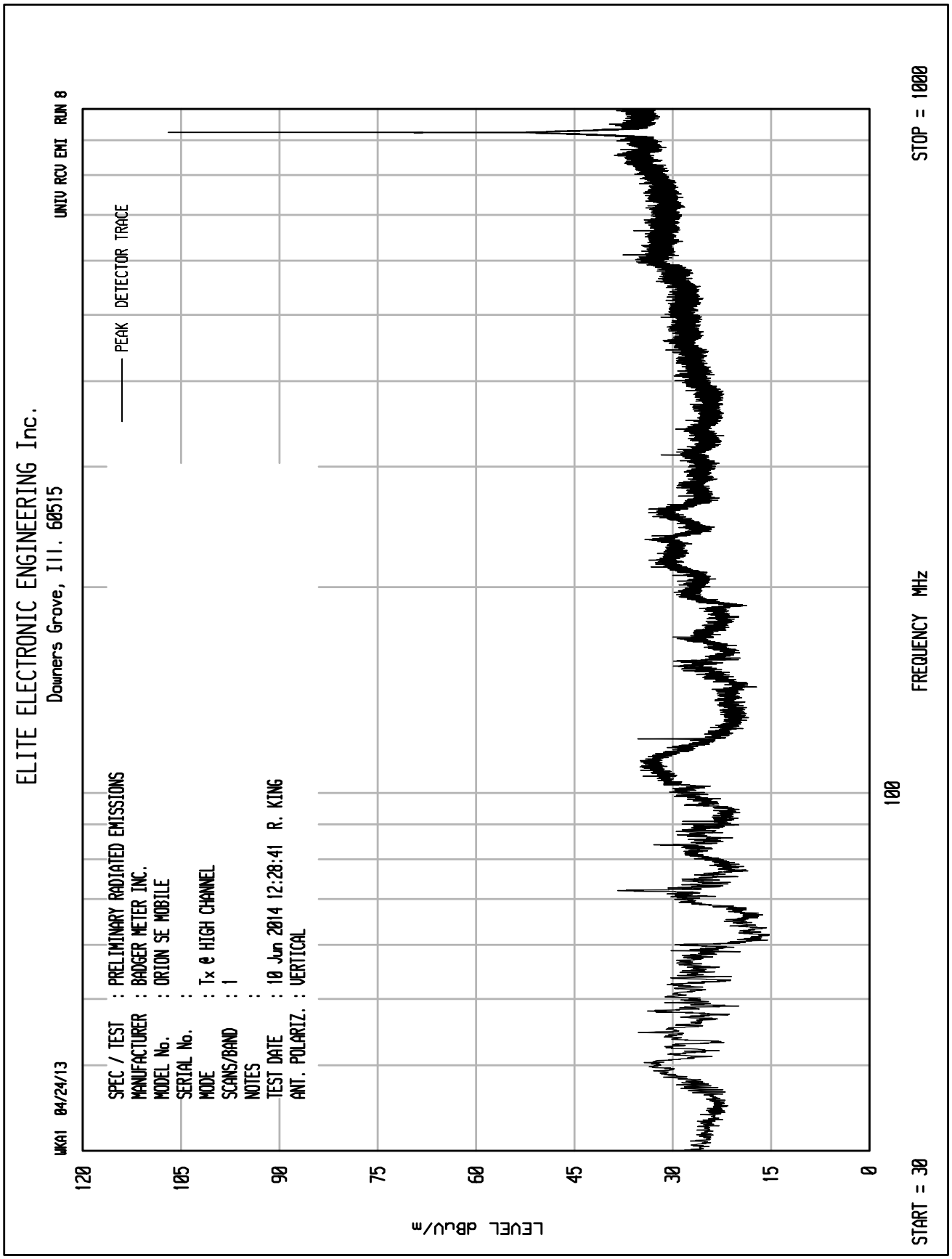

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 6
WKAI 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION SE MOBILE
SERIAL No. :
MODE : Tx @ MID CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 10 Jun 2014 12:23:37 R. KING
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000

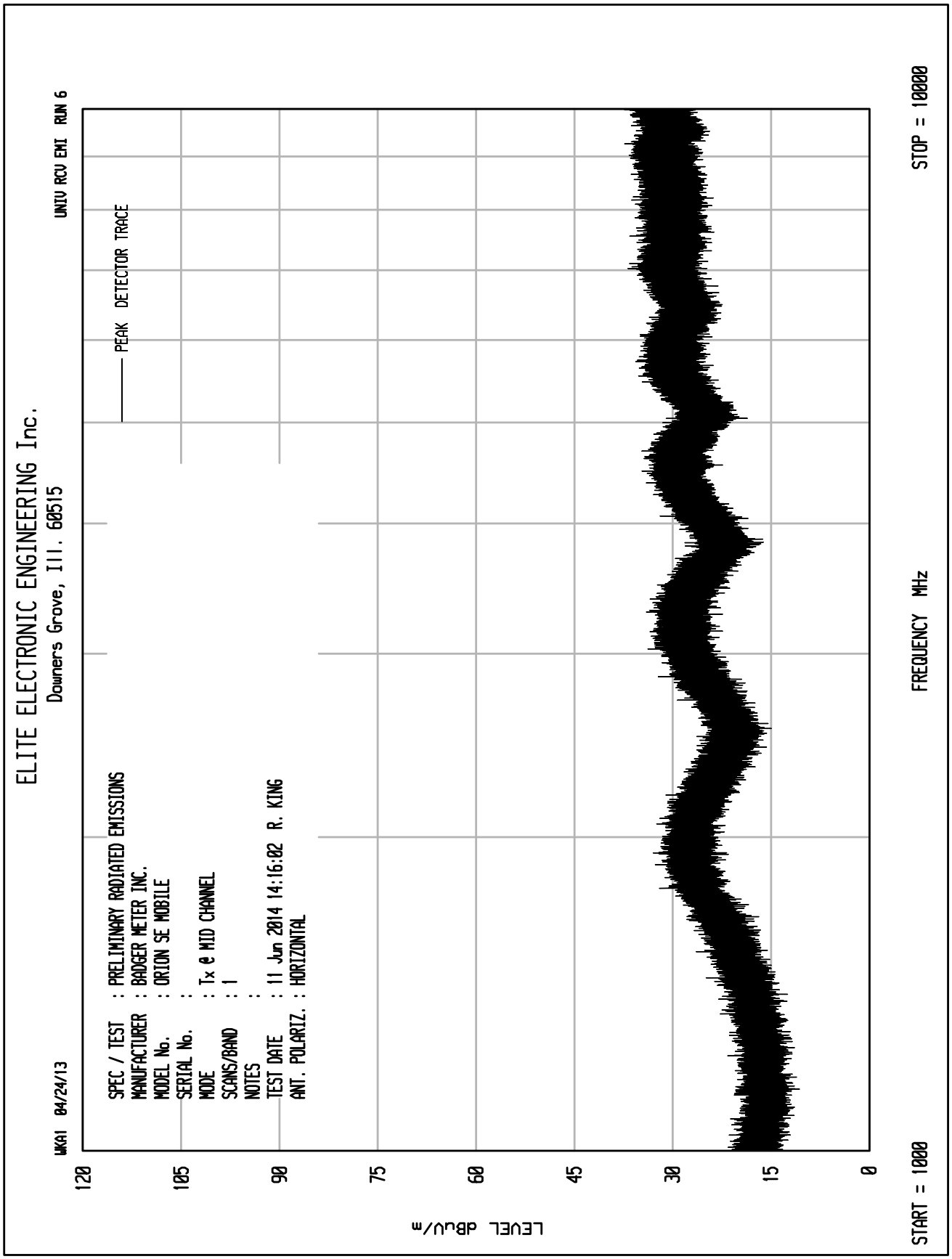

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 5
WKAI 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION SE MOBILE
SERIAL No. :
MODE : Tx @ MID CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 10 Jun 2014 12:22:19 R. KING
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000

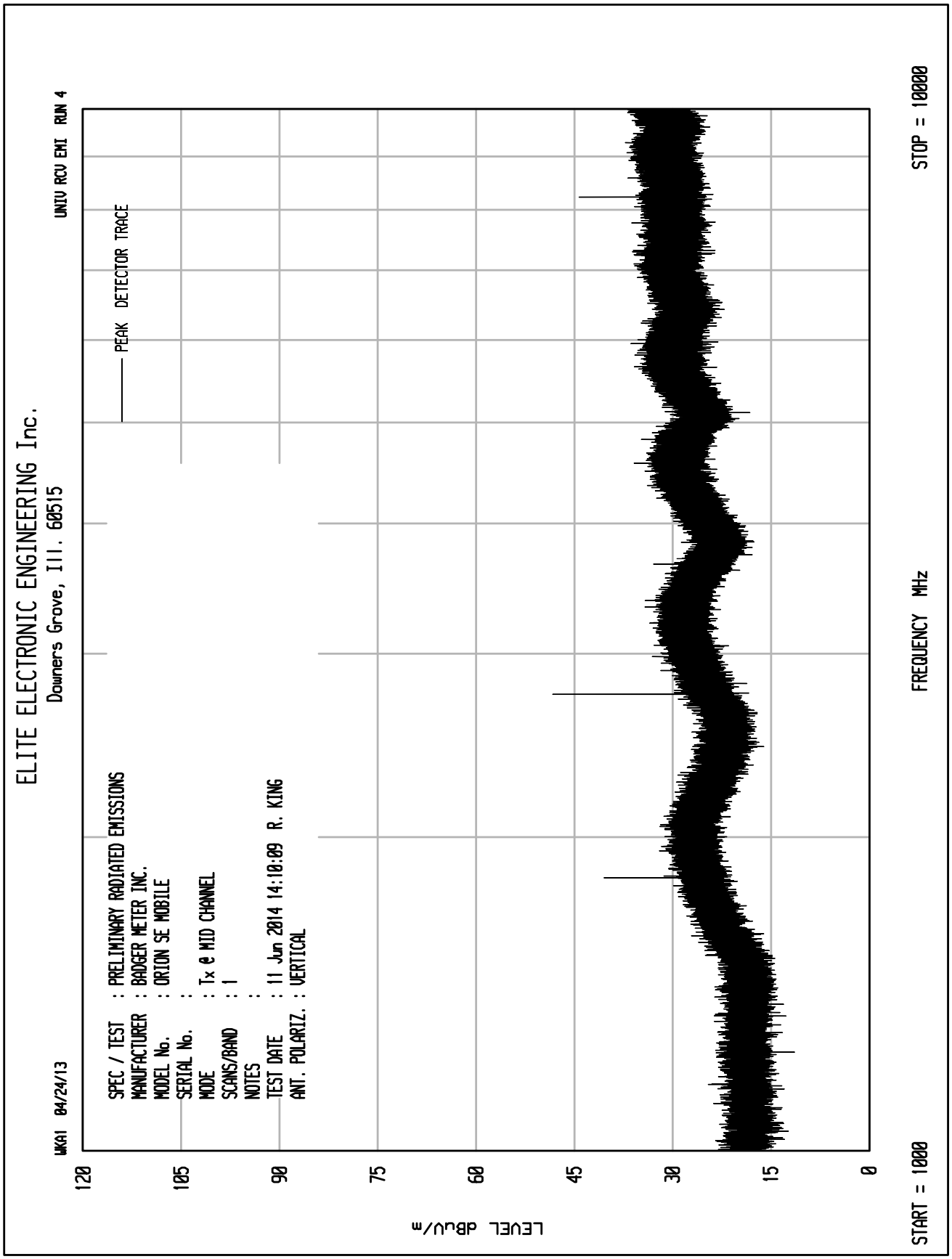

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 2
WKAI 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION SE MOBILE
SERIAL No. :
MODE : Tx @ HIGH CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 11 Jun 2014 12:53:58 R. KING
ANT. POLARIZ. : HORIZONTAL
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 3
WKAI 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION SE MOBILE
SERIAL No. :
MODE : Tx @ HIGH CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 11 Jun 2014 14:04:55 R. KING
ANT. POLARIZ. : VERTICAL
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 7
WKAI 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION SE MOBILE
SERIAL No. :
MODE : Tx @ HIGH CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 10 Jun 2014 12:26:05 R. KING
ANT. POLARIZ. : HORIZONTAL
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 8
WKAI 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION SE MOBILE
SERIAL No. :
MODE : Tx @ HIGH CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 10 Jun 2014 12:28:41 R. KING
ANT. POLARIZ. : VERTICAL
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 6
WKAI 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION SE MOBILE
SERIAL No. :
MODE : Tx @ MID CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 11 Jun 2014 14:16:02 R. KING
ANT. POLARIZ. : HORIZONTAL
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 4
WKAI 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION SE MOBILE
SERIAL No. :
MODE : Tx @ MID CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 11 Jun 2014 14:10:09 R. KING
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 10000

Manufacturer : Badger Meter, Inc.
Model No. : Orion SE Mobile
Serial No. : None Assigned
Specification : FCC-15.247 Spurious Radiated Emissions in Restricted Bands
Date : June 11, 2014
Mode : Tx @ 904.9MHz
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)
2714.70	H	54.7		2.2	32.7	-39.5	50.1	320.9	5000.0	-23.9
2714.70	V	54.7		2.2	32.7	-39.5	50.1	320.9	5000.0	-23.9
3619.60	H	51.7		2.6	33.5	-38.9	48.9	277.7	5000.0	-25.1
3619.60	V	50.3		2.6	33.5	-38.9	47.5	236.3	5000.0	-26.5
4524.50	H	51.5		2.8	34.5	-38.9	49.9	313.4	5000.0	-24.1
4524.50	V	52.0		2.8	34.5	-38.9	50.4	332.0	5000.0	-23.6
5429.40	H	45.4	*	3.1	34.9	-39.0	44.4	166.0	5000.0	-29.6
5429.40	V	46.1	*	3.1	34.9	-39.0	45.1	179.5	5000.0	-28.9
8144.10	H	49.8	*	3.9	35.9	-39.0	50.6	340.1	5000.0	-23.3
8144.10	V	49.6	*	3.9	35.9	-39.0	50.4	330.8	5000.0	-23.6
9049.00	H	47.4	*	3.9	36.2	-38.9	48.6	268.7	5000.0	-25.4
9049.00	V	47.6	*	3.9	36.2	-38.9	48.8	276.8	5000.0	-25.1

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]

Checked BY Richard E. King :

Richard E. King

Manufacturer : Badger Meter, Inc.
Model No. : Orion SE Mobile
Serial No. : None Assigned
Specification : FCC-15.247 Spurious Radiated Emissions in Restricted Bands
Date : June 11, 2014
Mode : Tx @ 904.9MHz
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)
2714.70	H	50.19		2.2	32.7	-39.5	-19.3	26.3	20.6	500.0	-27.7
2714.70	V	50.3		2.2	32.7	-39.5	-19.3	26.4	20.8	500.0	-27.6
3619.60	H	44.7		2.6	33.5	-38.9	-19.3	22.6	13.5	500.0	-31.4
3619.60	V	42.3		2.6	33.5	-38.9	-19.3	20.1	10.1	500.0	-33.9
4524.50	H	41.5		2.8	34.5	-38.9	-19.3	20.7	10.8	500.0	-33.3
4524.50	V	41.8		2.8	34.5	-38.9	-19.3	20.9	11.1	500.0	-33.1
5429.40	H	32.9	*	3.1	34.9	-39.0	-19.3	12.6	4.3	500.0	-41.4
5429.40	V	33.1	*	3.1	34.9	-39.0	-19.3	12.8	4.4	500.0	-41.2
8144.10	H	38.7	*	3.9	35.9	-39.0	-19.3	20.2	10.3	500.0	-33.7
8144.10	V	39.8	*	3.9	35.9	-39.0	-19.3	21.3	11.7	500.0	-32.6
9049.00	H	34.1	*	3.9	36.2	-38.9	-19.3	16.0	6.3	500.0	-38.0
9049.00	V	34.2	*	3.9	36.2	-38.9	-19.3	16.1	6.4	500.0	-37.9

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]

Checked BY Richard E. King :

Richard E. King

Manufacturer : Badger Meter, Inc.
Model No. : Orion SE Mobile
Serial No. : None Assigned
Specification : FCC-15.247 Spurious Radiated Emissions in Restricted Bands
Date : June 11, 2014
Mode : Tx @ 914.1MHz
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)
2741.70	H	53.3		2.2	32.8	-39.5	48.8	274.4	5000.0	-25.2
2741.70	V	54.6		2.2	32.8	-39.5	50.1	319.4	5000.0	-23.9
3655.60	H	48.8		2.6	33.5	-38.9	46.0	200.0	5000.0	-28.0
3655.60	V	48.8		2.6	33.5	-38.9	46.0	200.0	5000.0	-28.0
4569.50	H	52.5		2.8	34.5	-38.9	50.9	352.6	5000.0	-23.0
4569.50	V	52.7		2.8	34.5	-38.9	51.2	363.3	5000.0	-22.8
7311.20	H	47.9		3.7	35.6	-39.0	48.2	257.3	5000.0	-25.8
7311.20	V	49.6		3.7	35.6	-39.0	49.9	311.9	5000.0	-24.1
8225.10	H	49.1		3.9	35.9	-39.0	50.0	314.6	5000.0	-24.0
8225.10	V	51.4		3.9	35.9	-39.0	52.3	411.9	5000.0	-21.7
9139.00	H	46.3		3.9	36.2	-38.9	47.6	239.1	5000.0	-26.4
9139.00	V	45.7		3.9	36.2	-38.9	46.9	221.6	5000.0	-27.1

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]

Checked BY Richard E. King :

Richard E. King

Manufacturer : Badger Meter, Inc.
Model No. : Orion SE Mobile
Serial No. : None Assigned
Specification : FCC-15.247 Spurious Radiated Emissions in Restricted Bands
Date : June 11, 2014
Mode : Tx @ 914.1MHz
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)
2741.70	H	48.44		2.2	32.8	-39.5	-19.3	24.6	17.0	500.0	-29.4
2741.70	V	49.5		2.2	32.8	-39.5	-19.3	25.7	19.2	500.0	-28.3
3655.60	H	40.5		2.6	33.5	-38.9	-19.3	18.4	8.3	500.0	-35.6
3655.60	V	40.0		2.6	33.5	-38.9	-19.3	17.9	7.8	500.0	-36.1
4569.50	H	41.8		2.8	34.5	-38.9	-19.3	21.0	11.2	500.0	-33.0
4569.50	V	44.3		2.8	34.5	-38.9	-19.3	23.5	15.0	500.0	-30.5
7311.20	H	34.3		3.7	35.6	-39.0	-19.3	15.3	5.8	500.0	-38.7
7311.20	V	40.0		3.7	35.6	-39.0	-19.3	21.0	11.2	500.0	-33.0
8225.10	H	40.5		3.9	35.9	-39.0	-19.3	22.1	12.7	500.0	-31.9
8225.10	V	41.2		3.9	35.9	-39.0	-19.3	22.8	13.8	500.0	-31.2
9139.00	H	33.9		3.9	36.2	-38.9	-19.3	15.9	6.2	500.0	-38.1
9139.00	V	33.9		3.9	36.2	-38.9	-19.3	15.9	6.2	500.0	-38.1

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]

Checked BY Richard E. King :

Richard E. King

Manufacturer : Badger Meter, Inc.
Model No. : Orion SE Mobile
Serial No. : None Assigned
Specification : FCC-15.247 Spurious Radiated Emissions in Restricted Bands
Date : June 11, 2014
Mode : Tx @ 923.7MHz
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)
2771.10	H	55.1		2.2	32.8	-39.5	50.7	341.8	5000.0	-23.3
2771.10	V	56.1		2.2	32.8	-39.5	51.7	382.6	5000.0	-22.3
3694.80	H	43.8	*	2.6	33.5	-38.9	41.1	113.3	5000.0	-32.9
3694.80	V	44.4	*	2.6	33.5	-38.9	41.6	120.5	5000.0	-32.4
4618.50	H	51.6		2.9	34.6	-38.9	50.1	319.8	5000.0	-23.9
4618.50	V	51.8		2.9	34.6	-38.9	50.3	328.7	5000.0	-23.6
7389.60	H	46.8	*	3.7	35.7	-39.0	47.1	227.5	5000.0	-26.8
7389.60	V	50.1		3.7	35.7	-39.0	50.4	331.9	5000.0	-23.6
8313.30	H	50.5		3.9	35.9	-39.0	51.4	371.3	5000.0	-22.6
8313.30	V	51.0		3.9	35.9	-39.0	51.9	392.8	5000.0	-22.1

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]

Checked BY Richard E. King :

Richard E. King

Manufacturer : Badger Meter, Inc.
Model No. : Orion SE Mobile
Serial No. : None Assigned
Specification : FCC-15.247 Spurious Radiated Emissions in Restricted Bands
Date : June 11, 2014
Mode : Tx @ 923.7MHz
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)
2771.10	H	50.3		2.2	32.8	-39.5	-19.3	26.6	21.3	500.0	-27.4
2771.10	V	52.0		2.2	32.8	-39.5	-19.3	28.3	25.9	500.0	-25.7
3694.80	H	31.5	*	2.6	33.5	-38.9	-19.3	9.4	3.0	500.0	-44.5
3694.80	V	31.3	*	2.6	33.5	-38.9	-19.3	9.2	2.9	500.0	-44.8
4618.50	H	42.1		2.9	34.6	-38.9	-19.3	21.3	11.6	500.0	-32.7
4618.50	V	42.1		2.9	34.6	-38.9	-19.3	21.3	11.6	500.0	-32.7
7389.60	H	33.5	*	3.7	35.7	-39.0	-19.3	14.6	5.4	500.0	-39.4
7389.60	V	39.2		3.7	35.7	-39.0	-19.3	20.2	10.3	500.0	-33.7
8313.30	H	41.0		3.9	35.9	-39.0	-19.3	22.5	13.4	500.0	-31.5
8313.30	V	41.6		3.9	35.9	-39.0	-19.3	23.2	14.4	500.0	-30.8

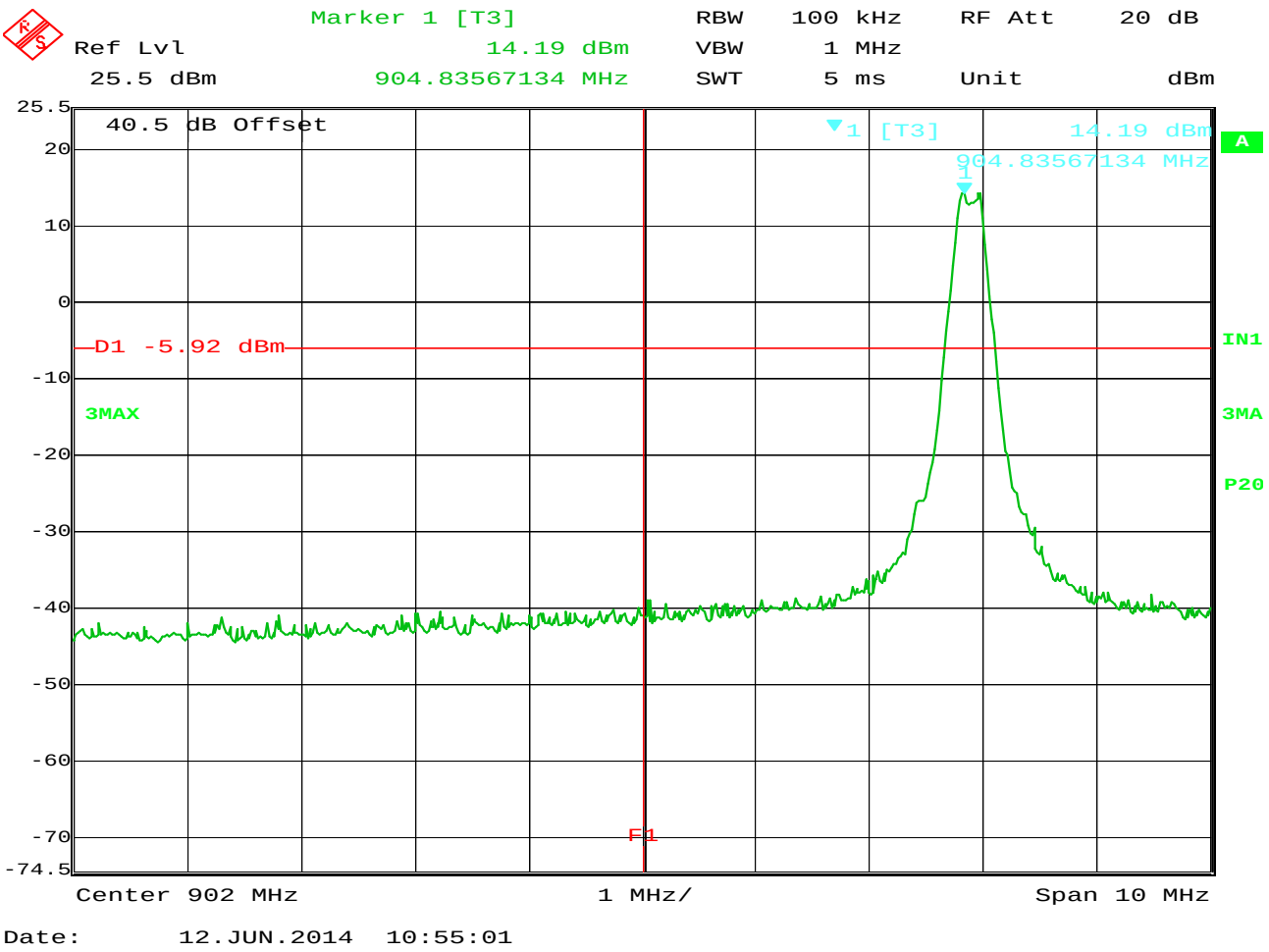
H – Horizontal V – Vertical

* - 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]

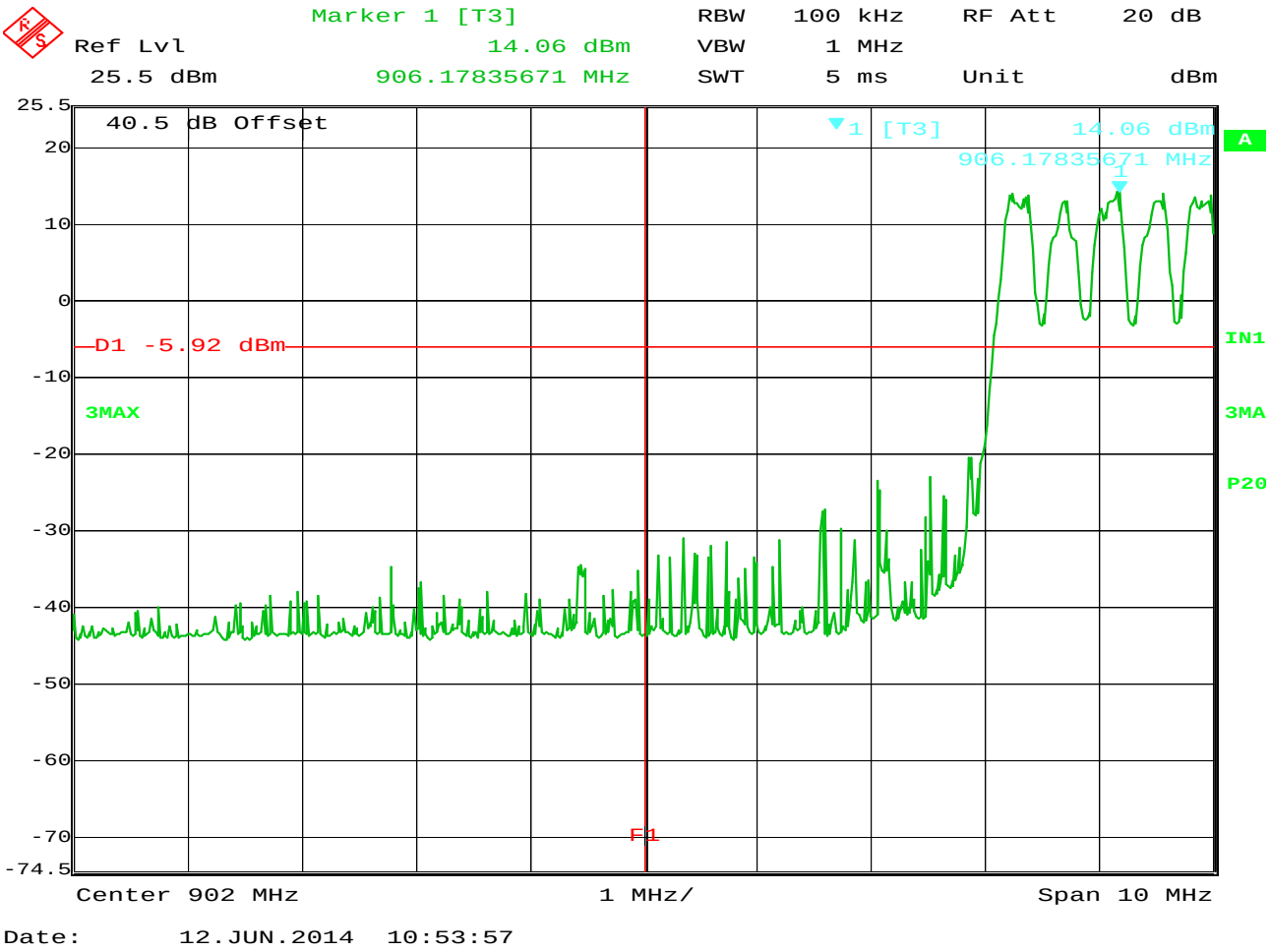
Checked BY Richard E. King :

Richard E. King



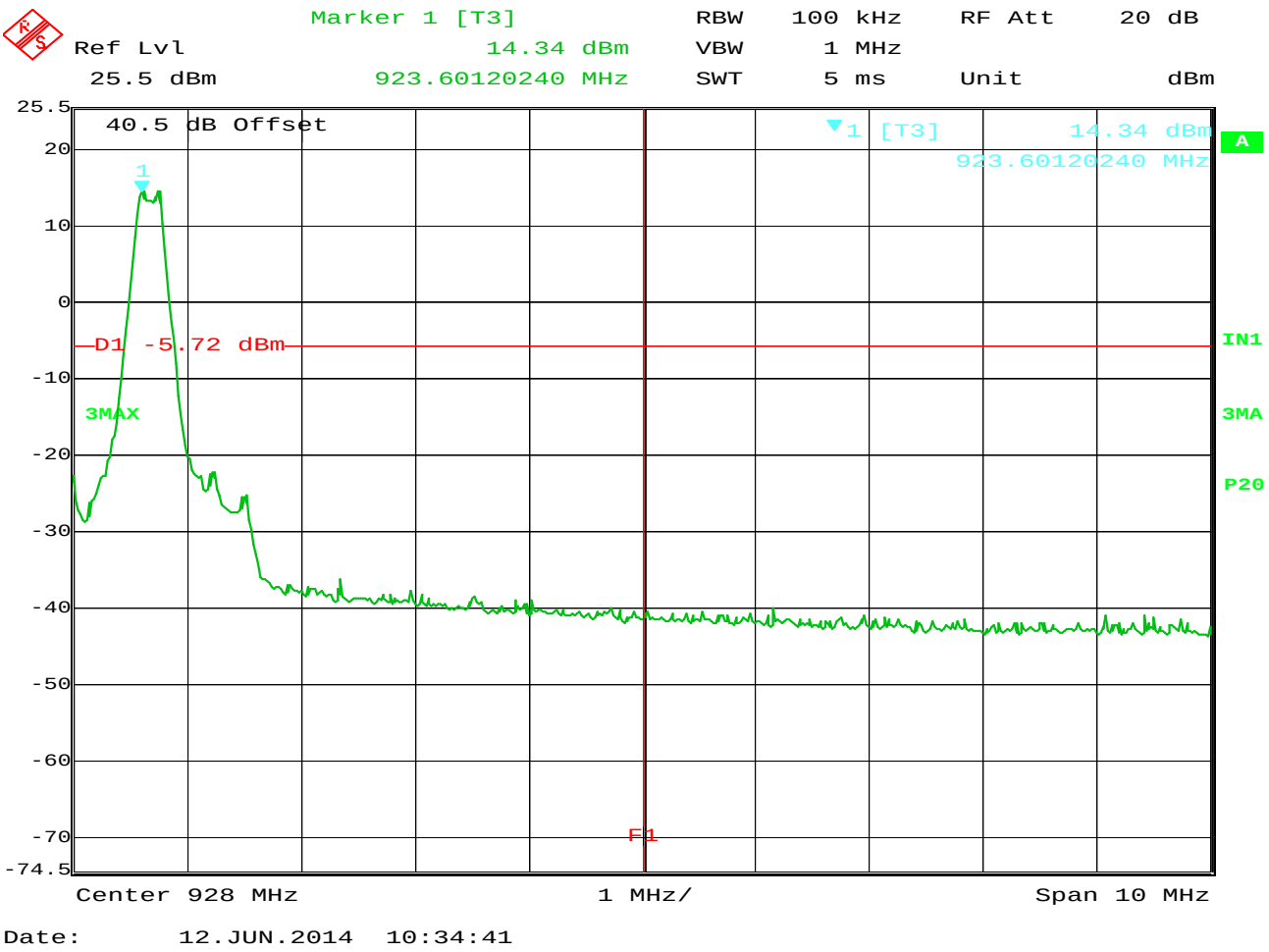
FCC 15.247(d) Band Edge Compliance

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile Transceiver
SERIAL NUMBER	:	
TEST MODE	:	Tx @ 904.9MHz
TEST DATE	:	June 12, 2014
TEST PARAMETERS	:	Band Edge Test
NOTES	:	Display Line D1 represents the 20dB down point from the peak emissions in a 100kHz bandwidth. Display Line F1 represents the band edge (902MHz).
EQUIPMENT USED	:	RBA0, T2SK, T2DH



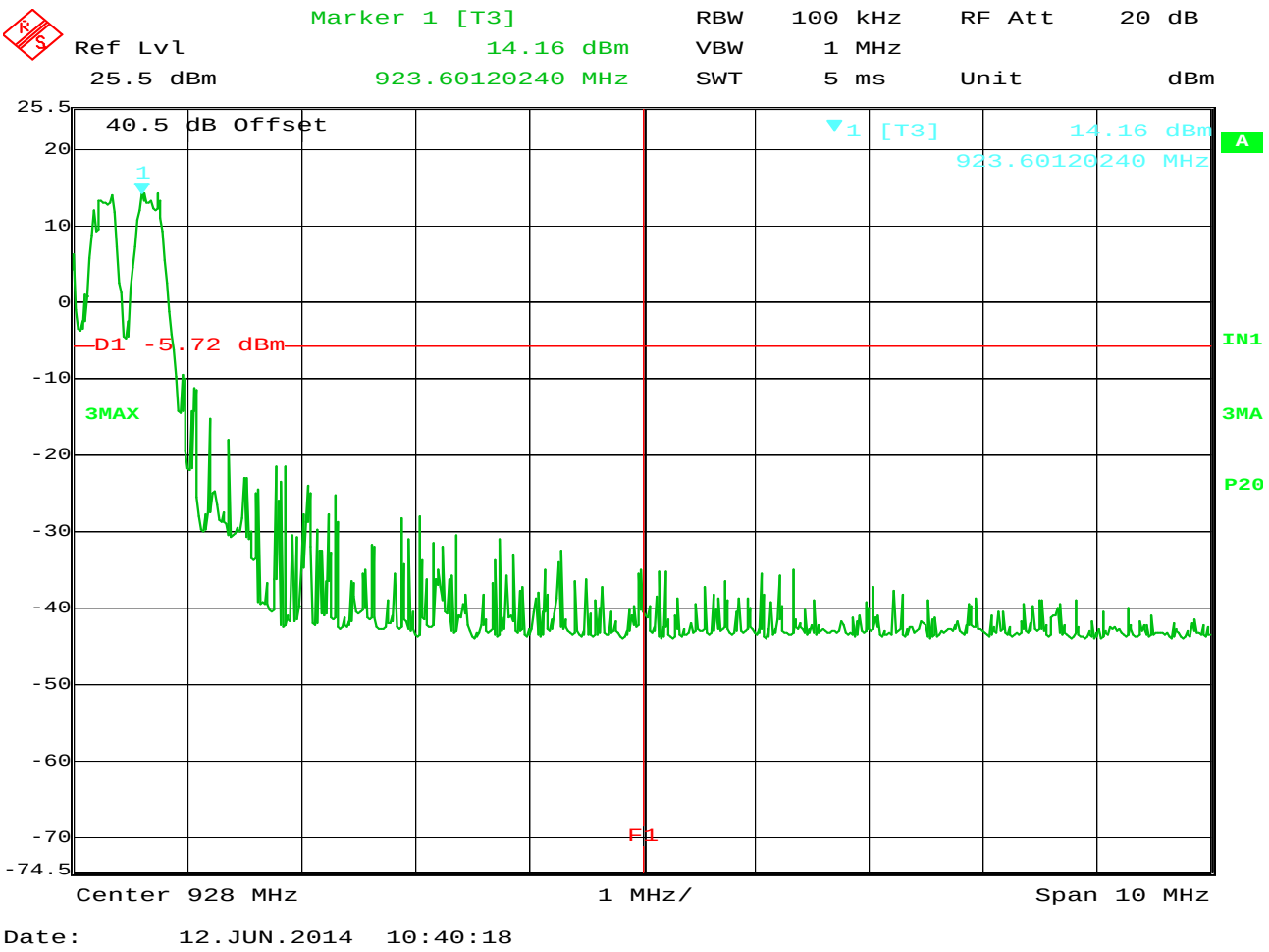
FCC 15.247(d) Band Edge Compliance

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile Transceiver
SERIAL NUMBER	:	
TEST MODE	:	Hoping Enabled
TEST DATE	:	June 12, 2014
TEST PARAMETERS	:	Band Edge Test
NOTES	:	Display Line D1 represents the 20dB down point from the peak emissions in a 100kHz bandwidth. Display Line F1 represents the band edge (902MHz).
EQUIPMENT USED	:	RBA0, T2SK, T2DH



FCC 15.247(d) Band Edge Compliance

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile Transceiver
SERIAL NUMBER	:	
TEST MODE	:	Tx @ 923.7MHz
TEST DATE	:	June 12, 2014
TEST PARAMETERS	:	Band Edge Test
NOTES	:	Display Line D1 represents the 20dB down point from the peak emissions in a 100kHz bandwidth. Display Line F1 represents the band edge (928MHz).
EQUIPMENT USED	:	RBA0, T2SK, T2DH



FCC 15.247(d) Band Edge Compliance

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Orion SE Mobile Transceiver
SERIAL NUMBER	:	
TEST MODE	:	Frequency Hopping
TEST DATE	:	June 12, 2014
TEST PARAMETERS	:	Band Edge Test
NOTES	:	Display Line D1 represents the 20dB down point from the peak emissions in a 100kHz bandwidth. Display Line F1 represents the band edge (928MHz).
EQUIPMENT USED	:	RBA0, T2SK, T2DH