Measurement of RF Emissions from a Model No. DX9, Plano RF module Transmitter

For	Horizon Hobby 2904 Research Rd. Champaign, IL 61822
P.O. Number	20190205EH-01
Date Tested	February 12, 2019
Test Personnel	Javier Cardenas
Test Specification	FCC "Code of Federal Regulations" Title 47 Part15, Subpart C Industry Canada RSS-247 Industry Canada RSS-Gen Industry Canada RSS-210

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REVISION HISTORY

Revision	Date	Description
—	22 FEB 2019	Initial release
A	26 FEB 2019	The following changes were made: -The address was changed from 4015 Fieldstone Road Champaign, IL 61822 to 2904 Research Rd. Champaign, IL 61822

Measurement of RF Emissions from a Plano RF module Transmitter

1. INTRODUCTION

1.1. Scope of Tests

This report presents the results of the RF emissions measurements performed on a Plano RF module, Model No. DX9 (hereinafter referred to as the Equipment Under Test (EUT)). The EUT was designed to transmit in the 2400-2483.5 MHz band using an internal antenna. The EUT was manufactured and submitted for testing by Horizon Hobby located in Champaign, IL.

The EUT was originally tested in July 2018. Since it was last tested, the EUT has been modified to include a change in hardware. These tests were performed to determine if the changes will affect the compliance.

The original test results were presented in Elite Electronic Engineering Test Report No. 1801061-01A.

1.2. Purpose

The test series was performed to determine if the EUT meets the Class II Permissive Change requirements of the FCC “Code of Federal Regulations” Title 47, Part 2, Subpart J, Section 2.1043(b)(2) and the Class II Permissive Change requirements of the Innovation, Science, and Economic Development Canada RSP-100, Section 7.3.

Testing was performed to the requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.231 for Intentional Radiators, Innovation, Science, and Economic Development Canada RSS-210, Annex A, and 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 21°C and the relative humidity was 16%.

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 Specifications, “Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices”

- Industry Canada Radio Standards Specification, RSS-Gen, “General Requirements for Compliance of Radio Apparatus”, Issue 4, November 2014

- Industry Canada Radio Standards Specification, RSS-210, “License-Exempt Radio Apparatus: Category I Equipment”, Issue 9, August 2016

3. EUT Setup and Operation

3.1. General Description

The EUT is a Horizon Hobby Plano RF module. This transmitter is made to fit in a controller. The controller in junction with the Plano RF module commands the functions of a RC device. A block diagram of the EUT setup is shown as Figure 1.

3.1.1. Power Input

The EUT was powered with four (4), 1.5VDC, AA batteries.

3.1.2. Peripheral Equipment

There was no peripheral equipment submitted with the EUT.

3.1.3. Signal Input/Output Leads

There were no interconnect cables submitted with the EUT.

3.1.4. Grounding

The EUT was ungrounded during the tests.

3.2. Operational Mode

For all tests the EUT and all peripheral equipment were placed on a 150cm high non-conductive stand. The EUT and all peripheral equipment were energized. The EUT was set to the following modes:

DSMR 5.5ms - When powered up and set to its “Surface” protocol, the EUT was set to transmit at 2478MHz.

DSM2 22ms - When powered up and set to its “Air” protocol, the EUT was set to transmit at 2478MHz.

3.3. EUT Modifications

No modifications were required for compliance to FCC Title 47, Part 15, Subpart C, Section 15.247.

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 measurements were performed with a spectrum analyzer. This receiver allows measurements with the bandwidths and detector functions specified in the requirements. The receiver bandwidth was 1MHz for the 1000MHz to 18000MHz radiated emissions data.

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 International System Units (SI).

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. Duty Cycle Factor Measurements

5.1.1.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.

5.1.2.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:

Duty Cycle Correction Factor (dB) = D.C. (dB)

D.C. (dB) = 20 x log [((pulse width (msec)) x (#pulses in a 100msecperiod)) / 100msec]

5.1.3. Results

Duty cycle plots and calculations for the DSMR 5.5ms and DSM2 22ms modes are shown on pages 17 through 21.

5.2. Radiated Measurements

5.2.1. Requirements

Per section 15.247(d), RSS-247 Section 5.5 and RSS-Gen Section 8.9, 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

5.2.2. 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.

A preliminary radiated emissions test was 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 1GHz to 18GHz was investigated using a peak detector function. The data was then processed by the computer to calculate equivalent field intensity.

The final open field emission tests were then manually performed over the frequency range of 1GHz to 18GHz. Between 1GHz and 18GHz, a broadband double ridged waveguide antenna was used as the pick-up

device for all frequencies. All significant broadband and narrowband signals were measured and recorded. The peak detected levels were converted to average levels using a duty cycle factor which was computed from the pulse train.

To ensure that maximum or worst case, emission levels were measured, the following steps were taken:

1) The EUT was set to the DSMR 5.5ms mode.
2) The EUT was rotated so that all of its sides were exposed to the receiving antenna.
3) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.
4) The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.
5) Steps (1) through (4) were repeated with the EUT set to the DSM2 22ms mode.

5.2.3.Results

The preliminary plots, with the EUT transmitting at 2478 MHz, are presented on data pages 22 and 29. The plots are presented for a reference only, and are not used to determine compliance.

The final open area radiated levels, with the EUT transmitting at 2478 MHz, are presented on data pages 30 through 35. 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 in Figures 3 through 4.

5.3. Peak Output Power

5.3.1.Requirement

Per section 15.247(b)(3) and RSS-247 Section 5.4(d), 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).

5.3.2.Procedures

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 equivalent power was determined from the field intensity levels measured at 3 meters using the substitution method. To determine the emission power, a 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.

5.3.3.Results

The results are presented on pages 36 and 37. The maximum EIRP measured from the transmitter was 25.2 dBm or 0.331 W which is below the 4 Watt limit

5.4. Band Edge Compliance

5.4.1. Requirements

Per section 15.247(d) and RSS-Gen, 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.

5.4.2. Procedures

5.4.2.1 Low Band Edge

1) The EUT was set to the DSMR 5.5ms mode.
2) The EUT was set to transmit continuously at the channel closest to the low band-edge (hopping function disabled).
3) To determine the band edge compliance, the following spectrum analyzer settings were used:

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

4) Step 3) was repeated with the DSM2 22ms mode.

5.4.2.2 High Band Edge

1) The EUT was set to the DSMR 5.5ms mode.
2) The EUT was set to transmit continuously at the channel closest to the high band-edge.
3) To determine the band edge compliance, the following spectrum analyzer settings were used:

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

5) Step 3) was repeated with the DSM2 22ms mode.

5.4.3. Results

Pages 38 through 41 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

5.5. 6dB Bandwidth Measurement

5.5.1. Requirement

Per 15.247(a)(2) and RSS-247 Section 5.2(a), the minimum 6dB bandwidth shall be at least 500kHz for all systems using digital modulation techniques.

5.5.2. 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.

5.5.3. Results

The plots on pages 42 through 45 show that the minimum 6 dB bandwidth was 679kHz 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 1.069MHz.

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 Horizon Hobby upon completion of the tests.

7. Conclusions

Since the modifications made on the EUT have degraded the performance by more than 3dB and the EUT met the requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.231 for Intentional Radiators, Innovation, Science, and Economic Development Canada RSS-210, Annex A, and ANSI C63.4-2014, it was determined that the Horizon Hobby Plano RF module did fully meet the technical requirements for a Class II Permissive Change.

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 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	4/5/2018	4/5/2019
CDX8	COMPUTER	ELITE	WORKSTATION	---	---	N/A	
GRE1	SIGNAL GENERATOR	AGILENT	E4438C	MY42081749	250KHZ-6GHZ	2/13/2018	2/13/2019
NTA3	BILOG ANTENNA	TESEQ	6112D	32853	25-1000MHz	10/3/2018	10/3/2019
NWQ1	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS-LINDGREN	3117	66655	1GHZ-18GHZ	4/10/2018	4/10/2020
NWQ2	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS LINDGREN	3117	66659	1GHZ-18GHZ	3/22/2018	3/22/2020
RBG3	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	101592	2HZ-44GHZ	2/20/2018	2/20/2019
WKA1	SOFTWARE, UNIVERSAL RCV EMI	ELITE	UNIV_RCV_EMI	1	---	I/O	

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.

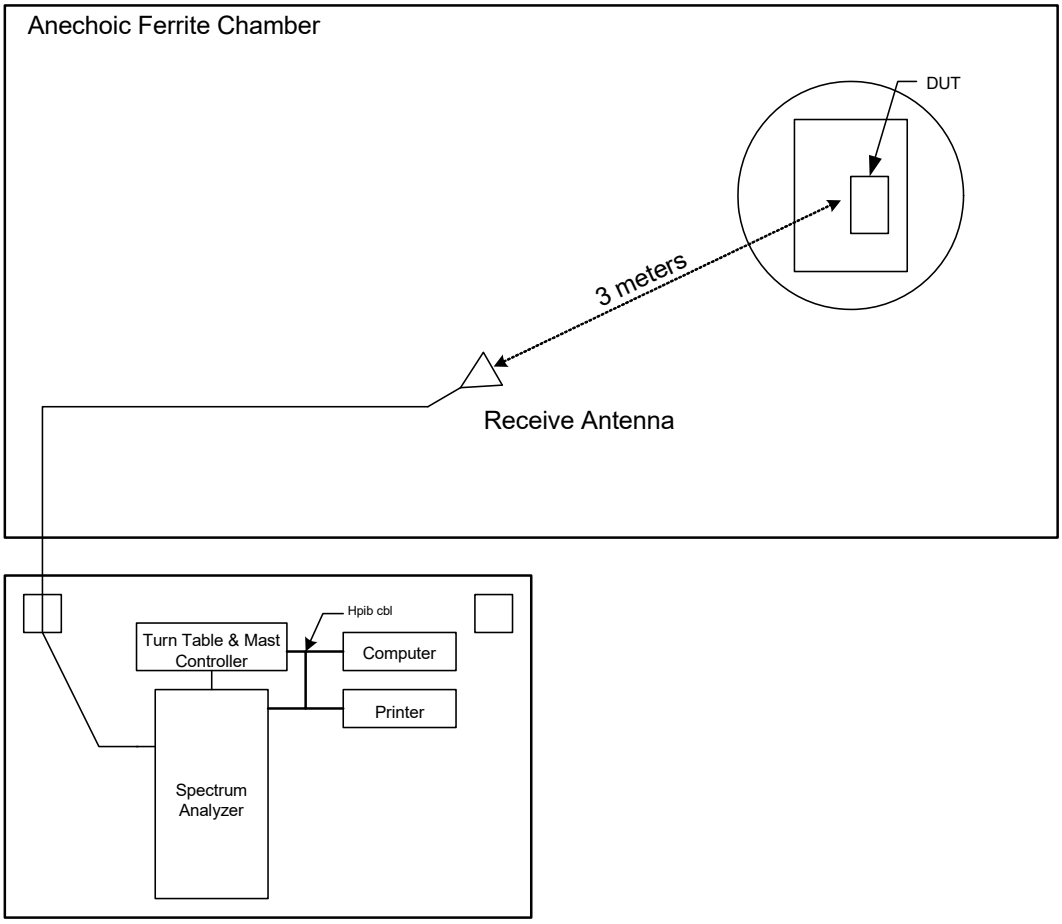


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

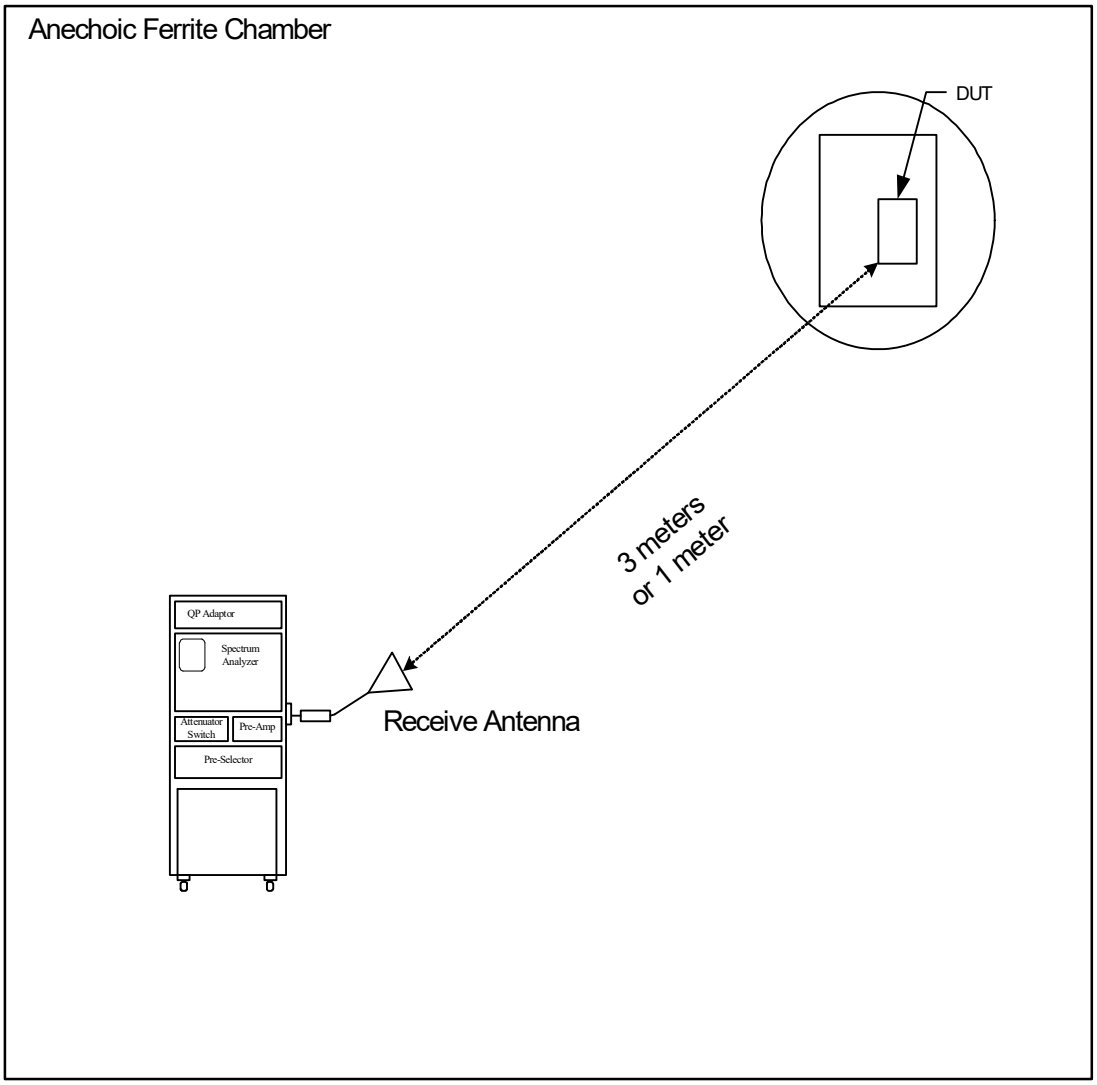

Anechoic Ferrite Chamber
DUT
3 meters
or 1 meter
QP Adaptor
Spectrum
Analyzer
Attenuator
Switch
Pre-Amp
Pre-Selector
Receive Antenna

Figure 2 – Photographs of the EUT

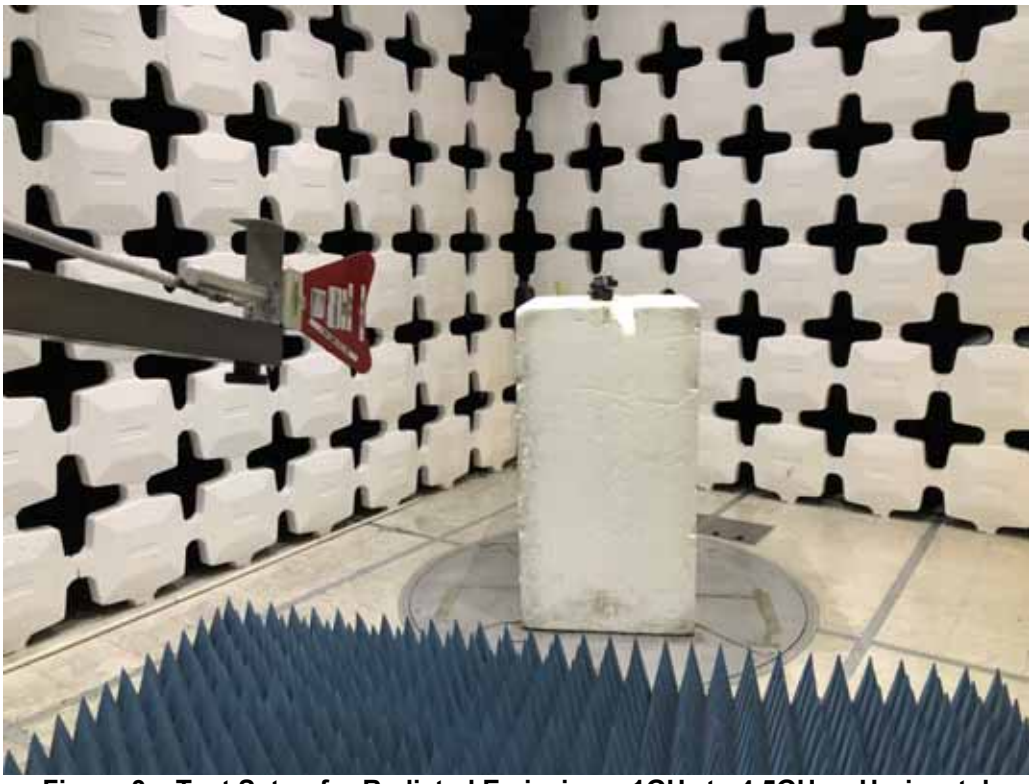


Figure 3 – Test Setup for Radiated Emissions, 1GHz to 4.5GHz – Horizontal Polarization

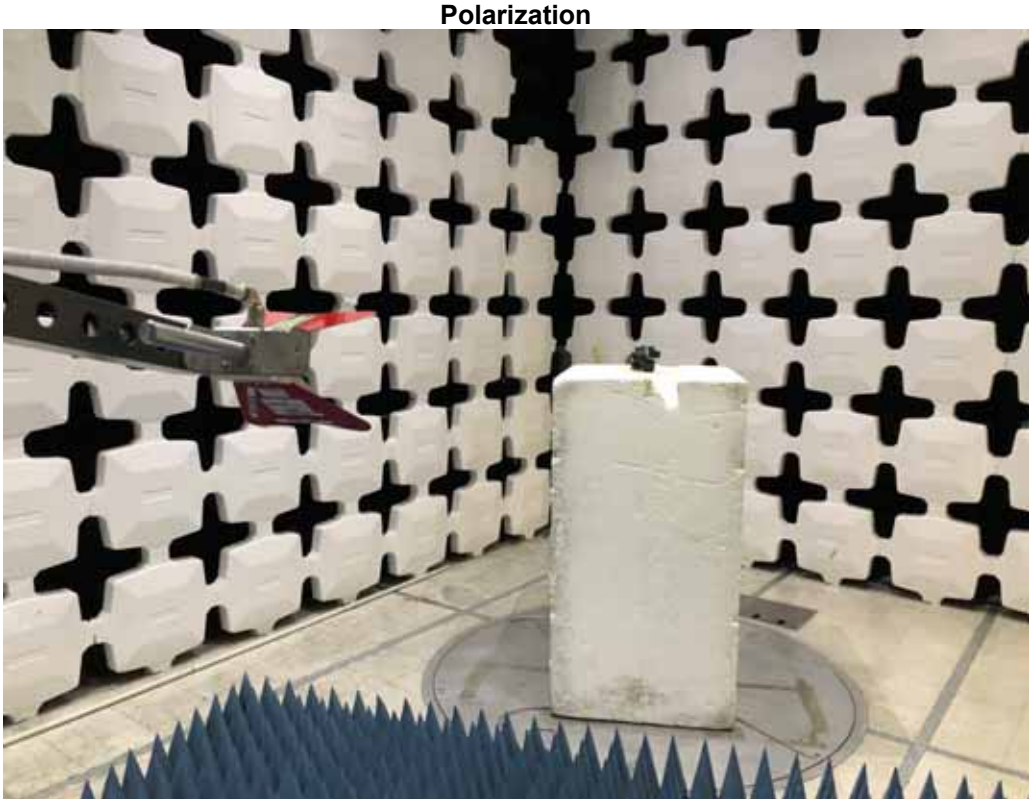
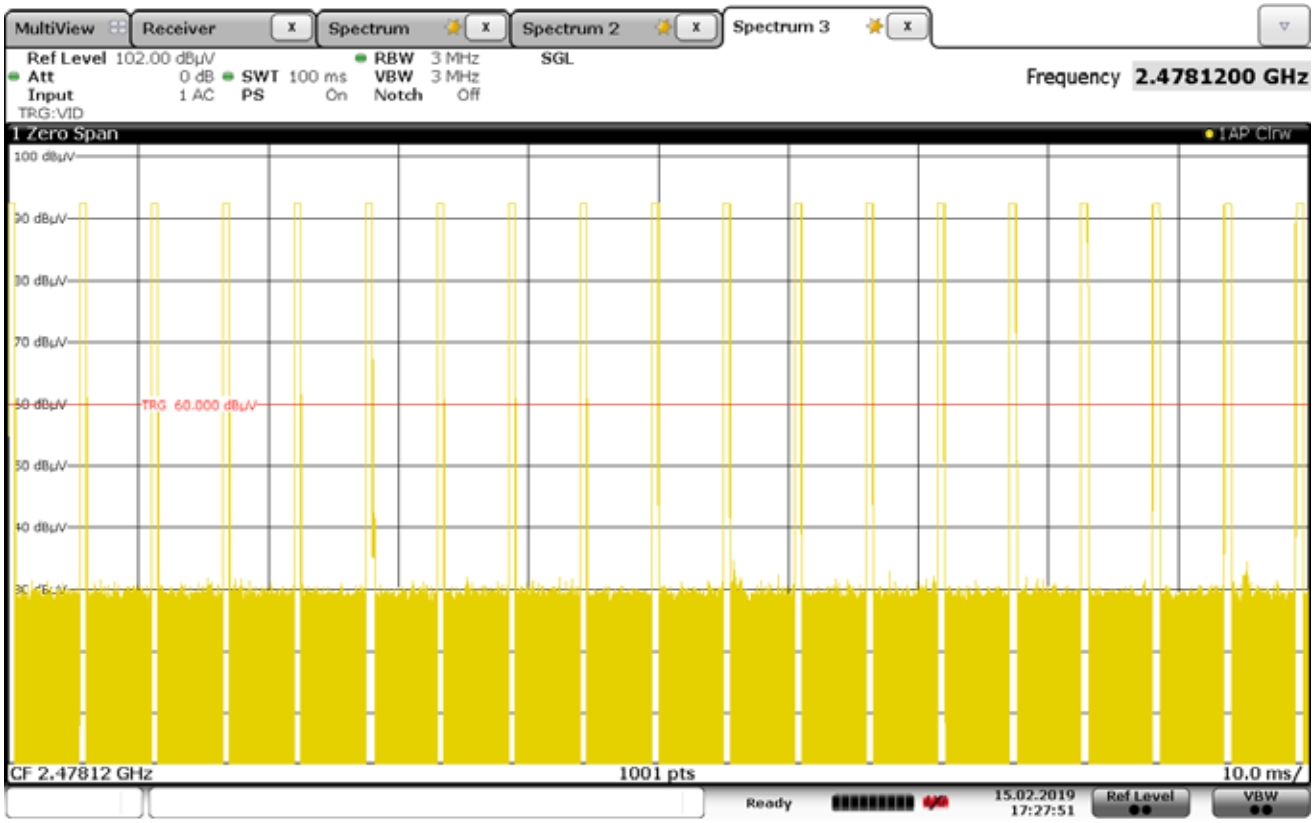
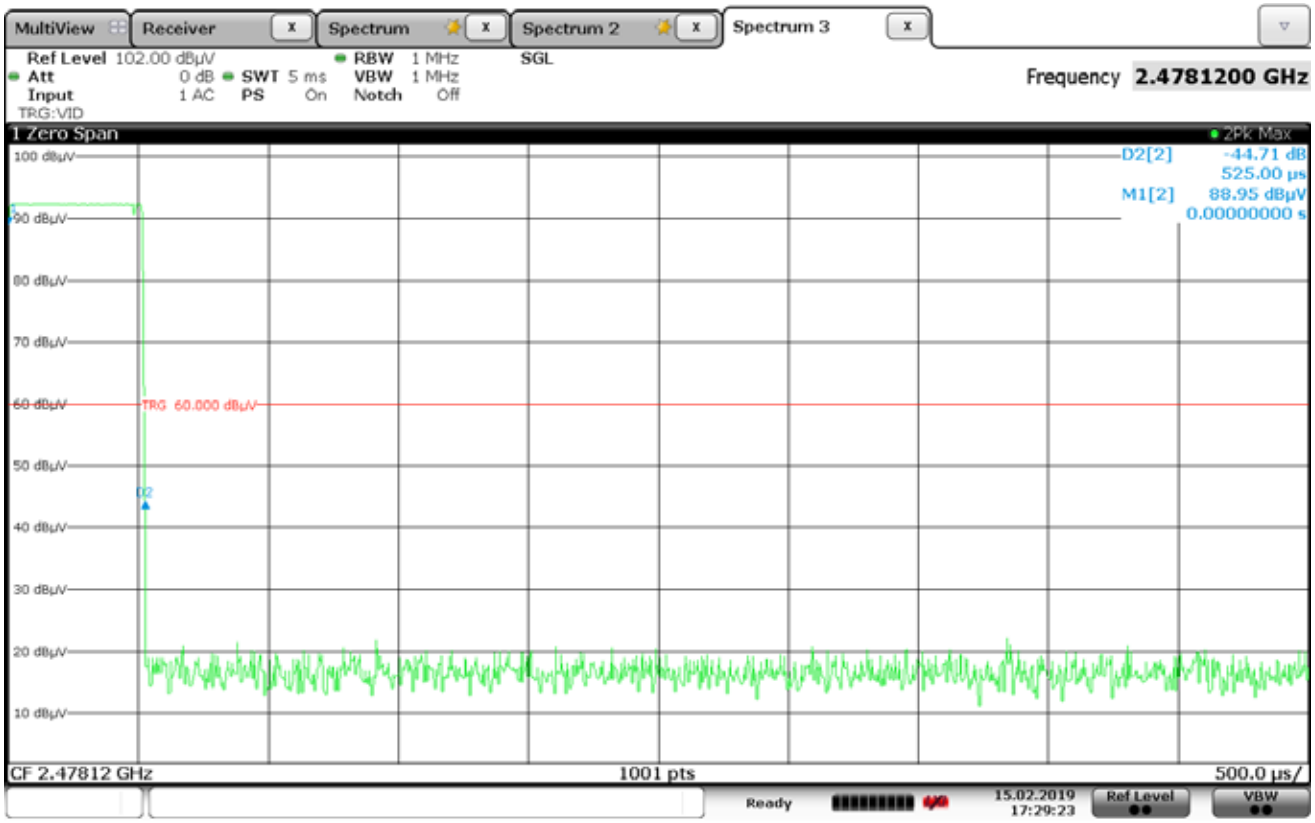


Figure 4 – Test Setup for Radiated Emissions, 1GHz to 4.5GHz – Vertical Polarization



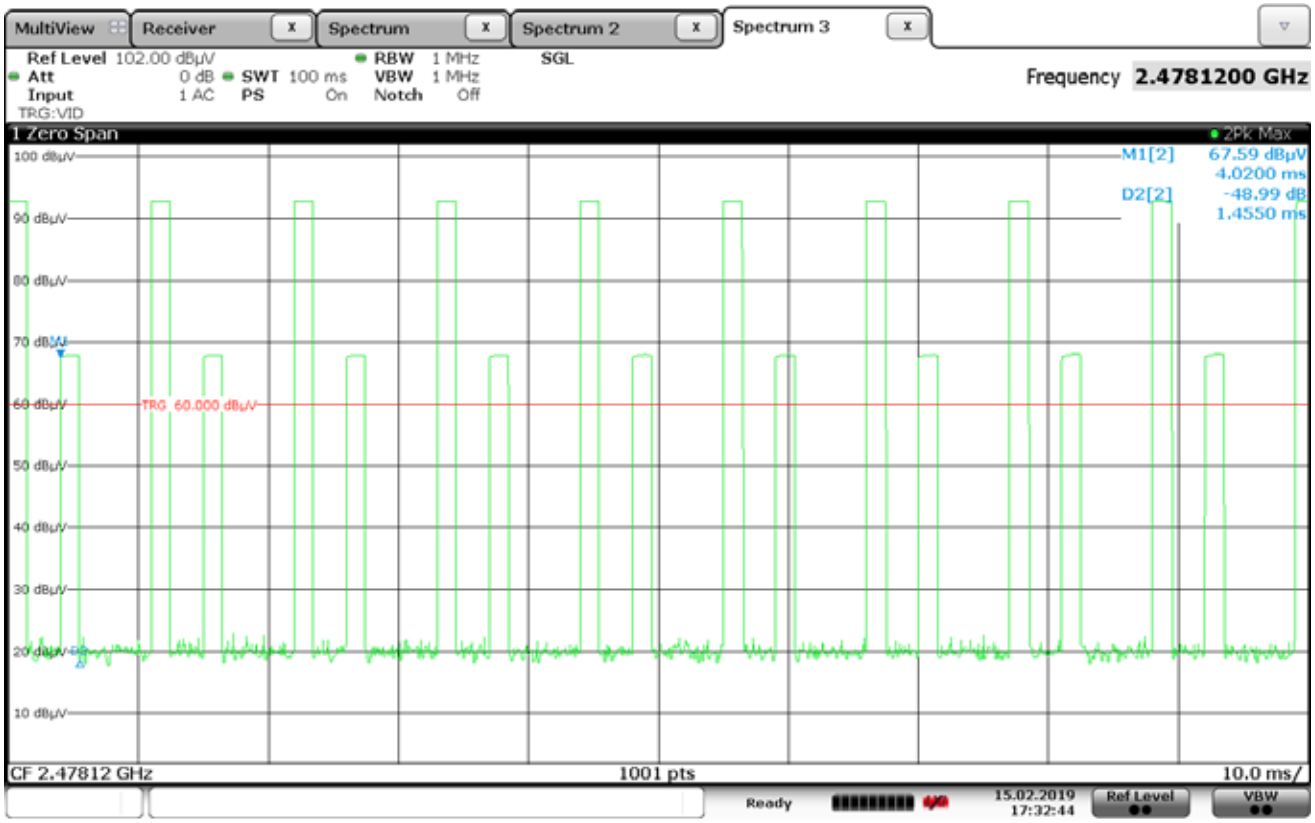
Manufacturer : Horizon Hobby
Model Number : DX9
Serial Number : N/A
Test : **Duty Cycle Calculation – 100ms**
Mode : DSMR 5.5ms
Parameters : 19 pulses within 100ms
Date : Feb 12,2019
Notes : Tx @ 2478MHz



Date: 15.FEB.2019 17:29:23

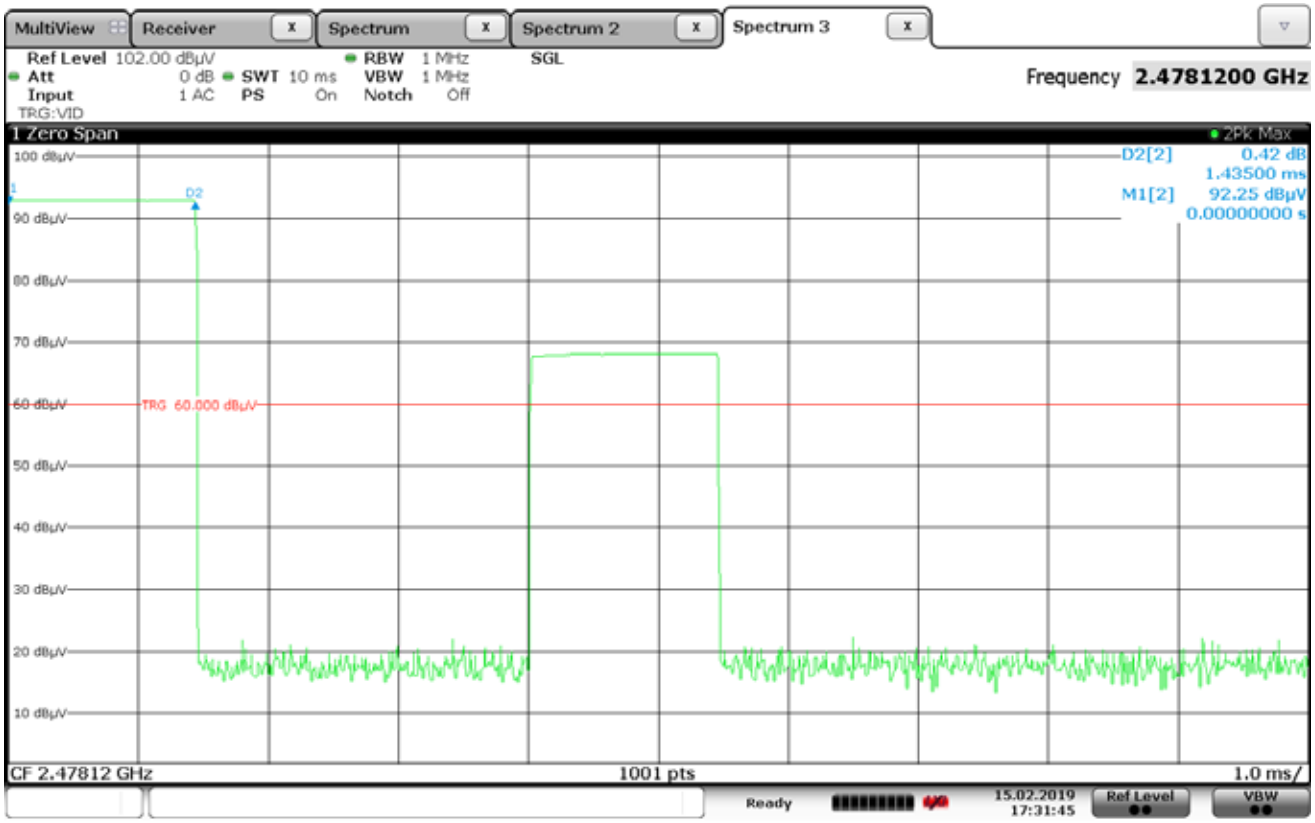
Manufacturer : Horizon Hobby
Model Number : DX9
Serial Number : N/A
Test : **Duty Cycle Calculation – Pulse Length**
Mode : DSMR 5.5ms
Parameters : Pulse length 0.525ms
Date : Feb 12,2019
Notes : Tx @ 2478MHz

Duty Cycle = 20 Log $\left(\frac{19 \times 0.520\text{ms}}{100\text{ms}}\right)$ = -20.02



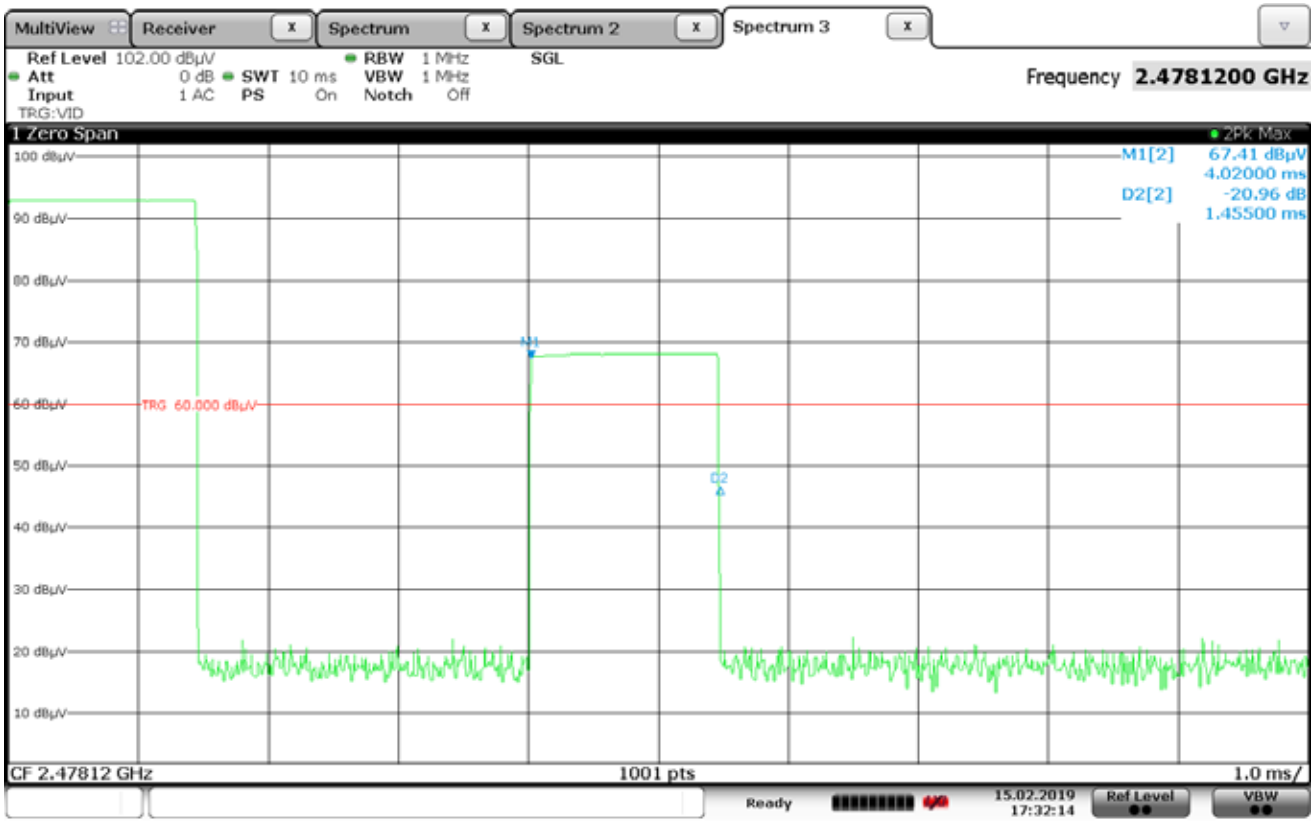
Date: 15.FEB.2019 17:32:44

Manufacturer : Horizon Hobby
Model Number : DX9
Serial Number : N/A
Test : **Duty Cycle Calculation – 100ms**
Mode : DSM2 22ms
Parameters : 10 “tall” pulses and 9 “short” pulses within 100ms
Date : Feb 12,2019
Notes : Tx @ 2478MHz



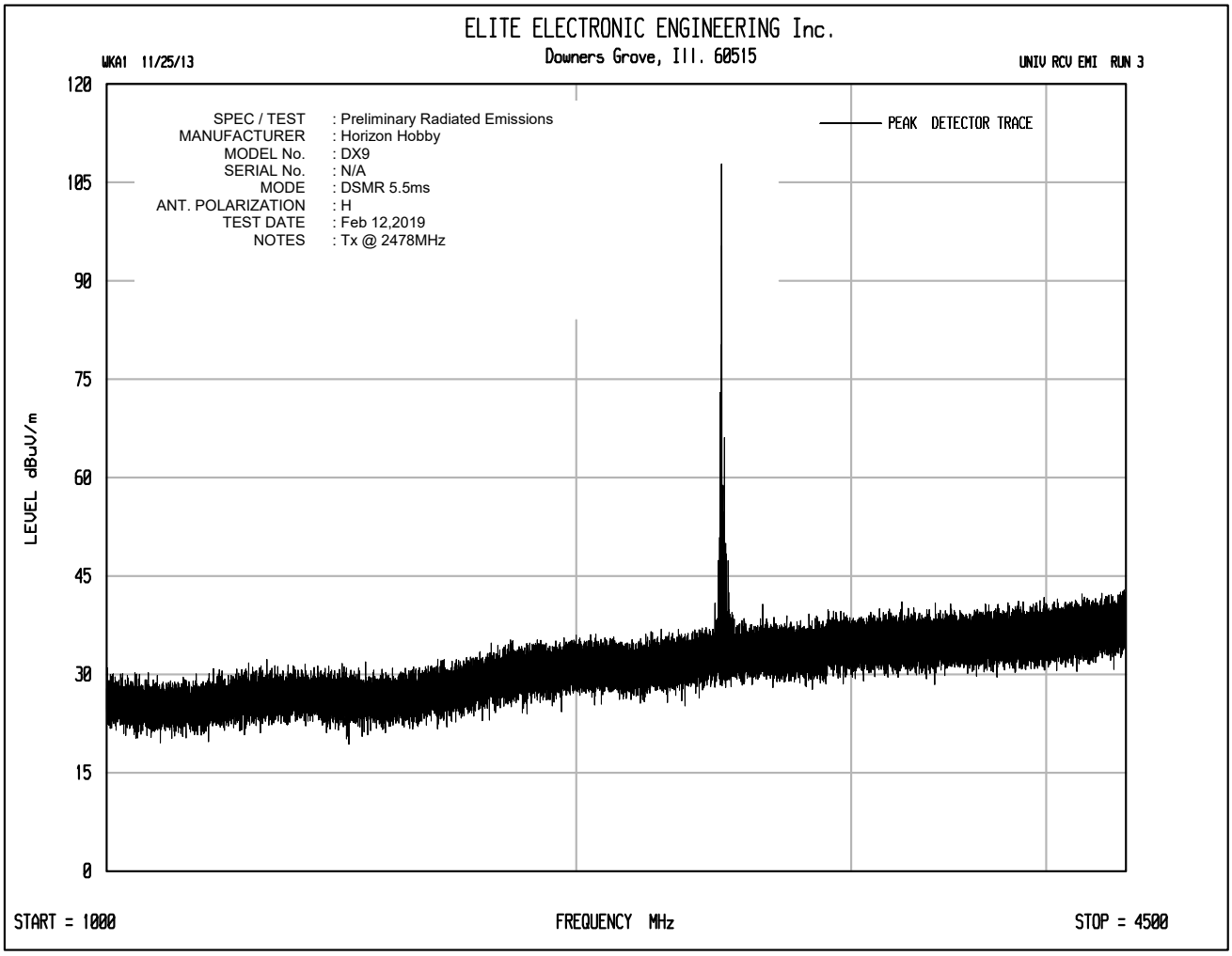
Date: 15.FEB.2019 17:31:45

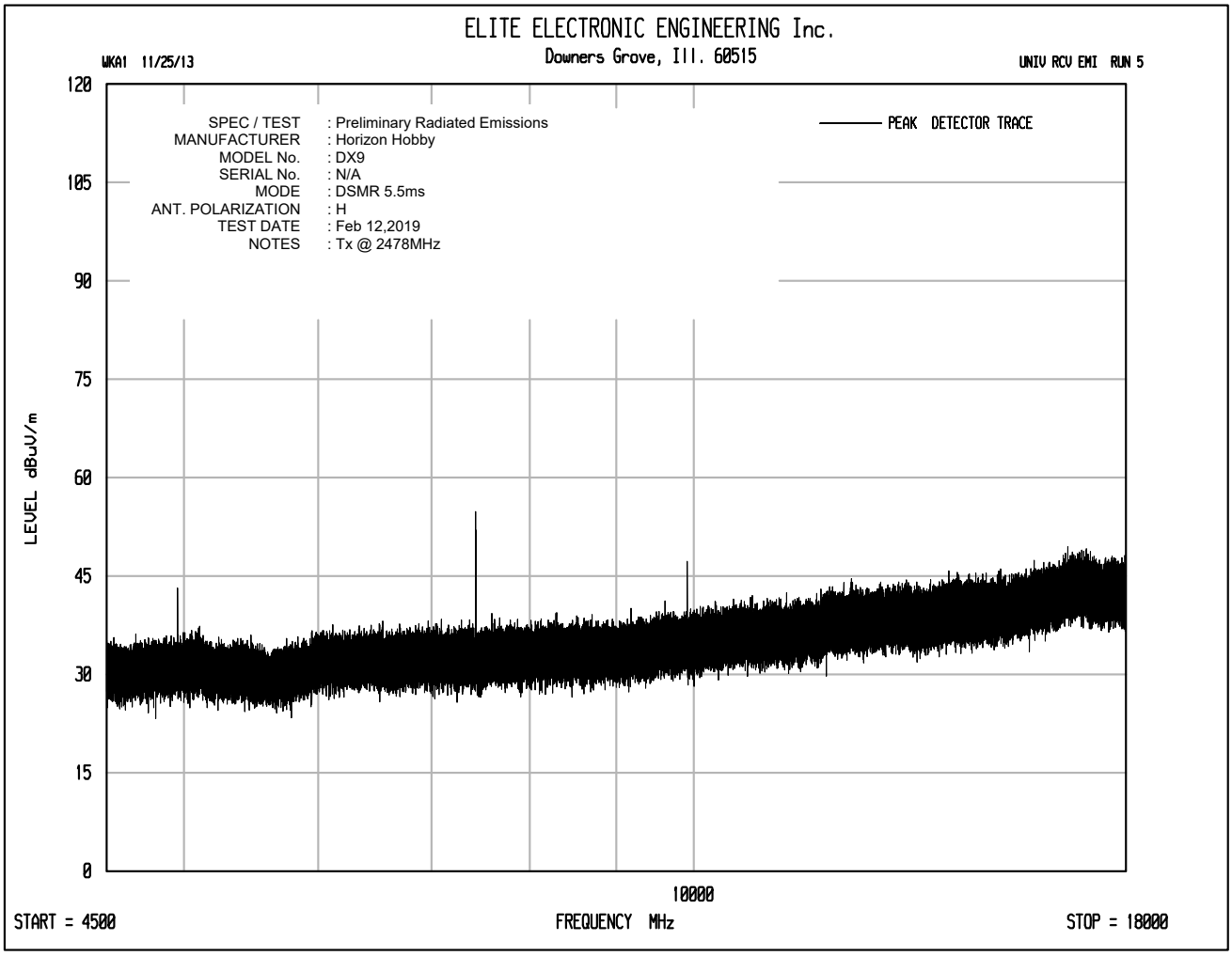
Manufacturer : Horizon Hobby
Model Number : DX9
Serial Number : N/A
Test : **Duty Cycle Calculation – "Tall" Pulse Length**
Mode : DSM2 22ms
Parameters : Pulse length 1.435ms
Date : Feb 12,2019
Notes : Tx @ 2478MHz

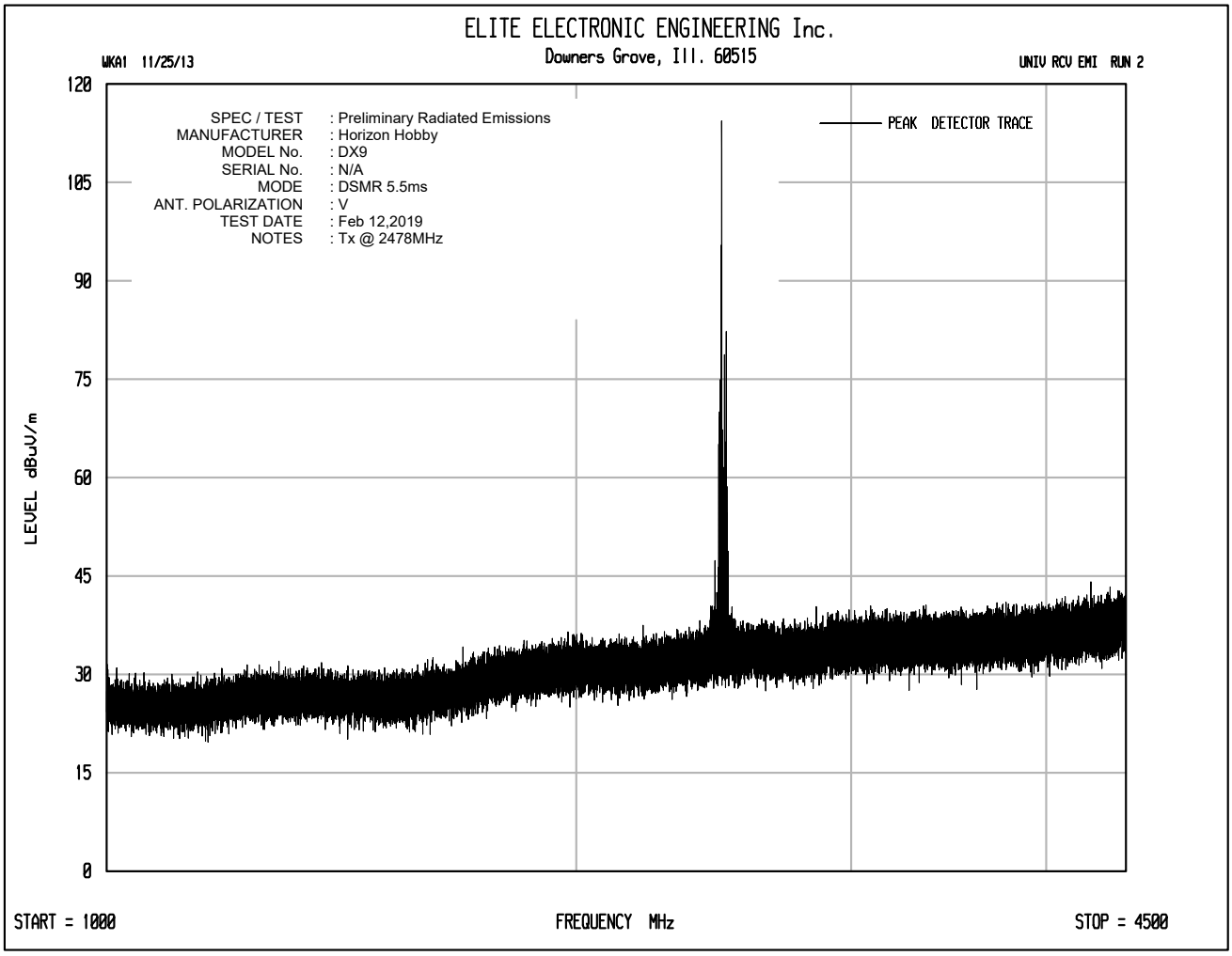


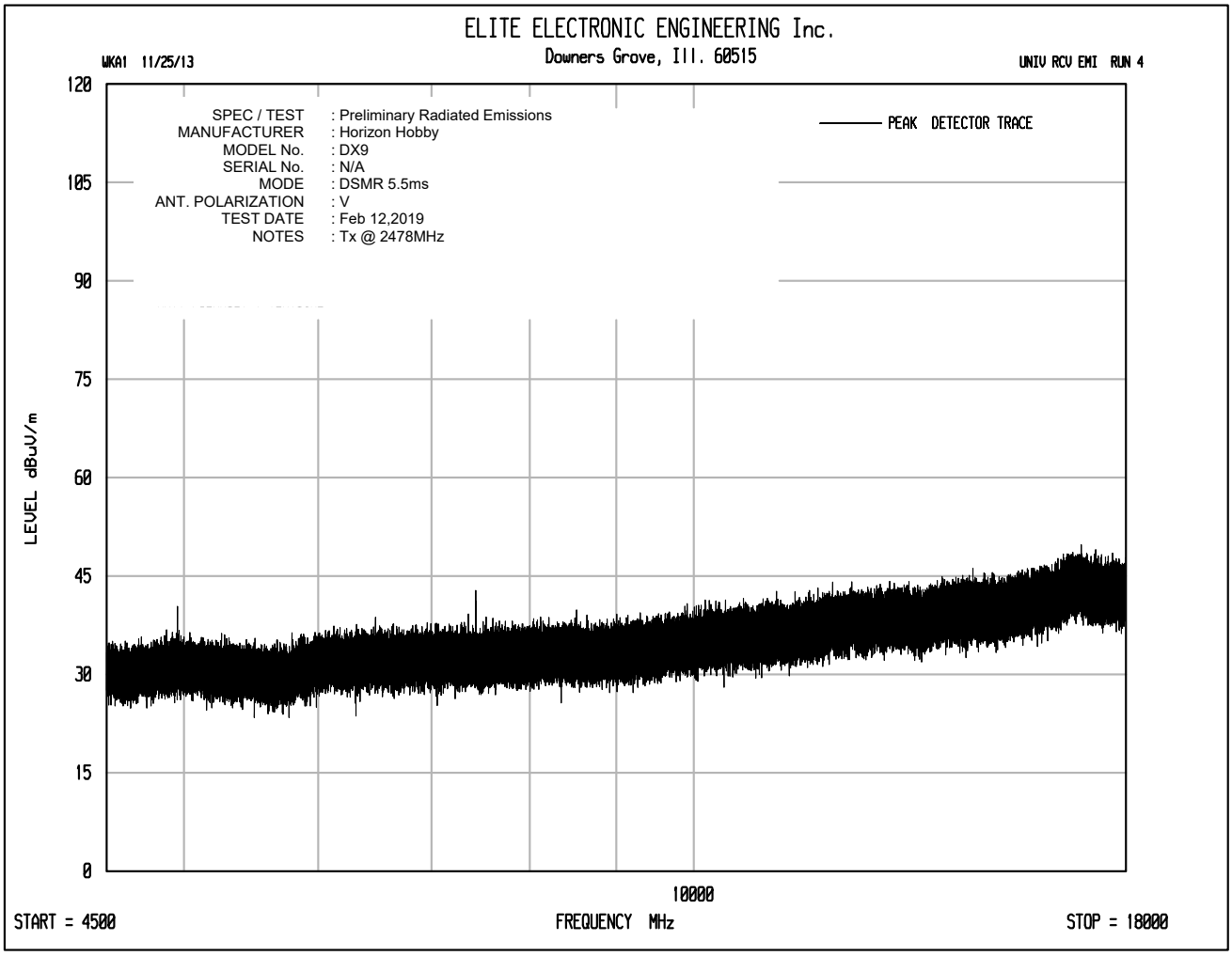
Manufacturer : Horizon Hobby
Model Number : DX9
Serial Number : N/A
Test : **Duty Cycle Calculation – "Short" Pulse Length**
Mode : DSM2 22ms
Parameters : Pulse length 1.455ms
Date : Feb 12,2019
Notes : Tx @ 2478MHz

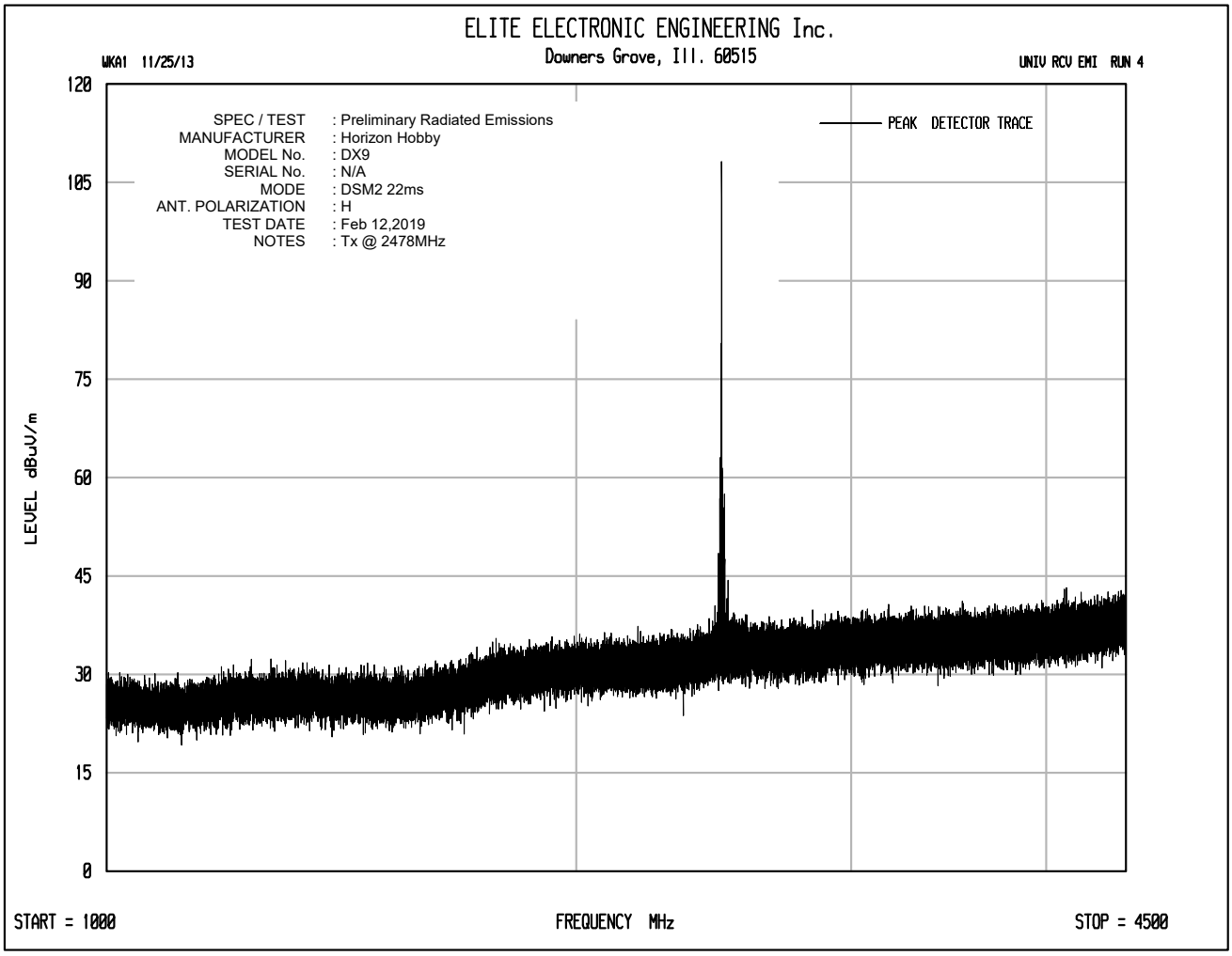
Duty Cycle = 20 Log $\left(\frac{(10\times1.435\text{ms})+(9\times1.455\text{ms})}{100\text{ms}}\right)$ = -11.17

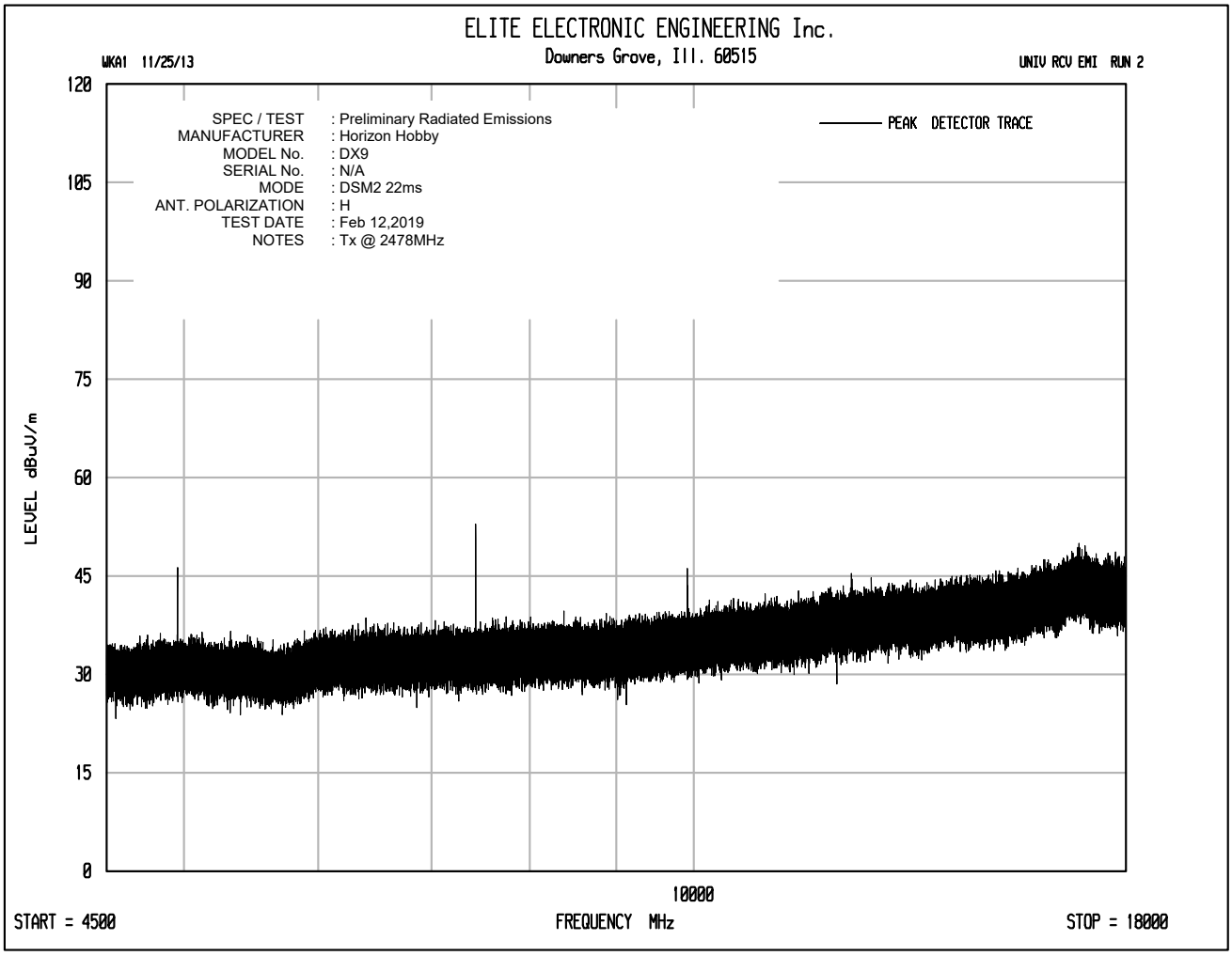

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 3
SPEC / TEST : Preliminary Radiated Emissions
MANUFACTURER : Horizon Hobby
MODEL No. : DX9
SERIAL No. : N/A
MODE : DSMR 5.5ms
ANT. POLARIZATION : H
TEST DATE : Feb 12,2019
NOTES : Tx @ 2478MHz
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 4500

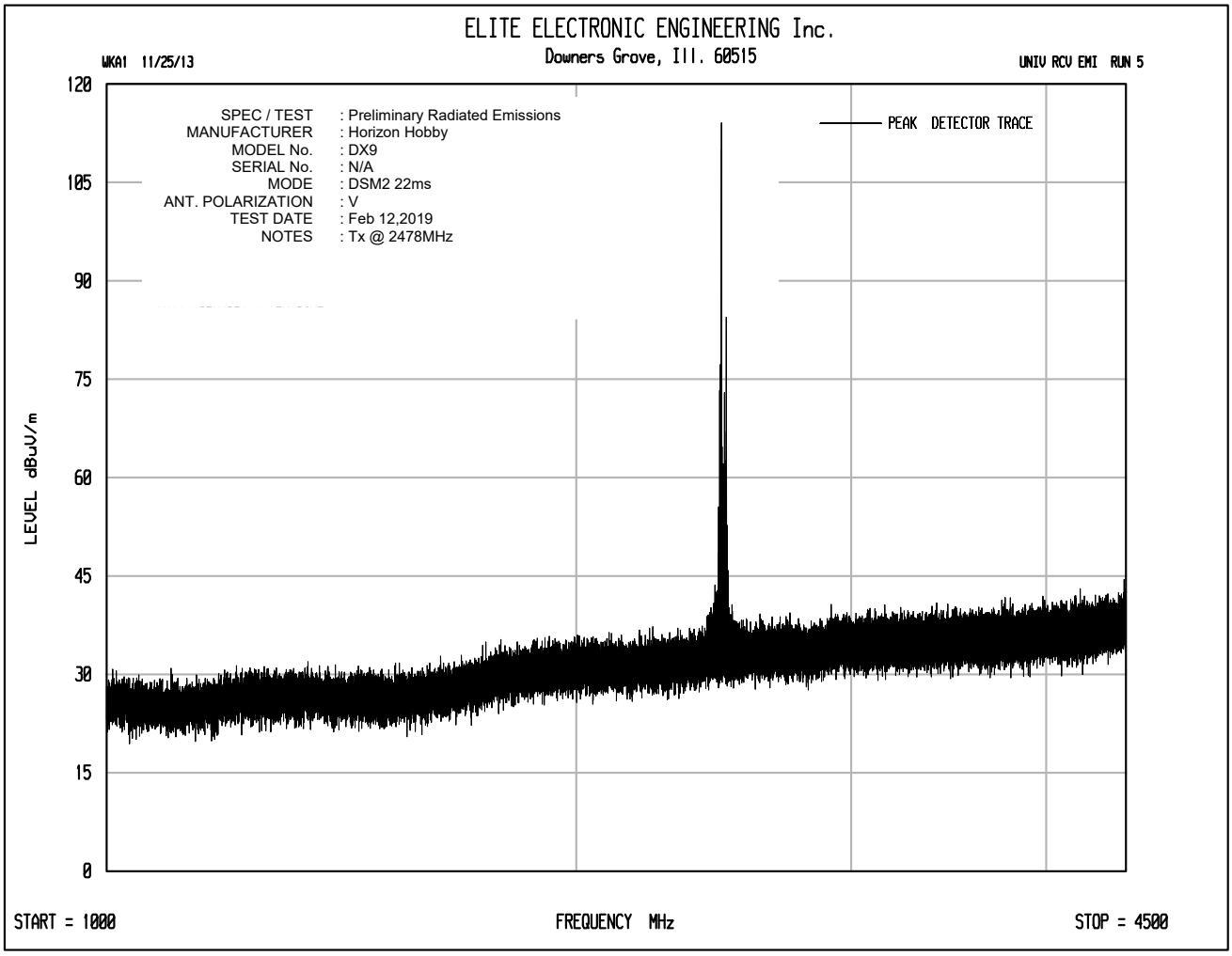

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 5
SPEC / TEST : Preliminary Radiated Emissions
MANUFACTURER : Horizon Hobby
MODEL No. : DX9
SERIAL No. : N/A
MODE : DSMR 5.5ms
ANT. POLARIZATION : H
TEST DATE : Feb 12,2019
NOTES : Tx @ 2478MHz
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
10000
START = 4500
FREQUENCY MHz
STOP = 18000

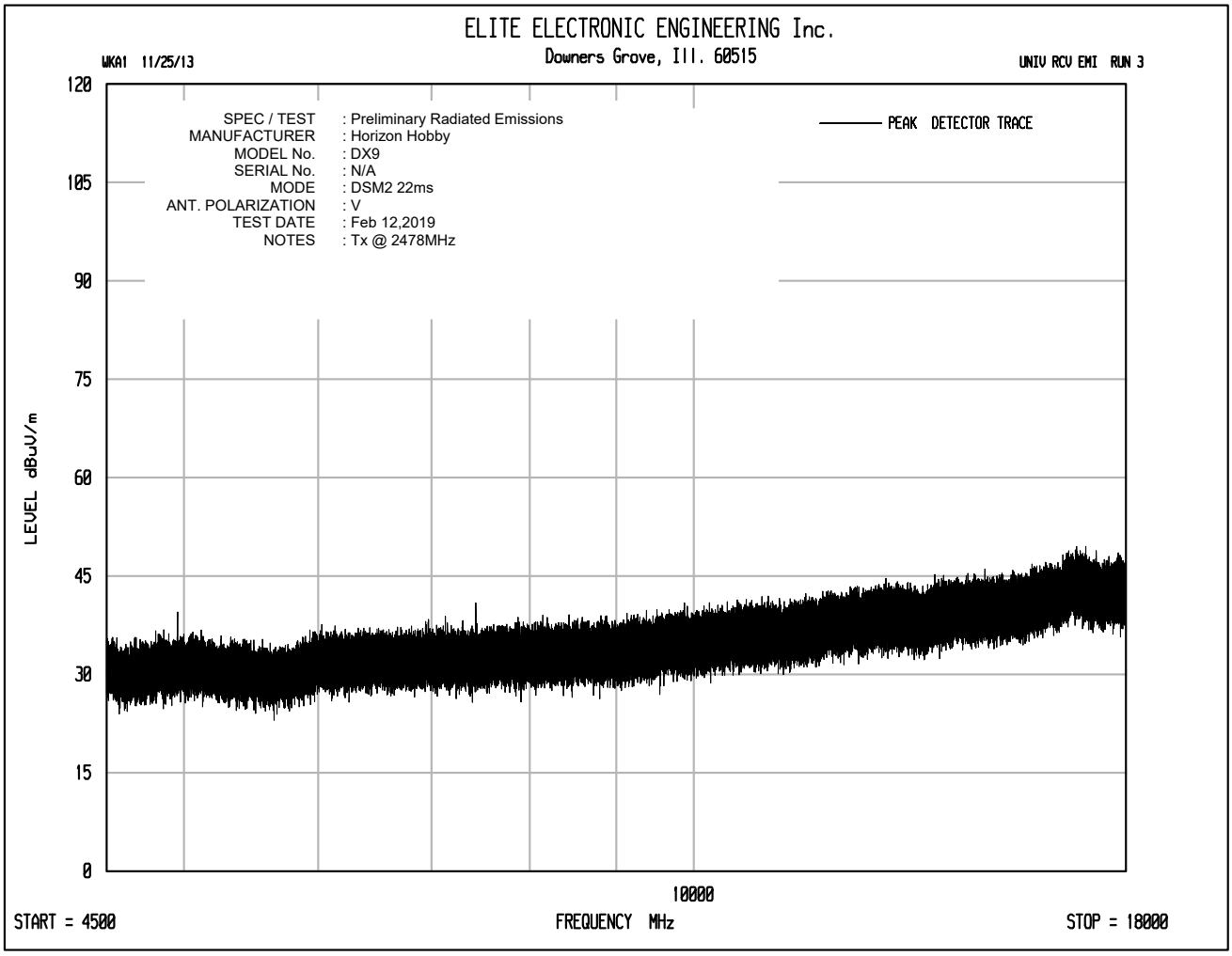

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 2
SPEC / TEST : Preliminary Radiated Emissions
MANUFACTURER : Horizon Hobby
MODEL No. : DX9
SERIAL No. : N/A
MODE : DSMR 5.5ms
ANT. POLARIZATION : V
TEST DATE : Feb 12,2019
NOTES : Tx @ 2478MHz
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 4500


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 4
SPEC / TEST : Preliminary Radiated Emissions
MANUFACTURER : Horizon Hobby
MODEL No. : DX9
SERIAL No. : N/A
MODE : DSMR 5.5ms
ANT. POLARIZATION : V
TEST DATE : Feb 12,2019
NOTES : Tx @ 2478MHz
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
10000
START = 4500
FREQUENCY MHz
STOP = 18000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 4
SPEC / TEST : Preliminary Radiated Emissions
MANUFACTURER : Horizon Hobby
MODEL No. : DX9
SERIAL No. : N/A
MODE : DSM2 22ms
ANT. POLARIZATION : H
TEST DATE : Feb 12,2019
NOTES : Tx @ 2478MHz
PEAK DETECTOR TRACE
LEVEL dBuU/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 4500


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 2
SPEC / TEST : Preliminary Radiated Emissions
MANUFACTURER : Horizon Hobby
MODEL No. : DX9
SERIAL No. : N/A
MODE : DSM2 22ms
ANT. POLARIZATION : H
TEST DATE : Feb 12,2019
NOTES : Tx @ 2478MHz
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
10000
START = 4500
FREQUENCY MHz
STOP = 18000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 5
SPEC / TEST : Preliminary Radiated Emissions
MANUFACTURER : Horizon Hobby
MODEL No. : DX9
SERIAL No. : N/A
MODE : DSM2 22ms
ANT. POLARIZATION : V
TEST DATE : Feb 12,2019
NOTES : Tx @ 2478MHz
PEAK DETECTOR TRACE
LEVEL dBuU/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 4500


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 3
SPEC / TEST : Preliminary Radiated Emissions
MANUFACTURER : Horizon Hobby
MODEL No. : DX9
SERIAL No. : N/A
MODE : DSM2 22ms
ANT. POLARIZATION : V
TEST DATE : Feb 12,2019
NOTES : Tx @ 2478MHz
PEAK DETECTOR TRACE
LEVEL dBuU/m
120
105
90
75
60
45
30
15
0
10000
START = 4500
FREQUENCY MHz
STOP = 18000

MANUFACTURER Horizon Hobby
EUT Plano RF module
SPECIFICATION FCC 15 C, Section 15.247
TEST Radiated Emissions not in the Restricted Bands – Peak
MODE DSMR 5.5ms – 2478MHz
DATE TESTED 02/12/2019

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)
2478.00	H	83.1		3.5	32.5	0.0	119.0	896322.2		
2478.00	V	82.5		3.5	32.5	0.0	118.5	841325.7		
9912.00	H	50.4		7.0	36.7	-39.2	54.8	549.0	28344.2	-34.3
9912.00	V	46.7		7.0	36.7	-39.2	51.1	360.2	28344.2	-37.9
14868.00	H	38.5	*	8.9	39.7	-38.2	48.9	278.0	28344.2	-40.2
14868.00	V	37.7	*	8.9	39.7	-38.2	48.1	253.8	28344.2	-41.0
17346.00	H	38.3	*	9.7	41.1	-37.7	51.3	366.9	28344.2	-37.8
17346.00	V	38.3	*	9.7	41.1	-37.7	51.3	368.1	28344.2	-37.7

Tested By: Javier Cardenas

MANUFACTURER Horizon Hobby
EUT Plano RF module
SPECIFICATION FCC 15 C, Section 15.247
TEST Radiated Emissions in the Restricted Bands – Peak
MODE DSMR 5.5ms – 2478MHz
DATE TESTED 02/12/2019

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)
4956.00	H	55.4		4.9	34.3	-39.3	55.3	582.2	5000.0	-18.7
4956.00	V	56.6		4.9	34.3	-39.3	56.5	668.5	5000.0	-17.5
7434.00	H	61.2		6.2	35.7	-39.4	63.7	1524.5	5000.0	-10.3
7434.00	V	56.7		6.2	35.7	-39.4	59.2	910.2	5000.0	-14.8
12390.00	H	52.0		8.0	38.8	-39.0	59.8	972.5	5000.0	-14.2
12390.00	V	50.5		8.0	38.8	-39.0	58.3	818.3	5000.0	-15.7

Tested By: Javier Cardenas

MANUFACTURER Horizon Hobby
EUT Plano RF module
SPECIFICATION FCC 15 C, Section 15.247
TEST Radiated Emissions in the Restricted Bands – Average
MODE DSMR 5.5ms – 2478MHz
DATE TESTED 02/12/2019

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)
4956.00	H	37.2		4.9	34.3	-39.3	-20.0	17.1	7.1	500.0	-36.9
4956.00	V	37.7		4.9	34.3	-39.3	-20.0	17.6	7.6	500.0	-36.4
7434.00	H	38.74		6.2	35.7	-39.4	-20.0	21.2	11.4	500.0	-32.8
7434.00	V	36.3		6.2	35.7	-39.4	-20.0	18.7	8.6	500.0	-35.3
12390.00	H	34.5		8.0	38.8	-39.0	-20.0	22.2	12.9	500.0	-31.8
12390.00	V	34.1		8.0	38.8	-39.0	-20.0	21.8	12.3	500.0	-32.2

Tested By: Javier Cardenas

MANUFACTURER Horizon Hobby
EUT Plano RF module
SPECIFICATION FCC 15 C, Section 15.247
TEST Radiated Emissions not in the Restricted Bands – Peak
MODE DSM2 22ms – 2478MHz
DATE TESTED 02/12/2019

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)
2478.00	H	83.2		3.5	32.5	0.0	119.2	909838.2		
2478.00	V	80.2		3.5	32.5	0.0	116.1	641156.7		
9912.00	H	54.6		7.0	36.7	-39.2	59.0	893.4	28771.6	-30.2
9912.00	V	51.2		7.0	36.7	-39.2	55.6	602.6	28771.6	-33.6
14868.00	H	39.3		8.9	39.7	-38.2	49.8	307.6	28771.6	-39.4
14868.00	V	38.7		8.9	39.7	-38.2	49.1	285.5	28771.6	-40.1
17346.00	H	37.9	*	9.7	41.1	-37.7	50.9	352.0	28771.6	-38.2
17346.00	V	37.6	*	9.7	41.1	-37.7	50.6	340.4	28771.6	-38.5

Tested By: Javier Cardenas

MANUFACTURER Horizon Hobby
EUT Plano RF module
SPECIFICATION FCC 15 C, Section 15.247
TEST Radiated Emissions in the Restricted Bands – Peak
MODE DSM2 22ms – 2478MHz
DATE TESTED 02/12/2019

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)
4956.00	H	56.1		4.9	34.3	-39.3	56.0	631.8	5000.0	-18.0
4956.00	V	55.2		4.9	34.3	-39.3	55.1	567.6	5000.0	-18.9
7434.00	H	62.9		6.2	35.7	-39.4	65.3	1847.7	5000.0	-8.6
7434.00	V	57.5		6.2	35.7	-39.4	60.0	994.6	5000.0	-14.0
12390.00	H	51.4		8.0	38.8	-39.0	59.1	902.4	5000.0	-14.9
12390.00	V	49.8		8.0	38.8	-39.0	57.6	756.7	5000.0	-16.4

Tested By: Javier Cardenas

MANUFACTURER Horizon Hobby
EUT Plano RF module
SPECIFICATION FCC 15 C, Section 15.247
TEST Radiated Emissions in the Restricted Bands – Average
MODE DSM2 22ms – 2478MHz
DATE TESTED 02/12/2019

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)
4956.00	H	39.9		4.9	34.3	-39.3	-11.2	28.6	26.9	500.0	-25.4
4956.00	V	37.8		4.9	34.3	-39.3	-11.2	26.4	20.9	500.0	-27.6
7434.00	H	43.87		6.2	35.7	-39.4	-11.2	35.1	56.8	500.0	-18.9
7434.00	V	38.6		6.2	35.7	-39.4	-11.2	29.9	31.1	500.0	-24.1
12390.00	H	35.0		8.0	38.8	-39.0	-11.2	31.5	37.5	500.0	-22.5
12390.00	V	34.5		8.0	38.8	-39.0	-11.2	31.0	35.4	500.0	-23.0

Tested By: Javier Cardenas

Manufacturer : Horizon Hobby
Test Item : Plano RF module
Serial No. : N/A
Mode : DSMR 5.5ms
Test : EIRP
Test Limits : FCC 15.247
Date : 02/12/2019
Notes : Tx @ 2478MHz

Freq. (MHz)	Ant Pol	Wide BW Meter Reading (dBuV)	Matched Sig. Gen. Reading (dBm)	Equivalent Antenna Gain (dB)	Cable Loss (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
2478.00	H	83.1	21.7	5.8	2.7	24.8	36.0	-11.2
2478.00	V	82.7	21.3	5.8	2.7	24.4	36.0	-11.6

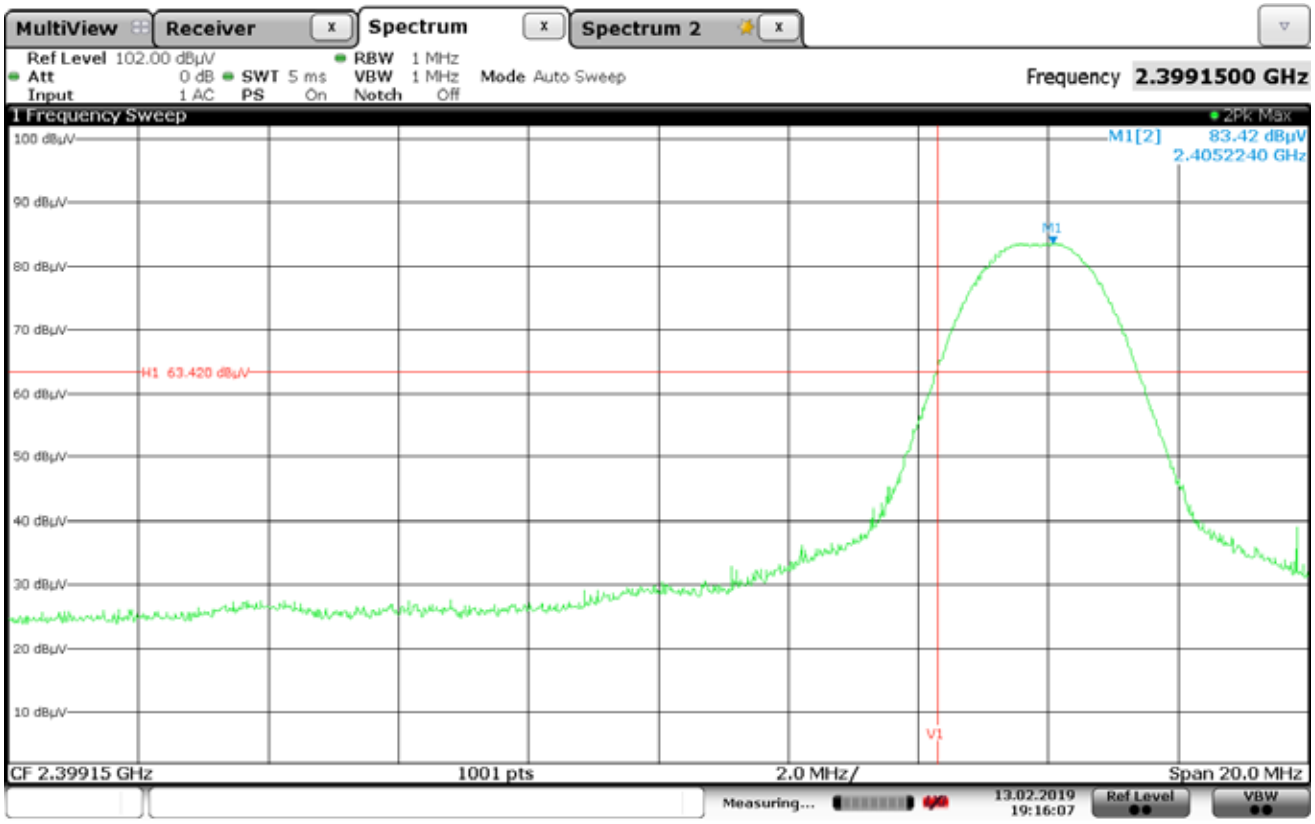
Tested By: Javier Cardenas

Manufacturer : Horizon Hobby
Test Item : Plano RF module
Serial No. : N/A
Mode : DSM2 22ms
Test : EIRP
Test Limits : FCC 15.247
Date : 02/12/2019
Notes : Tx @ 2478MHz

Freq. (MHz)	Ant Pol	Wide BW Meter Reading (dBuV)	Matched Sig. Gen. Reading (dBm)	Equivalent Antenna Gain (dB)	Cable Loss (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
2478.00	H	83.4	22.1	5.8	2.7	25.2	36.0	-10.8
2478.00	V	82.1	21.5	5.8	2.7	24.6	36.0	-11.4

Tested By: Javier Cardenas

Manufacturer : Horizon Hobby
Test Item : Plano RF module
Serial No. : N/A
Mode : DSMR 5.5ms
Test : Low Band Edge Compliance
Test Limits : FCC 15.247
Date : 02/12/2019
Notes : Tx @ 2478MHz



Date: 13.FEB.2019 19:16:07

Manufacturer : Horizon Hobby
Test Item : Plano RF module
Serial No. : N/A
Mode : DSMR 5.5ms
Test : High Band Edge Compliance
Test Limits : FCC 15.247
Date : 02/12/2019
Notes : Tx @ 2478MHz

Peak Measurement

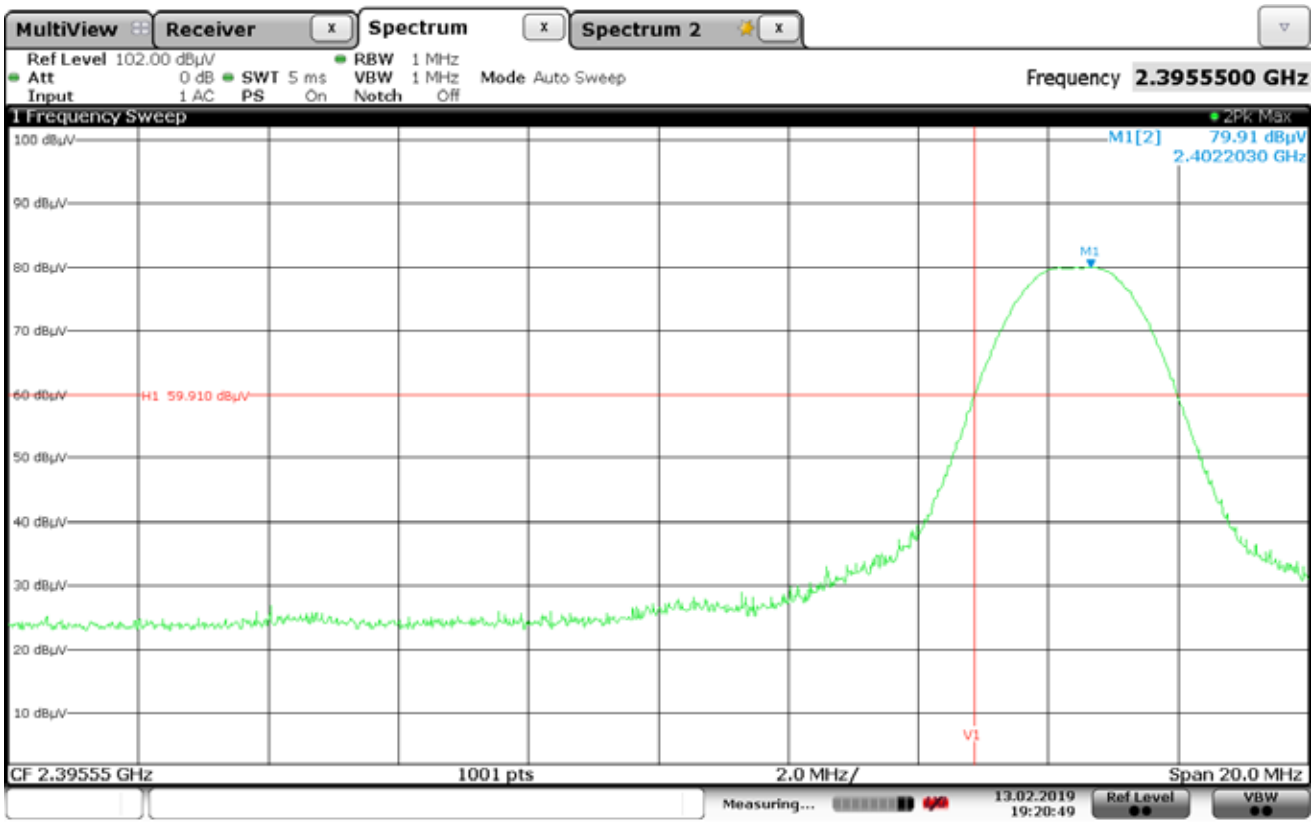
Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dBuV/m at 3m	Peak Total uV/m at 3 m	Peak Limit uV/m at 3 m	Margin (dB)
2483.50	H	34.1		3.5	32.5	0.0	70.1	3190.5	5000.0	-3.9
2483.50	V	33.0		3.5	32.5	0.0	69.0	2827.2	5000.0	-5.0

Average Measurement

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)
2483.50	H	10.3		3.5	32.5	0.0	-20.0	26.3	20.6	500.0	-27.7
2483.50	V	9.9		3.5	32.5	0.0	-20.0	25.9	19.7	500.0	-28.1

Tested By: Javier Cardenas

Manufacturer : Horizon Hobby
Test Item : Plano RF module
Serial No. : N/A
Mode : DSM2 22ms
Test : Low Band Edge Compliance
Test Limits : FCC 15.247
Date : 02/12/2019
Notes : Tx @ 2478MHz



Date: 13.FEB.2019 19:20:49

Manufacturer : Horizon Hobby
Test Item : Plano RF module
Serial No. : N/A
Mode : DSM2 22ms
Test : High Band Edge Compliance
Test Limits : FCC 15.247
Date : 02/12/2019
Notes : Tx @ 2478MHz

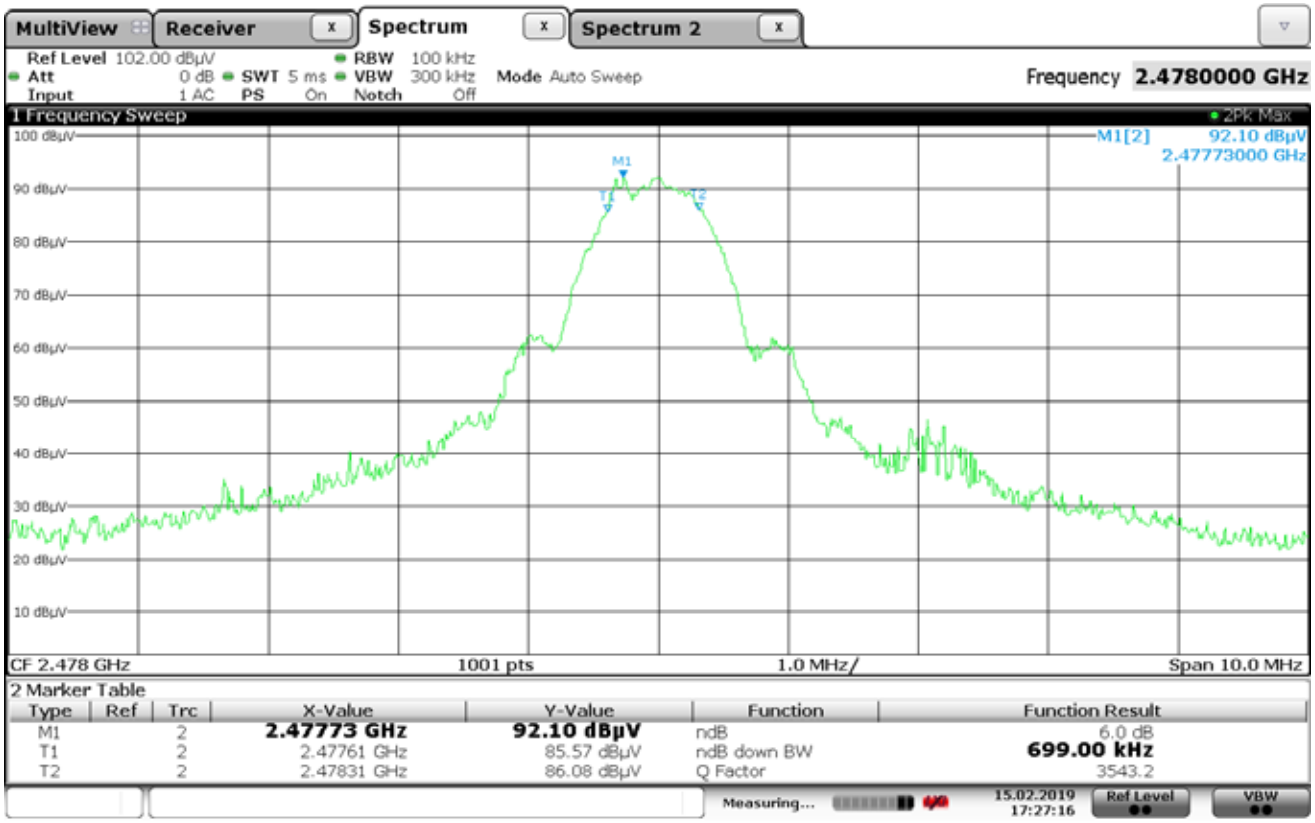
Peak Measurement

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)
2483.50	H	32.3		3.5	32.5	0.0	68.3	2602.3	5000.0	-5.7
2483.50	V	32.2		3.5	32.5	0.0	68.2	2566.6	5000.0	-5.8

Average Measurement

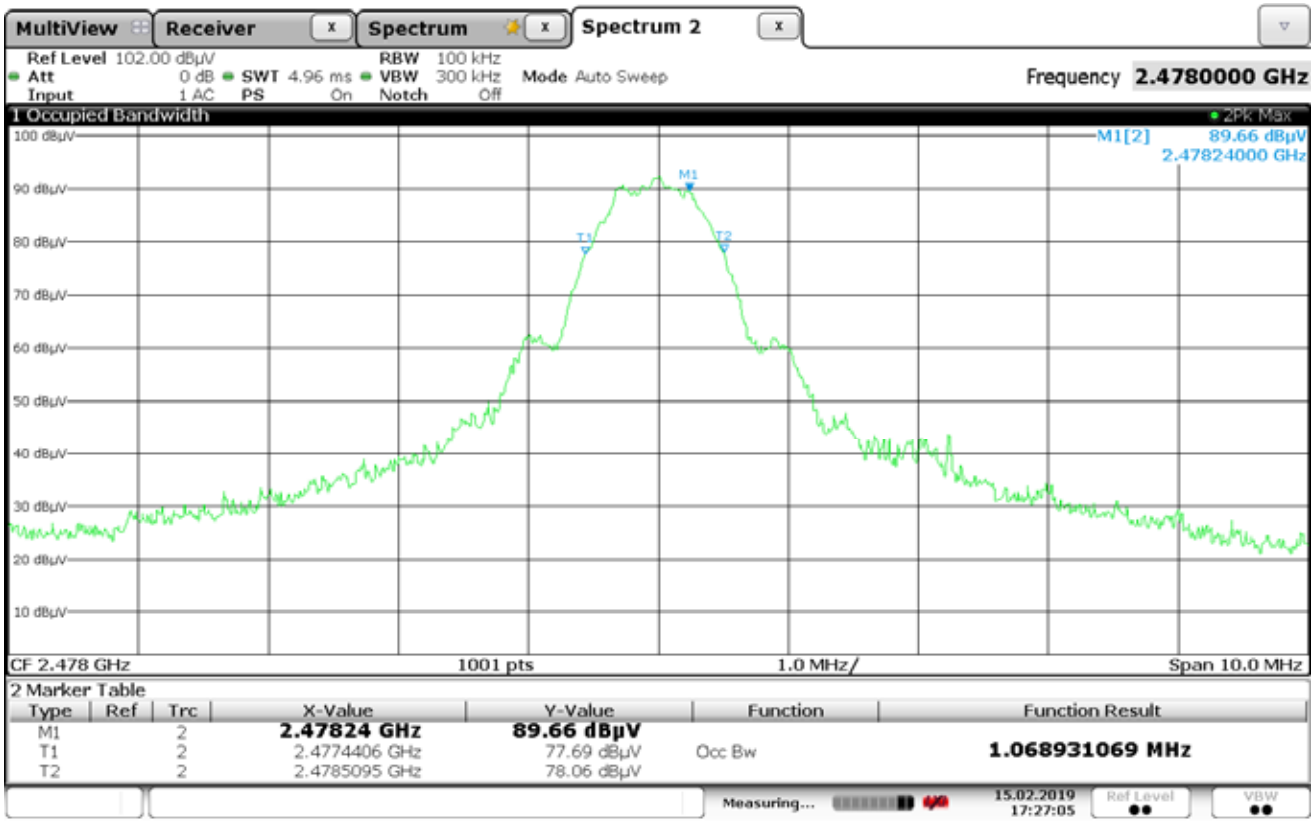
Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Average Total dBuV/m at 3m	Average Total uV/m at 3 m	Average Limit uV/m at 3 m	Margin (dB)
2483.50	H	11.2		3.5	32.5	0.0	-11.2	36.0	62.8	500.0	-18.0
2483.50	V	11.1		3.5	32.5	0.0	-11.2	35.8	61.8	500.0	-18.2

Tested By: Javier Cardenas



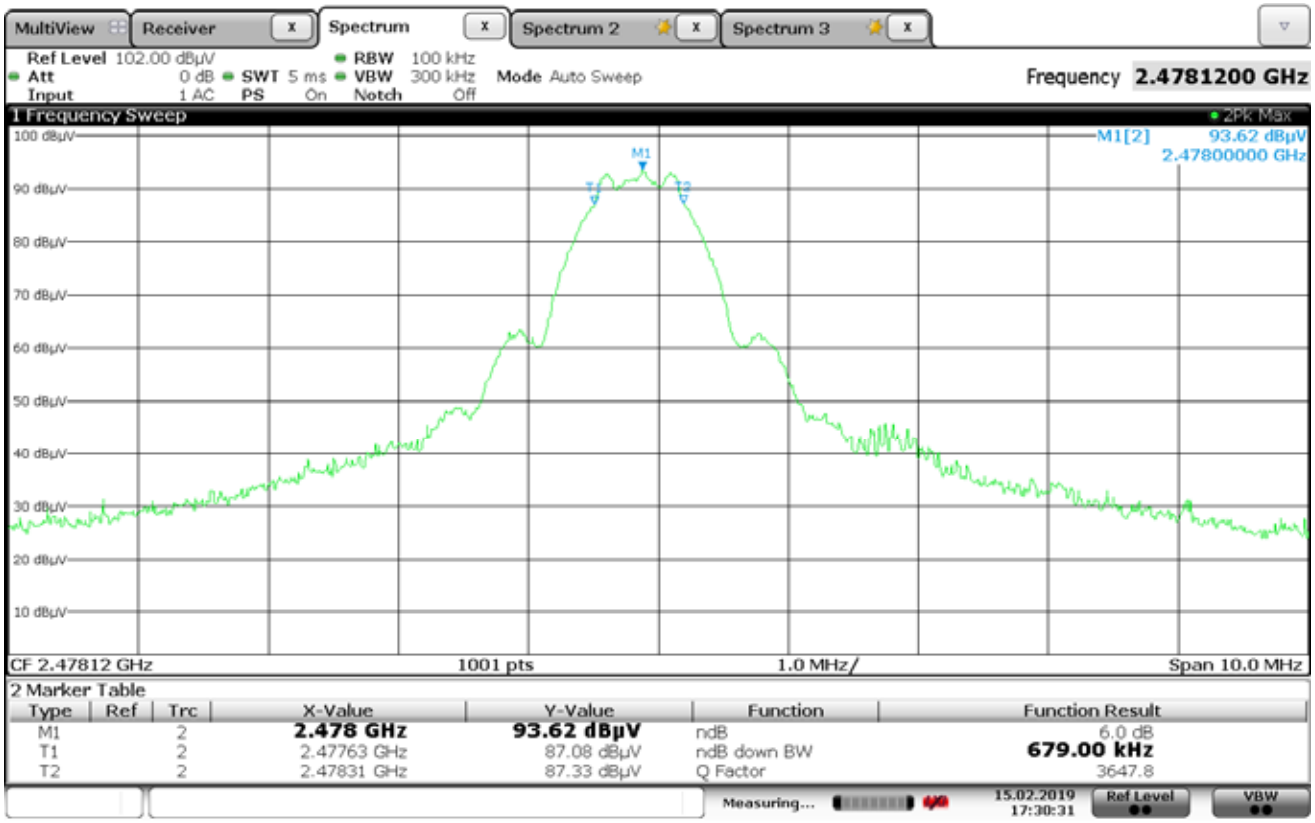
Date: 15.FEB.2019 17:27:16

Manufacturer : Horizon Hobby
Model Number : DX9
Serial Number : N/A
Test : **6dB Bandwidth**
Mode : DSMR 5.5ms
Parameters : 6dB Bandwidth = 699kHz
Date : Feb 12,2019
Notes : Tx @ 2478MHz



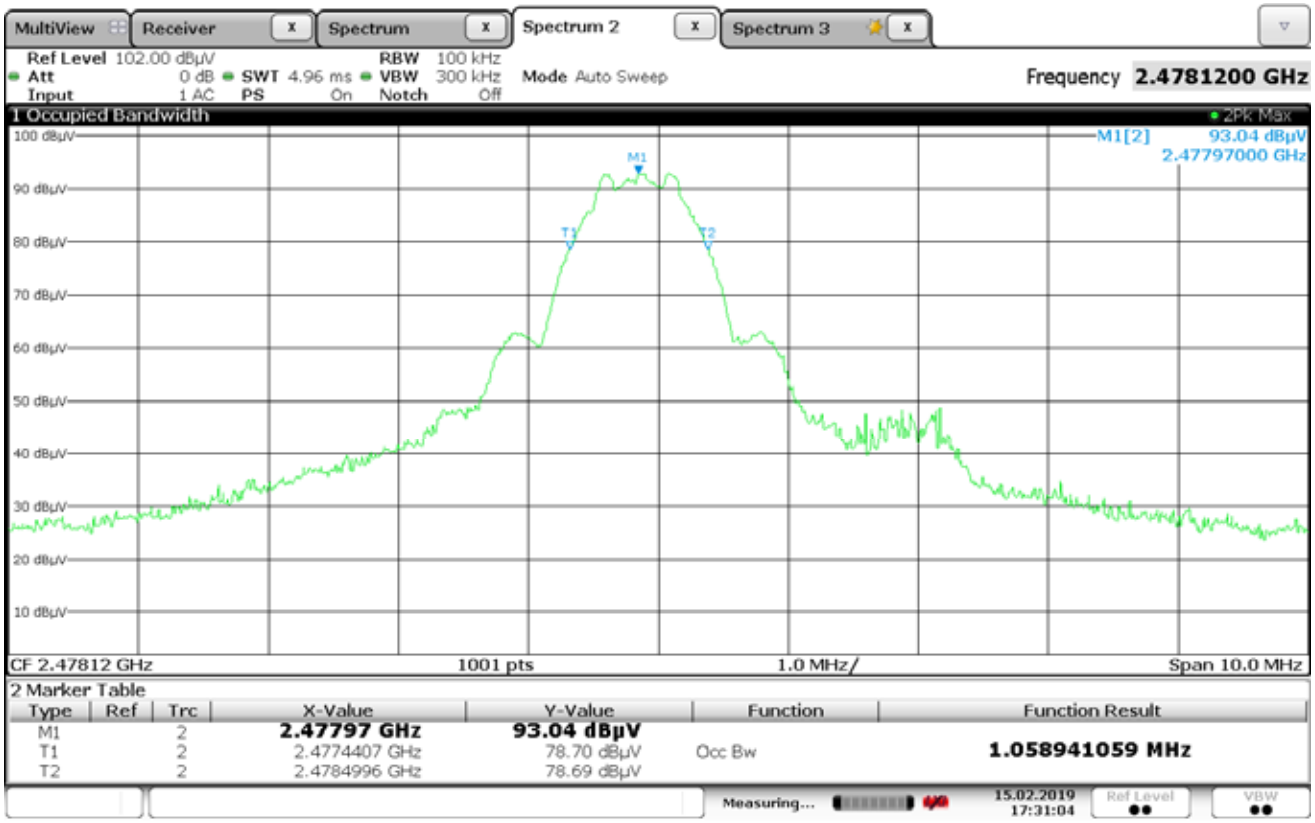
Date: 15.FEB.2019 17:27:05

Manufacturer	: Horizon Hobby
Model Number	: DX9
Serial Number	: N/A
Test	: **99% Occupied Bandwidth**
Mode	: DSMR 5.5ms
Parameters	: 99% Occupied Bandwidth = 1.069MHz
Date	: Feb 12,2019
Notes	: Tx @ 2478MHz



Date: 15.FEB.2019 17:30:31

Manufacturer	: Horizon Hobby
Model Number	: DX9
Serial Number	: N/A
Test	: **6dB Bandwidth**
Mode	: DSM2 22ms
Parameters	: 6dB Bandwidth = 679kHz
Date	: Feb 12,2019
Notes	: Tx @ 2478MHz



Date: 15.FEB.2019 17:31:05

Manufacturer	: Horizon Hobby
Model Number	: DX9
Serial Number	: N/A
Test	: **99% Occupied Bandwidth**
Mode	: DSM2 22ms
Parameters	: 99% Occupied Bandwidth = 1.059MHz
Date	: Feb 12,2019
Notes	: Tx @ 2478MHz