



## Measurement of RF Emissions from a Wireless Module Transmitter

---

For	Amatis Controls 210 Aspen Airport Business Center, Suite A Aspen, CO 81611
P.O. Number	PO-00093
Date Tested	August 31 – October 10, 2017
Test Personnel	Tylar Jozefczyk
Test Specification	FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.247 for Digital Modulation Intentional Radiators Operating within The bands 902-928MHz, 2400-2483.5MHz, and 5725-5850MHz Industry Canada RSS-GEN Industry Canada RSS-247

Test Report By:

A handwritten signature in black ink, appearing to read "Tylar Jozefczyk".

Tylar Jozefczyk  
EMC Engineer

Requested By:

Amatis Controls

Approved By:

A handwritten signature in black ink, appearing to read "Raymond J. Klouda".

Raymond J. Klouda  
Registered Professional  
Engineer of Illinois - 44894

PARAGRAPH	DESCRIPTION OF CONTENTS	PAGE NO.
1.	Introduction.....	5
1.1.	Scope of Tests.....	5
1.2.	Purpose .....	5
1.3.	Deviations, Additions and Exclusions.....	5
1.4.	EMC Laboratory Identification .....	5
1.5.	Laboratory Conditions.....	5
2.	Applicable Documents.....	5
3.	EUT Setup and Operation.....	6
3.1.	General Description .....	6
3.1.1.	Power Input.....	6
3.1.2.	Peripheral Equipment .....	6
3.1.3.	Signal Input/Output Leads .....	6
3.1.4.	Grounding .....	6
3.2.	Operational Mode .....	6
3.3.	EUT Modifications.....	6
4.	Test Facility and Test Instrumentation .....	6
4.1.	Shielded Enclosure.....	6
4.2.	Test Instrumentation.....	7
4.3.	Calibration Traceability .....	7
4.4.	Measurement Uncertainty .....	7
5.	Test Procedures .....	7
5.1.	Powerline Conducted Emissions .....	7
5.1.1.	Requirements.....	7
5.1.2.	Procedures.....	8
5.1.3.	Results .....	8
5.2.	6dB Bandwidth.....	8
5.2.1.	Requirement.....	8
5.2.2.	Procedures.....	8
5.2.3.	Results .....	9
5.3.	Peak Output Power.....	9
5.3.1.	Requirements.....	9
5.3.2.	Procedures.....	9
5.3.3.	Results .....	9
5.4.	Duty Cycle Factor Measurements .....	9
5.4.1.	Requirements.....	9
5.4.2.	Procedures.....	10
5.4.3.	Results .....	10
5.5.	Radiated Spurious Emissions Measurements.....	10
5.5.1.	Requirements.....	10
5.5.2.	Procedures.....	10
5.5.3.	Results .....	12
5.6.	Band Edge Compliance .....	12

 THIS REPORT SHALL NOT BE REPRODUCED, EXCEPT IN FULL, WITHOUT THE  
 WRITTEN APPROVAL OF ELITE ELECTRONIC ENGINEERING INCORPORATED.

## TABLE OF CONTENTS

PARAGRAPH	DESCRIPTION OF CONTENTS	PAGE NO.
5.6.1.	Requirement.....	12
5.6.2.	Procedures.....	12
5.6.2.1	Low Band Edge .....	12
5.6.2.2	High Band Edge.....	13
5.6.3.	Results .....	13
5.7.	Power Spectral Density .....	13
5.7.1.	Requirements.....	13
5.7.2.	Procedures.....	13
5.7.3.	Results .....	14
6.	Other Test Conditions .....	14
6.1.	Test Personnel and Witnesses.....	14
6.2.	Disposition of the EUT .....	14
7.	Conclusions .....	14
8.	Certification.....	14
9.	Equipment List.....	15

THIS REPORT SHALL NOT BE REPRODUCED, EXCEPT IN FULL, WITHOUT THE  
WRITTEN APPROVAL OF ELITE ELECTRONIC ENGINEERING INCORPORATED.

## REVISION HISTORY

Revision	Date	Description
—	02 Nov 2017	Initial release
A	09 Nov 2017 by TMJ	<ul style="list-style-type: none"><li>- Changed report number from 1702208-01 to 1702208-01 Rev. A on title page and in all headers.</li><li>- Changed manufacturer and address from Four Lakes Technology LLC to Amatis Controls.</li><li>- Changed requestor from Charles J Gervasi to Amatis Controls.</li></ul>
B	06 Dec 2017 by TMJ	<ul style="list-style-type: none"><li>- Changed report number from 1702208-01 Rev. A to 1702208-01 Rev. B on title page and in all headers.</li><li>- Changed manufacturer name on Conducted Emissions data pages from Four Lakes CC to Amatis Controls. Note added in section 5.5.3 about name differentiation on plots.</li><li>- Updated section 3.1.</li></ul>

## Measurement of RF Emissions from a Wireless Module Transmitter

### 1. INTRODUCTION

#### 1.1. Scope of Tests

This report represents the results of the series of radio interference measurements performed on an Amatis Controls Wireless Module transmitter (hereinafter referred to as the EUT). The EUT is a digital modulation transmitter. The transmitter was designed to transmit in the 2400-2483.5 MHz band using an internal antenna. The EUT was manufactured and submitted for testing by Amatis Controls located in Aspen, CO.

#### 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 8.8 and the radiated RF emission requirements of the Industry Canada Radio Standards Specification, RSS-247, Section 5 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 Certificate Number: 1786.01.

#### 1.5. Laboratory Conditions

The temperature at the time of the test was 23°C and the relative humidity was 36.5%.

### 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 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"
- Federal Communications Commission Office of Engineering and Technology Laboratory Division Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under Section 15.247, October 4, 2012
- Industry Canada Radio Standards Specification, RSS-Gen, "General Requirements for Compliance of Radio Apparatus", Issue 4, November 2014
- Industry Canada Radio Standards Specification, RSS-247, "Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices", Issue 2, February 2017

### 3. EUT SETUP AND OPERATION

#### 3.1. General Description

The EUT is an Amatis Controls Wireless Module. A block diagram of the EUT setup is shown as Figure 1. The EUT modular board contains the following:

- A Microchip AT86RF23X AVR Transceiver that operates between 2400-2480MHz.
- A Nordic Semiconductor nRF52832 System on Chip that operates between 2402-2462MHz as a Bluetooth SoC.
- A Skyworks SKY66112-11 RF front-end module interface
- 2 different antennas (3 total overall): two Johanson Technology 2450AT18A100E ZigBee Antennas and one Molex 0479480001 BLE Antenna.

##### 3.1.1. Power Input

The EUT was powered with 12VDC through 1-meter, unshielded leads. For the board used for Conducted Emissions, the EUT was powered with 3.3VDC through 1-meter, unshielded leads.

##### 3.1.2. Peripheral Equipment

The following peripheral equipment was submitted with the EUT:

Item	Description
Secondary Board	A second board with a 3.3VDC voltage used only for Conducted Emissions testing

##### 3.1.3. Signal Input/Output Leads

No interconnect cables were submitted with the EUT.

##### 3.1.4. Grounding

Since only two wires were used to provide the input power, the EUT was ungrounded during the tests. The third primary input terminal of the transformer was not used.

### 3.2. Operational Mode

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

- Transmit at one of the following ZigBee frequencies:
  - 2405MHz
  - 2446MHz
  - 2480MHz
- Bluetooth Low Energy transmit at one of the following frequencies:
  - 2402MHz
  - 2446MHz
  - 2480MHz

802.15.4 ZigBee Tx – The EUT was set to transmit a modulated ZigBee 802.15.4 signal on one of two antennas.

BLE – The EUT was set to transmit a BLE signal.

#### 3.3. EUT Modifications

No modifications were required for compliance to the FCC 15.247 standard.

### 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. 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 120kHz for the 30MHz to 1000MHz radiated emissions data and 1MHz for the 1000MHz to 5000MHz radiated emissions data.

#### 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 (dB $\mu$ V)	
	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 802.15.4 ZigBee Tx mode.
- b) Measurements were first made on the 3.3VDC high line.
- 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 3.3VDC neutral line.
- h) Steps (a) through (g) were repeated with the EUT operating in the BLE mode.

### 5.1.3. Results

The plots and tabular data of the peak, quasi-peak, and average conducted voltage levels acquired from each input power line with the EUT operated in the 802.15.4 ZigBee Tx mode are shown on pages 22 through 29. 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 0.159MHz. The emissions level at this frequency was 48dB within the limit. Photographs of the test configuration which yielded the highest or worst case, conducted emission levels are shown as Figure 2.

## 5.2. 6dB Bandwidth

### 5.2.1. Requirement

Per 15.247(a)(2), the minimum 6dB bandwidth shall be at least 500kHz for all systems using digital modulation techniques.

### 5.2.2. Procedures

The EUT was allowed to transmit continuously. The transmit channel was set separately to low, middle, and high channels. The resolution bandwidth (RBW) was set to 100kHz and the span was set to greater than the RBW.

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 30 through 41 show that the minimum 6dB bandwidth for 802.15.4 ZigBee Tx was 1.30MHz, which is greater than the minimum allowable 6dB bandwidth requirement of 500kHz for systems using digital modulation techniques. The 99% bandwidth was measured to be 2.2577MHz.

The plots on pages 30 through 41 also show that the minimum 6dB bandwidth for BLE was 739kHz, which is greater than the minimum allowable 6dB bandwidth requirement of 500kHz for systems using digital modulation techniques. The 99% bandwidth was measured to be 1.11888MHz.

## 5.3. Peak Output Power

### 5.3.1. Requirements

Per section 15.247(b)(3), for systems using digital modulation the maximum peak output conducted power shall not be greater than 1.0W (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).

A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released. Also, a transmitter activated automatically shall cease transmission within 5 seconds after activation.

### 5.3.2. Procedures

For the radiated emissions method, the EUT was placed on the non-conductive stand and set to transmit. A double ridged waveguide 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 6dB 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 channels.

The equivalent power was determined from the field intensity levels measured at 3 meters using the substitution method. To determine the emission power, a second double ridged waveguide 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 and antenna gain, as required. The peak power output was calculated for low, middle, and high hopping frequencies.

### 5.3.3. Results

For the radiated emissions method, the results are presented on pages 42 and 43. The maximum EIRP measured from the transmitter in the 802.15.4 ZigBee Tx mode was 0.04365W (16.4dBm), which is below the 1 Watt limit. The maximum EIRP measured from the transmitter in the BLE mode was 0.00158W (2.0dBm), which is below the 1 Watt limit.

## 5.4. Duty Cycle Factor Measurements

### 5.4.1. Requirements

Unless otherwise specified, 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. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

#### 5.4.2 Procedures

- a) The EUT was placed on the non-conductive stand and set to transmit continuously.
- b) A double ridged waveguide antenna was positioned at a 3 meter distance from the EUT. The output of the antenna was connected to the input of a spectrum analyzer.
- c) The center frequency of the spectrum analyzer was set to the transmit frequency of the EUT.
- d) The frequency span of the spectrum analyzer was set to 0Hz so that the time domain trace of the transmitted pulse of the EUT was displayed on the spectrum analyzer.
- e) The sweep time of the spectrum analyzer was adjusted so that the beginning and end of a single pulse could be seen on the display of the spectrum analyzer.
- f) The single sweep function of the spectrum analyzer was used multiple times to determine the maximum pulse width of the EUT.
- g) The maximum pulse width display of the spectrum analyzer was recorded and then plotted using a 'screen dump' utility.
- h) The sweep time of the spectrum analyzer was then adjusted to 100msec.
- i) The single sweep function of the spectrum analyzer was used multiple times to determine the maximum number of transmitted pulses that occurred in a 100msec time period.
- j) The maximum number of pulses transmitted in a 100msec time period was recorded and then plotted using a 'screen dump' utility.
- k) The duty cycle correction was calculated using the following equation:

$$\text{Duty Cycle Correction Factor (dB)} = \text{D.C. (dB)}$$

$$\text{D.C. (dB)} = 20 \times \log [(\text{pulse width (msec)}) \times (\#\text{pulses in a 100msec period})] / 100\text{msec}]$$

#### 5.4.3 Results

Duty cycle plots are shown on pages 44 and 45. The EUT transmits a 4 $\mu$ S pulse 140 times in a 100msec period. This results in a duty cycle correction factor of -45.0 dB.

### 5.5. Radiated Spurious Emissions Measurements

#### 5.5.1 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).

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

#### 5.5.2 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

C63.4-2014 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 25GHz was investigated using a peak detector function.

The final open field emission tests were then manually performed over the frequency range of 30MHz to 25GHz.

- 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 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 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. 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 axes 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. 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 axes 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  $20 \times \log(\text{on time}/100\text{msec})$ . These readings must be no greater than the limits specified in 15.209(a).

### 5.5.3. Results

Preliminary radiated emissions plots with the EUT transmitting at 802.15.4 ZigBee Tx channels and BLE channels are shown on pages 46 through 93. Final radiated emissions data are presented on data pages 94 through 111. As can be seen from the data, all emissions measured from the EUT were within the specification limits. The emissions level closest to the limit (worst case) occurred at RE Freq. The emissions level at this frequency was RE level 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 Figures 3 through 5.

Note: The plots in this section have Four Lakes CC as manufacturer instead of Amatis Controls. Four Lakes was the contractor for Amatis Controls.

## 5.6. Band Edge Compliance

### 5.6.1. 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.

### 5.6.2. Procedures

#### 5.6.2.1 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.
- 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)  $\geq 1\%$  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.

#### 5.6.2.2 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 maximized for worst case emissions at the measuring antenna. A peak reading was taken with a resolution bandwidth of 1MHz and a video bandwidth of 1MHz or greater. An average reading was then taken with a resolution bandwidth of 1MHz and a video bandwidth of 10Hz. The maximum peak and average meter readings were recorded.
- 4) 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 both the peak level of the fundamental emission and the band-edge emission under investigation.
  - c) Resolution bandwidth (RBW) = 1% of the span (but never less than 30kHz).
  - 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. This level corresponds to the maximized peak (or average) reading previously taken. The "marker-delta" method described in Public Notice DA 00-705 was then used to determine band edge compliance. The delta between the marker and the general limit (74dB $\mu$ V/m or 54dB $\mu$ V/m) was calculated by subtracting the general limit (74dB $\mu$ V/m or 54dB $\mu$ V/m) from the maximum reading taken with a 1MHz bandwidth. This delta represents how far below the marker the emissions outside of the authorized band of operation must be. A display line was placed at this level. All emissions which fall outside of the authorized band of operation must be below the 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.

In accordance with paragraph 15.247(d), the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

#### 5.6.3. Results

Pages 112 through 115 show the radiated band-edge compliance results. As can be seen from these plots, the radiated emissions at the low end band-edge are within the 20 dB down limits. The radiated emissions at the high end band-edge are within the general limits.

### 5.7. Power Spectral Density

#### 5.7.1. Requirements

Per section 15.247(d), the peak power spectral density from the intentional radiator shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

#### 5.7.2. Procedures

- 1) The EUT was placed on the non-conductive stand and set to transmit at a mid-channel.
- 2) A broadband measuring antenna was placed near the EUT.
- 3) To determine the power spectral density, the following spectrum analyzer settings were used:
  - a) Center frequency = transmit frequency
  - b) Resolution bandwidth (RBW) greater than the 20dB bandwidth.
  - c) Sweep time = auto
  - d) The peak detector and 'Max-Hold' function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined.
  - e) The analyzer's display was plotted using a 'screen dump' utility.
- 4) This reading corresponds to the peak EIRP measured for the mid channel.
- 5) Turn on Display Line 1 and place it at the peak of the measured level. Turn on Display Line 2 and

place it at the corresponding +8dBm level (e.g. if the peak output power is +18dBm then the +8dBm level will be 10dB down from the radiated level and if the peak output power is +6dBm then the +8dBm level will be 2dB above the radiated level.)

- 6) The EUT was then placed in the 802.15.4 ZigBee Tx mode.
- 7) To determine the power spectral density, the following spectrum analyzer settings were used:
  - a) Center frequency = transmit frequency
  - b) Span = 1.5 times the channel bandwidth
  - c) Resolution bandwidth (RBW)  $\geq 3\text{kHz}$
  - d) Video bandwidth (VBW)  $\geq 3 \times \text{RBW}$
  - e) Sweep time = auto couple
  - f) The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined. The peak detector and 'Max-Hold' function was engaged.
  - g) The analyzer's display was plotted using a 'screen dump' utility.
  - h) If the measured value exceeds the +8dBm limit, reduce the RBW (no less than 3kHz) and repeat step 7.
- 8) Step 7 was repeated with the EUT placed in BLE mode.

#### 5.7.3. Results

Pages 116 and 121 show the power spectral density results. As can be seen from the plots, the peak power density is less than 8dBm in a 3kHz band during any time interval of continuous transmission.

### 6. OTHER TEST CONDITIONS

#### 6.1. Test Personnel and Witnesses

All tests were performed by qualified personnel from Elite Electronic Engineering Incorporated.

#### 6.2. Disposition of the EUT

The EUT and all associated equipment were returned to Amatis Controls upon completion of the tests.

### 7. CONCLUSIONS

It was determined that the Amatis Controls Wireless Module digital modulation transmitter 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 2400-2483.5 MHz band, when tested per ANSI C63.4-2014.

It was also determined that the Amatis Controls Wireless Module digital modulation transmitter did fully meet the conducted and radiated RF emission requirements of the Industry Canada Radio Standards Specification, RSS-Gen Section 8.8 and RSS-247 Section 5, for transmitters, when tested per ANSI C63.4-2014.

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

## 9. EQUIPMENT LIST

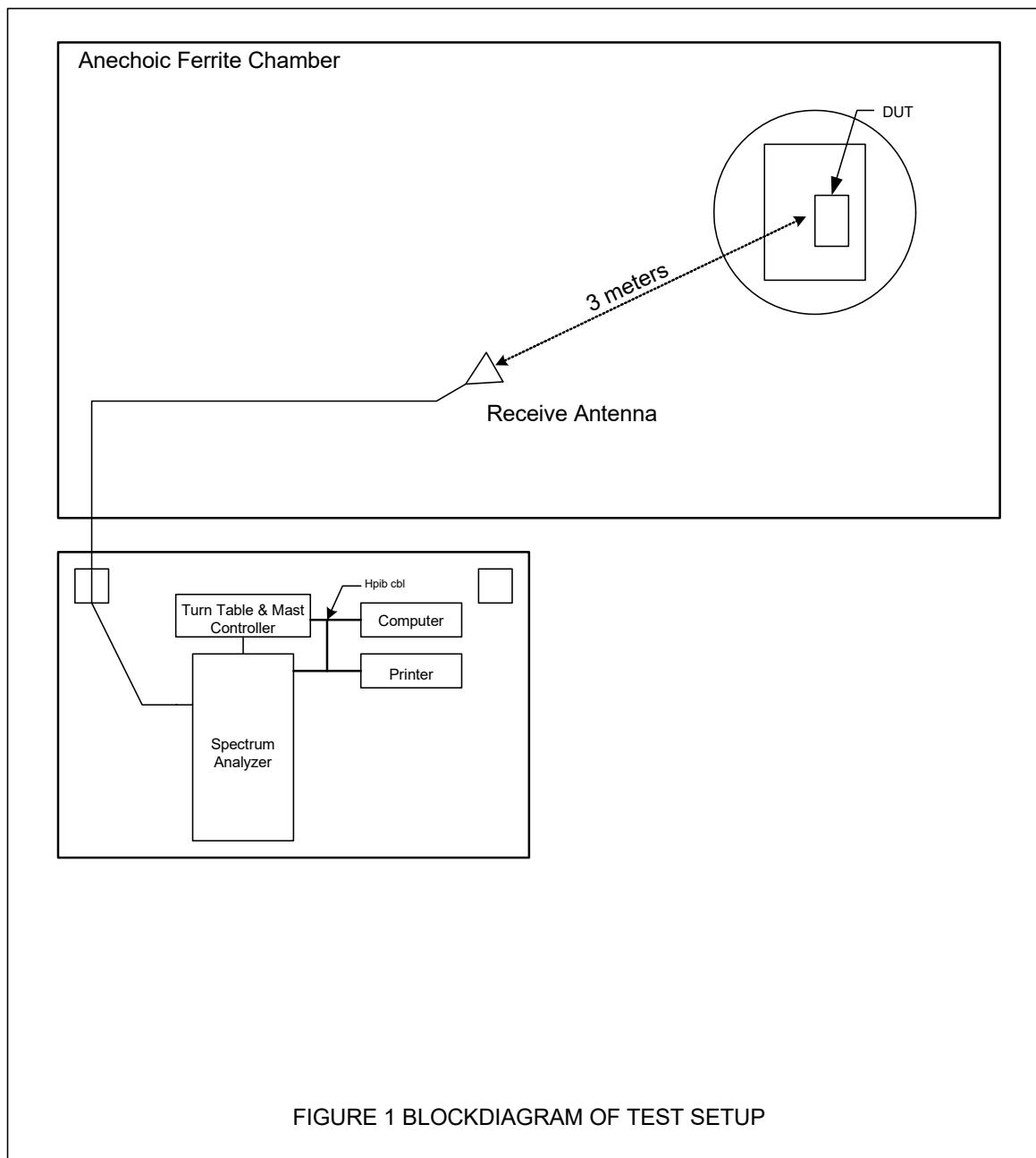
**Table 9-1 Equipment List**

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
APW0	PREAMPLIFIER	PLANAR ELECTRONICS	PE2-30-20G20R6G	PL2926/0646	20GHZ-26.5GHZ	3/22/2017	3/22/2018
APW11	PREAMPLIFIER	PMI	PE2-35-120-5R0-10-12-SFF	PL11685/1241	1GHZ-20GHZ	3/22/2017	3/22/2018
CDY0	WORKSTATION	ELITE	WORKSTATION		WINDOWS 7	N/A	
GRB0	1MHZ, LISN SIGNAL CHECKER	ELITE	LISNCHKR1M	1	1MHZ	1/12/2017	1/12/2018
NHG0	STANDARD GAIN HORN ANTENNA	NARDA	638	---	18-26.5GHZ	NOTE 1	
NTA4	BILOG ANTENNA	TESEQ	6112D	46660	20-2000GHZ	8/18/2017	8/18/2018
PHA0	MAGNETIC FIELD PROBE	ELECTRO-METRICS	EM-6882	134	22-230MHZ	NOTE 1	
PLF1	CISPR16 50UH LISN	ELITE	CISPR16/70A	001	.15-30MHz	5/8/2017	5/8/2018
PLF3	CISPR16 50UH LISN	ELITE	CISPER16/70A	003	.15-30MHz	5/8/2017	5/8/2018
RBG0	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	101533	10HZ-44GHZ	11/10/2016	11/10/2017
RBG3	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	101592	2HZ-44GHZ	1/11/2017	1/11/2018
SES0	24VDC POWER SUPPLY	P-TRANS	FS-32024-1M	001	18-27VDC	NOTE 1	
T1E8	10DB 25W ATTENUATOR	WEINSCHEL	46-10-34	BH7996	DC-18GHZ	7/6/2016	7/6/2018
VBR8	CISPR EN FCC CE VOLTAGE.exe						
WKA1	SOFTWARE, UNIVERSAL RCV EMI	ELITE	UNIV_RCV_EMI	1	---	I/O	
XLQY	5W, 50 OHM TERMINATION	JFW INDUSTRIES	50T-052	---	DC-2GHZ	7/7/2016	7/7/2018
XPRO	HIGH PASS FILTER	K&L MICROWAVE	11SH10-4800/X20000	001	4.8-20GHZ	9/12/2017	9/12/2019

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.



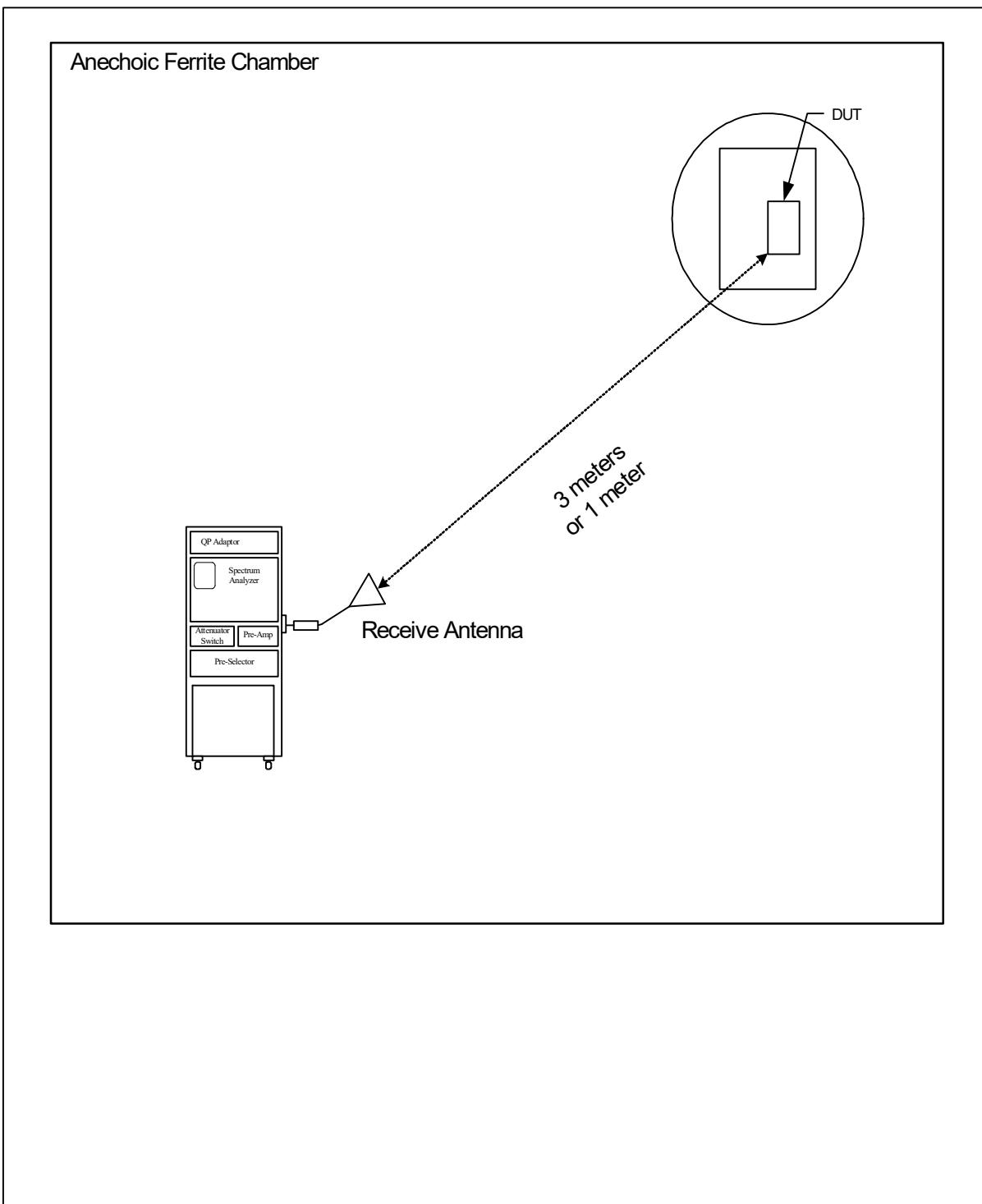


Figure 2



Test Setup for Conducted Emissions

Figure 3

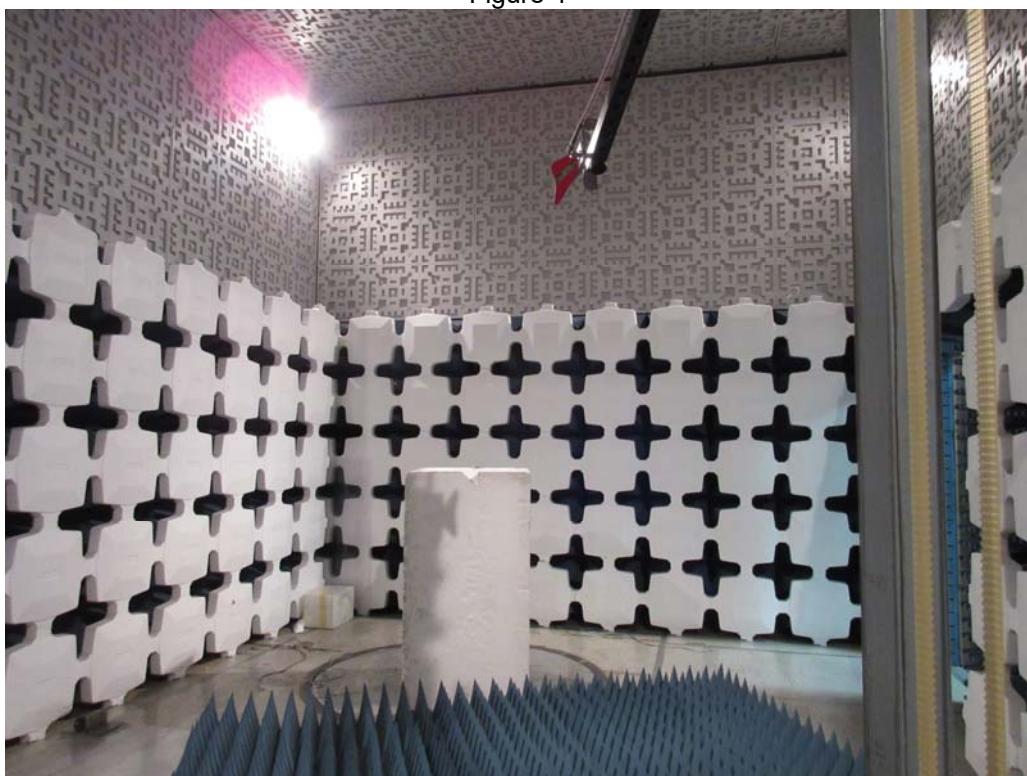


Test Setup for Radiated Emissions, 30MHz to 1GHz – Horizontal Polarization



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

Figure 4



Test Setup for Radiated Emissions, 1 to 18GHz – Horizontal Polarization



Test Setup for Radiated Emissions, 1 to 18GHz – Vertical Polarization

Figure 5



Test Setup for Radiated Emissions, 18 to 25GHz – Horizontal Polarization



Test Setup for Radiated Emissions, 18 to 25GHz – Vertical Polarization

## FCC Part 15 Subpart B Conducted Emissions Test

### Significant Emissions Data

VBR8 04/23/2015

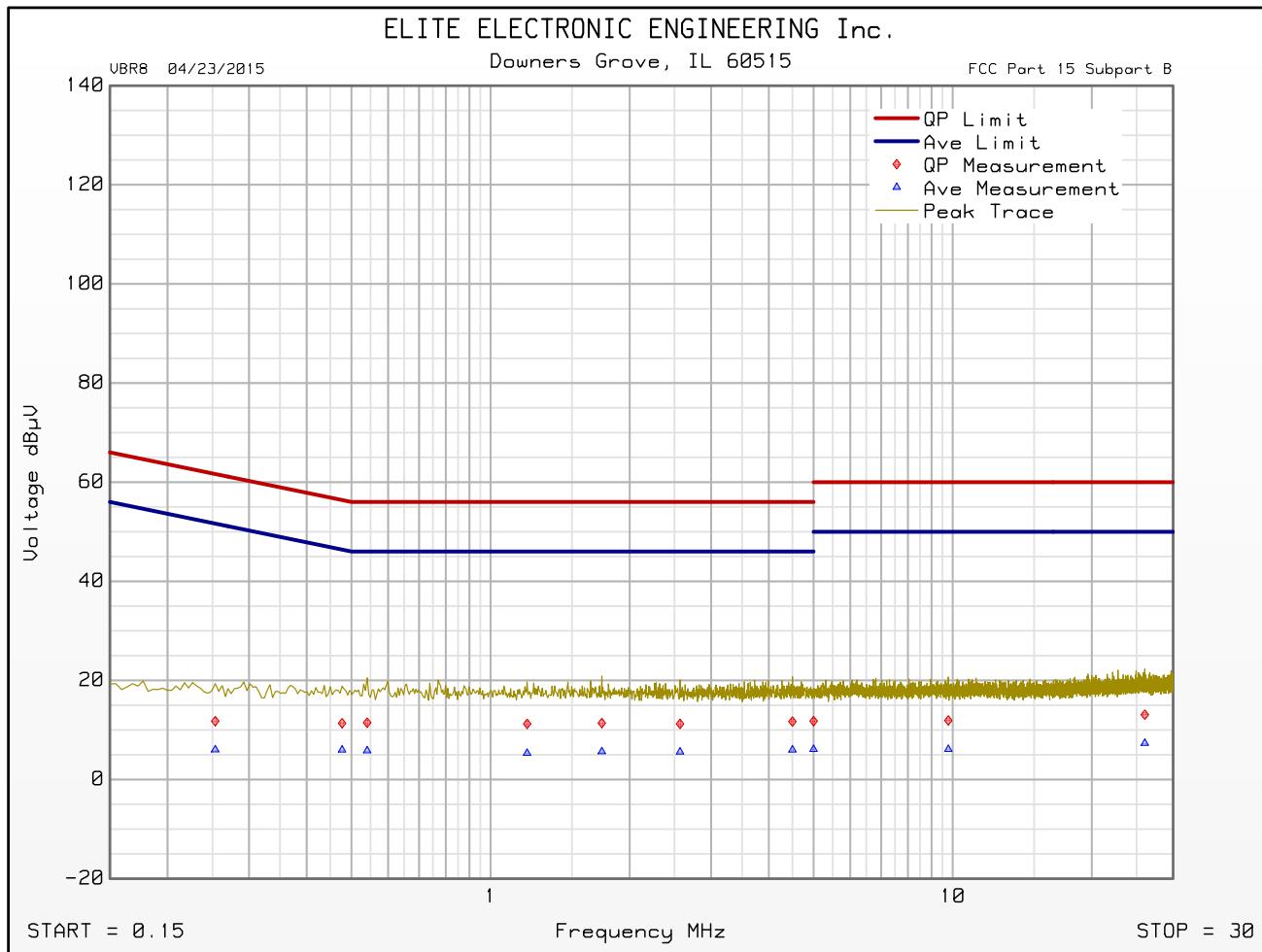
Manufacturer : AMATIS CONTROLS  
Model : RF MODULE  
DUT Revision : 1.1  
Serial Number :  
DUT Mode : TX 2445MHz  
Line Tested : L1  
Scan Step Time [ms] : 30  
Meas. Threshold [dB] : -2  
Notes : ZIGBEE  
Test Engineer : R. King  
Limit : Class B  
Test Date : Oct 10, 2017 04:17:27 PM  
Data Filter : Up to 80 maximum levels detected with 6 dB level excursion threshold over 2 dB margin below limit

Freq MHz	Quasi-peak Level dB $\mu$ V	Quasi-peak Limit dB $\mu$ V	Excessive Quasi-peak Emissions	Average Level dB $\mu$ V	Average Limit dB $\mu$ V	Excessive Average Emissions
0.254	11.8	61.6		6.0	51.6	
0.477	11.4	56.4		6.0	46.4	
0.541	11.5	56.0		5.8	46.0	
1.200	11.2	56.0		5.3	46.0	
1.741	11.4	56.0		5.6	46.0	
2.570	11.2	56.0		5.6	46.0	
5.000	11.8	56.0		6.1	46.0	
9.783	11.9	60.0		6.1	50.0	
26.047	13.1	60.0		7.3	50.0	

## FCC Part 15 Subpart B Conducted Emissions Test Cumulative Data

VBR8 04/23/2015

Manufacturer : AMATIS CONTROLS  
Model : RF MODULE  
DUT Revision : 1.1  
Serial Number :  
DUT Mode : TX 2445MHz  
Line Tested : L1  
Scan Step Time [ms] : 30  
Meas. Threshold [dB] : -2  
Notes : ZIGBEE  
Test Engineer : R. King  
Limit : Class B  
Test Date : Oct 10, 2017 04:17:27 PM



Emissions Meet QP Limit  
Emissions Meet Ave Limit

## FCC Part 15 Subpart B Conducted Emissions Test

### Significant Emissions Data

VBR8 04/23/2015

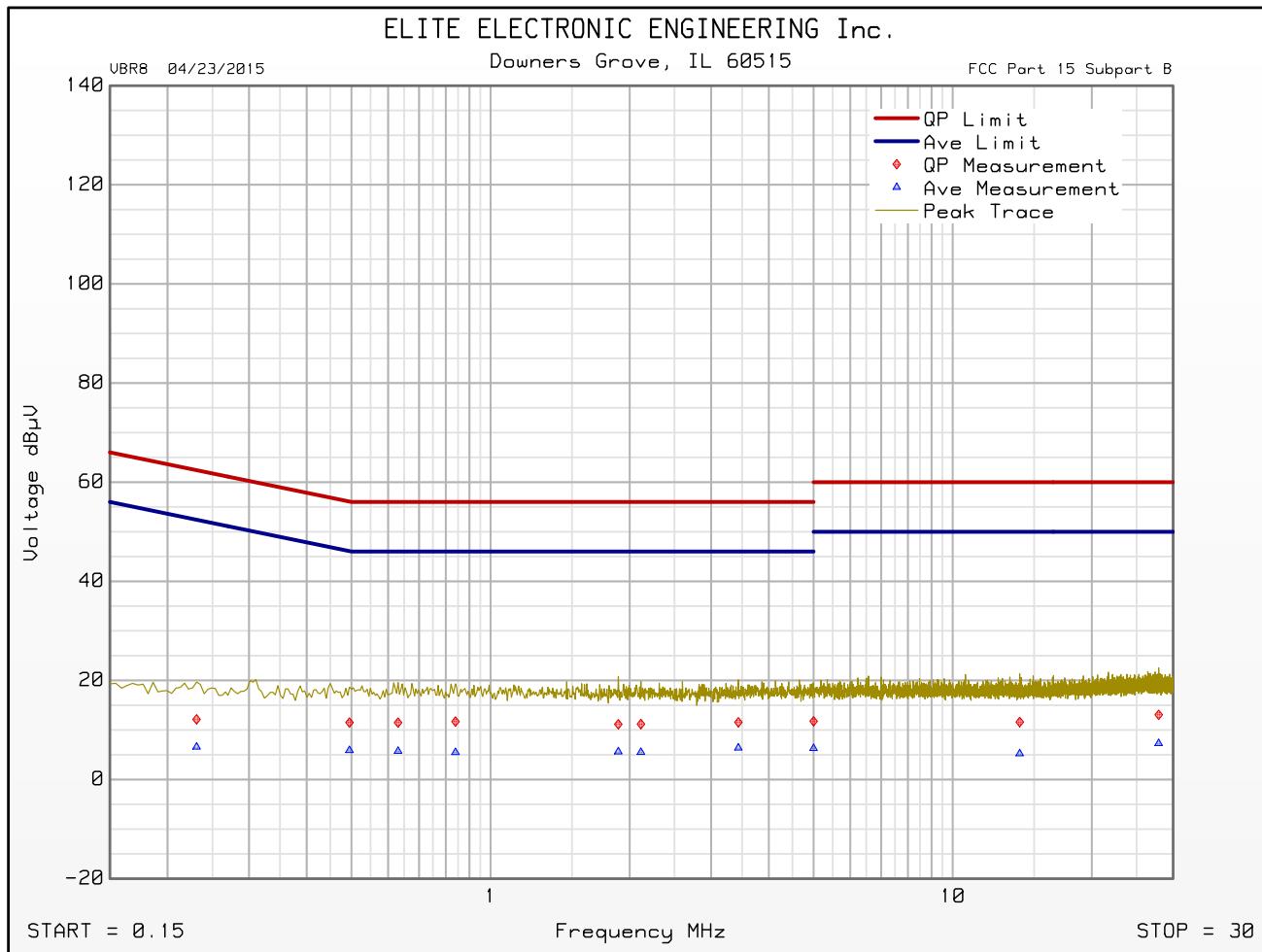
Manufacturer : AMATIS CONTROLS  
 Model : RF MODULE  
 DUT Revision : 1.1  
 Serial Number :  
 DUT Mode : TX 2445MHz  
 Line Tested : L2  
 Scan Step Time [ms] : 30  
 Meas. Threshold [dB] : -2  
 Notes : ZIGBEE  
 Test Engineer : R. King  
 Limit : Class B  
 Test Date : Oct 10, 2017 04:09:27 PM  
 Data Filter : Up to 80 maximum levels detected with 6 dB level excursion threshold over 2 dB margin below limit

Freq MHz	Quasi-peak Level dB $\mu$ V	Quasi-peak Limit dB $\mu$ V	Excessive Quasi-peak Emissions	Average Level dB $\mu$ V	Average Limit dB $\mu$ V	Excessive Average Emissions
0.231	12.1	62.4		6.6	52.4	
0.495	11.5	56.1		5.9	46.1	
0.631	11.5	56.0		5.7	46.0	
0.840	11.7	56.0		5.5	46.0	
1.889	11.2	56.0		5.6	46.0	
2.115	11.2	56.0		5.5	46.0	
5.000	11.8	56.0		6.3	46.0	
13.964	11.6	60.0		5.2	50.0	
27.910	13.1	60.0		7.3	50.0	

## FCC Part 15 Subpart B Conducted Emissions Test Cumulative Data

VBR8 04/23/2015

Manufacturer : AMATIS CONTROLS  
Model : RF MODULE  
DUT Revision : 1.1  
Serial Number :  
DUT Mode : TX 2445MHz  
Line Tested : L2  
Scan Step Time [ms] : 30  
Meas. Threshold [dB] : -2  
Notes : ZIGBEE  
Test Engineer : R. King  
Limit : Class B  
Test Date : Oct 10, 2017 04:09:27 PM



Emissions Meet QP Limit  
Emissions Meet Ave Limit

## FCC Part 15 Subpart B Conducted Emissions Test

### Significant Emissions Data

VBR8 04/23/2015

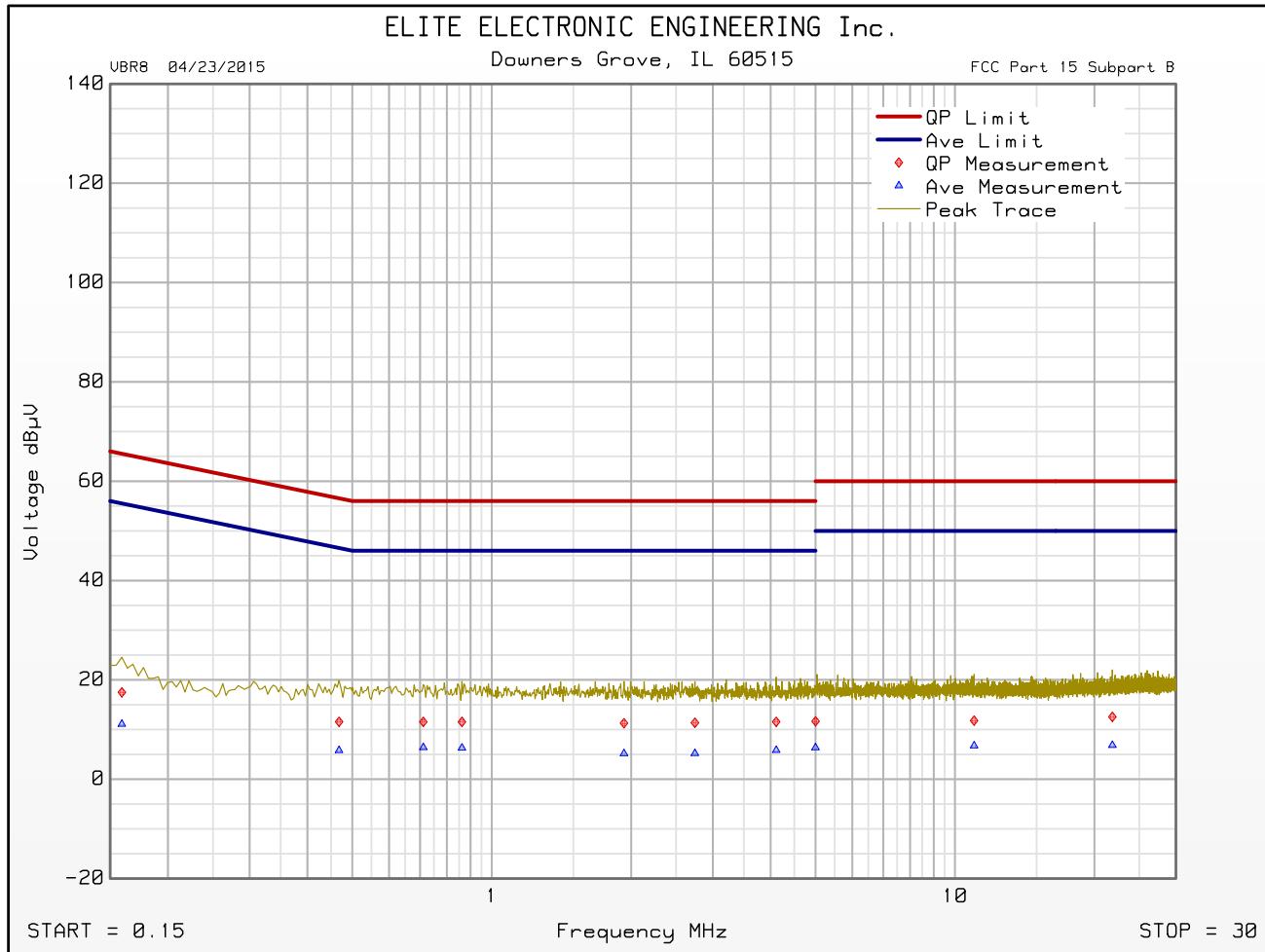
Manufacturer : AMATIS CONTROLS  
Model : RF MODULE  
DUT Revision : 1.2  
Serial Number :  
DUT Mode : TX 2445MHz  
Line Tested : L1  
Scan Step Time [ms] : 30  
Meas. Threshold [dB] : -2  
Notes : BLE  
Test Engineer : R. King  
Limit : Class B  
Test Date : Oct 10, 2017 04:23:36 PM  
Data Filter : Up to 80 maximum levels detected with 6 dB level excursion threshold over 2 dB margin below limit

Freq MHz	Quasi-peak Level dB $\mu$ V	Quasi-peak Limit dB $\mu$ V	Excessive Quasi-peak Emissions	Average Level dB $\mu$ V	Average Limit dB $\mu$ V	Excessive Average Emissions
0.159	17.5	65.5		11.1	55.5	
0.468	11.6	56.5		5.8	46.5	
0.712	11.5	56.0		6.4	46.0	
0.862	11.5	56.0		6.3	46.0	
1.930	11.3	56.0		5.2	46.0	
2.745	11.4	56.0		5.2	46.0	
5.000	11.7	56.0		6.4	46.0	
10.998	11.8	60.0		6.7	50.0	
21.871	12.6	60.0		6.8	50.0	

## FCC Part 15 Subpart B Conducted Emissions Test Cumulative Data

VBR8 04/23/2015

Manufacturer : AMATIS CONTROLS  
Model : RF MODULE  
DUT Revision : 1.2  
Serial Number :  
DUT Mode : TX 2445MHz  
Line Tested : L1  
Scan Step Time [ms] : 30  
Meas. Threshold [dB] : -2  
Notes : BLE  
Test Engineer : R. King  
Limit : Class B  
Test Date : Oct 10, 2017 04:23:36 PM



Emissions Meet QP Limit  
Emissions Meet Ave Limit

## FCC Part 15 Subpart B Conducted Emissions Test

### Significant Emissions Data

VBR8 04/23/2015

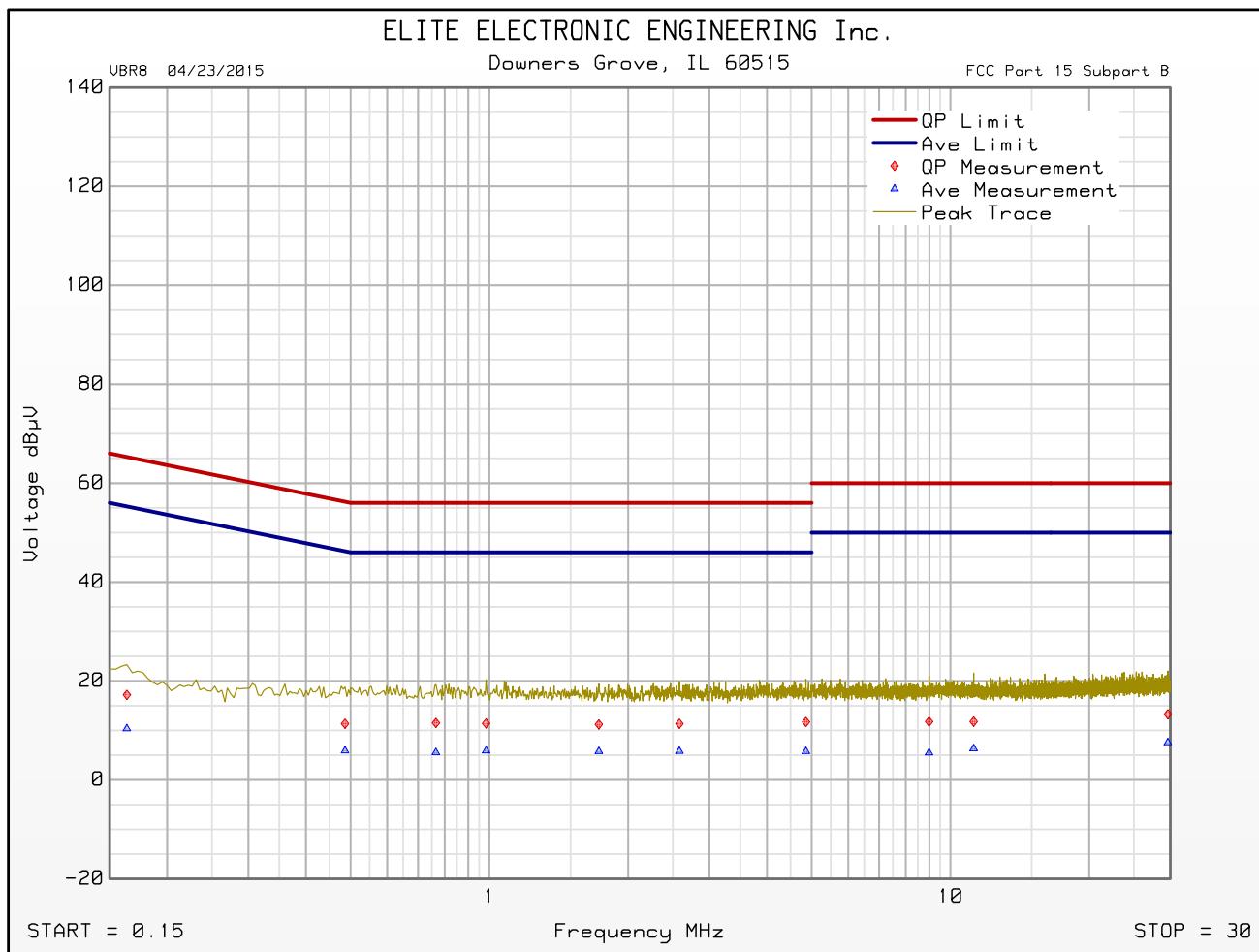
Manufacturer : AMATIS CONTROLS  
 Model : RF MODULE  
 DUT Revision : 1.2  
 Serial Number :  
 DUT Mode : TX 2445MHz  
 Line Tested : L2  
 Scan Step Time [ms] : 30  
 Meas. Threshold [dB] : -2  
 Notes : BLE  
 Test Engineer : R. King  
 Limit : Class B  
 Test Date : Oct 10, 2017 04:28:51 PM  
 Data Filter : Up to 80 maximum levels detected with 6 dB level excursion threshold over 2 dB margin below limit

Freq MHz	Quasi-peak Level dB $\mu$ V	Quasi-peak Limit dB $\mu$ V	Excessive Quasi-peak Emissions	Average Level dB $\mu$ V	Average Limit dB $\mu$ V	Excessive Average Emissions
0.164	17.2	65.3		10.4	55.3	
0.486	11.4	56.2		5.9	46.2	
0.766	11.5	56.0		5.5	46.0	
0.984	11.4	56.0		5.9	46.0	
1.727	11.2	56.0		5.8	46.0	
2.583	11.4	56.0		5.8	46.0	
4.859	11.7	56.0		5.8	46.0	
8.987	11.8	60.0		5.5	50.0	
11.228	11.8	60.0		6.3	50.0	
29.629	13.3	60.0		7.6	50.0	

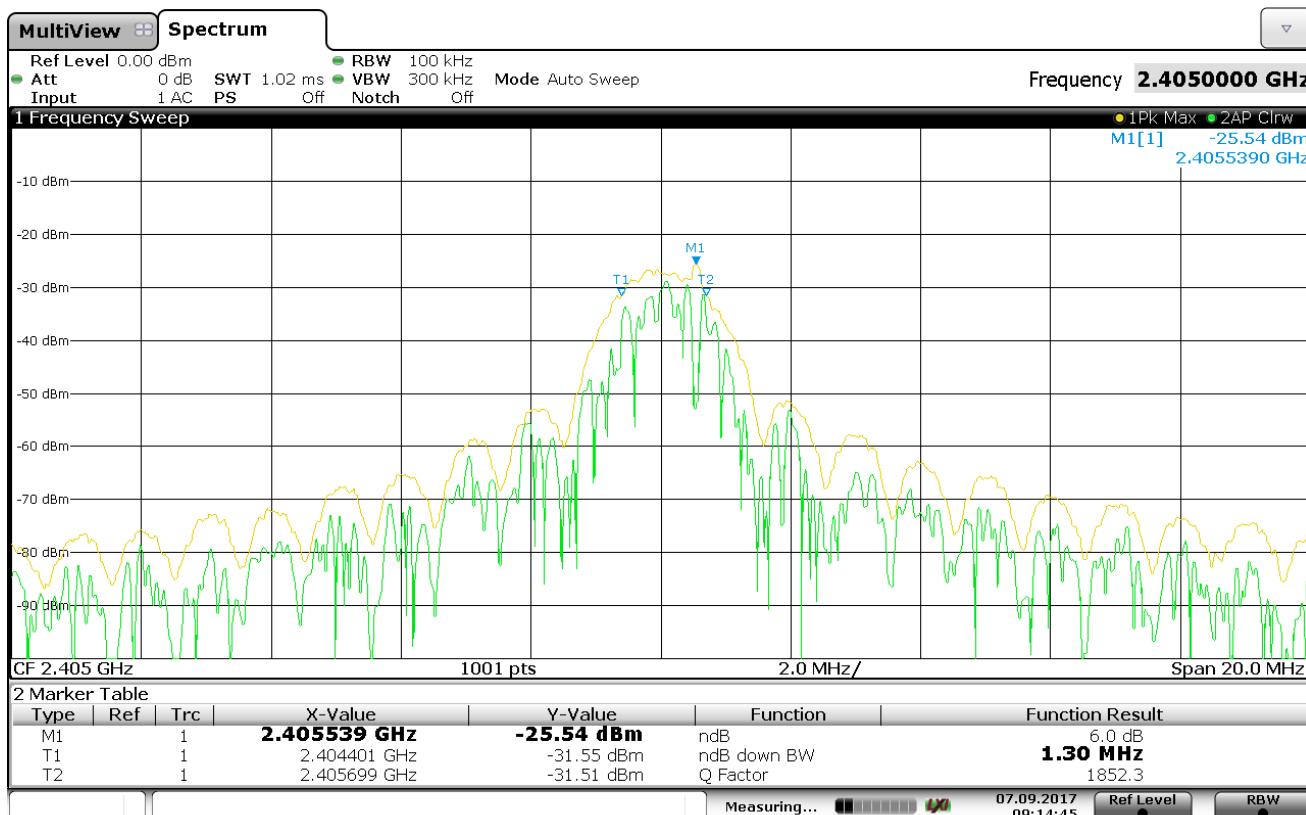
## FCC Part 15 Subpart B Conducted Emissions Test Cumulative Data

VBR8 04/23/2015

Manufacturer : AMATIS CONTROLS  
Model : RF MODULE  
DUT Revision : 1.2  
Serial Number :  
DUT Mode : TX 2445MHz  
Line Tested : L2  
Scan Step Time [ms] : 30  
Meas. Threshold [dB] : -2  
Notes : BLE  
Test Engineer : R. King  
Limit : Class B  
Test Date : Oct 10, 2017 04:28:51 PM



Emissions Meet QP Limit  
Emissions Meet Ave Limit

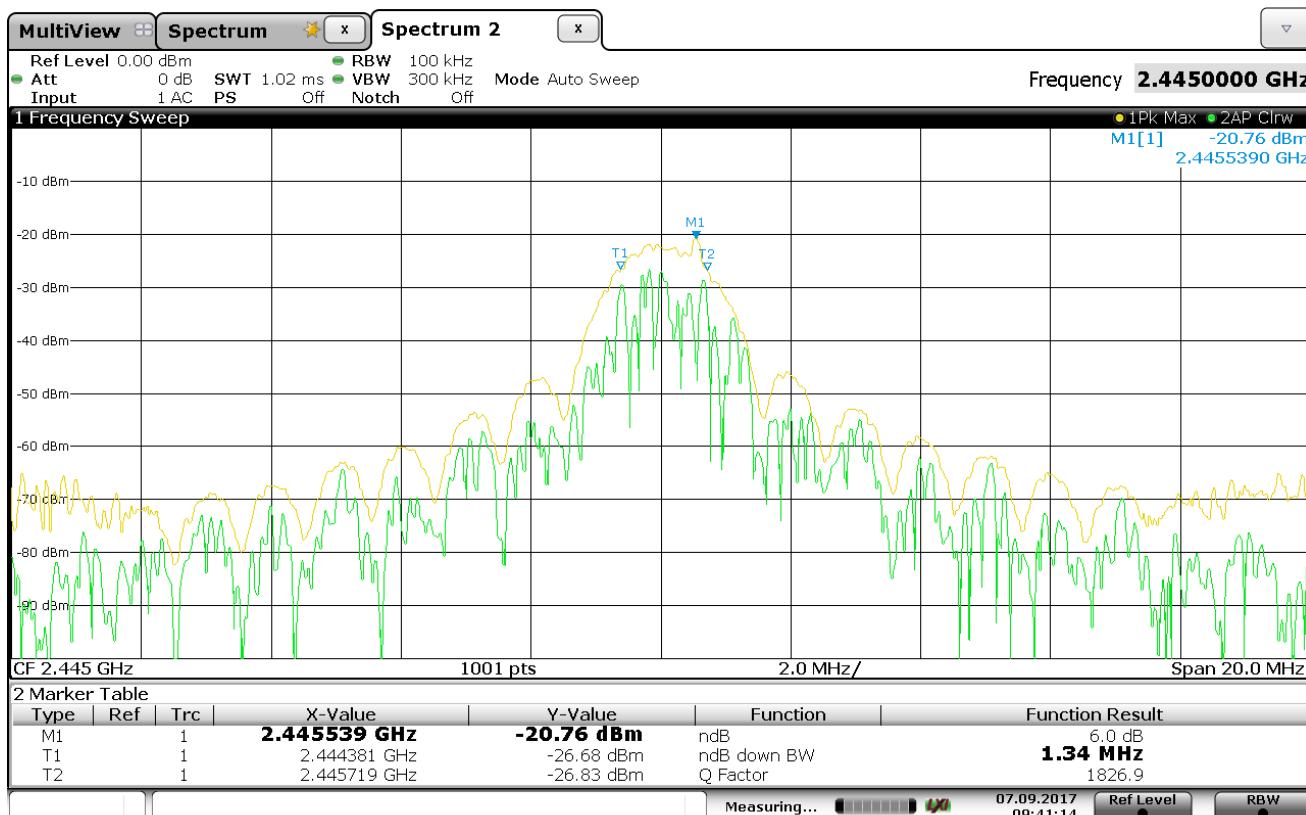


Date: 7.SEP.2017 09:14:45

## 6dB BANDWIDTH

MANUFACTURER : Amatis Controls  
 EUT : Wireless Module  
 TEST MODE : 802.15.4 ZigBee Tx – 2405MHz  
 : 6dB BW = 1.30MHz

## NOTES



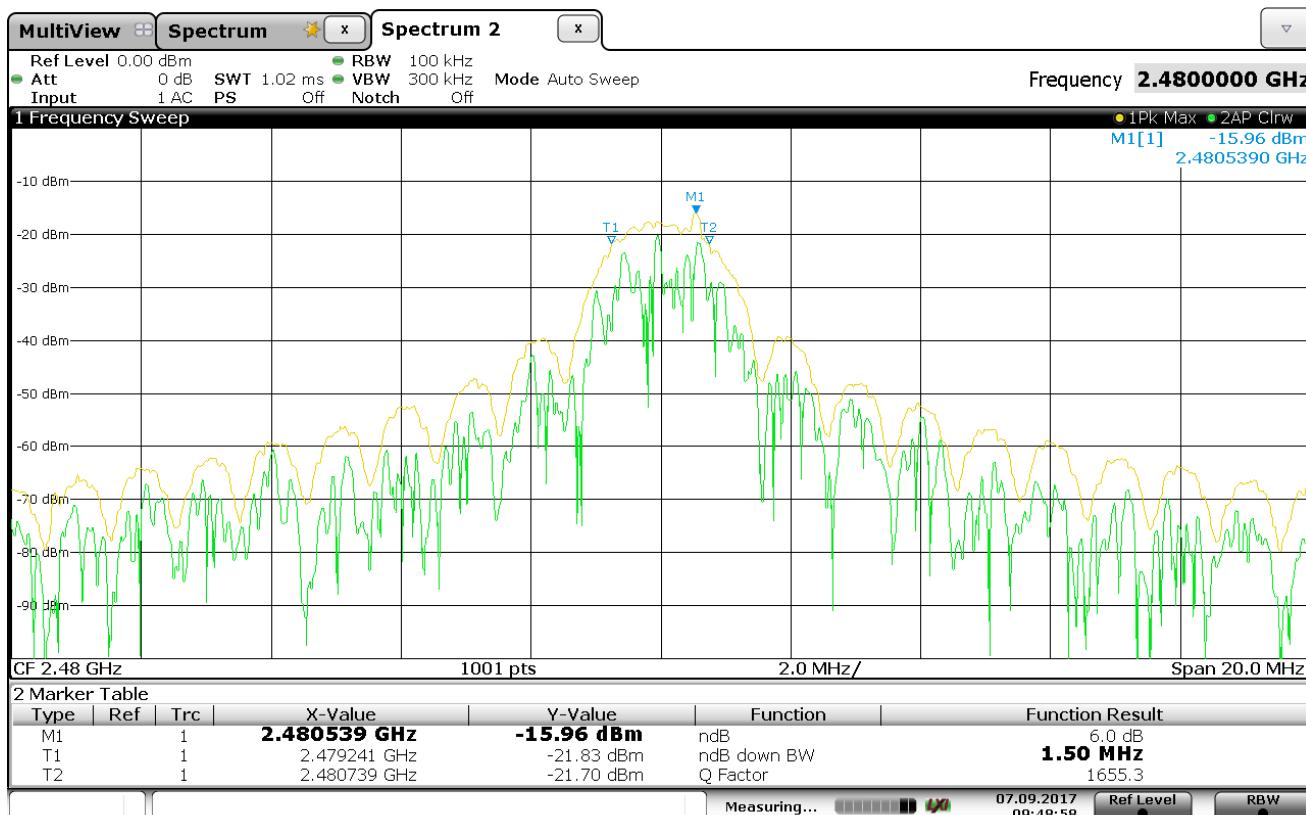
Date: 7.SEP.2017 09:41:14

## 6dB BANDWIDTH

MANUFACTURER : Amatis Controls  
 EUT : Wireless Module  
 TEST MODE : 802.15.4 ZigBee Tx – 2445MHz  
 : 6dB BW = 1.34MHz

---

## NOTES



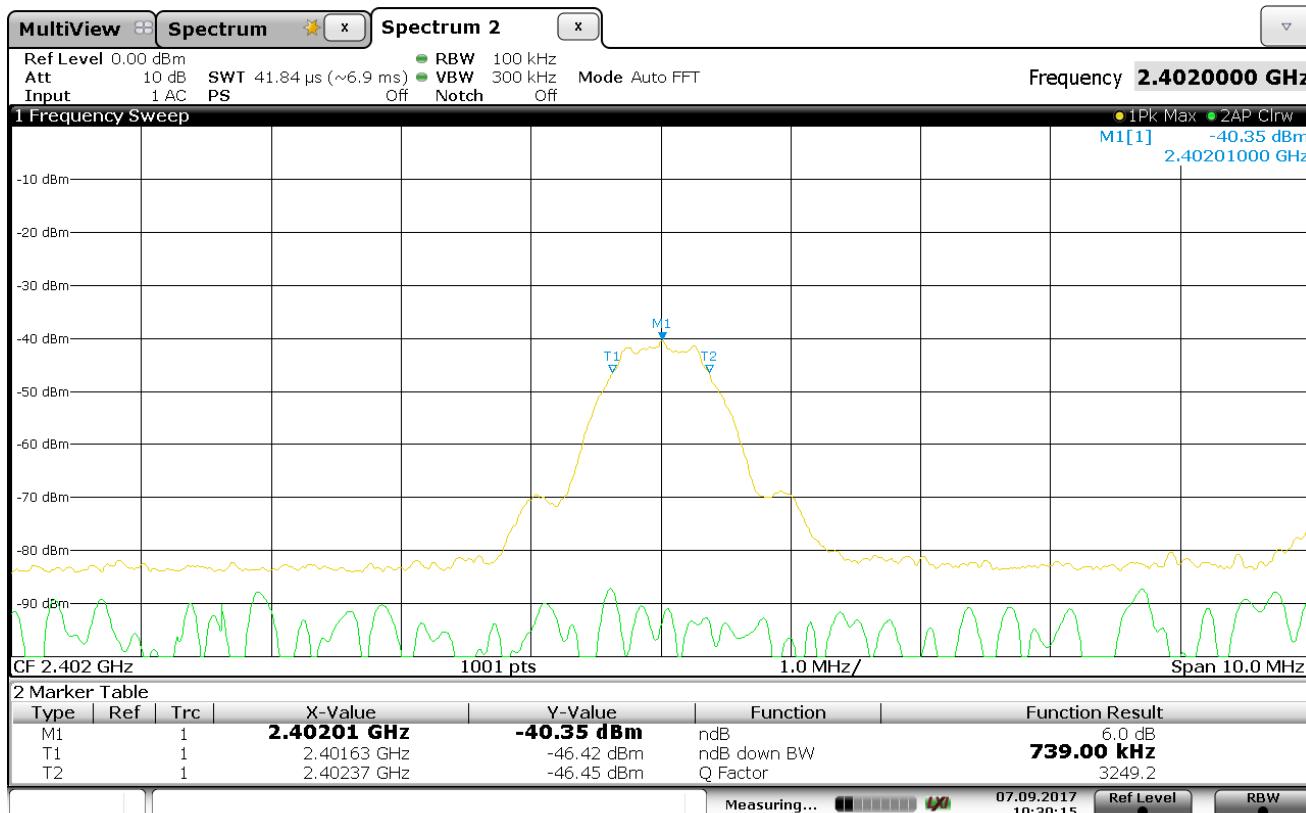
Date: 7.SEP.2017 09:48:58

## 6dB BANDWIDTH

MANUFACTURER : Amatis Controls  
EUT : Wireless Module  
TEST MODE : 802.15.4 ZigBee Tx – 2480MHz  
: 6dB BW = 1.50MHz

---

## NOTES

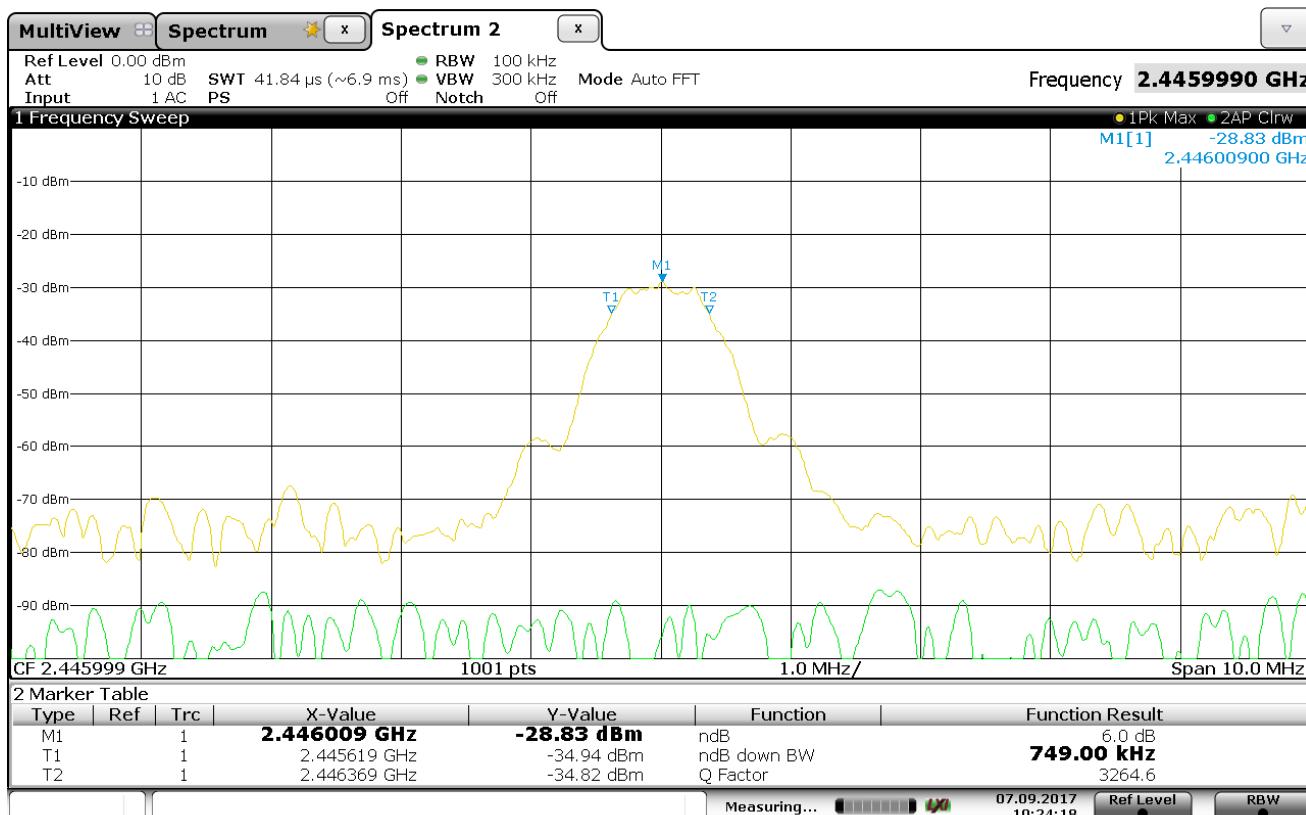


Date: 7.SEP.2017 10:30:15

## 6dB BANDWIDTH

MANUFACTURER : Amatis Controls  
EUT : Wireless Module  
TEST MODE : BLE – 2402MHz  
: 6dB BW = 739.00kHz

## NOTES

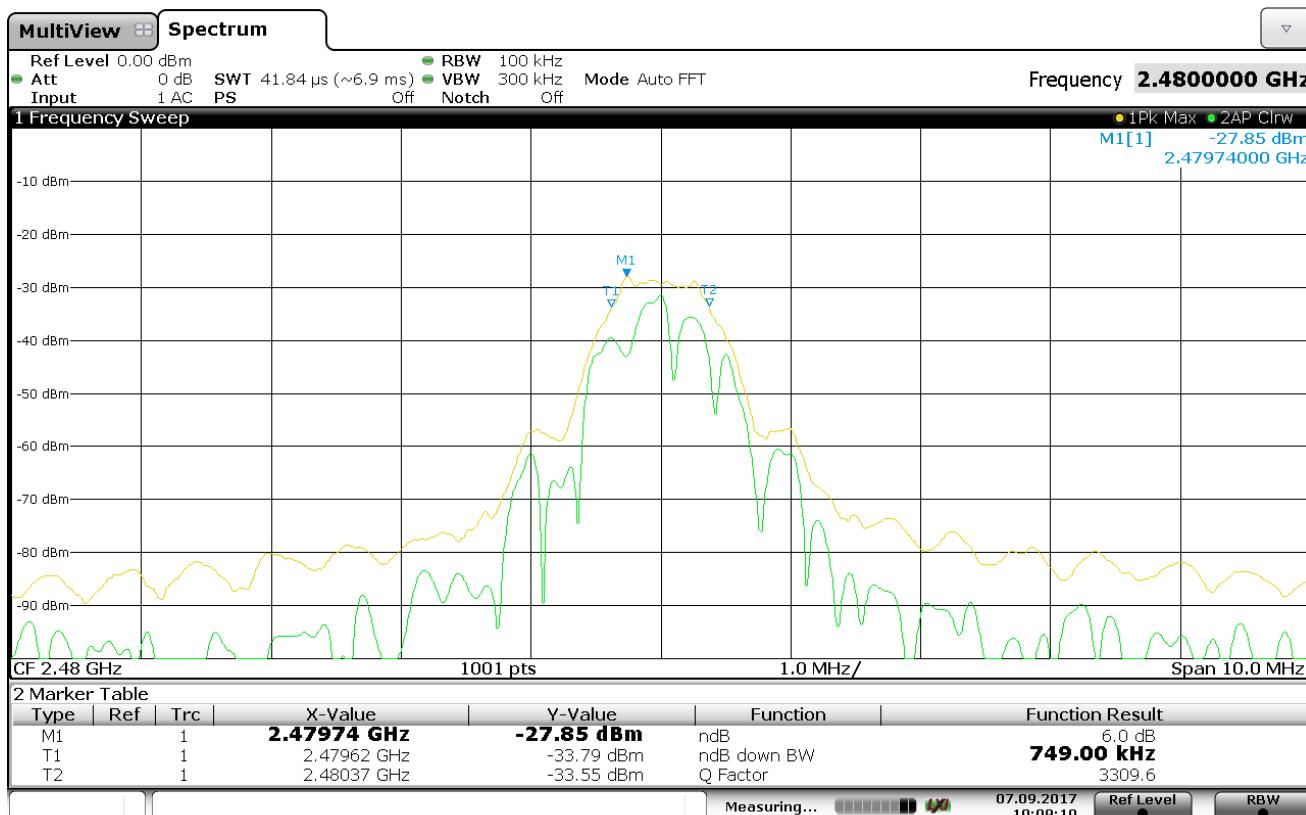


Date: 7.SEP.2017 10:24:18

## 6dB BANDWIDTH

MANUFACTURER : Amatis Controls  
EUT : Wireless Module  
TEST MODE : BLE – 2445MHz  
: 6dB BW = 749.00kHz

## NOTES

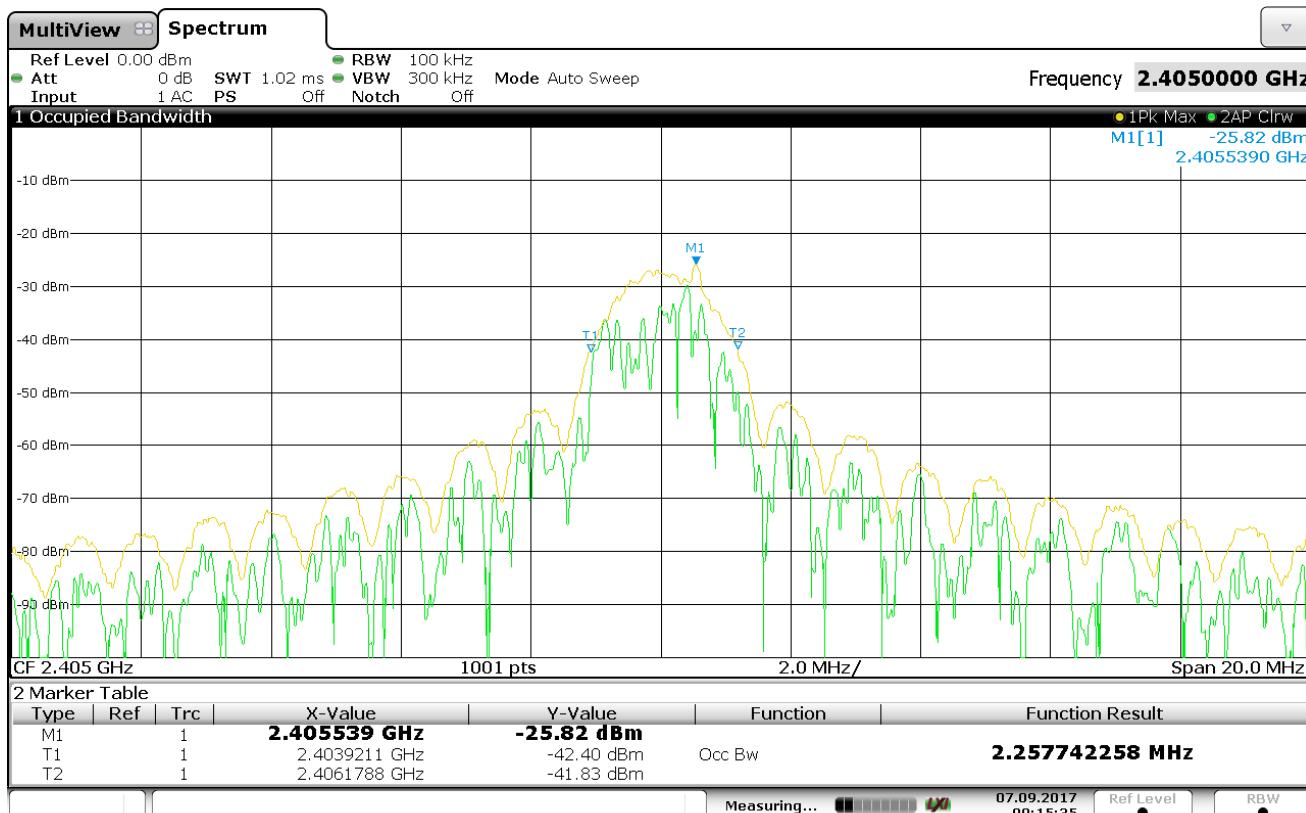


Date: 7.SEP.2017 10:09:10

## 6dB BANDWIDTH

MANUFACTURER : Amatis Controls  
 EUT : Wireless Module  
 TEST MODE : BLE – 2480MHz  
 : 6dB BW = 749.00Hz

## NOTES

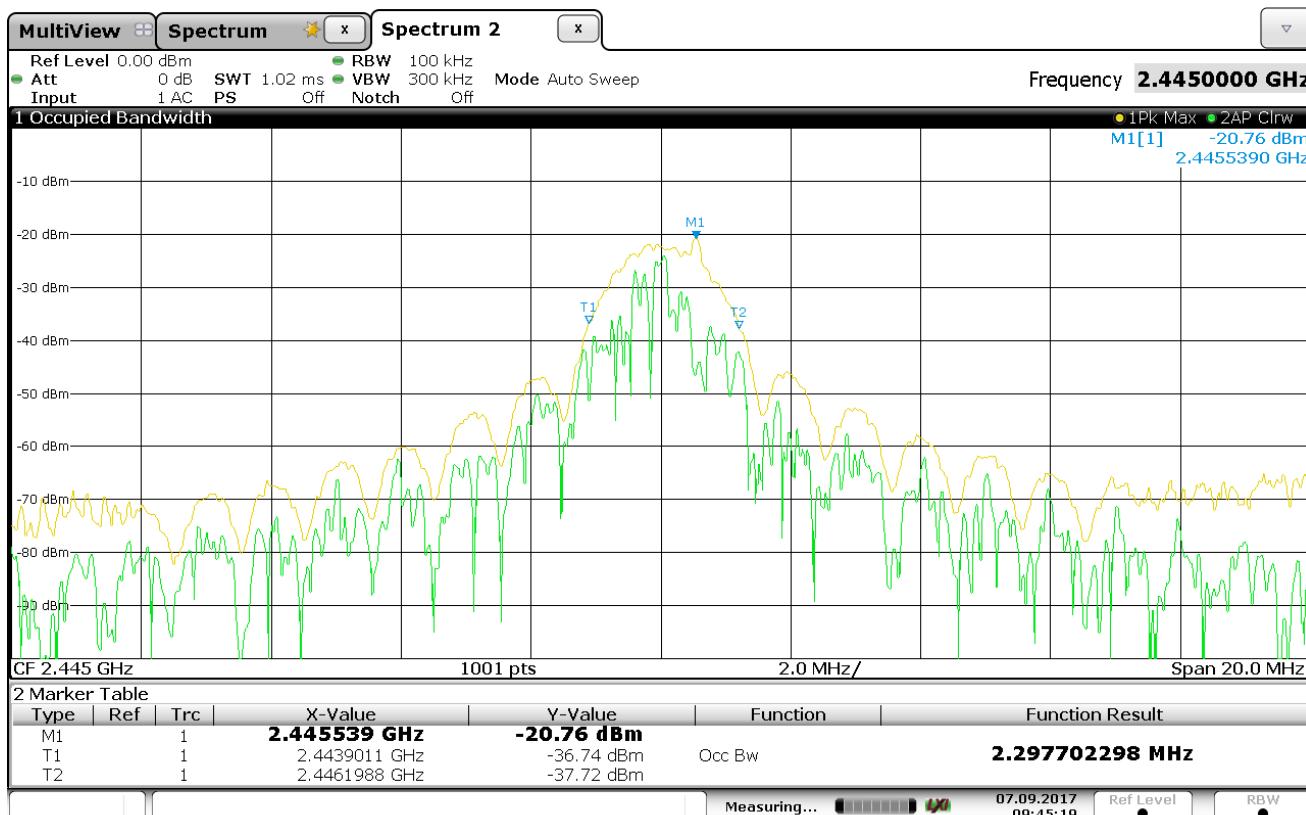


Date: 7.SEP.2017 09:15:35

## 99% BANDWIDTH

MANUFACTURER : Amatis Controls  
 EUT : Wireless Module  
 TEST MODE : 802.15.4 ZigBee Tx – 2405MHz  
 : 99% BW = 2.257MHz

## NOTES

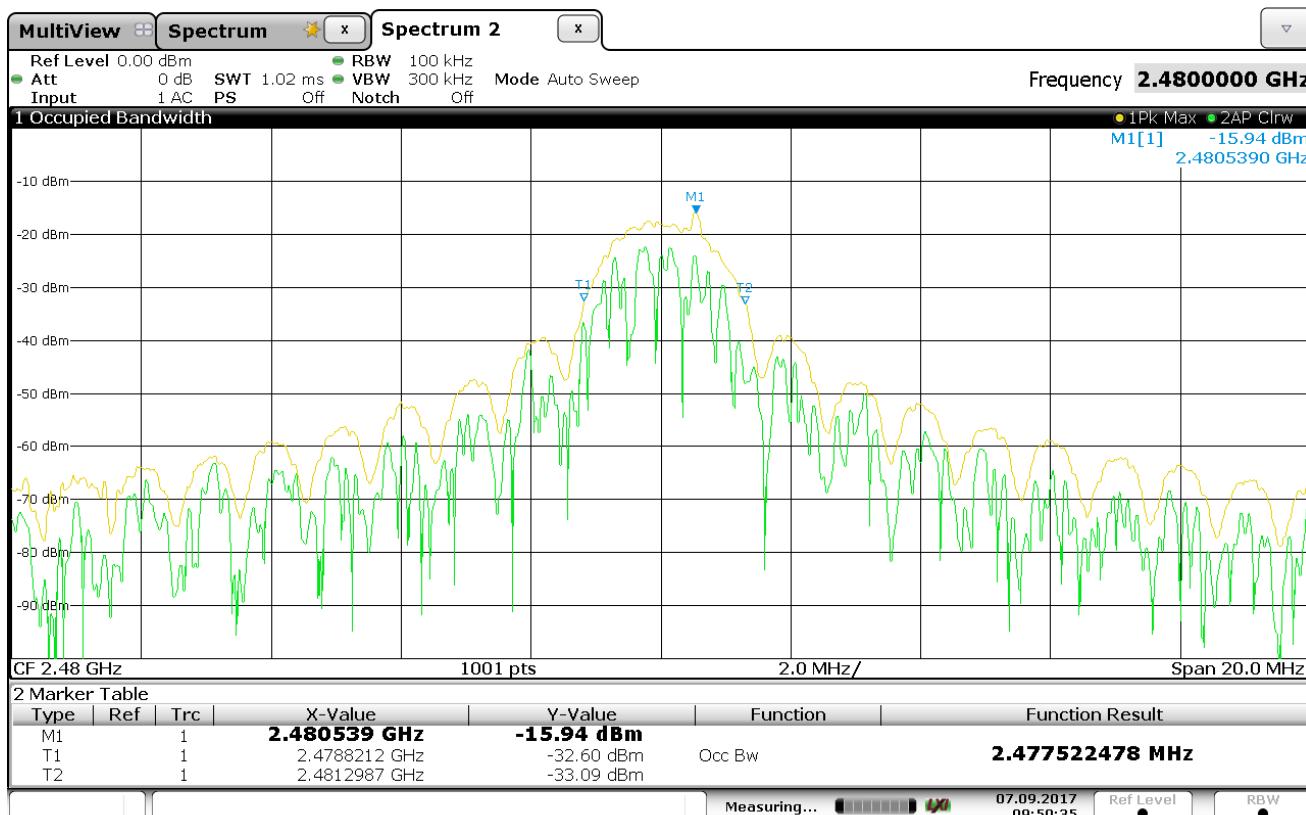


Date: 7.SEP.2017 09:45:19

## 99% BANDWIDTH

MANUFACTURER : Amatis Controls  
EUT : Wireless Module  
TEST MODE : 802.15.4 ZigBee Tx – 2445MHz  
: 99% BW = 2.2977MHz

## NOTES



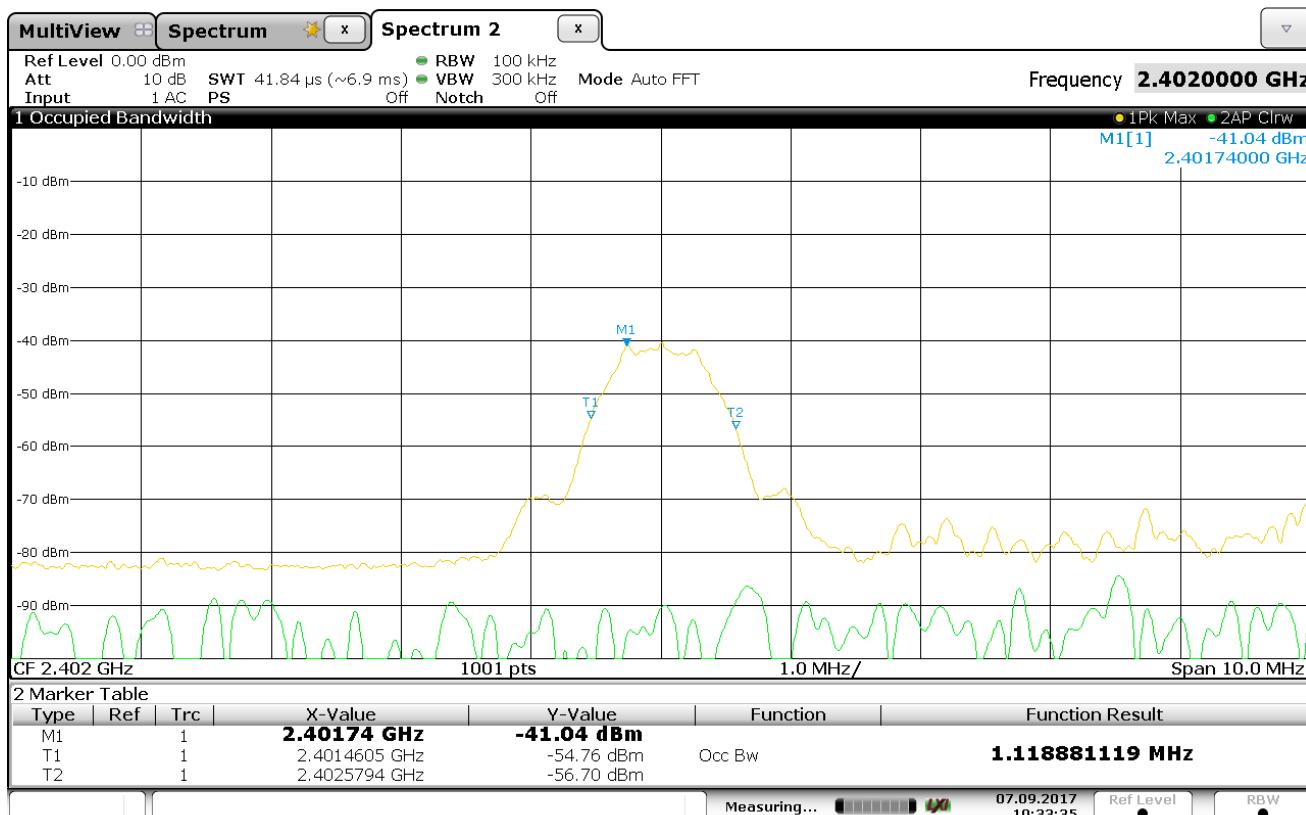
Date: 7.SEP.2017 09:50:35

## 99% BANDWIDTH

MANUFACTURER : Amatis Controls  
EUT : Wireless Module  
TEST MODE : 802.15.4 ZigBee Tx – 2480MHz  
: 99% BW = 2.4775MHz

---

## NOTES



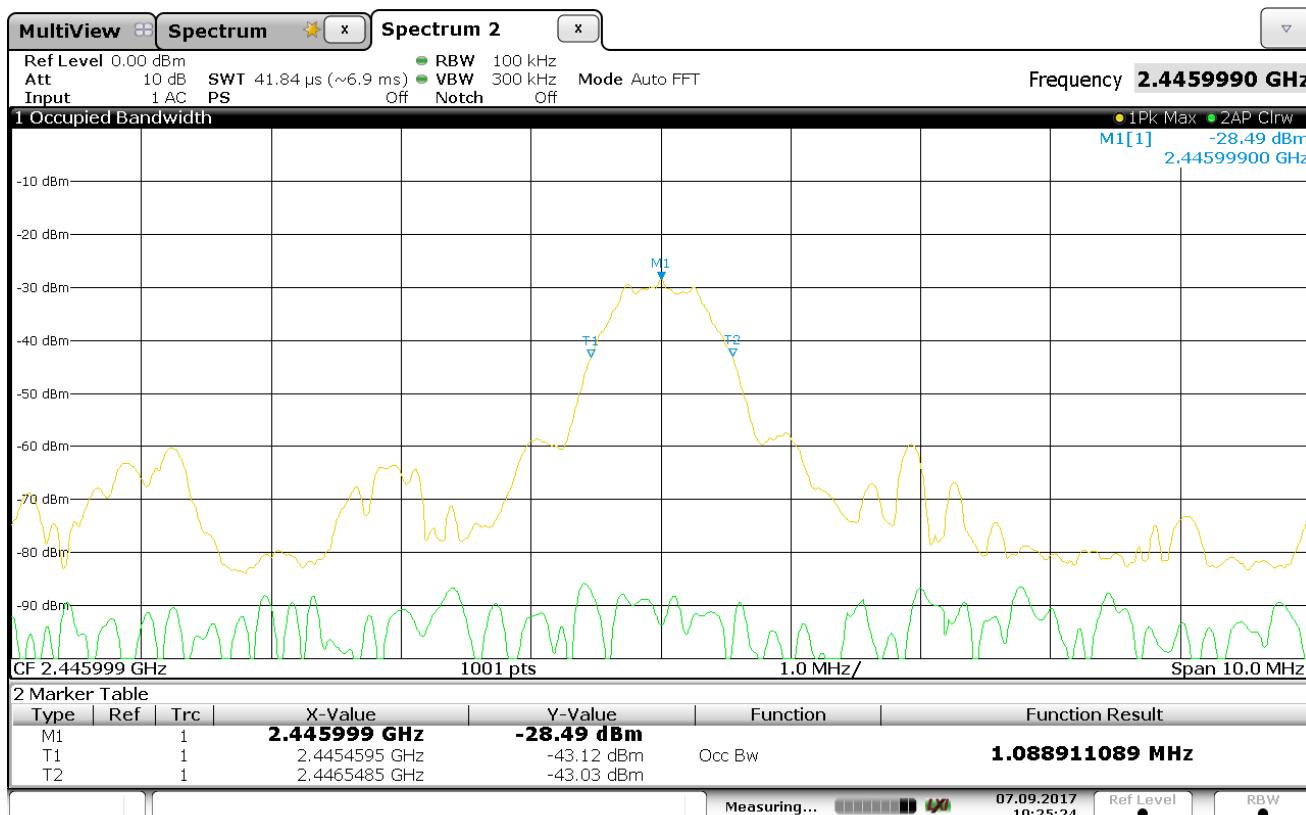
Date: 7.SEP.2017 10:33:34

## 99% BANDWIDTH

MANUFACTURER : Amatis Controls  
EUT : Wireless Module  
TEST MODE : BLE – 2402MHz  
: 99% BW = 1.11888MHz

---

## NOTES

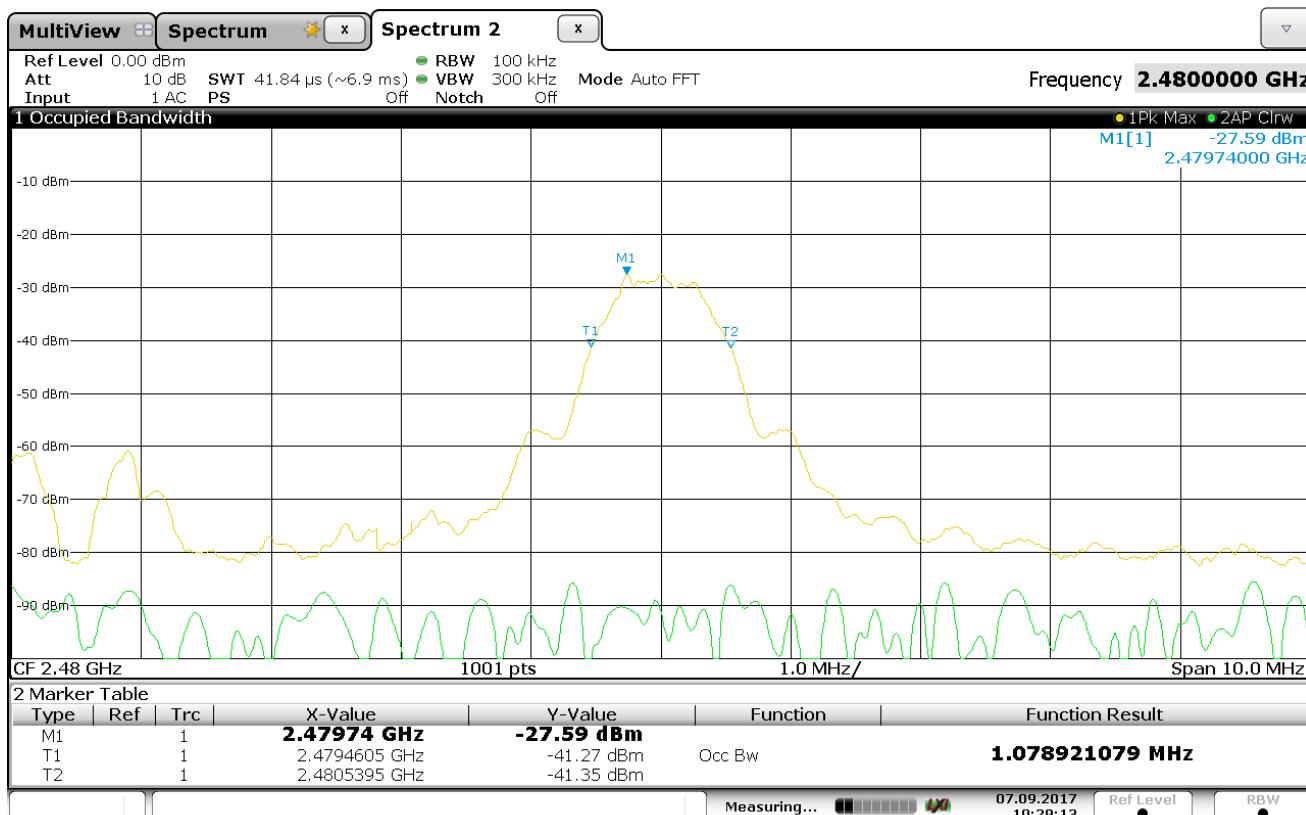


Date: 7.SEP.2017 10:25:24

## 99% BANDWIDTH

MANUFACTURER : Amatis Controls  
EUT : Wireless Module  
TEST MODE : BLE – 2445MHz  
: 99% BW = 1.0889MHz

## NOTES



Date: 7.SEP.2017 10:29:13

## 99% BANDWIDTH

MANUFACTURER : Amatis Controls  
EUT : Wireless Module  
TEST MODE : BLE – 2480MHz  
: 99% BW = 1.0789MHz

---

## NOTES

**DATA PAGE**

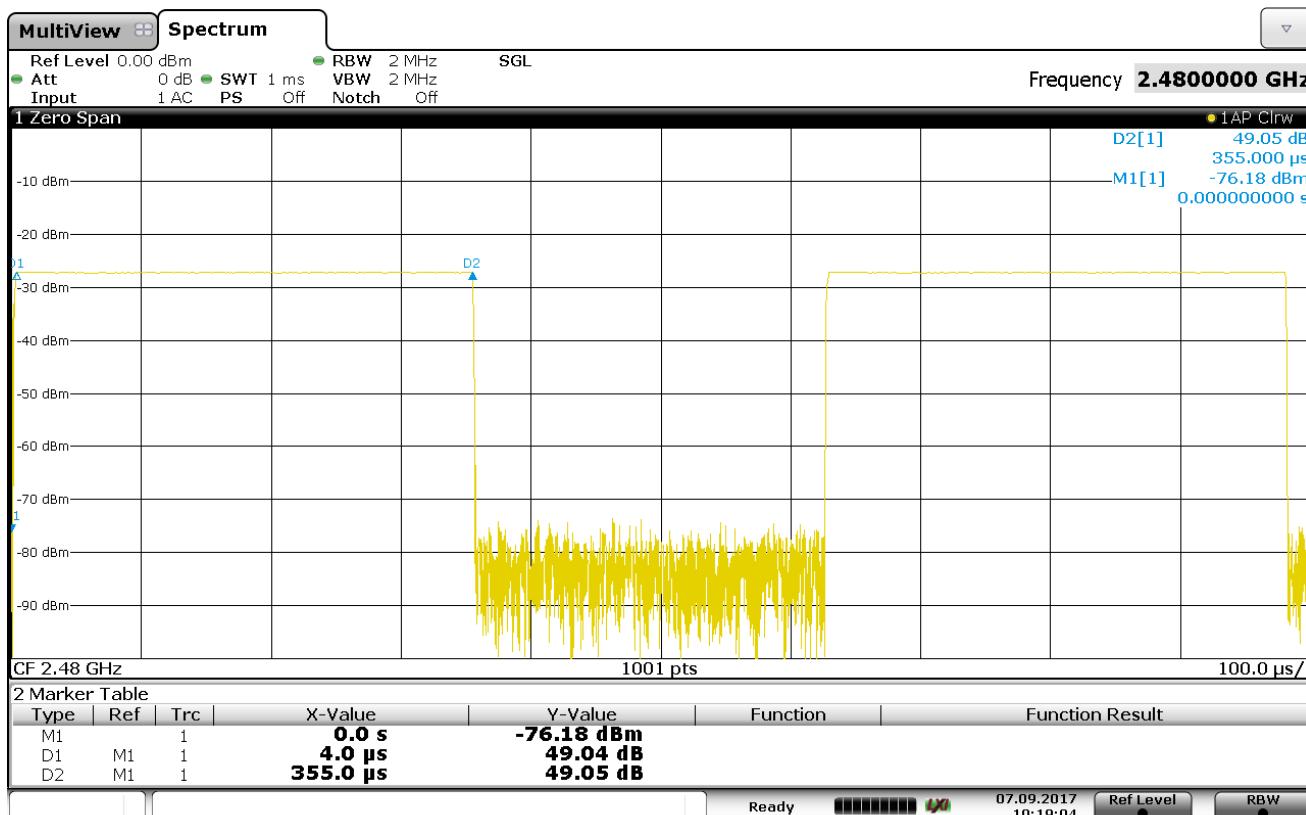
Manufacturer : Amatis Controls  
EUT : Wireless Module  
Mode : 802.15.4 ZigBee Tx  
Test Specification : FCC-15.247, RSS-247 Peak Output Power  
Date : October 10, 2017

Freq. (MHz)	Ant Pol	Wide BW Meter Reading (dB $\mu$ V)	Matched Sig. Gen. Reading (dBm)	Equivalent Antenna Gain (dB)	Cable Loss (dB)	EIRP (dBm)
2405.00	H	74.1	12.1	5.9	2.8	15.2
2405.00	V	70.7	9.0	5.9	2.8	12.1
2445.00	H	75.2	13.3	5.9	2.8	16.4
2445.00	V	74.2	12.6	5.9	2.8	15.7
2480.00	H	38.3	-23.5	5.9	2.8	-20.4
2480.00	V	34.0	-27.6	5.9	2.8	-24.5

**DATA PAGE**

Manufacturer : Amatis Controls  
EUT : Wireless Module  
Mode : BLE  
Test Specification : FCC-15.247, RSS-247 Peak Output Power  
Date : October 10, 2017

Freq. (MHz)	Ant Pol	Wide BW Meter Reading (dB $\mu$ V)	Matched Sig. Gen. Reading (dBm)	Equivalent Antenna Gain (dB)	Cable Loss (dB)	EIRP (dBm)
2402.00	H	59.2	-2.8	5.8	2.7	0.3
2402.00	V	53.2	-8.5	5.8	2.7	-5.4
2445.00	H	60.7	-1.2	5.9	2.8	2.0
2445.00	V	53.7	-8.0	5.9	2.8	-4.8
2480.00	H	59.4	-2.4	5.9	2.8	0.7
2480.00	V	55.5	-6.2	5.9	2.8	-3.0

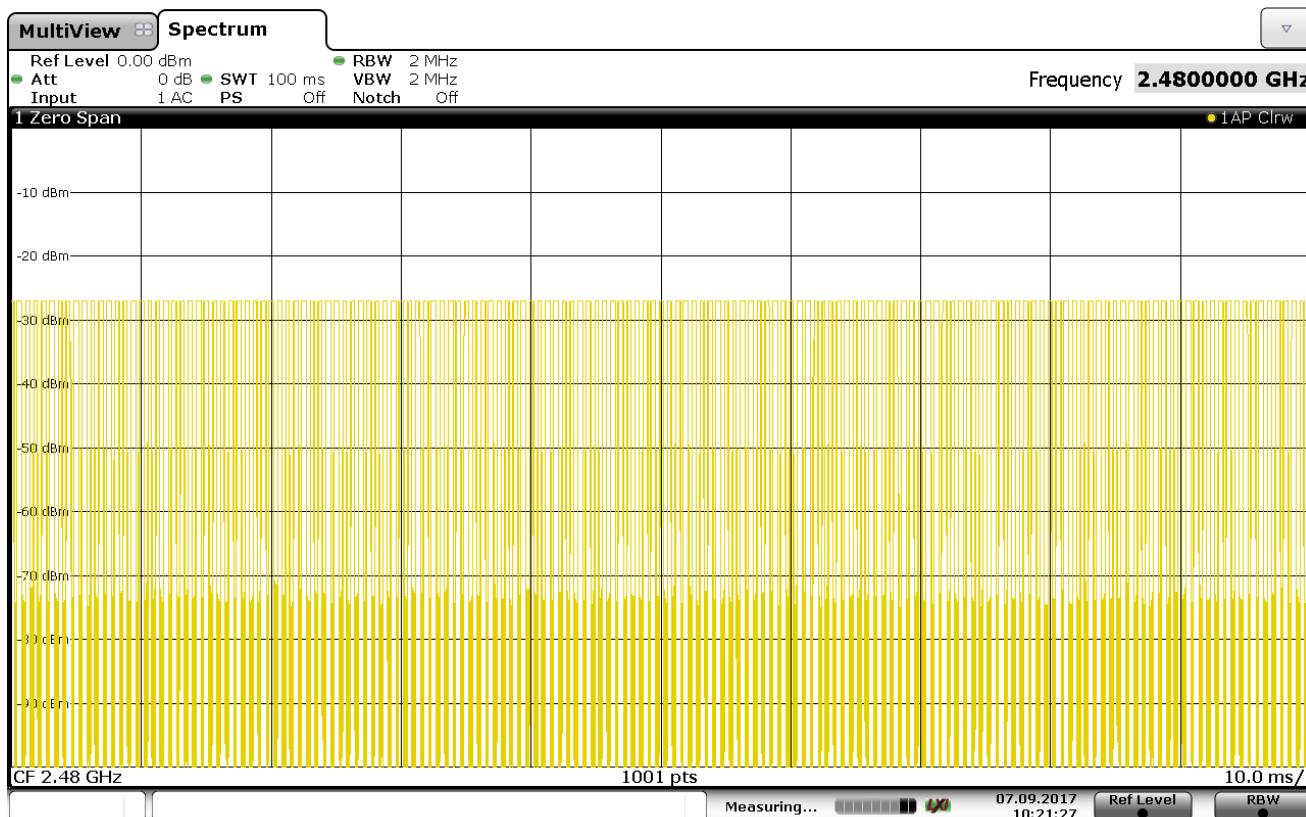


Date: 7.SEP.2017 10:19:04

## DUTY CYCLE

MANUFACTURER : Amatis Controls  
 MODEL NUMBER : Model #1  
 TEST MODE : Mid Channel - BLE

NOTES – On-time = 4µS, Period = 355µS

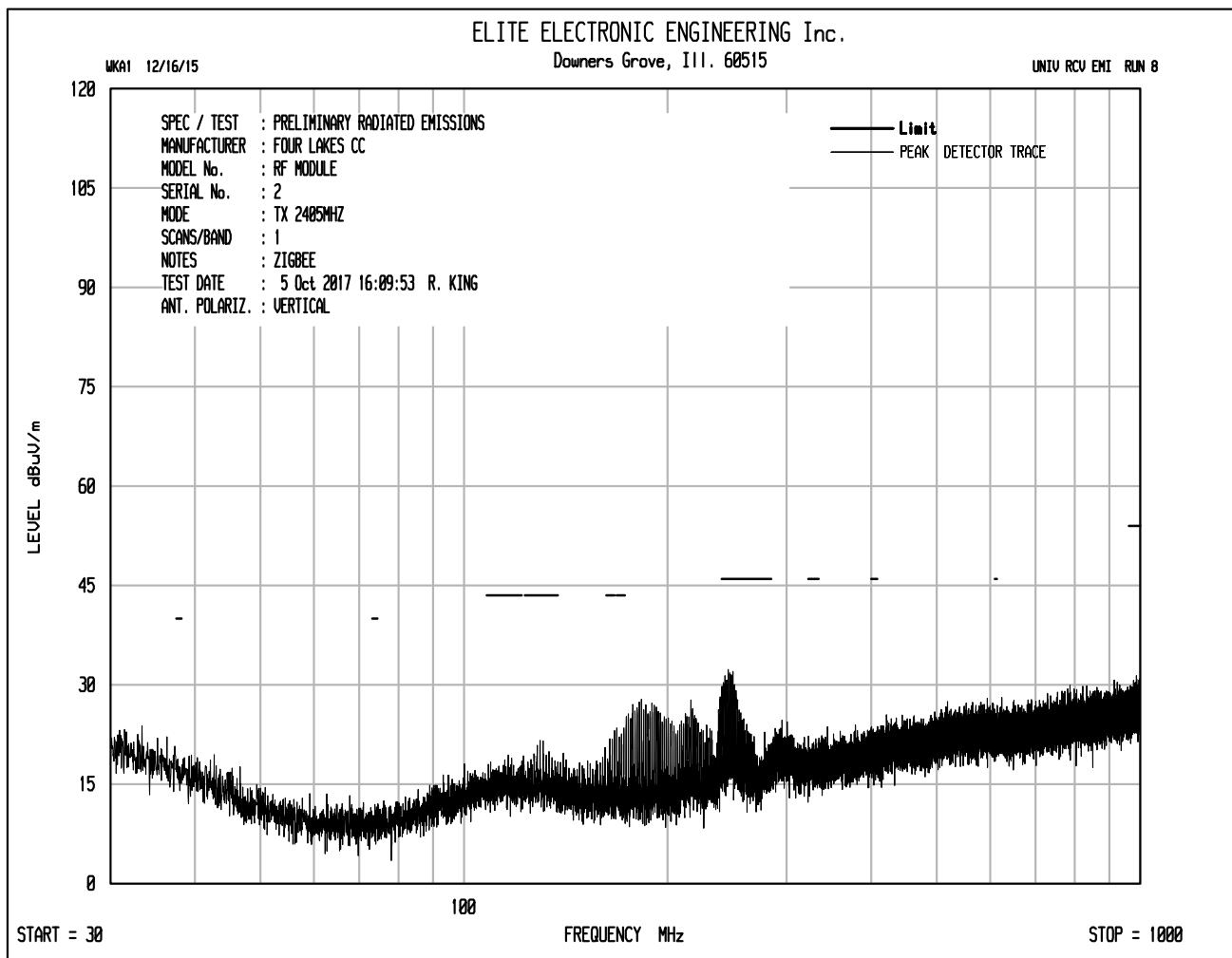


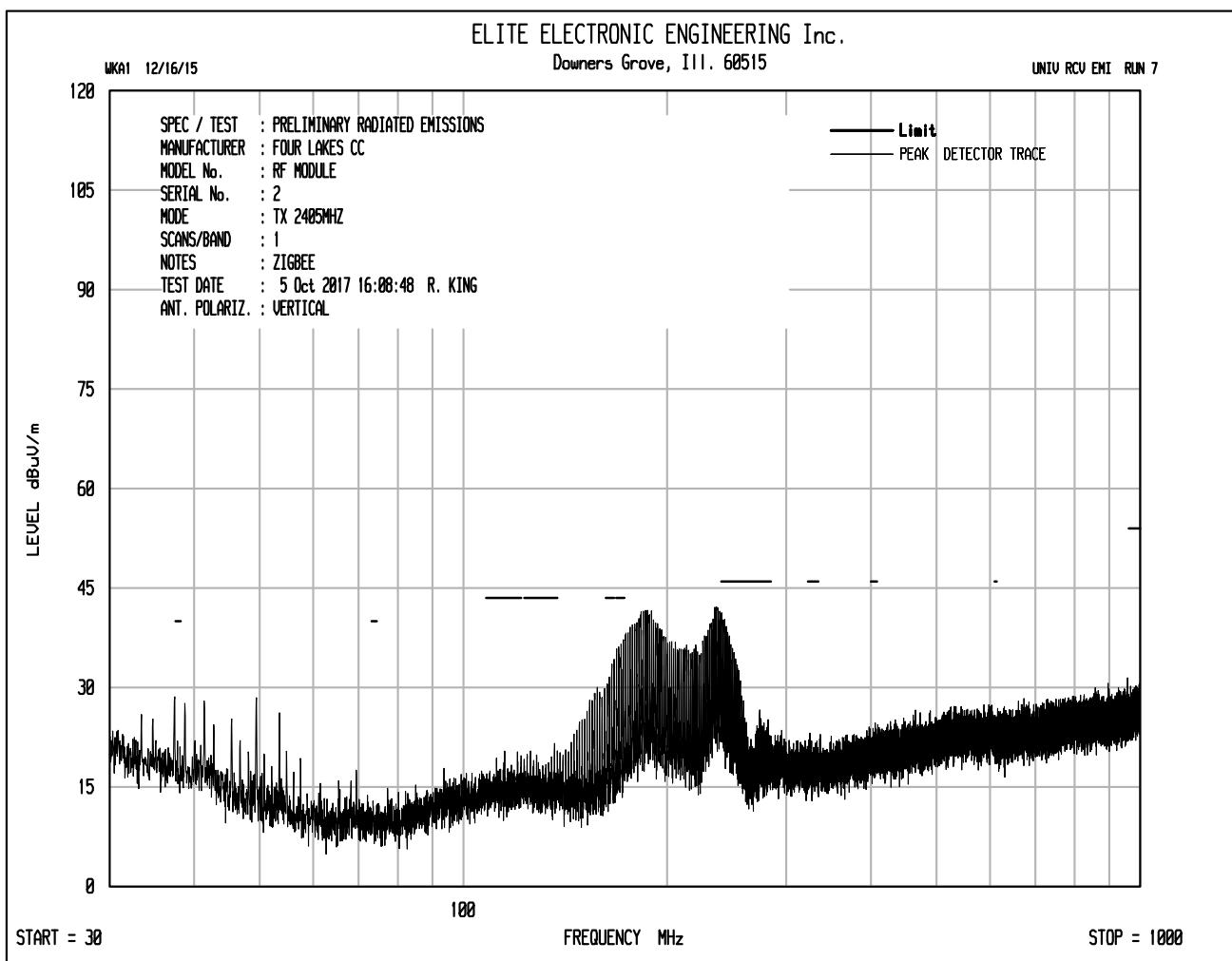
Date: 7.SEP.2017 10:21:27

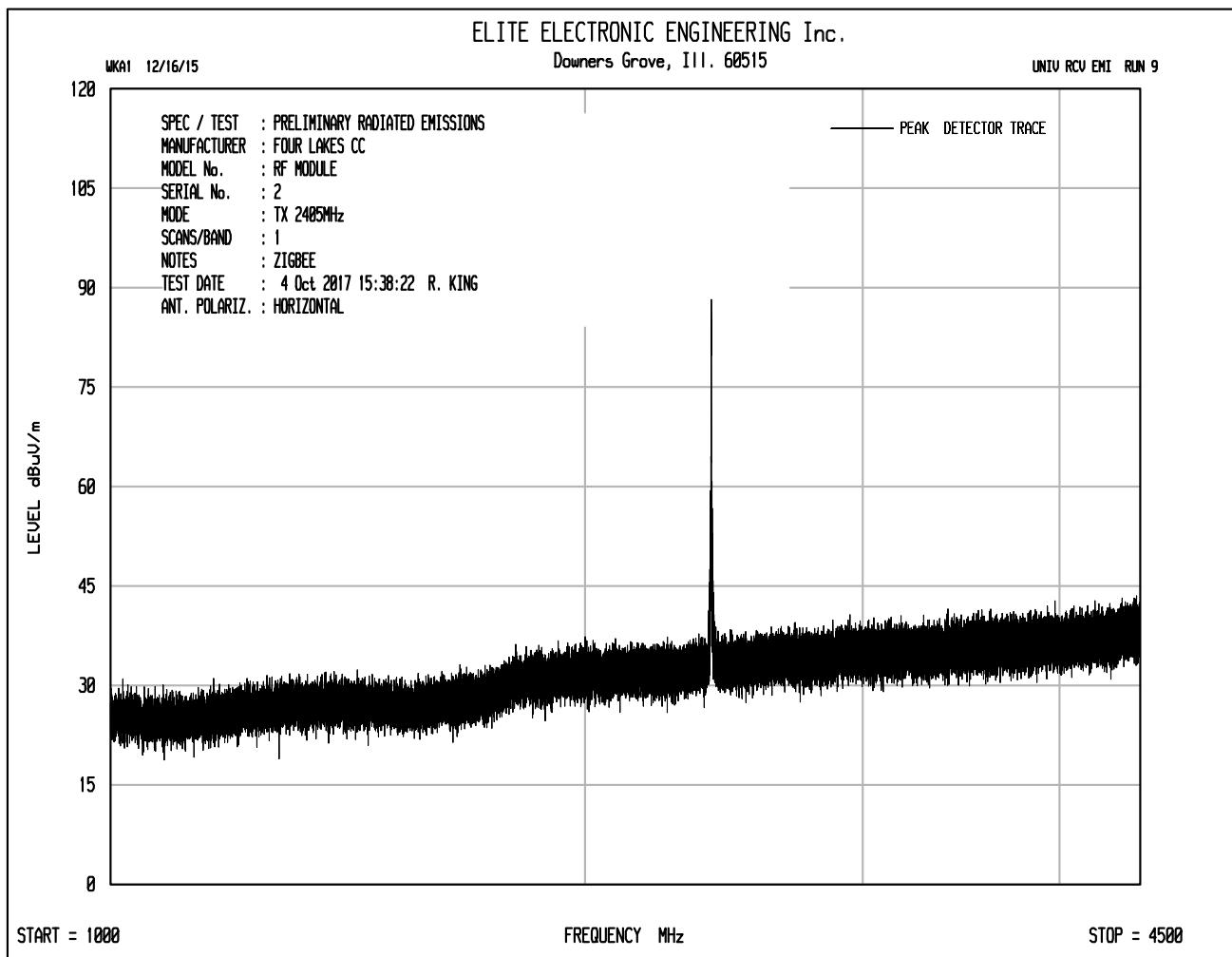
## DUTY CYCLE

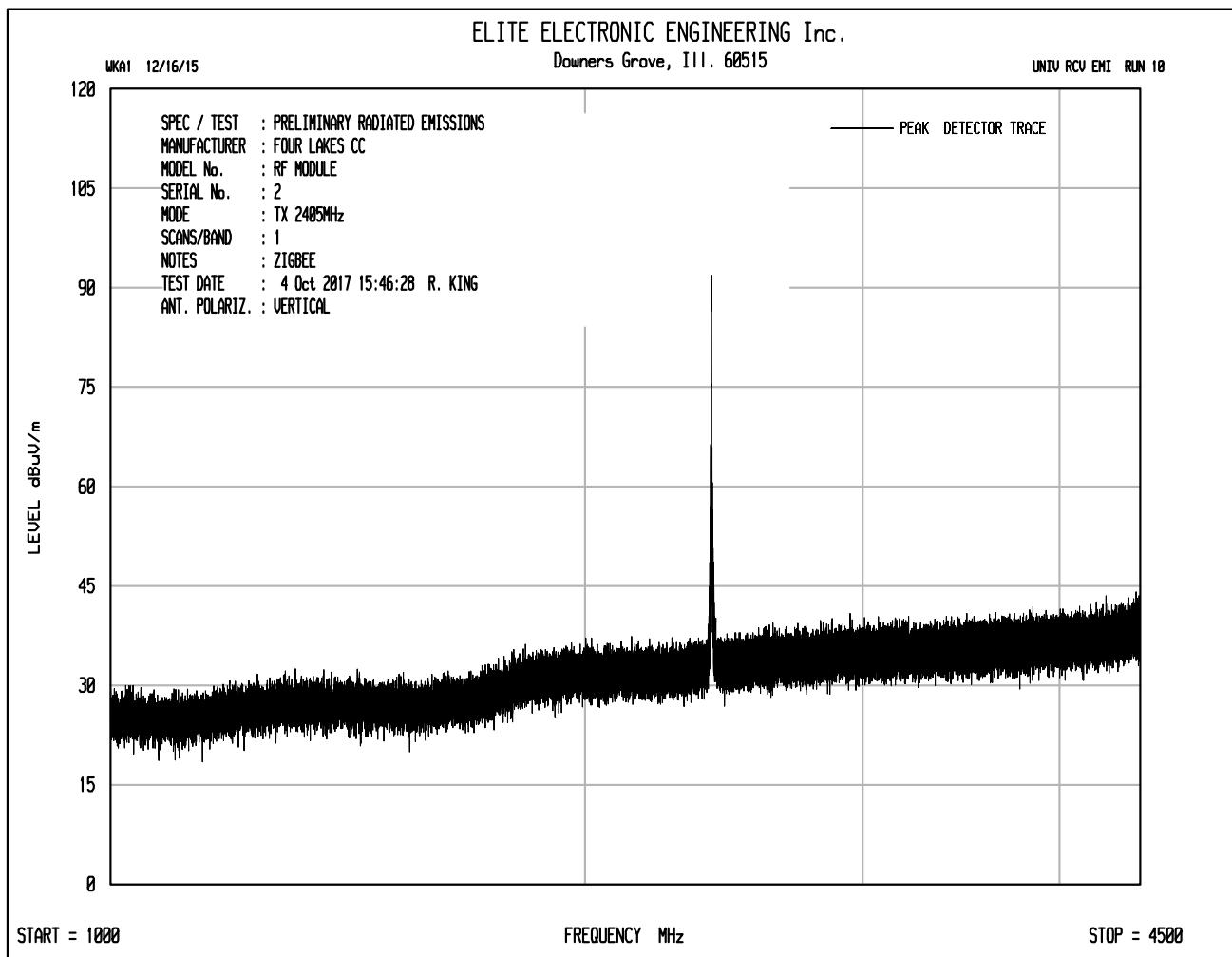
MANUFACTURER : Amatis Controls  
 MODEL NUMBER : Model #1  
 TEST MODE : Mid Channel - BLE

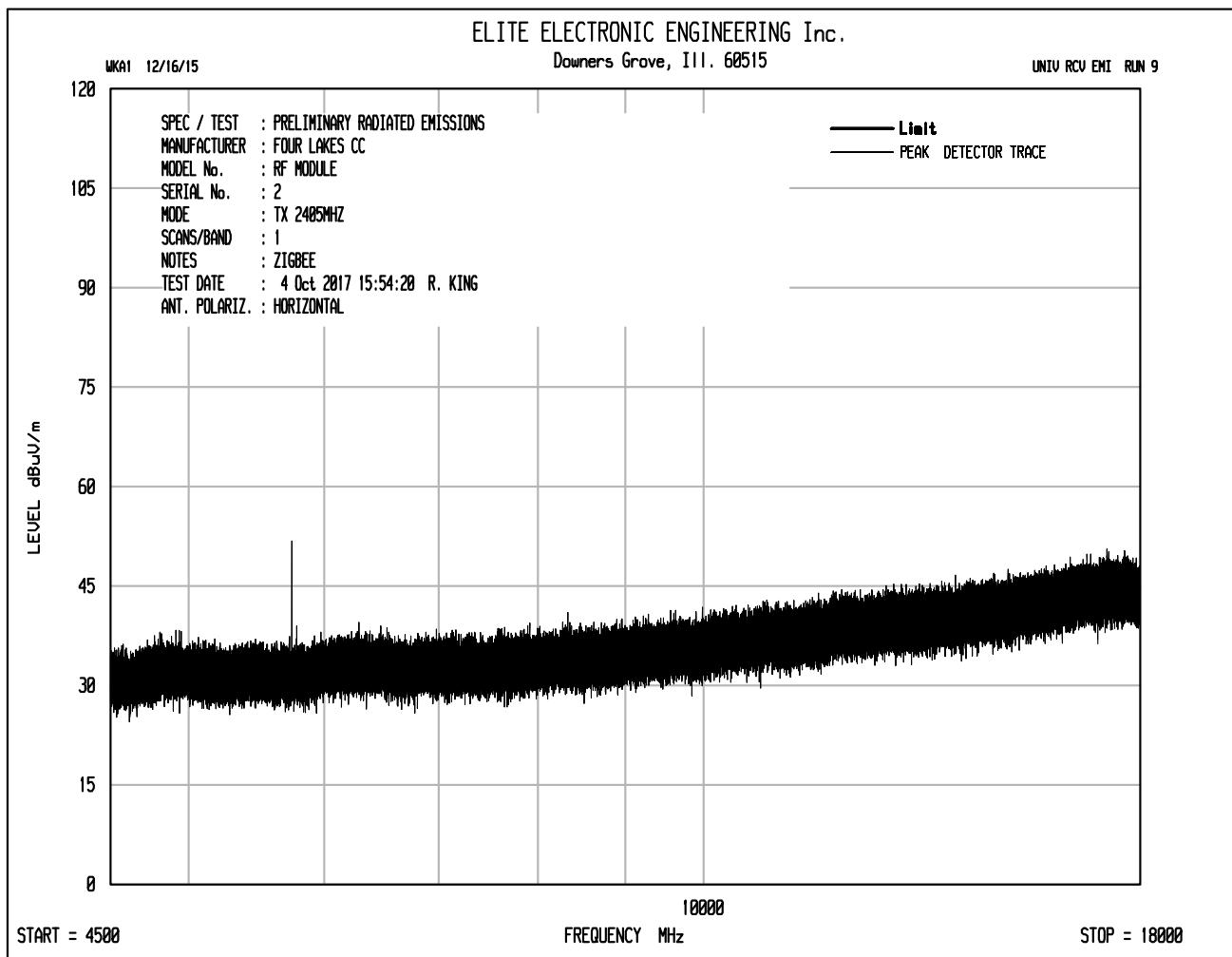
NOTES – # of pulses in a 100ms period = 140. Duty Cycle = -45.036dB

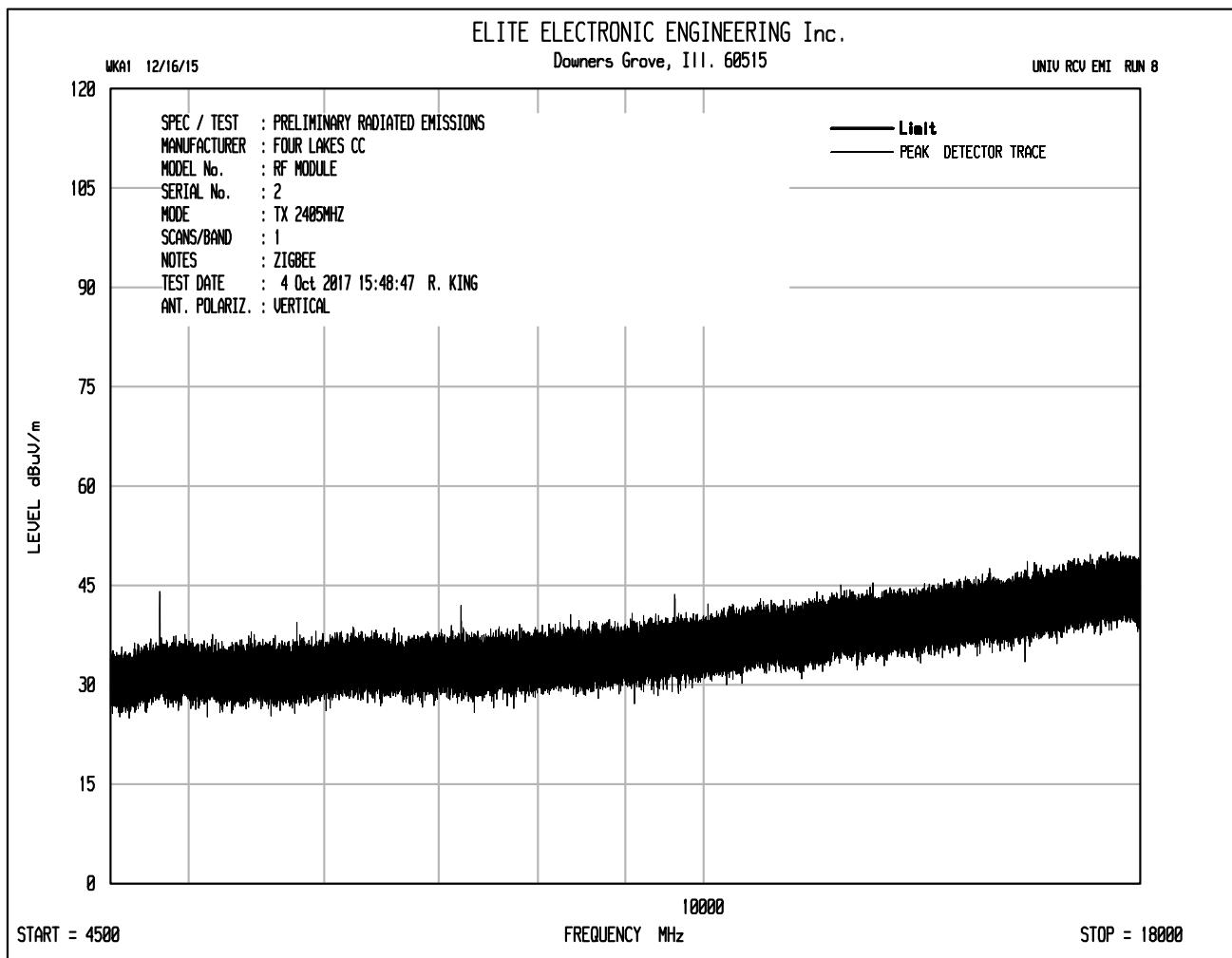








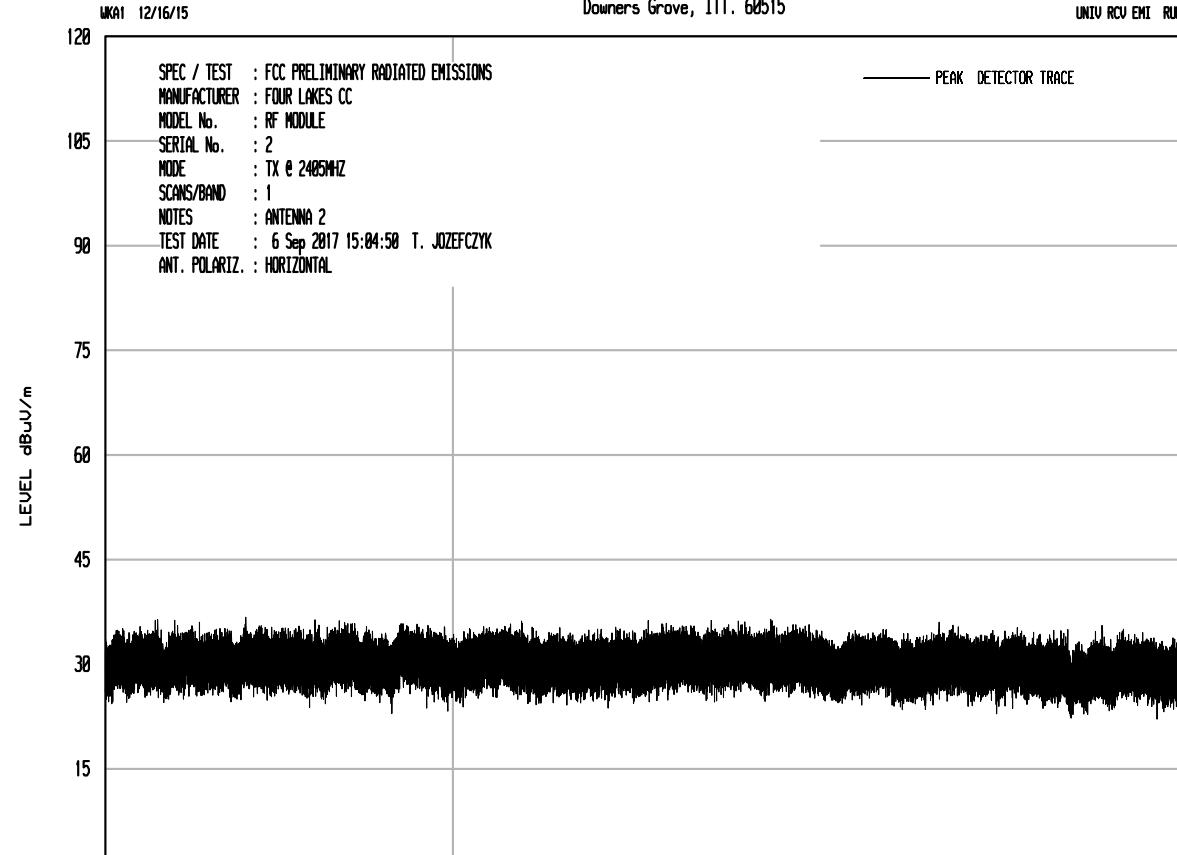




## ELITE ELECTRONIC ENGINEERING Inc.

Downers Grove, Ill. 60515

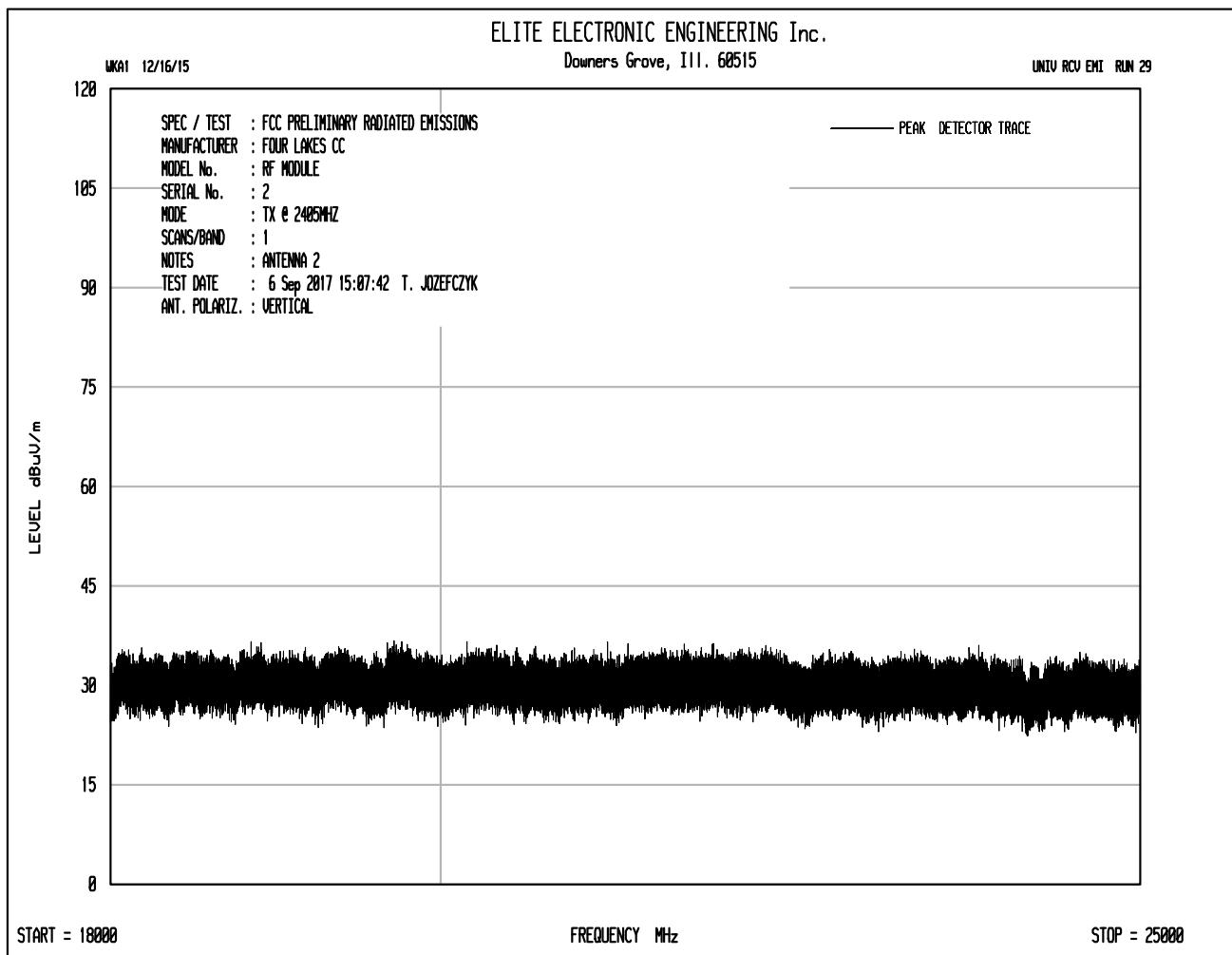
UNIV RCV EMI RUN 28

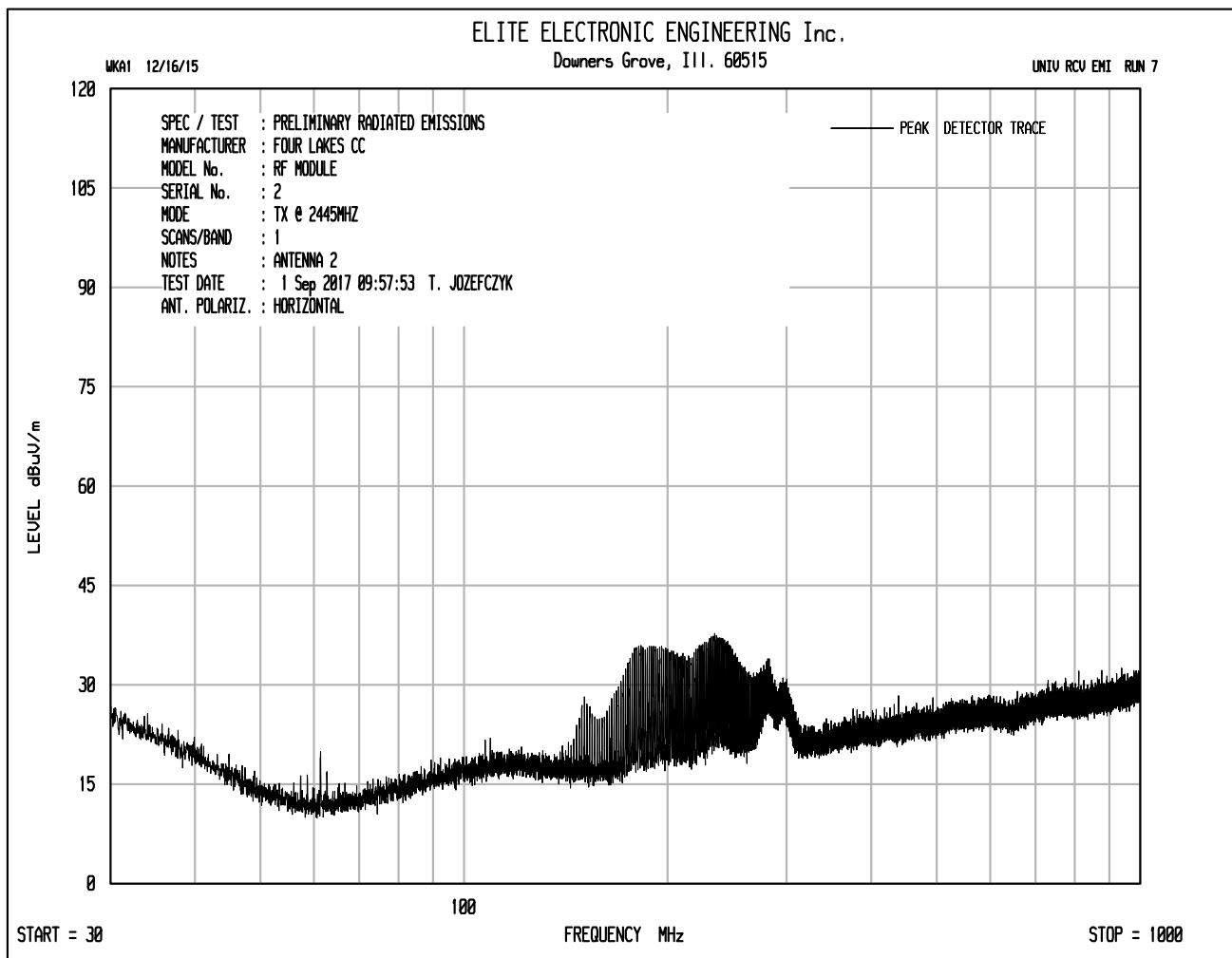


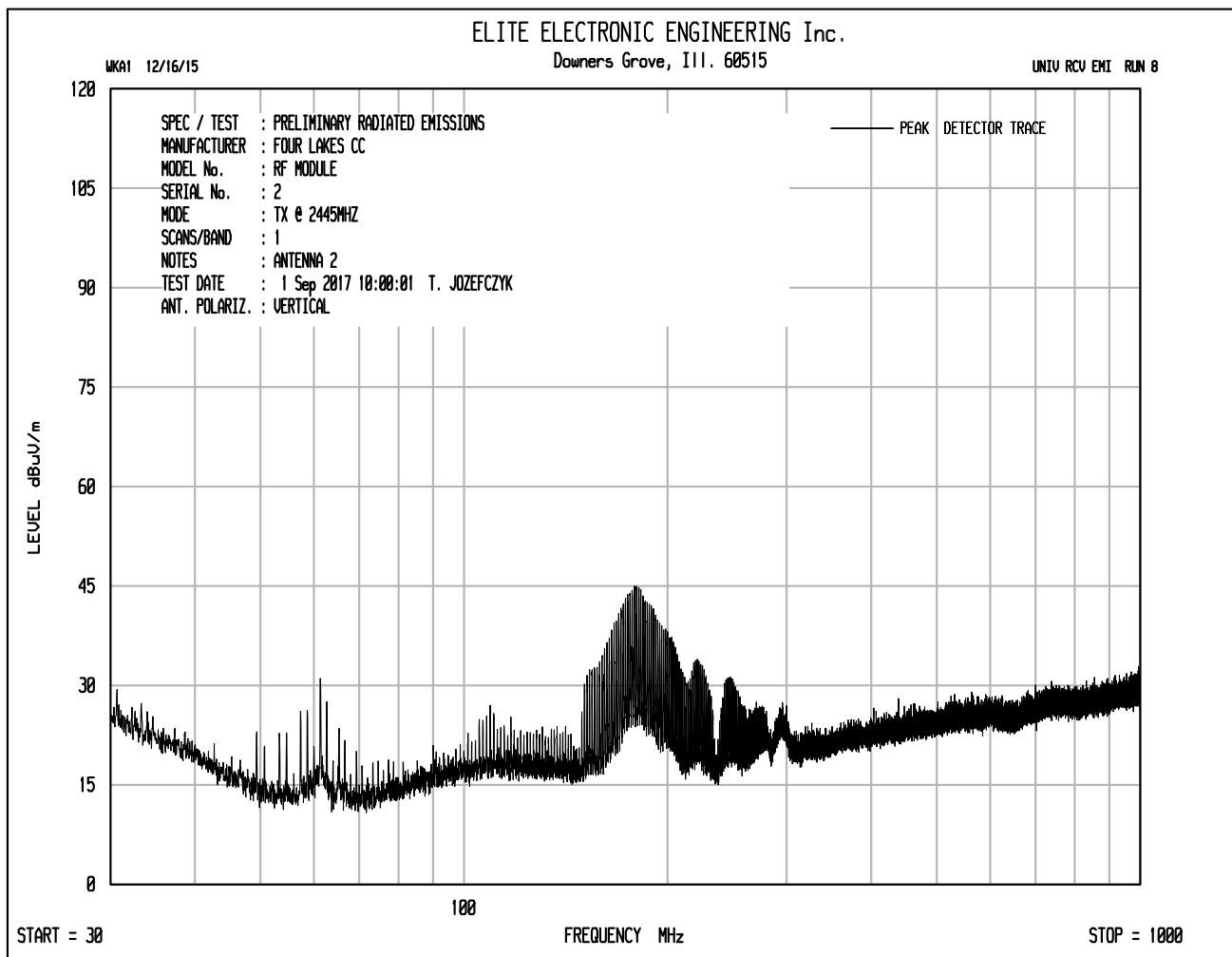
START = 18000

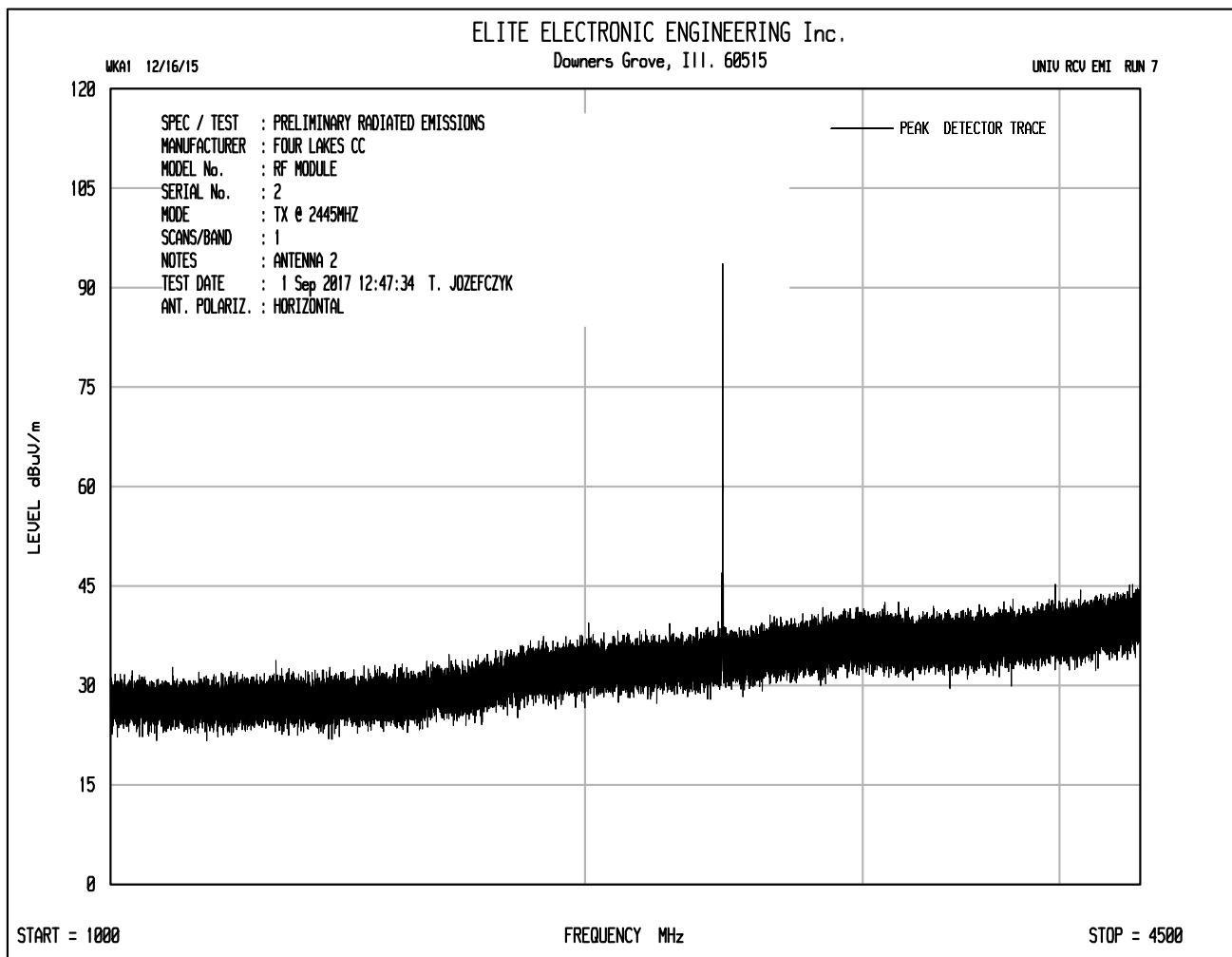
FREQUENCY MHz

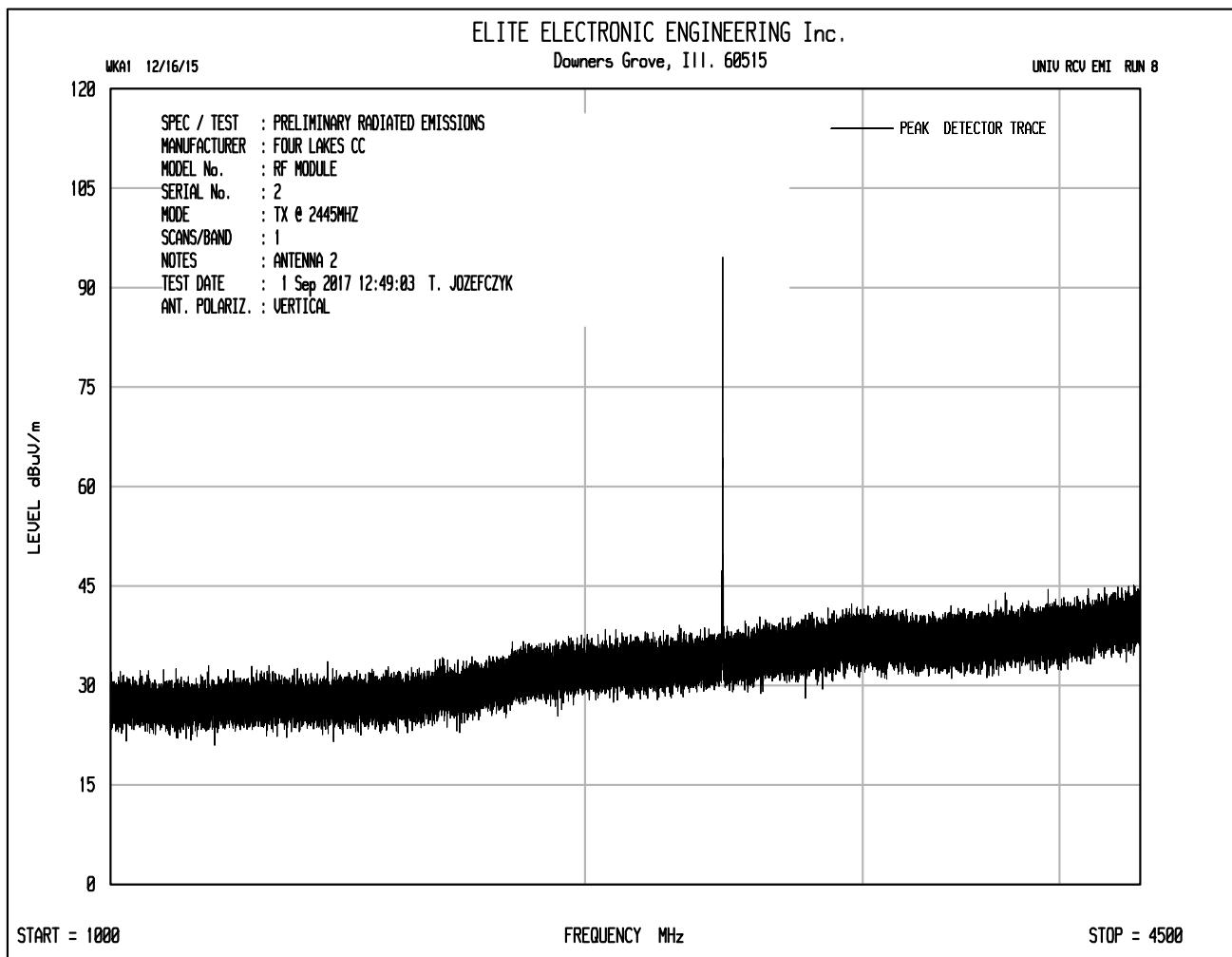
STOP = 25000

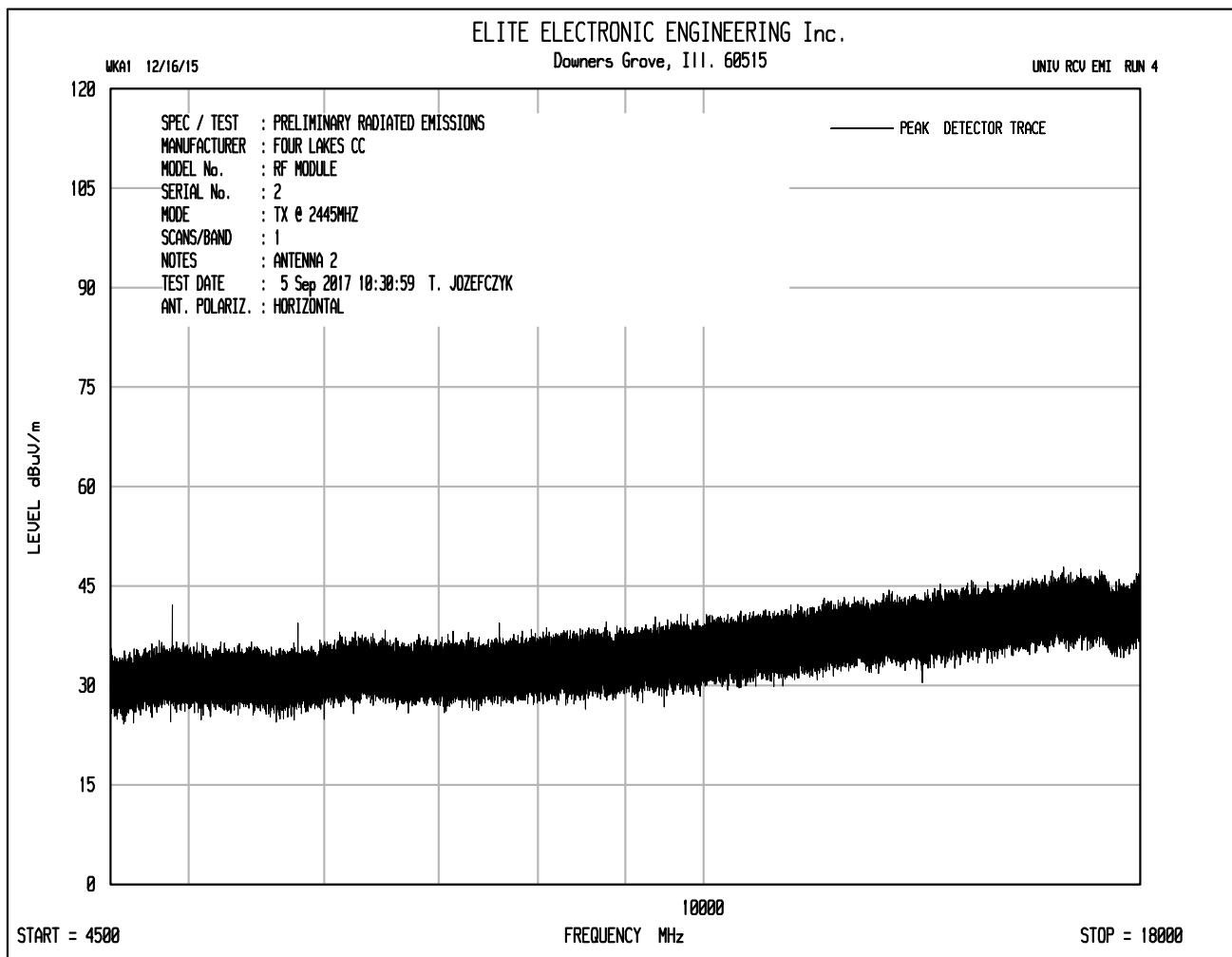


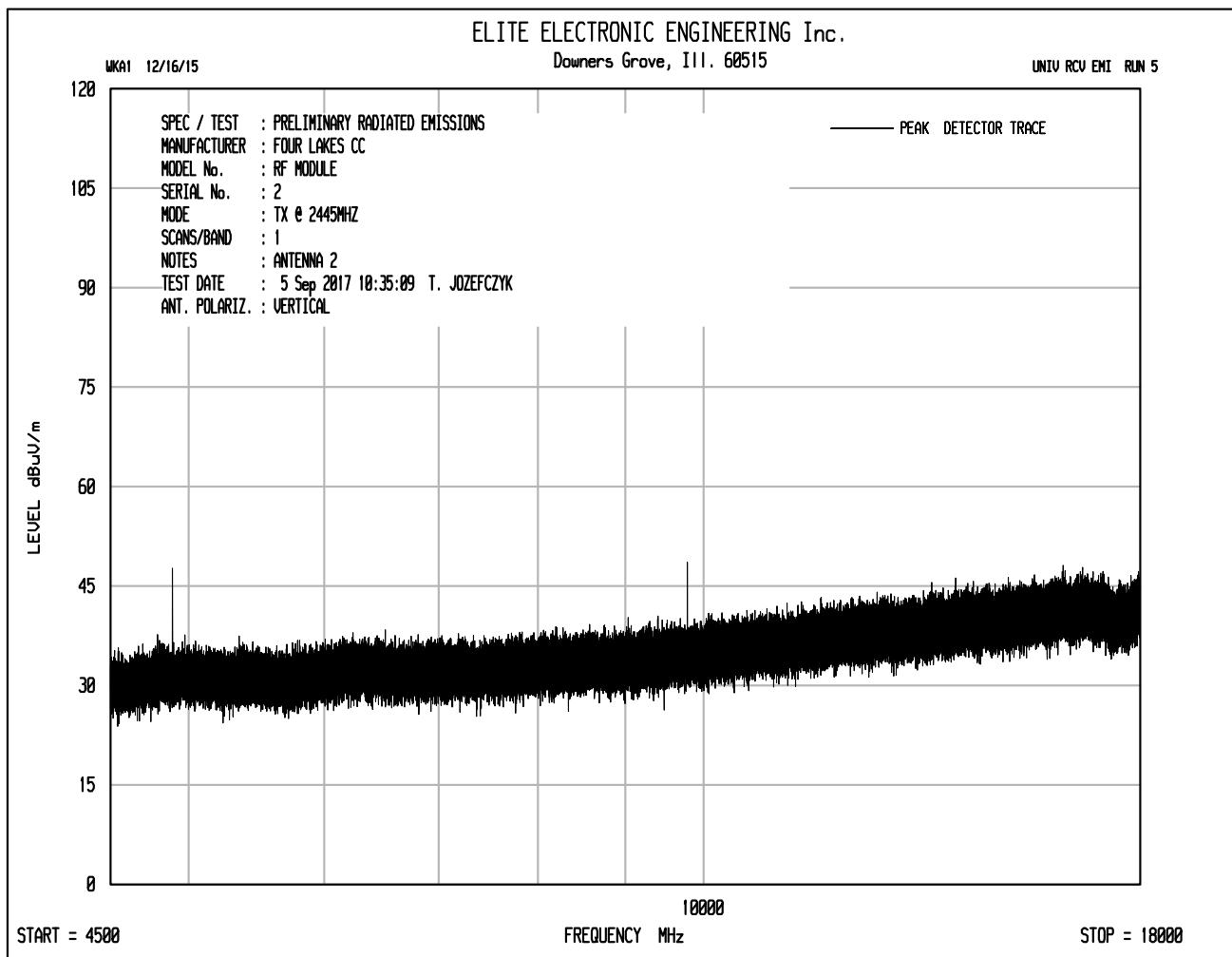








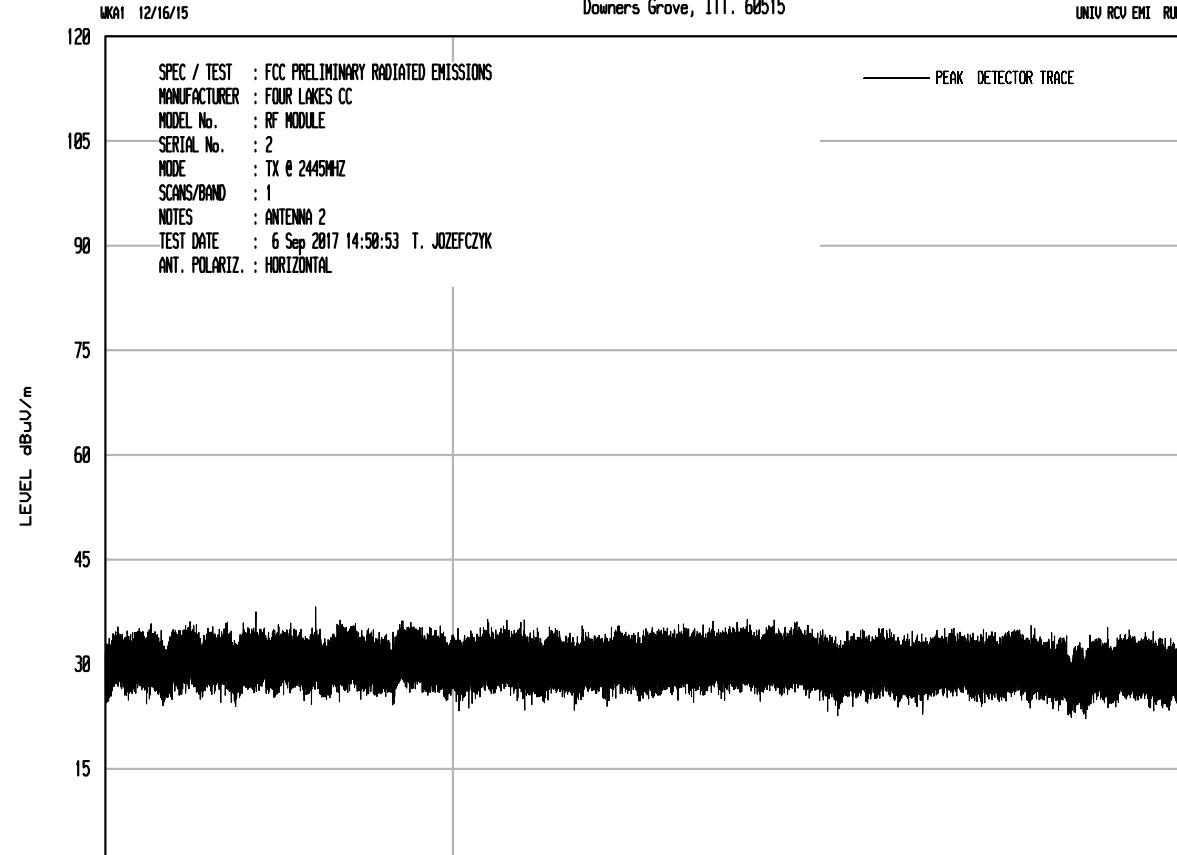


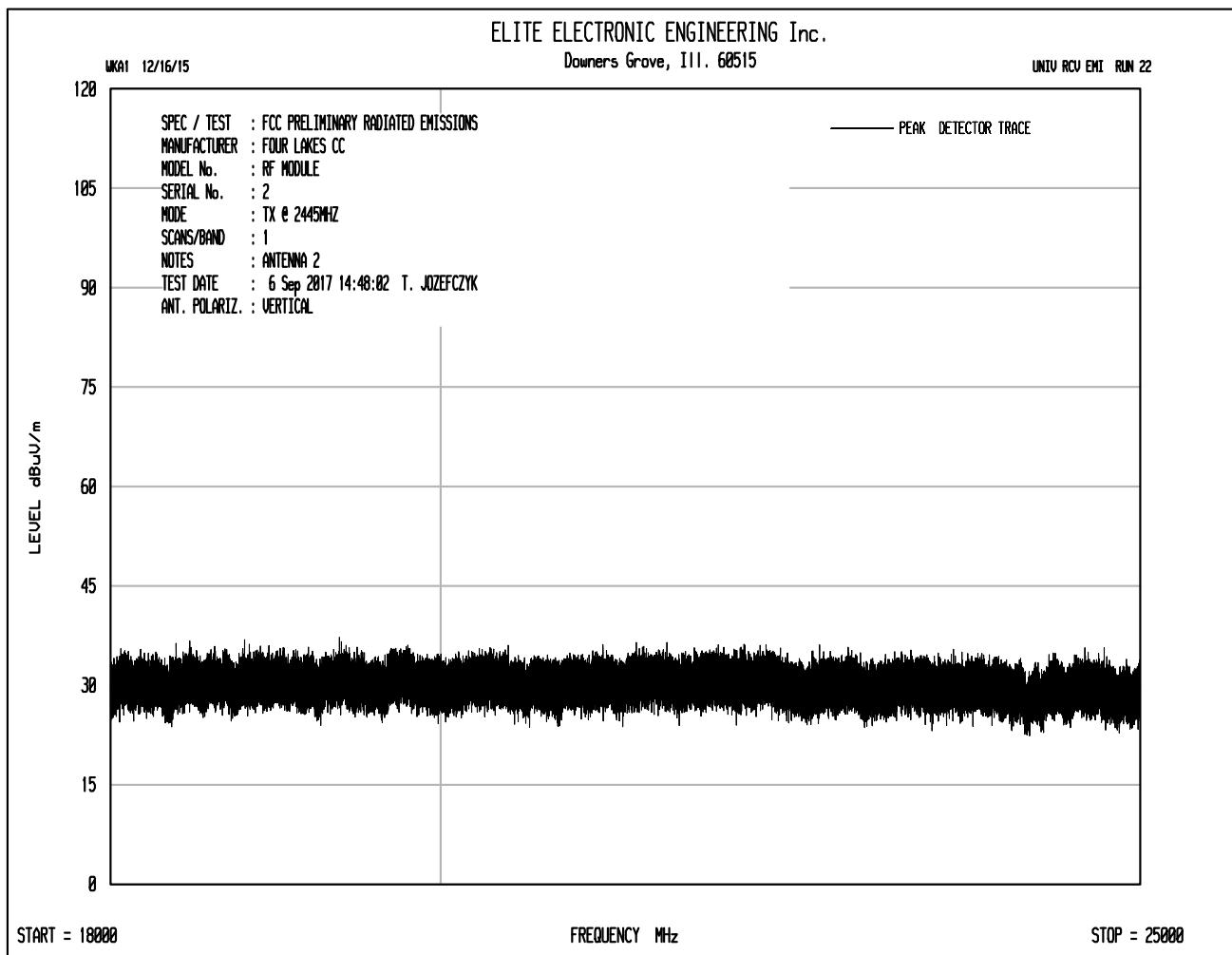


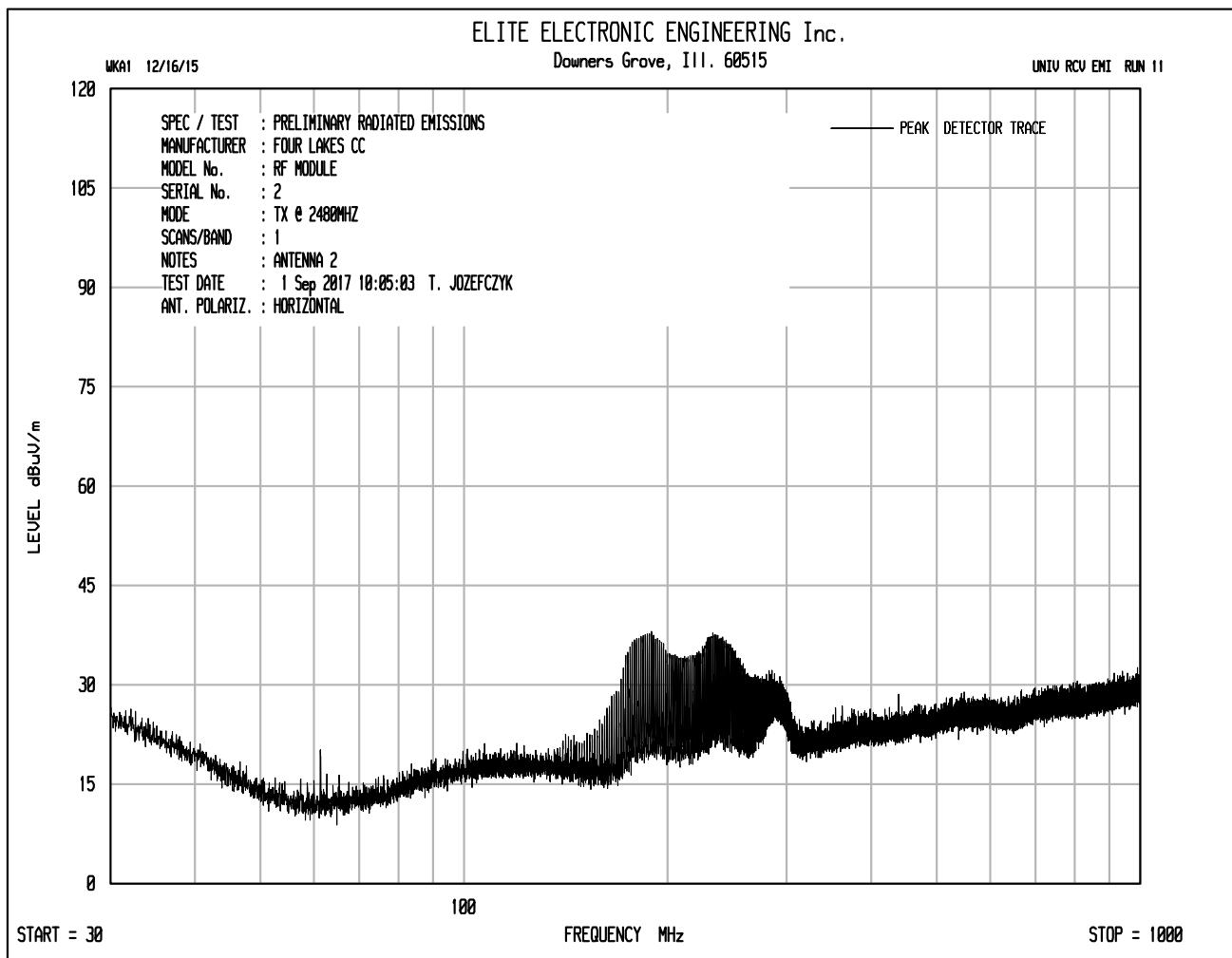
## ELITE ELECTRONIC ENGINEERING Inc.

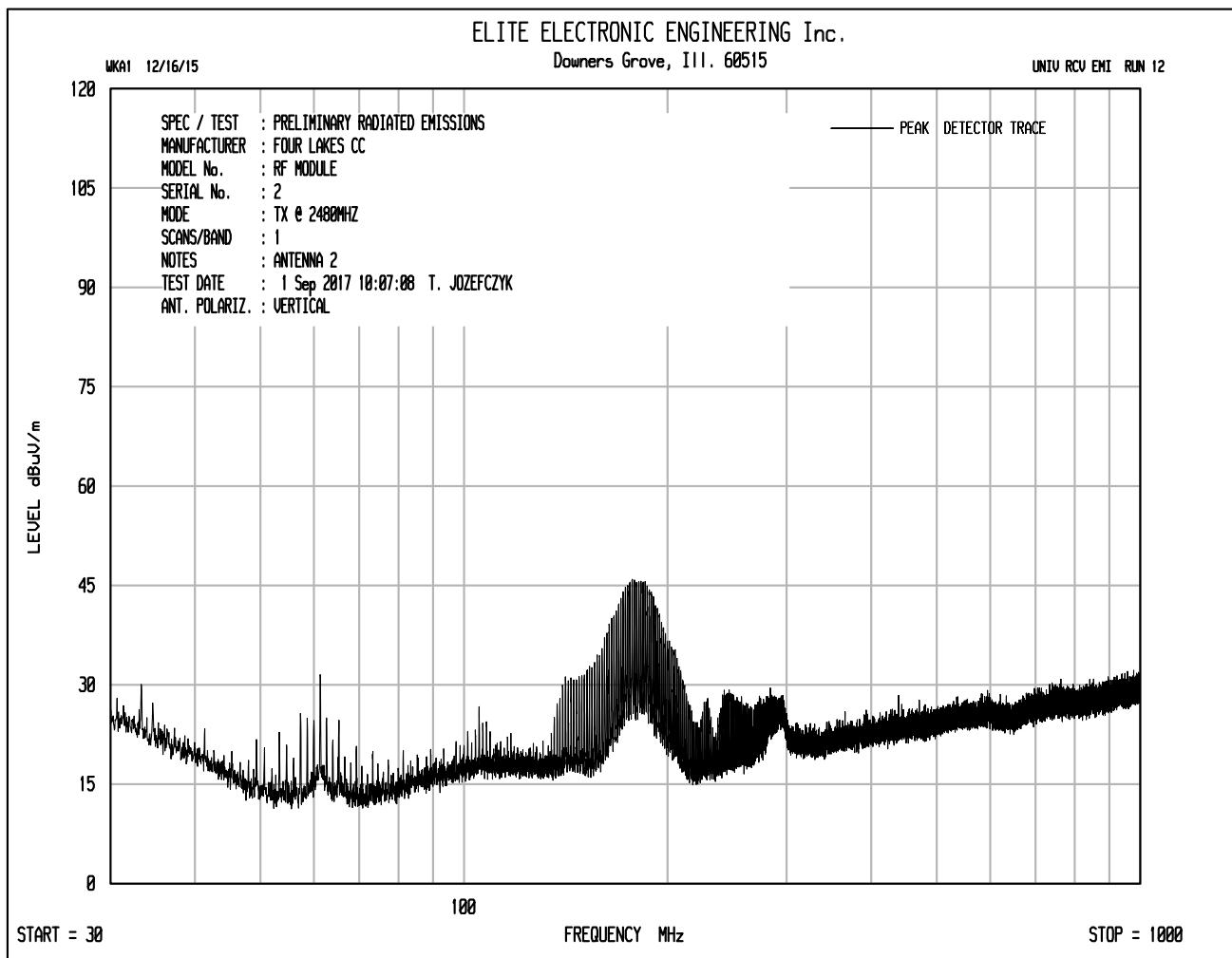
Downers Grove, Ill. 60515

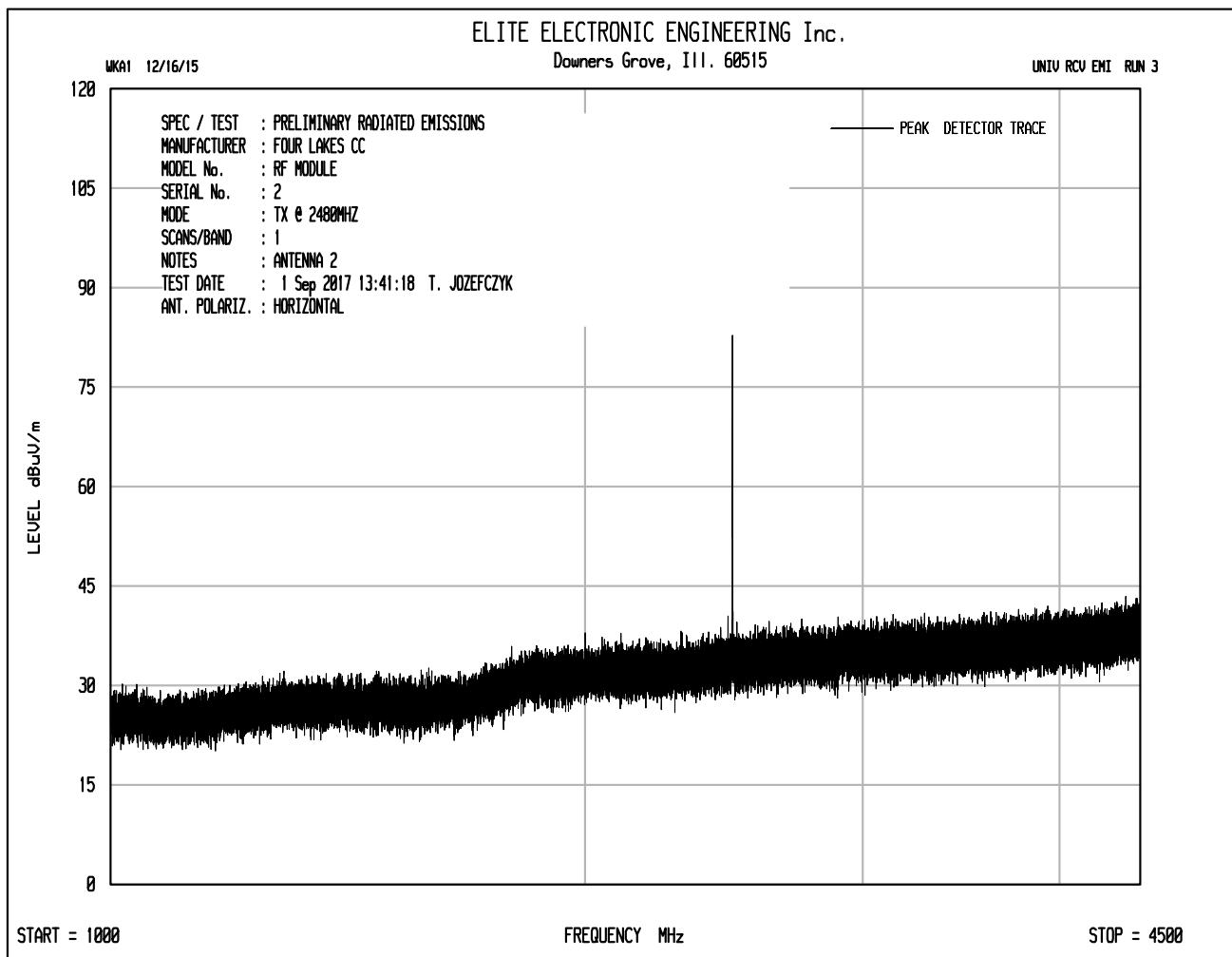
UNIV RCV EMI RUN 23

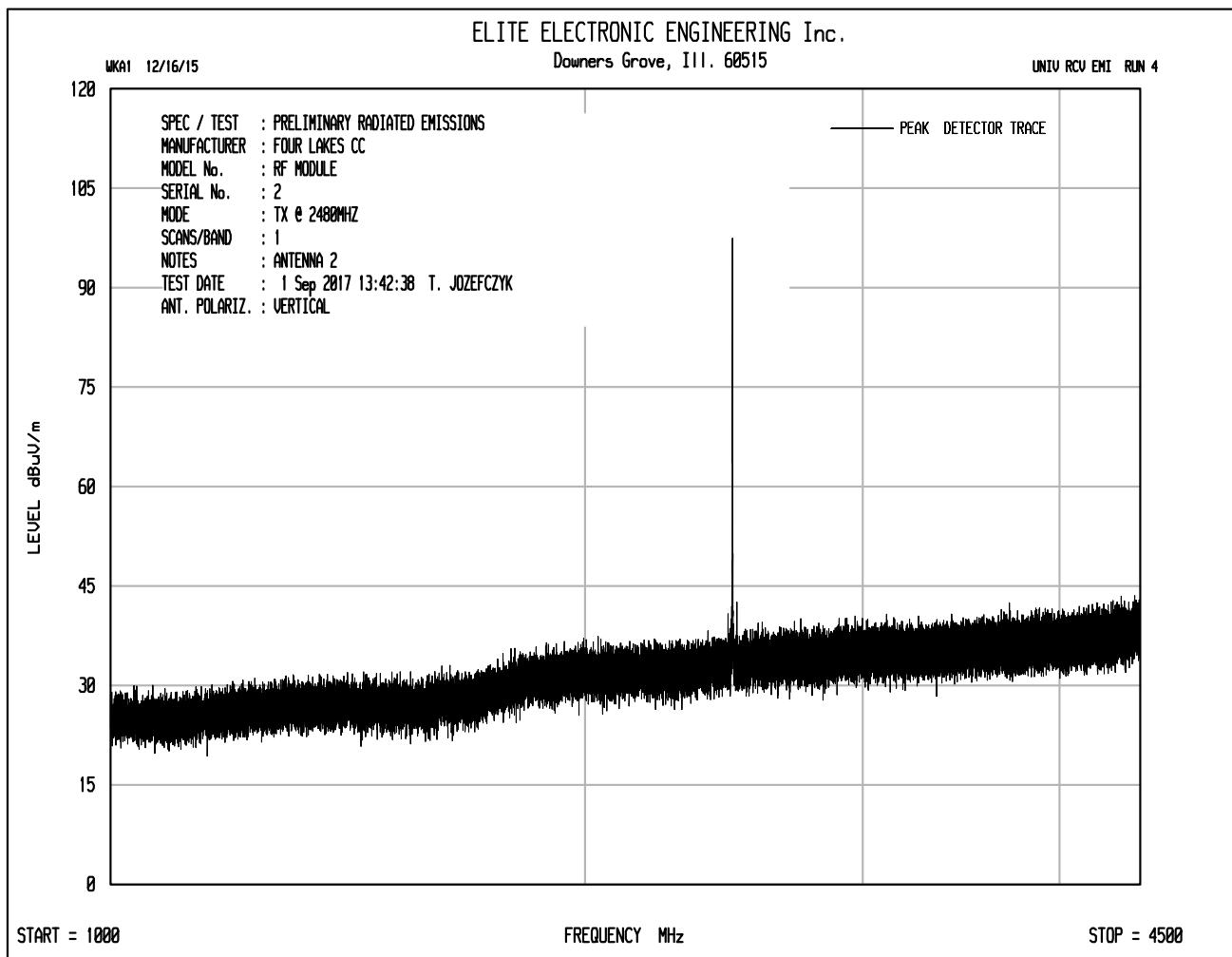


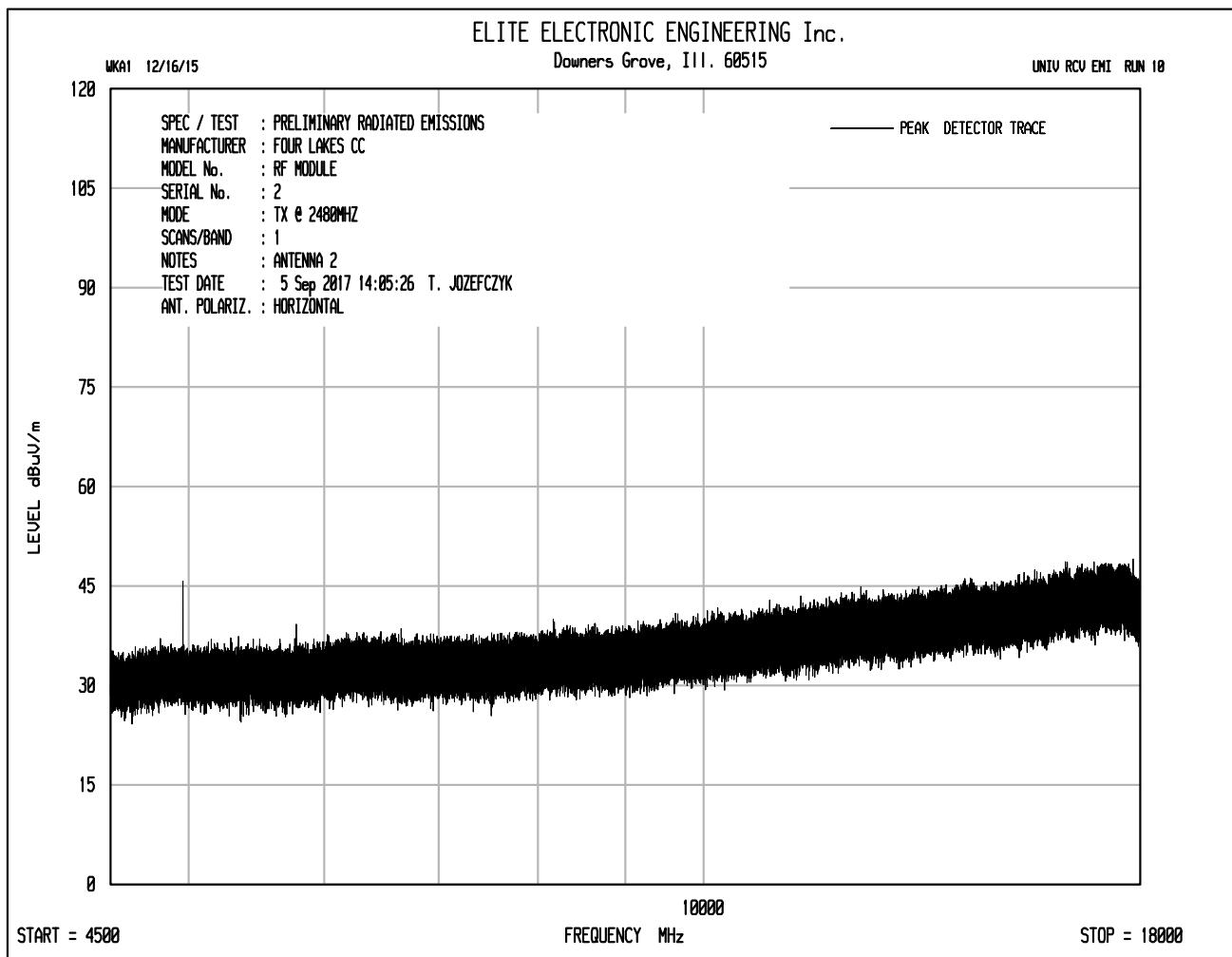


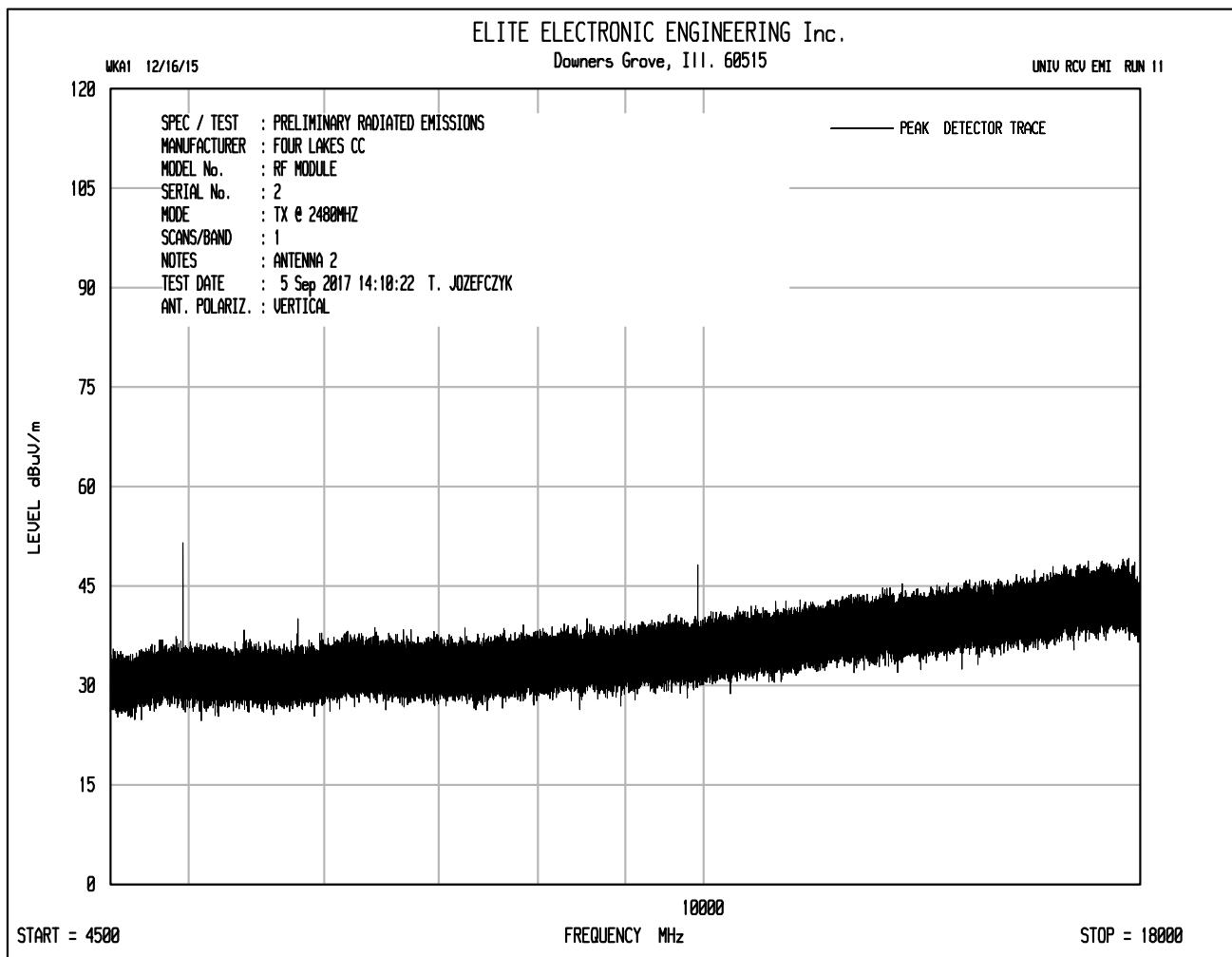


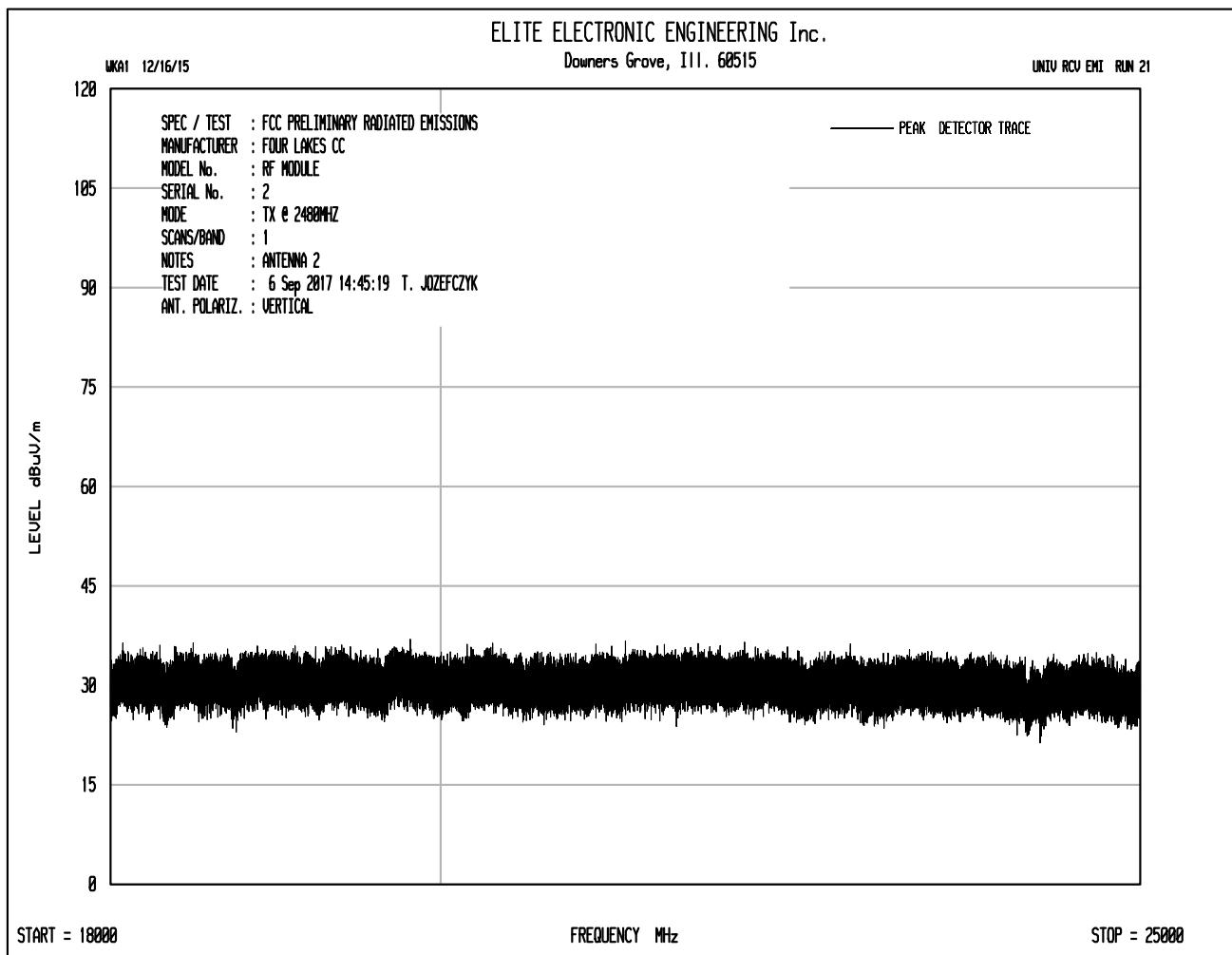


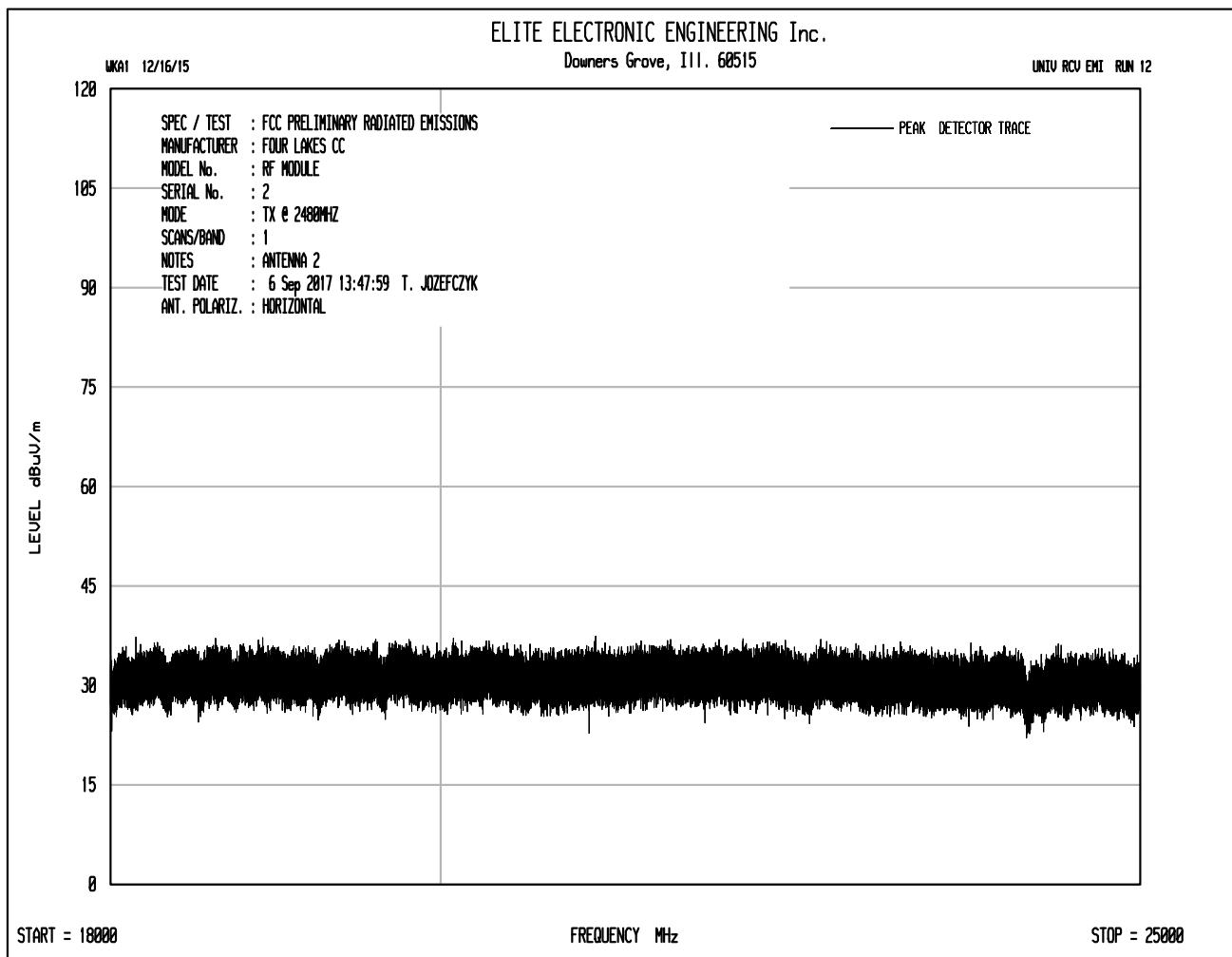


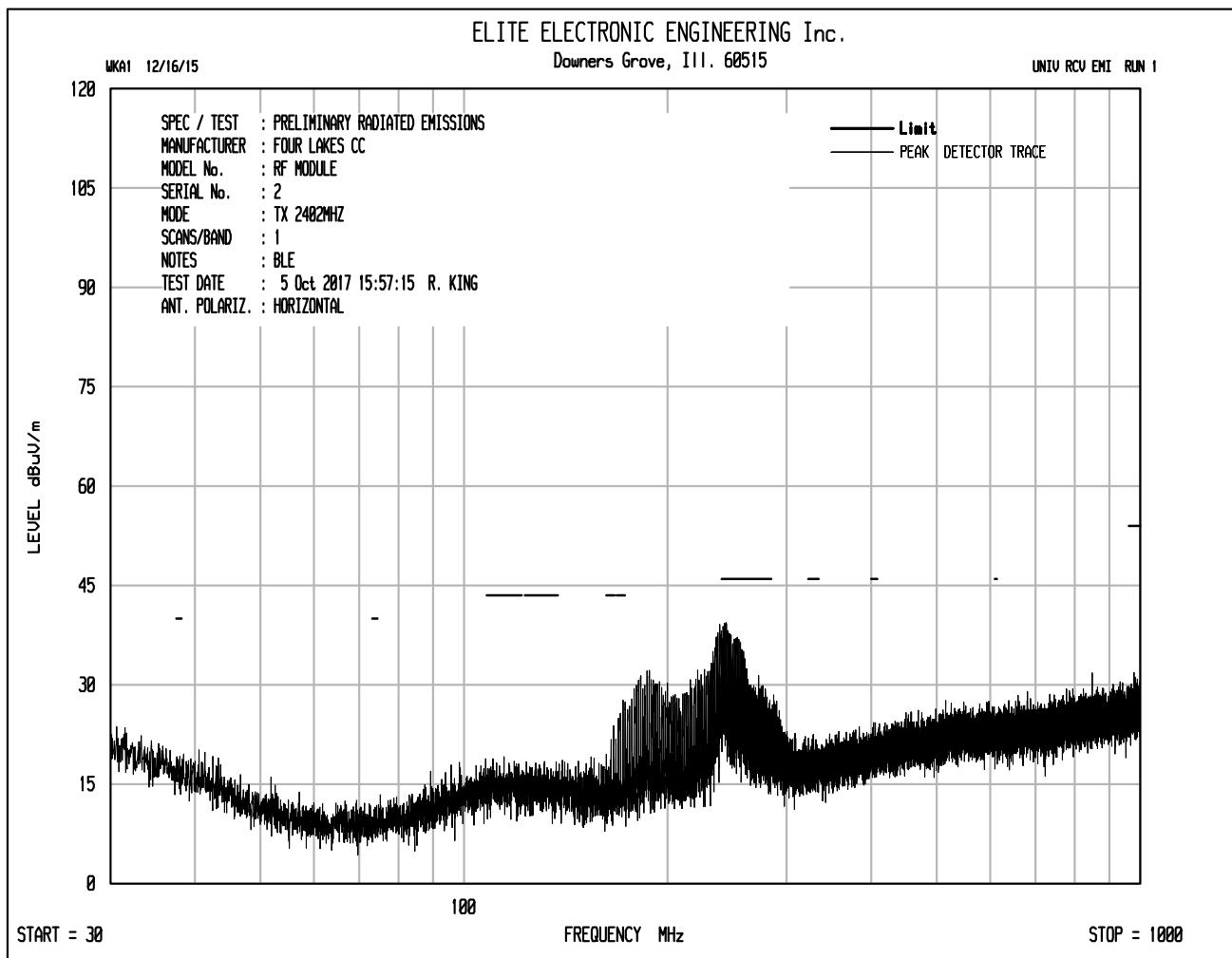


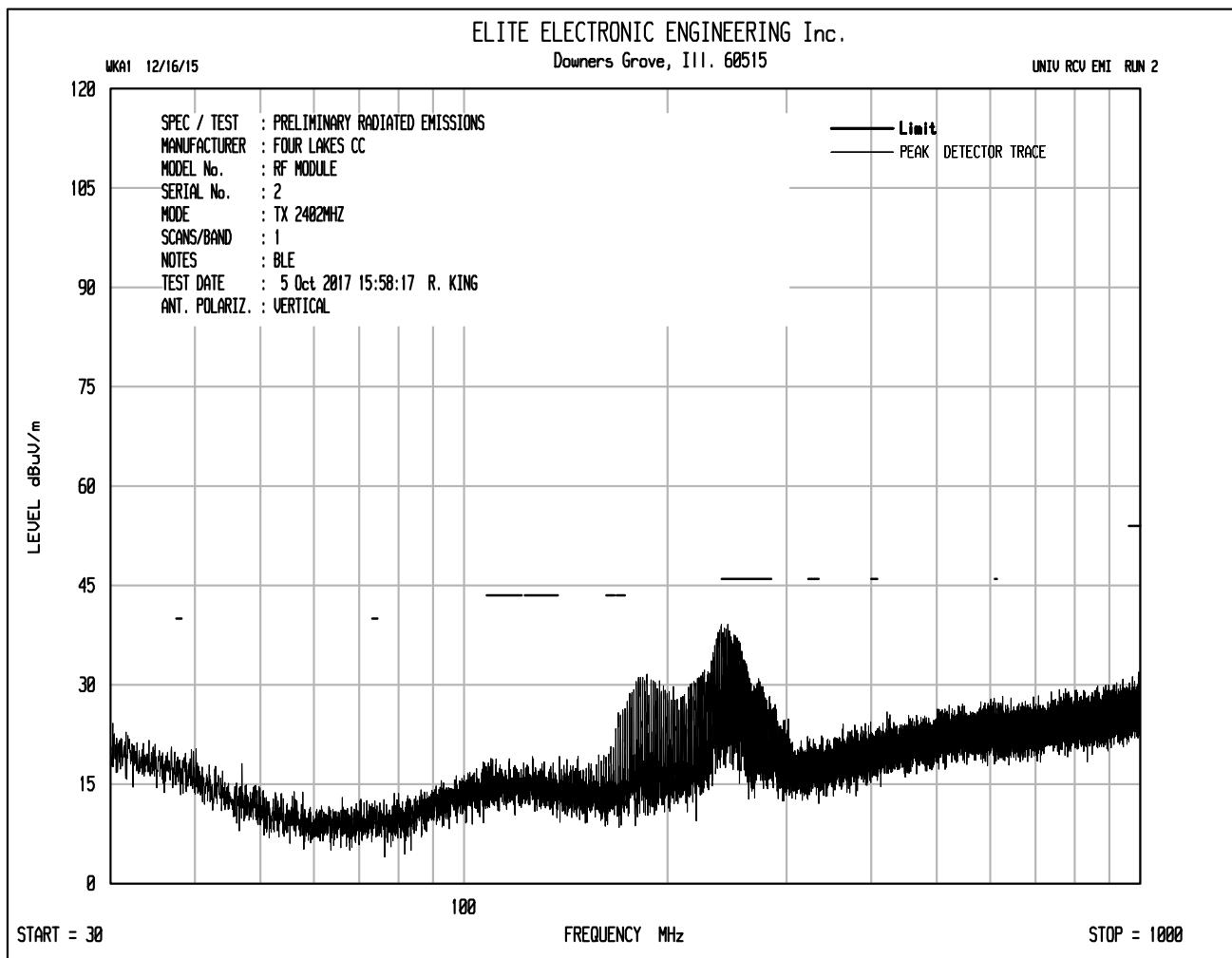


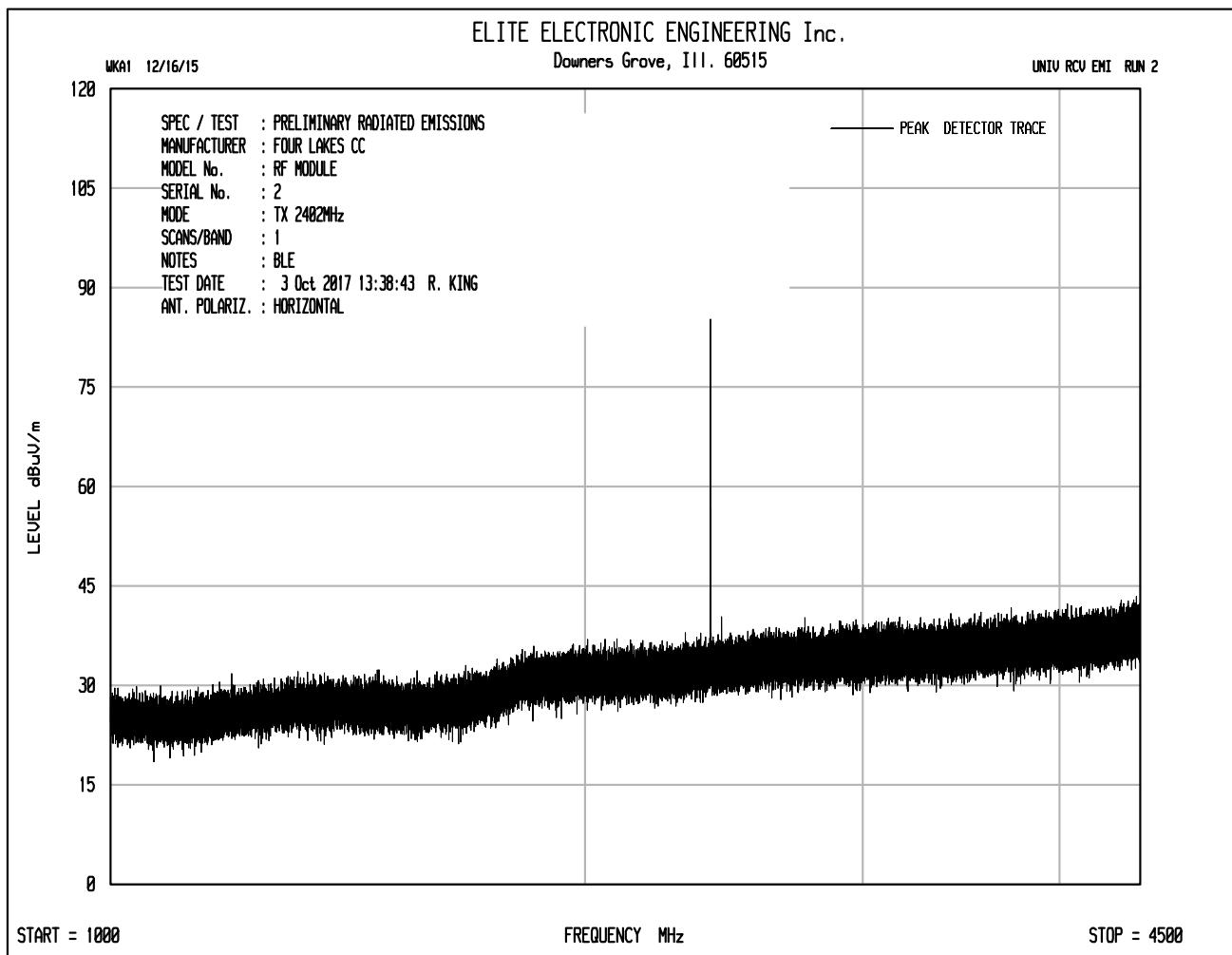


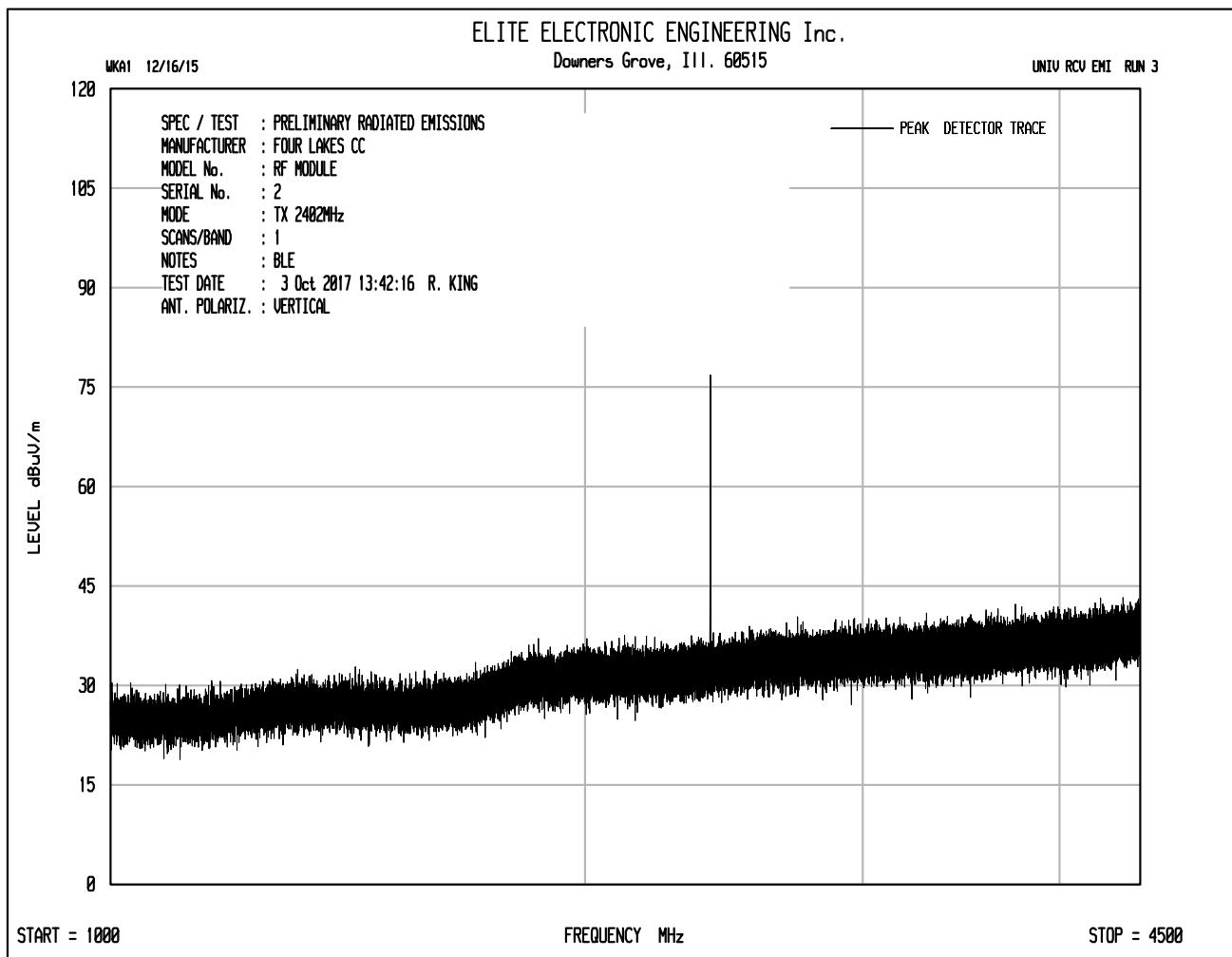


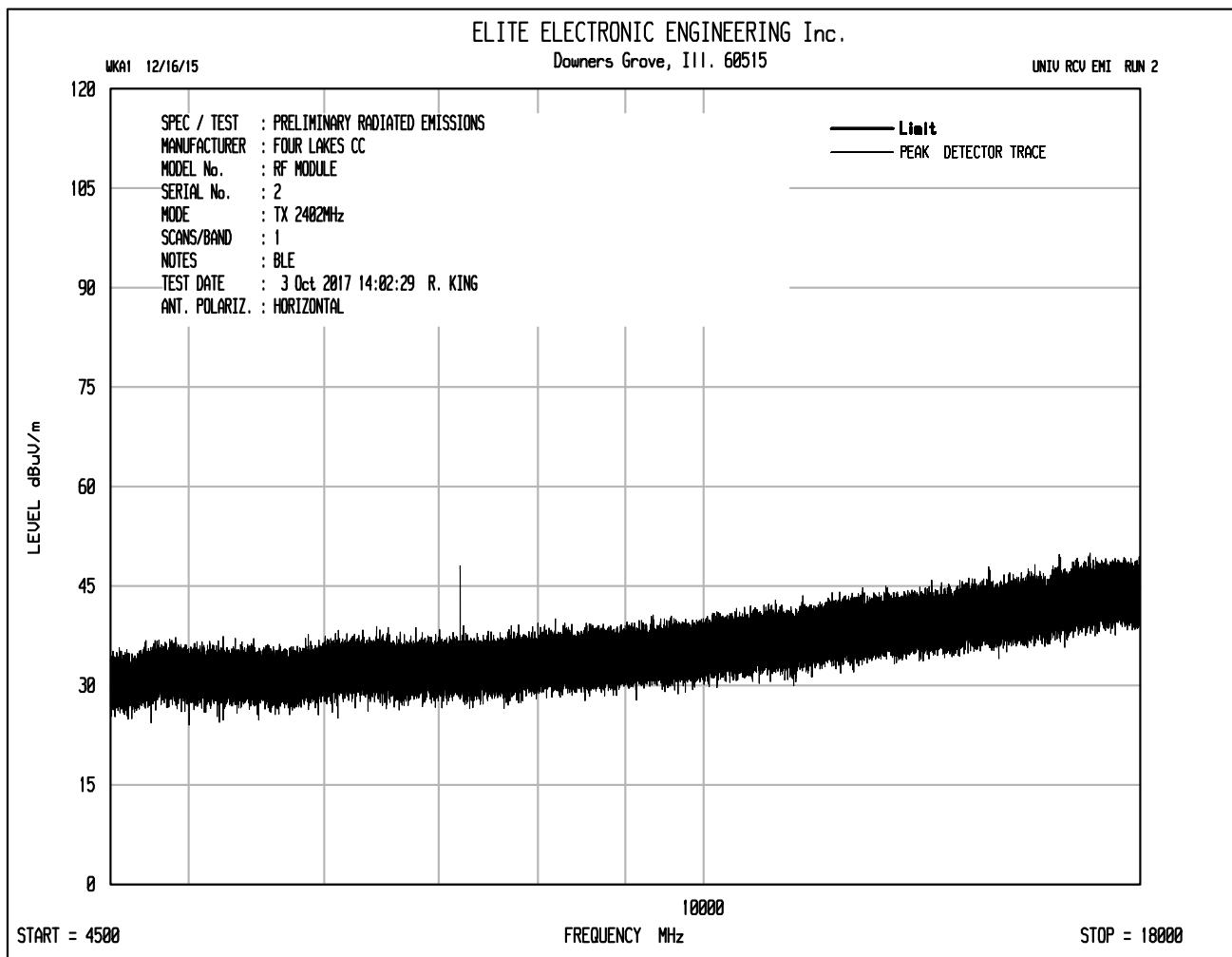


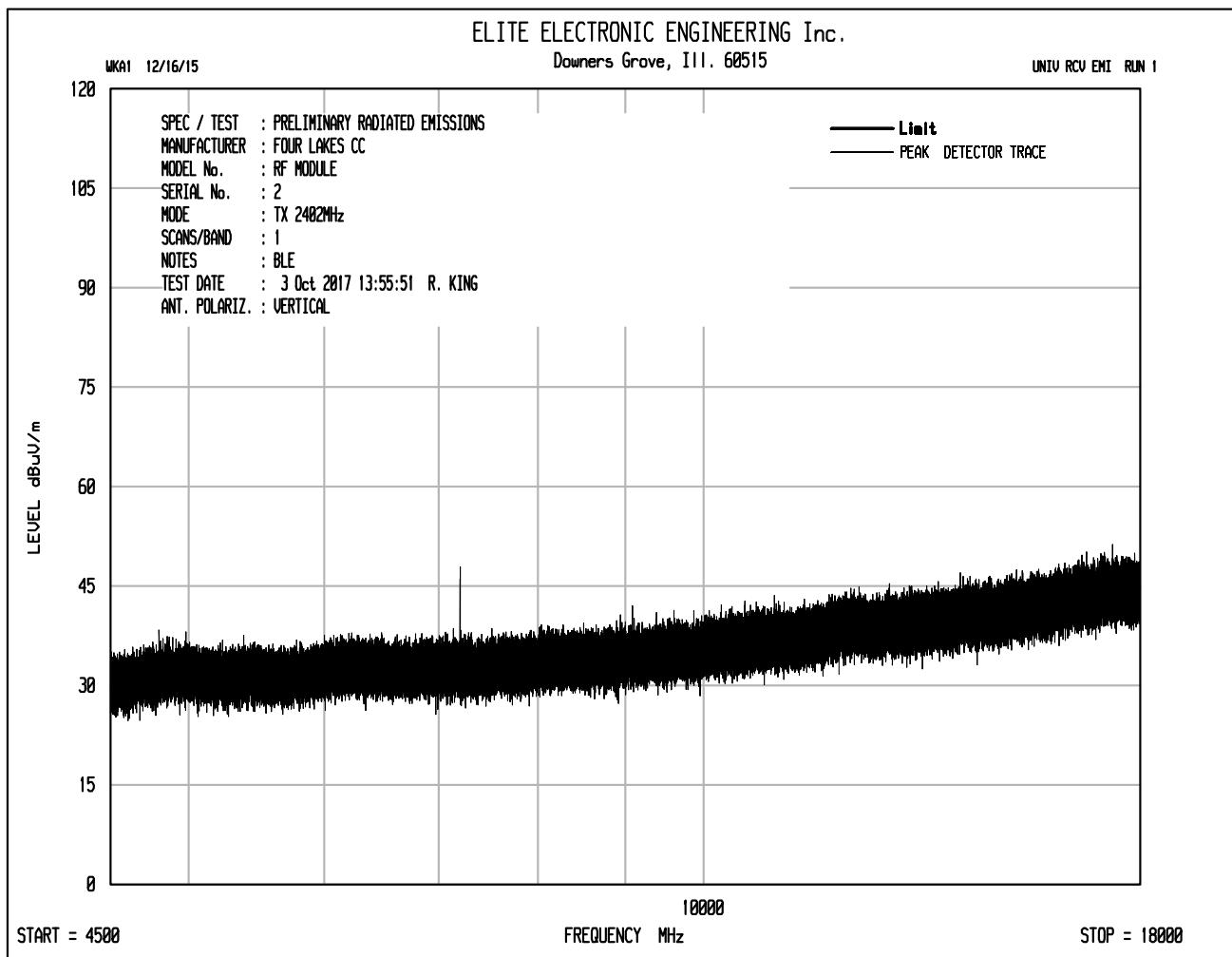


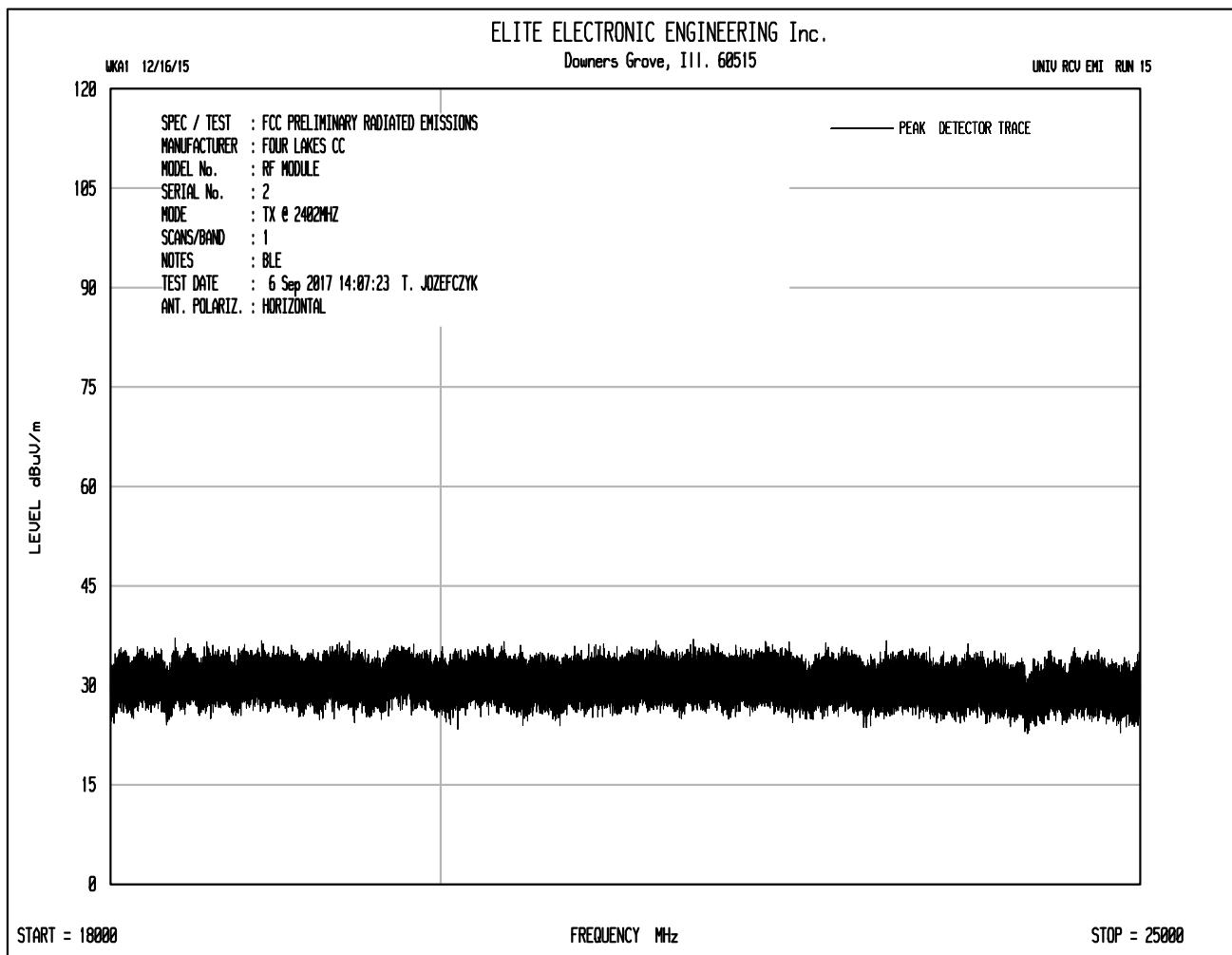


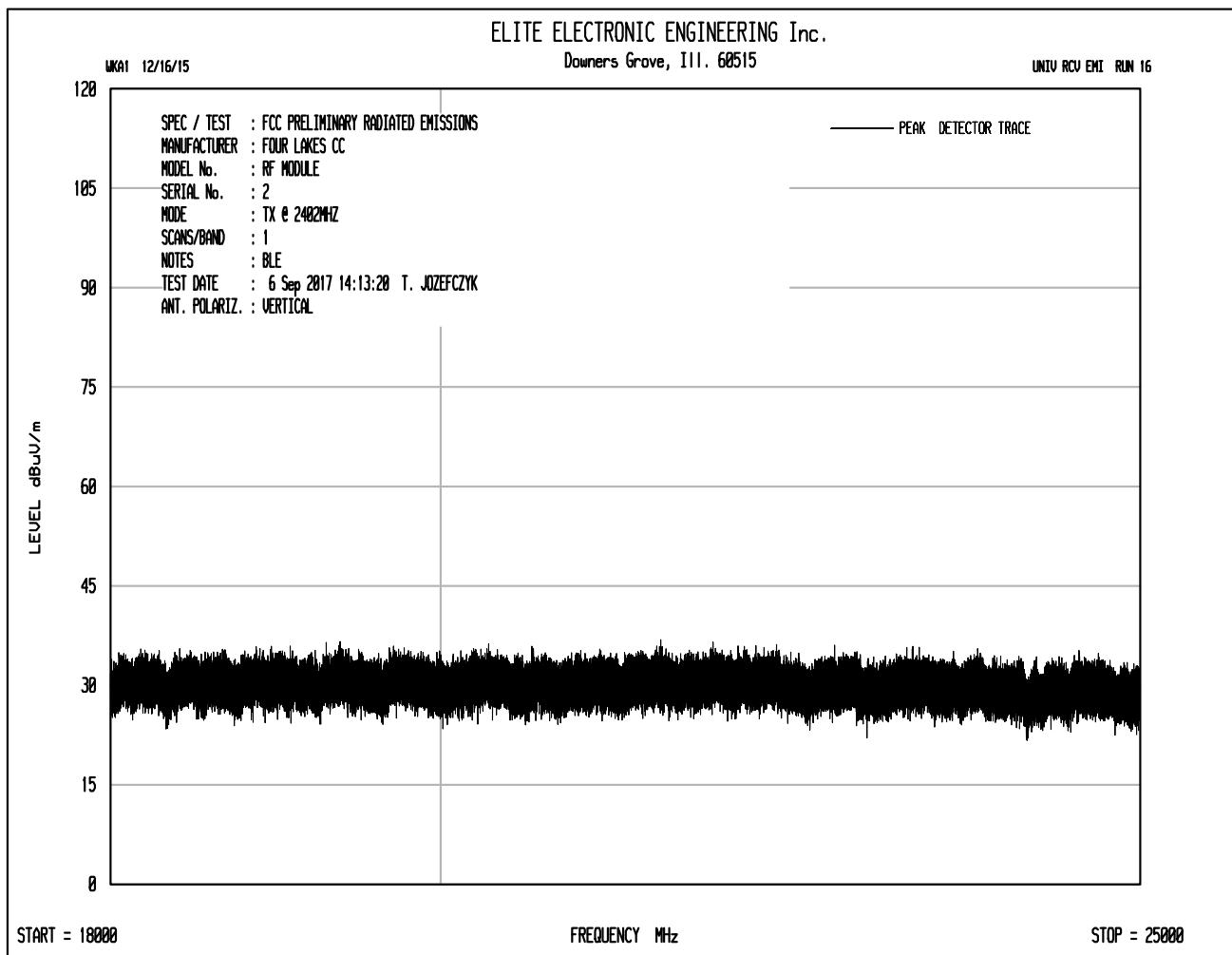


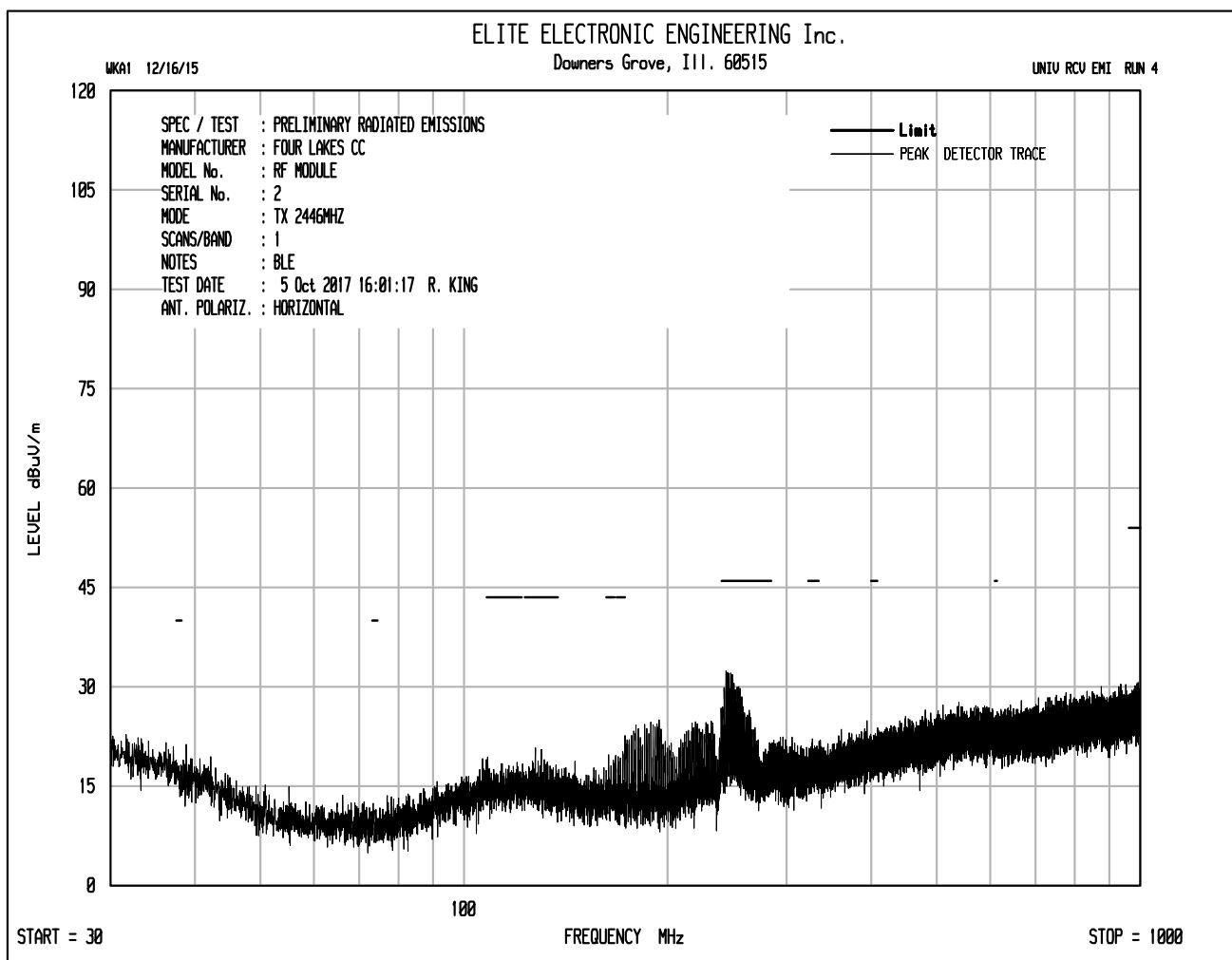


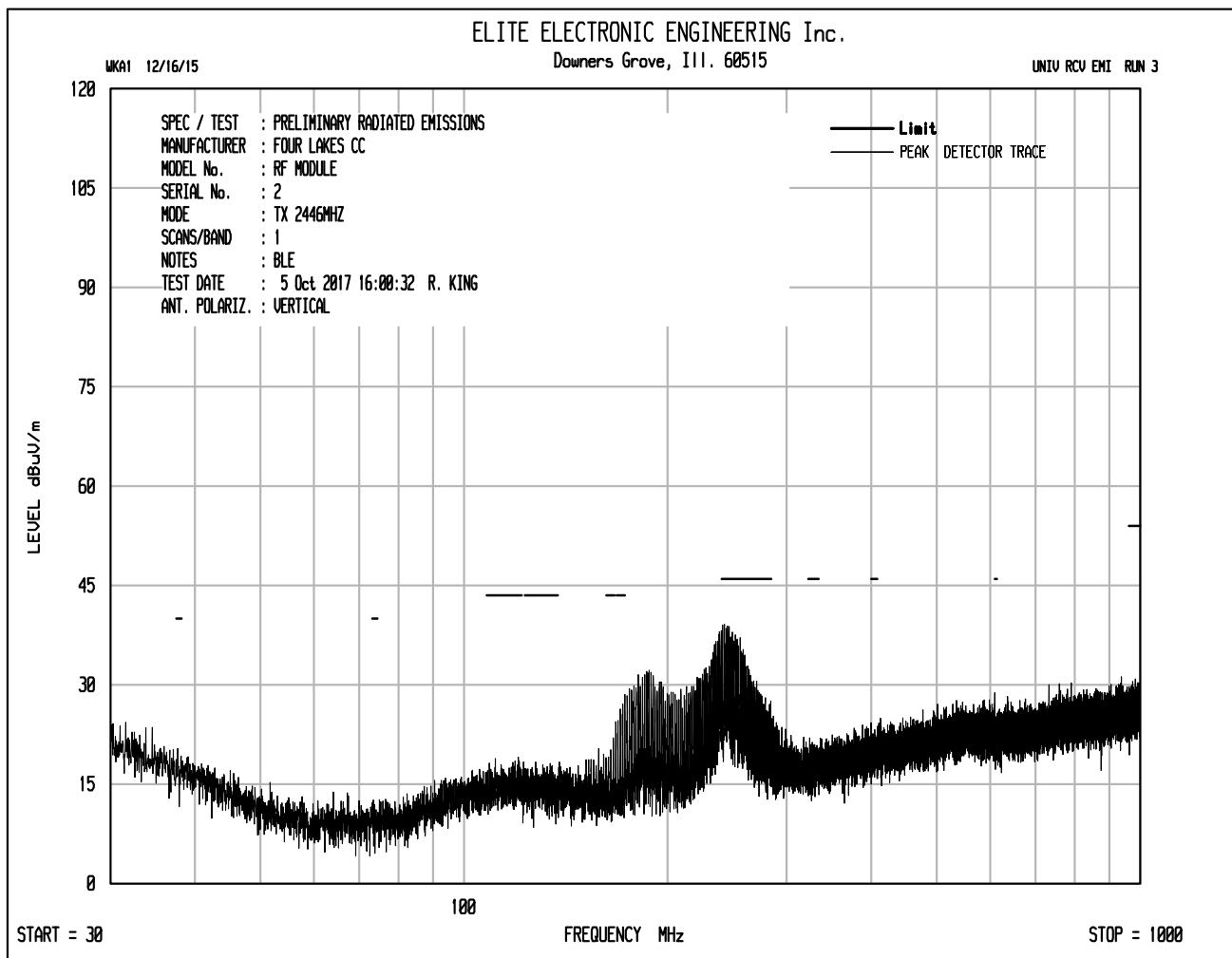


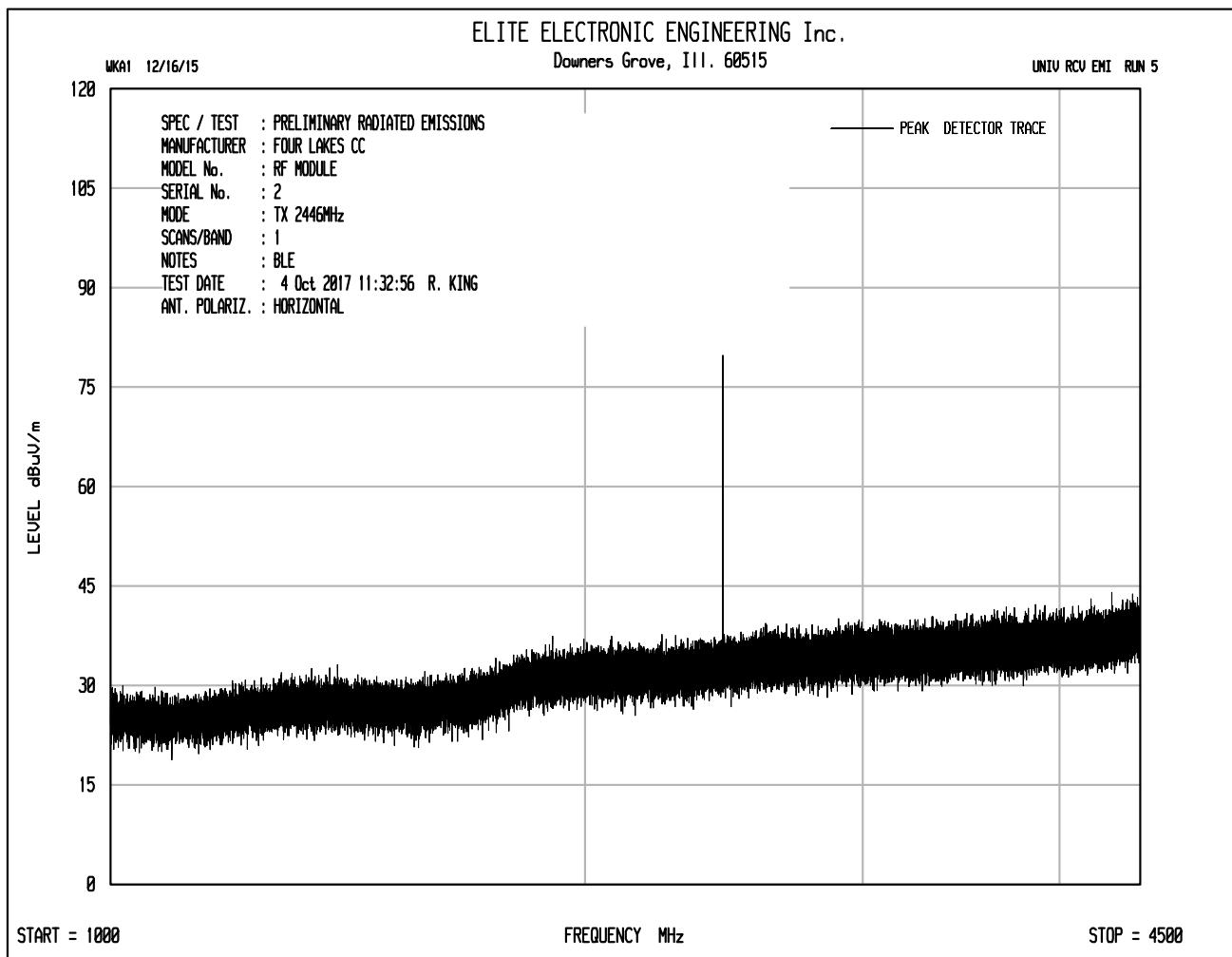


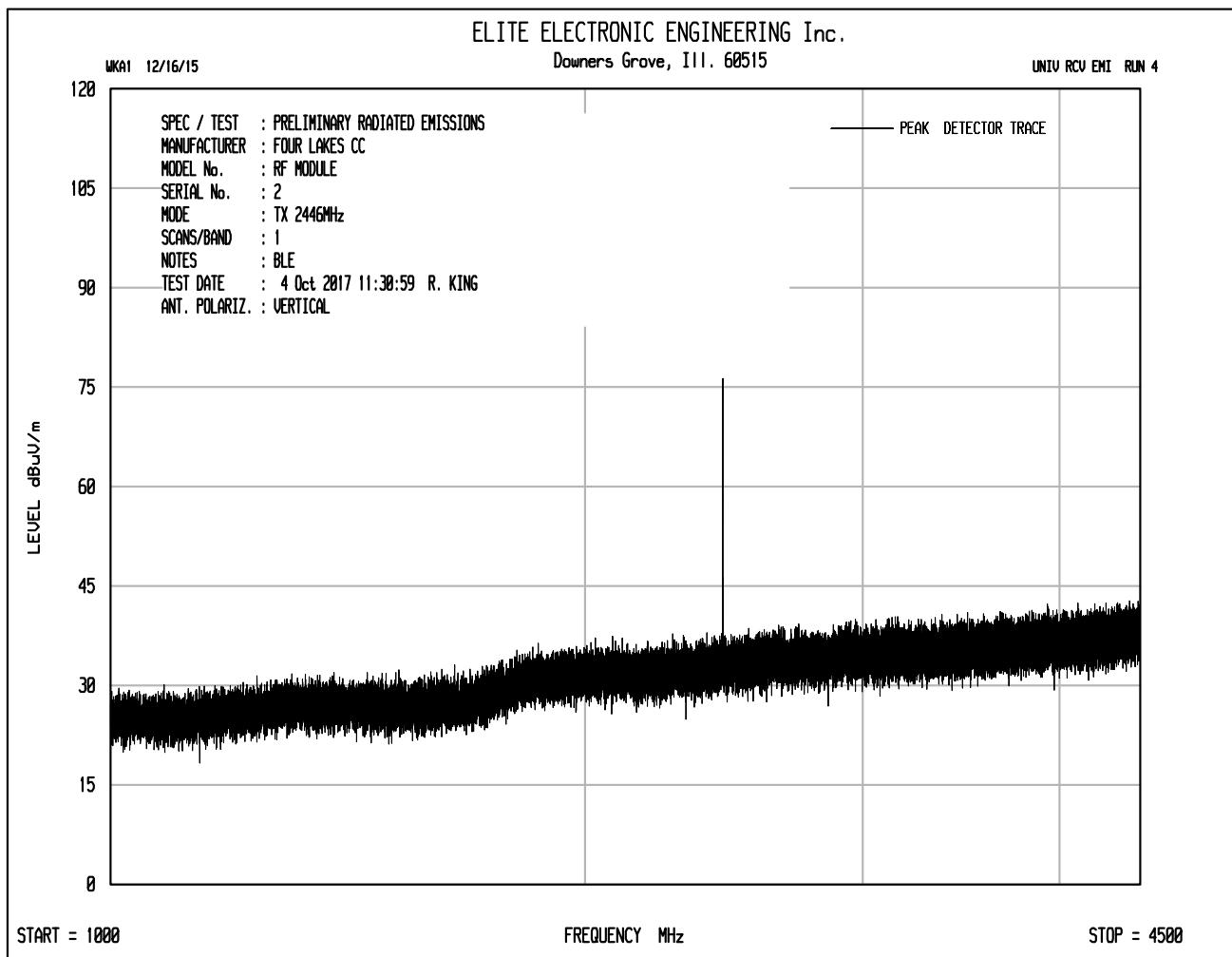


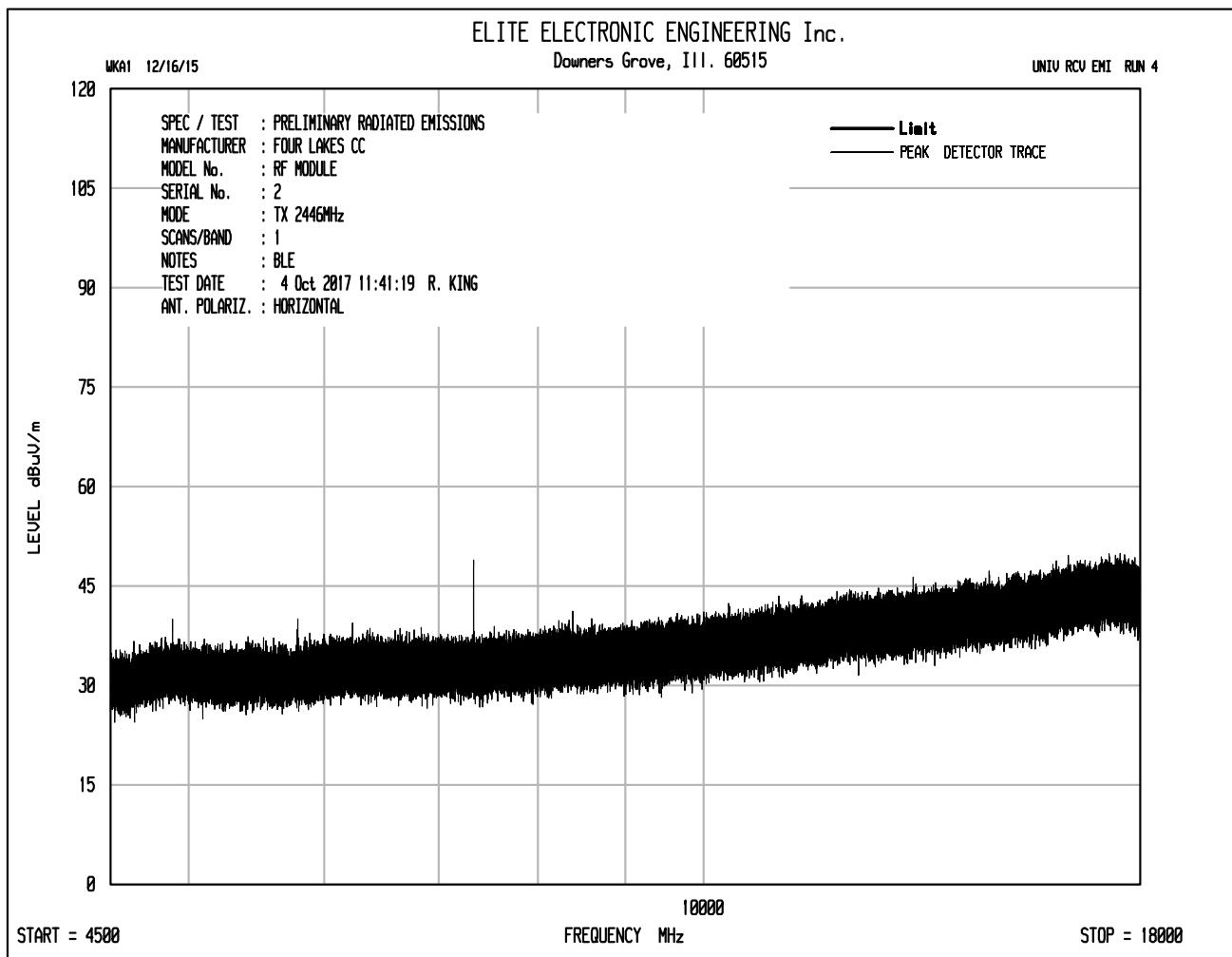


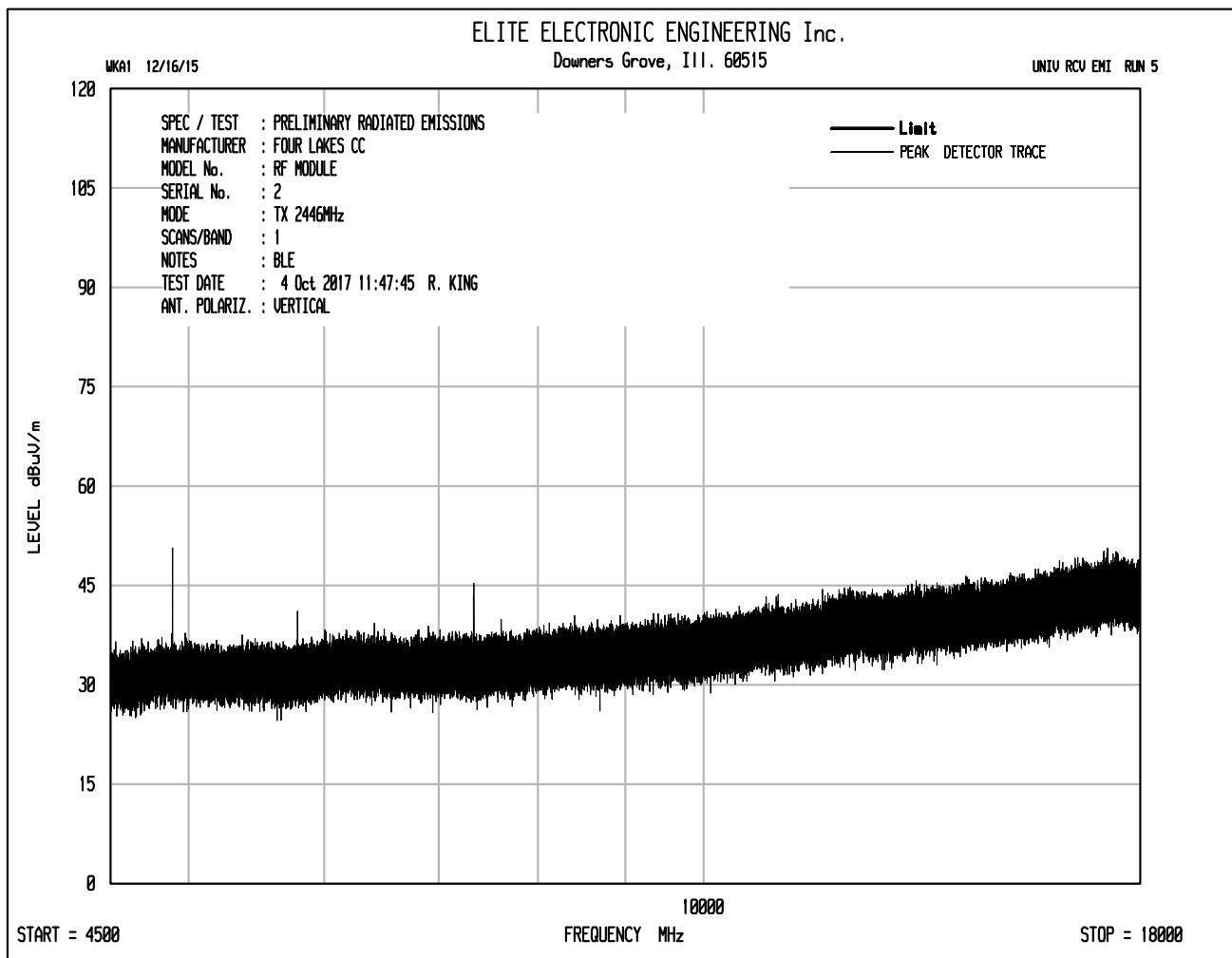


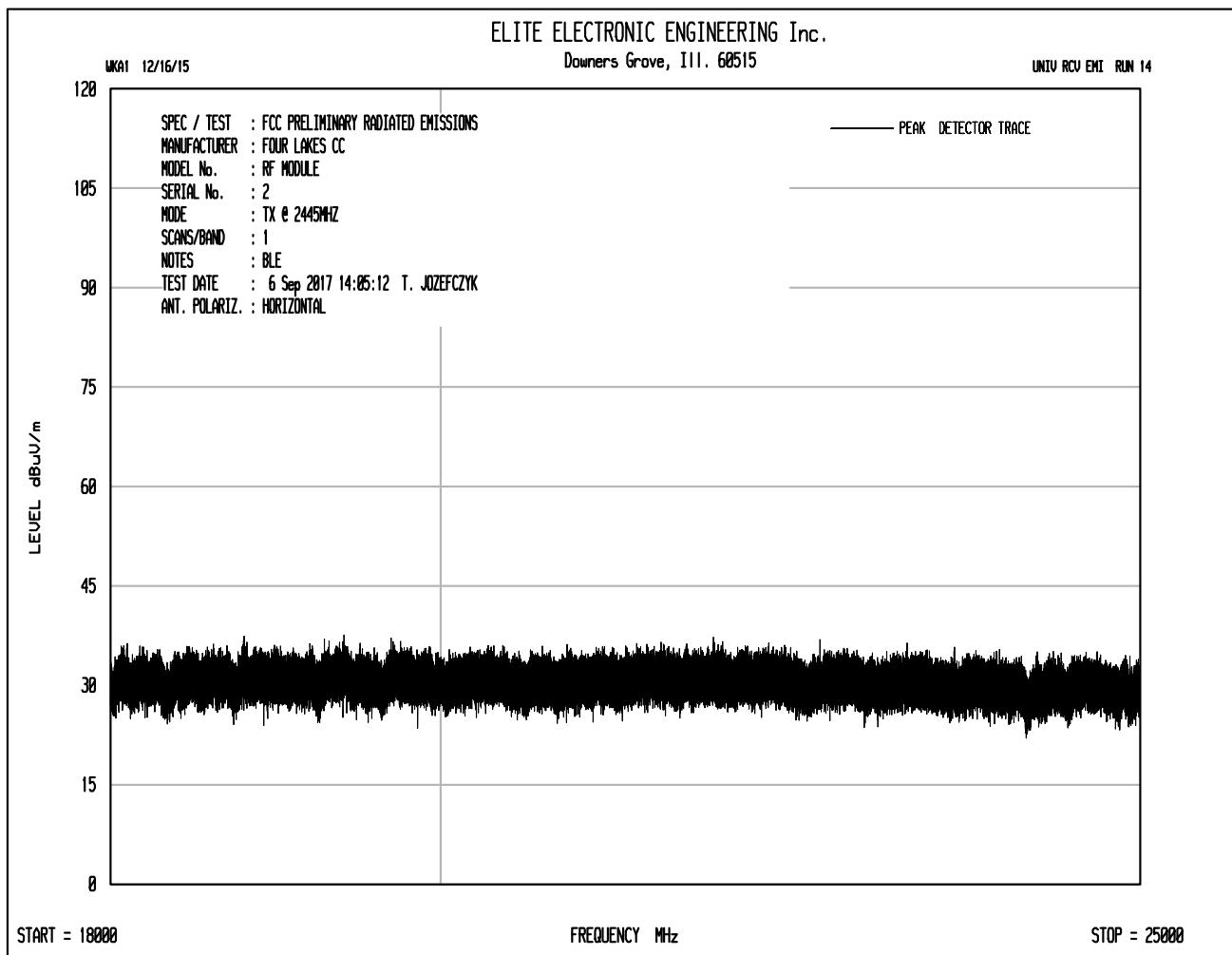


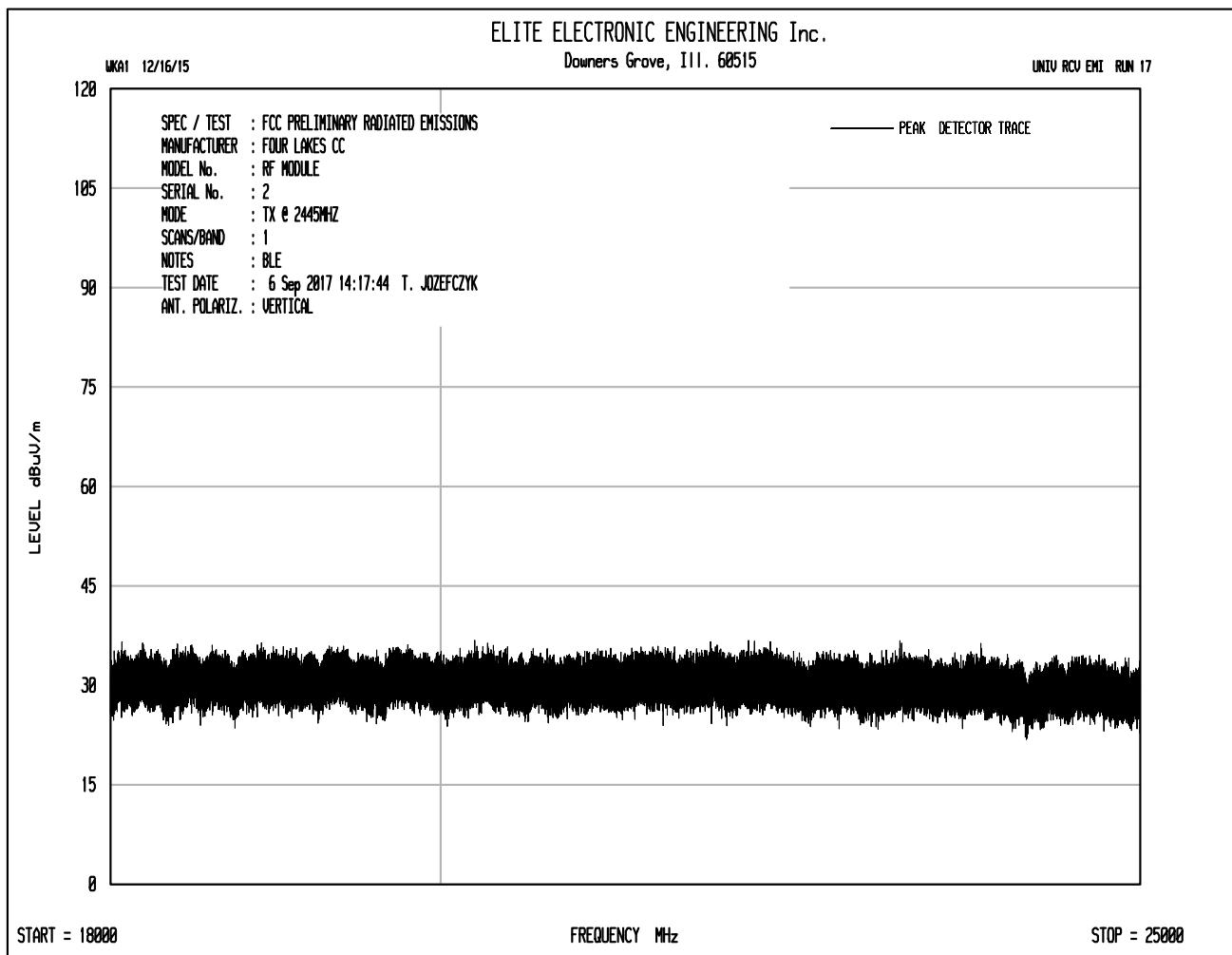


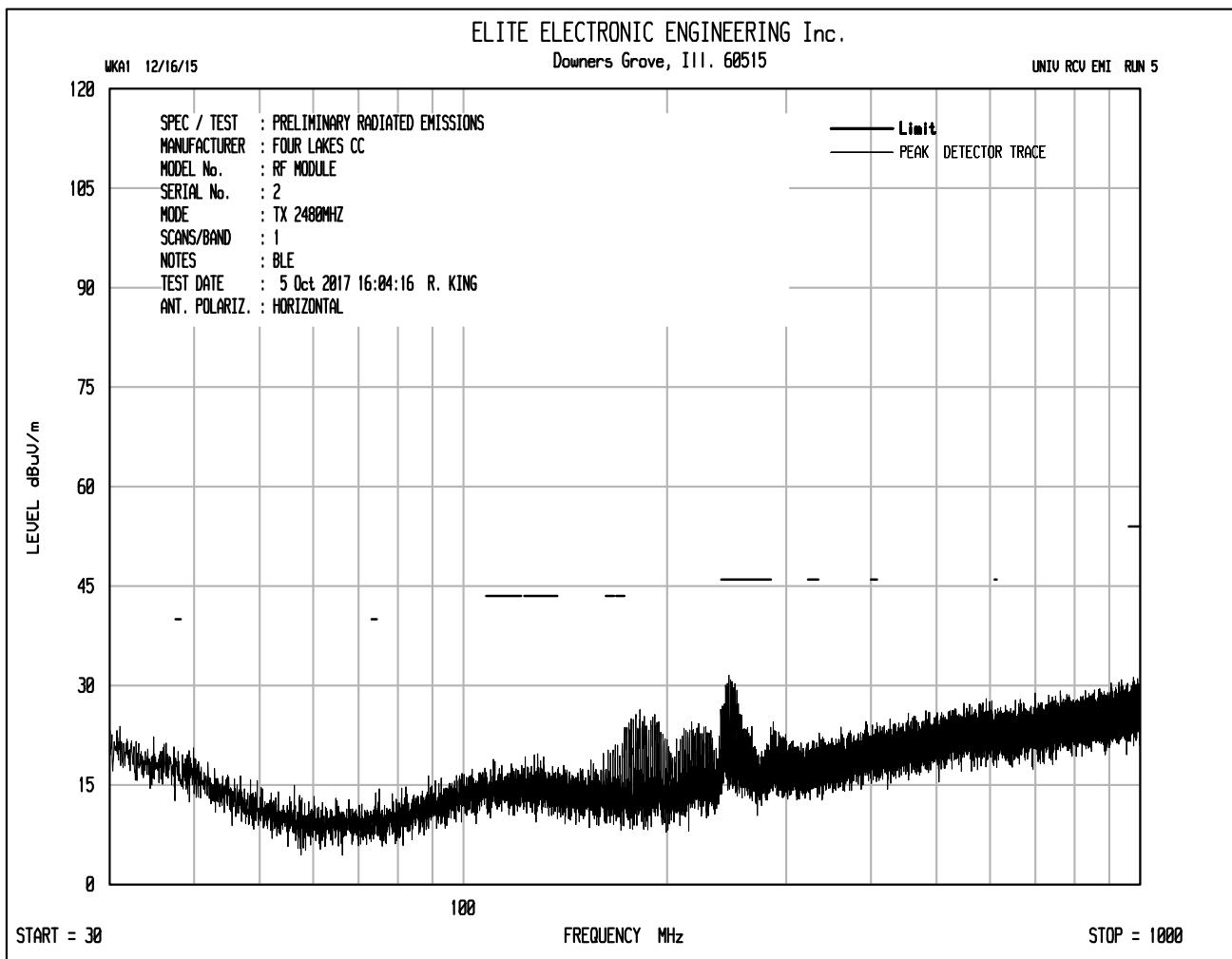


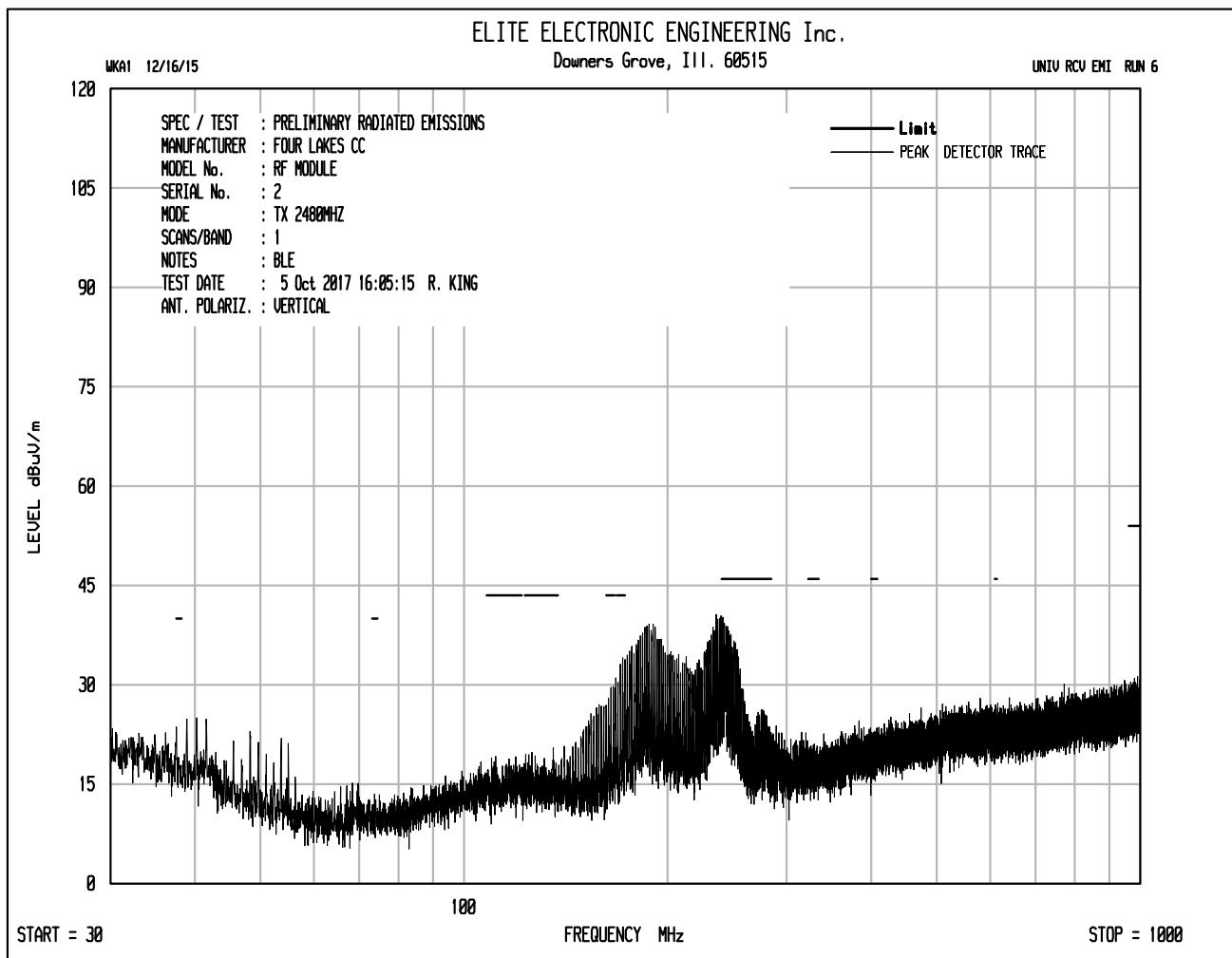


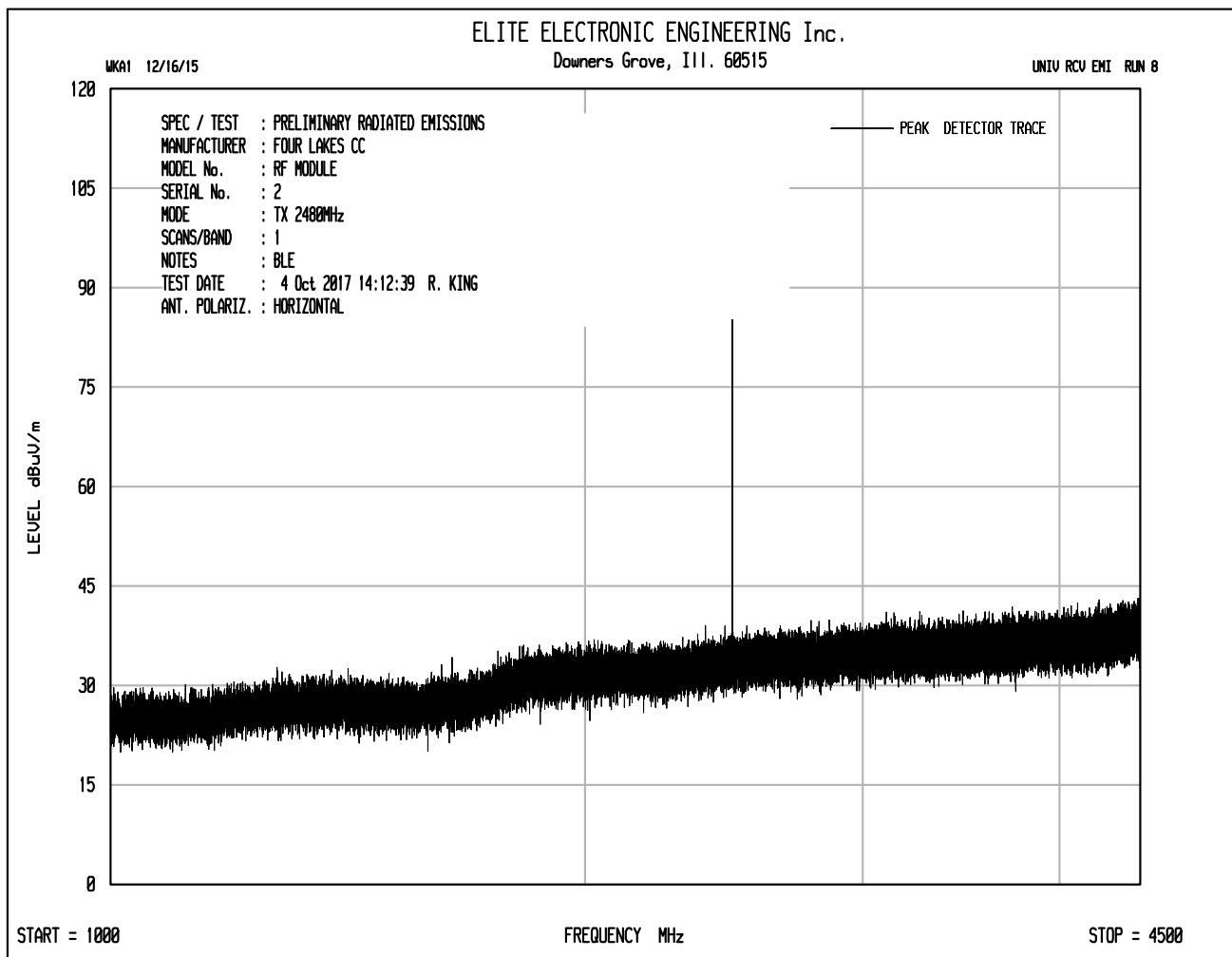


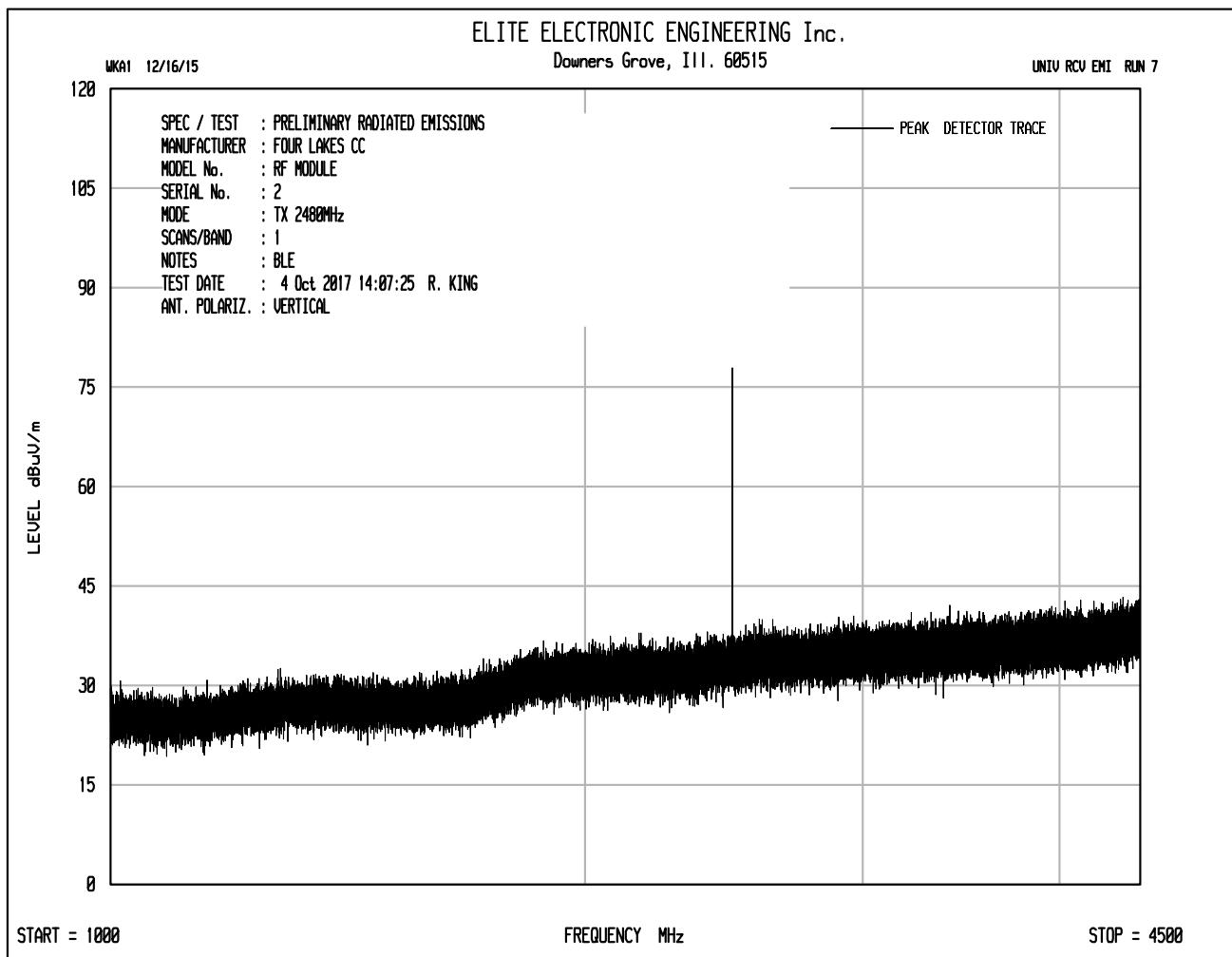


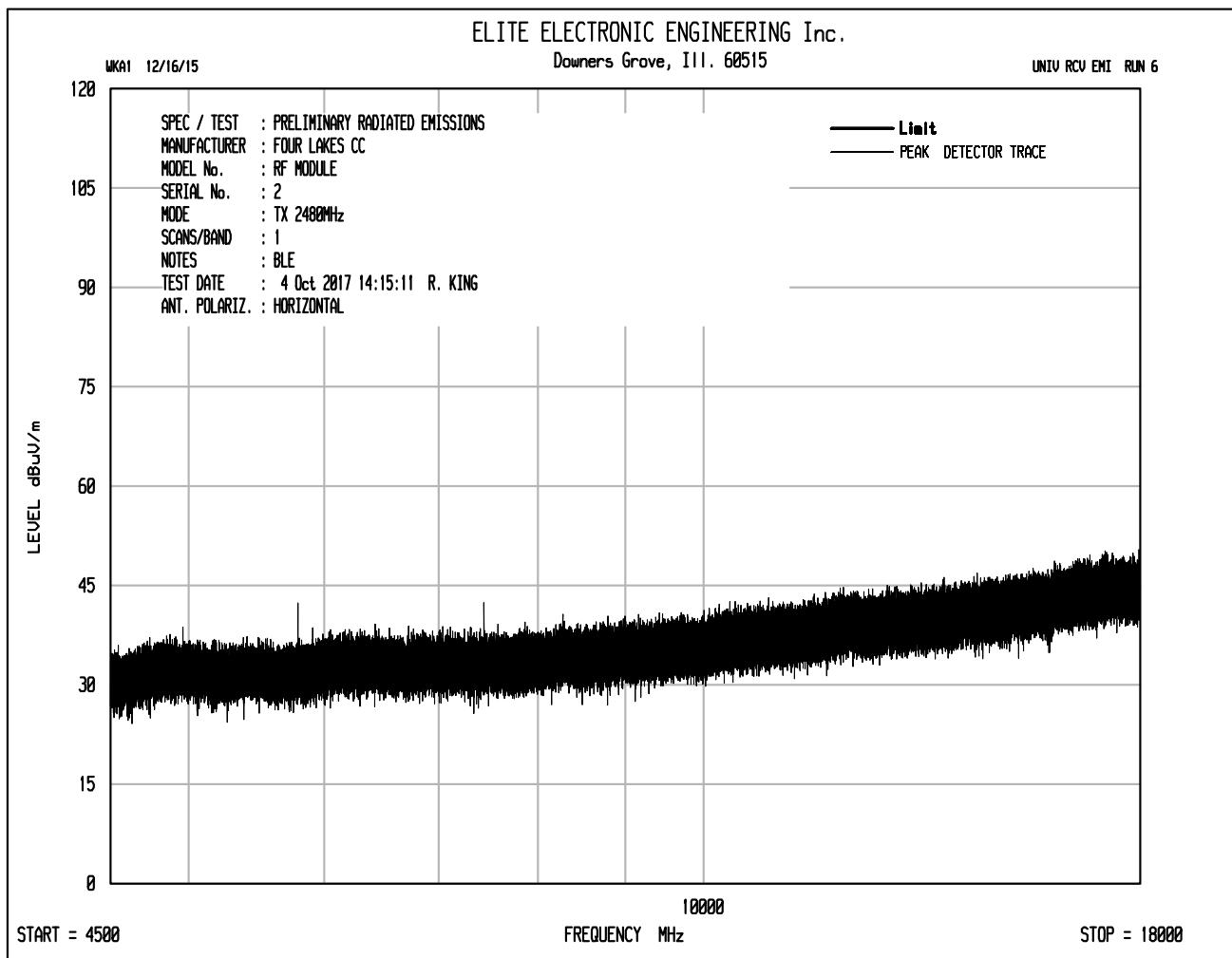


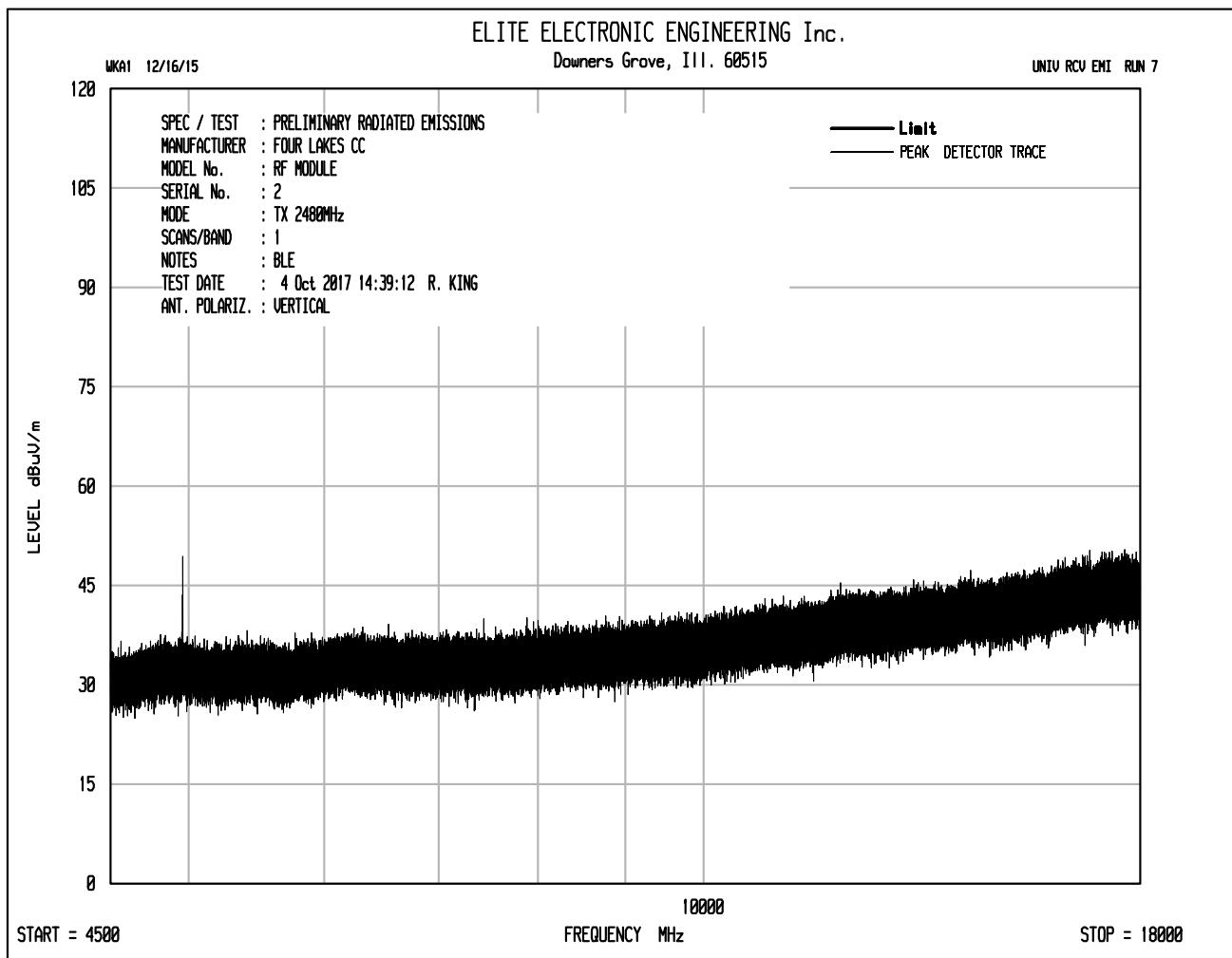


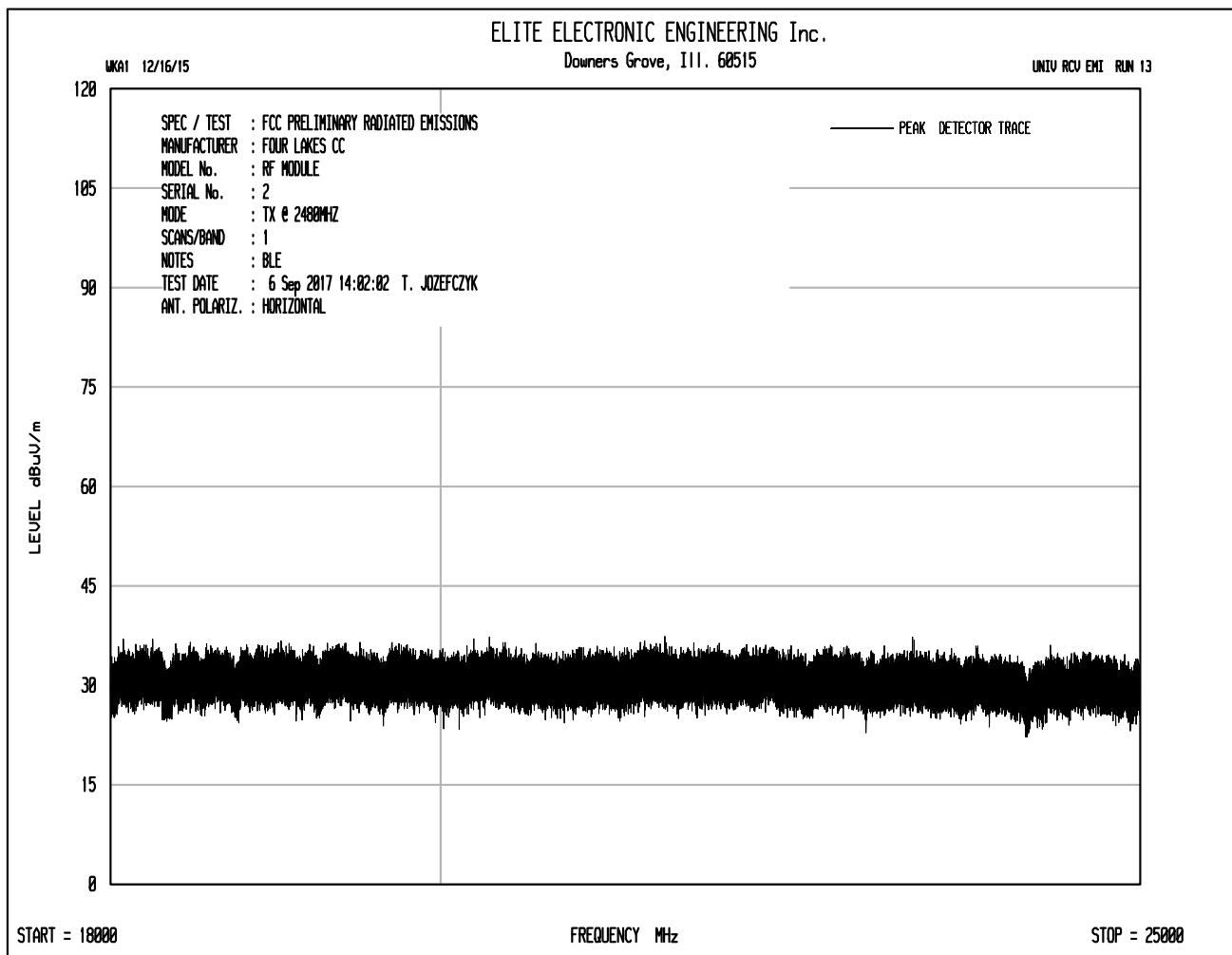


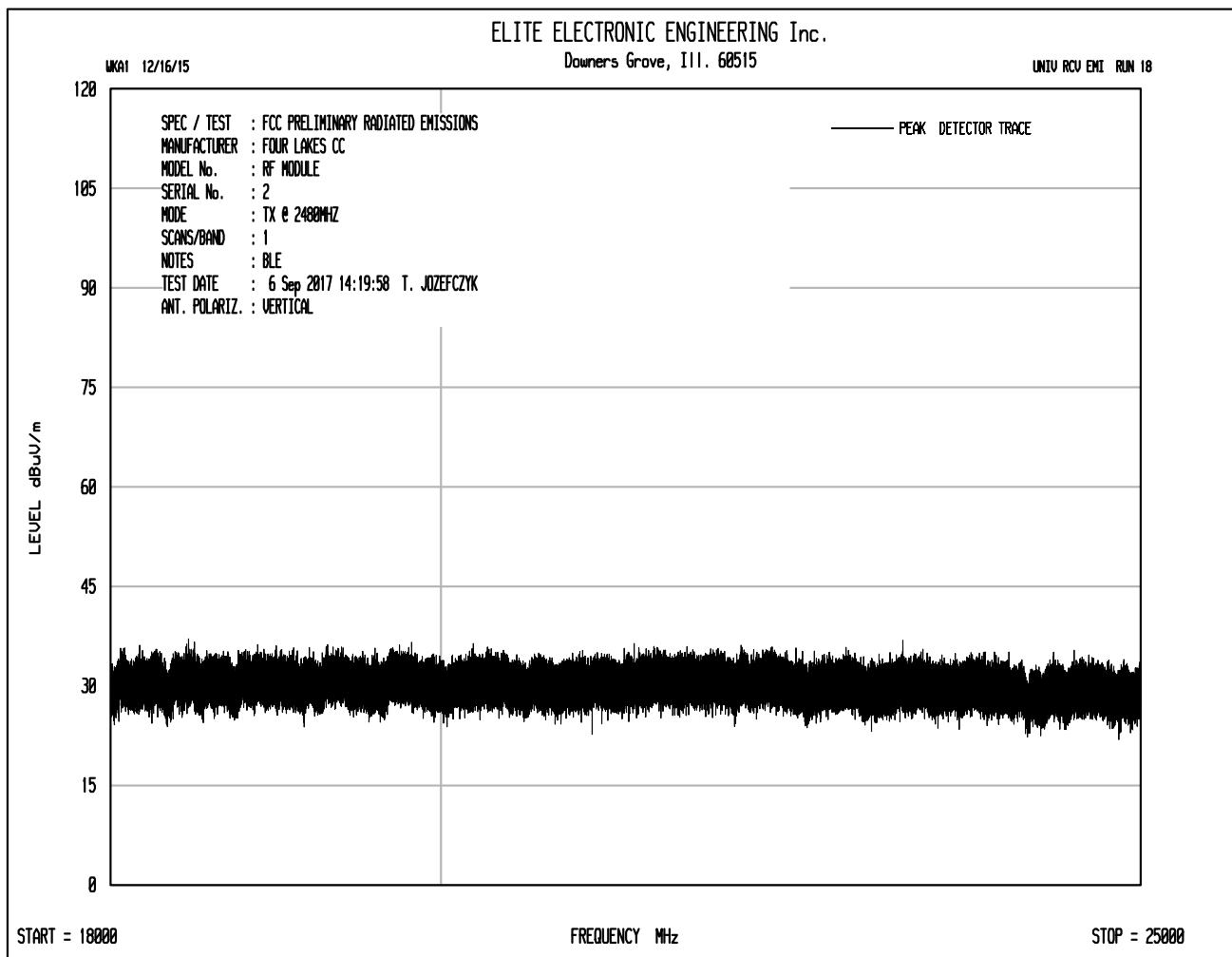












## DATA SHEET

Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Mode : 802.15.4 ZigBee Tx – 2405MHz  
 Test Specification : FCC-15.247, RSS-247 Radiated Spurious Emissions - Harmonics in Non-Restricted Bands  
 Test Date : 10/5/2017

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dB $\mu$ V/m at 3m	Peak Total $\mu$ V/m at 3 m	Peak Limit $\mu$ V/m at 3 m	Margin (dB)
2405.00	H	72.6	4.3	32.0	0.0	108.9	277445.7		
2405.00	V	69.0	4.3	32.0	0.0	105.3	183306.5		
7215.00	H	43.7	6.9	35.7	-39.4	46.8	219.9	27744.6	-42.0
7215.00	V	46.1	6.9	35.7	-39.4	49.3	290.3	27744.6	-39.6
9620.00	H	42.2	8.2	36.6	-39.3	47.8	246.0	27744.6	-41.0
9620.00	V	44.5	8.2	36.6	-39.3	50.1	318.4	27744.6	-38.8
14430.00	H	39.3	9.6	39.6	-38.3	50.2	322.8	27744.6	-38.7
14430.00	V	38.4	9.6	39.6	-38.3	49.3	291.7	27744.6	-39.6
16835.00	H	36.8	10.9	41.7	-37.5	52.0	398.4	27744.6	-36.9
16835.00	V	36.4	10.9	41.7	-37.5	51.6	380.0	27744.6	-37.3
21645.00	H	35.3	2.2	40.6	-28.9	49.2	287.6	27744.6	-39.7
21645.00	V	35.0	2.2	40.6	-28.9	48.9	280.1	27744.6	-39.9
24050.00	H	34.9	2.2	40.6	-30.3	47.5	236.8	27744.6	-41.4
24050.00	V	34.5	2.2	40.6	-30.3	47.1	225.9	27744.6	-41.8

**DATA SHEET**

Manufacturer : Amatis Controls  
EUT : Wireless Module  
Mode : 802.15.4 ZigBee Tx – 2405MHz  
Test Specification : FCC-15.247, RSS-247 Radiated Spurious Emissions - Harmonics in Restricted Band  
Test Date : 10/5/2017

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dB $\mu$ V/m at 3m	Peak Total $\mu$ V/m at 3 m	Peak Limit $\mu$ V/m at 3 m	Margin (dB)
4810.00	H	51.7	5.7	34.6	-39.3	52.7	431.5	5000.0	-21.3
4810.00	V	53.8	5.7	34.6	-39.3	54.7	545.1	5000.0	-19.3
12025.00	H	49.3	8.6	38.7	-39.2	57.5	749.0	5000.0	-16.5
12025.00	V	49.6	8.6	38.7	-39.2	57.8	778.9	5000.0	-16.1
19240.00	H	34.1	2.2	40.4	-28.7	48.0	250.0	5000.0	-26.0
19240.00	V	33.0	2.2	40.4	-28.7	46.8	219.8	5000.0	-27.1

## DATA SHEET

Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Mode : 802.15.4 ZigBee Tx – 2405MHz  
 Test Specification : FCC-15.247, RSS-247 Radiated Spurious Emissions – Restricted Band Averages  
 Test Date : 10/5/2017

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Average Total dB $\mu$ V/m at 3m	Average Total $\mu$ V/m at 3 m	Average Limit $\mu$ V/m at 3 m	Margin (dB)
4810.00	H	38.0	5.7	34.6	-39.3	0.0	38.9	88.5	500.0	-15.0
4810.00	V	40.8	5.7	34.6	-39.3	0.0	41.7	122.0	500.0	-12.3
12025.00	H	33.3	8.6	38.7	-39.2	0.0	41.5	119.3	500.0	-12.4
12025.00	V	33.7	8.6	38.7	-39.2	0.0	41.9	124.2	500.0	-12.1
19240.00	H	19.8	2.2	40.4	-28.7	0.0	33.7	48.4	500.0	-20.3
19240.00	V	18.7	2.2	40.4	-28.7	0.0	32.6	42.6	500.0	-21.4

## DATA SHEET

Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Mode : 802.15.4 ZigBee Tx – 2445MHz  
 Test Specification : FCC-15.247, RSS-247 Radiated Spurious Emissions – Harmonics in Non-Restricted Bands  
 Test Date : 10/5/2017

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dB $\mu$ V/m at 3m	Peak Total $\mu$ V/m at 3 m	Peak Limit $\mu$ V/m at 3 m	Margin (dB)
2445.00	H	73.7	4.3	32.1	0.0	110.1	319263.5		
2445.00	V	72.8	4.3	32.1	0.0	109.2	288170.4		
9780.00	H	50.5	8.3	36.9	-39.3	56.4	659.2	31926.4	-33.7
9780.00	V	52.6	8.3	36.9	-39.3	58.5	840.4	31926.4	-31.6
14670.00	H	48.9	9.7	39.6	-38.2	60.0	999.8	31926.4	-30.1
14670.00	V	48.6	9.7	39.6	-38.2	59.7	965.8	31926.4	-30.4
17115.00	H	49.2	11.0	41.6	-37.6	64.1	1611.8	31926.4	-25.9
17115.00	V	49.2	11.0	41.6	-37.6	64.2	1617.4	31926.4	-25.9
22005.00	H	35.7	2.2	40.6	-29.4	49.0	282.9	31926.4	-41.1
22005.00	V	35.3	2.2	40.6	-29.4	48.7	271.4	31926.4	-41.4
24450.00	H	34.5	2.2	40.6	-30.4	46.9	221.4	31926.4	-43.2
24450.00	V	34.9	2.2	40.6	-30.4	47.3	232.9	31926.4	-42.7

**DATA SHEET**

Manufacturer : Amatis Controls  
EUT : Wireless Module  
Mode : 802.15.4 ZigBee Tx – 2445MHz  
Test Specification : FCC-15.247, RSS-247 Radiated Spurious Emissions - Harmonics in Restricted Bands  
Test Date : 10/5/2017

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dB $\mu$ V/m at 3m	Peak Total $\mu$ V/m at 3 m	Peak Limit $\mu$ V/m at 3 m	Margin (dB)
4890.00	H	50.7	5.7	34.5	-39.3	51.7	384.0	5000.0	-22.3
4890.00	V	53.5	5.7	34.5	-39.3	54.4	527.6	5000.0	-19.5
7335.00	H	51.4	6.9	35.7	-39.4	54.5	529.2	5000.0	-19.5
7335.00	V	51.4	6.9	35.7	-39.4	54.5	531.7	5000.0	-19.5
12225.00	H	48.7	8.9	38.8	-39.1	57.3	735.4	5000.0	-16.6
12225.00	V	48.7	8.9	38.8	-39.1	57.4	741.4	5000.0	-16.6
19560.00	H	33.8	2.2	40.4	-28.6	47.8	246.6	5000.0	-26.1
19560.00	V	33.6	2.2	40.4	-28.6	47.6	240.2	5000.0	-26.4

## DATA SHEET

Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Mode : 802.15.4 ZigBee Tx – 2445MHz  
 Test Specification : FCC-15.247, RSS-247 Radiated Spurious Emissions – Restricted Band Averages  
 Test Date : 10/5/2017

Freq. MHz	Ant Pol	Meter (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Average Total dB $\mu$ V/m at 3m	Average Total $\mu$ V/m at 3 m	Average Limit $\mu$ V/m at 3 m	Margin (dB)
4890.00	H	35.9	5.7	34.5	-39.3	0.0	36.8	69.3	500.0	-17.2
4890.00	V	42.5	5.7	34.5	-39.3	0.0	43.5	149.6	500.0	-10.5
7335.00	H	37.75	6.9	35.7	-39.4	0.0	40.9	110.6	500.0	-13.1
7335.00	V	38.4	6.9	35.7	-39.4	0.0	41.5	118.9	500.0	-12.5
12225.00	H	34.4	8.9	38.8	-39.1	0.0	43.1	142.4	500.0	-10.9
12225.00	V	34.4	8.9	38.8	-39.1	0.0	43.1	142.2	500.0	-10.9
19560.00	H	19.1	2.2	40.4	-28.6	0.0	33.1	45.3	500.0	-20.8
19560.00	V	19.3	2.2	40.4	-28.6	0.0	33.3	46.2	500.0	-20.7

## DATA SHEET

Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Mode : 802.15.4 ZigBee Tx – 2480MHz  
 Test Specification : FCC-15.247, RSS-247 Radiated Spurious Emissions - Harmonics in Non-Restricted Bands  
 Test Date : 10/5/2017

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dB $\mu$ V/m at 3m	Peak Total $\mu$ V/m at 3 m	Peak Limit $\mu$ V/m at 3 m	Margin (dB)
2480.00	H	36.0	4.3	32.2	0.0	72.5	4210.1		
2480.00	V	32.0	4.3	32.2	0.0	68.5	2656.4		
9920.00	H	38.9	8.3	37.0	-39.2	44.9	175.1	500.0	-9.1
9920.00	V	38.6	8.3	37.0	-39.2	44.6	170.4	500.0	-9.4
14880.00	H	38.0	9.8	39.7	-38.2	49.3	292.2	500.0	-4.7
14880.00	V	38.0	9.8	39.7	-38.2	49.4	293.6	500.0	-4.6
17360.00	H	37.6	11.0	41.4	-37.7	52.3	410.7	500.0	-1.7
17360.00	V	37.6	11.0	41.4	-37.7	52.3	410.3	500.0	-1.7
24800.00	H	34.9	2.2	40.6	-31.2	46.6	213.9	500.0	-7.4
24800.00	V	34.6	2.2	40.6	-31.2	46.2	204.7	500.0	-7.8

## DATA SHEET

Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Mode : 802.15.4 ZigBee Tx – 2480MHz  
 Test Specification : FCC-15.247, RSS-247 Radiated Spurious Emissions – Harmonics in Restricted Bands  
 Test Date : 10/5/2017

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dB $\mu$ V/m at 3m	Peak Total $\mu$ V/m at 3 m	Peak Limit $\mu$ V/m at 3 m	Margin (dB)
4960.00	H	46.5	5.8	34.5	-39.3	47.5	235.9	5000.0	-26.5
4960.00	V	48.0	5.8	34.5	-39.3	49.0	280.4	5000.0	-25.0
7440.00	H	49.1	6.9	35.6	-39.4	52.2	407.6	5000.0	-21.8
7440.00	V	48.9	6.9	35.6	-39.4	52.0	398.3	5000.0	-22.0
12400.00	H	47.8	9.4	38.8	-39.0	56.9	703.4	5000.0	-17.0
12400.00	V	48.4	9.4	38.8	-39.0	57.6	760.7	5000.0	-16.4
19840.00	H	34.1	2.2	40.4	-28.4	48.3	261.0	5000.0	-25.6
19840.00	V	34.4	2.2	40.4	-28.4	48.6	269.3	5000.0	-25.4
22320.00	H	34.4	2.2	40.6	-29.3	47.9	249.1	5000.0	-26.1
22320.00	V	35.1	2.2	40.6	-29.3	48.6	269.7	5000.0	-25.4

## DATA SHEET

Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Mode : 802.15.4 ZigBee Tx – 2480MHz  
 Test Specification : FCC-15.247, RSS-247 Radiated Spurious Emissions – Restricted Band Averages  
 Test Date : 10/5/2017

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Average Total dB $\mu$ V/m at 3m	Average Total $\mu$ V/m at 3 m	Average Limit $\mu$ V/m at 3 m	Margin (dB)
4960.00	H	41.2	5.8	34.5	-39.3	0.0	42.1	127.4	500.0	-11.9
4960.00	V	41.4	5.8	34.5	-39.3	0.0	42.4	131.3	500.0	-11.6
7440.00	H	37.65	6.9	35.6	-39.4	0.0	40.8	109.1	500.0	-13.2
7440.00	V	39.0	6.9	35.6	-39.4	0.0	42.1	126.7	500.0	-11.9
12400.00	H	33.7	9.4	38.8	-39.0	0.0	42.9	139.7	500.0	-11.1
12400.00	V	34.0	9.4	38.8	-39.0	0.0	43.1	143.6	500.0	-10.8
19840.00	H	19.4	2.2	40.4	-28.4	0.0	33.7	48.3	500.0	-20.3
19840.00	V	19.4	2.2	40.4	-28.4	0.0	33.6	48.0	500.0	-20.3
22320.00	H	21.9	2.2	40.6	-29.3	0.0	35.4	58.9	500.0	-18.6
22320.00	V	22.0	2.2	40.6	-29.3	0.0	35.5	59.8	500.0	-18.5

## DATA SHEET

Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Mode : BLE – 2402MHz  
 Test Specification : FCC-15.247, RSS-247 Radiated Spurious Emissions - Harmonics in Non-Restricted Bands  
 Test Date : 10/5/2017

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dB $\mu$ V/m at 3m	Peak Total $\mu$ V/m at 3 m	Peak Limit $\mu$ V/m at 3 m	Margin (dB)
2402.00	H	58.9	4.3	32.0	0.0	95.2	57231.7		
2402.00	V	52.7	4.3	32.0	0.0	88.9	27998.6		
7206.00	H	55.0	6.9	36.0	-39.4	58.5	837.9	5723.2	-16.7
7206.00	V	53.9	6.9	36.0	-39.4	57.3	730.6	5723.2	-17.9
9608.00	H	37.7	8.2	36.9	-39.3	43.5	149.2	5723.2	-31.7
9608.00	V	38.6	8.2	36.9	-39.3	44.4	166.3	5723.2	-30.7
14412.00	H	38.7	9.6	39.4	-38.3	49.3	292.0	5723.2	-25.8
14412.00	V	39.3	9.6	39.4	-38.3	49.9	313.2	5723.2	-25.2
16814.00	H	38.9	10.9	41.6	-37.5	53.9	498.0	5723.2	-21.2
16814.00	V	38.7	10.9	41.6	-37.5	53.7	486.6	5723.2	-21.4
21618.00	H	35.3	2.2	40.6	-28.9	49.2	288.0	5723.2	-26.0
21618.00	V	35.7	2.2	40.6	-28.9	49.6	301.2	5723.2	-25.6
24020.00	H	33.9	2.2	40.6	-30.2	46.5	211.8	5723.2	-28.6
24020.00	V	32.8	2.2	40.6	-30.2	45.5	188.1	5723.2	-29.7

**DATA SHEET**

Manufacturer : Amatis Controls  
EUT : Wireless Module  
Model No. : Model #1  
Mode : BLE – 2402MHz  
Test Specification : FCC-15.247, RSS-247 Radiated Spurious Emissions - Harmonics in Restricted Bands  
Test Date : 10/5/2017

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dB $\mu$ V/m at 3m	Peak Total $\mu$ V/m at 3 m	Peak Limit $\mu$ V/m at 3 m	Margin (dB)
4804.00	H	52.9	5.7	34.1	-39.3	53.3	463.6	5000.0	-20.7
4804.00	V	55.0	5.7	34.1	-39.3	55.4	589.7	5000.0	-18.6
12010.00	H	49.9	8.6	38.5	-39.2	57.9	785.2	5000.0	-16.1
12010.00	V	49.3	8.6	38.5	-39.2	57.2	727.7	5000.0	-16.7
19216.00	H	33.3	2.2	40.4	-28.8	47.1	227.1	5000.0	-26.9
19216.00	V	33.6	2.2	40.4	-28.8	47.4	235.4	5000.0	-26.5

## DATA SHEET

Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Model No. : Model #1  
 Mode : BLE – 2402MHz  
 Test Specification : FCC-15.247, RSS-247 Radiated Spurious Emissions – Restricted Band Averages  
 Test Date : 10/5/2017

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Average Total dB $\mu$ V/m at 3m	Average Total $\mu$ V/m at 3 m	Average Limit $\mu$ V/m at 3 m	Margin (dB)
4804.00	H	40.5	5.7	34.1	-39.3	0.0	41.0	111.7	500.0	-13.0
4804.00	V	42.7	5.7	34.1	-39.3	0.0	43.1	143.3	500.0	-10.9
12010.00	H	33.8	8.6	38.5	-39.2	0.0	41.8	122.6	500.0	-12.2
12010.00	V	33.8	8.6	38.5	-39.2	0.0	41.7	122.3	500.0	-12.2
19216.00	H	19.3	2.2	40.4	-28.8	0.0	33.1	45.3	500.0	-20.9
19216.00	V	19.0	2.2	40.4	-28.8	0.0	32.8	43.7	500.0	-21.2

## DATA SHEET

Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Model No. : Model #1  
 Mode : BLE – 2446MHz  
 Test Specification : FCC-15.247, RSS-247 Radiated Spurious Emissions - Harmonics in Non-Restricted Bands  
 Test Date : 10/5/2017

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dB $\mu$ V/m at 3m	Peak Total $\mu$ V/m at 3 m	Peak Limit $\mu$ V/m at 3 m	Margin (dB)
2446.00	H	60.5	4.3	32.1	0.0	96.9	70008.5		
2446.00	V	52.9	4.3	32.1	0.0	89.3	29251.7		
9784.00	H	41.0	8.3	37.0	-39.3	47.0	223.9	7000.8	-29.9
9784.00	V	42.4	8.3	37.0	-39.3	48.4	262.1	7000.8	-28.5
14676.00	H	39.4	9.7	39.5	-38.2	50.5	333.8	7000.8	-26.4
14676.00	V	39.5	9.7	39.5	-38.2	50.6	337.6	7000.8	-26.3
17122.00	H	39.5	11.0	41.5	-37.6	54.4	522.7	7000.8	-22.5
17122.00	V	38.7	11.0	41.5	-37.6	53.6	476.7	7000.8	-23.3
24460.00	H	34.3	2.2	40.6	-30.4	46.7	216.2	7000.8	-30.2
24460.00	V	34.3	2.2	40.6	-30.4	46.7	217.5	7000.8	-30.2

## DATA SHEET

Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Model No. : Model #1  
 Mode : BLE – 2446MHz  
 Test Specification : FCC-15.247, RSS-247 Radiated Spurious Emissions - Harmonics in Restricted Bands  
 Test Date : 10/5/2017

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dB $\mu$ V/m at 3m	Peak Total $\mu$ V/m at 3 m	Peak Limit $\mu$ V/m at 3 m	Margin (dB)
4892.00	H	53.3	5.7	34.1	-39.3	53.8	490.7	5000.0	-20.2
4892.00	V	56.6	5.7	34.1	-39.3	57.1	720.0	5000.0	-16.8
7338.00	H	56.6	6.9	35.9	-39.4	60.0	996.1	5000.0	-14.0
7338.00	V	42.3	6.9	35.9	-39.4	45.7	192.9	5000.0	-28.3
12230.00	H	50.0	9.0	38.5	-39.1	58.4	831.8	5000.0	-15.6
12230.00	V	51.0	9.0	38.5	-39.1	59.4	933.3	5000.0	-14.6
19568.00	H	33.2	2.2	40.4	-28.6	47.3	231.5	5000.0	-26.7
19568.00	V	34.1	2.2	40.4	-28.6	48.2	256.2	5000.0	-25.8
22014.00	H	32.5	2.2	40.6	-29.4	45.8	195.3	5000.0	-28.2
22014.00	V	33.1	2.2	40.6	-29.4	46.5	210.7	5000.0	-27.5

## DATA SHEET

Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Model No. : Model #1  
 Mode : BLE – 2446MHz  
 Test Specification : FCC-15.247, RSS-247 Radiated Spurious Emissions – Restricted Band Averages  
 Test Date : 10/5/2017

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Average Total dB $\mu$ V/m at 3m	Average Total $\mu$ V/m at 3 m	Average Limit $\mu$ V/m at 3 m	Margin (dB)
4892.00	H	38.4	5.7	34.1	-39.3	0.0	39.0	88.9	500.0	-15.0
4892.00	V	43.8	5.7	34.1	-39.3	0.0	44.4	165.5	500.0	-9.6
7338.00	H	41.43	6.9	35.9	-39.4	0.0	44.8	174.5	500.0	-9.1
7338.00	V	41.7	6.9	35.9	-39.4	0.0	45.1	180.2	500.0	-8.9
12230.00	H	34.6	9.0	38.5	-39.1	0.0	43.0	140.5	500.0	-11.0
12230.00	V	34.5	9.0	38.5	-39.1	0.0	42.9	139.8	500.0	-11.1
19568.00	H	19.3	2.2	40.4	-28.6	0.0	33.4	46.6	500.0	-20.6
19568.00	V	19.3	2.2	40.4	-28.6	0.0	33.3	46.3	500.0	-20.7
22014.00	H	18.5	2.2	40.6	-29.4	0.0	31.8	39.1	500.0	-22.1
22014.00	V	18.7	2.2	40.6	-29.4	0.0	32.0	39.9	500.0	-22.0

## DATA SHEET

Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Model No. : Model #1  
 Mode : BLE – 2480MHz  
 Test Specification : FCC-15.247, RSS-247 Radiated Spurious Emissions - Harmonics in Non-Restricted Bands  
 Test Date : 10/5/2017

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dB $\mu$ V/m at 3m	Peak Total $\mu$ V/m at 3 m	Peak Limit $\mu$ V/m at 3 m	Margin (dB)
2480.00	H	57.7	4.3	32.2	0.0	94.2	51320.9		
2480.00	V	53.8	4.3	32.2	0.0	90.3	32718.6		
9920.00	H	41.7	8.3	37.0	-39.2	47.7	242.0	5132.1	-26.5
9920.00	V	41.9	8.3	37.0	-39.2	47.9	248.8	5132.1	-26.3
14880.00	H	39.4	9.8	39.7	-38.2	50.8	345.3	5132.1	-23.4
14880.00	V	39.4	9.8	39.7	-38.2	50.7	343.3	5132.1	-23.5
17360.00	H	38.1	11.0	41.4	-37.7	52.7	433.6	5132.1	-21.5
17360.00	V	38.8	11.0	41.4	-37.7	53.4	467.3	5132.1	-20.8
24800.00	H	34.5	2.2	40.6	-31.2	46.2	203.8	5132.1	-28.0
24800.00	V	34.1	2.2	40.6	-31.2	45.8	194.4	5132.1	-28.4

## DATA SHEET

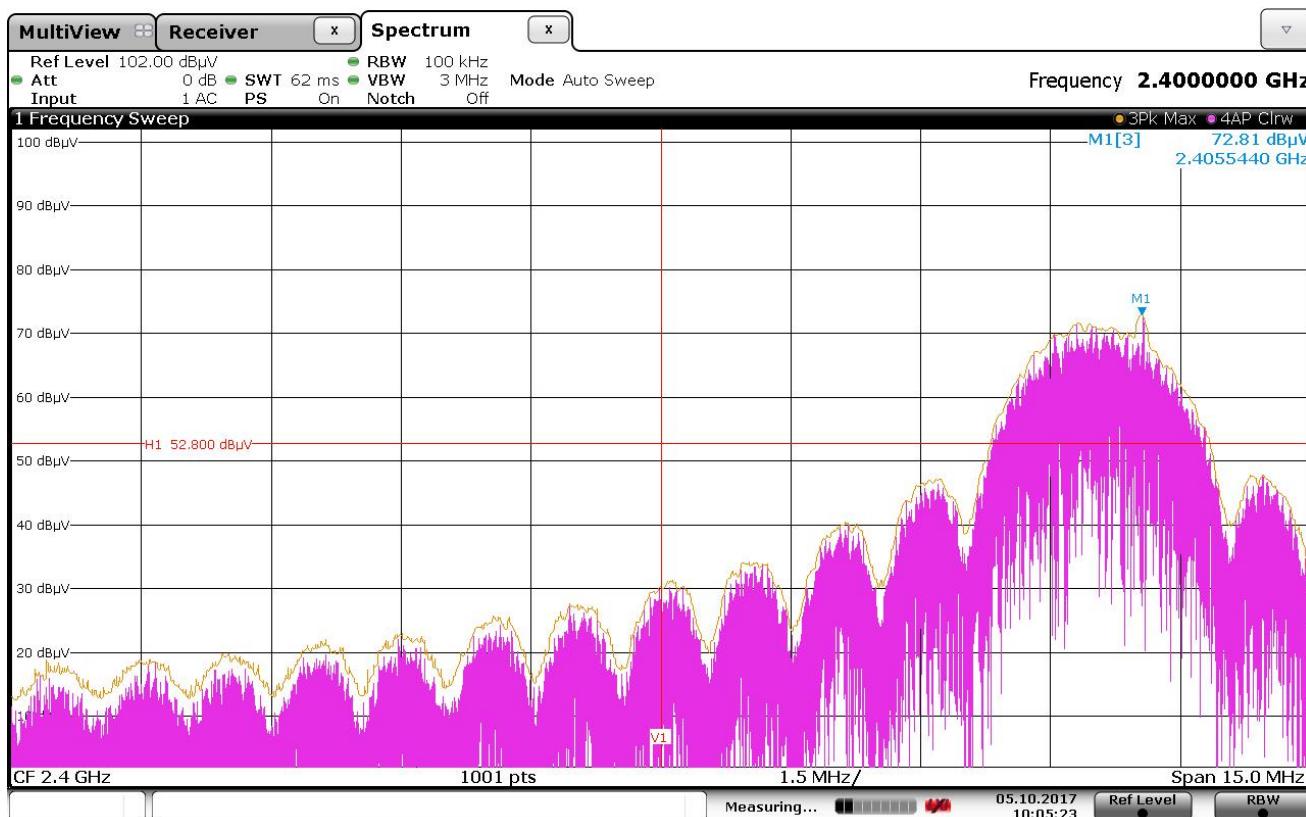
Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Model No. : Model #1  
 Mode : BLE – 2480MHz  
 Test Specification : FCC-15.247, RSS-247 Radiated Spurious Emissions - Harmonics in Restricted Bands  
 Test Date : 10/5/2017

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dB $\mu$ V/m at 3m	Peak Total $\mu$ V/m at 3 m	Peak Limit $\mu$ V/m at 3 m	Margin (dB)
4960.00	H	52.9	5.8	34.5	-39.3	53.8	492.3	5000.0	-20.1
4960.00	V	55.7	5.8	34.5	-39.3	56.6	678.0	5000.0	-17.4
7440.00	H	56.7	6.9	35.6	-39.4	59.8	976.6	5000.0	-14.2
7440.00	V	57.1	6.9	35.6	-39.4	60.2	1026.2	5000.0	-13.8
12400.00	H	47.8	9.4	38.8	-39.0	57.0	706.6	5000.0	-17.0
12400.00	V	47.9	9.4	38.8	-39.0	57.1	712.3	5000.0	-16.9
19840.00	H	33.9	2.2	40.4	-28.4	48.1	254.8	5000.0	-25.9
19840.00	V	33.2	2.2	40.4	-28.4	47.5	236.4	5000.0	-26.5
22320.00	H	33.8	2.2	40.6	-29.3	47.4	233.3	5000.0	-26.6
22320.00	V	33.5	2.2	40.6	-29.3	47.0	224.9	5000.0	-26.9

## DATA SHEET

Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Model No. : Model #1  
 Mode : BLE – 2480MHz  
 Test Specification : FCC-15.247, RSS-247 Radiated Spurious Emissions – Restricted Band Averages  
 Test Date : 10/5/2017

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Average Total dB $\mu$ V/m at 3m	Average Total $\mu$ V/m at 3 m	Average Limit $\mu$ V/m at 3 m	Margin (dB)
4960.00	H	39.6	5.8	34.5	-39.3	0.0	40.5	106.0	500.0	-13.5
4960.00	V	44.5	5.8	34.5	-39.3	0.0	45.5	187.6	500.0	-8.5
7440.00	H	41.81	6.9	35.6	-39.4	0.0	44.9	176.1	500.0	-9.1
7440.00	V	42.6	6.9	35.6	-39.4	0.0	45.7	191.7	500.0	-8.3
12400.00	H	34.1	9.4	38.8	-39.0	0.0	43.3	145.8	500.0	-10.7
12400.00	V	34.0	9.4	38.8	-39.0	0.0	43.2	144.8	500.0	-10.8
19840.00	H	19.0	2.2	40.4	-28.4	0.0	33.2	45.9	500.0	-20.7
19840.00	V	19.1	2.2	40.4	-28.4	0.0	33.4	46.7	500.0	-20.6
22320.00	H	19.4	2.2	40.6	-29.3	0.0	33.0	44.5	500.0	-21.0
22320.00	V	18.9	2.2	40.6	-29.3	0.0	32.4	41.6	500.0	-21.6



Date: 5.OCT.2017 10:05:23

## BAND EDGE

MANUFACTURER : Amatis Controls  
 EUT : Wireless Module  
 MODEL NUMBER : Model #1  
 TEST MODE : 802.15.4 ZigBee Tx – 2400MHz

## NOTES



Date: 5.OCT.2017 15:50:24

## BAND EDGE

MANUFACTURER : Amatis Controls  
 EUT : Wireless Module  
 MODEL NUMBER : Model #1  
 TEST MODE : BLE – 2400MHz

## NOTES

## DATA SHEET

Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Model No. : Model #1  
 Mode : 802.15.4 ZigBee Tx – 2480MHz  
 Test Specification : FCC-15.247, RSS-247 Band Edge – Peak Measurement

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dB $\mu$ V/m at 3m	Peak Total $\mu$ V/m at 3 m	Peak Limit $\mu$ V/m at 3 m	Margin (dB)
2483.50	H	21.0	4.3	32.2	0.0	57.5	752.7	5000.0	-16.4
2483.50	V	17.5	4.3	32.2	0.0	54.0	503.0	5000.0	-19.9

## DATA SHEET

Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Model No. : Model #1  
 Mode : 802.15.4 ZigBee Tx – 2480MHz  
 Test Specification : FCC-15.247, RSS-247 Band Edge – Average Measurement

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Total dB $\mu$ V/m at 3m	Total $\mu$ V/m at 3 m	Limit $\mu$ V/m at 3 m	Margin (dB)
2483.50	H	11.1	4.3	32.2	0.0	0.0	47.6	241.1	500.0	-6.3
2483.50	V	8.5	4.3	32.2	0.0	0.0	45.0	177.9	500.0	-9.0

## DATA SHEET

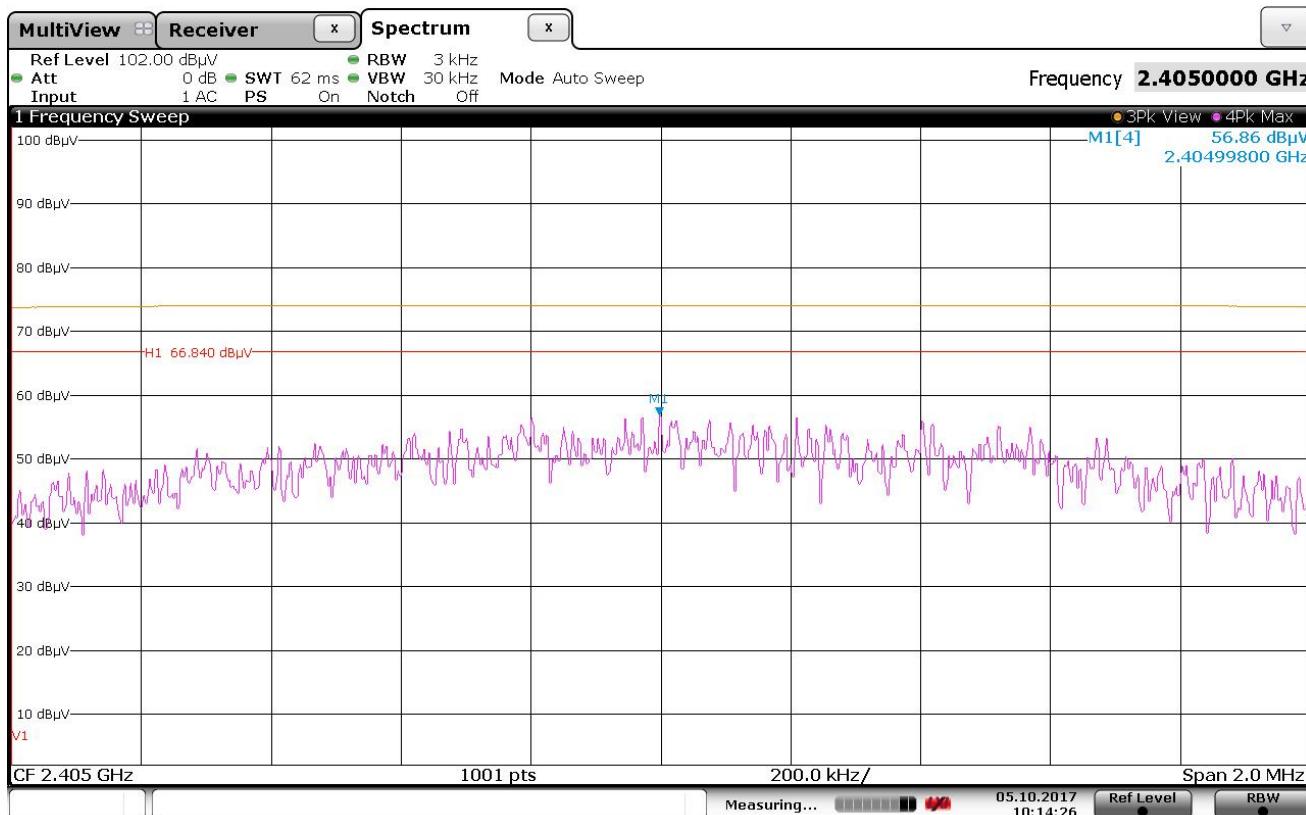
Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Model No. : Model #1  
 Mode : BLE – 2480MHz  
 Test Specification : FCC-15.247, RSS-247 Band Edge – Peak Measurement

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dB $\mu$ V/m at 3m	Peak Total $\mu$ V/m at 3 m	Peak Limit $\mu$ V/m at 3 m	Margin (dB)
2483.50	H	28.2	4.3	32.2	0.0	64.8	1730.3	5000.0	-9.2
2483.50	V	21.4	4.3	32.2	0.0	58.0	791.8	5000.0	-16.0

## DATA SHEET

Manufacturer : Amatis Controls  
 EUT : Wireless Module  
 Model No. : Model #1  
 Mode : 802.15.4 ZigBee Tx – 2480MHz  
 Test Specification : FCC-15.247, RSS-247 Band Edge – Average Measurement

Freq. MHz	Ant Pol	Meter Reading (dB $\mu$ V)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Total dB $\mu$ V/m at 3m	Total $\mu$ V/m at 3 m	Limit $\mu$ V/m at 3 m	Margin (dB)
2483.50	H	7.6	4.3	32.2	0.0	0.0	44.1	160.0	500.0	-9.9
2483.50	V	7.4	4.3	32.2	0.0	0.0	43.9	157.3	500.0	-10.0

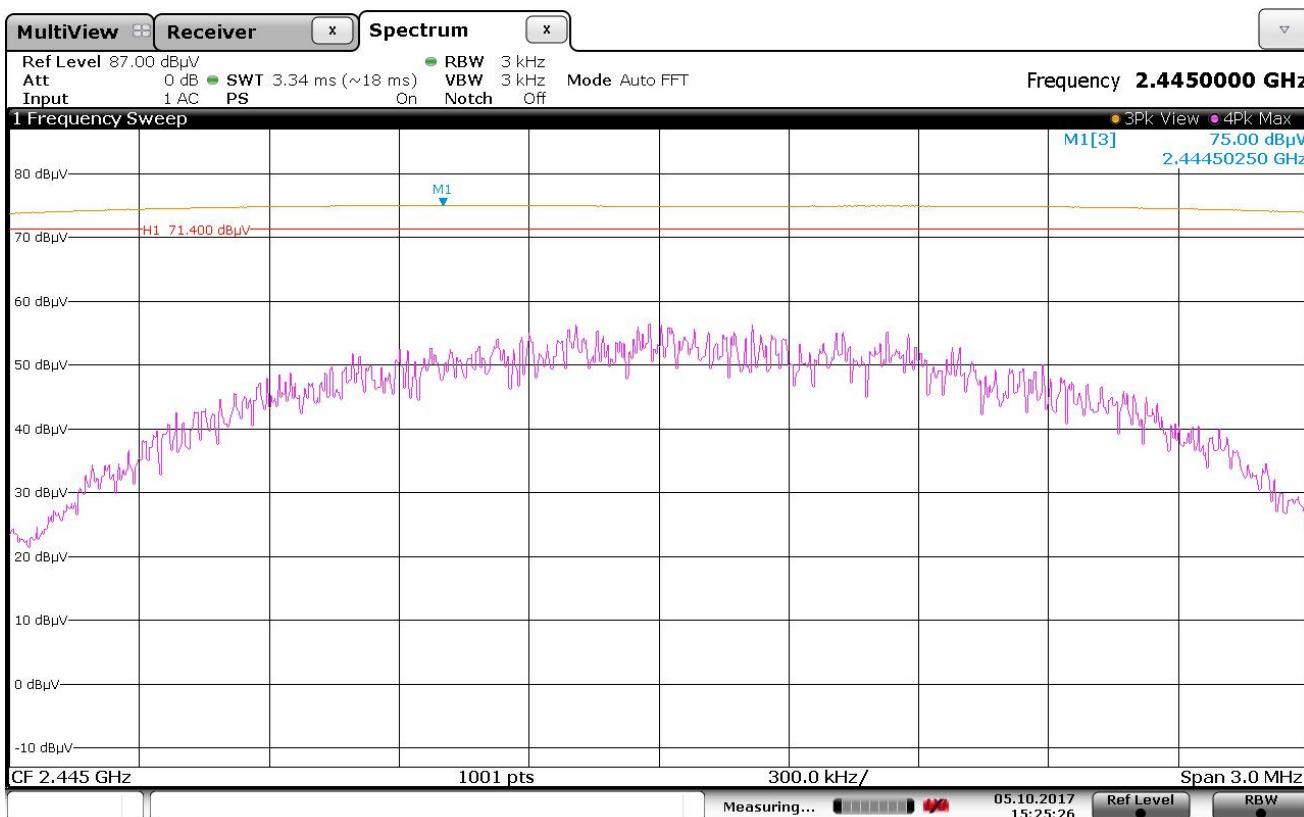


Date: 5.OCT.2017 10:14:27

## POWER SPECTRAL DENSITY

**MANUFACTURER** : Amatis Controls  
**EUT** : Wireless Module  
**MODEL NUMBER** : Model #1  
**TEST MODE** : 802.15.4 ZigBee Tx – 2405MHz  
: PSD = 56.86dB $\mu$ V

## NOTES

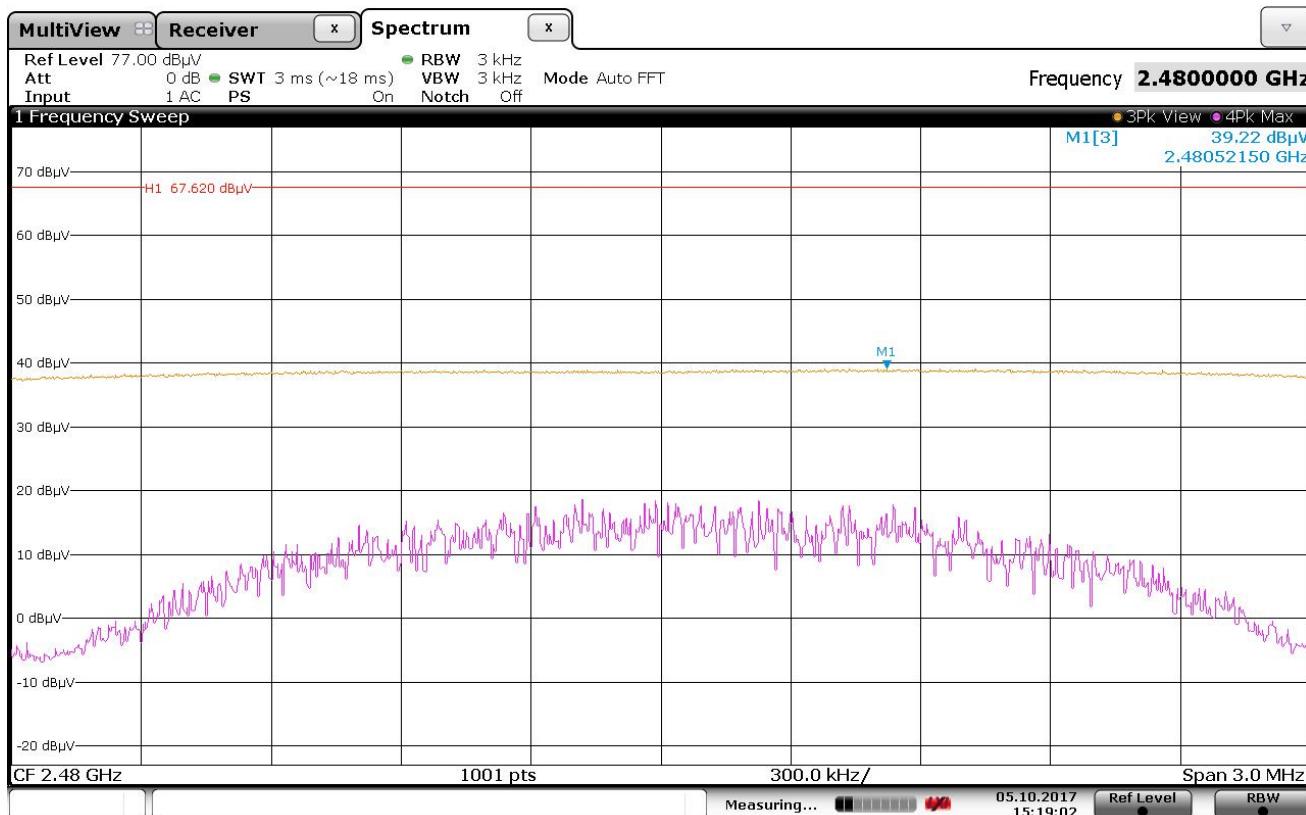


Date: 5.OCT.2017 15:25:26

## POWER SPECTRAL DENSITY

MANUFACTURER : Amatis Controls  
EUT : Wireless Module  
TEST MODE : 802.15.4 ZigBee Tx – 2445MHz  
: PSD = 75.00dB $\mu$ V

## NOTES

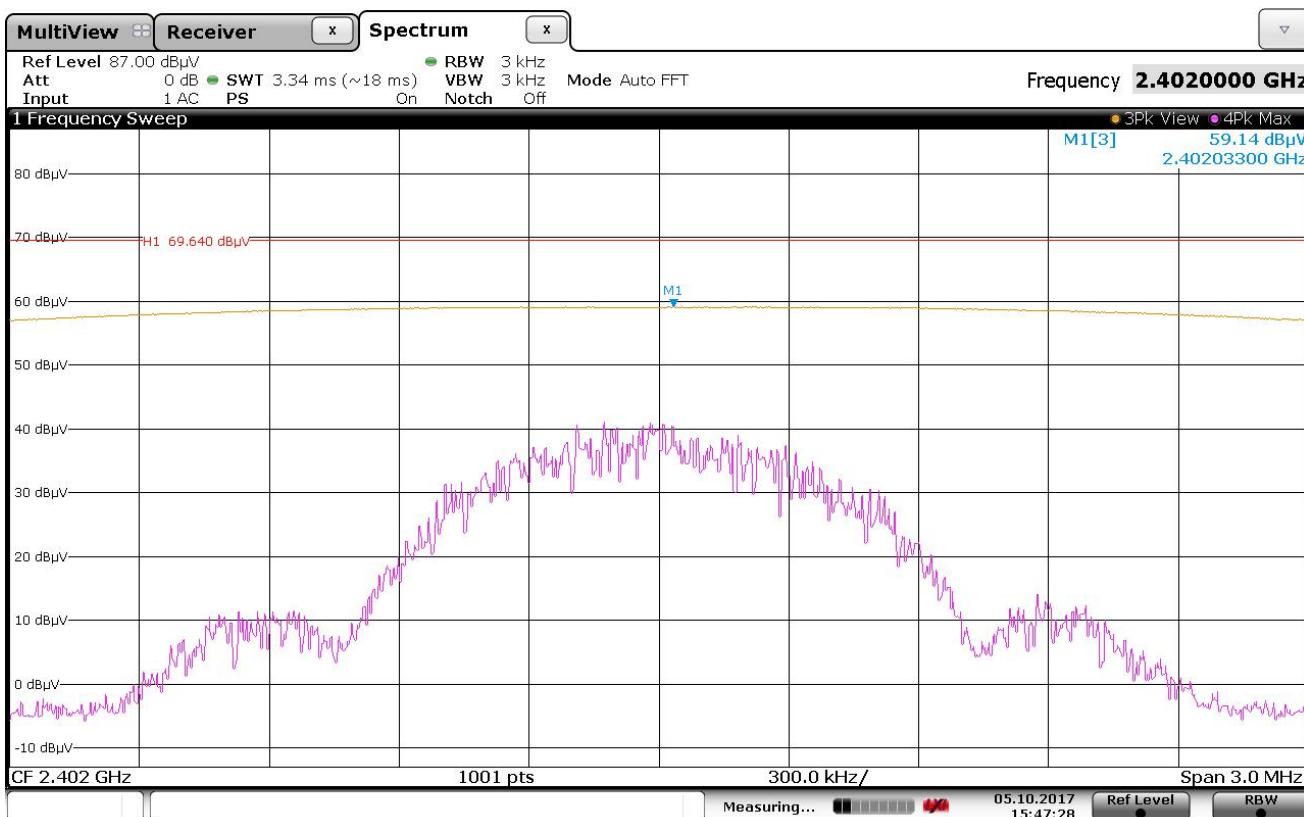


Date: 5.OCT.2017 15:19:02

## POWER SPECTRAL DENSITY

MANUFACTURER : Amatis Controls  
 EUT : Wireless Module  
 TEST MODE : 802.15.4 ZigBee Tx – 2480MHz  
 : PSD = 39.22dB $\mu$ V

## NOTES

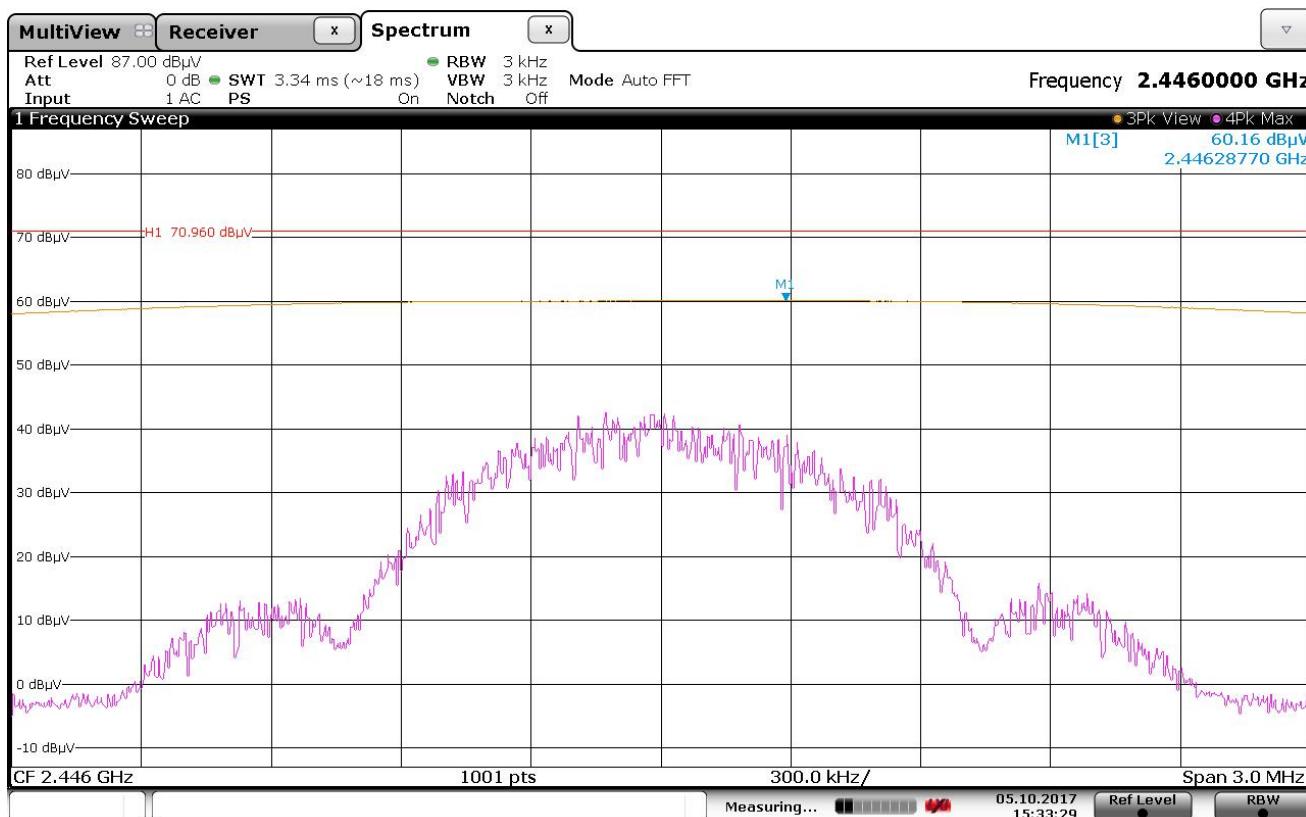


Date: 5.OCT.2017 15:47:28

## POWER SPECTRAL DENSITY

MANUFACTURER : Amatis Controls  
 EUT : Wireless Module  
 TEST MODE : BLE – 2402MHz  
 : PSD = 59.14dB $\mu$ V

## NOTES

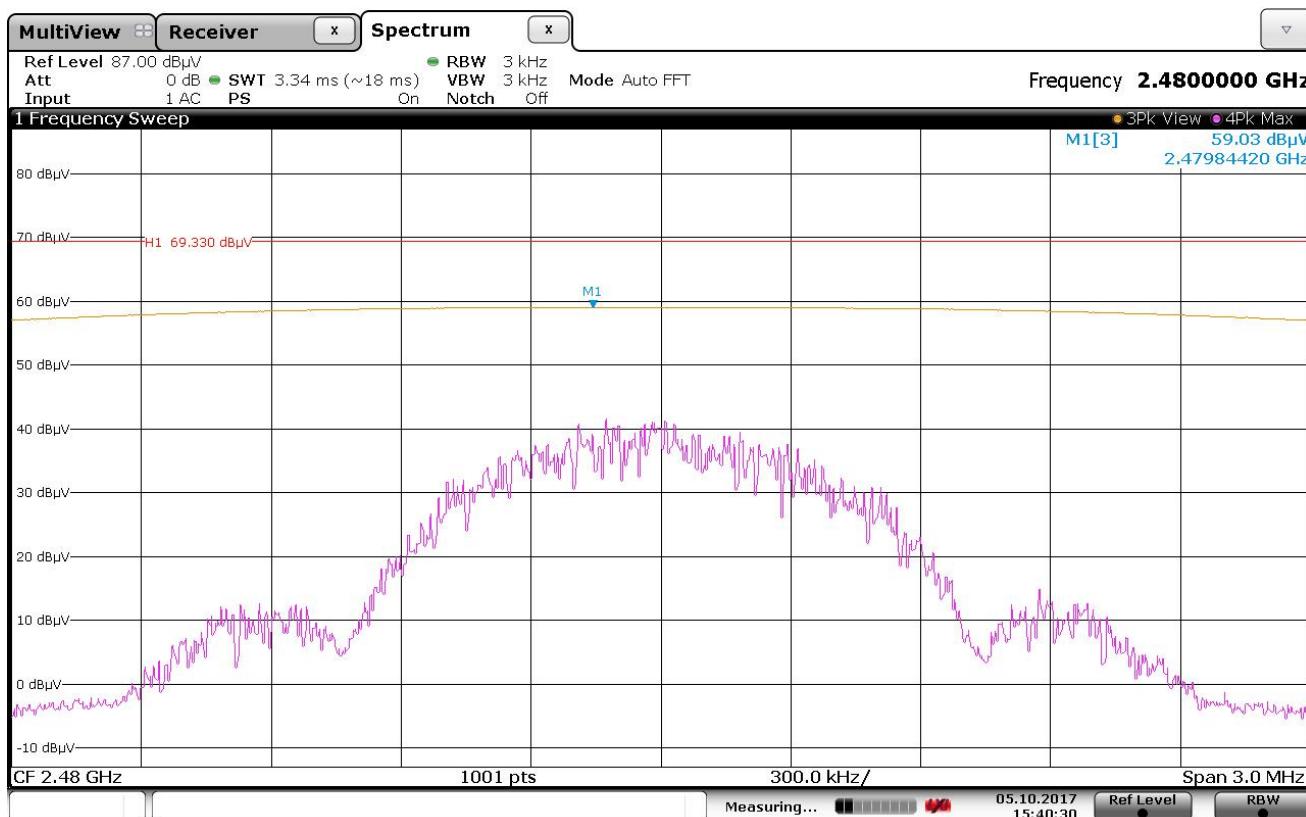


Date: 5.OCT.2017 15:33:29

## POWER SPECTRAL DENSITY

MANUFACTURER : Amatis Controls  
 EUT : Wireless Module  
 TEST MODE : BLE – 2446MHz  
 : PSD = 60.16dB $\mu$ V

## NOTES



Date: 5.OCT.2017 15:40:30

## POWER SPECTRAL DENSITY

MANUFACTURER : Amatis Controls  
 EUT : Wireless Module  
 TEST MODE : BLE – 2480MHz  
 : PSD = 59.03dB $\mu$ V

## NOTES