Measurement of RF Emissions from a Galaxy Gateway Gen 3 Transceiver

For	Badger Meter 4545 W Brown Deer Road Milwaukee, WI 53223
P.O. Number	265197
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Test Specification	FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.247 for Frequency Hopping Spread Spectrum Intentional Radiators Operating within the band 902-928MHz Industry Canada RSS-GEN Industry Canada RSS-210

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REVISION HISTORY

Revision	Date	Description
—	January 13, 2014	Initial release

Measurement of RF Emissions from a Transceiver, Model No. Galaxy Gateway Gen 3

1. INTRODUCTION

1.1. Scope of Tests

This report represents the results of the series of radio interference measurements performed on a Badger Meter Transceiver, Model No. Galaxy Gateway Gen 3, (hereinafter referred to as the Equipment Under Test (EUT)). Two samples of the circuit board were provided for testing. Sample #3 was used for all powerline conducted emissions tests and for testing with the EUT operating in the transmit at 904.9MHz and the transmit at 914.5MHz modes (except for band edge and 20dB bandwidth tests). Sample #4 was used for testing with the EUT operating in the transmit at 924.5MHz, hopping enabled modes, band edge tests, and 20dB bandwidth tests.

The EUT is a frequency hopping spread spectrum transceiver. The EUT was designed to transmit and receive in the 902-928 MHz band using one of two removable, Laird Technologies Base Phantom 450MHz, Model No. OEM2326-110 antennas. The EUT was also designed to receive in the 450 – 470MHz MHz band using one of two removable, Laird Technologies Base Phantom 450MHz, Model No. OEM2326-110 antennas. The EUT was manufactured and submitted for testing by Badger Meter located in Milwaukee, WI.

During normal operation, the EUT can only transmit using one of the Laird Technologies Base Phantom 450MHz, Model No. OEM2326-110 antennas. When the EUT is transmitting, all receive functions are disabled. When the EUT is in the receive mode, all transmit functions are disabled. The EUT can receive in the 902-928MHz band using one of the Laird Technologies Base Phantom 450MHz, Model No. OEM2326-110 antennas while simultaneously receiving in the 450-470MHz band using the other Laird Technologies Base Phantom 450MHz, Model No. OEM2326-110 antennas.

This test report does not include test results on the receiver portion of the EUT. See Elite Electronic Engineering, Inc. Engineering Test Report No. 1304473-02 for receiver test results.

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 C, Sections 15.207 and 15.247 for Intentional Radiators. The test series was also performed to determine if the EUT meets the conducted RF emission requirements of the Industry Canada Radio Standards Specification, RSS-Gen, Section 7.2.4 and the radiated RF emission requirements of the Industry Canada Radio Standards Specification, 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 American Association for Laboratory Accreditation (A2LA). A2LA Certificate Number: 1786.01.

1.5. Laboratory Conditions

The temperature at the time of the test was 23^{o}C and the relative humidity was 17%.

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, Subpart 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 Radio Standards Specification, RSS-Gen, "General Requirements and Information for the Certification of Radiocommunication Equipment", Issue 3, December 2010

- Industry Canada Radio Standards Specification, RSS-210, "Low-power License-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment", Issue 8, December 2010

3. EUT SETUP AND OPERATION

3.1. General Description

The EUT is a Badger Meter, Transceiver, Model No. Galaxy Gateway Gen 3. A block diagram of the EUT setup is shown as Figure 1.

3.1.1. Power Input

The EUT obtained 24VDC power through 2 leads from the output of an Emerson AC Power Adapter, M/N: DP4024N3M, S/N: H825LM00H002L.The Emerson AC Power Adapter received 115V 60Hz power through a 3 wire, unshielded, 2.4 meter long power cord. For power line conducted emissions tests, each primary lead was connected through a line impedance stabilization network (LISN) which was located on the ground plane. The network complies with the requirements of Paragraph 4.1.2 of ANSI C63.4-2009.

3.1.2. Peripheral Equipment

The following peripheral equipment was submitted with the EUT:

Item	Description
Laptop computer	HP EliteBook 8570p used to program the EUT via a serial cable. The laptop computer was disconnected from the EUT after programming was complete.

3.1.3. Signal Input/Output Leads

The following interconnect cables were submitted with the EUT:

Item	Description
Coaxial Cable	Times Microwave Systems Coaxial Cable (LMR-240) used to connect ANT1 port on the circuit board of the EUT to the Laird Technologies Base Phantom 450MHz, Model No. OEM2326-110 antenna. (30 cm length inside the enclosure. 85cm length outside the enclosure.)
Coaxial Cable	Times Microwave Systems Coaxial Cable (LMR-240) used to connect ANT2 port on the circuit board of the EUT to the Laird Technologies Base Phantom 450MHz, Model No. OEM2326-110 antenna. (30 cm length inside the enclosure. 85cm length outside the enclosure.)
Shielded 6 wire cable	100 feet of shielded 6 wire cable used to provide 24VDC input power to the EUT and to connect the EUT to the serial port of the laptop computer.

3.1.4.Grounding

The EUT was not grounded during the tests.

3.2. Software

For all tests the EUT had the following firmware loaded onto it:

- Host CPU firmware version is v3.0.0
- Radio CPU firmware version is v3.0.4

The laptop used to the following software to program the EUT:

- Endpoint Serial Console v1.0

3.3. Operational Mode

For all tests, the EUT was placed on the turntable of the test chamber. The EUT was energized. The EUT was programmed to operate in one of the following modes:

- Transmit at 904.9MHz (Ch. 1)
- Transmit at 914.5MHHz (Ch. 25)
- Transmit at 924.5MHHz (Ch. 50)
- 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. All equipment was calibrated per the instruction manuals supplied by the manufacturer.

Conducted and radiated emission measurements were performed with a spectrum analyzer. This receiver allows measurements with the bandwidths and detector functions specified by the FCC. The receiver bandwidth was 9kHz for the 150kHz to 30MHz conducted emissions data, 120kHz for the 30MHz to 1000MHz radiated emissions data and 1MHz for the radiated emissions data above 1000MHz.

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	1.07	-1.07
Expanded Uncertainty (95% confidence)	2.1	-2.1

Radiated Emissions Measurements		
Combined Standard Uncertainty	2.26	-2.18
Expanded Uncertainty (95% confidence)	4.5	-4.4

5. TEST PROCEDURES

5.1. Powerline Conducted Emissions

5.1.1.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.

5.1.2.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 EUT was operated in the Transmit at 914.5MHz mode.

b) Measurements were first made on the 120V, 60Hz high line of the Emerson AC Power Adapter, M/N: DP4024N3M.

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 120V, 60Hz high line of the Emerson AC Power Adapter, M/N: DP4024N3M.

5.1.3.Results

The plots of the peak, quasi-peak, and average conducted voltage levels acquired from each input power line with the EUT operated in the Transmit at 914.5MHz mode are shown on pages 22 and 24. The tabular quasi-peak and average results from each input power line with the EUT operated in the Transmit at 914.5MHz mode are shown on pages 21 and 23. All power line conducted emissions measured from the EUT were within the specification limits. The emissions level closest to the limit (worst case) occurred at 6.296MHz. The emissions level at this frequency was 1.6dB within the limit. Photographs of the test configuration which yielded the highest or worst case, conducted emission levels are shown on Figure 2.

5.2. 20dB Bandwidth

5.2.1.Requirement

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.Procedures

The antenna output port of the EUT was connected to the spectrum analyzer through 50dB 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.

5.2.3.Results

The plots on pages 25 through 27 show that the maximum 20 dB bandwidth was 370.7kHz. The 99% bandwidth was measured to be 314.6kHz. Therefore, since the 20dB bandwidth of the hopping channel is 250kHz or greater, but not greater than 500kHz, the system shall use at least 25 hopping channels.

5.3. Carrier Frequency Separation

5.3.1.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.

5.3.2.Procedures

The antenna output port of the EUT was connected to the spectrum analyzer through 50dB of attenuation. With the hopping function enabled, the EUT was allowed to transmit continuously.

The resolution bandwidth (RBW) was set 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

5.3.3.Results

Page 28 shows the carrier frequency separation. As can be seen from this plot, the carrier frequency separation is 400.8kHz, which is greater than the 20dB bandwidth (370.7kHz).

5.4. Number of Hopping Frequencies

5.4.1.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.

5.4.2.Procedures

The antenna output port of the EUT was connected to the spectrum analyzer through 50dB of attenuation. With the hopping function enabled, the EUT was allowed to transmit continuously.

The resolution bandwidth (RBW) was set 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.

5.4.3.Results

Page 29 shows the number of hopping frequencies. As can be seen from this plot, the number of hopping frequencies is 50 which is greater than 25 which is the minimum number of required hopping frequencies for systems with a 20dB bandwidth greater than 250kHz.

5.5. Time of Occupancy

5.5.1.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.

5.5.2.Procedures

The antenna output port of the EUT was connected to the spectrum analyzer through 50dB of attenuation. With the hopping function enabled, the EUT was allowed to transmit continuously.

The resolution bandwidth (RBW) was set to 1 MHz. The peak detector and 'Max-Hold' function were engaged. With the span set to 0Hz, the sweep time was adjusted to capture a single event in order to measure the dwell time per hop. The analyzer's display was plotted using a 'screen dump' utility. Then, the sweep time was expanded to 10 seconds 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.

5.5.3.Results

Pages 30 and 31 show the plots for the time of occupancy. As can be seen from the plots, the time of occupancy can be determined by (dwell time/hop) multiplied by (# of hops). This calculated value is equal to = 0.039seconds which is less than the 0.4 seconds maximum allowed.

5.6. Peak Output Power

5.6.1.Requirements

Per section 15.247(b)(2), for frequency hopping systems operating in the 902-928MHz band and employing at least 50 hopping channels, the maximum peak output conducted power shall not be greater than 1W (30dBm). 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 4 Watt (36dBm).

If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below 30dBm by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.6.2.Procedures

The antenna output port of the EUT was connected to a power sensor through 30dB of attenuation. The power sensor was connected to a power meter. 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 maximum meter reading was recorded.

5.6.3.Results

The results are presented on page 32. The maximum peak conducted output power from the transmitter was 0.832W (29.2 dBm) which is below the 1 Watt limit.

5.7. Duty Cycle Factor Measurements

5.7.1.Requirements

The duty cycle factor is used to convert peak detected readings to average readings. Per 15.35(c), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value.

5.7.2.Procedures

a) 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 10msec/div (100msec total span).
b) The markers are set at the beginning and end of a word.
c) The duty cycle is then calculated as the on-time/100msec.
d) The duty cycle correction factor is converted to dB using the following formula:

Duty Cycle (dB) = 20 x Log(Duty Cycle)

5.7.3.Results

The plot of the duty cycle is shown on data page 33. The duty cycle factor was computed to be -8.16dB.

5.8. Antenna Conducted Spurious Emissions

5.8.1.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.

5.8.2.Procedures

The antenna output port of the EUT was connected to the spectrum analyzer through 50dB 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.

5.8.3.Results

The results of the antenna conducted emissions levels were plotted. These plots are presented on pages 34 through 36. These plots show that the spurious emissions were at least 20 dB below the level of the fundamental in any 100kHz bandwidth.

5.9. Radiated Spurious Emissions Measurements

5.9.1.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

5.9.2.Procedures

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.

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 emission is pulsed, the reading can be adjusted by a “duty cycle correction factor” derived from 20*log(on time/100msec). These readings must be no greater than the limits specified in 15.209(a).

The resultant field strength (FS) is a summation in decibels (dB) of the receiver meter reading (MTR), the antenna correction factor (AF), and the cable loss factor (CF). If an external pre-amplifier is used, the total is reduced by its gain (-PA). If a duty cycle correction factor (DC) is required, it is added to the total.

Formula 1: FS (dBuV/m) = MTR (dBuV) + AF (dB/m) + CF (dB) + (- PA (dB)) + DC (dB)

To convert the Field Strength dBuV/m term to uV/m, the dBuV/m is first divided by 20. The Base 10 AntiLog is taken of this quotient. The result is the Field Strength value in uV/m terms.

Formula 2: FS (uV/m) = AntiLog [(FS (dBuV/m))/20]

5.9.3.Results

Preliminary radiated emissions plots with the EUT transmitting at low, mid, and high channels are shown on pages 37 through 48. Final radiated emissions data are presented on data pages 49 through 57. As can be seen from the data, all emissions measured from the EUT were within the specification limits. The emissions level closet to the limit (worst case) occurred at 2714.7MHz. The emissions level at this frequency was 3.1dB within the limit. See data pages 35 through 46 for details. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figure 3 and Figure 4.

5.10. Band Edge Compliance

5.10.1. Requirement

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

5.10.2. Procedures

5.10.2.1 Low Band Edge

1) The antenna output port of the EUT was connected to the spectrum analyzer through 50dB 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.

5.10.2.2 High Band Edge

1) The antenna output port of the EUT was connected to the spectrum analyzer through 50dB 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.

5.10.3. Results

Pages 58 through 61 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. OTHER TEST CONDITIONS

6.1. Test Personnel and Witnesses

All tests were performed by qualified personnel from Elite Electronic Engineering Incorporated. *The test series was partially witnessed by Badger Meter personnel.

6.2. Disposition of the EUT

The EUT and all associated equipment were returned to Badger Meter upon completion of the tests.

7. CONCLUSIONS

It was determined that the Badger Meter Transceiver, Model No. Galaxy Gateway Gen 3, did fully meet the conducted and radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.205 et seq. for Intentional Radiators, when tested per ANSI C63.4-2009.

It was also determined that the Badger Meter Transceiver, Model No. Galaxy Gateway Gen 3, did fully meet the conducted RF emission requirements of the Industry Canada Radio Standards Specification, RSS-Gen, Section 7.2.4 and the radiated RF emission requirements of the Industry Canada Radio Standards Specification, RSS-210, Annex 8 for transmitters. Testing was performed in accordance with ANSI C63.4-2009.

8. 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.

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

9. EQUIPMENT LIST

Table 9-1 Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
APW3	PREAMPLIFIER	PLANAR ELECTRONICS	PE2-35-120-5R0-10-12	PL2924	1GHZ-20GHZ	10/8/2013	10/8/2014
CDY0	WORKSTATION	ELITE	WORKSTATION			N/A	
CMA1	Controllers	EMCO	2090	9701-1213	---	N/A	
MPC2	DUAL POWER METER	HEWLETT PACKARD	EPM-442A	US37480150	0.1MHZ-50GHZ	3/18/2013	3/18/2014
MPI1	POWER SENSOR	AGILIENT	E9304A	MY41496041	9KHZ-6GHZ	5/29/2013	5/29/2014
NTA2	BILOG ANTENNA	TESEQ	6112D	28040	25-1000MHz	8/30/2013	8/30/2014
NWQ2	DOUBLE RIDGED WAVEGUIDE ANTENNA		3117	66659	1GHZ-18GHZ	3/18/2013	3/18/2014
PLF2	CISPR16 50UH LISN	ELITE	CISPR16/70A	002	.15-30MHz	6/25/2013	6/25/2014
PLF4	CISPR16 50UH LISN	ELITE	CISPR16/70A	003	.15-30MHz	6/25/2013	6/25/2014
RBB0	EMI TEST RECEIVER 20HZ TO 40 GHZ.		ESIB40	100250	20 HZ TO 40GHZ	3/7/2013	3/7/2014
T1N2	10DB 20W ATTENUATOR	NARDA	766-10	---	DC-4GHZ	8/5/2013	8/5/2014
T2DM	20DB, 25W ATTENUATOR	WEINSCHEL	46-20-34	BS2141	DC-18GHZ	8/5/2013	8/5/2014
T2DP	20DB, 25W ATTENUATOR	WEINSCHEL	46-20-34	BS0921	DC-18GHZ	8/5/2013	8/5/2014
T2SK	20DB 25W ATTENUATOR	WEINSCHEL	46-20-34	CD5022	DC-18GHZ	11/7/2013	11/7/2014
XLJB	5W, 50 OHM TERMINATION	JFW INDUSTRIES	50T-052	12	DC-2GHZ	8/6/2013	8/6/2014
XLQP	5W, 50 OHM TERMINATION	JFW INDUSTRIES	50T-052	55	DC-2GHZ	8/8/2013	8/8/2014
XPQ2	HIGH PASS FILTER	K&L MICROWAVE	4IH30-1804/T10000-0	3	1.8-10GHZ	10/25/2013	10/25/2014

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.

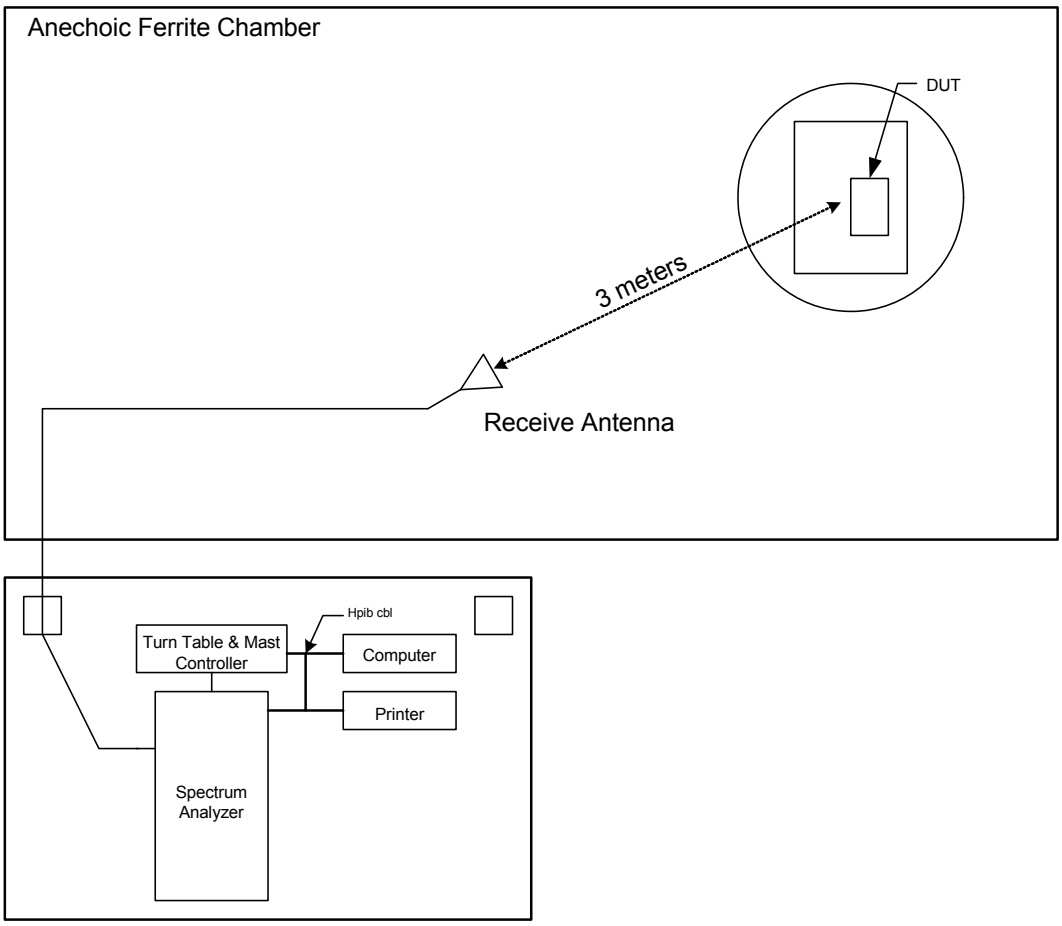


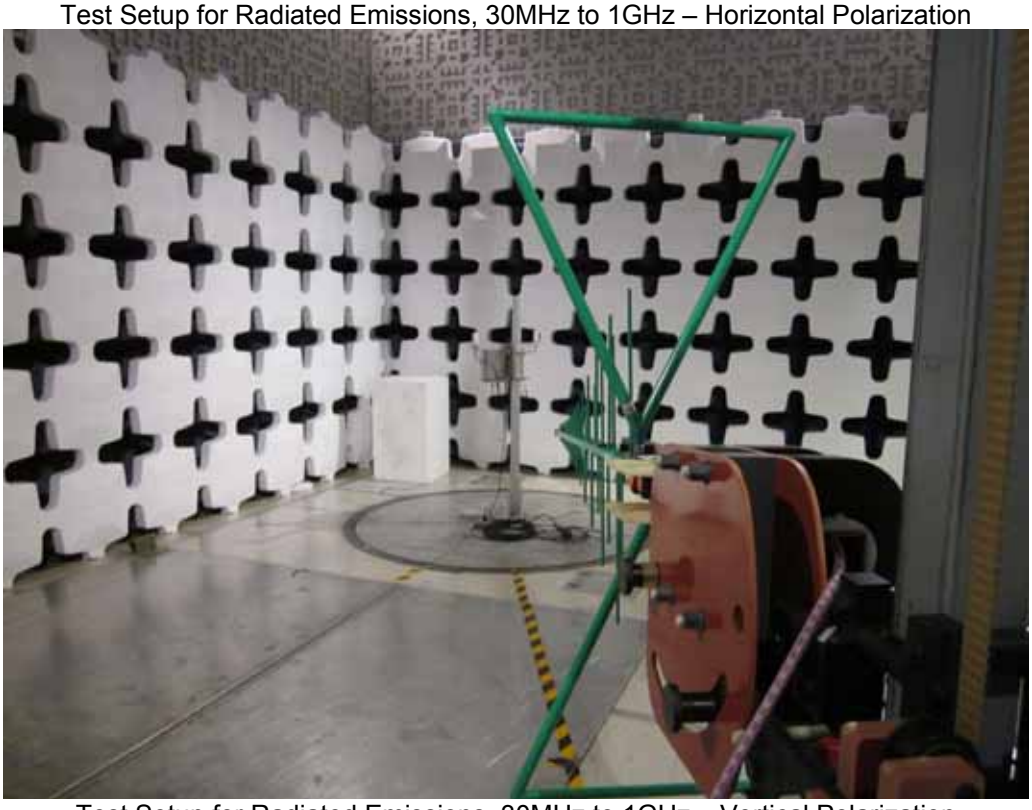
FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 2

Test Setup for Conducted Emissions

Figure 3

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



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

Figure 4

Test Setup for Radiated Emissions above 1GHz – Horizontal Polarization

Test Setup for Radiated Emissions above1GHz – Vertical Polarization

FCC Part 15 Subpart B Conducted Emissions Test

Significant Emissions Data

VB** 02/09/2011

Manufacturer	:	BADGER METER
Model	:	GALAXY GATEWAY GEN 3
DUT Revision	:	
Serial Number	:	Sample #3
DUT Mode	:	Tx @ 914.5MHz
Line Tested	:	120V, 60Hz HIGH
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-10
Notes	:	
Test Engineer	:	M. Longinotti
Limit	:	Class B
Test Date	:	Jan 08, 2014 09:27:54 AM
Data Filter	:	Up to 80 maximum levels detected with 6 dB level excursion threshold over 10 dB margin below limit

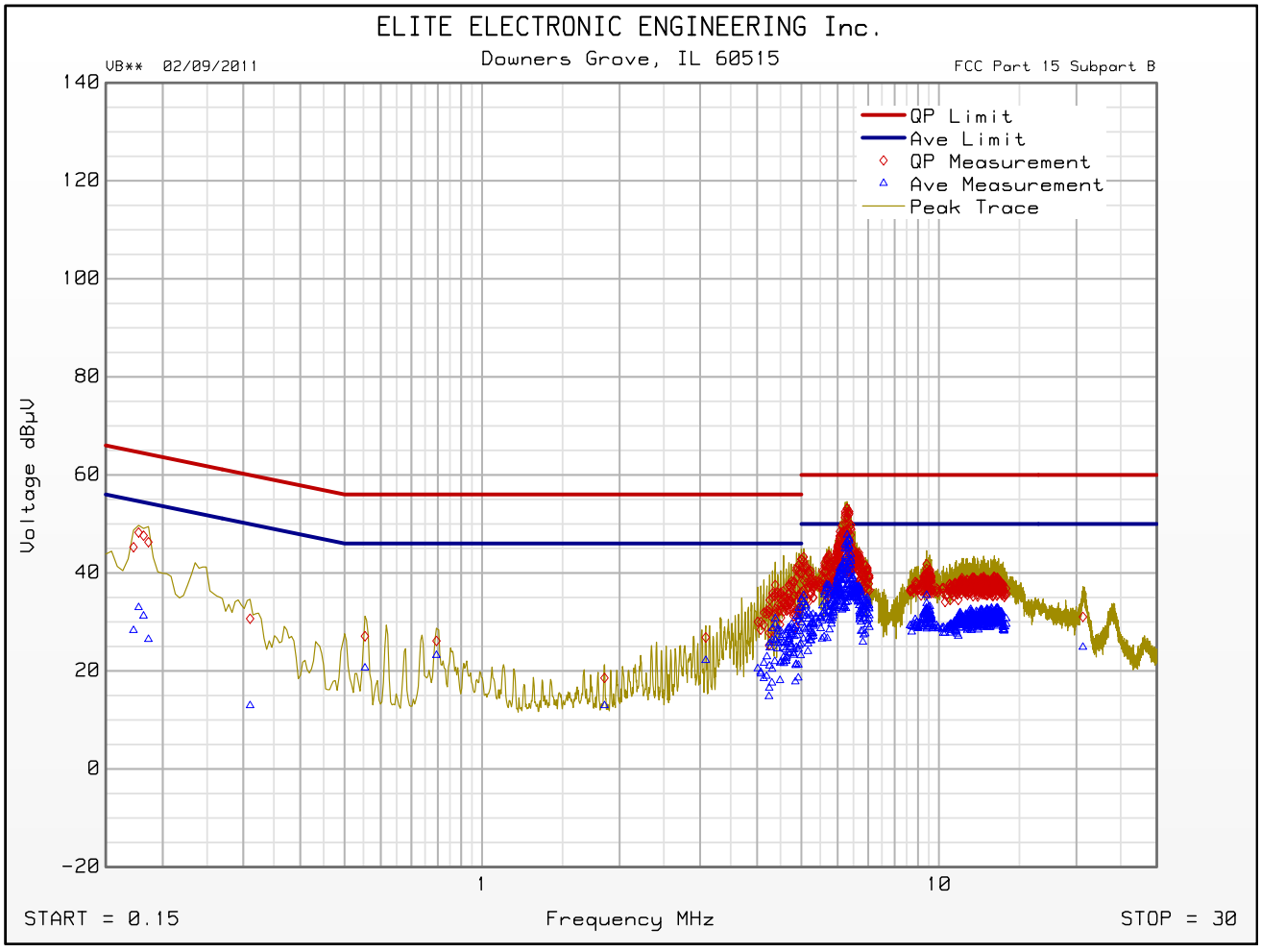
Freq MHz	Quasi-peak Level dBµV	Quasi-peak Limit dBµV	Excessive Quasi-peak Emissions	Average Level dBµV	Average Limit dBµV	Excessive Average Emissions
0.177	48.3	64.6		33.0	54.6	
0.311	30.7	60.0		13.0	50.0	
0.554	27.1	56.0		20.6	46.0	
0.795	26.1	56.0		23.2	46.0	
1.853	18.6	56.0		13.0	46.0	
3.087	26.8	56.0		22.2	46.0	
4.999	42.8	56.0		34.6	46.0	
6.058	46.6	60.0		40.3	50.0	
6.067	47.5	60.0		41.0	50.0	
6.116	45.6	60.0		40.7	50.0	
6.130	49.6	60.0		41.1	50.0	
6.175	48.3	60.0		42.1	50.0	
6.188	48.6	60.0		42.0	50.0	
6.233	52.5	60.0		45.8	50.0	
6.296	53.2	60.0		47.8	50.0	
6.355	52.5	60.0		47.0	50.0	
6.359	52.5	60.0		46.6	50.0	
6.418	49.8	60.0		43.8	50.0	
9.396	41.8	60.0		35.5	50.0	
20.674	31.0	60.0		24.9	50.0	

FCC Part 15 Subpart B Conducted Emissions Test

Cumulative Data

VB** 02/09/2011

Manufacturer	:	BADGER METER
Model	:	GALAXY GATEWAY GEN 3
DUT Revision	:	
Serial Number	:	Sample #3
DUT Mode	:	Tx @ 914.5MHz
Line Tested	:	120V, 60Hz HIGH
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-10
Notes	:	
Test Engineer	:	M. Longinotti
Limit	:	Class B
Test Date	:	Jan 08, 2014 09:27:54 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	:	GALAXY GATEWAY GEN 3
DUT Revision	:	
Serial Number	:	Sample #3
DUT Mode	:	Tx @ 914.5MHz
Line Tested	:	120V, 60Hz RETURN
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-10
Notes	:	
Test Engineer	:	M. Longinotti
Limit	:	Class B
Test Date	:	Jan 08, 2014 09:05:55 AM
Data Filter	:	Up to 80 maximum levels detected with 6 dB level excursion threshold over 10 dB margin below limit

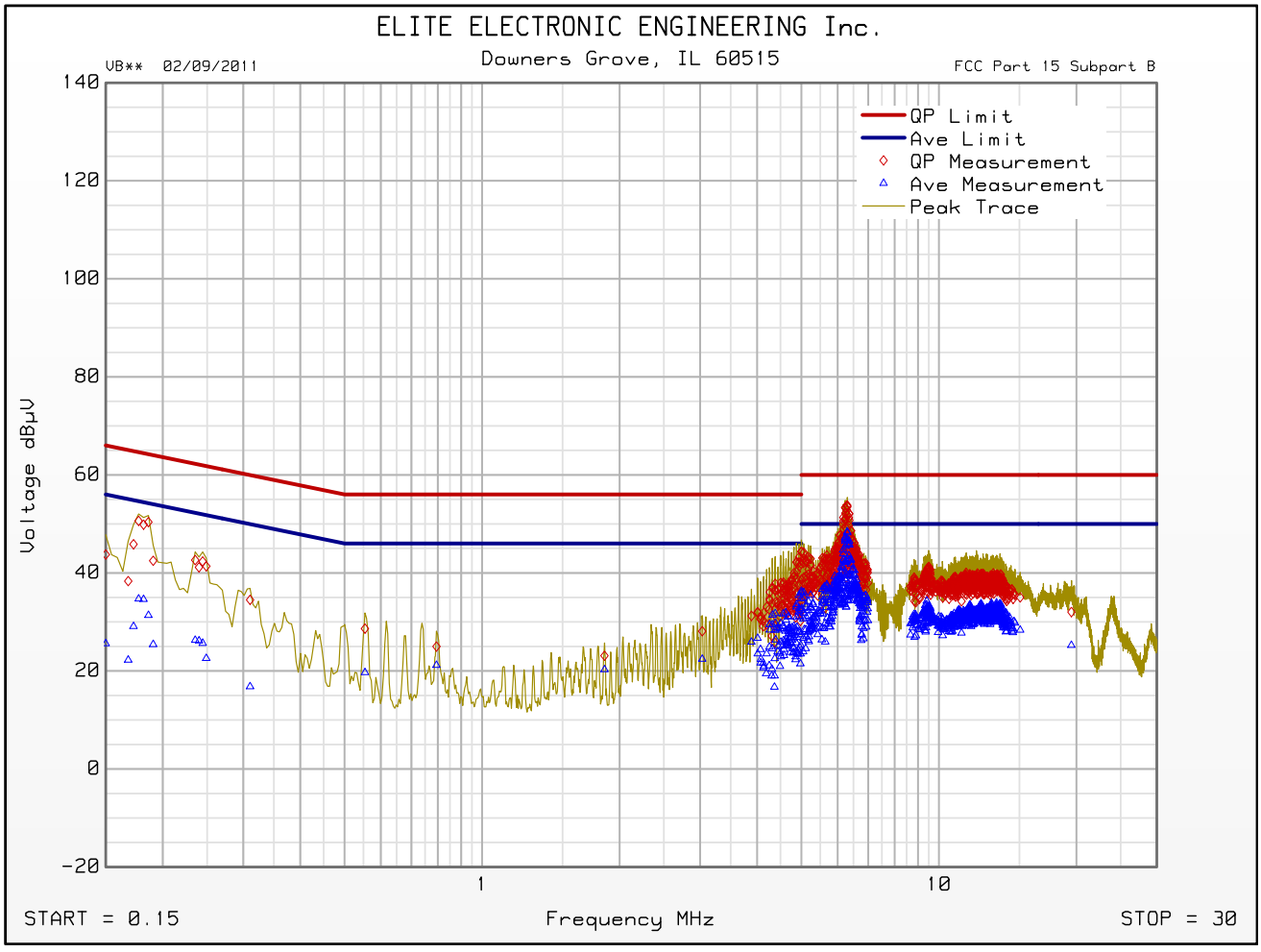
Freq MHz	Quasi-peak Level dBµV	Quasi-peak Limit dBµV	Excessive Quasi-peak Emissions	Average Level dBµV	Average Limit dBµV	Excessive Average Emissions
0.186	50.4	64.2		31.4	54.2	
0.311	34.5	60.0		16.8	50.0	
0.554	28.6	56.0		19.7	46.0	
0.795	25.0	56.0		21.2	46.0	
1.853	23.1	56.0		20.3	46.0	
3.033	28.1	56.0		22.4	46.0	
4.999	44.4	56.0		36.3	46.0	
6.116	47.2	60.0		41.3	50.0	
6.130	47.3	60.0		41.0	50.0	
6.175	51.3	60.0		44.7	50.0	
6.238	53.4	60.0		47.3	50.0	
6.296	53.8	60.0		48.4	50.0	
6.301	53.8	60.0		48.2	50.0	
6.359	52.1	60.0		46.5	50.0	
6.364	52.1	60.0		45.7	50.0	
6.418	48.6	60.0		42.7	50.0	
6.476	46.5	60.0		40.8	50.0	
6.530	46.2	60.0		40.5	50.0	
9.504	41.3	60.0		33.1	50.0	
19.504	32.0	60.0		25.2	50.0	

FCC Part 15 Subpart B Conducted Emissions Test

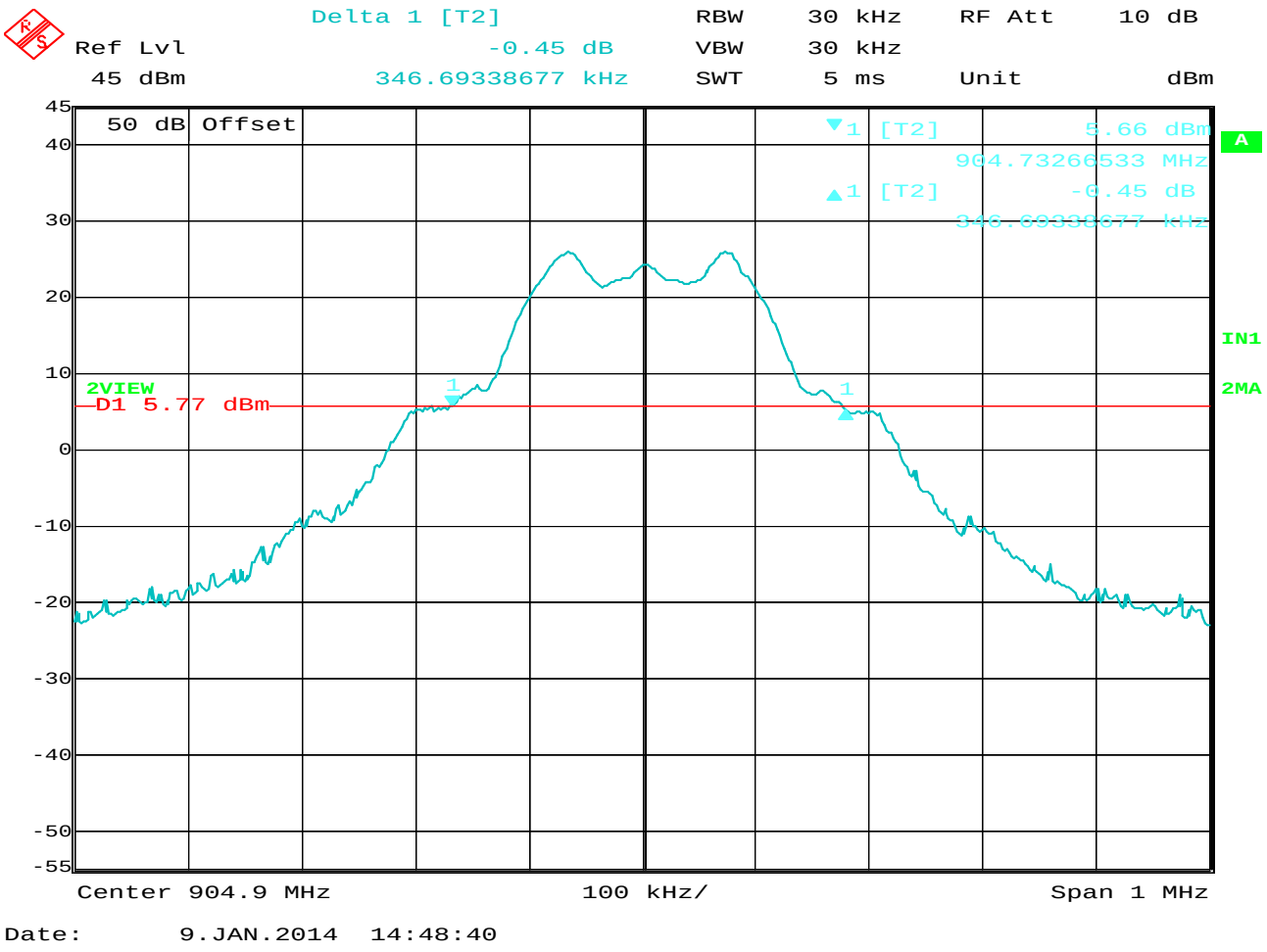
Cumulative Data

VB** 02/09/2011

Manufacturer	:	BADGER METER
Model	:	GALAXY GATEWAY GEN 3
DUT Revision	:	
Serial Number	:	Sample #3
DUT Mode	:	Tx @ 914.5MHz
Line Tested	:	120V, 60Hz RETURN
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-10
Notes	:	
Test Engineer	:	M. Longinotti
Limit	:	Class B
Test Date	:	Jan 08, 2014 09:05:55 AM

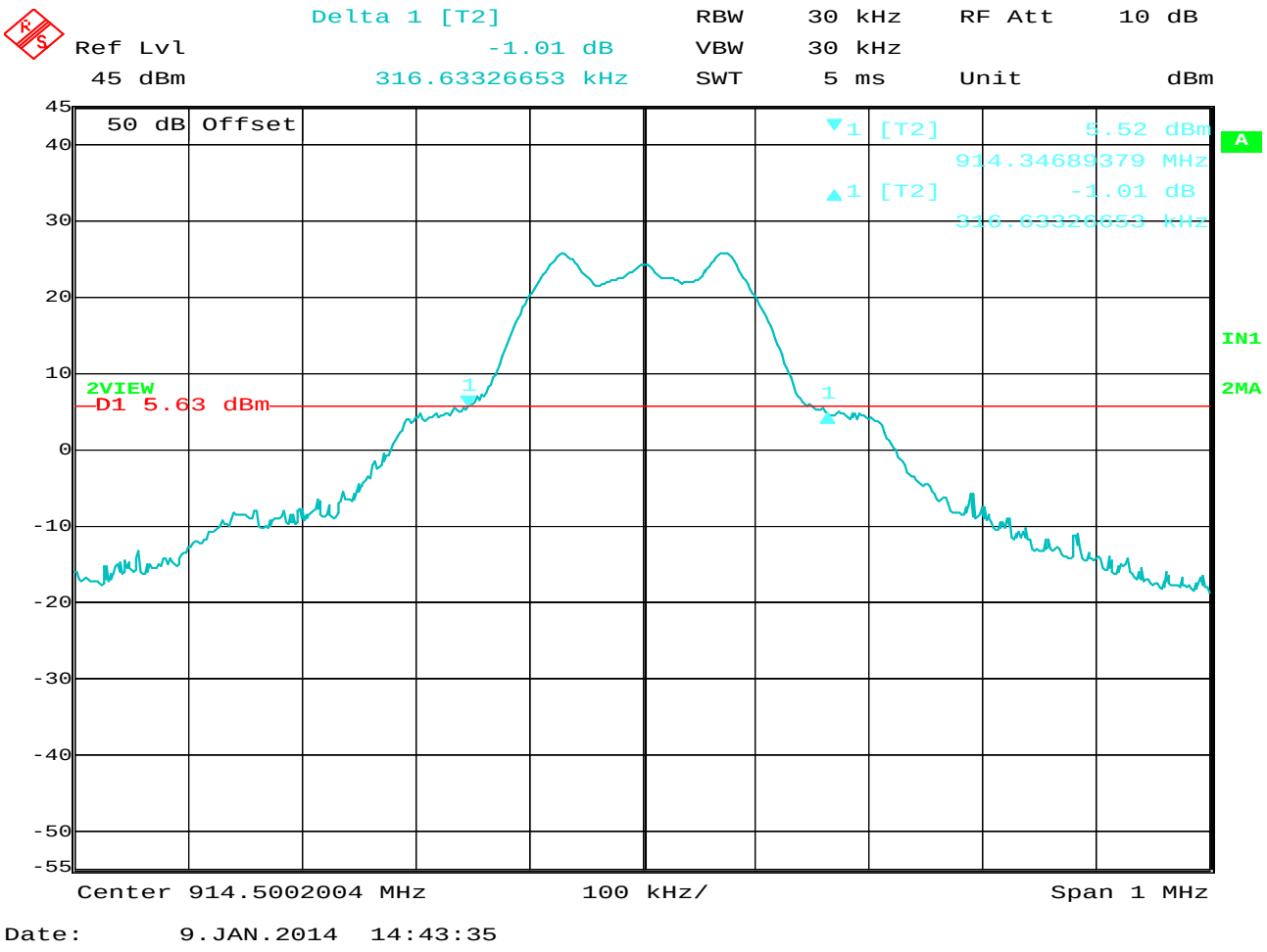


Emissions Meet QP Limit
Emissions Meet Ave Limit



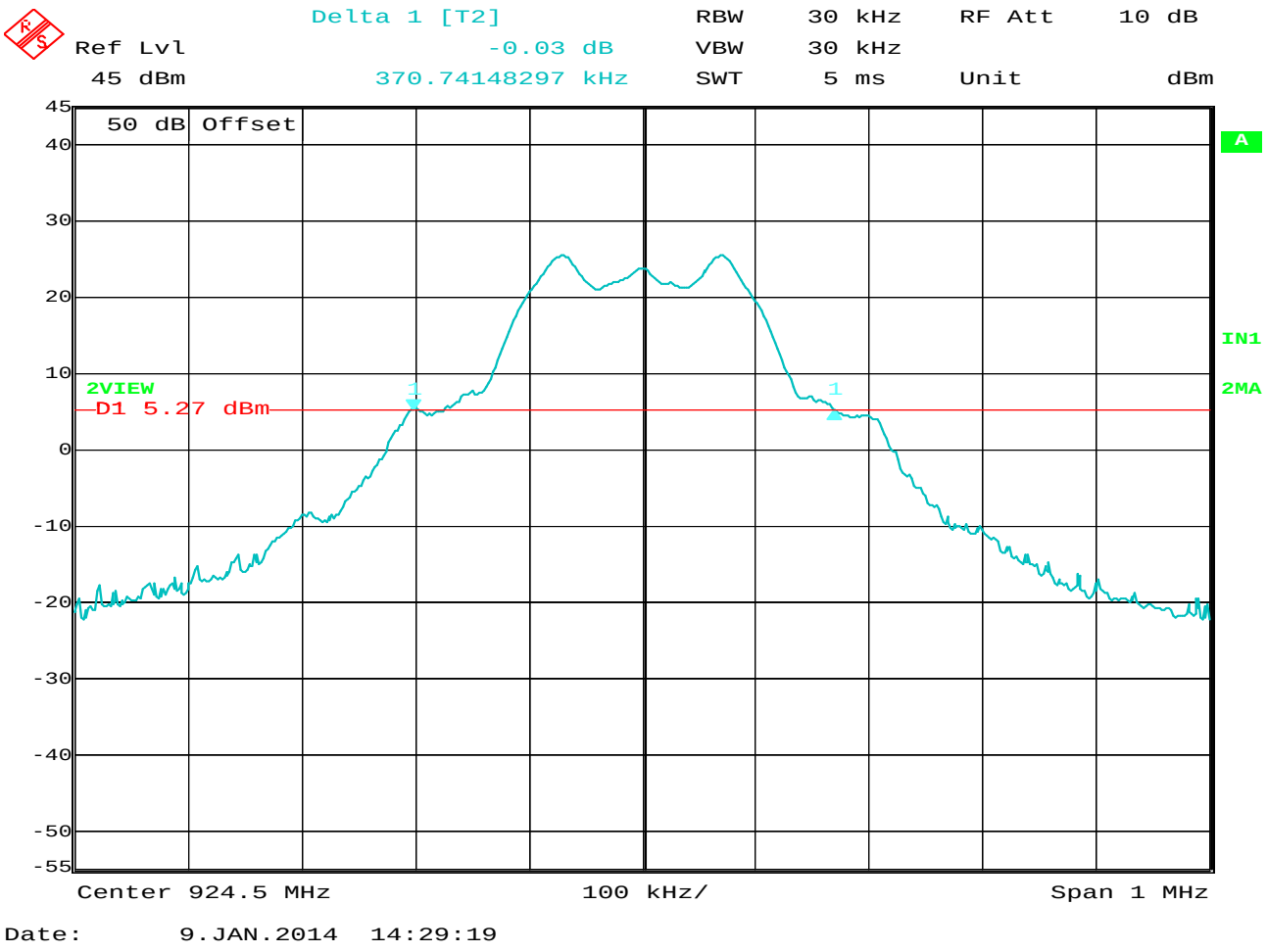
20dB Bandwidth

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Galaxy Gateway Gen 3
SERIAL NUMBER	:	Sample #4
TEST MODE	:	Tx @ Ch. 1 (904.9MHz)
NOTES	:	Output Power = 8D, Ant 1 port
TEST DATE	:	January 9, 2014
TEST PARAMETERS	:	20dB bandwidth
NOTES	:	20dB bandwidth = 346.7kHz
EQUIPMENT USED	:	RBB0, T1EQ, T2DP, T2DM



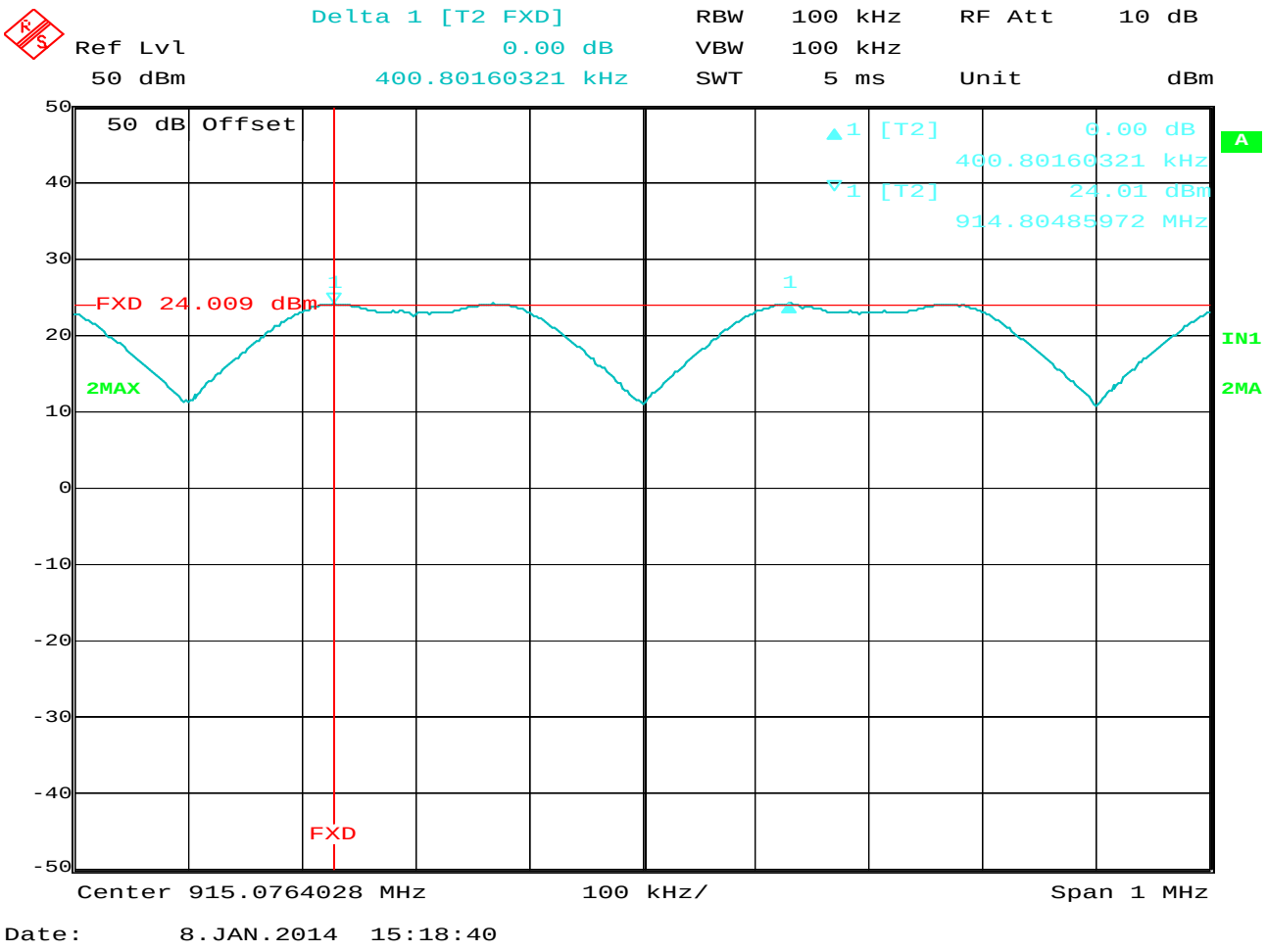
20dB Bandwidth

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Galaxy Gateway Gen 3
SERIAL NUMBER	:	Sample #4
TEST MODE	:	Tx @ Ch. 25 (914.5MHz)
NOTES	:	Output Power = 8D, Ant 1 port
TEST DATE	:	January 9, 2014
TEST PARAMETERS	:	20dB bandwidth
NOTES	:	20dB bandwidth = 316.6kHz
EQUIPMENT USED	:	RBB0, T1EQ, T2DP, T2DM



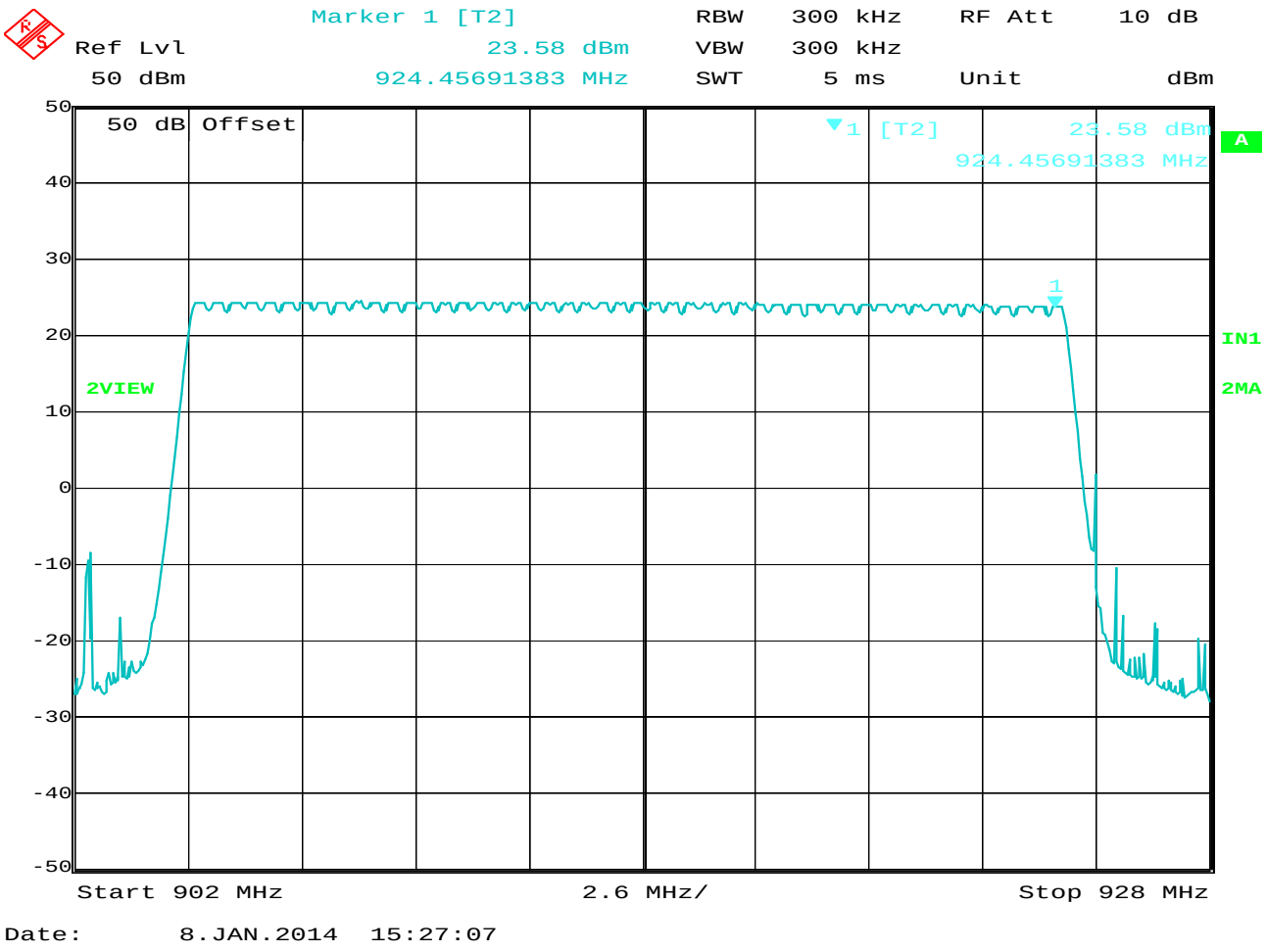
20dB Bandwidth

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Galaxy Gateway Gen 3
SERIAL NUMBER	:	Sample #4
TEST MODE	:	Tx @ Ch. 50 (924.5MHz)
NOTES	:	Output Power = 8D, Ant 1 port
TEST DATE	:	January 9, 2014
TEST PARAMETERS	:	20dB bandwidth
NOTES	:	20dB bandwidth = 370.7kHz
EQUIPMENT USED	:	RBB0, T1EQ, T2DP, T2DM



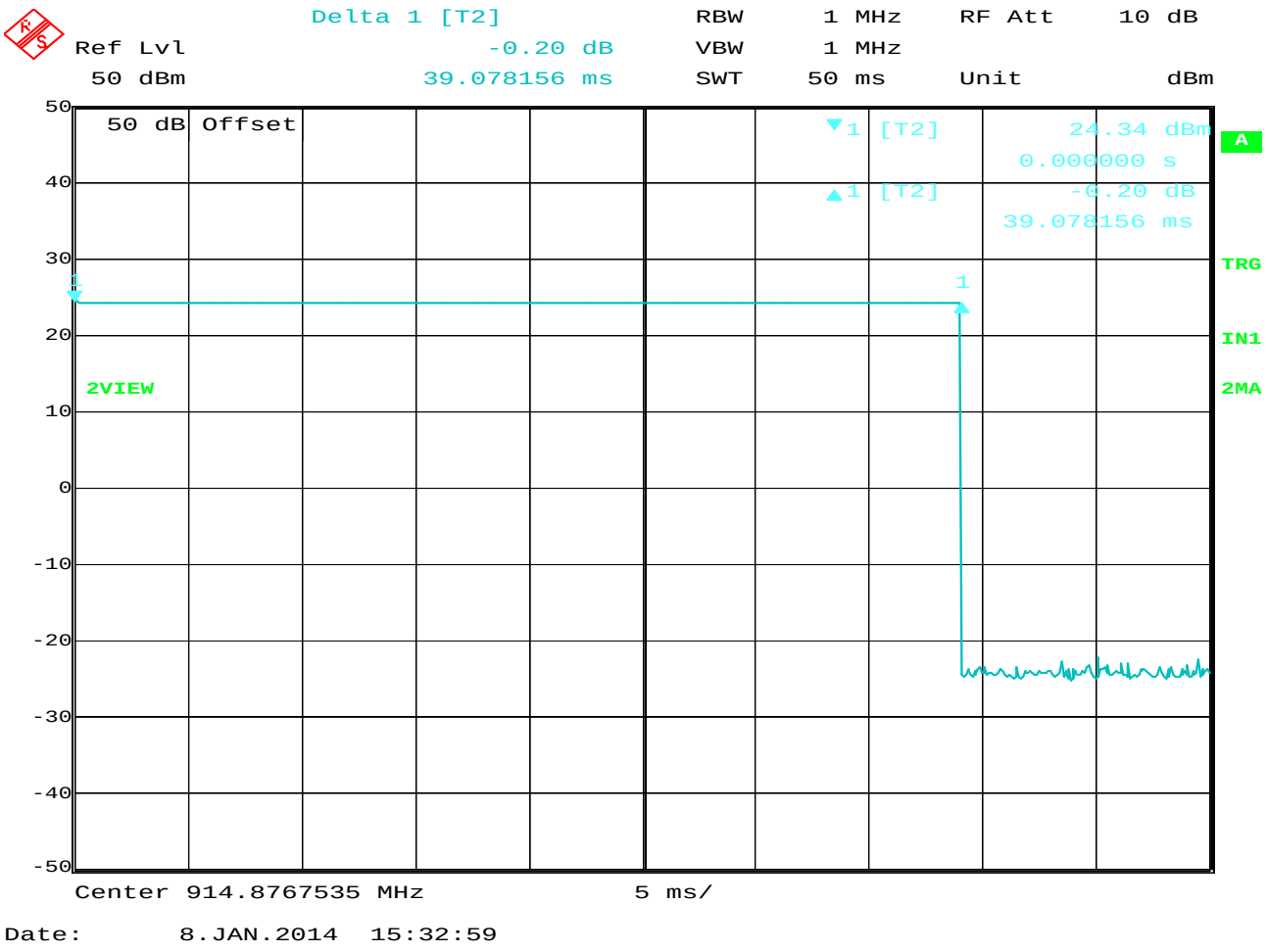
Carrier Frequency Separation

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Galaxy Gateway Gen 3
SERIAL NUMBER	:	Sample #4
TEST MODE	:	Hopping enabled
NOTES	:	Output Power = 8D, Ant 1 port
TEST DATE	:	January 8, 2014
TEST PARAMETERS	:	Carrier Frequency Separation
NOTES	:	Carrier Frequency Separation = 400.8kHz
EQUIPMENT USED	:	RBB0, T1EQ, T2DP, T2DM



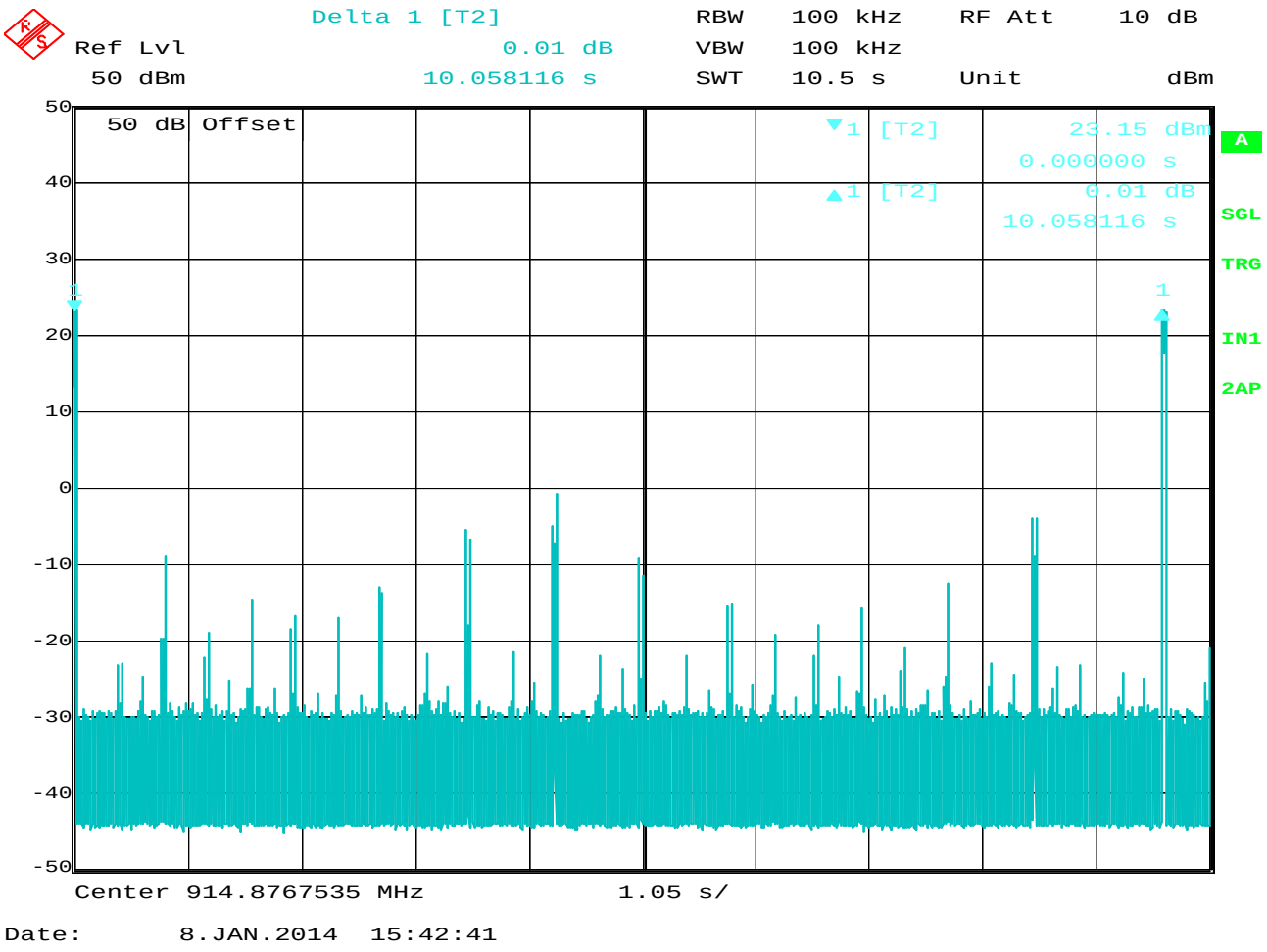
Number of Hopping Frequencies

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Galaxy Gateway Gen 3
SERIAL NUMBER	:	Sample #4
TEST MODE	:	Hopping enabled
NOTES	:	Output Power = 8D, Ant 1 port
TEST DATE	:	January 8, 2014
TEST PARAMETERS	:	Number of hopping frequencies
NOTES	:	Number of hopping frequencies = 50
EQUIPMENT USED	:	RBB0, T1EQ, T2DP, T2DM



Time of Occupancy

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Galaxy Gateway Gen 3
SERIAL NUMBER	:	Sample #4
TEST MODE	:	Hopping enabled
NOTES	:	Output Power = 8D, Ant 1 port
TEST DATE	:	January 8, 2014
TEST PARAMETERS	:	Time of Occupancy
NOTES	:	Dwell time per hop = 39msec
EQUIPMENT USED	:	RBB0, T1EQ, T2DP, T2DM



Time of Occupancy

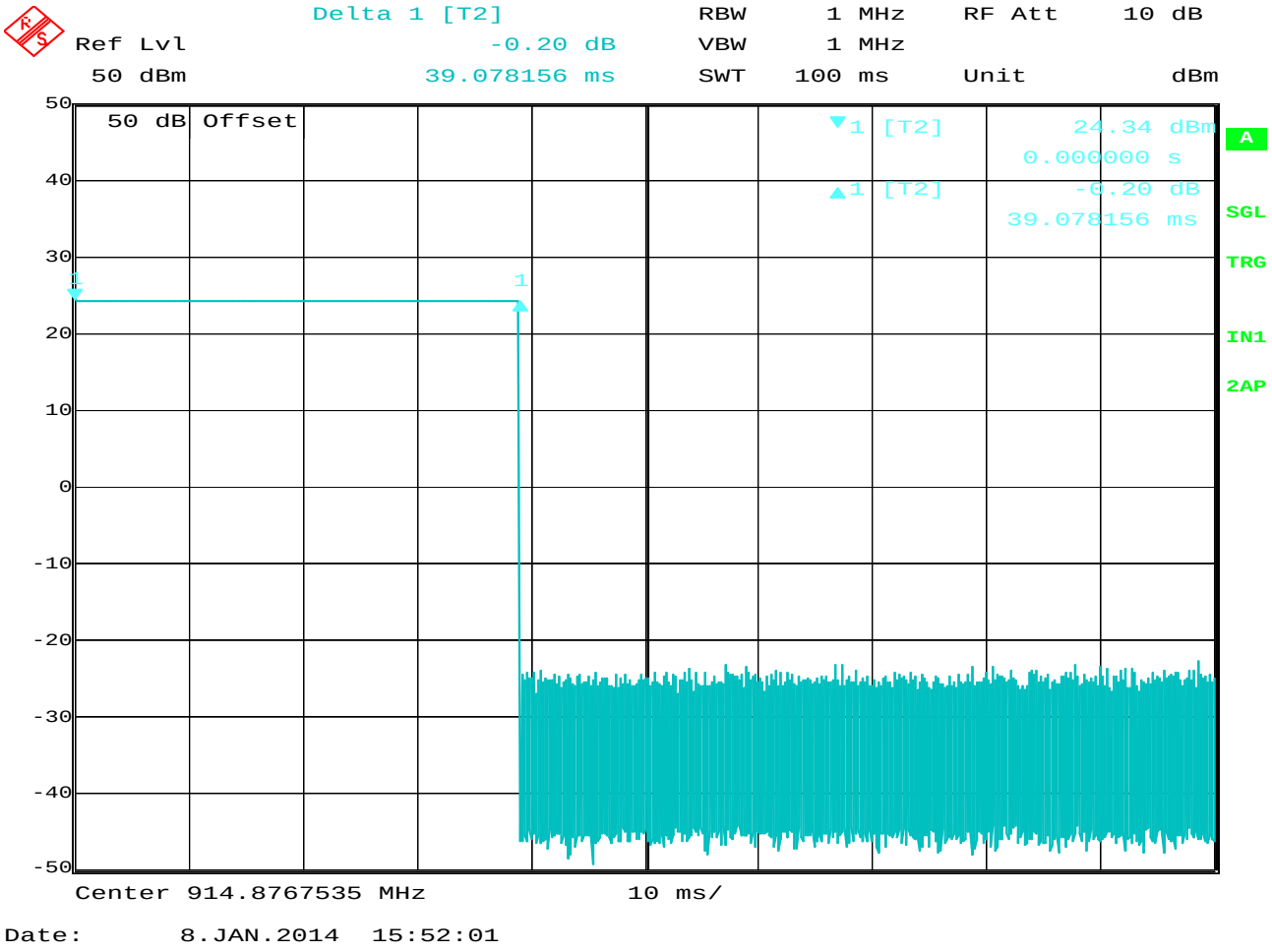
MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Galaxy Gateway Gen 3
SERIAL NUMBER	:	Sample #4
TEST MODE	:	Hopping enabled
NOTES	:	Output Power = 8D, Ant 1 port
TEST DATE	:	January 8, 2014
TEST PARAMETERS	:	Time of Occupancy
NOTES	:	Number of hops in a 10 second time period = 1.
	:	Time of Occupancy = (dwell time/hop) x (# of hops in 10 sec period)
	:	Time of Occupancy = 39msec /hop x 1 hop in a 10 sec period
	:	Time of Occupancy = 39msec = 0.039sec
EQUIPMENT USED	:	RBB0, T1EQ, T2DP, T2DM

DATA PAGE

MANUFACTURER : Badger Meter
EUT : Transceiver
MODEL : Galaxy Gateway Gen 3
SERIAL NO. : Sample #3 for Ch. 1 and Ch. 25, Sample #4 for Ch. 50
TEST MODE : See Below
SPECIFICATION : Peak Output Power (Antenna Conducted)
DATE : January 6, 2014
TEST EQUIPMENT : MPC2, MPI1, XLQP, T2SK, T1N2
NOTES : Output Power = 8D, Antenna Port 1

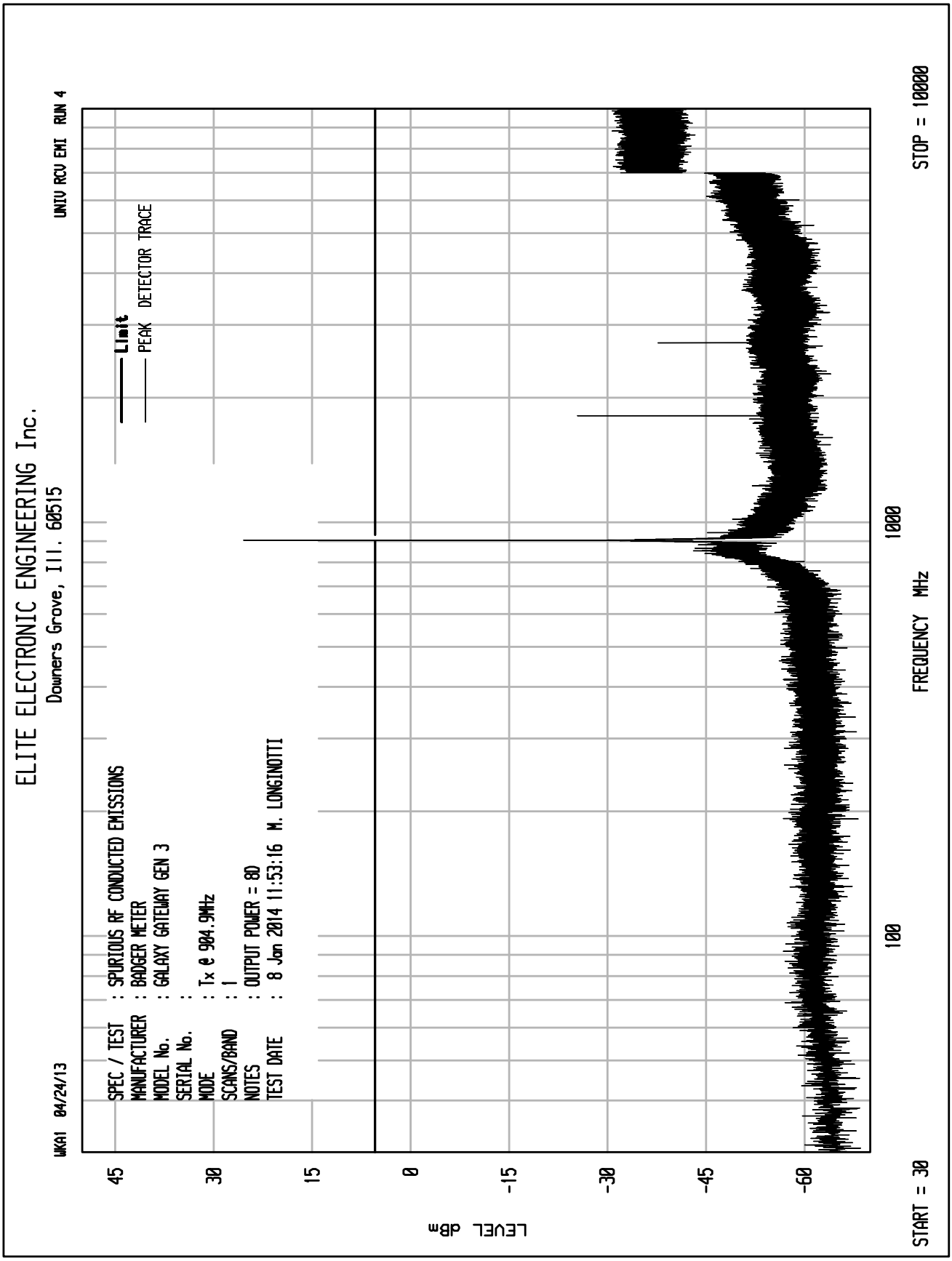
Transmit Channel	Transmit Frequency MHz	Measured Output Power dBm	Limit dBm
1	904.9	29.2	30.0
25	914.5	28.8	30.0
50	924.5	28.5	30.0

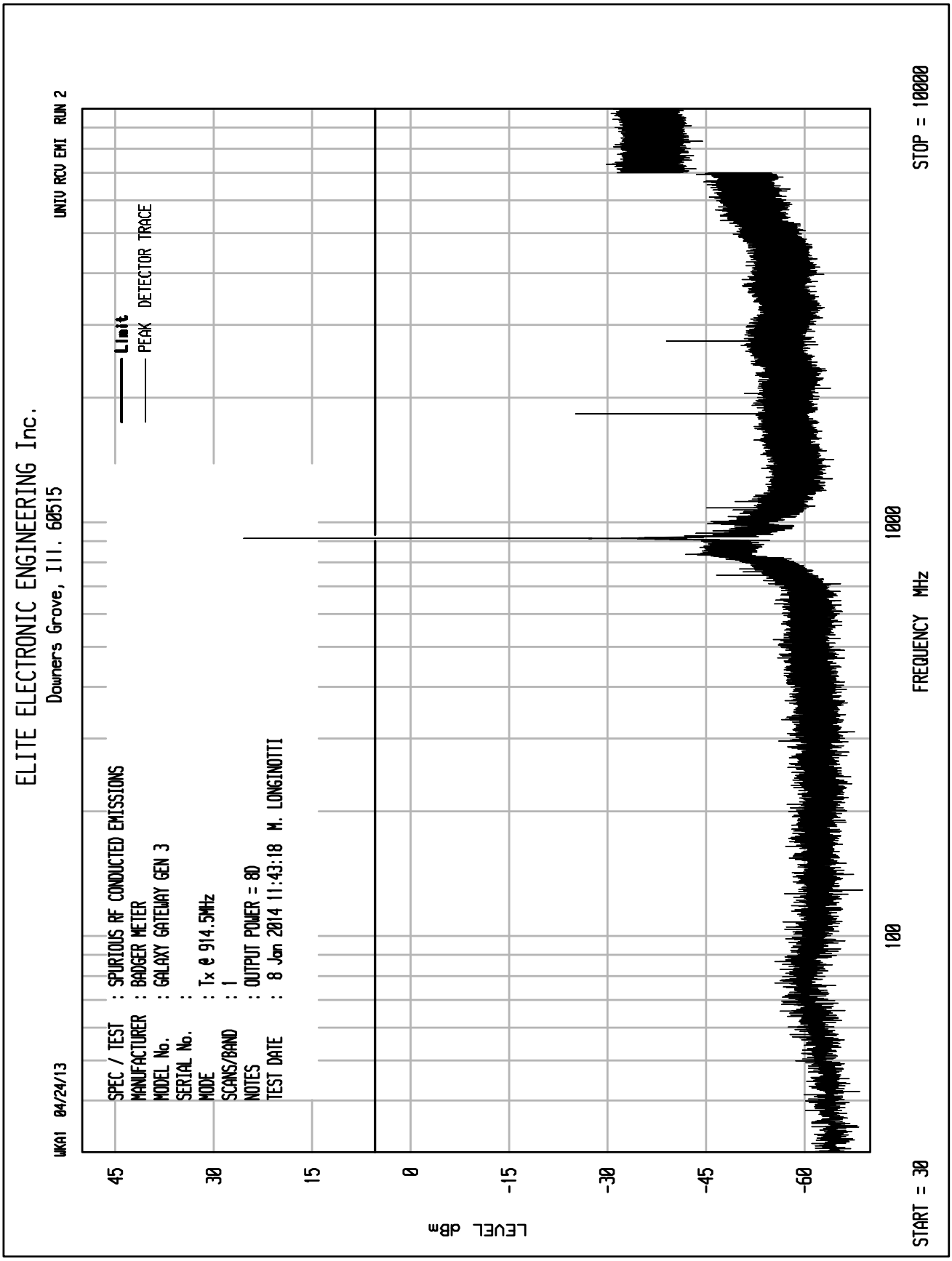
Checked By: MARK E. LONGINOTTI

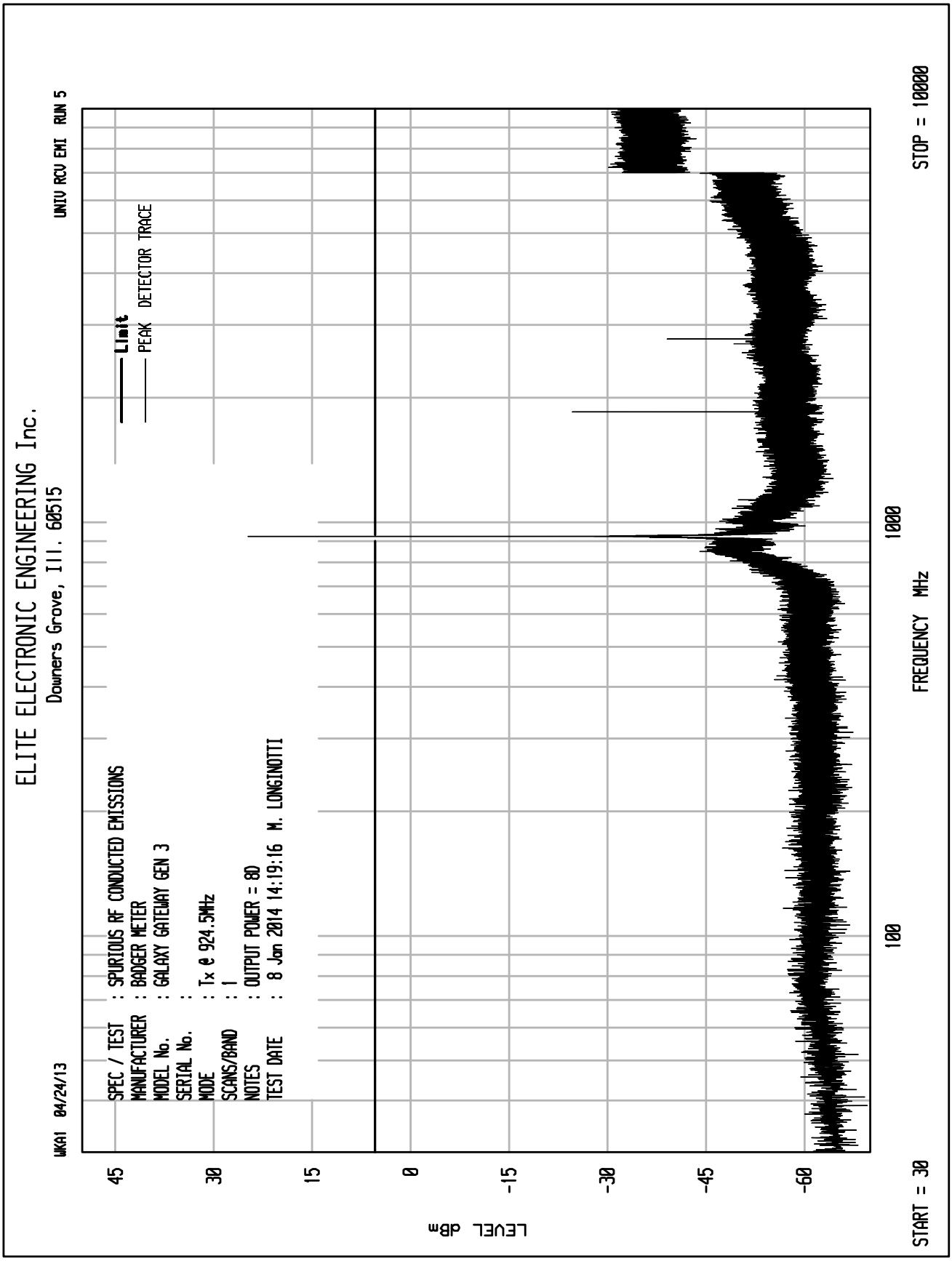


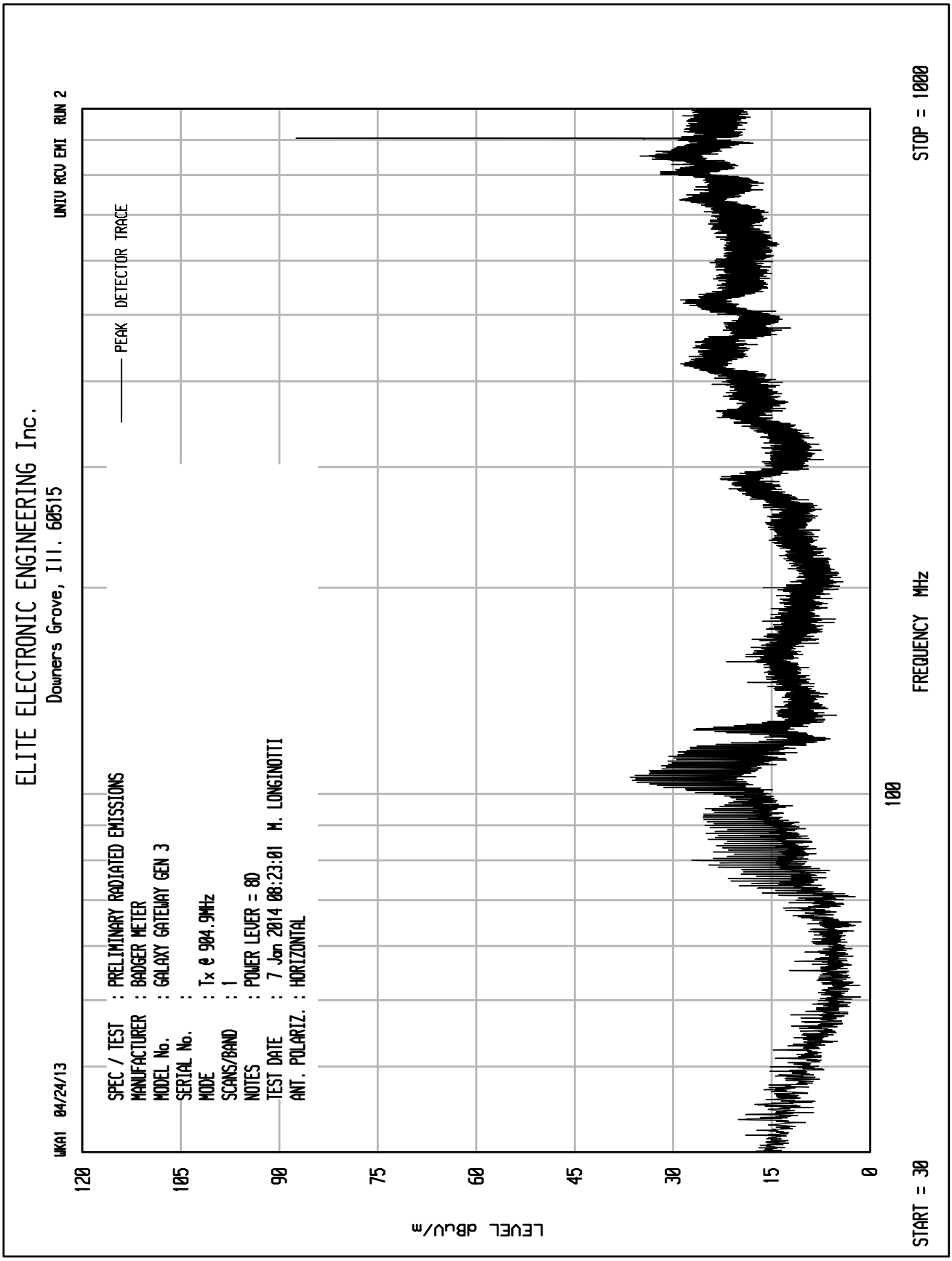
Duty Cycle Correction Factor

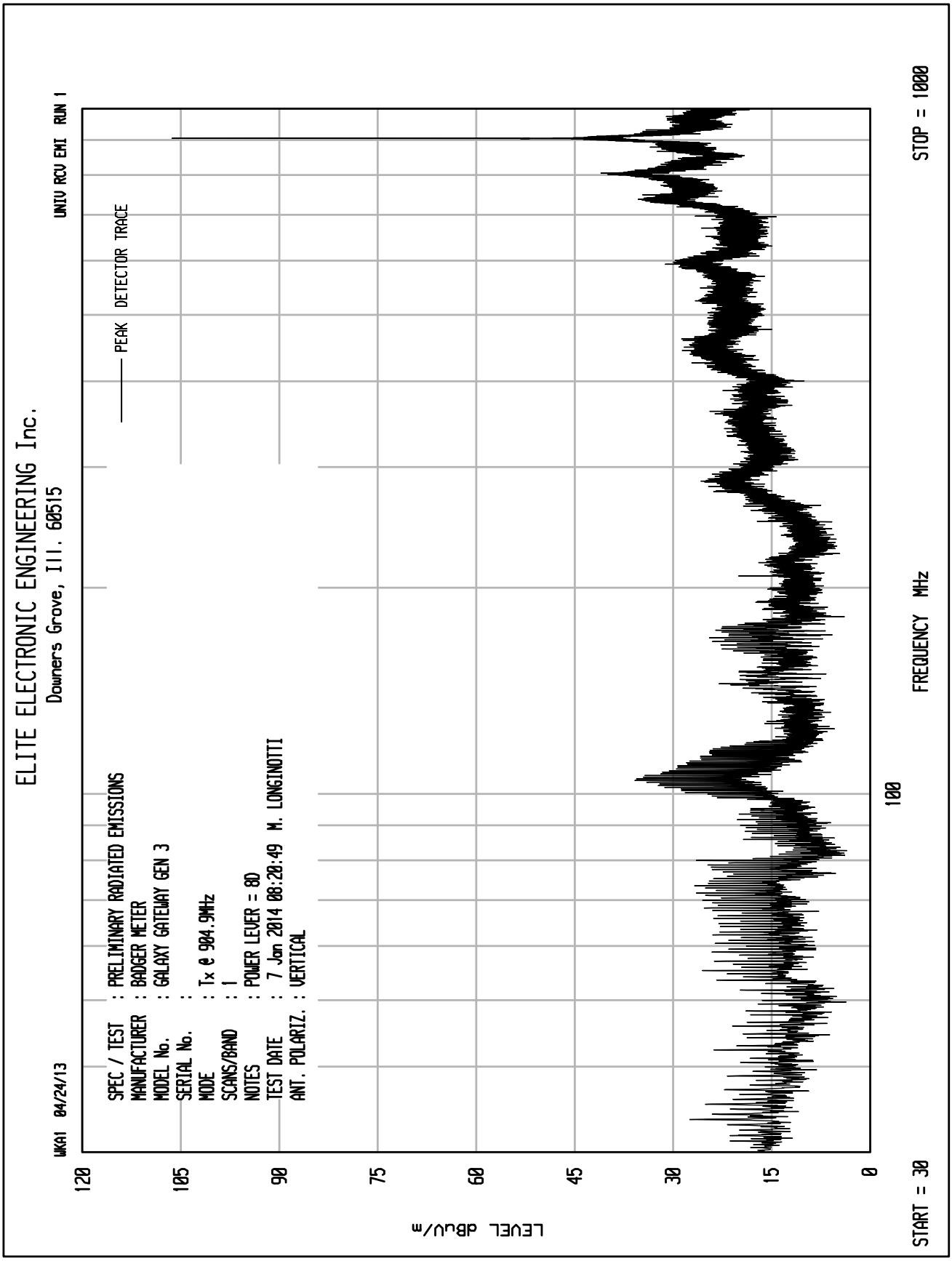
MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Galaxy Gateway Gen 3
SERIAL NUMBER	:	Sample #4
TEST MODE	:	Hopping enabled
NOTES	:	Output Power = 8D, Ant 1 port
TEST DATE	:	January 8, 2014
TEST PARAMETERS	:	Duty Cycle Correction Factor
NOTES	:	Duty Cycle Correction Factor = 20 x Log ((on-time)/(100msec))
	:	Duty Cycle Correction Factor = 20 x Log ((39.08msec)/(100msec))
	:	Duty Cycle Correction Factor = -8.16dB
EQUIPMENT USED	:	RBB0, T1EQ, T2DP, T2DM

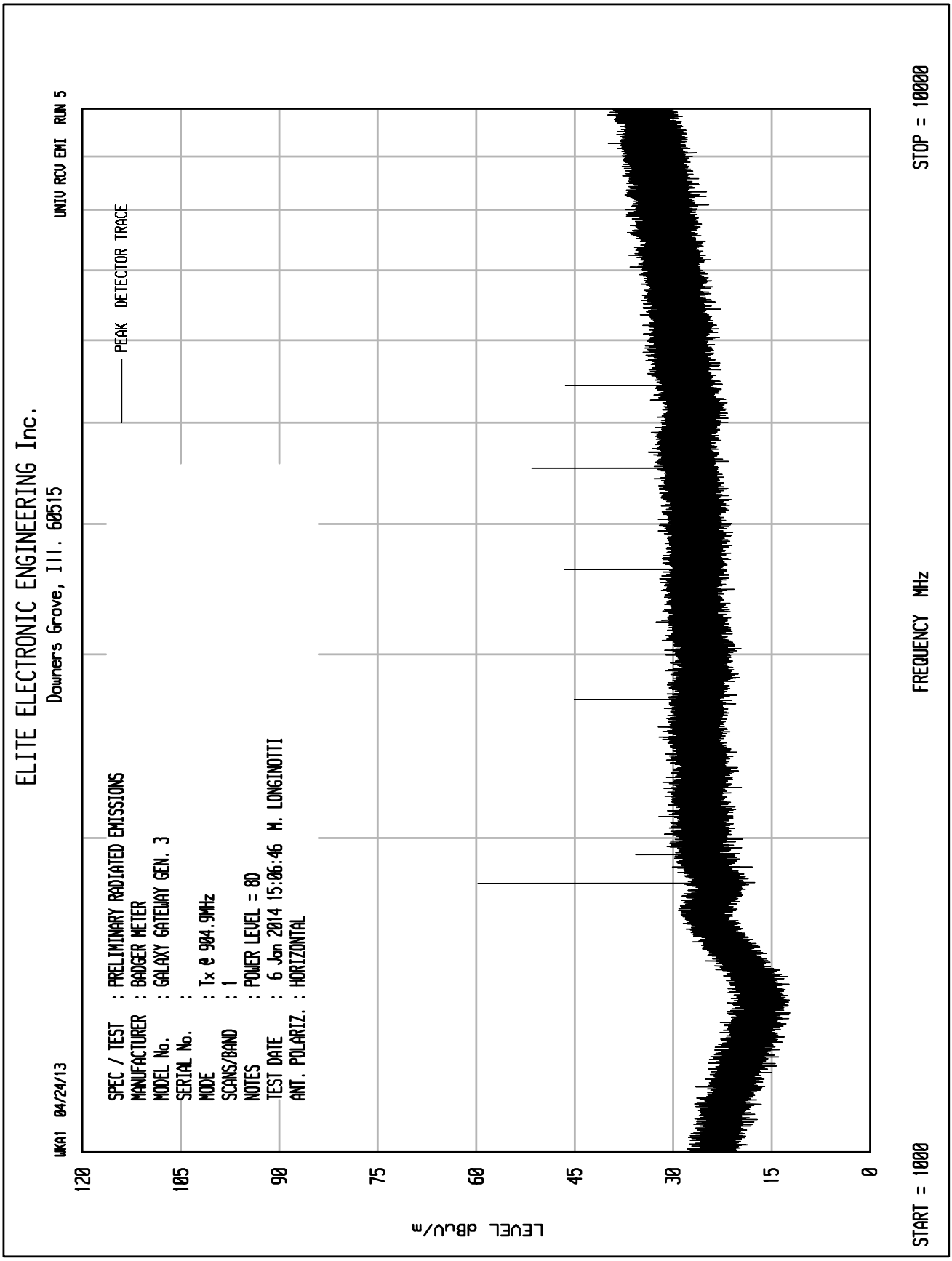

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 4
WKA1 04/24/13
SPEC / TEST : SPURIOUS RF CONDUCTED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : GALAXY GATEWAY GEN 3
SERIAL No. : :
MODE : Tx @ 904.9MHz
SCANS/BAND : 1
NOTES : OUTPUT POWER = 8D
TEST DATE : 8 Jan 2014 11:53:16 M. LONGINOTTI
Limit
PEAK DETECTOR TRACE
LEVEL dBm
45
30
15
0
-15
-30
-45
-60
START = 30
100
1000
STOP = 10000
FREQUENCY MHz

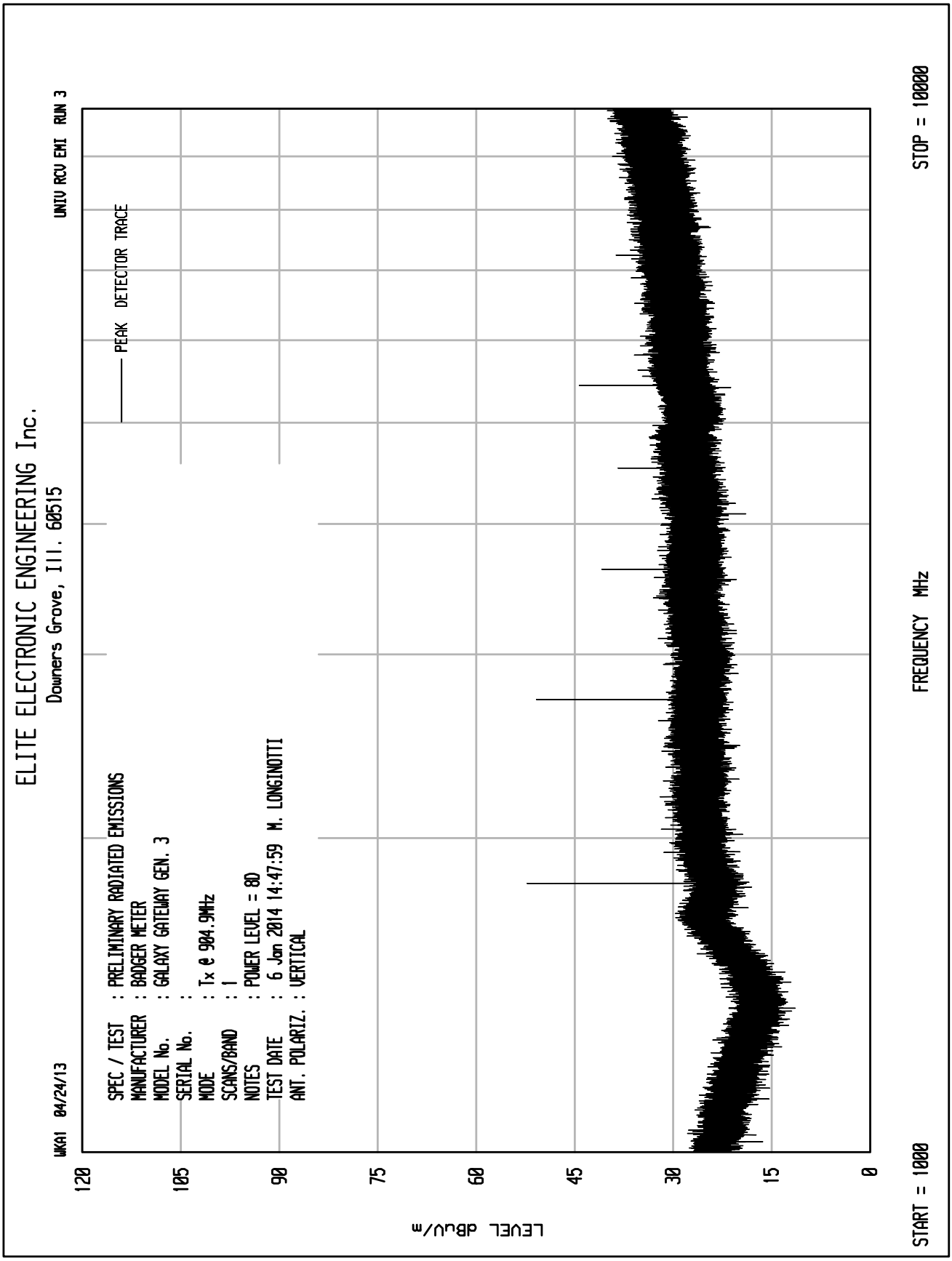

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 2
WKA1 04/24/13
SPEC / TEST : SPURIOUS RF CONDUCTED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : GALAXY GATEWAY GEN 3
SERIAL No. : :
MODE : Tx @ 914.5MHz
SCANS/BAND : 1
NOTES : OUTPUT POWER = 8D
TEST DATE : 8 Jan 2014 11:43:18 M. LONGINOTTI
Limit
PEAK DETECTOR TRACE
LEVEL dBm
45
30
15
0
-15
-30
-45
-60
START = 30
100
1000
STOP = 10000
FREQUENCY MHz

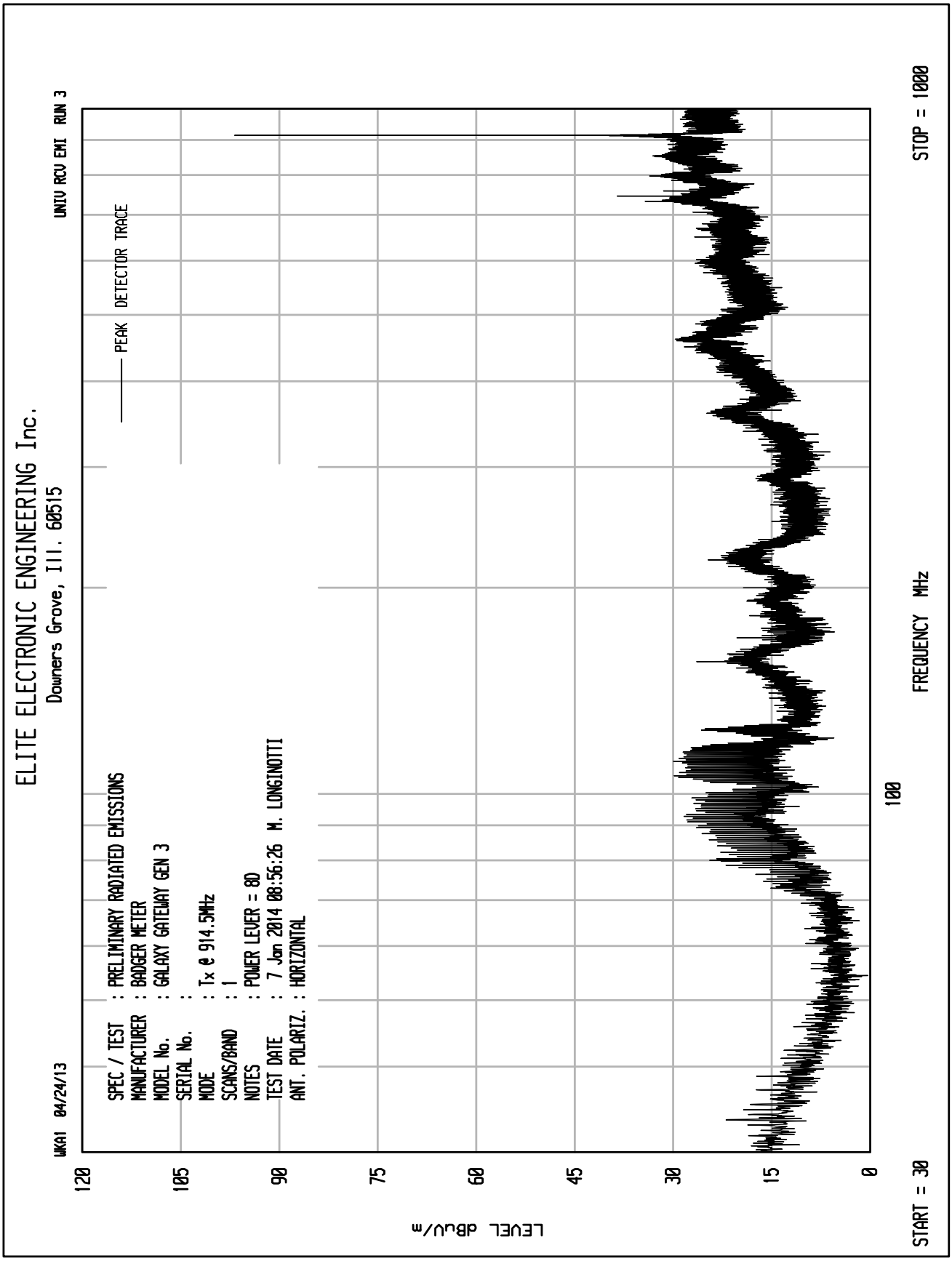

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 5
WKA1 04/24/13
SPEC / TEST : SPURIOUS RF CONDUCTED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : GALAXY GATEWAY GEN 3
SERIAL No. : :
MODE : Tx @ 924.5MHz
SCANS/BAND : 1
NOTES : OUTPUT POWER = 80
TEST DATE : 8 Jan 2014 14:19:16 M. LONGINOTTI
Limit
PEAK DETECTOR TRACE
LEVEL dBm
45
30
15
0
-15
-30
-45
-60
START = 30
100
1000
STOP = 10000
FREQUENCY MHz

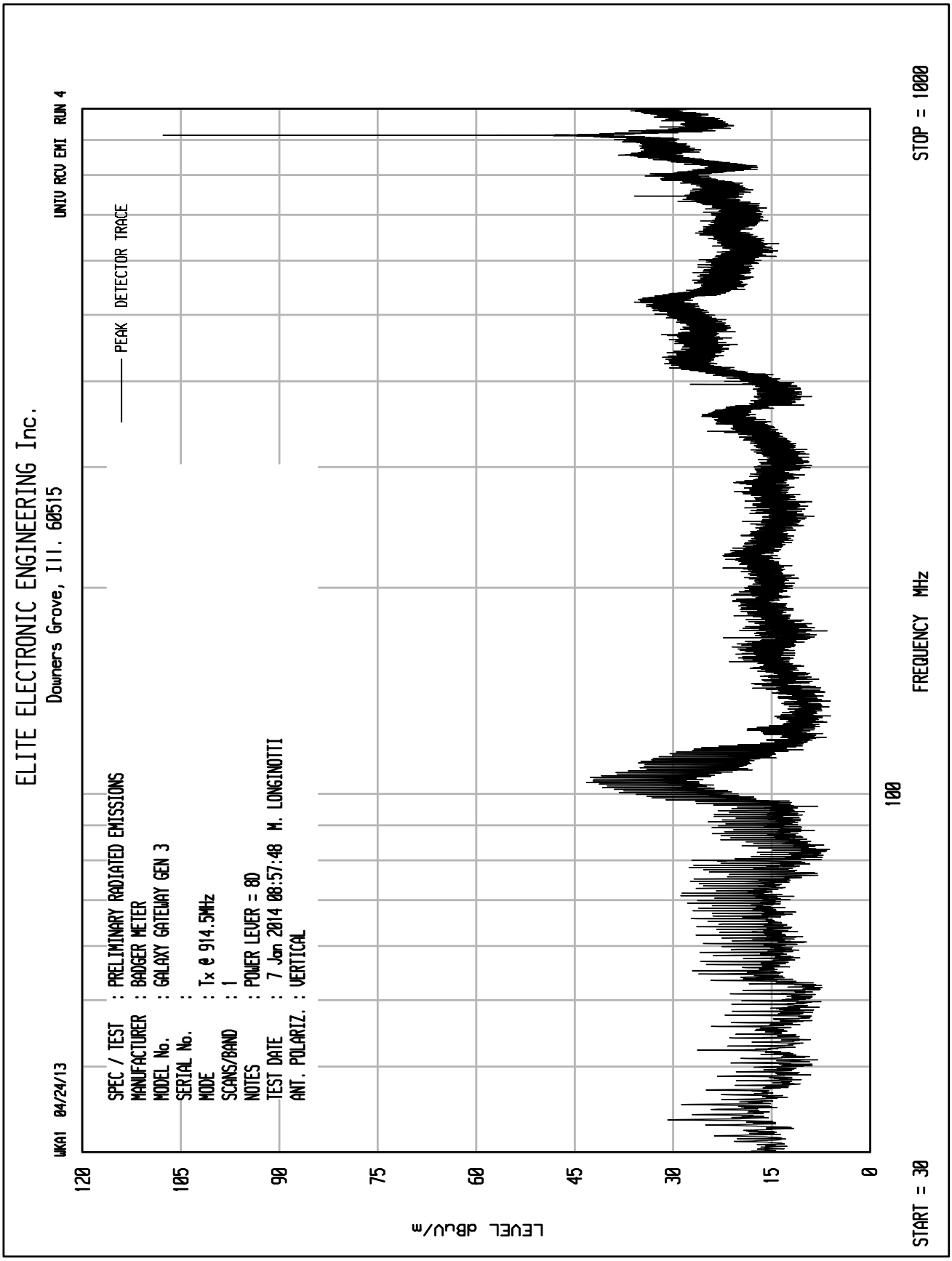

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 2
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : GALAXY GATEWAY GEN 3
SERIAL No. :
MODE : Tx @ 904.9MHz
SCANS/BAND : 1
NOTES : POWER LEVER = 80
TEST DATE : 7 Jan 2014 08:23:01 M. LONGINOTTI
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

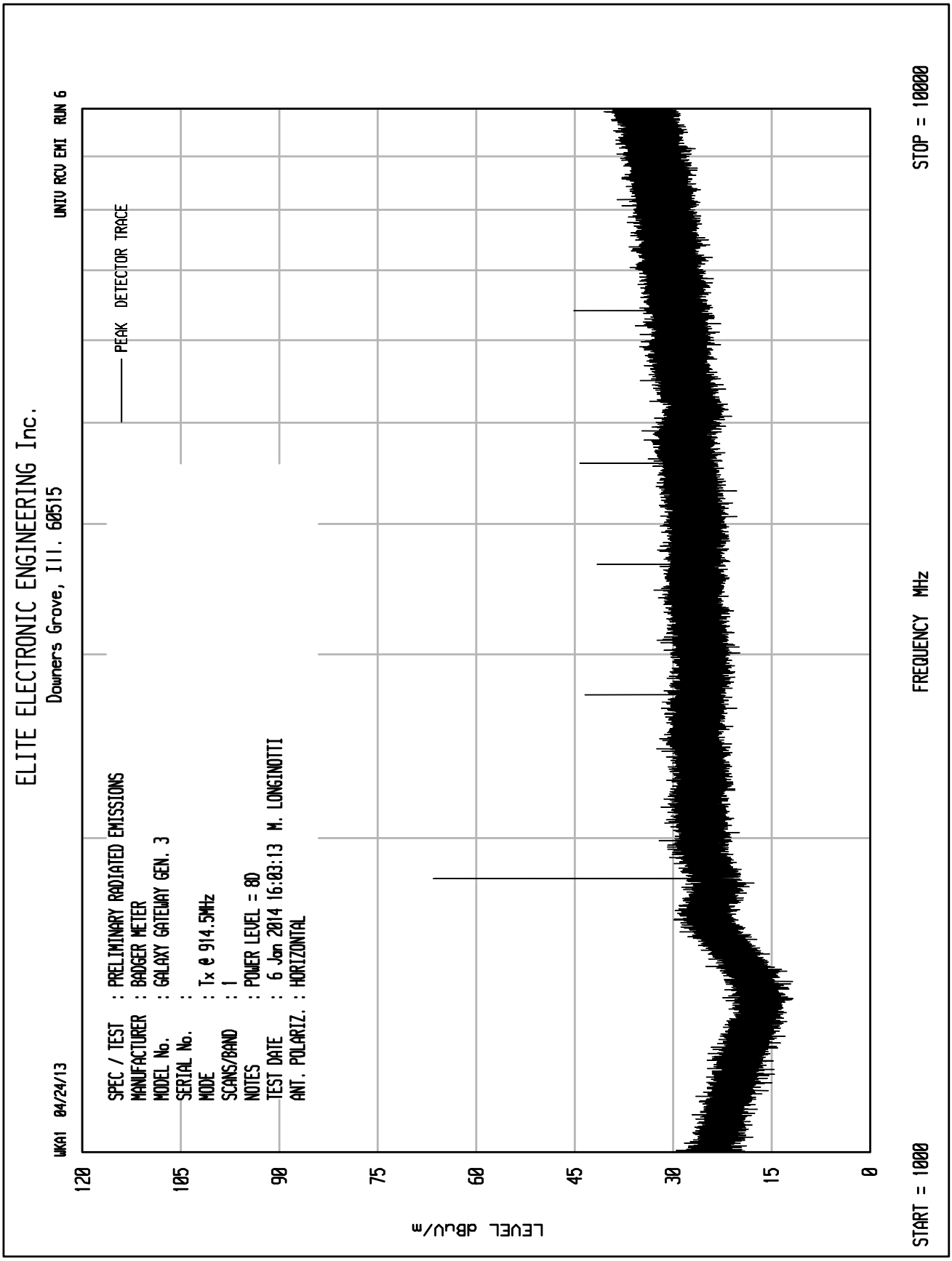

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 1
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : GALAXY GATEWAY GEN 3
SERIAL No. :
MODE : Tx @ 904.9MHz
SCANS/BAND : 1
NOTES : POWER LEVER = 80
TEST DATE : 7 Jan 2014 08:20:49 M. LONGINOTTI
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

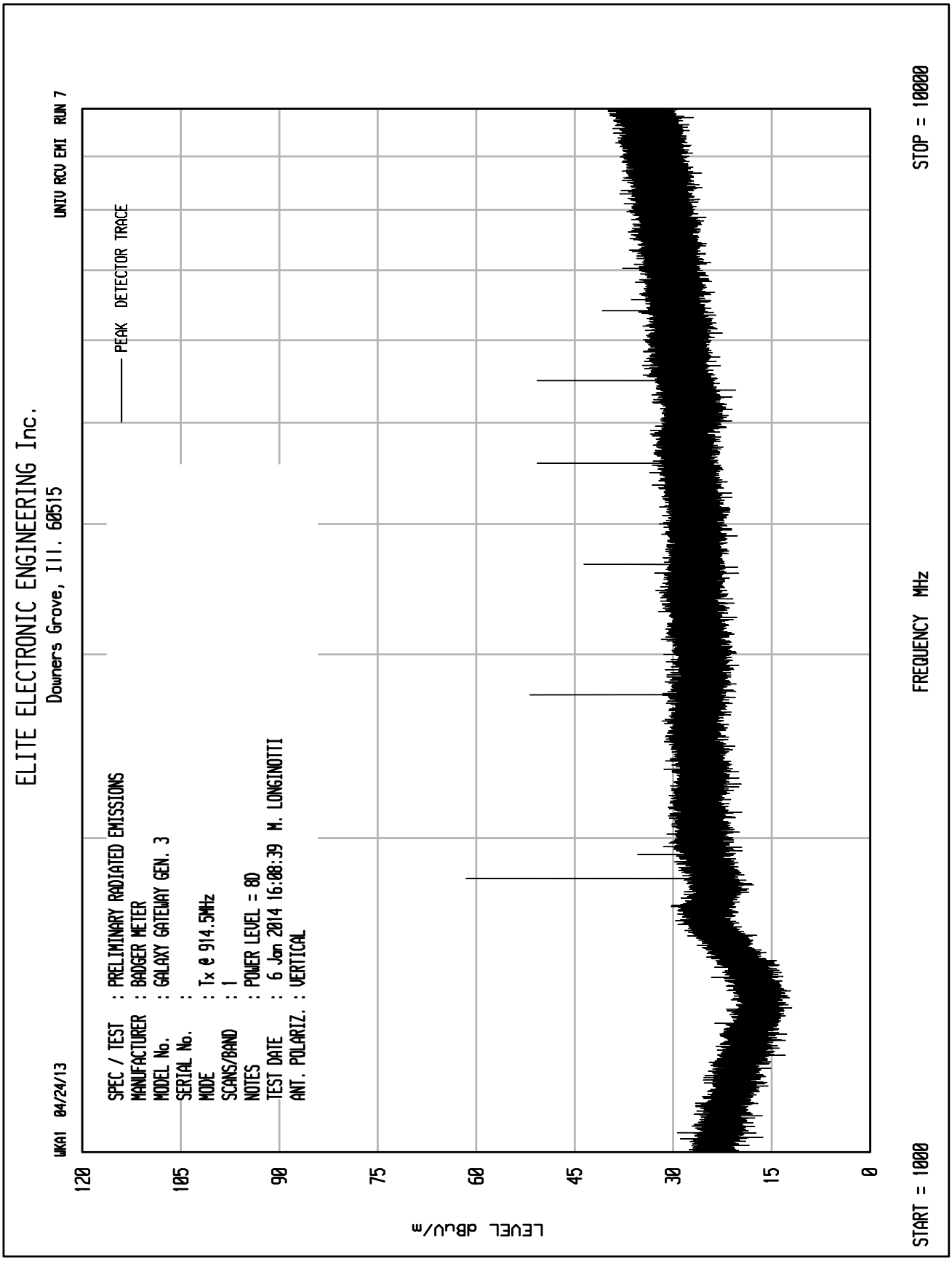

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 5
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : GALAXY GATEWAY GEN. 3
SERIAL No. : :
MODE : Tx @ 904.9MHz
SCANS/BAND : 1
NOTES : POWER LEVEL = 80
TEST DATE : 6 Jan 2014 15:06:46 M. LONGINOTTI
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 10000

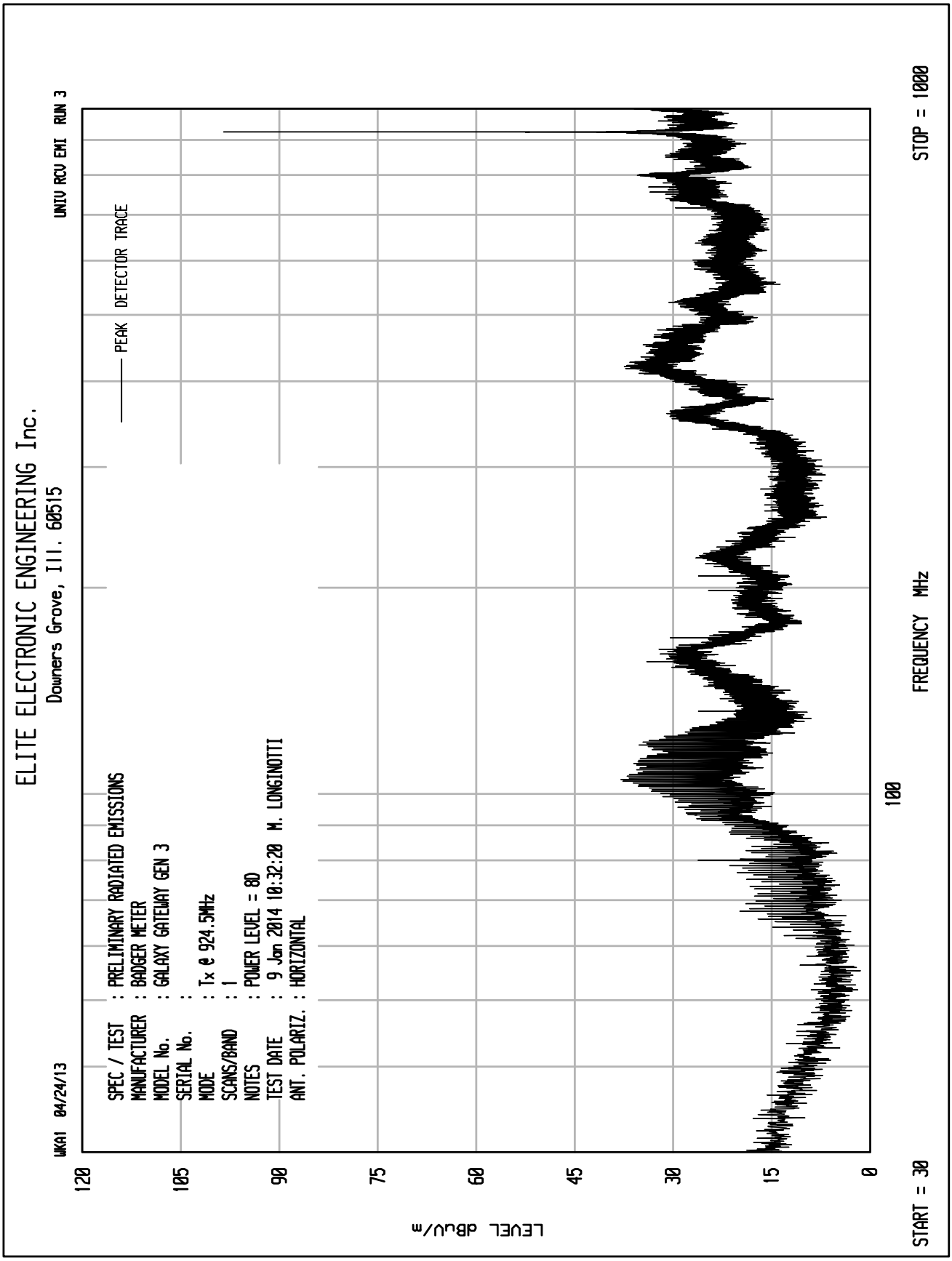

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 3
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : GALAXY GATEWAY GEN. 3
SERIAL No. :
MODE : Tx @ 904.9MHz
SCANS/BAND : 1
NOTES : POWER LEVEL = 80
TEST DATE : 6 Jan 2014 14:47:59 M. LONGINOTTI
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 10000

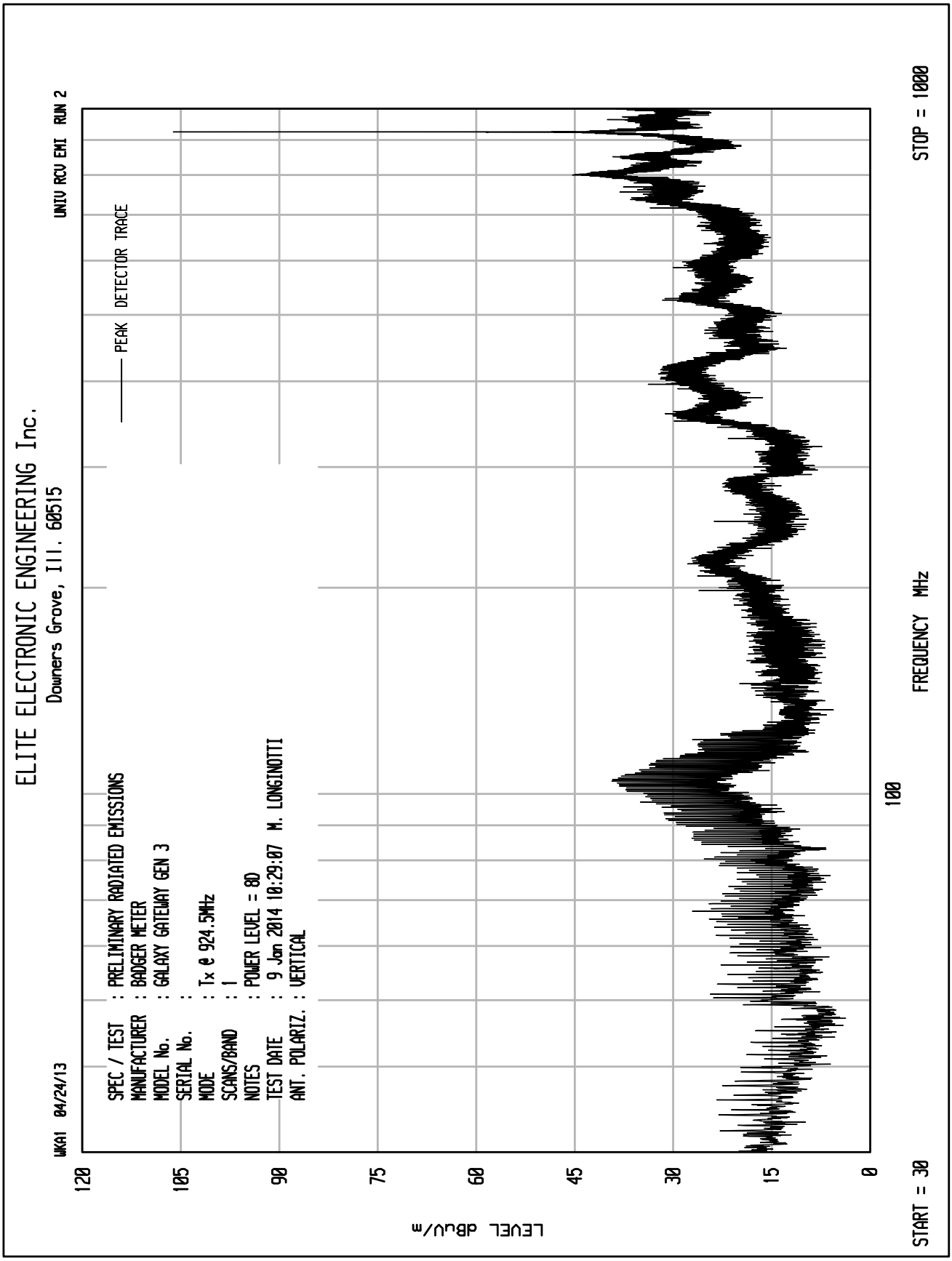

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 3
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : GALAXY GATEWAY GEN 3
SERIAL No. :
MODE : Tx @ 914.5MHz
SCANS/BAND : 1
NOTES : POWER LEVER = 80
TEST DATE : 7 Jan 2014 08:56:26 M. LONGINOTTI
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 30
100
STOP = 1000
FREQUENCY MHz

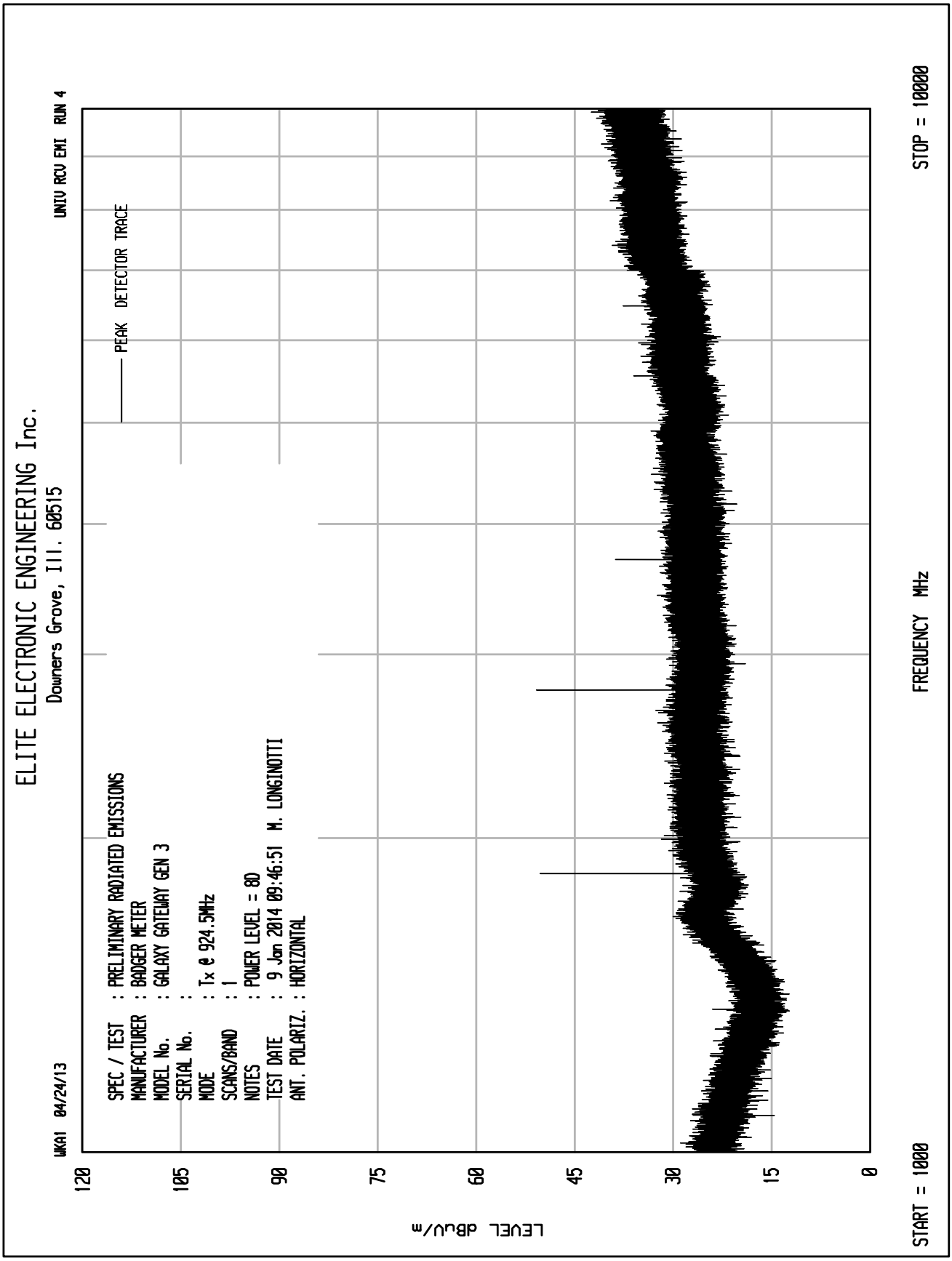

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 4
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : GALAXY GATEWAY GEN 3
SERIAL No. :
MODE : Tx @ 914.5MHz
SCANS/BAND : 1
NOTES : POWER LEVER = 80
TEST DATE : 7 Jan 2014 08:57:48 M. LONGINOTTI
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

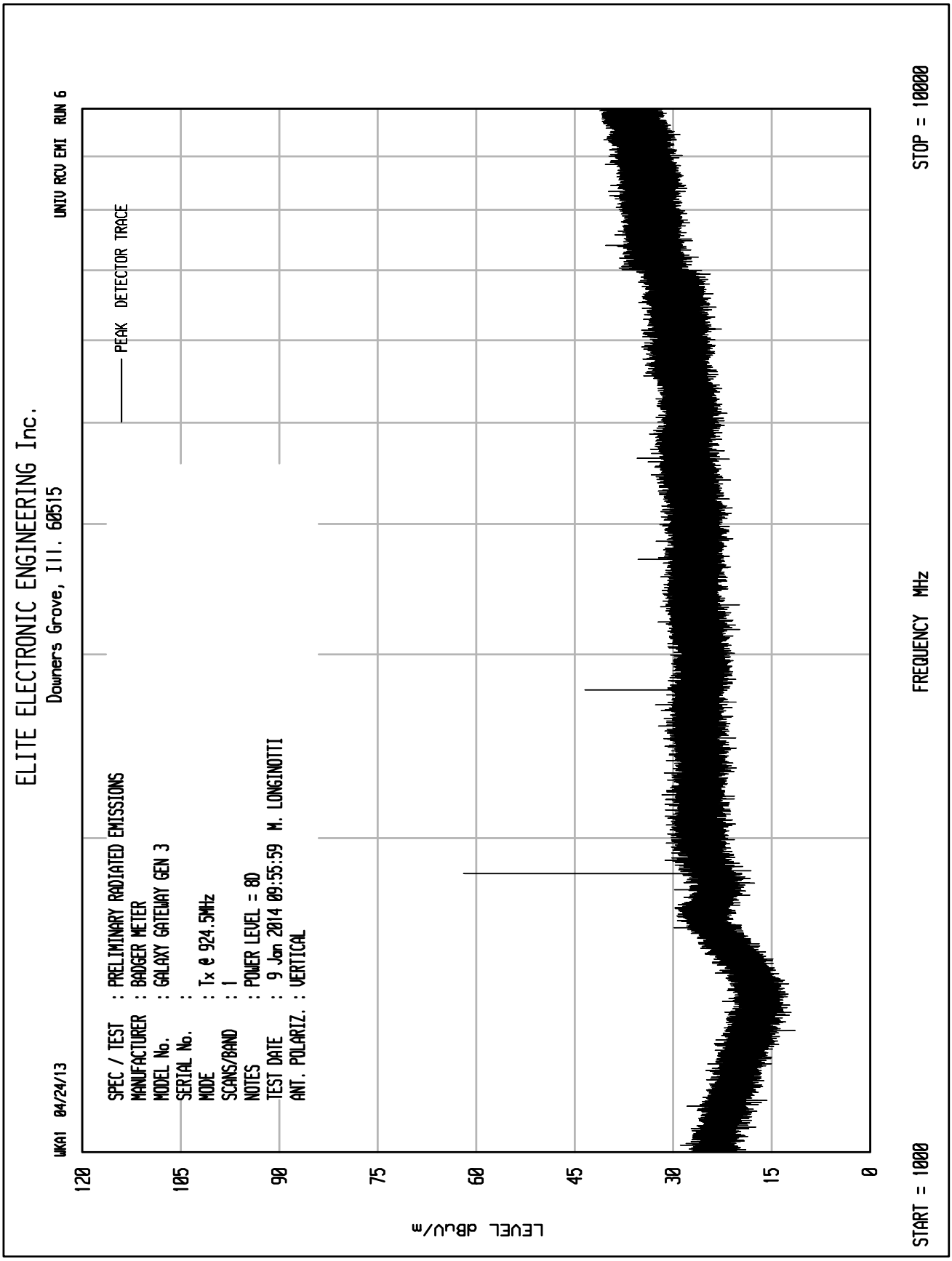

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 6
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : GALAXY GATEWAY GEN. 3
SERIAL No. :
MODE : Tx @ 914.5MHz
SCANS/BAND : 1
NOTES : POWER LEVEL = 80
TEST DATE : 6 Jan 2014 16:03:13 M. LONGINOTTI
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 7
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : GALAXY GATEWAY GEN. 3
SERIAL No. : :
MODE : Tx @ 914.5MHz
SCANS/BAND : 1
NOTES : POWER LEVEL = 80
TEST DATE : 6 Jan 2014 16:08:39 M. LONGINOTTI
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 3
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : GALAXY GATEWAY GEN 3
SERIAL No. :
MODE : Tx @ 924.5MHz
SCANS/BAND : 1
NOTES : POWER LEVEL = 80
TEST DATE : 9 Jan 2014 10:32:20 M. LONGINOTTI
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 30
100
STOP = 1000
FREQUENCY MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 2
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : GALAXY GATEWAY GEN 3
SERIAL No. :
MODE : Tx @ 924.5MHz
SCANS/BAND : 1
NOTES : POWER LEVEL = 80
TEST DATE : 9 Jan 2014 10:29:07 M. LONGINOTTI
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 4
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : GALAXY GATEWAY GEN 3
SERIAL No. : :
MODE : Tx @ 924.5MHz
SCANS/BAND : 1
NOTES : POWER LEVEL = 80
TEST DATE : 9 Jan 2014 09:46:51 M. LONGINOTTI
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 6
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : GALAXY GATEWAY GEN 3
SERIAL No. : :
MODE : Tx @ 924.5MHz
SCANS/BAND : 1
NOTES : POWER LEVEL = 80
TEST DATE : 9 Jan 2014 09:55:59 M. LONGINOTTI
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 10000

DATA PAGE

MANUFACTURER	Badger Meter
TEST ITEM	Transceiver
MODEL NO.	Galaxy Gateway Gen 3
SERIAL NO.	Sample #3
SPECIFICATION	FCC 15.247 and RSS-210
TEST	Spurious Radiated Emissions
TEST EQUIPMENT	NTA2, NWQ2, APW3, XPQ2, RBB0, CMA1, CDY0
MODE	Transmit at 904.9MHz, Power Level = 8D
DATE TESTED	January 6, 2014 through January 9, 2014
NOTES	Quasi-Peak Readings in restricted bands

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	QP Total dBuV/m at 3m	QP Total uV/m at 3 m	QP Limit uV/m at 3 m	Margin (dB)
108.08	H	21.9		0.7	12.0	0.0	34.6	53.8	150.0	-8.9
108.08	V	25.6		0.7	12.0	0.0	38.3	82.4	150.0	-5.2

Checked By: MARK E. LONGINOTTI

DATA PAGE

MANUFACTURER	Badger Meter
TEST ITEM	Transceiver
MODEL NO.	Galaxy Gateway Gen 3
SERIAL NO.	Sample #3
SPECIFICATION	FCC 15.247 and RSS-210
TEST	Spurious Radiated Emissions
TEST EQUIPMENT	NTA2, NWQ2, APW3, XPQ2, RBB0, CMA1, CDY0
MODE	Transmit at 904.9MHz, Power Level = 8D
DATE TESTED	January 6, 2014 through January 9, 2014
NOTES	Peak Readings in restricted bands

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dBuV/m at 3m	Peak Total uV/m at 3 m	Peak Limit uV/m at 3 m	Margin (dB)
2714.70	H	60.5		3.7	32.7	-40.3	56.6	675.0	5000.0	-17.4
2714.70	V	64.7		3.7	32.7	-40.3	60.8	1094.8	5000.0	-13.2
3619.60	H	55.5		4.3	33.3	-40.1	52.9	441.8	5000.0	-21.1
3619.60	V	53.4		4.3	33.3	-40.1	50.8	346.9	5000.0	-23.2
4524.50	H	59.2		4.7	33.6	-40.0	57.6	755.5	5000.0	-16.4
4524.50	V	56.7		4.7	33.6	-40.0	55.1	566.6	5000.0	-18.9
5429.40	H	51.5		5.2	34.6	-40.1	51.2	361.0	5000.0	-22.8
5429.40	V	55.2		5.2	34.6	-40.1	54.9	552.8	5000.0	-19.1
8144.10	H	48.5	Ambient	6.5	35.7	-39.6	51.2	361.3	5000.0	-22.8
8144.10	V	48.1	Ambient	6.5	35.7	-39.6	50.8	345.0	5000.0	-23.2
9049.00	H	48.7	Ambient	6.5	36.1	-39.1	52.3	412.0	5000.0	-21.7
9049.00	V	48.9	Ambient	6.5	36.1	-39.1	52.5	421.6	5000.0	-21.5

Checked By: MARK E. LONGINOTTI

DATA PAGE

MANUFACTURER	Badger Meter
TEST ITEM	Transceiver
MODEL NO.	Galaxy Gateway Gen 3
SERIAL NO.	Sample #3
SPECIFICATION	FCC 15.247 and RSS-210
TEST	Spurious Radiated Emissions
TEST EQUIPMENT	NTA2, NWQ2, APW3, XPQ2, RBB0, CMA1, CDY0
MODE	Transmit at 904.9MHz, Power Level = 8D
DATE TESTED	January 6, 2014 through January 9, 2014
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)	Average Total dBuV/m at 3m	Average Total uV/m at 3 m	Average Limit uV/m at 3 m	Margin (dB)
2714.70	H	57.90		3.7	32.7	-40.3	-8.2	45.8	195.6	500.0	-8.2
2714.70	V	63.0		3.7	32.7	-40.3	-8.2	50.9	351.8	500.0	-3.1
3619.60	H	50.7		4.3	33.3	-40.1	-8.2	39.9	99.4	500.0	-14.0
3619.60	V	47.5		4.3	33.3	-40.1	-8.2	36.7	68.7	500.0	-17.2
4524.50	H	56.6		4.7	33.6	-40.0	-8.2	46.8	218.9	500.0	-7.2
4524.50	V	53.3		4.7	33.6	-40.0	-8.2	43.5	149.7	500.0	-10.5
5429.40	H	45.2		5.2	34.6	-40.1	-8.2	36.7	68.3	500.0	-17.3
5429.40	V	51.4		5.2	34.6	-40.1	-8.2	42.9	139.5	500.0	-11.1
8144.10	H	36.0	Ambient	6.5	35.7	-39.6	-8.2	30.5	33.5	500.0	-23.5
8144.10	V	35.0	Ambient	6.5	35.7	-39.6	-8.2	29.5	29.8	500.0	-24.5
9049.00	H	35.2	Ambient	6.5	36.1	-39.1	-8.2	30.6	34.0	500.0	-23.3
9049.00	V	35.4	Ambient	6.5	36.1	-39.1	-8.2	30.8	34.8	500.0	-23.1

Checked By: MARK E. LONGINOTTI

DATA PAGE

MANUFACTURER	Badger Meter
TEST ITEM	Transceiver
MODEL NO.	Galaxy Gateway Gen 3
SERIAL NO.	Sample #3
SPECIFICATION	FCC 15.247 and RSS-210
TEST	Spurious Radiated Emissions
TEST EQUIPMENT	NTA2, NWQ2, APW3, XPQ2, RBB0, CMA1, CDY0
MODE	Transmit at 914.5MHz, Power Level = 8D
DATE TESTED	January 6, 2014 through January 9, 2014
NOTES	Quasi-Peak Readings in restricted bands

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	QP Total dBuV/m at 3m	QP Total uV/m at 3 m	QP Limit uV/m at 3 m	Margin (dB)
108.01	H	20.4		0.7	12.0	0.0	33.1	45.2	150.0	-10.4
108.08	V	24.9		0.7	12.0	0.0	37.6	76.0	150.0	-5.9

Checked By: MARK E. LONGINOTTI

DATA PAGE

MANUFACTURER	Badger Meter
TEST ITEM	Transceiver
MODEL NO.	Galaxy Gateway Gen 3
SERIAL NO.	Sample #3
SPECIFICATION	FCC 15.247 and RSS-210
TEST	Spurious Radiated Emissions
TEST EQUIPMENT	NTA2, NWQ2, APW3, XPQ2, RBB0, CMA1, CDY0
MODE	Transmit at 914.5MHz, Power Level = 8D
DATE TESTED	January 6, 2014 through January 9, 2014
NOTES	Peak Readings in restricted bands

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dBuV/m at 3m	Peak Total uV/m at 3 m	Peak Limit uV/m at 3 m	Margin (dB)
2743.50	H	62.3		3.7	32.7	-40.3	58.4	830.2	5000.0	-15.6
2743.50	V	63.3		3.7	32.7	-40.3	59.4	931.5	5000.0	-14.6
3658.00	H	54.1		4.3	33.3	-40.1	51.6	378.7	5000.0	-22.4
3658.00	V	54.3		4.3	33.3	-40.1	51.8	387.5	5000.0	-22.2
4572.50	H	54.8		4.7	33.8	-40.0	53.4	466.8	5000.0	-20.6
4572.50	V	56.0		4.7	33.8	-40.0	54.6	536.0	5000.0	-19.4
7316.00	H	48.6	Ambient	6.2	35.4	-39.8	50.4	332.0	5000.0	-23.6
7316.00	V	49.2	Ambient	6.2	35.4	-39.8	51.0	355.8	5000.0	-23.0
8230.50	H	49.1	Ambient	6.5	35.8	-39.5	51.8	390.7	5000.0	-22.1
8230.50	V	48.9	Ambient	6.5	35.8	-39.5	51.6	381.8	5000.0	-22.3
9145.00	H	48.7	Ambient	6.6	36.2	-39.0	52.4	418.4	5000.0	-21.5
9145.00	V	48.7	Ambient	6.6	36.2	-39.0	52.4	418.4	5000.0	-21.5

Checked By: MARK E. LONGINOTTI

DATA PAGE

MANUFACTURER	Badger Meter
TEST ITEM	Transceiver
MODEL NO.	Galaxy Gateway Gen 3
SERIAL NO.	Sample #3
SPECIFICATION	FCC 15.247 and RSS-210
TEST	Spurious Radiated Emissions
TEST EQUIPMENT	NTA2, NWQ2, APW3, XPQ2, RBB0, CMA1, CDY0
MODE	Transmit at 914.5MHz, Power Level = 8D
DATE TESTED	January 6, 2014 through January 9, 2014
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)	Average Total dBuV/m at 3m	Average Total uV/m at 3 m	Average Limit uV/m at 3 m	Margin (dB)
2743.50	H	60.30		3.7	32.7	-40.3	-8.2	48.2	257.7	500.0	-5.8
2743.50	V	61.4		3.7	32.7	-40.3	-8.2	49.3	292.5	500.0	-4.7
3658.00	H	49.1		4.3	33.3	-40.1	-8.2	38.4	83.2	500.0	-15.6
3658.00	V	49.0		4.3	33.3	-40.1	-8.2	38.3	82.3	500.0	-15.7
4572.50	H	49.7		4.7	33.8	-40.0	-8.2	40.1	101.4	500.0	-13.9
4572.50	V	51.2		4.7	33.8	-40.0	-8.2	41.6	120.5	500.0	-12.4
7316.00	H	35.3	Ambient	6.2	35.4	-39.8	-8.2	29.0	28.1	500.0	-25.0
7316.00	V	36.9	Ambient	6.2	35.4	-39.8	-8.2	30.6	33.7	500.0	-23.4
8230.50	H	36.3	Ambient	6.5	35.8	-39.5	-8.2	30.9	35.0	500.0	-23.1
8230.50	V	35.1	Ambient	6.5	35.8	-39.5	-8.2	29.7	30.5	500.0	-24.3
9145.00	H	35.0	Ambient	6.6	36.2	-39.0	-8.2	30.6	33.8	500.0	-23.4
9145.00	V	35.1	Ambient	6.6	36.2	-39.0	-8.2	30.7	34.2	500.0	-23.3

Checked By: MARK E. LONGINOTTI

DATA PAGE

MANUFACTURER	Badger Meter
TEST ITEM	Transceiver
MODEL NO.	Galaxy Gateway Gen 3
SERIAL NO.	Sample #4
SPECIFICATION	FCC 15.247 and RSS-210
TEST	Spurious Radiated Emissions
TEST EQUIPMENT	NTA2, NWQ2, APW3, XPQ2, RBB0, CMA1, CDY0
MODE	Transmit at 924.5MHz, Power Level = 8D
DATE TESTED	January 6, 2014 through January 9, 2014
NOTES	Quasi-Peak Readings in restricted bands

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	QP Total dBuV/m at 3m	QP Total uV/m at 3 m	QP Limit uV/m at 3 m	Margin (dB)
108.11	H	21.3		0.7	12.0	0.0	34.0	50.2	150.0	-9.5
108.11	V	22.9		0.7	12.0	0.0	35.6	60.4	150.0	-7.9

Checked By: MARK E. LONGINOTTI

DATA PAGE

MANUFACTURER	Badger Meter
TEST ITEM	Transceiver
MODEL NO.	Galaxy Gateway Gen 3
SERIAL NO.	Sample #4
SPECIFICATION	FCC 15.247 and RSS-210
TEST	Spurious Radiated Emissions
TEST EQUIPMENT	NTA2, NWQ2, APW3, XPQ2, RBB0, CMA1, CDY0
MODE	Transmit at 924.5MHz, Power Level = 8D
DATE TESTED	January 6, 2014 through January 9, 2014
NOTES	Peak Readings in restricted bands

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dBuV/m at 3m	Peak Total uV/m at 3 m	Peak Limit uV/m at 3 m	Margin (dB)
2773.50	H	58.0		3.7	32.7	-40.3	54.1	505.8	5000.0	-19.9
2773.50	V	61.8		3.7	32.7	-40.3	57.9	783.5	5000.0	-16.1
3698.00	H	58.4		4.3	33.3	-40.1	55.9	625.7	5000.0	-18.1
3698.00	V	56.2		4.3	33.3	-40.1	53.7	485.7	5000.0	-20.3
4622.50	H	53.9		4.8	34.0	-40.0	52.7	431.0	5000.0	-21.3
4622.50	V	55.1		4.8	34.0	-40.0	53.9	494.8	5000.0	-20.1
7396.00	H	48.3	Ambient	6.2	35.4	-39.7	50.2	323.7	5000.0	-23.8
7396.00	V	49.9	Ambient	6.2	35.4	-39.7	51.8	389.2	5000.0	-22.2
8320.50	H	48.9	Ambient	6.5	35.8	-39.5	51.7	384.8	5000.0	-22.3
8320.50	V	49.6	Ambient	6.5	35.8	-39.5	52.4	417.1	5000.0	-21.6
9245.00	H		Ambient	6.6	36.2	-39.0	3.9	1.6	17486.6	-81.0
9245.00	V		Ambient	6.6	36.2	-39.0	3.9	1.6	17486.6	-81.0

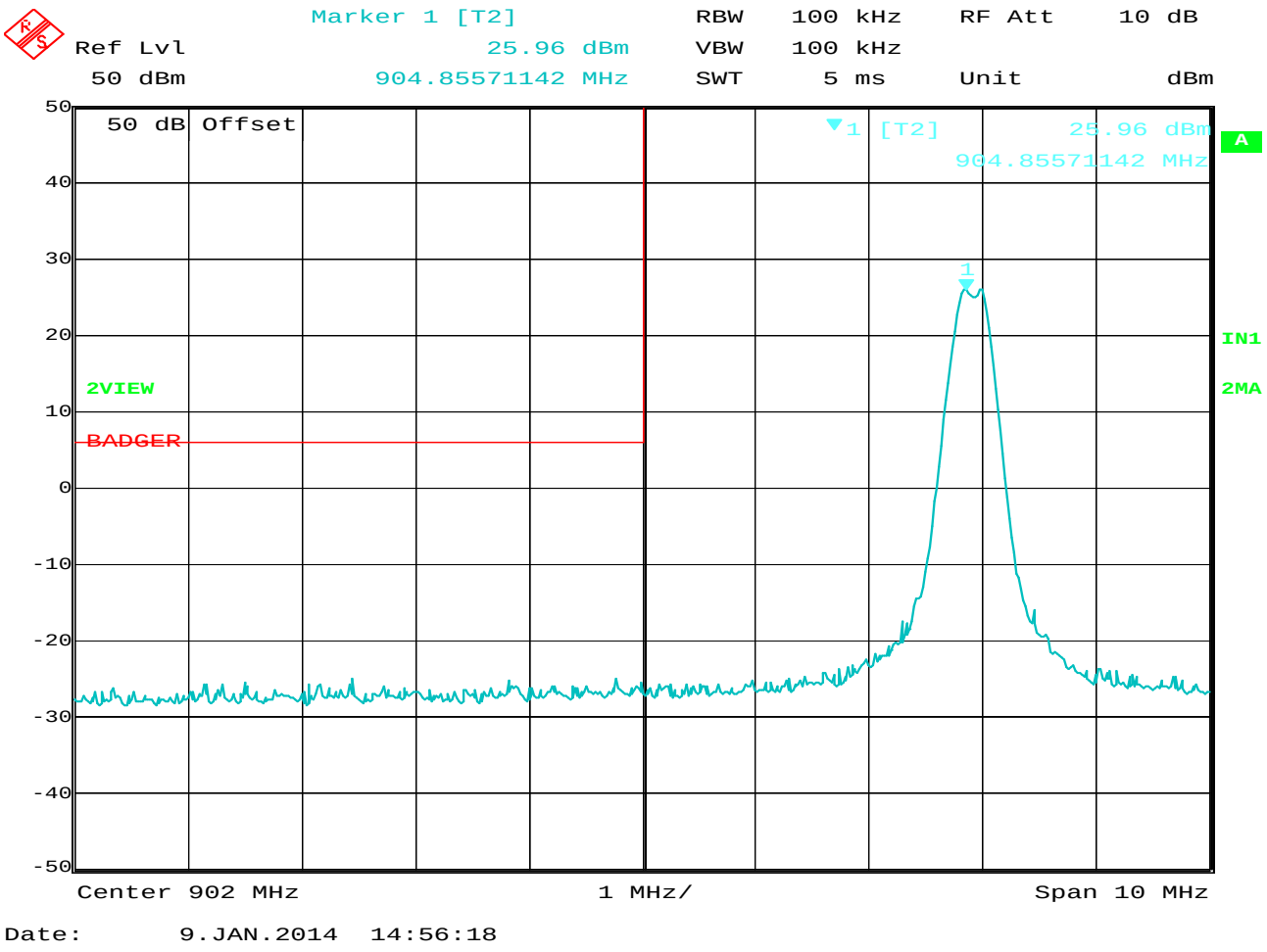
Checked By: MARK E. LONGINOTTI

DATA PAGE

MANUFACTURER	Badger Meter
TEST ITEM	Transceiver
MODEL NO.	Galaxy Gateway Gen 3
SERIAL NO.	Sample #4
SPECIFICATION	FCC 15.247 and RSS-210
TEST	Spurious Radiated Emissions
TEST EQUIPMENT	NTA2, NWQ2, APW3, XPQ2, RBB0, CMA1, CDY0
MODE	Transmit at 924.5MHz, Power Level = 8D
DATE TESTED	January 6, 2014 through January 9, 2014
NOTES	Average Readings in restricted bands

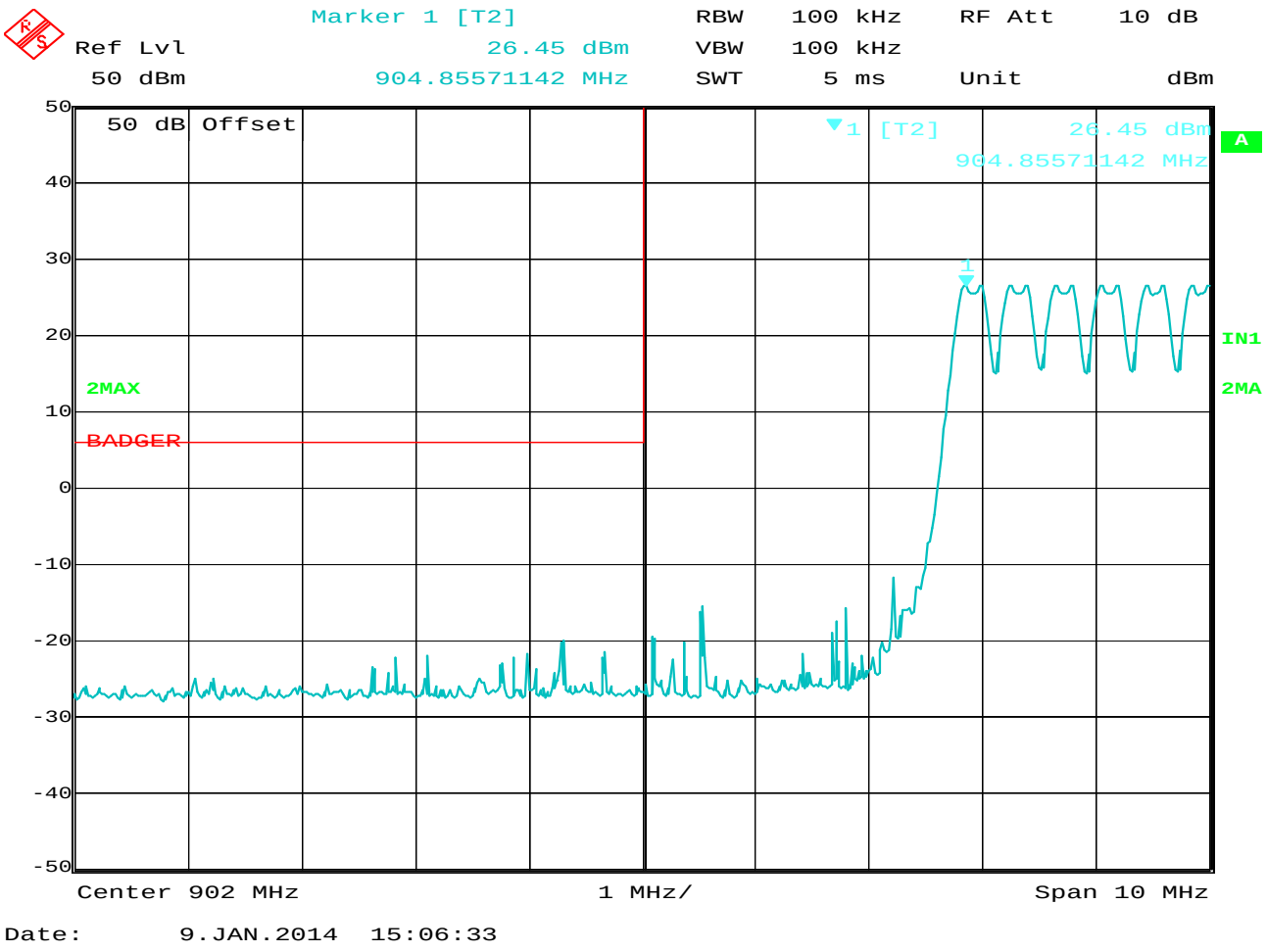
Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Average Total dBuV/m at 3m	Average Total uV/m at 3 m	Average Limit uV/m at 3 m	Margin (dB)
2773.50	H	52.30		3.7	32.7	-40.3	-8.2	40.2	102.6	500.0	-13.8
2773.50	V	56.3		3.7	32.7	-40.3	-8.2	44.2	162.6	500.0	-9.8
3698.00	H	55.4		4.3	33.3	-40.1	-8.2	44.8	173.1	500.0	-9.2
3698.00	V	52.0		4.3	33.3	-40.1	-8.2	41.4	117.0	500.0	-12.6
4622.50	H	48.7		4.8	34.0	-40.0	-8.2	39.3	92.6	500.0	-14.7
4622.50	V	49.8		4.8	34.0	-40.0	-8.2	40.4	105.1	500.0	-13.6
7396.00	H	36.2	Ambient	6.2	35.4	-39.7	-8.2	29.9	31.4	500.0	-24.0
7396.00	V	35.8	Ambient	6.2	35.4	-39.7	-8.2	29.5	30.0	500.0	-24.4
8320.50	H	36.6	Ambient	6.5	35.8	-39.5	-8.2	31.2	36.5	500.0	-22.7
8320.50	V	38.3	Ambient	6.5	35.8	-39.5	-8.2	32.9	44.4	500.0	-21.0

Checked By: MARK E. LONGINOTTI



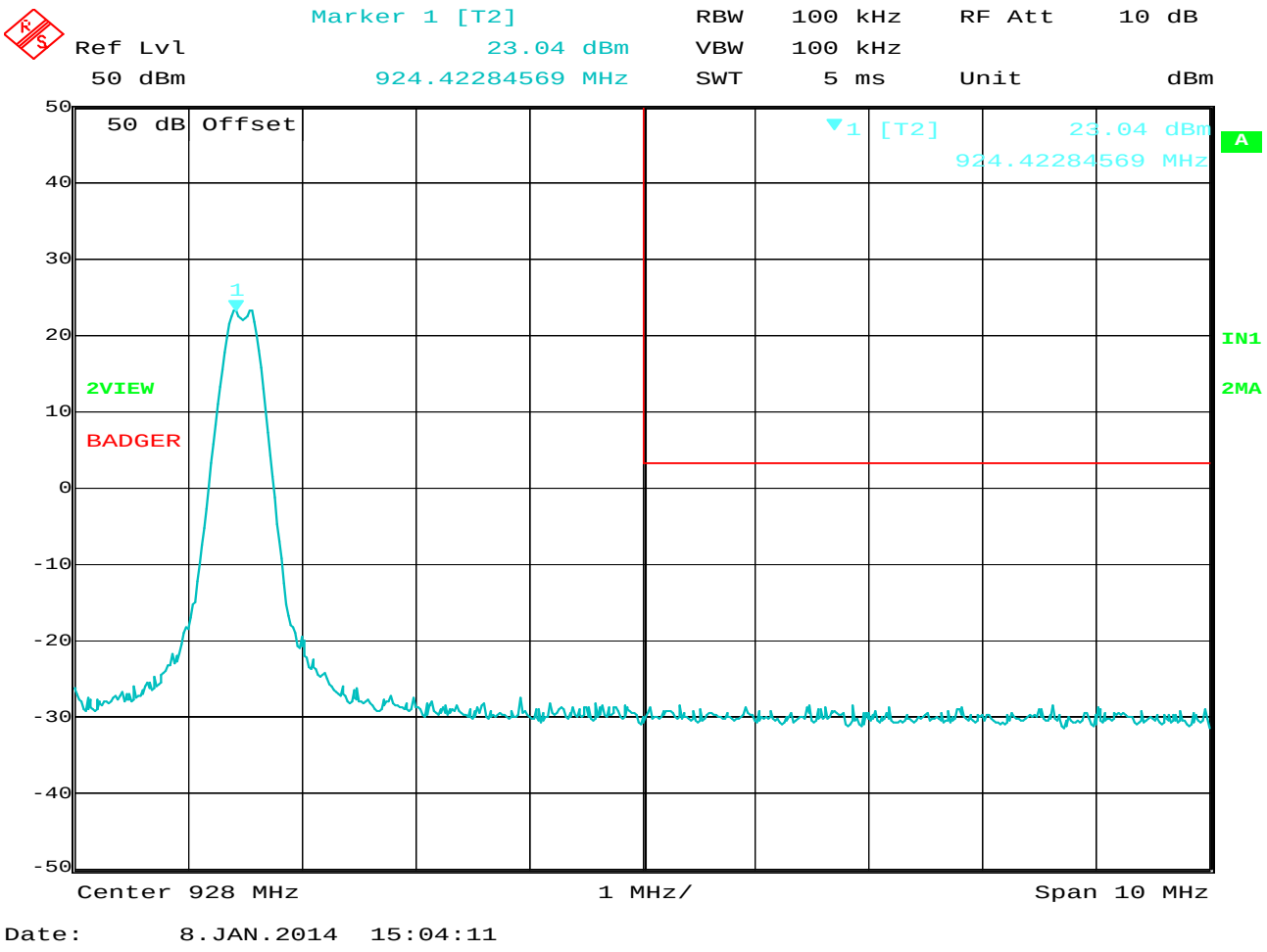
Band-Edge Compliance

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Galaxy Gateway Gen 3
SERIAL NUMBER	:	Sample #4
TEST MODE	:	Tx @ Ch. 1 (904.9MHz)
NOTES	:	Output Power = 8D, Ant 1 port
TEST DATE	:	January 9, 2014
TEST PARAMETERS	:	Band-Edge Compliance
NOTES	:	The emissions at the band-edges must be at least 20dB below the highest level measured within the band.
EQUIPMENT USED	:	RBB0, T1EQ, T2DP, T2DM



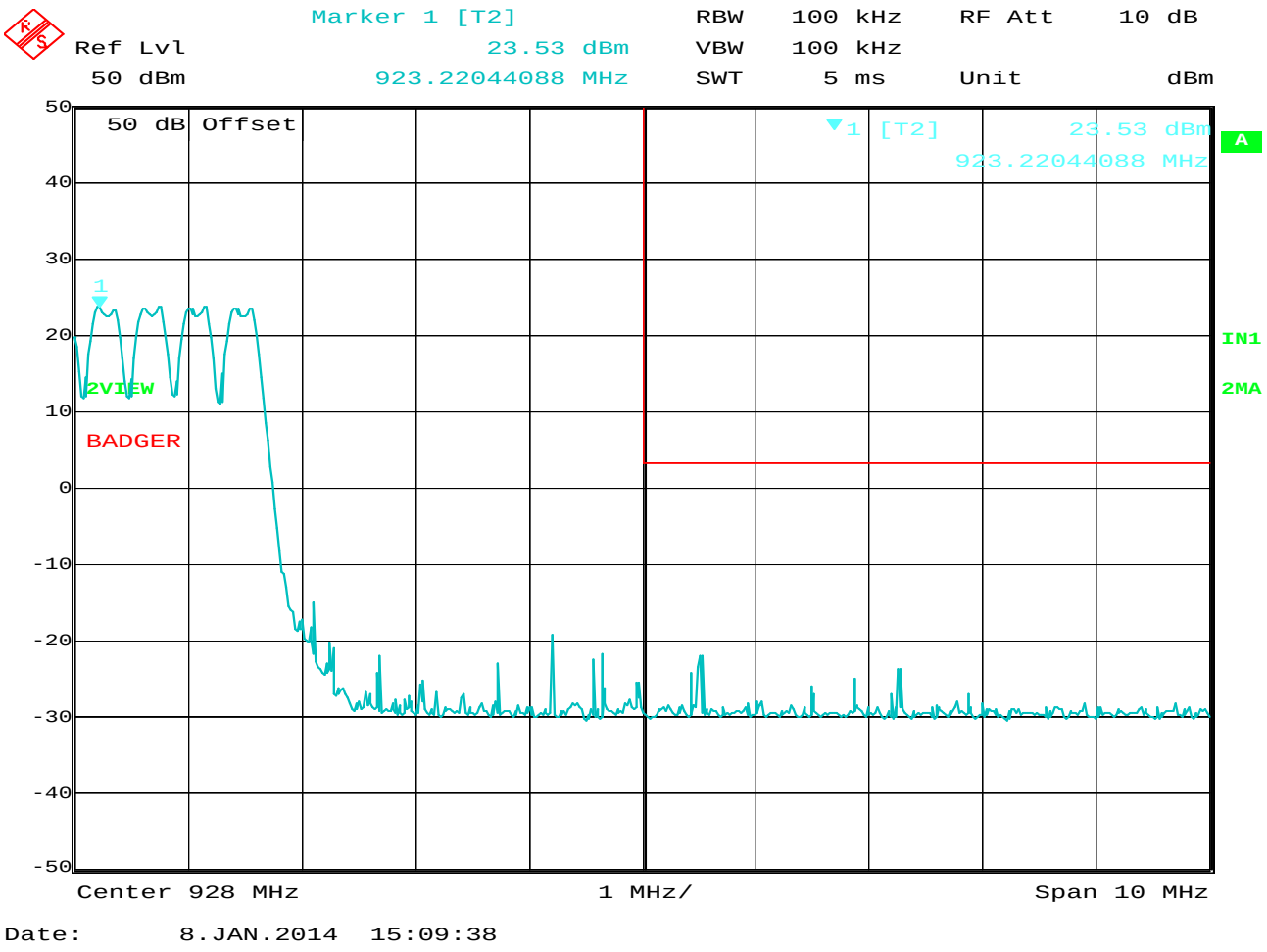
Band-Edge Compliance

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Galaxy Gateway Gen 3
SERIAL NUMBER	:	Sample #4
TEST MODE	:	Hopping Enabled
NOTES	:	Output Power = 8D, Ant 1 port
TEST DATE	:	January 9, 2014
TEST PARAMETERS	:	Band-Edge Compliance
NOTES	:	The emissions at the band-edges must be at least 20dB below the highest level measured within the band.
EQUIPMENT USED	:	RBB0, T1EQ, T2DP, T2DM



Band-Edge Compliance

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Galaxy Gateway Gen 3
SERIAL NUMBER	:	Sample #4
TEST MODE	:	Tx @ Ch. 50 (924.5MHz)
NOTES	:	Output Power = 8D, Ant 1 port
TEST DATE	:	January 8, 2014
TEST PARAMETERS	:	Band-Edge Compliance
NOTES	:	The emissions at the band-edges must be at least 20dB below the highest level measured within the band.
EQUIPMENT USED	:	RBB0, T1EQ, T2DP, T2DM



Band-Edge Compliance

MANUFACTURER	:	Badger Meter
MODEL NUMBER	:	Galaxy Gateway Gen 3
SERIAL NUMBER	:	Sample #4
TEST MODE	:	Hopping enabled
NOTES	:	Output Power = 8D, Ant 1 port
TEST DATE	:	January 8, 2014
TEST PARAMETERS	:	Band-Edge Compliance
NOTES	:	The emissions at the band-edges must be at least 20dB below the highest level measured within the band.
EQUIPMENT USED	:	RBB0, T1EQ, T2DP, T2DM