Measurement of RF Interference from an OCE Water Meter Transmitter

For	Badger Meter, Incorporated 4545 W. Brown Deer Road Milwaukee, WI 53223
P.O. Number	324439
Date Tested	March 31 through April 6, 2017
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, Industry Canada RSS-247 Industry Canada RSS-GEN

Test Report By:

Richard E. King

Richard King
EMC Engineer

Requested By:

Randy Schultz
Badger Meter, Incorporated

Approved By:

Raymond J. Klouda

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

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REVISION HISTORY

Revision	Date	Description
—	04/06/2017	Initial release

Measurement of RF Emissions from a Water Meter, Part No. OCE Transmitter

1. INTRODUCTION

1.1 Scope of Tests

This document represents the results of the series of radio interference measurements performed on a Badger Meter, Incorporated Water Meter, Part No. OCE, Serial No. 110000261, transmitter (hereinafter referred to as the EUT). The EUT is a frequency hopping spread spectrum transmitter. The transmitter was designed to transmit in the 902-928 MHz band using an integral antenna. The EUT was manufactured and submitted for testing by Badger Meter, Incorporated located in Milwaukee, WI.

1.2 Purpose

The test series was performed to determine if the EUT meets the conducted RF emission requirements, radiated RF emissions requirements, and additional provisions of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.207 and 15.247 for Intentional Radiators Operating within the 902-928 MHz band.

The test series was also performed to determine if the EUT meets the conducted RF emission requirements, radiated RF emissions requirements, and additional provisions of the Industry Canada Radio Standards Specification RSS-Gen Section 8.8 and Industry Canada Radio Standards Specification RSS-247 for Transmitters.

Testing was performed in accordance with ANSI C63.4-2014.

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 Lab Code: 1786-01.

1.5 Laboratory Conditions

The temperature at the time of the test was 22°C and the relative humidity was 33%.

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 2016
- ANSI C63.4-2014, "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”
- ANSI C63.10-2013, "American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices”
- FCC Public Notice, DA 00-705, "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems", Released March 30, 2000
- Industry Canada RSS-247, Issue 2, February 2017, “Spectrum Management and Telecommunications Radio Standards Specification, Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs), and License-Exempt Local Area Network (LE-LAN) Devices”

- Industry Canada RSS-GEN, Issue 4, November 2014, “Spectrum Management and Telecommunications Radio Standards Specification, General Requirements for Compliance of Radio Apparatus”

3. EUT SETUP AND OPERATION

3.1 General Description

The EUT is a Water Meter, Part No. OCE. A block diagram of the EUT setup is shown as Figure 1 and Figure 2.

3.1.1 Power Input

The EUT was powered by 3VDC from internal batteries.

3.1.2 Peripheral Equipment

No peripheral equipment was submitted with the EUT.

3.1.3 Interconnect Cables

No interconnect cables were submitted with the EUT.

3.1.4 Grounding

The EUT was ungrounded during the tests.

3.2 Software

For all tests the EUT had Firmware Version 1.0.379 loaded onto the device to provide correct load characteristics.

3.3 Operational Mode

The EUT was energized. The unit was programmed to operate in one of the following modes:

- Transmit at 904.89MHz
- Transmit at 914.1MHHz
- Transmit at 923.7MHHz
- 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 C63.4-2014 for site attenuation.

4.2 Test Instrumentation

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

Conducted and radiated emission tests were performed with an EMI receiver utilizes the bandwidths and detectors specified by the FCC.

4.3 Calibration Traceability

Test equipment is maintained and calibrated on a regular basis with a calibration interval not greater than two years. 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 Transmitter

5.1.1 Powerline Conducted Emissions

5.1.1.1 Requirements

Since the EUT is powered by internal batteries and has no connections for AC power, no conducted emissions are required.

5.1.2 20dB Bandwidth

5.1.2.1 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.

5.1.2.2 Procedures

The EUT was set up inside the chamber. 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.

5.1.2.3 Results

The plots on pages 18 through 20 show that the maximum 20 dB bandwidth was 301.2kHz. 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.

5.1.3 Carrier Frequency Separation

5.1.3.1 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.

5.1.3.2 Procedures

The EUT was set up inside the chamber. 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.

5.1.3.3 Results

Page 21 shows the carrier frequency separation. As can be seen from this plot, the carrier frequency separation is 401.6kHz, which is greater than the 20dB bandwidth (301.2kHz).

5.1.4 Number of Hopping Frequencies

5.1.4.1 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.

5.1.4.2 Procedures

The EUT was set up inside the chamber. With the hopping function enabled, the EUT was allowed to transmit continuously.

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

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

5.1.4.3 Results

Page 22 shows the number of hopping frequencies. As can be seen from this plot, the number of hopping frequencies is 48 which is greater than 25 which is the minimum number of required hopping frequencies for systems with a 20dB bandwidth greater than 250kHz.

5.1.5 Time of Occupancy

5.1.5.1 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.

5.1.5.2 Procedures

The EUT was set up inside the chamber. 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.

5.1.5.3 Results

Pages 23 and 24 show the plots for the time of occupancy (dwell time). As can be seen from the plots, the time of occupancy can be determined by 4.04mS multiplied by 7 hops. This calculated value is equal to .028 seconds which is less than the 0.4 seconds maximum allowed.

5.1.6 Peak Output Power

5.1.6.1 Requirements

Per section 15.247(b)(2), for frequency hopping systems operating in the 902-928MHz band and employing less than 50 hopping channels, but at least 25 hopping channels, the maximum peak output conducted power shall not be greater than 0.25W (24dBm). Per section 15.247(b)(4), this limit is based on the use of antennas with directional gains that do not exceed 6dBi. Since the limit allows for a 6dBi antenna gain, the maximum EIRP can be increased by 6dB to 1 Watt (30dBm). If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below 24dBm by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.1.6.2 Procedures

The EUT was placed on the non-conductive stand and set to transmit. A bilog 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 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.

5.1.6.3 Results

The results are presented on page 25. The maximum EIRP measured from the transmitter was 10.5 dBm or 0.011 Watts which is below the 1 Watt limit.

5.1.7 Duty Cycle Factor Measurements

5.1.7.1 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 500usec/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).

5.1.7.2 Results

The plots of the duty cycle are shown on data pages 26 and 27. The duty cycle was calculated to as DC = 20*LOG ((4.04mS*6)/100mS) = -12.3 dB.

5.1.8 Radiated Spurious Emissions Measurements

5.1.8.1 Requirements

Per section 15.247(d), in any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated emissions measurement. Attenuation below the general limits specified in §15.209(a) is not required. In addition, 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).

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

5.1.8.2 Procedures

Radiated measurements were performed in a 32ft. x 20ft. x 14ft. high shielded enclosure. The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads.

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

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

1) For all harmonics not in the restricted bands, the following procedure was used:
   a) The field strength of the fundamental was measured using a bilog antenna. The bilog antenna was positioned at a 3 meter distance from the EUT. The EUT was placed on an 80 meter non-conductive stand. A peak detector with a resolution bandwidth of 100 kHz was used on the spectrum analyzer.
   b) The field strengths of all of the harmonics not in the restricted band were then measured using a double-ridged waveguide antenna. The waveguide antenna was positioned at a 3 meter distance from the EUT. The EUT was placed on a 1.5 meter high non-conductive stand. A peak detector with a resolution bandwidth of 100 kHz was used on the spectrum analyzer.
   c) To ensure that maximum or worst case emission levels at the fundamental and harmonics were measured, the following steps were taken when measuring the fundamental emissions and the spurious emissions:
      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) All harmonics not in the restricted bands must be at least 20 dB below levels measured at the fundamental. However, attenuation below the general limits specified in §15.209(a) is not required.
2) 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. The EUT was placed on an 80cm high non-conductive stand. 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. The EUT was placed on a 1.5 meter high non-conductive stand. A peak detector with a resolution bandwidth of 1 MHz was used on the spectrum analyzer.
   c) To ensure that maximum or worst case emission levels were measured, the following steps were taken when taking all measurements:
      i) The EUT was rotated so that all of its sides were exposed to the receiving antenna.
      ii) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.
      iii) The measuring antenna was raised and lowered for each antenna polarization to maximize the readings.
      iv) In instances where it was necessary to use a shortened cable between the measuring antenna and the spectrum analyzer. The measuring antenna was not raised or lowered to ensure maximized readings, instead the EUT was rotated through all axis to ensure the maximum readings were

recorded for the EUT.

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

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

f) Next, for all radiated emissions measurements above 1GHz, the resolution bandwidth was set to 1MHz. The analyzer was set to linear mode with a 10Hz video bandwidth in order to simulate an average detector. An average reading was taken.

If the dwell time per channel of the hopping signal is less than 100msec, then the reading obtained with the 10 Hz video bandwidth may be further adjusted by a “duty cycle correction factor”, derived from 20*log(dwell time/100msec). These readings must be no greater than the limits specified in 15.209(a).

5.1.8.3 Results

Preliminary radiated emissions plots with the EUT transmitting at Low Frequency, Middle Frequency, and High Frequency are shown on pages 28 through 39. Final radiated emissions data are presented on data pages 40 through 48. 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 as Figures 2 and 3.

5.1.9 Band Edge Compliance

5.1.9.1 Requirements

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

5.1.9.2 Procedures

5.1.9.2.1 Low Band Edge

1) The EUT was setup inside the test chamber on a non-conductive stand.
2) A broadband measuring antenna was placed at a test distance of 3 meters from the EUT.
3) The EUT was set to transmit continuously at the channel closest to the low band-edge hopping function disabled.
4) The EUT was maximized for worst case emissions at the measuring antenna. The maximum meter reading was recorded.
5) 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.

6) Step 5) was repeated with the frequency hopping function enabled.

5.1.9.2.2 High Band Edge

1) The EUT was setup inside the test chamber on a non-conductive stand.
2) A broadband measuring antenna was placed at a test distance of 3 meters from the EUT.
3) The EUT was set to transmit continuously at the channel closest to the high band-edge hopping function disabled.
4) The EUT was maximized for worst case emissions at the measuring antenna.
5) 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.

6) Step 5) was repeated with the frequency hopping function enabled.

5.1.9.3 Results

Pages 49 through 52 show the radiated 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, Incorporated Water Meter, Part No. OCE frequency hopping spread spectrum transmitter, Serial No. 110000261, did fully meet the conducted and radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.207 and 15.247 for Intentional Radiators Operating within the 902-928 MHz band, when tested per ANSI C63.4-2014.

It was also determined that the Badger Meter, Incorporated Water Meter, Part No. OCE frequency hopping spread spectrum transmitter, Serial No. 110000261, did fully meet the conducted and radiated RF emission requirements of the Industry Canada Radio Standards Specification RSS-Gen Section 8.8 and Radio Standards Specification RSS-247 for transmitters, when tested per ANSI C63.4-2014.

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 A2LA, 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	4/18/2016	4/18/2017
GRE0	SIGNAL GENERATOR	AGILENT TECHNOLOGIES	E4438C	MY42083127	250KHZ-6GHZ	2/15/2017	2/15/2018
NDQ1	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	313	400-1000MHZ	6/16/2016	6/16/2018
NTA3	BILOG ANTENNA	TESEQ	6112D	32853	25-1000MHz	3/23/2016	4/23/2017
NWQ2	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS LINDGREN	3117	66659	1GHZ-18GHZ	3/2/2016	3/2/2018
RAKI	RF SECTION	HEWLETT PACKARD	85462A	3411A00181	0.009-6500MHZ	2/23/2017	2/23/2018
RAKJ	RF FILTER SECTION	HEWLETT PACKARD	85460A	3330A00154	---	2/23/2017	2/23/2018
RBG2	EMI ANALYZER	ROHDE & SCHWARZ	ESW500	101591	2HZ-44GHZ	11/22/2016	11/22/2017
XPQ2	HIGH PASS FILTER	K&L MICROWAVE	4IH30-1804/T10000-0	3	1.8-10GHZ	9/14/2016	9/14/2017

I/O: Initial Only
N/A: Not Applicable
Note 1: For the purpose of this test, the equipment was calibrated over the specified frequency range, pulse rate, or modulation prior to the test or monitored by a calibrated instrument.

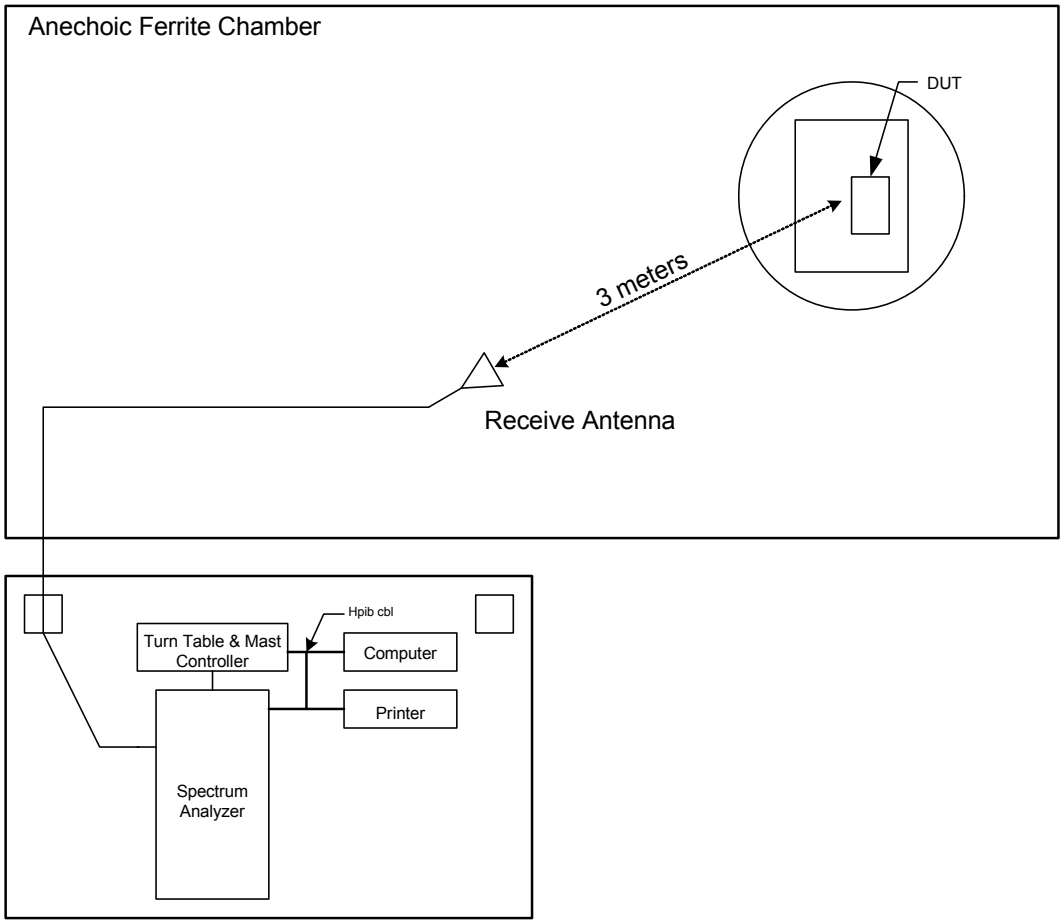


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 2

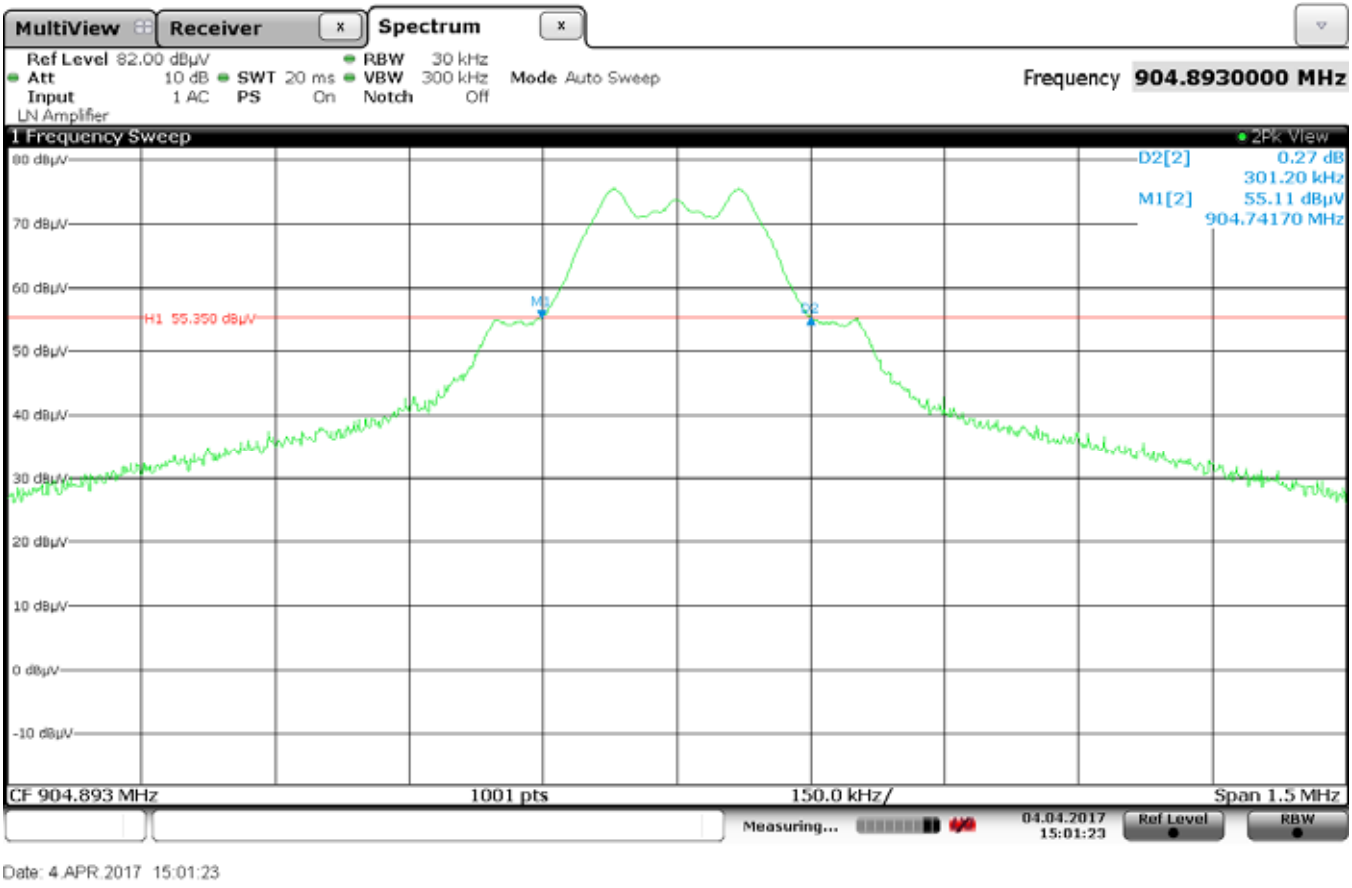
Test Setup for Radiated Emissions – 30MHz to 1GHz, Horizontal Polarization

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

Figure 3

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

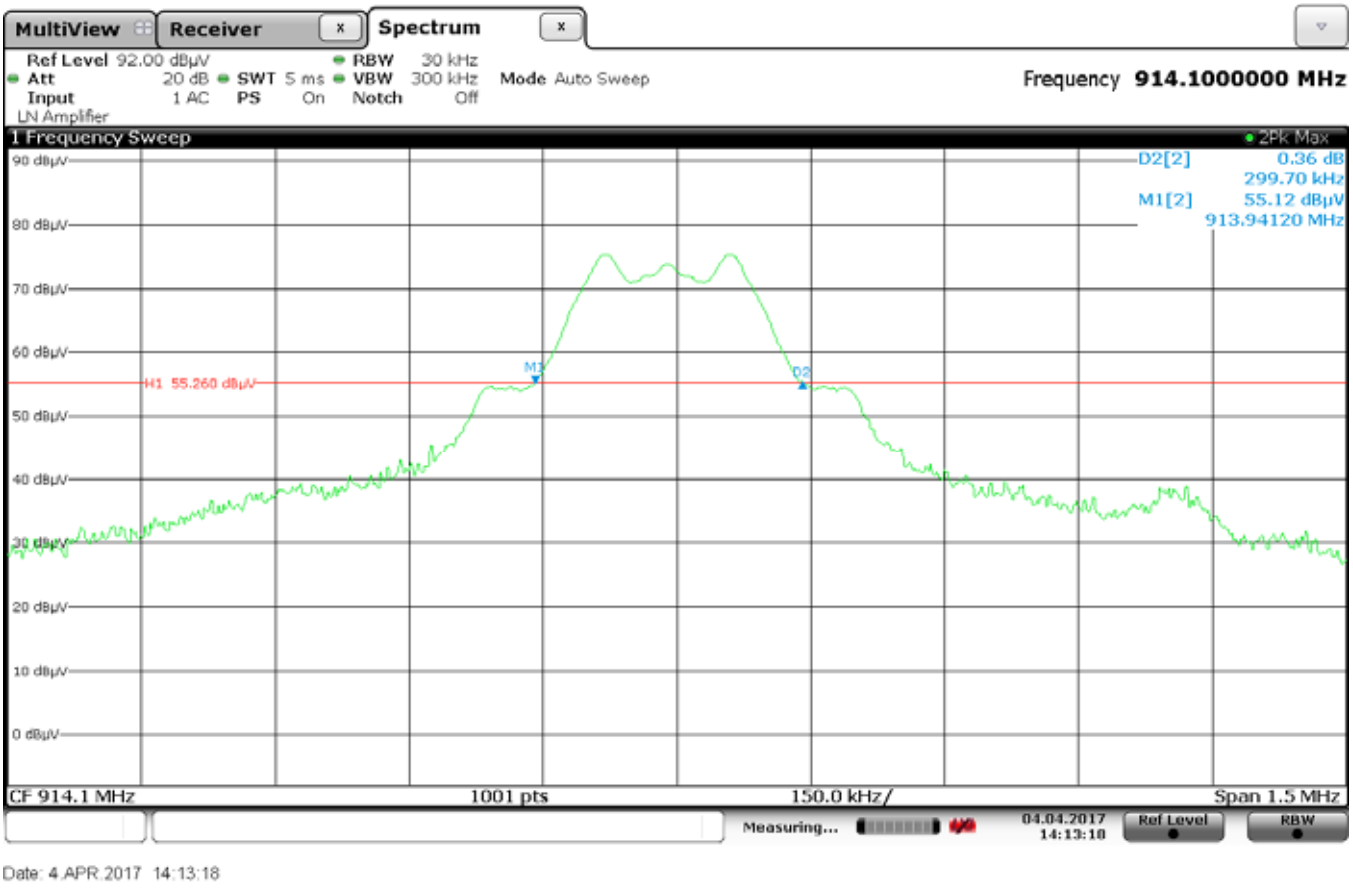
Test Setup for Radiated Emissions – 1GHz to 10GHz, Vertical Polarization



Date: 4.APR.2017 15:01:23

FCC 15.247(a) 20dB Bandwidth

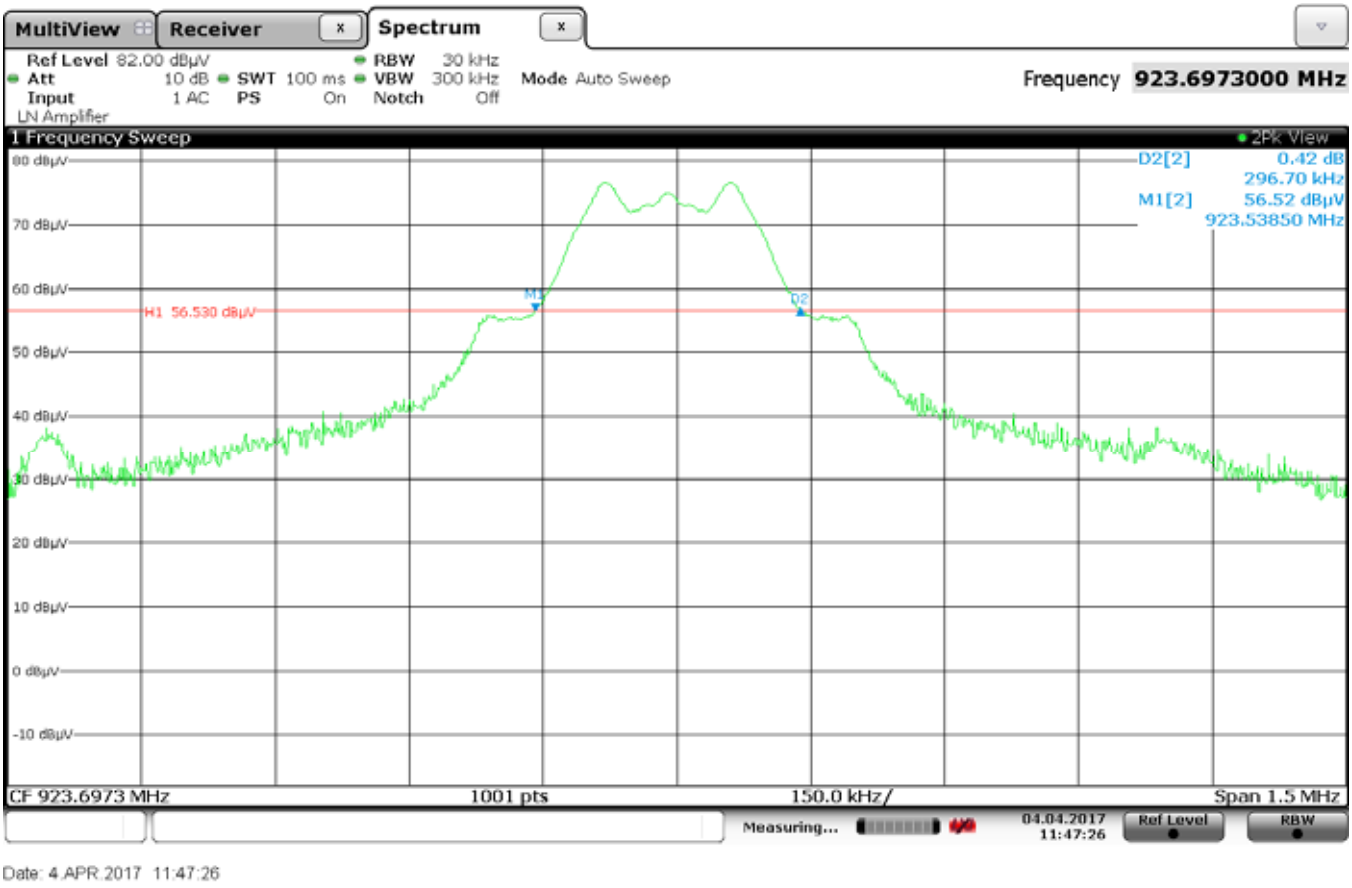
Manufacturer	:	Badger Meter, Incorporated
Model Number	:	OCE
Serial Number	:	110000261
Mode	:	Tx 904.9MHz
Parameters	:	20dB Bandwidth = 301.2kHz
Date	:	4/4/2017
Notes	:	



Date: 4.APR.2017 14:13:18

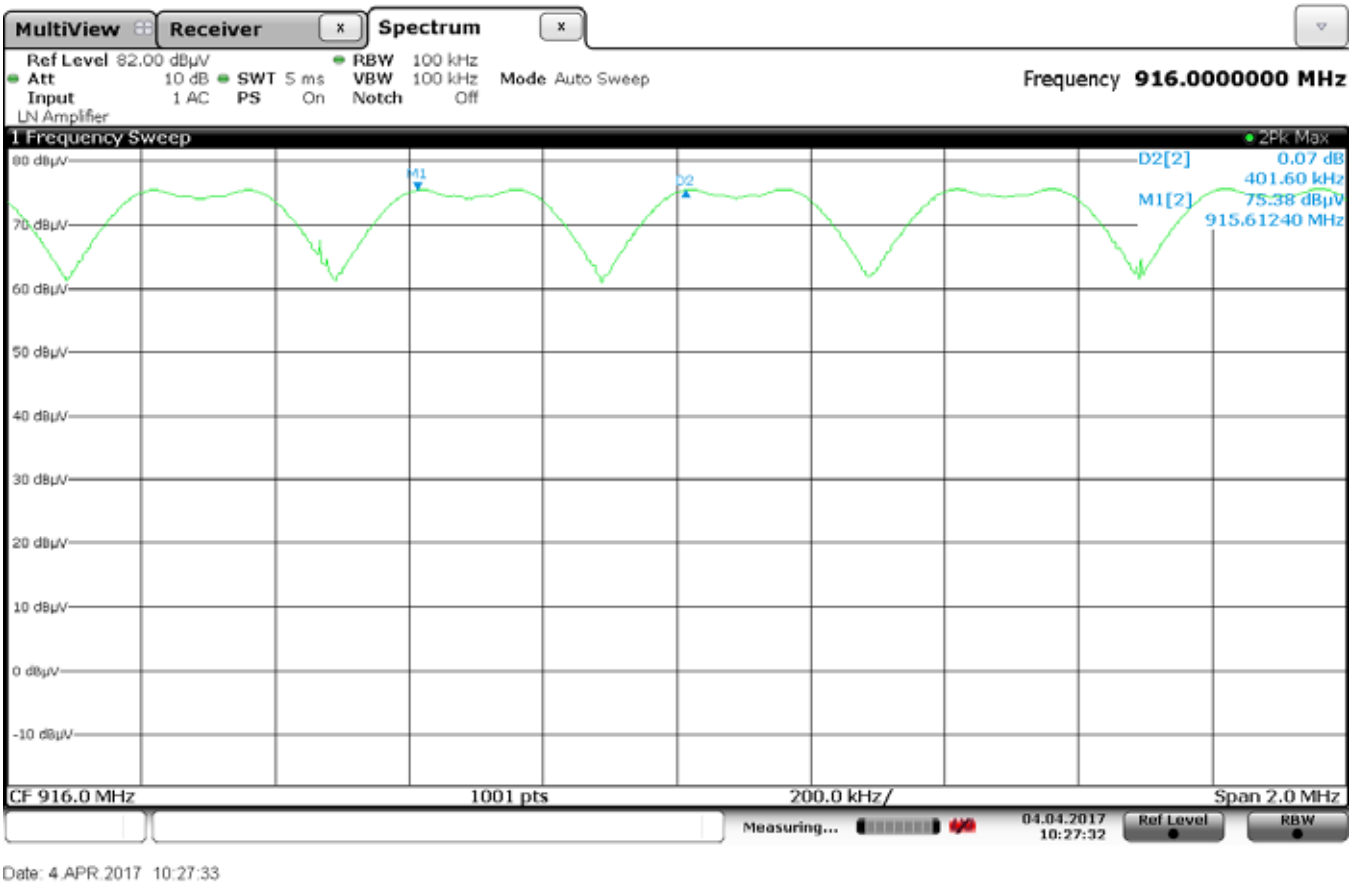
FCC 15.247 Band-edge Compliance

Manufacturer	:	Badger Meter, Incorporated
Model Number	:	OCE
Serial Number	:	110000261
Mode	:	Tx 914.1MHz
Parameters	:	20dB Bandwidth = 299.7kHz
Date	:	4/4/2017
Notes	:	



FCC 15.247 Band-edge Compliance

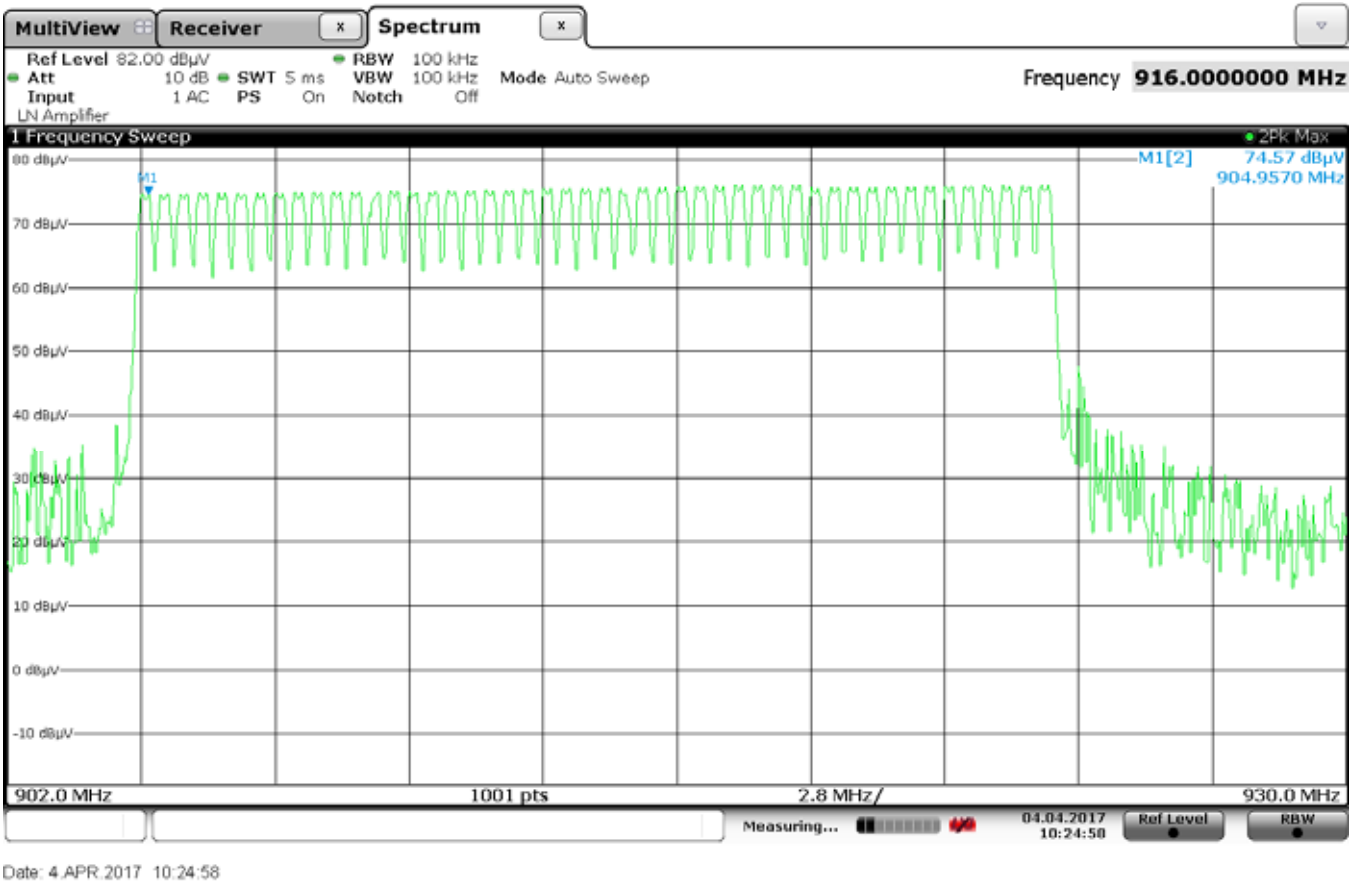
Manufacturer	:	Badger Meter, Incorporated
Model Number	:	OCE
Serial Number	:	110000261
Mode	:	Tx 923.7MHz
Parameters	:	20dB Bandwidth = 296.7kHz
Date	:	4/4/2017
Notes	:	



Date: 4.APR.2017 10:27:33

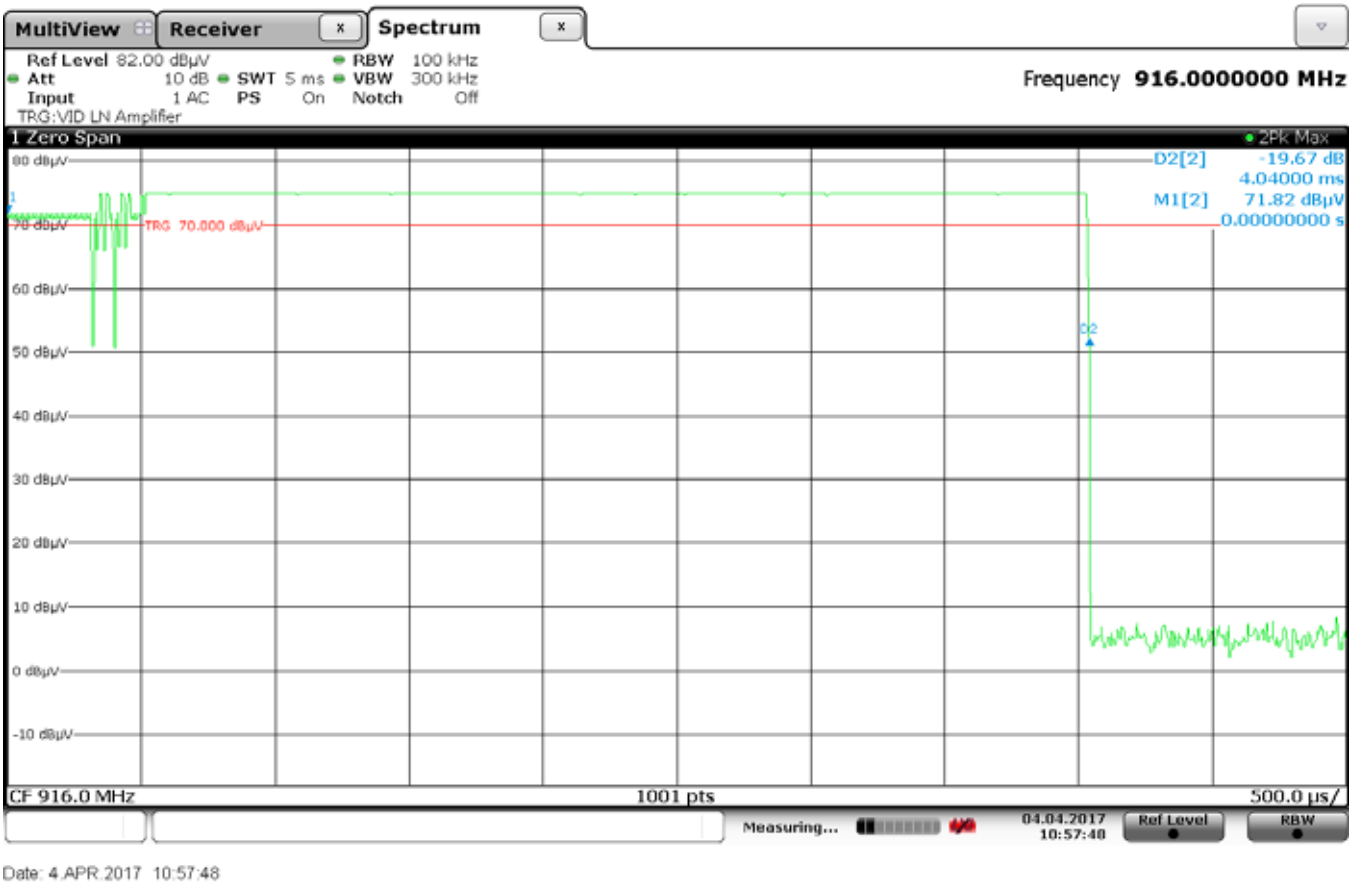
FCC 15.247(a) Carrier Frequency Separation

Manufacturer	:	Badger Meter, Incorporated
Model Number	:	OCE
Serial Number	:	110000261
Mode	:	Frequency Hopping
Parameters	:	Carrier Frequency Separation = 401.6kHz
Date	:	4/4/2017
Notes	:	



FCC 15.247(a) Number of Hopping Frequencies

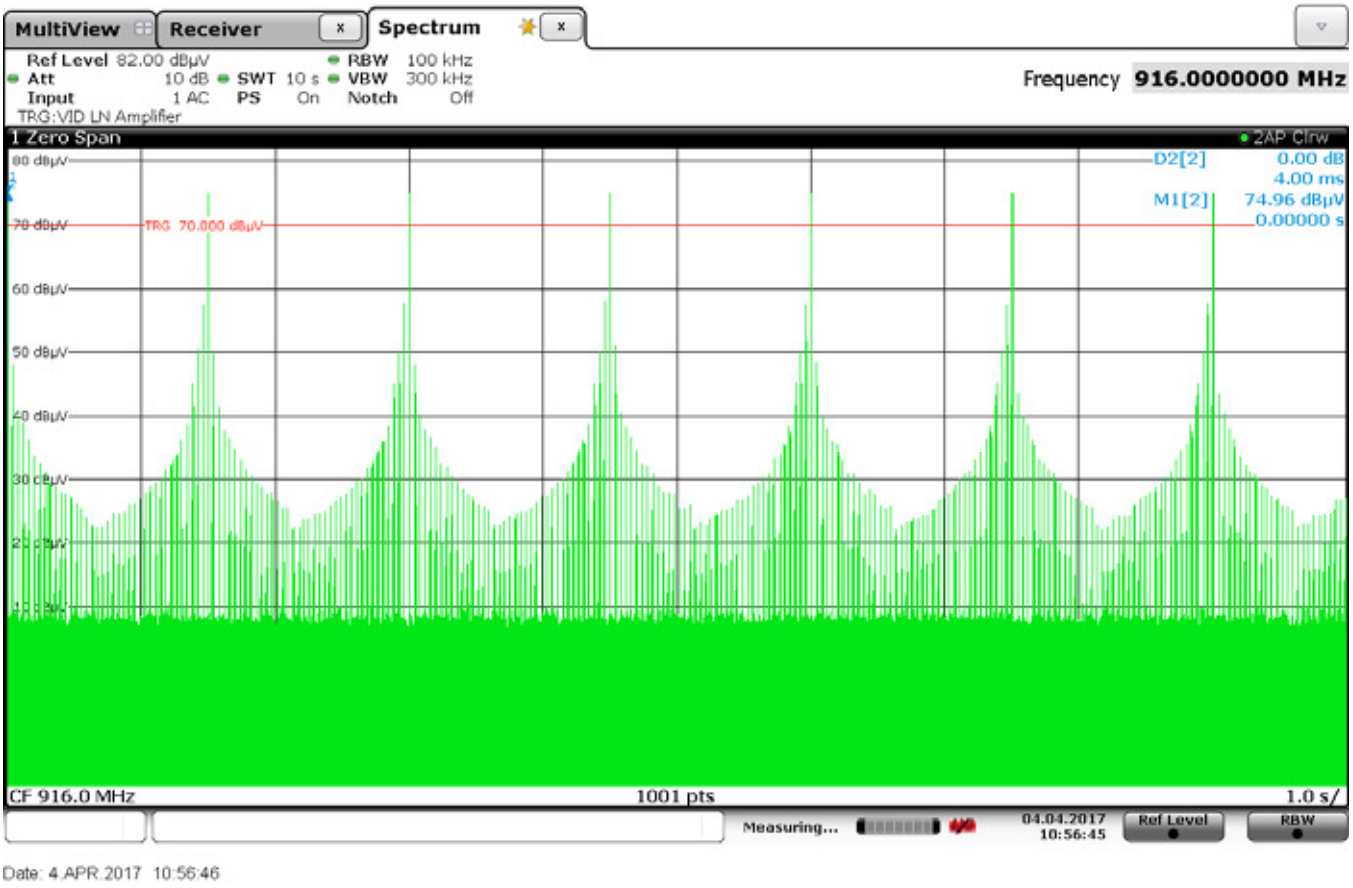
Manufacturer	:	Badger Meter, Incorporated
Model Number	:	OCE
Serial Number	:	110000261
Mode	:	Frequency Hopping
Parameters	:	Number of Hopping Channels = 48
Date	:	4/4/2017
Notes	:	



Date: 4.APR.2017 10:57:48

15.247(a) Time of Occupancy

Manufacturer	:	Badger Meter, Incorporated
Model Number	:	OCE
Serial Number	:	110000261
Mode	:	Frequency Hopping
Parameters	:	Time of Occupancy
Date	:	4/4/2017
Notes	:	Worst Case Pulse = 4.04msec. Number of times it hits a channel in a 10 second period is 7. Therefore the time of occupancy is 4.04mS x 7 times = 28.2msec



15.247(a) Time of Occupancy

Manufacturer	:	Badger Meter, Incorporated
Model Number	:	OCE
Serial Number	:	110000261
Mode	:	Frequency Hopping
Parameters	:	Time of Occupancy
Date	:	4/4/2017
Notes	:	Worst Case Pulse = 4.04msec. Number of times it hits a channel in a 10 second period is 7. Therefore the time of occupancy is 4.04mS x 7 times = 28.2msec

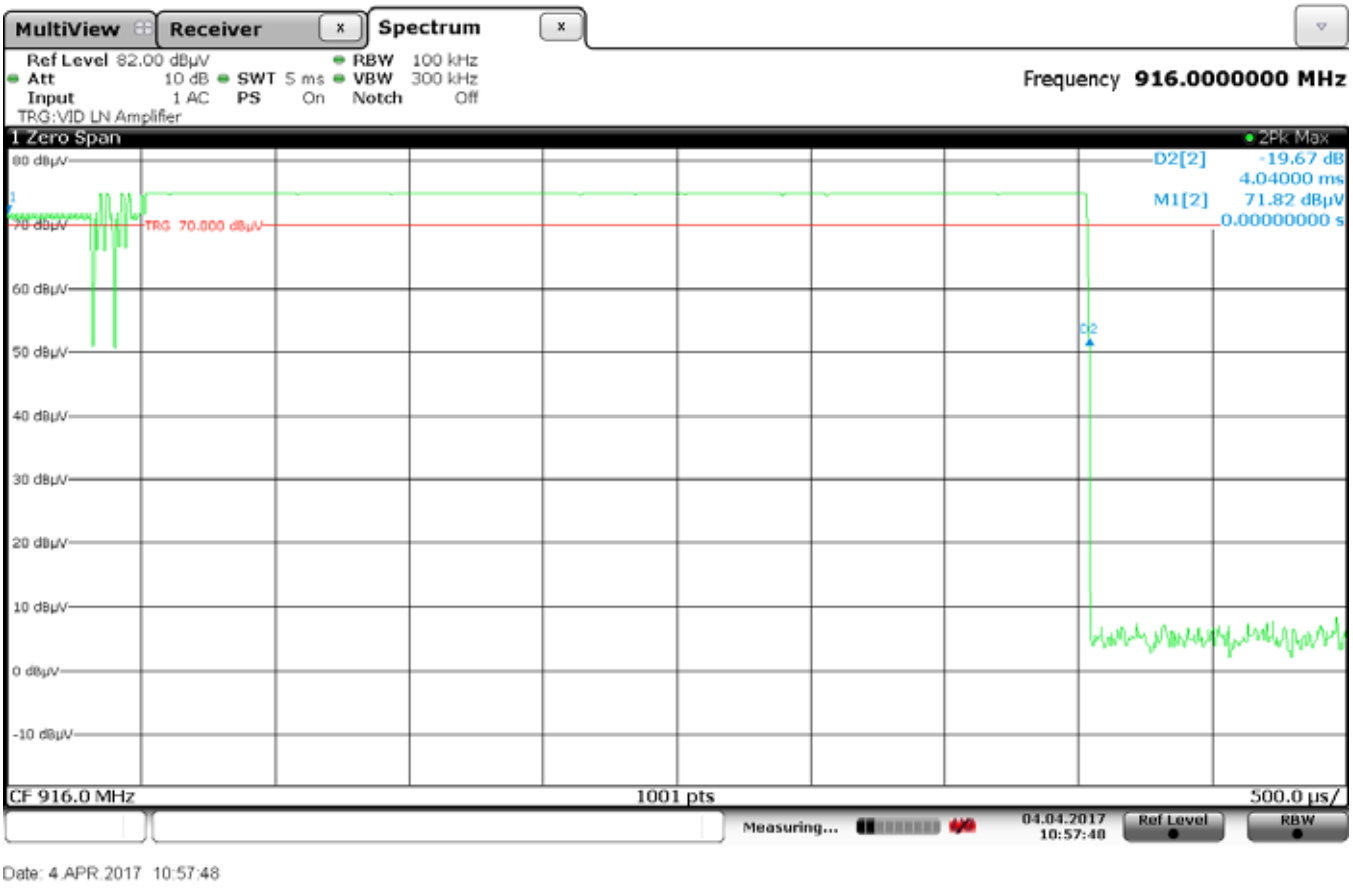
Manufacturer : Badger Meter, Incorporated
Test Item : Water Meter
Model No. : OCE
Serial No. : 110000261
Mode : Transmitting
Test Specification : FCC-15.247, RSS-247 Peak Output Power
Date : 3/31/2017
Test Distance : 3 Meters
Notes :

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	58.5	-10.2	2.2	1.6	-9.7	30.0
904.90	V	77.8	9.2	2.2	1.6	9.7	30.0
914.10	H	63.3	-5.6	2.2	1.6	-5.1	30.0
914.10	V	76.3	8.2	2.2	1.6	8.7	30.0
923.69	H	66.5	-2.6	2.2	1.7	-2.1	30.0
923.69	V	78.1	10.0	2.2	1.7	10.5	30.0

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

Checked BY Richard E. King :

Richard E. King



Date: 4.APR.2017 10:57:48

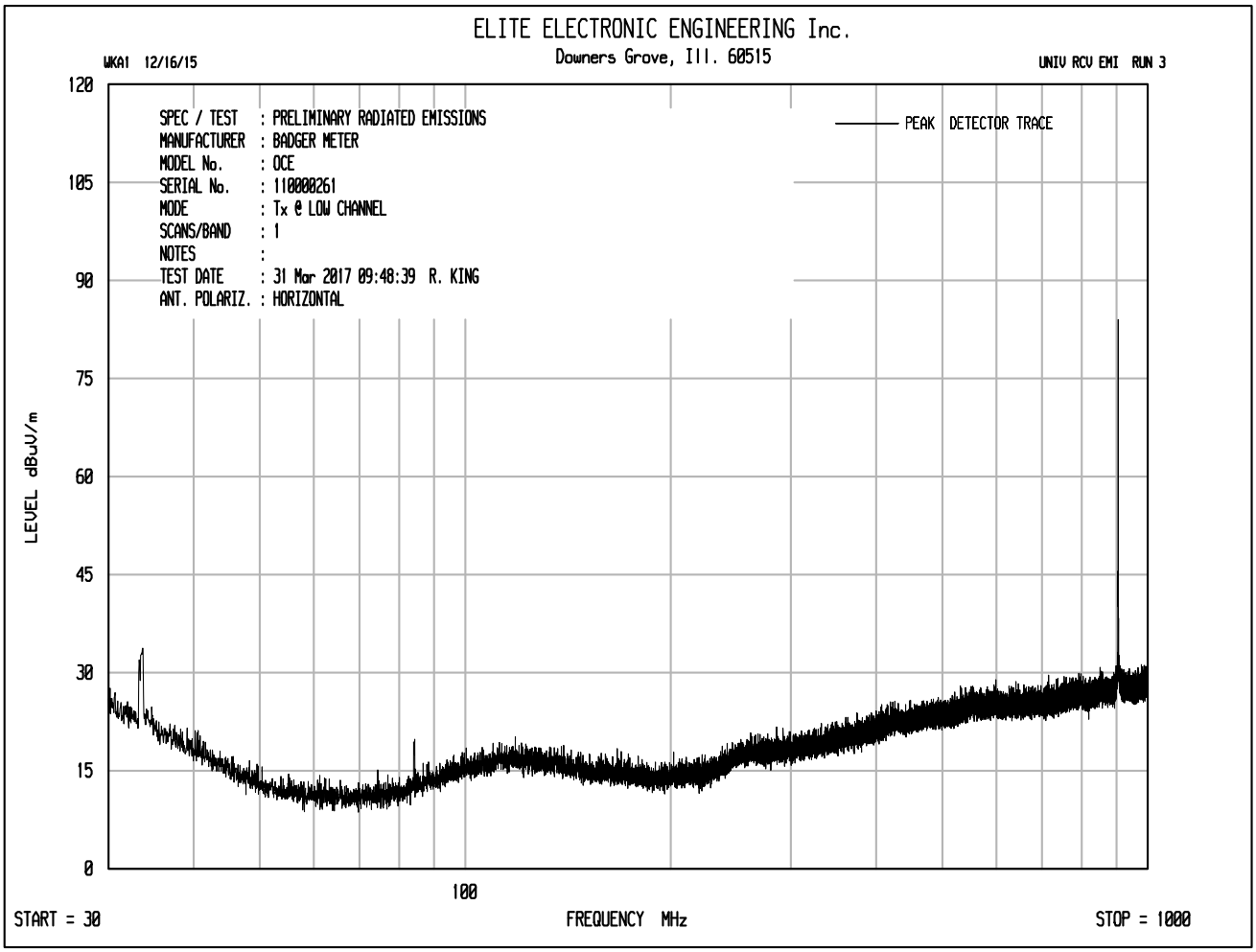
15.35(c) Duty Cycle Factor

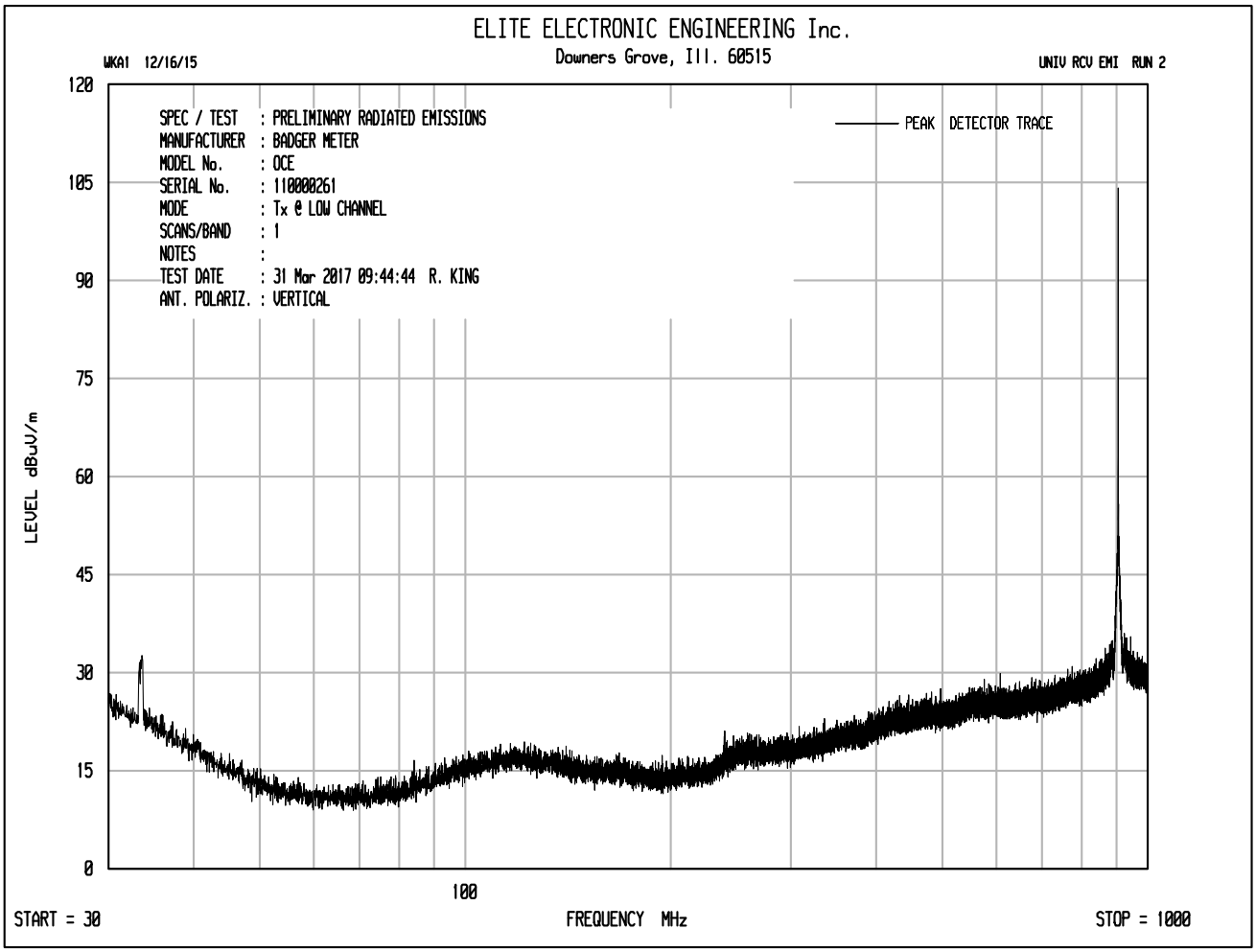
Manufacturer : Badger Meter, Incorporated
Model Number : OCE
Serial Number : 110000261
Mode : Frequency Hopping
Parameters : Duty Cycle
Date : 4/4/2017
Notes : Pulse Width = 4.04mS

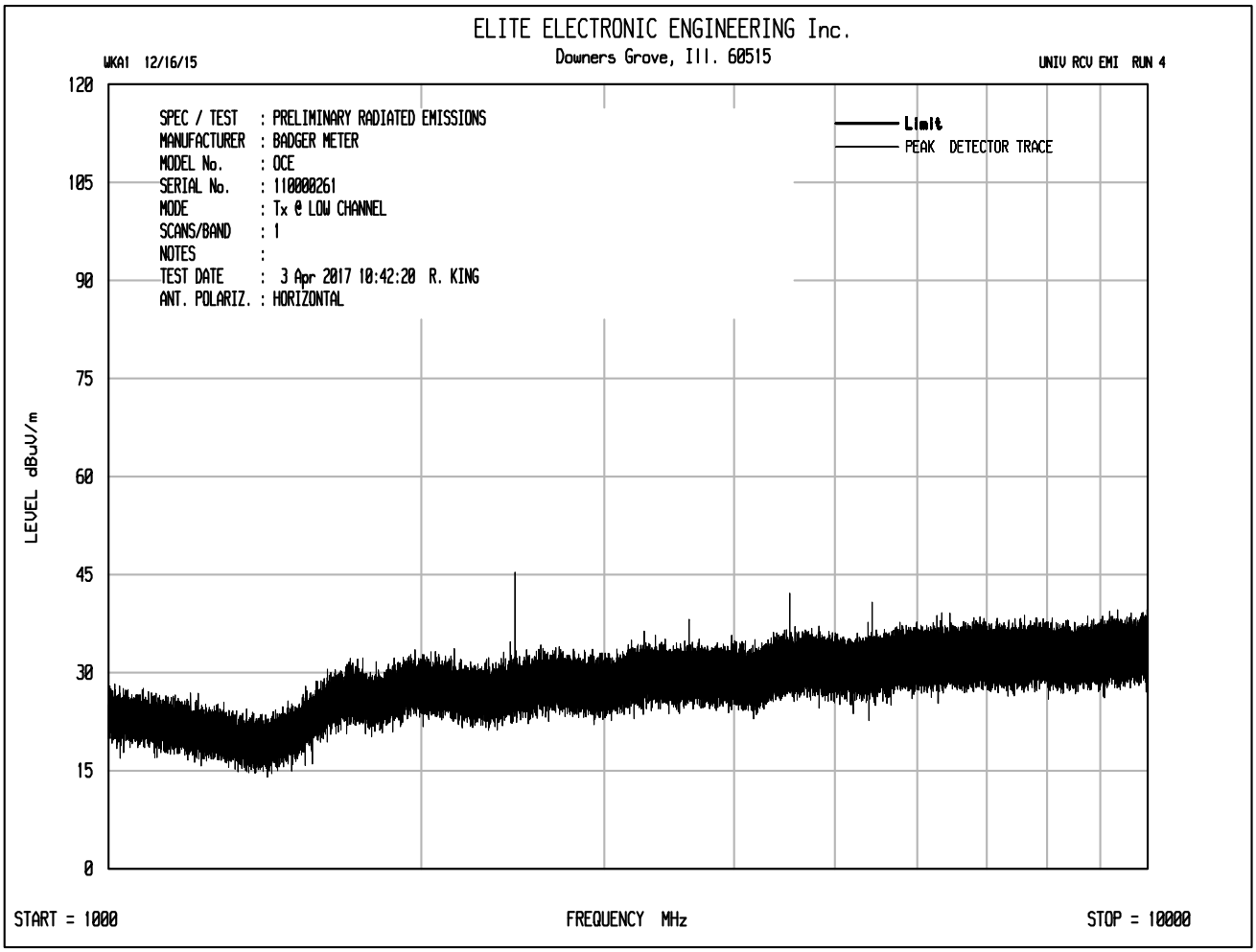
Date: 4.APR.2017 11:15:25

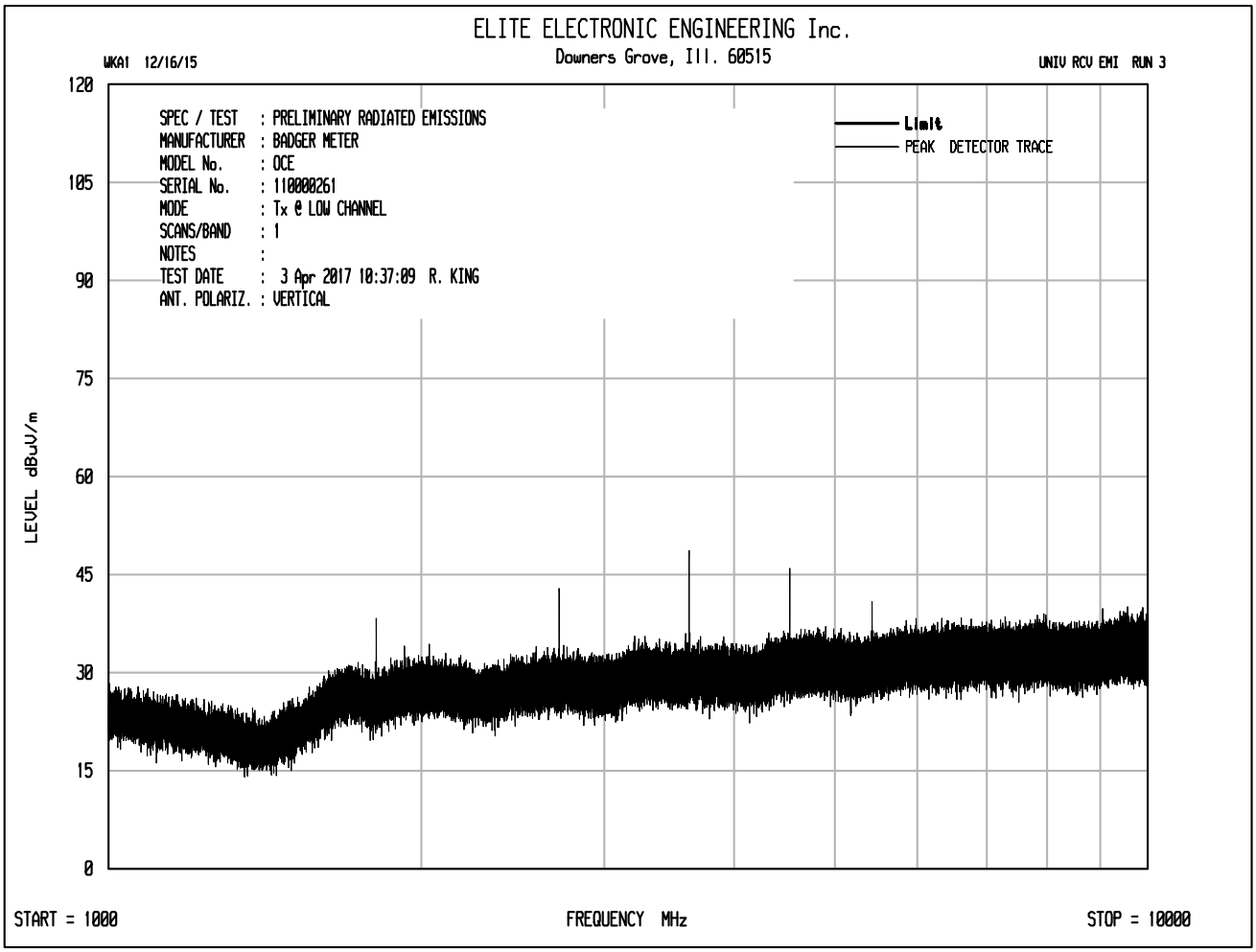
15.35(c) Duty Cycle Factor

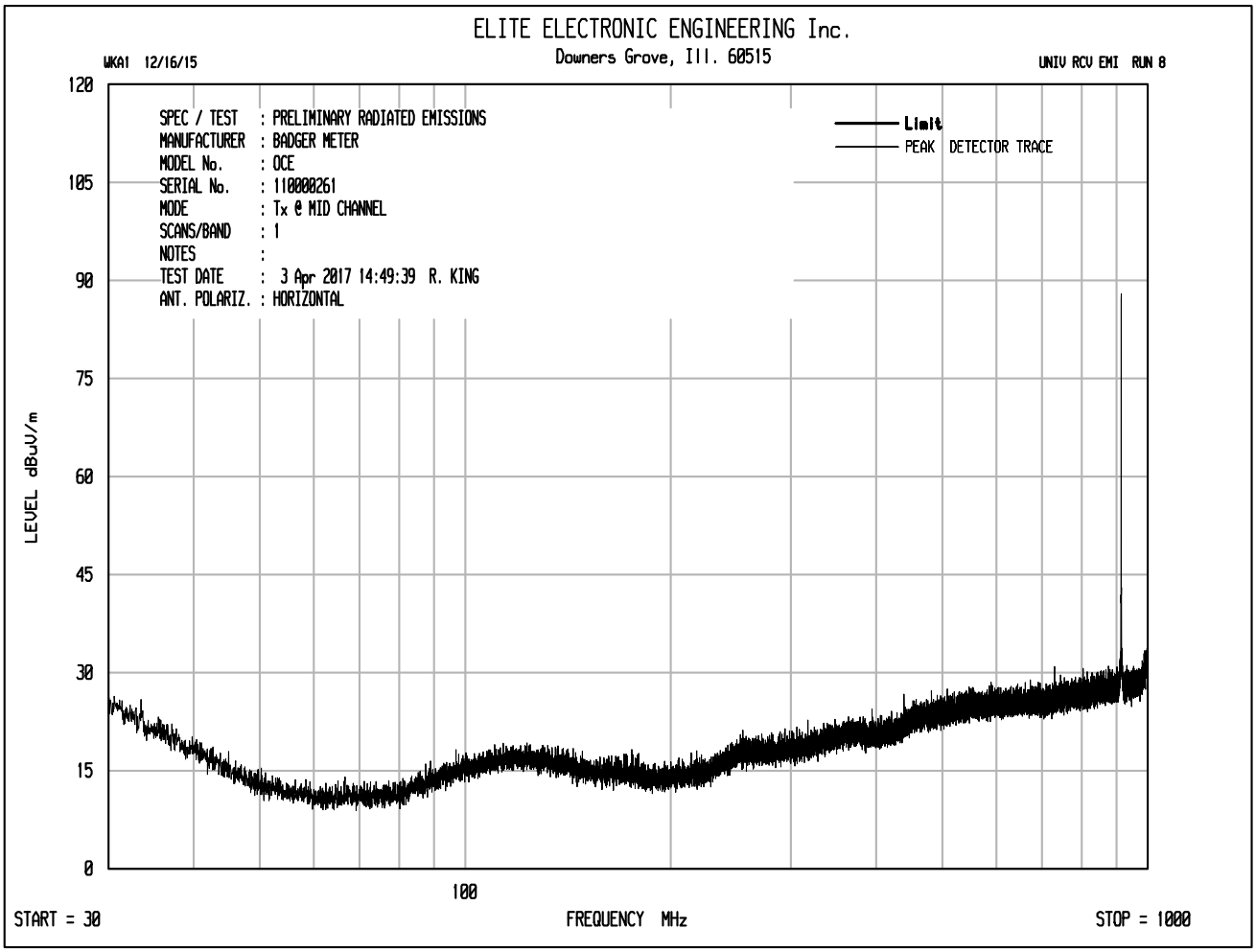
Manufacturer	:	Badger Meter, Incorporated
Model Number	:	OCE
Serial Number	:	110000261
Mode	:	Frequency Hopping
Parameters	:	Duty Cycle
Date	:	4/4/2017
Notes	:	DC = 20*LOG ((4.04mS*6)/100mS) = -12.3dB

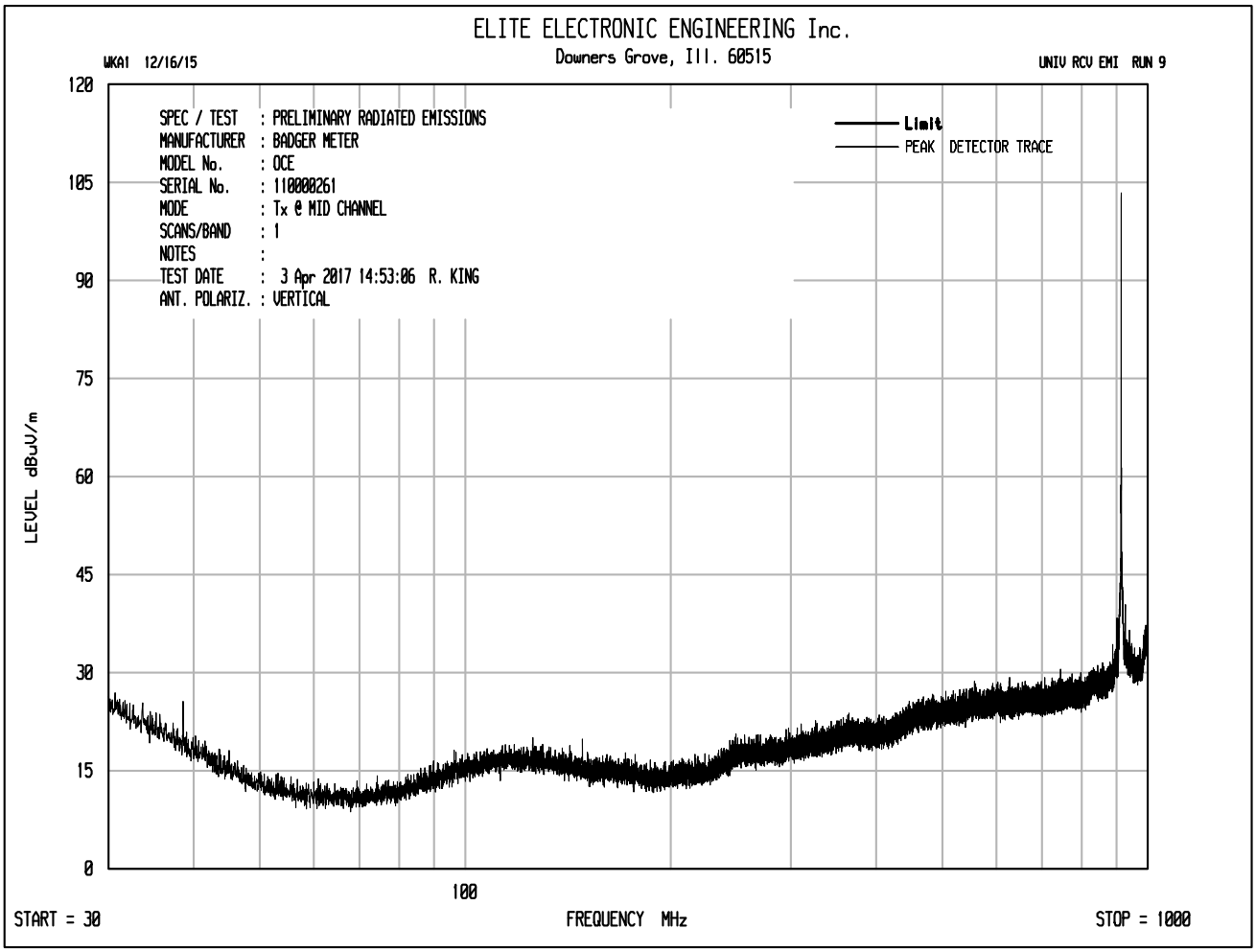

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 12/16/15
UNIV RCV EMI RUN 3
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : OCE
SERIAL No. : 110000261
MODE : Tx @ LOW CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 31 Mar 2017 09:48:39 R. KING
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
100
START = 30
FREQUENCY MHz
STOP = 1000

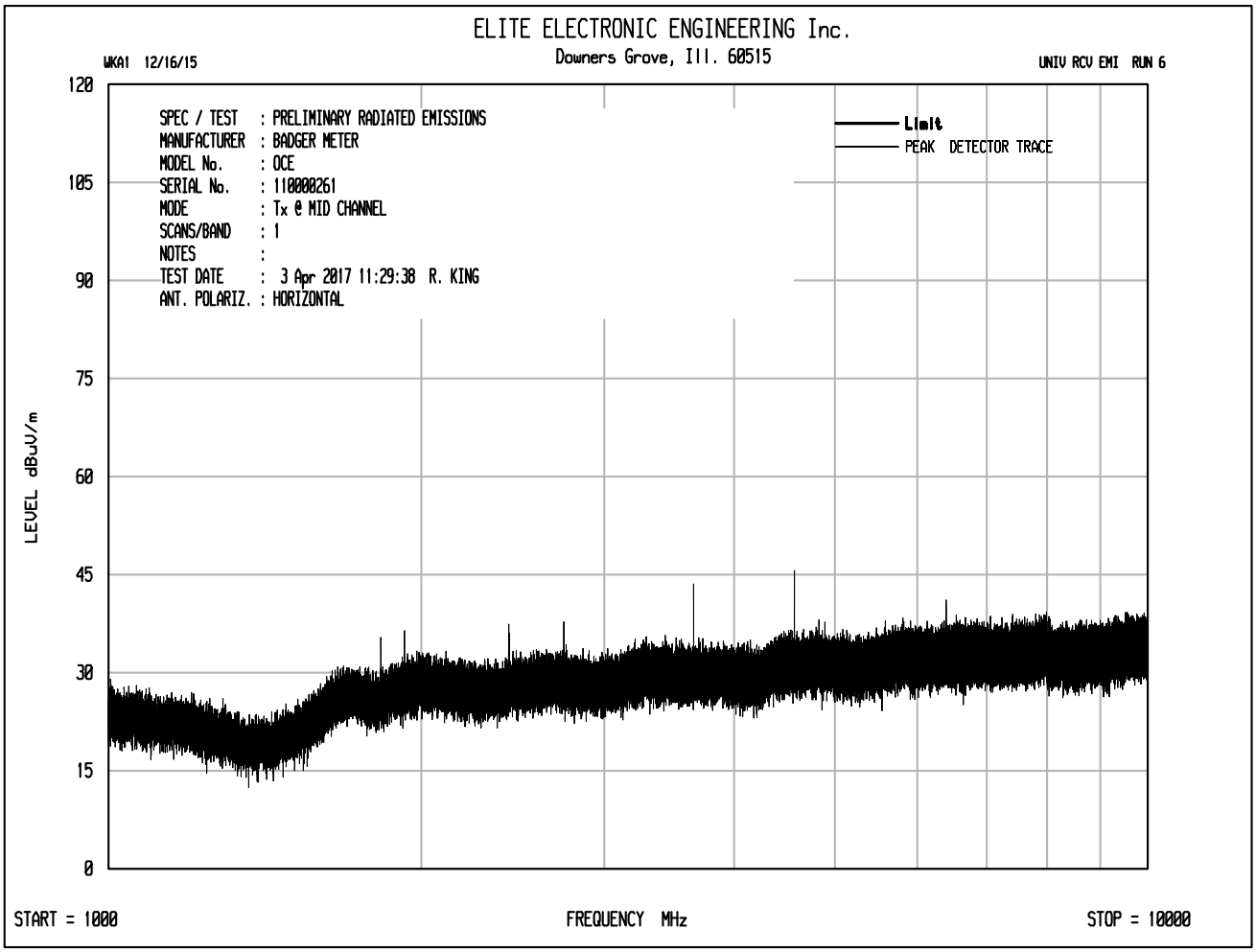

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 12/16/15
UNIV RCV EMI RUN 2
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : OCE
SERIAL No. : 110000261
MODE : Tx @ LOW CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 31 Mar 2017 09:44:44 R. KING
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
100
START = 30
FREQUENCY MHz
STOP = 1000

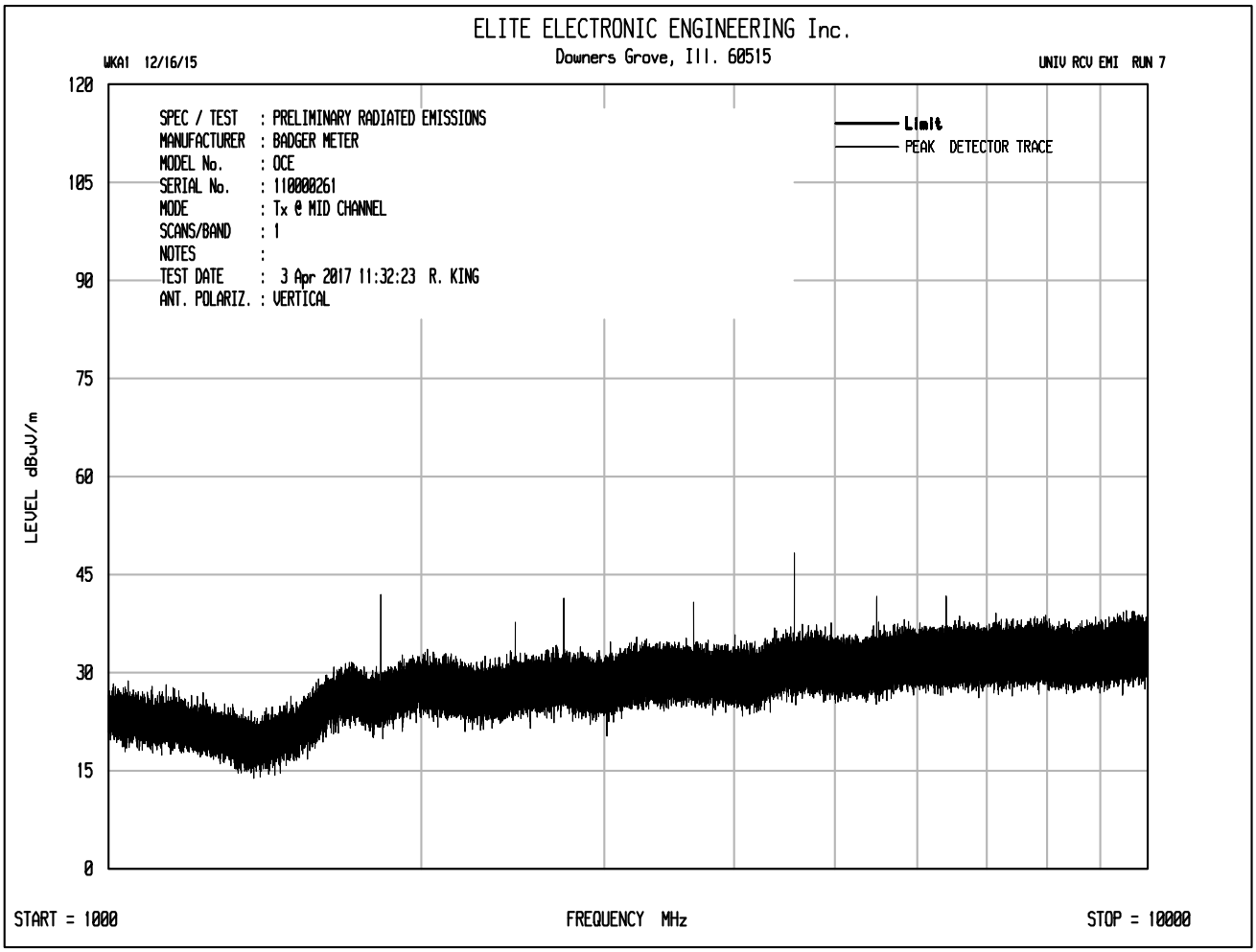

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 12/16/15
UNIV RCV EMI RUN 4
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : OCE
SERIAL No. : 110000261
MODE : Tx @ LOW CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 3 Apr 2017 10:42:20 R. KING
ANT. POLARIZ. : HORIZONTAL
Limit
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 10000

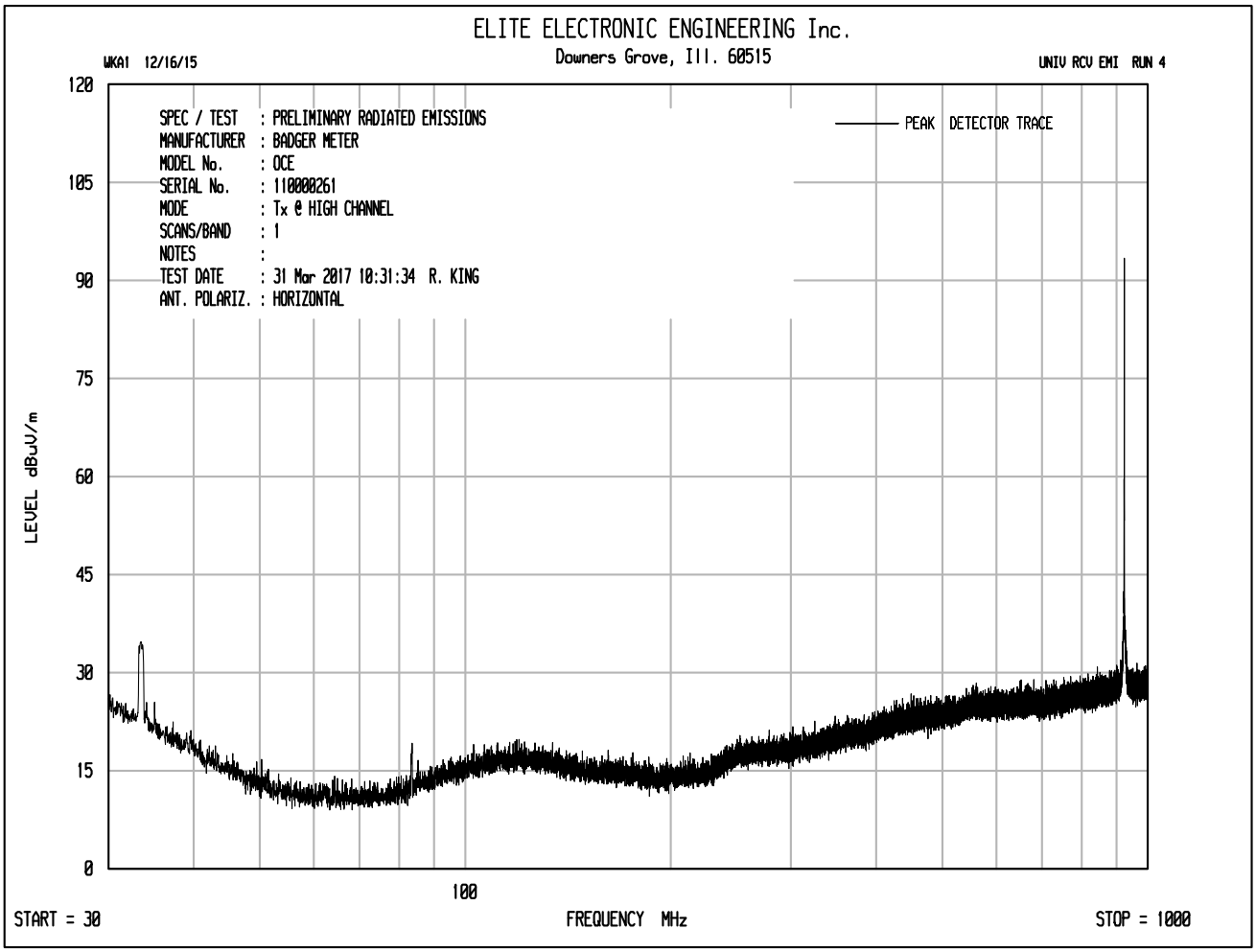

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 12/16/15
UNIV RCV EMI RUN 3
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : OCE
SERIAL No. : 110000261
MODE : Tx @ LOW CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 3 Apr 2017 10:37:09 R. KING
ANT. POLARIZ. : VERTICAL
Limit
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 10000

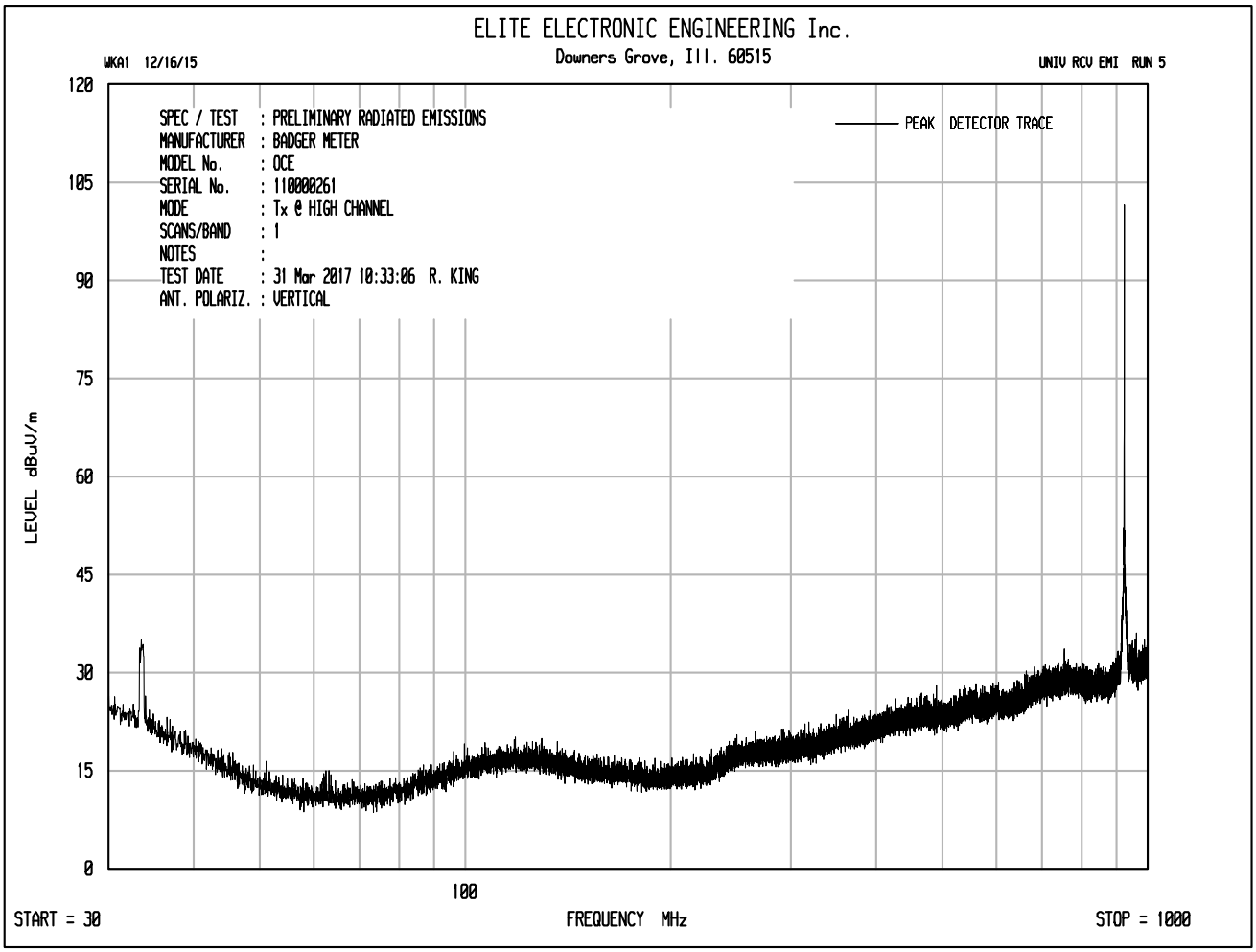

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 12/16/15
UNIV RCV EMI RUN 8
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : OCE
SERIAL No. : 110000261
MODE : Tx @ MID CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 3 Apr 2017 14:49:39 R. KING
ANT. POLARIZ. : HORIZONTAL
Limit
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
100
START = 30
FREQUENCY MHz
STOP = 1000

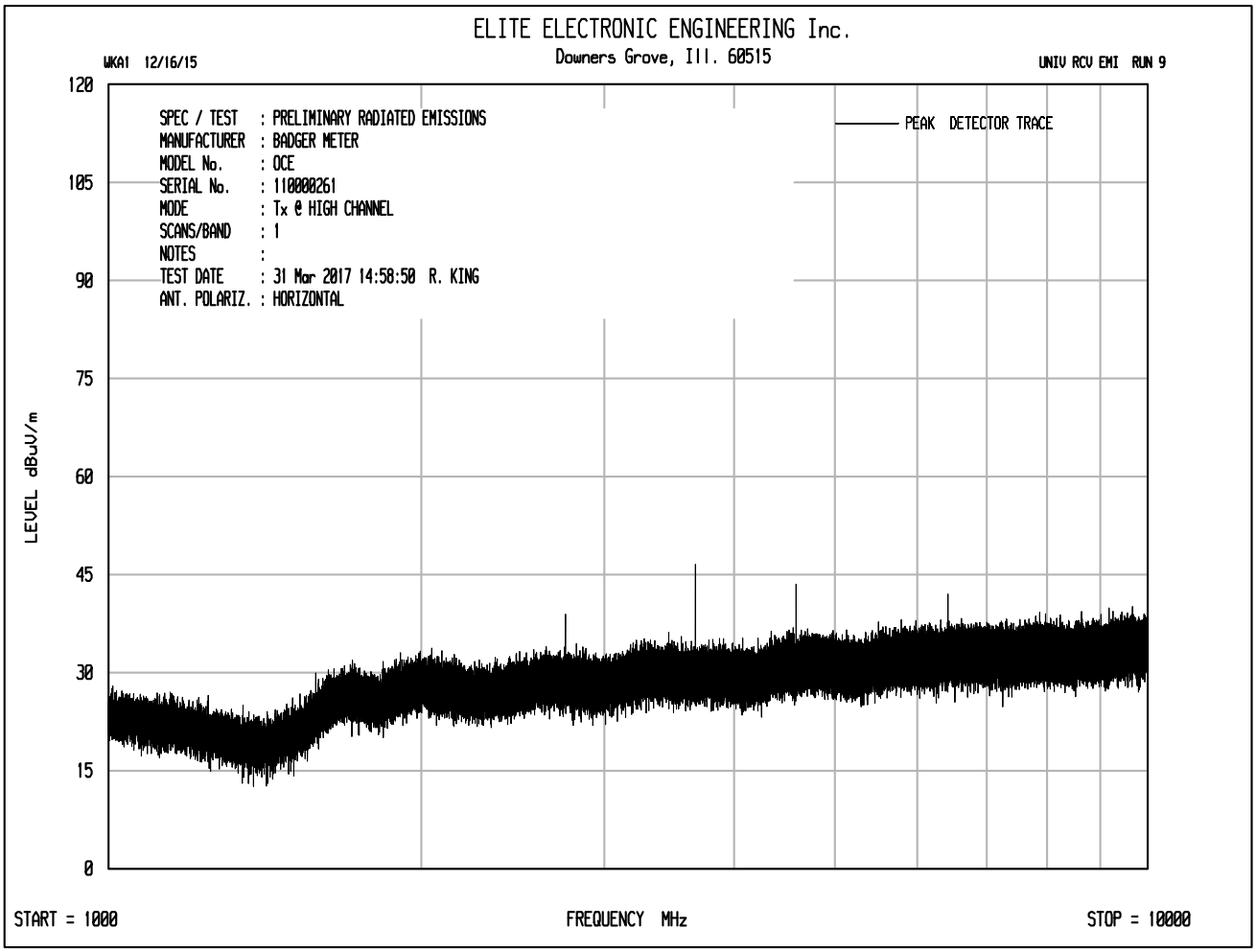

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 12/16/15
UNIV RCV EMI RUN 9
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : OCE
SERIAL No. : 110000261
MODE : Tx @ MID CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 3 Apr 2017 14:53:06 R. KING
ANT. POLARIZ. : VERTICAL
Limit
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
100
START = 30
FREQUENCY MHz
STOP = 1000

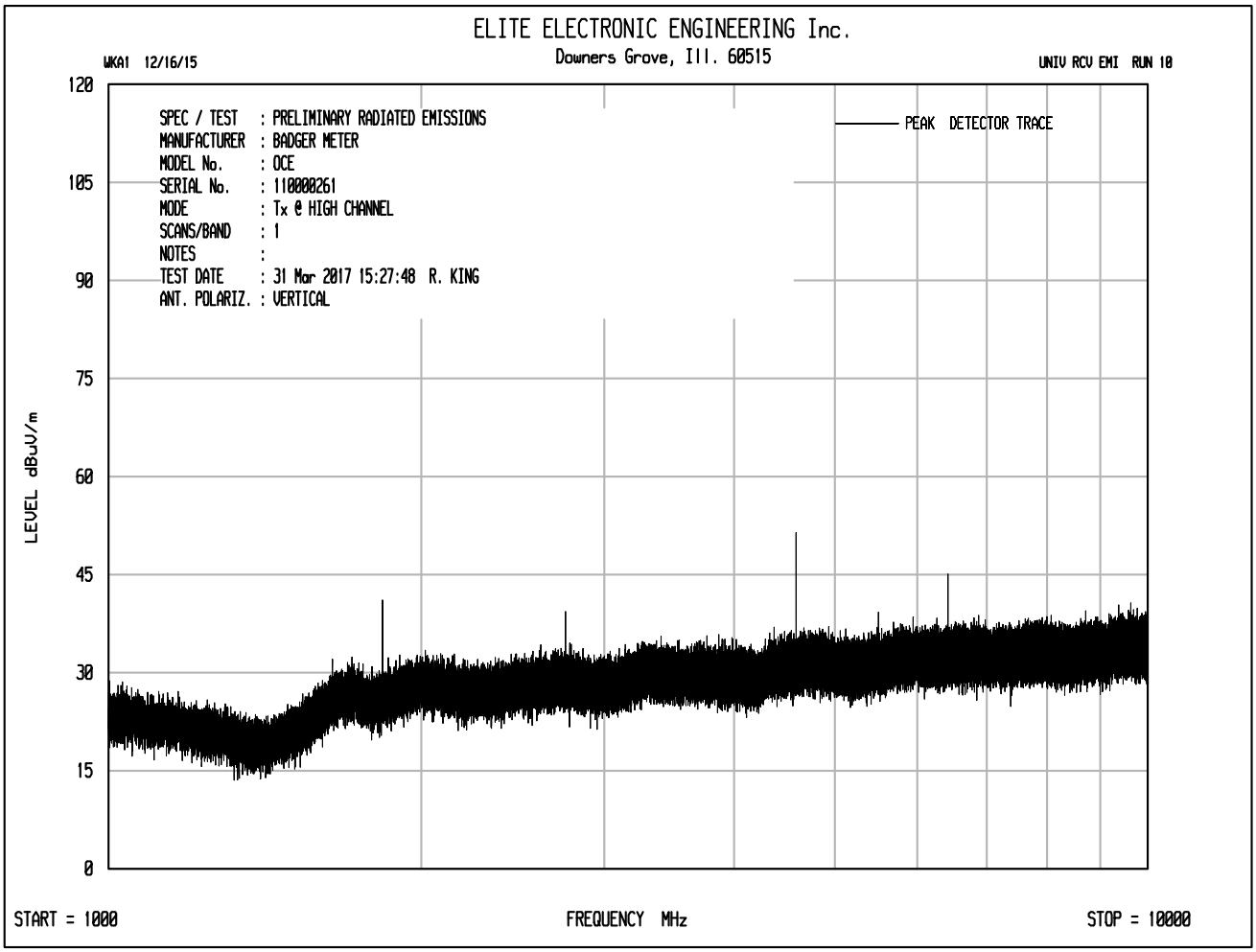

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 12/16/15
UNIV RCV EMI RUN 6
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : OCE
SERIAL No. : 110000261
MODE : Tx @ MID CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 3 Apr 2017 11:29:38 R. KING
ANT. POLARIZ. : HORIZONTAL
Limit
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 10000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 12/16/15
UNIV RCV EMI RUN 7
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : OCE
SERIAL No. : 110000261
MODE : Tx @ MID CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 3 Apr 2017 11:32:23 R. KING
ANT. POLARIZ. : VERTICAL
Limit
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 10000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 12/16/15
UNIV RCV EMI RUN 4
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : OCE
SERIAL No. : 110000261
MODE : Tx @ HIGH CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 31 Mar 2017 10:31:34 R. KING
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
100
START = 30
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 12/16/15
UNIV RCV EMI RUN 5
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : OCE
SERIAL No. : 110000261
MODE : Tx @ HIGH CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 31 Mar 2017 10:33:06 R. KING
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
100
START = 30
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 12/16/15
UNIV RCV EMI RUN 9
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : OCE
SERIAL No. : 110000261
MODE : Tx @ HIGH CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 31 Mar 2017 14:58:50 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
WKA1 12/16/15
UNIV RCV EMI RUN 10
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : OCE
SERIAL No. : 110000261
MODE : Tx @ HIGH CHANNEL
SCANS/BAND : 1
NOTES :
TEST DATE : 31 Mar 2017 15:27:48 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, Incorporated
Test Item : Water Meter
Model No. : OCE
Serial No. : 110000261
Mode : Tx @ 904.89MHz
Test Specification : FCC-15.247, RSS-247 Peak Radiated Emissions in Restricted Bands
Date : 4/3/2017
Test Distance : 3
Notes : Peak Detector with 1MHz Resolution Bandwidth

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	56.8		3.7	32.5	-39.8	53.2	456.3	5000.0	-20.8
2714.70	V	59.7		3.7	32.5	-39.8	56.1	638.0	5000.0	-17.9
3619.60	H	59.2		4.3	33.2	-39.2	57.4	740.4	5000.0	-16.6
3619.60	V	63.0		4.3	33.2	-39.2	61.2	1154.6	5000.0	-12.7
4524.50	H	58.3		4.7	34.0	-39.2	57.8	778.4	5000.0	-16.2
4524.50	V	57.7		4.7	34.0	-39.2	57.2	724.0	5000.0	-16.8
5429.39	H	52.3		5.2	34.8	-39.4	52.8	436.7	5000.0	-21.2
5429.39	V	54.8		5.2	34.8	-39.4	55.3	585.0	5000.0	-18.6
8144.09	H	49.6	*	6.5	35.9	-39.4	52.6	428.7	5000.0	-21.3
8144.09	V	49.4	*	6.5	35.9	-39.4	52.4	415.1	5000.0	-21.6
9048.99	H	49.4	*	6.5	36.7	-39.3	53.3	462.5	5000.0	-20.7
9048.99	V	48.5	*	6.5	36.7	-39.3	52.3	414.1	5000.0	-21.6

Total (dBuV/m) = Meter Reading + CBL FAC + Ant Fac + Pre Amp

Checked BY Richard E. King :

Richard E. King

Manufacturer : Badger Meter, Incorporated
Test Item : Water Meter
Model No. : OCE
Serial No. : 110000261
Mode : Tx @ 904.89MHz
Test Specification : FCC-15.247, RSS-247 Average Radiated Emissions in Restricted Bands
Date : 4/3/2017
Test Distance : 3
Notes : Average Detector with 1MHz Resolution Bandwidth

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	51.64		3.7	32.5	-39.8	-12.3	35.8	61.5	500.0	-18.2
2714.70	V	56.3		3.7	32.5	-39.8	-12.3	40.4	104.9	500.0	-13.6
3619.60	H	55.0		4.3	33.2	-39.2	-12.3	40.9	111.5	500.0	-13.0
3619.60	V	60.5		4.3	33.2	-39.2	-12.3	46.4	209.9	500.0	-7.5
4524.50	H	53.5		4.7	34.0	-39.2	-12.3	40.7	108.4	500.0	-13.3
4524.50	V	52.6		4.7	34.0	-39.2	-12.3	39.9	98.4	500.0	-14.1
5429.39	H	40.3		5.2	34.8	-39.4	-12.3	28.5	26.7	500.0	-25.4
5429.39	V	48.1		5.2	34.8	-39.4	-12.3	36.3	65.3	500.0	-17.7
8144.09	H	33.9	*	6.5	35.9	-39.4	-12.3	24.6	17.0	500.0	-29.4
8144.09	V	33.8	*	6.5	35.9	-39.4	-12.3	24.5	16.9	500.0	-29.4
9048.99	H	33.8	*	6.5	36.7	-39.3	-12.3	25.4	18.5	500.0	-28.6
9048.99	V	34.0	*	6.5	36.7	-39.3	-12.3	25.5	18.9	500.0	-28.4

Total (dBuV/m) = Meter Reading + CBL FAC + Ant Fac + Pre Amp + Duty Cycle

Checked BY Richard E. King :

Richard E. King

Manufacturer : Badger Meter, Incorporated
Test Item : Water Meter
Model No. : OCE
Serial No. : 110000261
Mode : Tx @ 904.89MHz
Test Specification : FCC-15.247, RSS-247 Peak Radiated Emissions not in Restricted Bands
Date : 4/3/2017
Test Distance : 3
Notes : Peak Detector with 100kHz Resolution Bandwidth

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)
904.90	H	58.4		2.0	26.5	0.0	86.9	22238.2		
904.90	V	77.8		2.0	26.5	0.0	106.3	206347.8		
1809.80	H	48.4		2.9	30.5	-40.0	41.8	122.4	20634.8	-44.5
1809.80	V	50.3		2.9	30.5	-40.0	43.7	152.3	20634.8	-42.6
6334.29	H	46.6		5.6	35.2	-39.4	48.0	251.2	20634.8	-38.3
6334.29	V	48.3		5.6	35.2	-39.4	49.7	305.9	20634.8	-36.6
7239.19	H	39.5		6.1	36.0	-39.4	42.2	129.0	20634.8	-44.1
7239.19	V	41.3		6.1	36.0	-39.4	44.0	157.7	20634.8	-42.3

Checked BY Richard E. King :

Richard E. King

Manufacturer : Badger Meter, Incorporated
Test Item : Water Meter
Model No. : OCE
Serial No. : 110000261
Mode : Tx @ 914.1MHz
Test Specification : FCC-15.247, RSS-247 Peak Radiated Emissions in Restricted Bands
Date : 4/3/2017
Test Distance : 3
Notes : Peak Detector with 1MHz Resolution Bandwidth

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)
2742.30	H	56.5		3.7	32.5	-39.7	53.0	446.0	5000.0	-21.0
2742.30	V	59.4		3.7	32.5	-39.7	55.9	624.9	5000.0	-18.1
3656.40	H	57.8		4.3	33.2	-39.2	56.1	636.8	5000.0	-17.9
3656.40	V	63.4		4.3	33.2	-39.2	61.7	1213.5	5000.0	-12.3
4570.50	H	56.7		4.7	34.0	-39.2	56.2	648.0	5000.0	-17.7
4570.50	V	57.8		4.7	34.0	-39.2	57.3	734.7	5000.0	-16.7
7312.80	H	49.0	*	6.2	36.0	-39.4	51.6	382.2	5000.0	-22.3
7312.80	V	49.4	*	6.2	36.0	-39.4	52.1	403.5	5000.0	-21.9
8226.90	H	49.2	*	6.5	36.0	-39.4	52.2	409.5	5000.0	-21.7
8226.90	V	49.5	*	6.5	36.0	-39.4	52.5	422.5	5000.0	-21.5
9141.00	H	48.9	*	6.6	36.6	-39.3	52.8	436.7	5000.0	-21.2
9141.00	V	48.4	*	6.6	36.6	-39.3	52.3	412.3	5000.0	-21.7

Total (dBuV/m) = Meter Reading + CBL FAC + Ant Fac + Pre Amp

Checked BY Richard E. King :

Richard E. King

Manufacturer : Badger Meter, Incorporated
Test Item : Water Meter
Model No. : OCE
Serial No. : 110000261
Mode : Tx @ 914.1MHz
Test Specification : FCC-15.247, RSS-247 Average Radiated Emissions in Restricted Bands
Date : 4/3/2017
Test Distance : 3
Notes : Average Detector with 1MHz Resolution Bandwidth

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)
2742.30	H	53.70		3.7	32.5	-39.7	-12.3	37.9	78.6	500.0	-16.1
2742.30	V	55.8		3.7	32.5	-39.7	-12.3	40.0	100.1	500.0	-14.0
3656.40	H	53.1		4.3	33.2	-39.2	-12.3	39.0	89.1	500.0	-15.0
3656.40	V	60.7		4.3	33.2	-39.2	-12.3	46.7	216.0	500.0	-7.3
4570.50	H	53.1		4.7	34.0	-39.2	-12.3	40.4	104.4	500.0	-13.6
4570.50	V	53.0		4.7	34.0	-39.2	-12.3	40.3	103.2	500.0	-13.7
7312.80	H	34.5	*	6.2	36.0	-39.4	-12.3	24.9	17.6	500.0	-29.1
7312.80	V	34.6	*	6.2	36.0	-39.4	-12.3	25.0	17.8	500.0	-29.0
8226.90	H	33.9	*	6.5	36.0	-39.4	-12.3	24.6	17.0	500.0	-29.4
8226.90	V	33.9	*	6.5	36.0	-39.4	-12.3	24.6	17.1	500.0	-29.3
9141.00	H	33.9	*	6.6	36.6	-39.3	-12.3	25.5	18.8	500.0	-28.5
9141.00	V	33.9	*	6.6	36.6	-39.3	-12.3	25.5	18.8	500.0	-28.5

Total (dBuV/m) = Meter Reading + CBL FAC + Ant Fac + Pre Amp + Duty Cycle

Checked BY Richard E. King :

Richard E. King

Manufacturer : Badger Meter, Incorporated
Test Item : Water Meter
Model No. : OCE
Serial No. : 110000261
Mode : Tx @ 914.1MHz
Test Specification : FCC-15.247, RSS-247 Peak Radiated Emissions not in Restricted Bands
Date : 4/3/2017
Test Distance : 3
Notes : Peak Detector with 100kHz Resolution Bandwidth

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)
914.10	H	62.8		2.1	26.5	0.0	91.3	36865.6		
914.10	V	76.6		2.1	26.5	0.0	105.2	181811.5		
1828.20	H	47.5		2.9	30.6	-40.0	41.1	113.3	18181.1	-44.1
1828.20	V	51.2		2.9	30.6	-40.0	44.7	172.5	18181.1	-40.5
5484.60	H	44.5		5.2	34.8	-39.4	45.1	179.4	18181.1	-40.1
5484.60	V	49.3		5.2	34.8	-39.4	49.9	313.6	18181.1	-35.3
6398.70	H	45.8		5.7	35.3	-39.4	47.4	234.7	18181.1	-37.8
6398.70	V	49.1		5.7	35.3	-39.4	50.7	344.3	18181.1	-34.5

Checked BY Richard E. King :

Richard E. King

Manufacturer : Badger Meter, Incorporated
Test Item : Water Meter
Model No. : OCE
Serial No. : 110000261
Mode : Tx @ 923.69MHz
Test Specification : FCC-15.247, RSS-247 Peak Radiated Emissions in Restricted Bands
Date : 4/3/2017
Test Distance : 3
Notes : Peak Detector with 1MHz Resolution Bandwidth

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)
2771.07	H	56.3		3.7	32.6	-39.7	52.9	440.5	5000.0	-21.1
2771.07	V	58.0		3.7	32.6	-39.7	54.6	536.3	5000.0	-19.4
3694.76	H	59.1		4.3	33.2	-39.2	57.4	740.7	5000.0	-16.6
3694.76	V	63.6		4.3	33.2	-39.2	61.9	1237.8	5000.0	-12.1
4618.45	H	55.6		4.8	34.0	-39.3	55.1	571.4	5000.0	-18.8
4618.45	V	58.7		4.8	34.0	-39.3	58.2	811.9	5000.0	-15.8
7389.52	H	49.2	*	6.2	35.9	-39.4	51.9	392.5	5000.0	-22.1
7389.52	V	46.0	*	6.2	35.9	-39.4	48.7	270.9	5000.0	-25.3
8313.21	H	49.1	*	6.5	36.1	-39.4	52.2	409.3	5000.0	-21.7
8313.21	V	48.0	*	6.5	36.1	-39.4	51.2	361.1	5000.0	-22.8

Total (dBuV/m) = Meter Reading + CBL FAC + Ant Fac + Pre Amp

Checked BY Richard E. King :

Richard E. King

Manufacturer : Badger Meter, Incorporated
Test Item : Water Meter
Model No. : OCE
Serial No. : 110000261
Mode : Tx @ 923.69MHz
Test Specification : FCC-15.247, RSS-247 Average Radiated Emissions in Restricted Bands
Date : 4/3/2017
Test Distance : 3
Notes : Average Detector with 1MHz Resolution Bandwidth

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)
2771.07	H	50.86		3.7	32.6	-39.7	-12.1	35.3	58.4	500.0	-18.7
2771.07	V	54.4		3.7	32.6	-39.7	-12.1	38.8	87.4	500.0	-15.2
3694.76	H	55.4		4.3	33.2	-39.2	-12.1	41.6	120.0	500.0	-12.4
3694.76	V	60.7		4.3	33.2	-39.2	-12.1	46.9	220.6	500.0	-7.1
4618.45	H	49.6		4.8	34.0	-39.3	-12.1	37.0	70.8	500.0	-17.0
4618.45	V	53.8		4.8	34.0	-39.3	-12.1	41.2	114.8	500.0	-12.8
7389.52	H	33.8		6.2	35.9	-39.4	-12.1	24.4	16.6	500.0	-29.6
7389.52	V	33.8	*	6.2	35.9	-39.4	-12.1	24.4	16.6	500.0	-29.6
8313.21	H	33.7	*	6.5	36.1	-39.4	-12.1	24.7	17.3	500.0	-29.2
8313.21	V	33.7	*(	6.5	36.1	-39.4	-12.1	24.7	17.2	500.0	-29.3

Total (dBuV/m) = Meter Reading + CBL FAC + Ant Fac + Pre Amp + Duty Cycle

Checked BY Richard E. King :

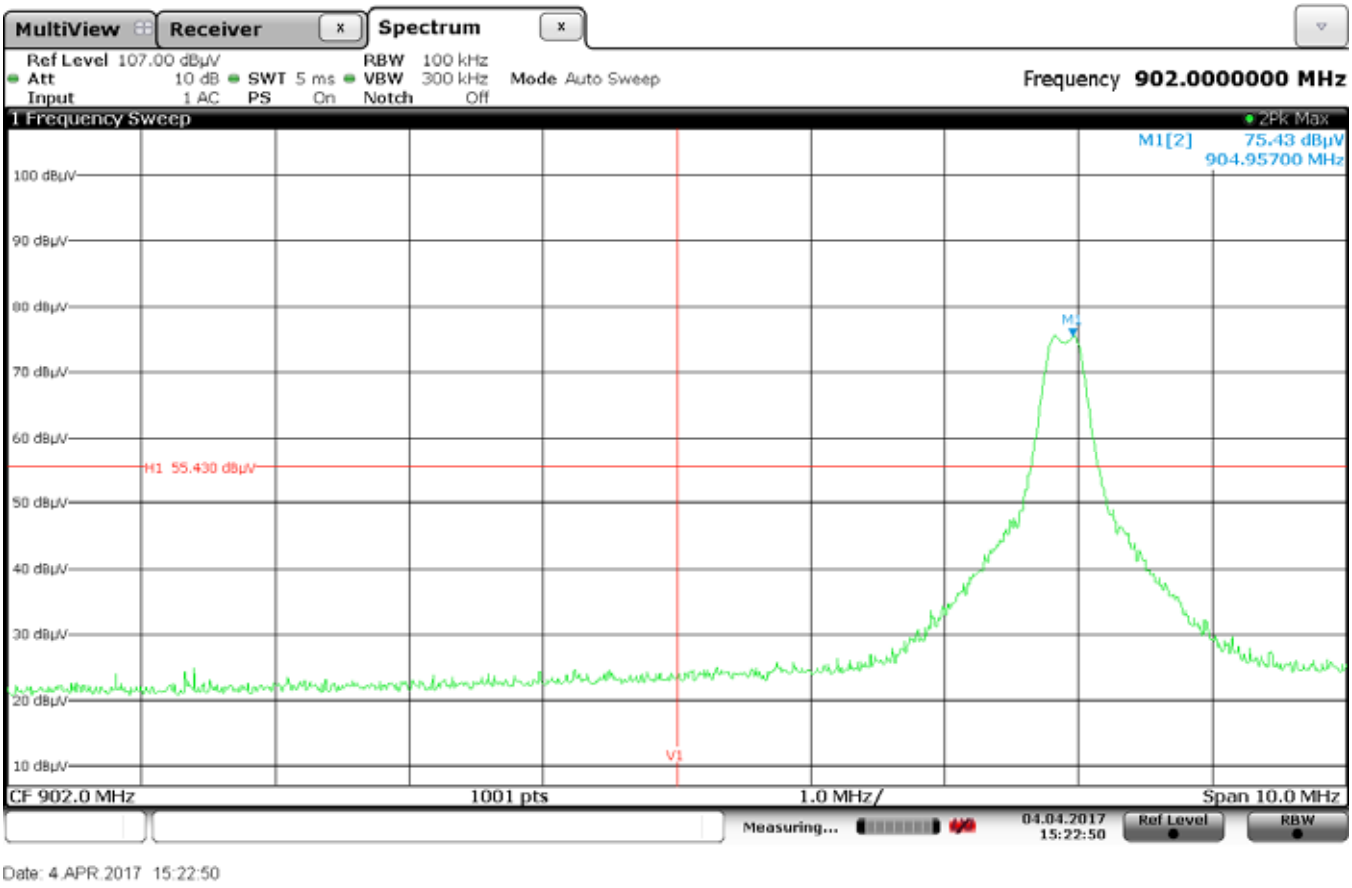
Richard E. King

Manufacturer : Badger Meter, Incorporated
Test Item : Water Meter
Model No. : OCE
Serial No. : 110000261
Mode : Tx @ 923.69MHz
Test Specification : FCC-15.247, RSS-247 Peak Radiated Emissions not in Restricted Bands
Date : 4/3/2017
Test Distance : 3
Notes : Peak Detector with 100kHz Resolution Bandwidth

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)
923.69	H	66.4		2.1	26.5	0.0	94.9	55739.0		
923.69	V	77.1		2.1	26.5	0.0	105.6	190835.5		
1847.38	H	46.4		3.0	30.8	-40.0	40.1	101.2	19083.5	-45.5
1847.38	V	51.6		3.0	30.8	-40.0	45.4	185.2	19083.5	-40.3
5542.14	H	43.6		5.2	34.8	-39.4	44.2	163.1	19083.5	-41.4
5542.14	V	45.4		5.2	34.8	-39.4	46.1	200.9	19083.5	-39.6
6465.83	H	45.5		5.7	35.5	-39.4	47.3	230.4	19083.5	-38.4
6465.83	V	46.0		5.7	35.5	-39.4	47.8	245.2	19083.5	-37.8
9236.90	H	39.3	*	6.6	36.6	-39.3	43.2	144.7	19083.5	-42.4
9236.90	V	38.5	*	6.6	36.6	-39.3	42.4	132.2	19083.5	-43.2

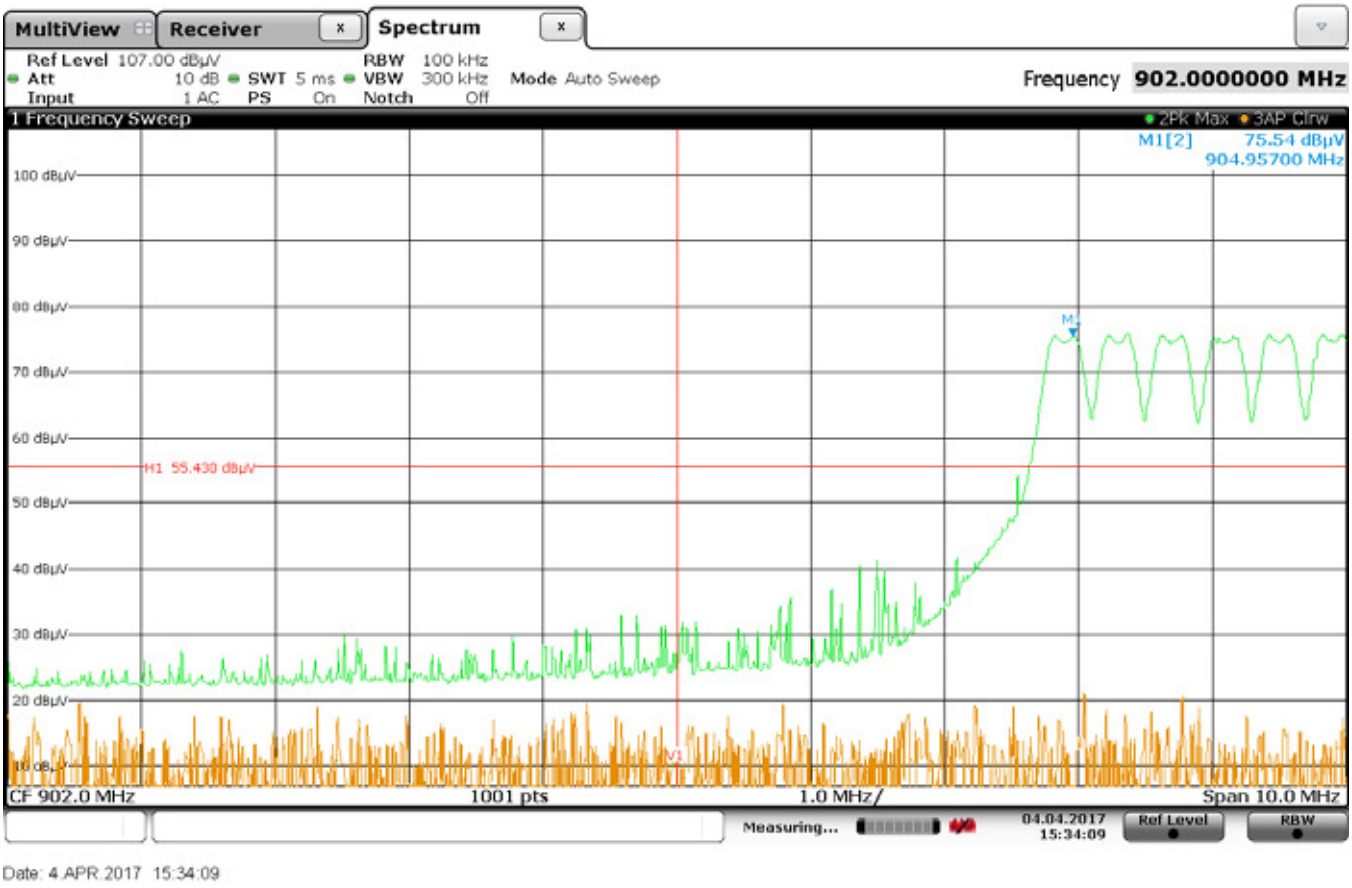
Checked BY Richard E. King :

Richard E. King



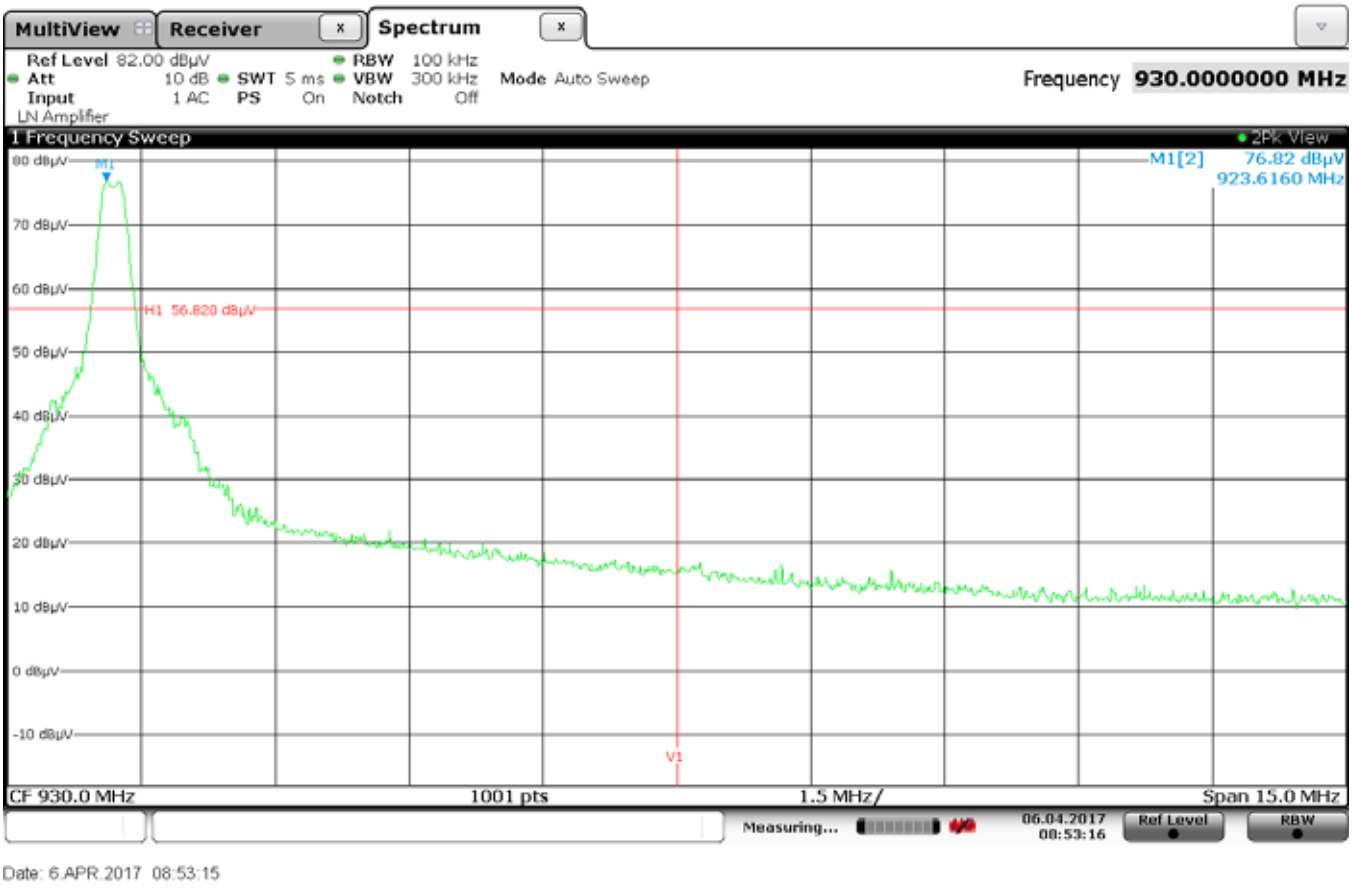
FCC 15.247(d) Band Edge Compliance

Manufacturer	:	Badger Meter, Incorporated
Model Number	:	OCE
Serial Number	:	110000261
Mode	:	Tx @ 904.89MHz
Parameters	:	Band Edge Test
Date	:	4/4/2017
Notes	:	Display Line H1 represents the 20dB down point from the peak emissions in a 100kHz bandwidth. Display Line V1 represents the band edge (902MHz).



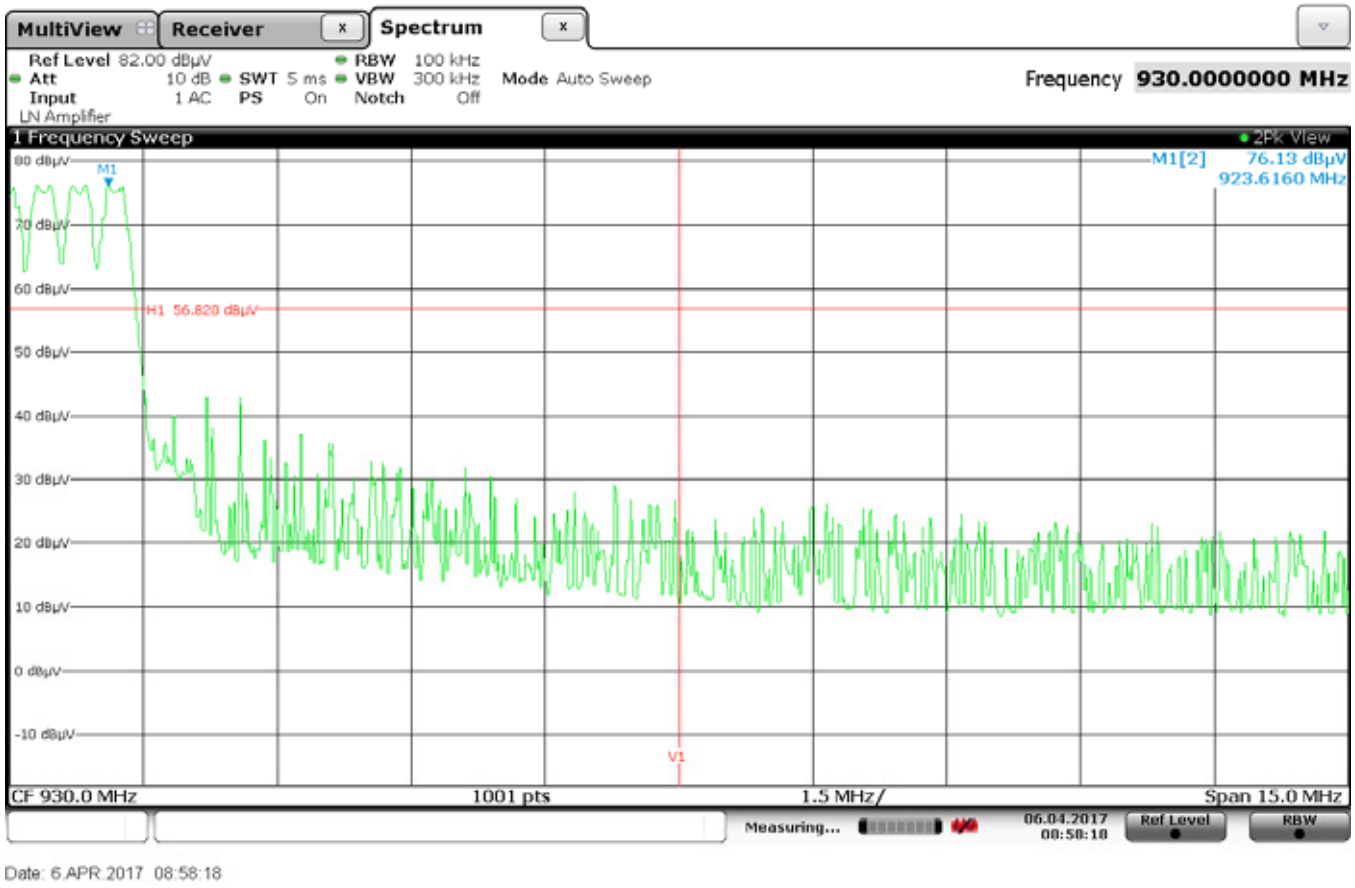
FCC 15.247(d) Band Edge Compliance

Manufacturer	:	Badger Meter, Incorporated
Model Number	:	OCE
Serial Number	:	110000261
Mode	:	Frequency Hopping
Parameters	:	Band Edge Test
Date	:	4/4/2017
Notes	:	Display Line H1 represents the 20dB down point from the peak emissions in a 100kHz bandwidth. Display Line V1 represents the band edge (902MHz)



FCC 15.247(d) Band Edge Compliance

Manufacturer	:	Badger Meter, Incorporated
Model Number	:	OCE
Serial Number	:	110000261
Mode	:	Tx @ 923.69MHz
Parameters	:	Band Edge Test
Date	:	4/4/2017
Notes	:	Display Line H1 represents the 20dB down point from the peak emissions in a 100kHz bandwidth. Display Line V1 represents the band edge (930MHz).



FCC 15.247(d) Band Edge Compliance

Manufacturer	:	Badger Meter, Incorporated
Model Number	:	OCE
Serial Number	:	110000261
Mode	:	Frequency Hopping
Parameters	:	Band Edge Test
Date	:	4/4/2017
Notes	:	Display Line H1 represents the 20dB down point from the peak emissions in a 100kHz bandwidth. Display Line V1 represents the band edge (930MHz).