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Emissions Test Report

EUT Name: Parsyl Trek

FCC ID: 2AQ8LTREKA1 IC: 24340-TrekA1

Model No.: TrekA1 v1.1

CFR 47 Part 15.247: 2017, RSS 247 Issue 2, 2017

Prepared for:

Client	Parsyl Inc.
Address	2714 Walnut Street
Address	Denver CO 80205
Contact Person	Thayer Hirsh
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Prepared by:

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Revisions

Revision No.	Date MM/DD/YYYY	Reason for Change	Author
0	01/10/2019	Initial version	D. Foster
1	2/12/2019	Made reviewer changes	D. Foster
2	05/23/2019	Make reviewer changes	D. Foster

Note: Latest revision report will replace all previous reports.

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Report#31960168.001

Statement of compliance

Manufacturer: Parsyl Inc.
Requester / Applicant: Thayer Hirsh
Name of Equipment: Parsyl Trek
Model No. Parsyl Trek
Type of Equipment: BT parcel tracking device
Application of Regulations: CFR47 part 15.247:2018 and RSS247: 2017
Test Dates: 01/04-01/08/2019

Guidance Documents:

Emissions: ANSI C63.10-2013 CFR47 part 15.247:2018 and RSS247: 2017

Test Methods:

Emissions:

The electromagnetic compatibility test and documented data described in this report has been performed and recorded by TUV Rheinland, in accordance with the standards and procedures listed herein. As the responsible authorized agent of the EMC laboratory, I hereby declare that the equipment described above has been shown to be compliant with the EMC requirements of the stated regulations and standards based on these results. If any special accessories and/or modifications were required for compliance, they are listed in the of this report.

This report must not be used to claim product endorsement by A2LA or any agency of the U.S. Government. This report shall not be reproduced except in full, without the written authorization of TUV Rheinland of North America.

Donn Foster	May 23, 2019	Josie Sabado	May 23, 2019
Test Engineer	Date	Laboratory Signature	Date

INDUSTRY CANADA

Testing Cert #3331.02 US1131 2932M-1

1 Executive Summary

1.1 Scope

The purpose of the following report is to demonstrate compliance of the Parsyl Trek to the various regulatory requirements further listed in this Report.

It is the responsibility of the manufacturer to assure that additional production units of this model are manufactured with identical or EMI equivalent electrical and mechanical components. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

1.2 Purpose

Testing was performed to evaluate the EMC performance of the EUT in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report.

1.3 Summary of Test Results

Table 1: Summary of Test Results

Test	Test Method	Test Parameters	Result
Duty Cycle	CFR 47 Part 15.247: 2018, RSS 247 Issue 2, 2017	Limits	**Pass**
Occupied Bandwidth	CFR 47 Part 15.247: 2018, RSS 247 Issue 2, 2017	Limits	**Pass**
Output power	CFR 47 Part 15.247: 2018, RSS 247 Issue 2, 2017	Limits	**Pass**
Power Spectral Density	CFR 47 Part 15.247: 2018, RSS 247 Issue 2, 2017	Limits	**Pass**
Non-restricted band emissions	CFR 47 Part 15.247: 2018, RSS 247 Issue 2, 2017	Limits	**Pass**
Restricted band edge	CFR 47 Part 15.247: 2018, RSS 247 Issue 2, 2017	Limits	**Pass**
Restricted band emissions	CFR 47 Part 15.247: 2018, RSS 247 Issue 2, 2017	Limits	**Pass**
AC conducted emissions	CFR 47 Part 15.207: 2018, RSS Gen	Limits	**Pass**

Note:

1.4 Special Accessories

No special accessories were necessary in order to achieve compliance.

1.5 Equipment Modifications

None

2 Laboratory Information

2.1 Accreditations & Endorsements

2.1.1 US Federal Communications Commission

TUV Rheinland of North America at 1279 Quarry Ln, Pleasanton, CA 94566 is recognized by the commission for performing testing services for the general public on a fee basis. These laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (US1131). The laboratory scope of accreditation includes: Title 47 CFR Parts 15, 18, and 90. The accreditation is updated every 3 years.

2.1.2 NIST / A2LA

TUV Rheinland of North America is accredited by the National Voluntary Laboratory Accreditation Program, which is administered under the auspices of the National Institute of Standards and Technology. The laboratory has been assessed and accredited in accordance with ISO Guide 17025:2005 and ISO 9002 (Lab Code 3331.02). The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated annually.

2.1.3 Canada – Industry Canada

TUV Rheinland of North America at the 1279 Quarry Ln, Pleasanton, CA 94566 address is accredited by Industry Canada for performing testing services for the general public on a fee basis. This laboratory test facilities have been fully described in reports submitted to and accepted by Industry Canada (File Number 2932M). The accreditation is updated every 3 years.

2.1.4 Japan – VCCI

The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) is a group that consists of Information Technology Equipment (ITE) manufacturers and EMC test laboratories. The purpose of the Council is to take voluntary control measures against electromagnetic interference from Information Technology Equipment, and thereby contribute to the development of a socially beneficial and responsible state of affairs in the realm of Information Technology Equipment in Japan. TUV Rheinland of North America at 1279 Quarry Ln, Pleasanton, CA 94566 has been assessed and approved in accordance with the Regulations for Voluntary Control Measures.

VCCI Registration No. for Pleasanton: A-0268

2.1.5 Acceptance by Mutual Recognition Arrangement

The United States has an established agreement with specific countries under the Asia Pacific Laboratory Accreditation Corporation (APLAC) Mutual Recognition Arrangement. Under this agreement, all TUV Rheinland at 1279 Quarry Ln, Pleasanton, CA 94566 test results and test reports within the scope of the laboratory NIST / A2LA accreditation will be accepted by each member country.

2.2 Test Facilities

All of the test facilities are located at 1279 Quarry Lane, Pleasanton, California 94566, USA.

2.2.1 Emission Test Facility

The Semi-Anechoic chamber and AC Line Conducted measurement facility used to collect the radiated and conducted data has been constructed in accordance with ANSI C63.7:1992. The site has been measured in accordance with and verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4-2014, at a test distance of 3 and 5 meters. The site is listed with the FCC and accredited by A2LA (Lab Code 3331.02). The 3/5-meter semi-anechoic chamber used to collect the radiated data has been verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4-2014, at a test distance of 3 meter and 5 meters. A report detailing this site can be obtained from TUV Rheinland of North America.

2.3 Measurement Uncertainty

Two types of measurement uncertainty are expressed in this report, per *ISO Guide To The Expression Of Uncertainty In Measurement*, 1st Edition, 1995.

The Combined Standard Uncertainty is the standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities; it is equal to the positive square root of the sum of the variances or co-variances of these other quantities, weighted according to how the measurement result varies with changes in these quantities. The term *standard uncertainty* is the result of a measurement expressed as a standard deviation.

2.3.1 Sample Calculation – radiated & conducted emissions

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

Field Strength (dBµV/m) = RAW - AMP + CBL + ACF

Where: RAW = Measured level before correction (dBµV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu V/m = 10^{\frac{dB\mu V/m}{20}}$$

Sample radiated emissions calculation @ 30 MHz

Measurement +Antenna Factor–Amplifier Gain+Cable loss=Radiated Emissions (dBuV/m)

25 dBuV/m + 17.5 dB – 20 dB + 1.0 dB = 23.5 dBuV/m

2.3.2 Measurement Uncertainty Emissions

Per CISPR 16-4-2	**U_{lab}**	**U_{cispr}**
Radiated Disturbance @ 10 meters		
30 – 1,000 MHz	2.25 dB	4.51 dB
Radiated Disturbance @ 3 meters		
30 – 1,000 MHz	2.26 dB	4.52 dB
1 – 6 GHz	2.12 dB	4.25 dB
6 – 18 GHz	2.47 dB	4.93 dB
Conducted Disturbance @ Mains Terminals		
150 kHz – 30 MHz	1.09 dB	2.18 dB
Disturbance Power		
30 MHz– 300 MHz	3.92 dB	4.3 dB

Measurement Uncertainty – Radio Testing

The estimated combined standard uncertainty for frequency error measurements is ± 3.88 Hz
The estimated combined standard uncertainty for carrier power measurements is ± 0.7 dB.
The estimated combined standard uncertainty for adjacent channel power measurements is ± 1.47 dB.
The estimated combined standard uncertainty for modulation frequency response measurements is ± 0.46 dB.
The estimated combined standard uncertainty for transmitter conducted emission measurements is ± 2.06 dB

The expanded uncertainty at a level of 95% confidence is obtained by multiplying the combined standard uncertainty by a coverage factor of 2. Compliance criteria are not based on measurement uncertainty.

2.3.3 Calibration Traceability

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Measurement method complies with ANSI/NCSL Z540-1-1994 and ISO Standard 17025:2005.

3 Product Information

3.1 Product Description

The Parsyl Trek tracks packages recording temperature, humidity, light, impact and GPS. Small, cheap and easy to use with unmatched accuracy and operating range, all with a multi-year battery life.

3.2 Equipment Configuration

A description of the equipment configuration is given in the Test Plan Section. The EUT was tested as called for in the test standard and was configured and operated in a manner consistent with its intended use. The EUT was controlled from the support laptop used to configure the various modes of operation. The placement of the EUT system components was guided by the test standard and selected to represent typical installation conditions.

3.3 Operating Mode

A description of the operation mode is given in the Test Plan Section.

The final operating mode was selected to produce the worst case radiation for emissions testing.

3.4 Unique Antenna Connector

The Parsyl Trek has an internal fixed antenna which is not removable.

4 Duty Cycle

Test Method

The ANSI C63.10-2013 Section 11.6 Conducted method was used to measure the duty cycle. The preliminary investigation was not necessary to determine the highest power output for each mode the unit has only one mode and one power level. The system was powered on and port 1 connected to the Spectrum analyzer. A diag program was used to set the AP in continuous Tx mode and also to set the channel, channel power and data rate. This test was conducted on 3 channels. The analyzer was configured as follows.

Cable loss was entered as an offset

RBW=10 MHz

VBW= 20 MHz

Span = 0Hz

Reference level= as needed to maintain headroom

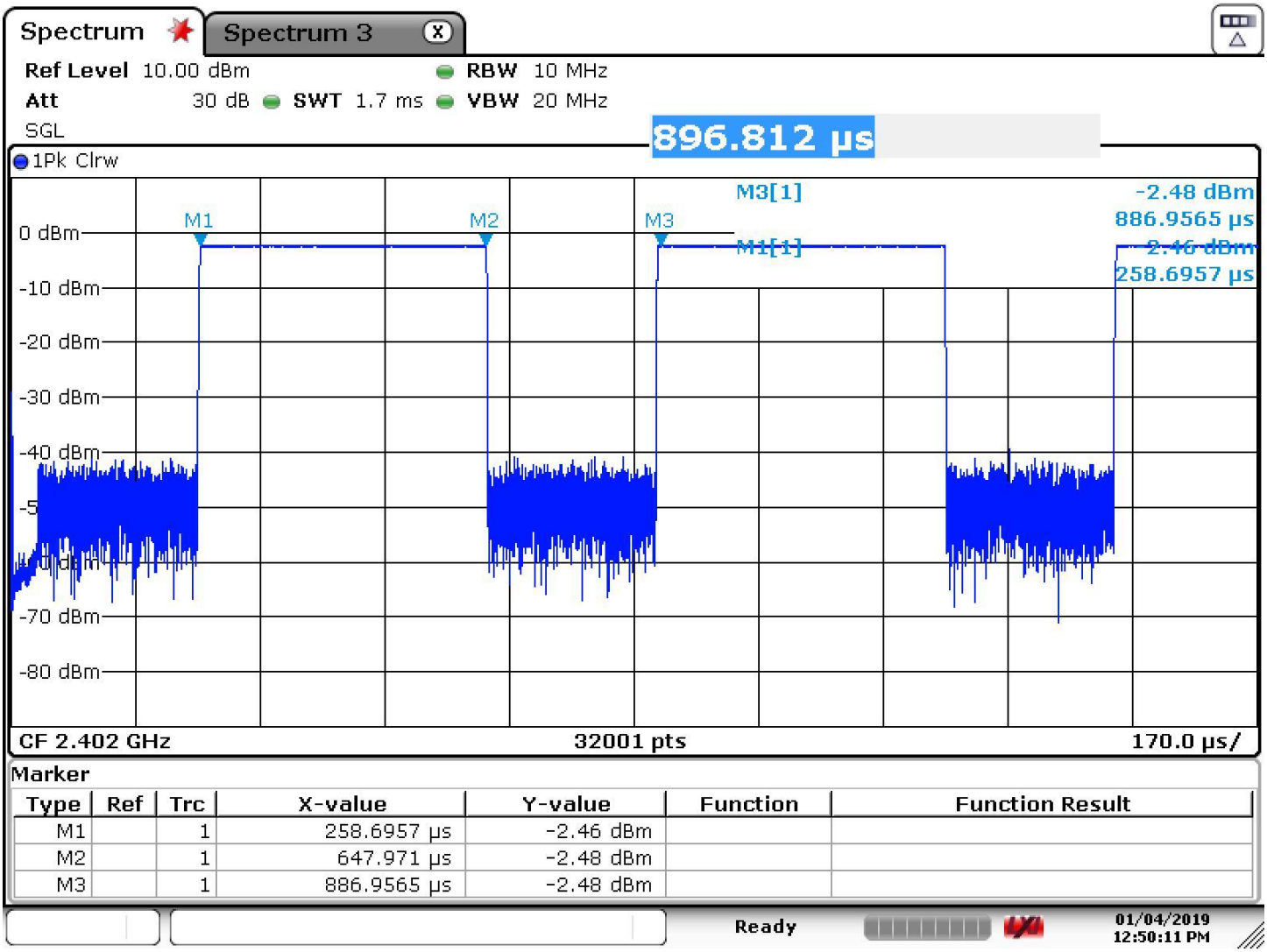
SWT= 5ms adjusted as needed to capture approx. 1.5 cycles

The off time and cycle time were captured using the marker functions and the duty cycle calculated.

Test Conditions: Conducted Measurement (SA), Normal Temperature	**Date**: 01/04/2019
Antenna Type:	Integrated PIFA antenna
Duty cycle correction: table below	Data Rate: 1 mbps
Ambient Temp.: 23º C	Relative Humidity: 33 %RH

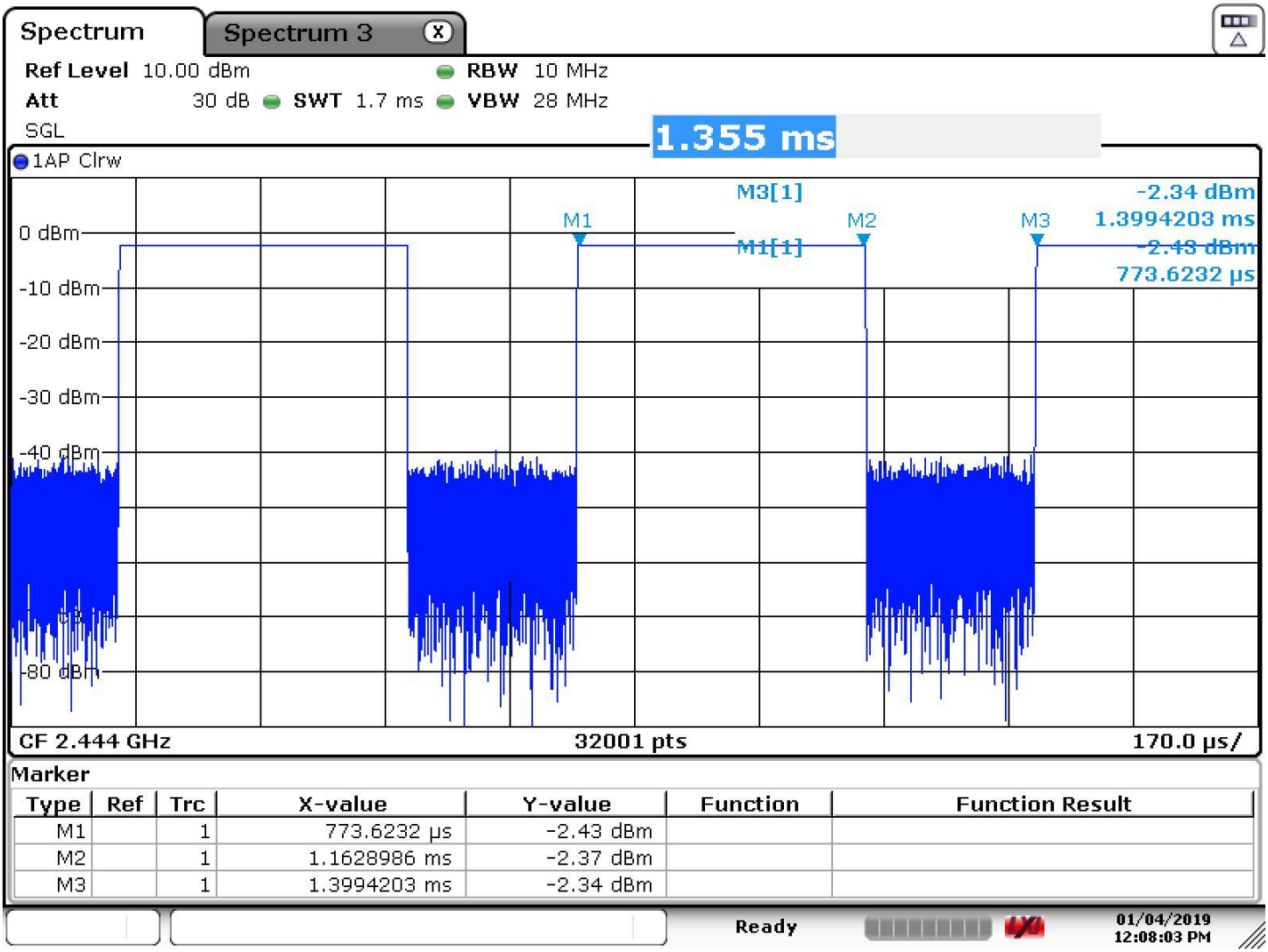
Duty cycle		
Mode	% of 100% cycle	DCCF dbm
GFSK channel 0	61%	-4.01319
GFSK channel 26	62%	-4.01319
GFSK channel 39	63%	-4.01319

4.1 Results



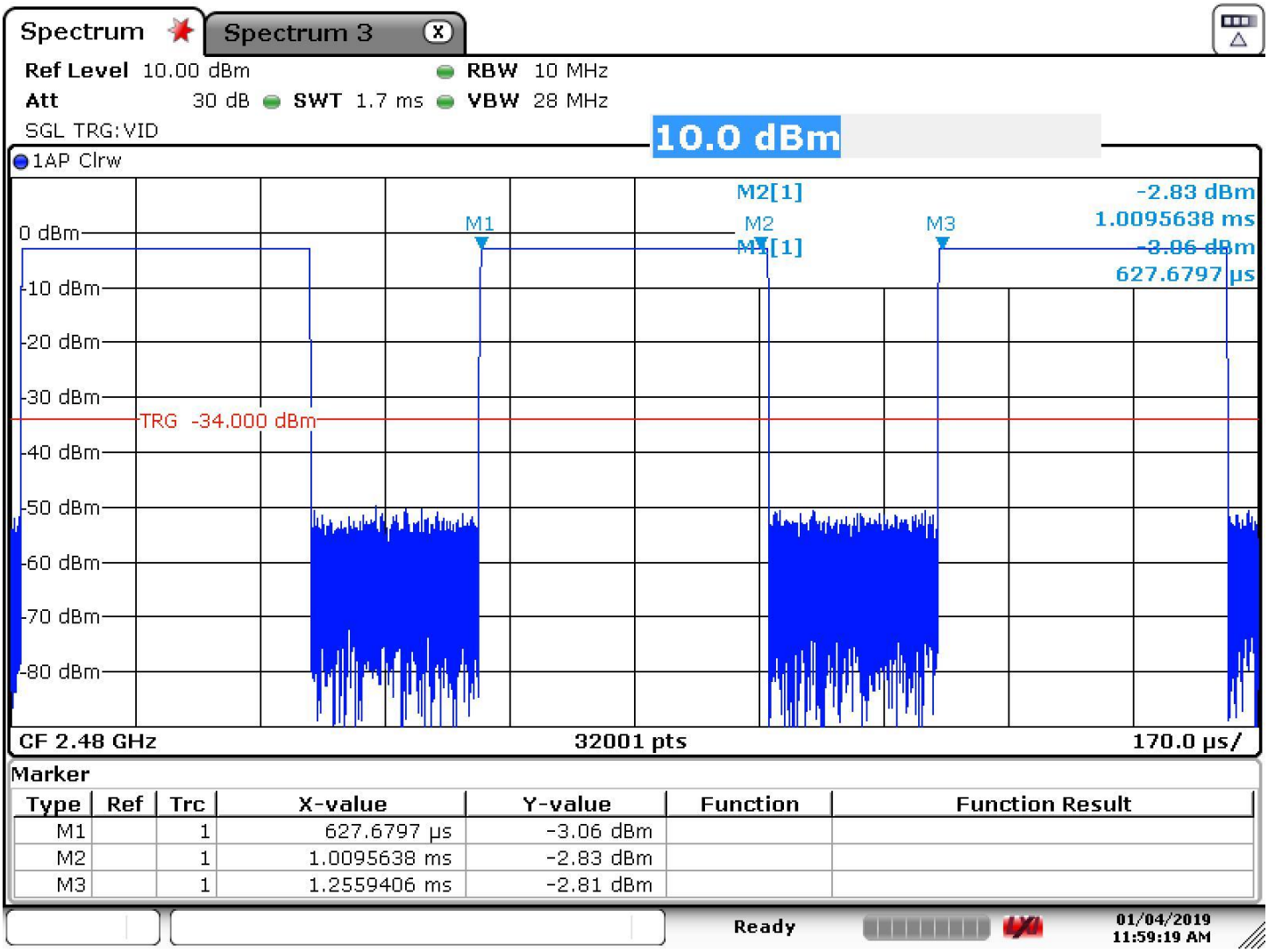
Date: 4.JAN.2019 12:50:11

Duty Cycle channel 0



Date: 4.JAN.2019 12:08:03

Duty Cycle channel 26



Date: 4.JAN.2019 11:59:19

Duty Cycle channel 39

5 Output Power Requirements

The maximum output power requirement is the maximum equivalent isotropic radiated power delivering at the transmitting antenna under specified conditions of measurements in the presence of modulation.

The maximum output power and harmonics shall not exceed CFR47 Part 15.247 (b):2018 and RSS 247: 2017 Sect. 5.4.4.

The maximum allowable transmitted power in the band 2400-2483.5 MHz: 1 W .

5.1 Test Method

The ANSI C63.10-2013 Section 11.9.1.1. Conducted method was used to measure the channel power output. The preliminary investigation was not needed as the BT runs only one modulation and one power setting. This test was conducted on 3 channels. The result indicated in the tables below.

RBW= 1 MHz

VBW= 3 MHz

Span= 3 MHz

SWP= Auto

Trace= Max hold

\Detector= Peak

5.2 Test Setup

A diagram of the configuration of this test is found in the test plan.

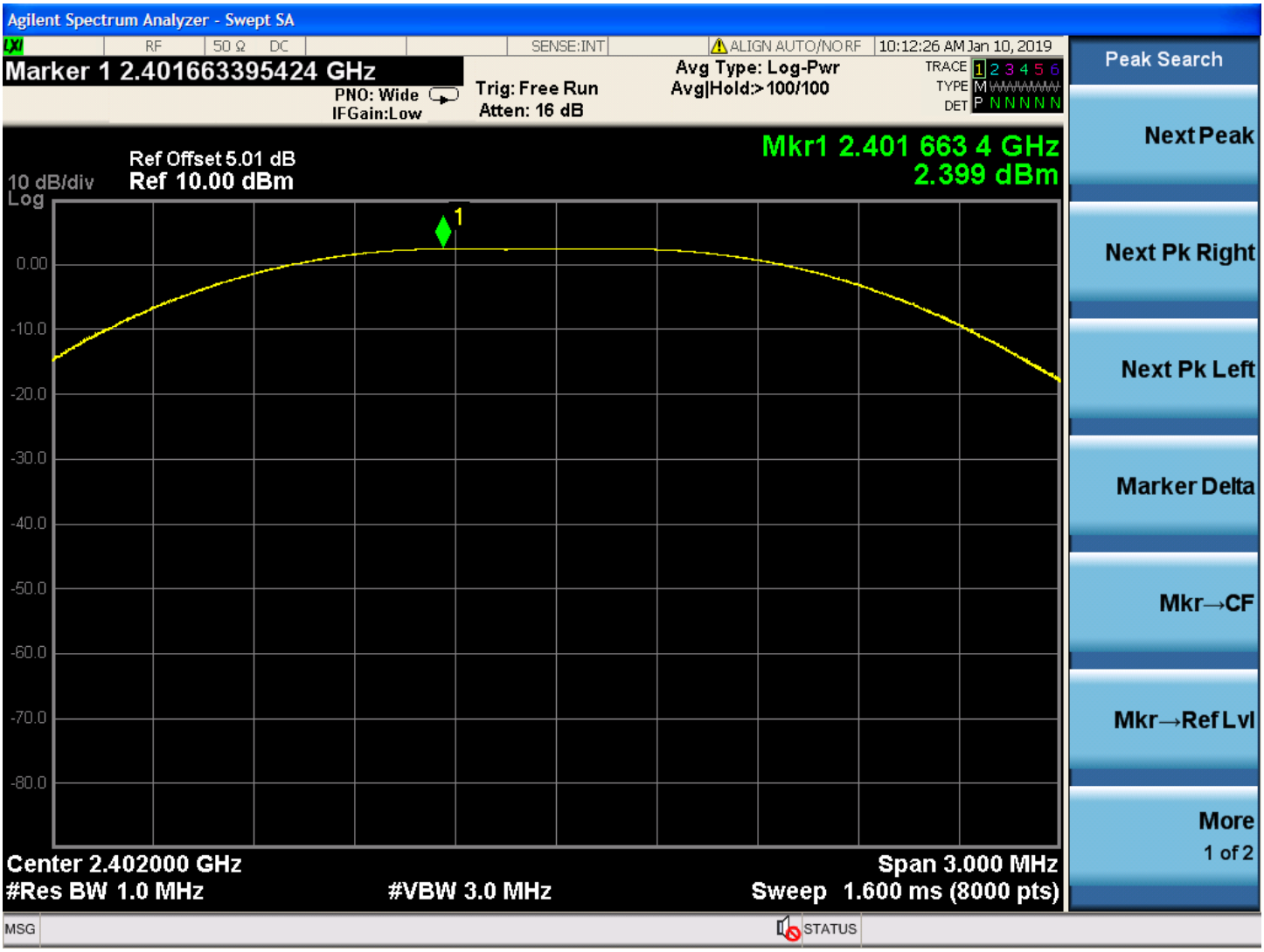
5.2.1 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

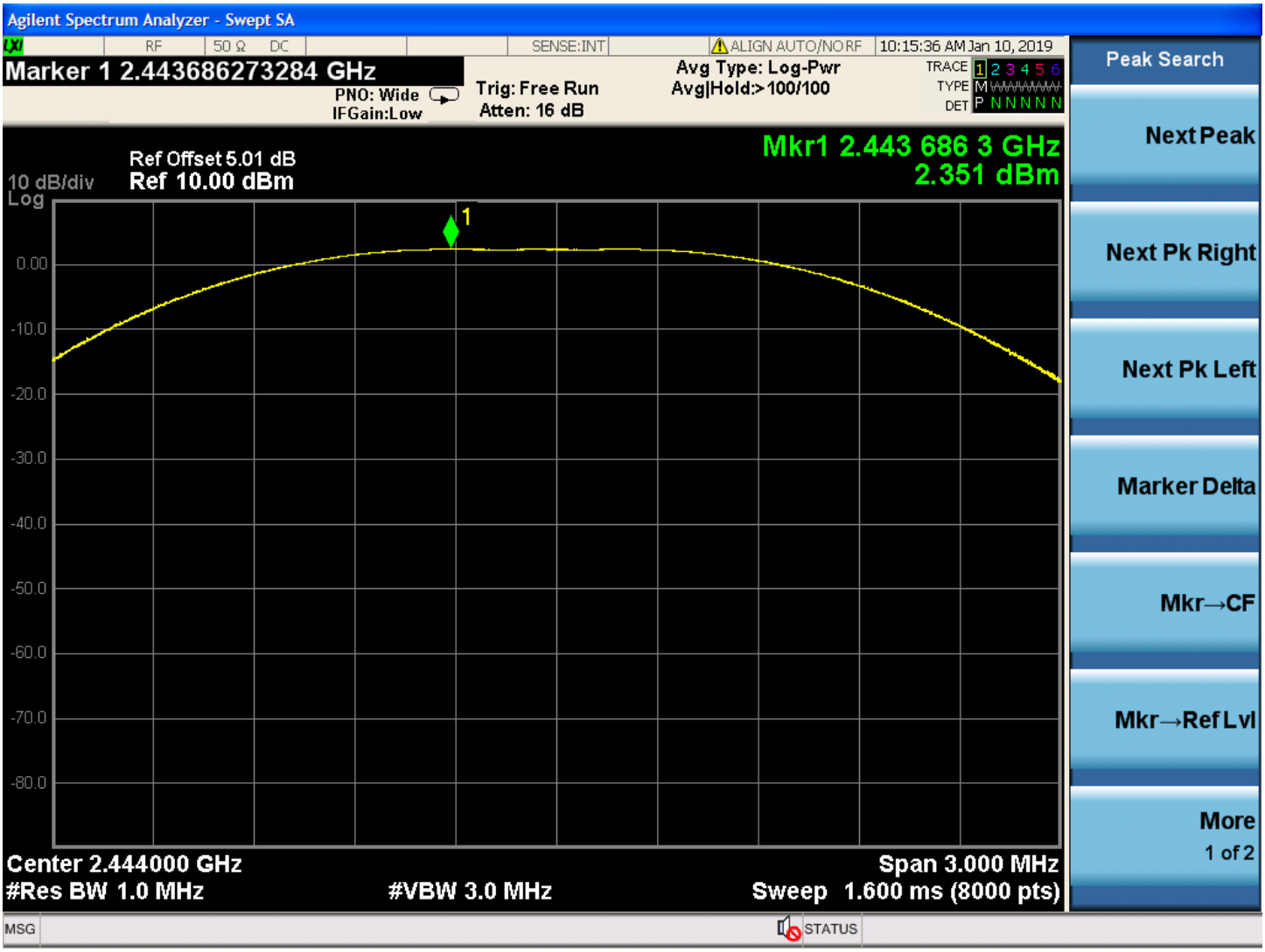
Table 1: RF Output Power at the Antenna Port – Test Results

Test Conditions: Conducted Measurement, Normal Temperature	**Date**: 01/04/2019
Antenna Type: Integrated Antenna	**Power Setting:** Fixed
Max. Antenna Gain: 0.39 dbi	**Signal State:** Modulated
Duty Cycle: see section 4	**Data Rate:** 1 mbps
Ambient Temp.: 23º C	**Relative Humidity:** 33 %RH

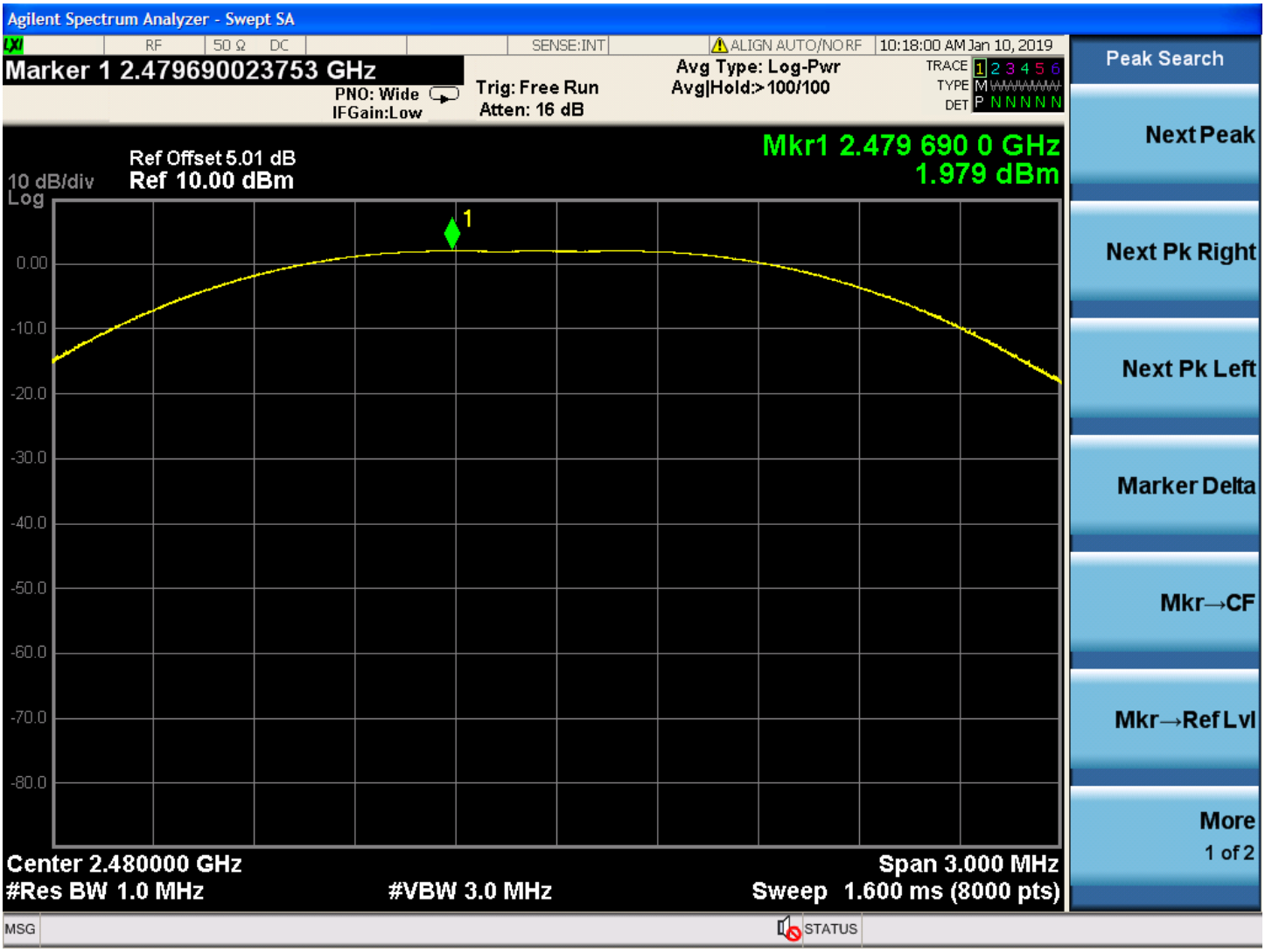
Results				
Mode	**Operating Channel**	**Limit [dBm]**	**Power [dBm]**	**Comments**
BLE	2402 MHz	+30.00	2.399	
	2444 MHz	+30.00	2.359	
	2480 MHz	+30.00	1.979	



Channel power BLE mode 2402 MHz.



Channel power BLE mode 2444 MHz.



Channel power BLE mode 2480 MHz.

6 Occupied Bandwidth

The occupied bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency.

The 99% bandwidth is the bandwidth in which 99% of the transmitted power occupied.

20 dB bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer.

The 6dB bandwidth is defined the bandwidth of 6dBr from highest transmitted level of the fundamental frequency.

The minimum 6 dB bandwidth shall be at least 500 kHz per Section CFR47 15.247(a2) 2017 and RSS-247 Sect. 5.3(a) Issue 2, 2017.

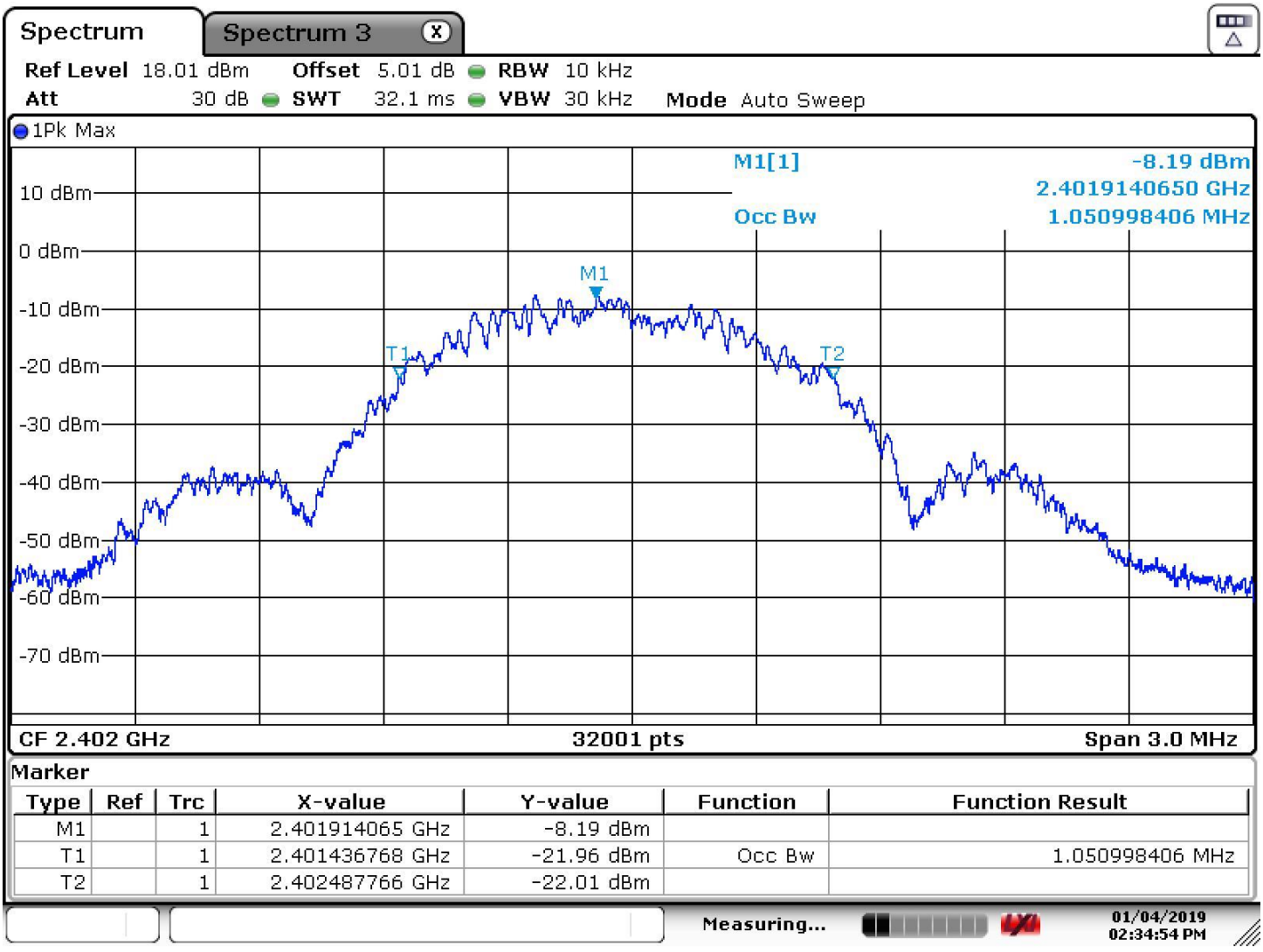
6.1.1 Test Method

The conducted method was used to measure the occupied bandwidth according to ANSI C63.10:2013 Section 11.8. The measurement was performed with modulation per CFR47 15.247 (a) (2) 2017 and RSS 247: 2017. This test was conducted on 3 channels. The result indicated below.

Test setup: A diagram of the test setup can be found in the test plan

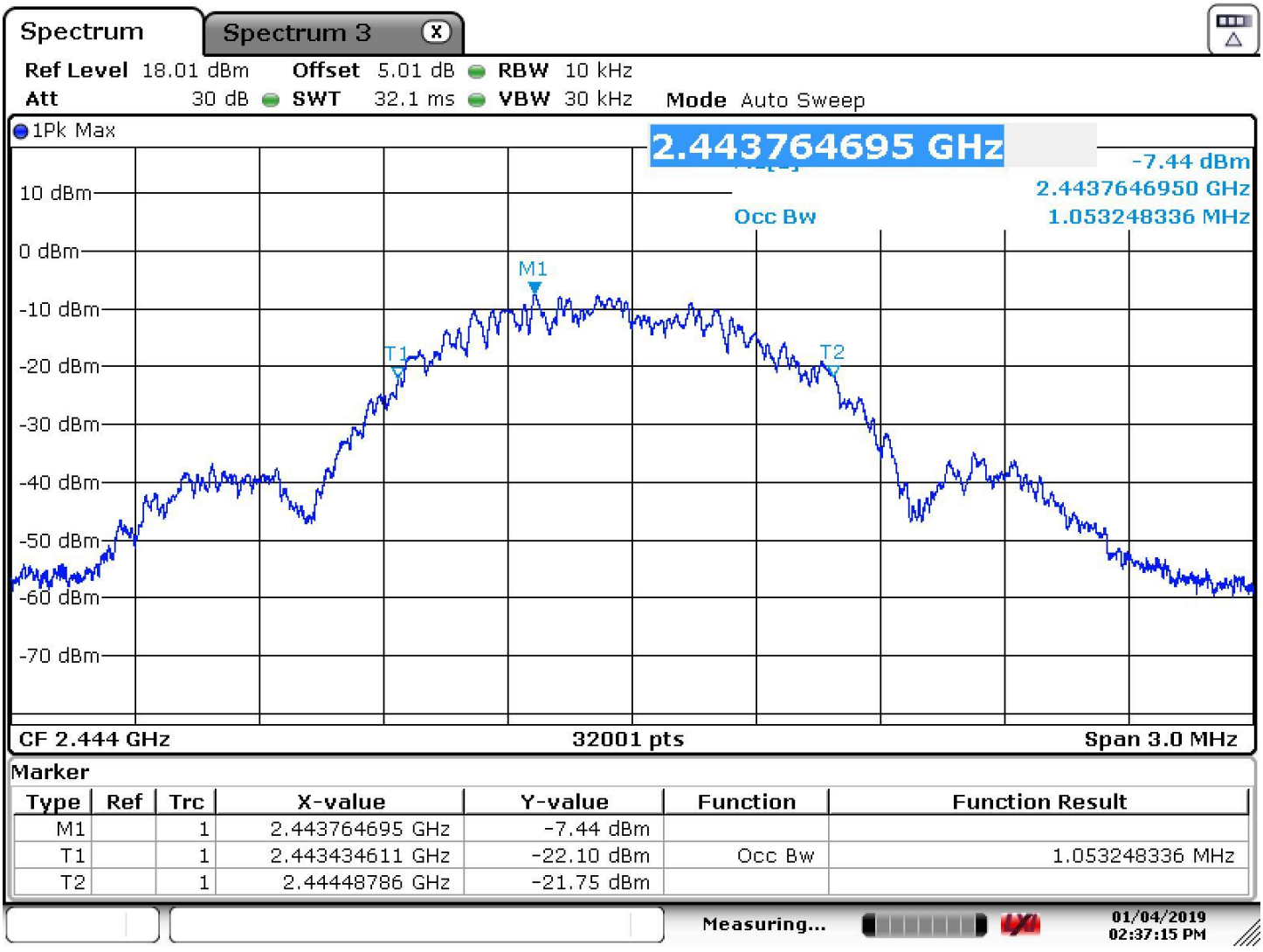
Table 2: Occupied Bandwidth results

Test Conditions: Conducted Measurement, Normal Temperature			**Date**: 01/04/2019	
Antenna Type: Integrated Antenna			**Power Setting:** Fixed	
Max. Antenna Gain: 0.39 dbi			**Signal State:** Modulated	
Duty Cycle: : see section 4			**Data Rate:** 1 mbps	
Ambient Temp.: 23º C			**Relative Humidity:** 33 %RH	
Results				
Mode	**Operating Channel**	**Limit**	**99% OBW MHz**	**-6db BW MHz**
BLE	2402 MHz	>500khz	1.05	765.19
	2444 MHz	>500khz	1.05	774.07
	2480 MHz	>500khz	1.05	786.93



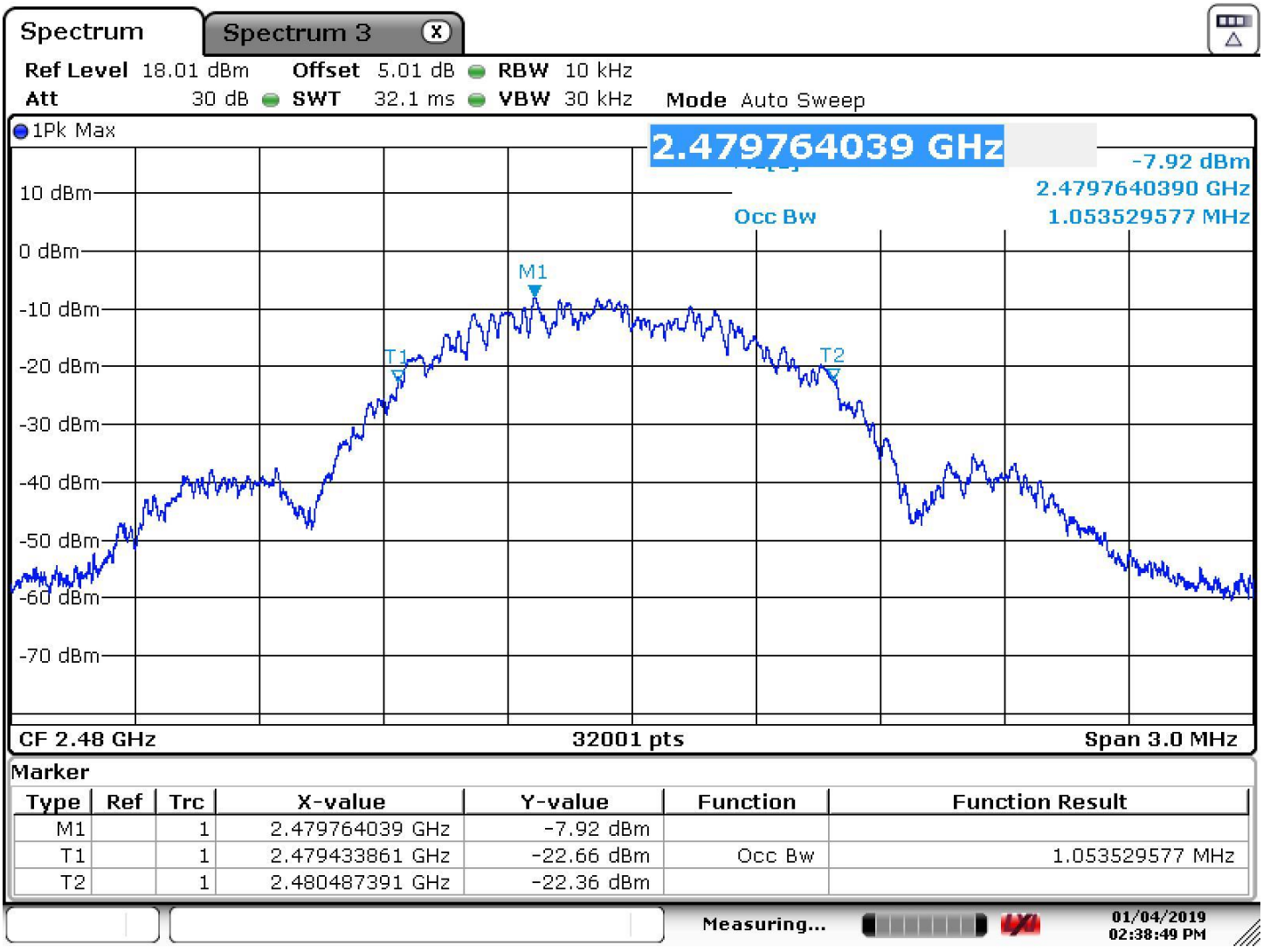
Date: 4.JAN.2019 14:34:53

99% OBW BLE mode 2402 MHz.



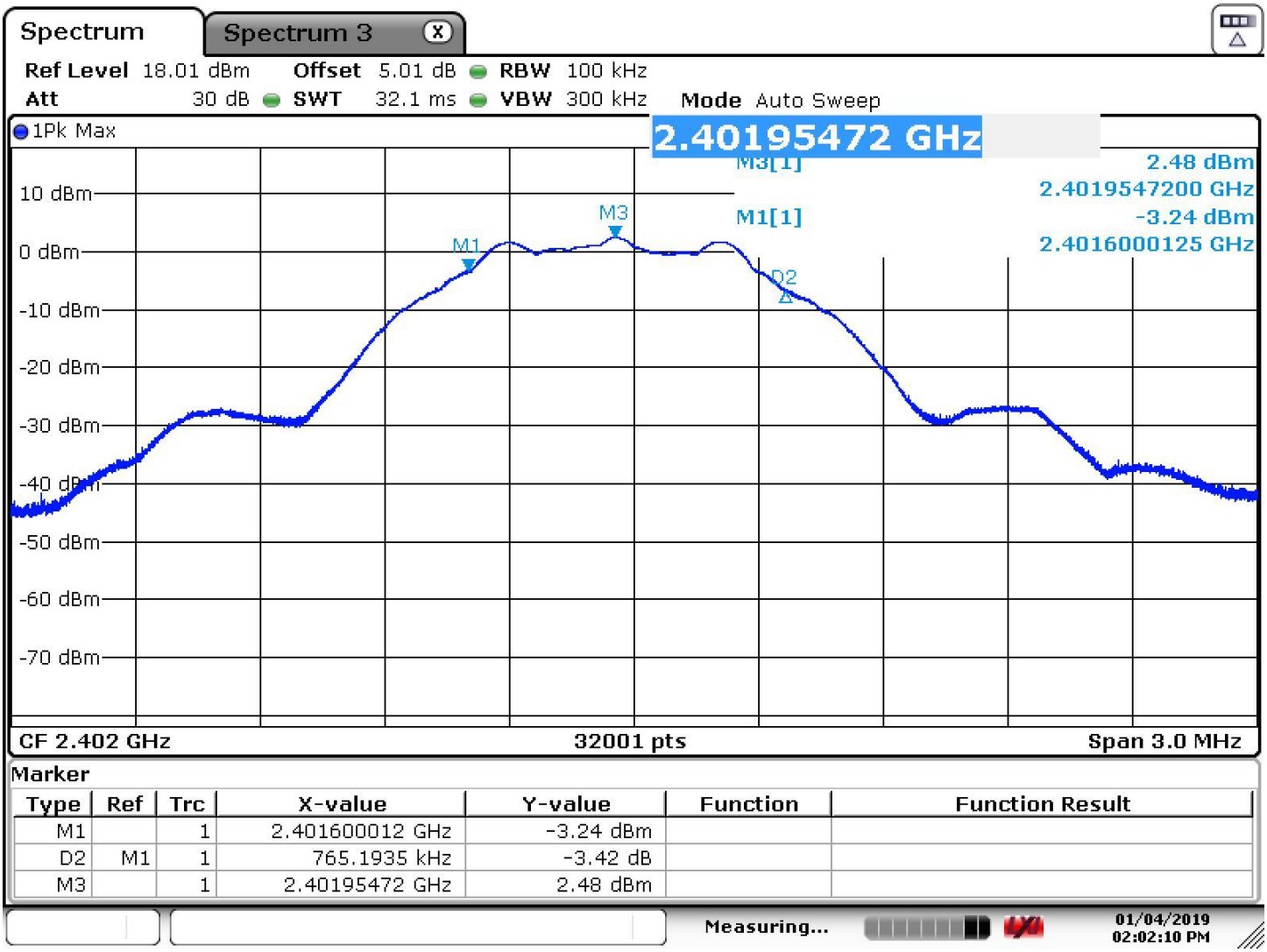
Date: 4.JAN.2019 14:37:16

99% OBW BLE mode 2444



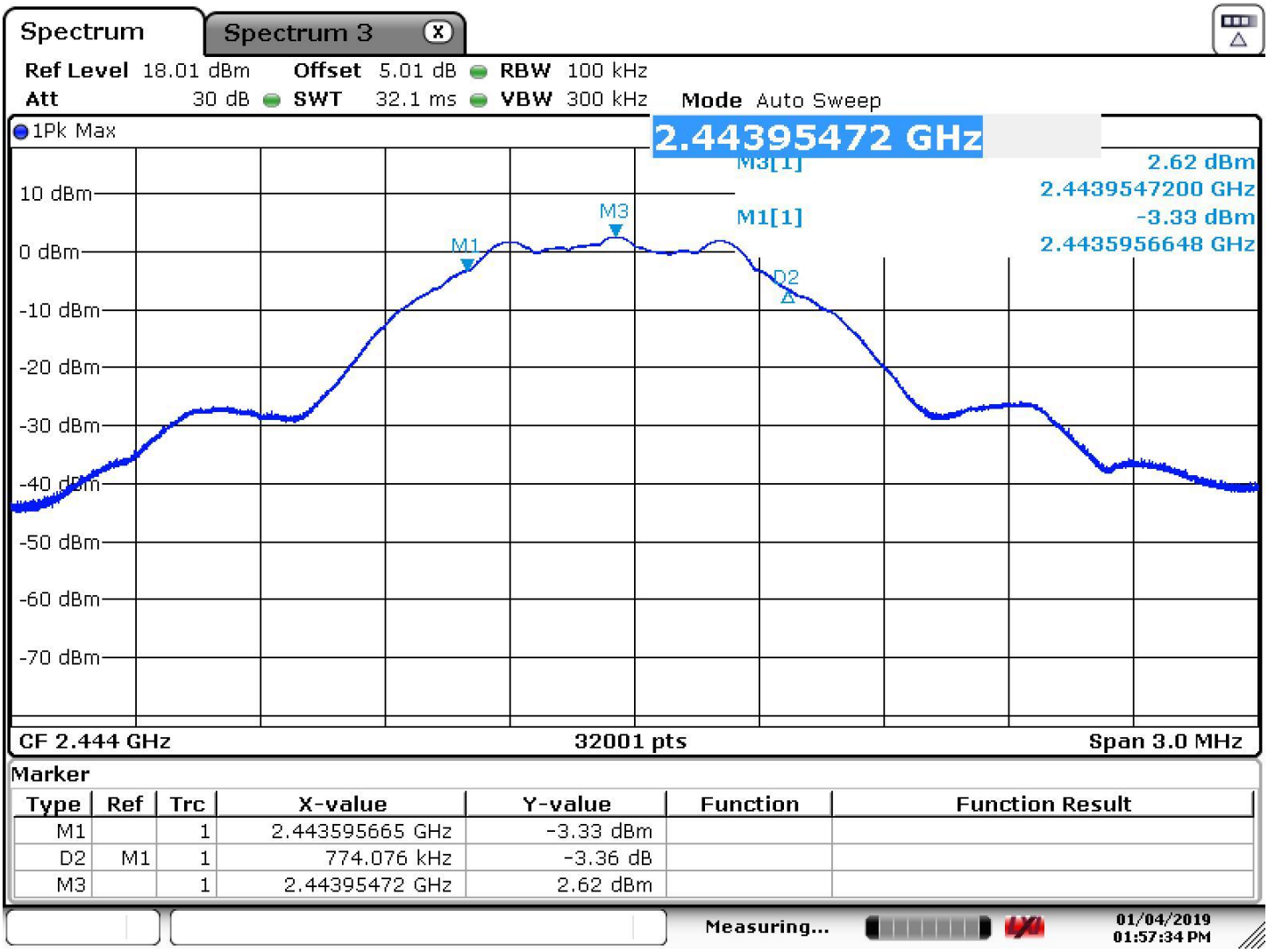
Date: 4.JAN.2019 14:38:49

99% OBW BLE mode 2480 MHz.



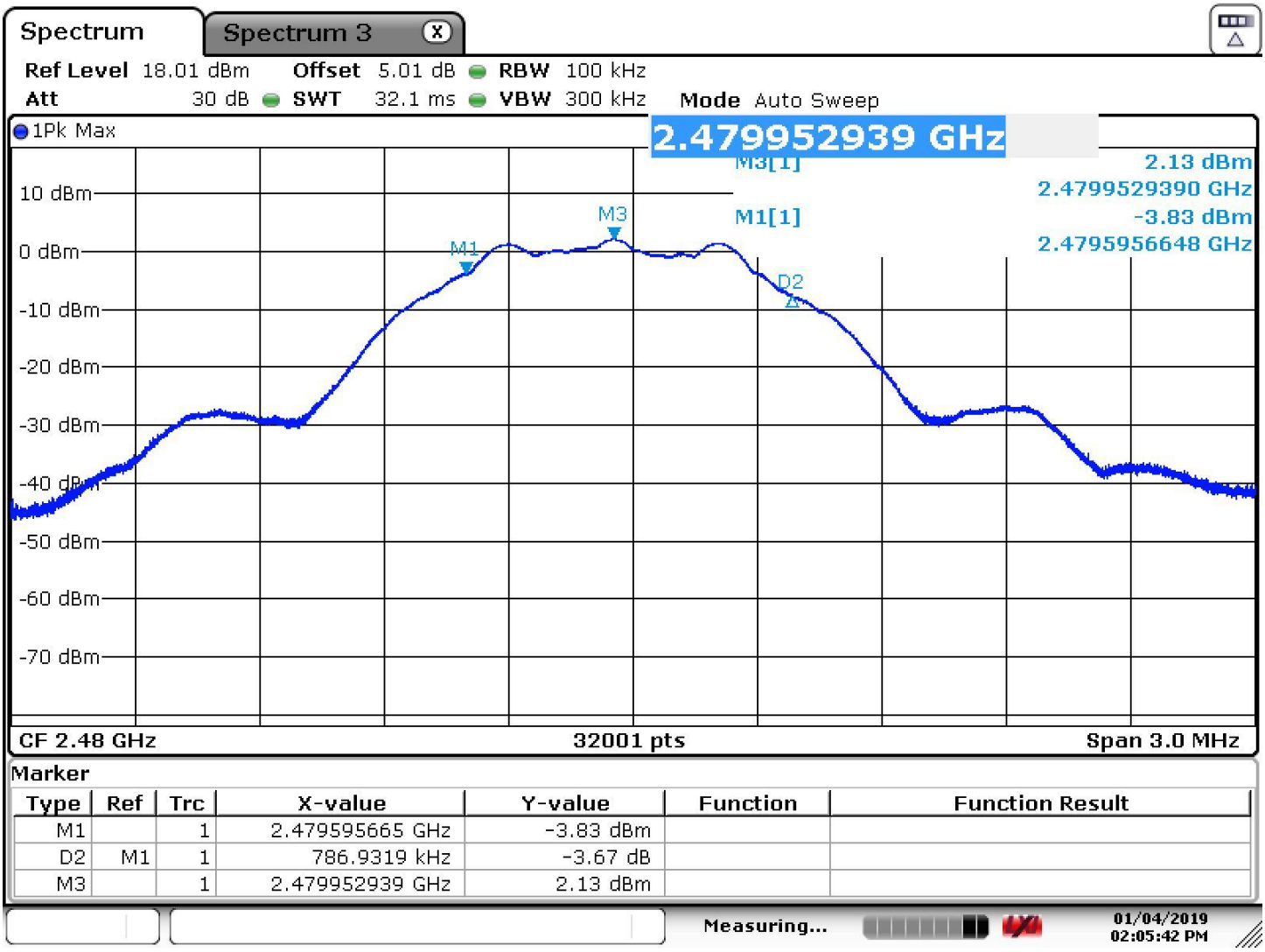
Date: 4.JAN.2019 14:02:10

6db OBW Channel 2402



Date: 4.JAN.2019 13:57:34

6db OBW Channel 2444



Date: 4.JAN.2019 14:05:43

6db OBW Channel 2480

7 Peak Power Spectral Density

According to the CFR47 Part 15.247 (e) and RSS 247 Sect.5.2 (b), the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

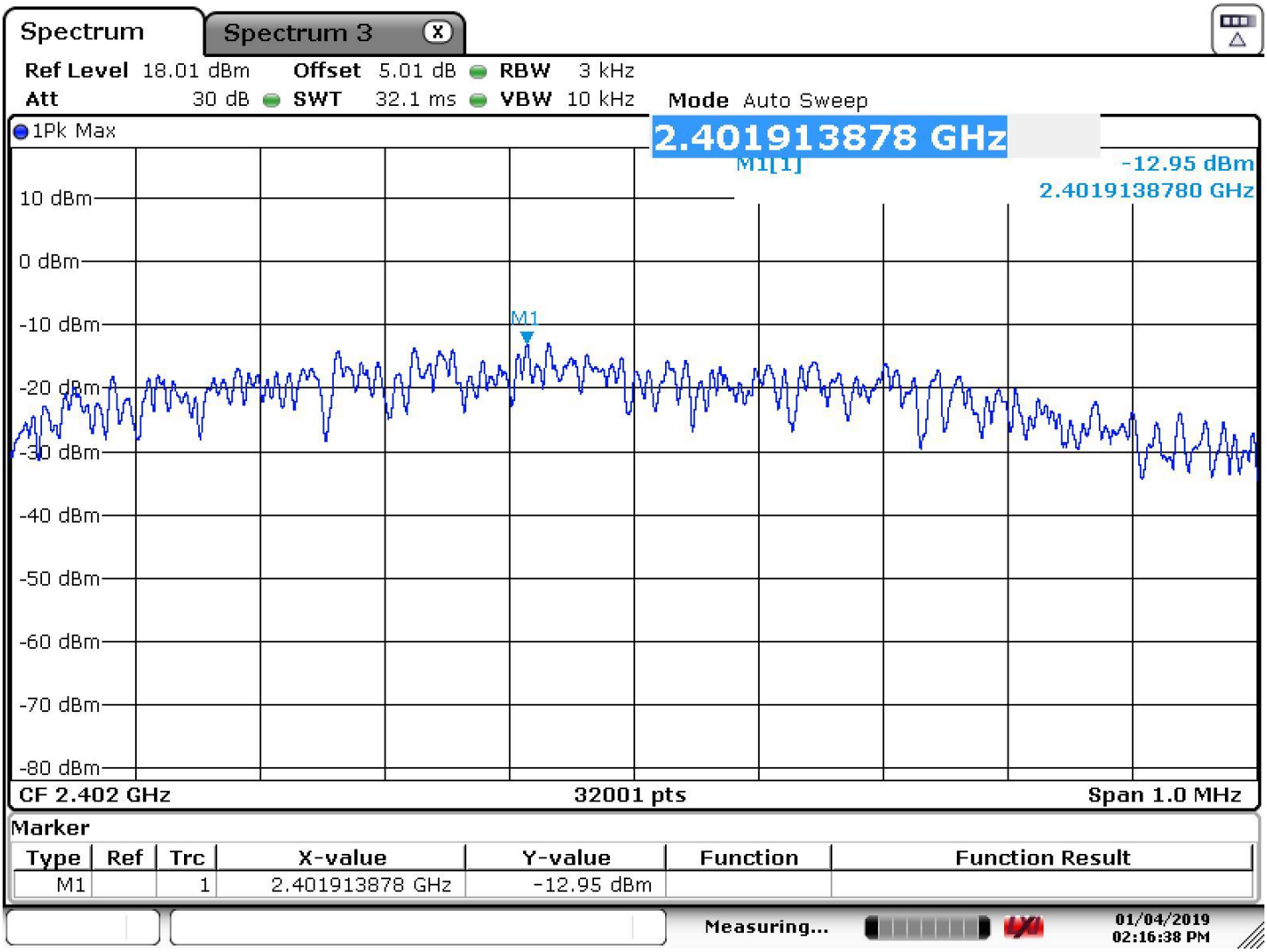
7.1.1 Test Method

The conducted method was used to measure the channel power output per ANSI C63.10-2013 Section 11.9.1.1. The measurement was performed per ANSI C63.10-2013 Section 11.10.2 with modulation per CFR47 Part 15.247 (e) and RSS 247 Sect.5.2 (b).

Set the span to 1.5 times the DTS bandwidth.
Set the RBW to 3 kHz ≥ RBW ≤ 100 kHz.
Set the VBW ≥ [3 × RBW].
Detector = peak.
Sweep time = auto couple.
Trace mode = max hold

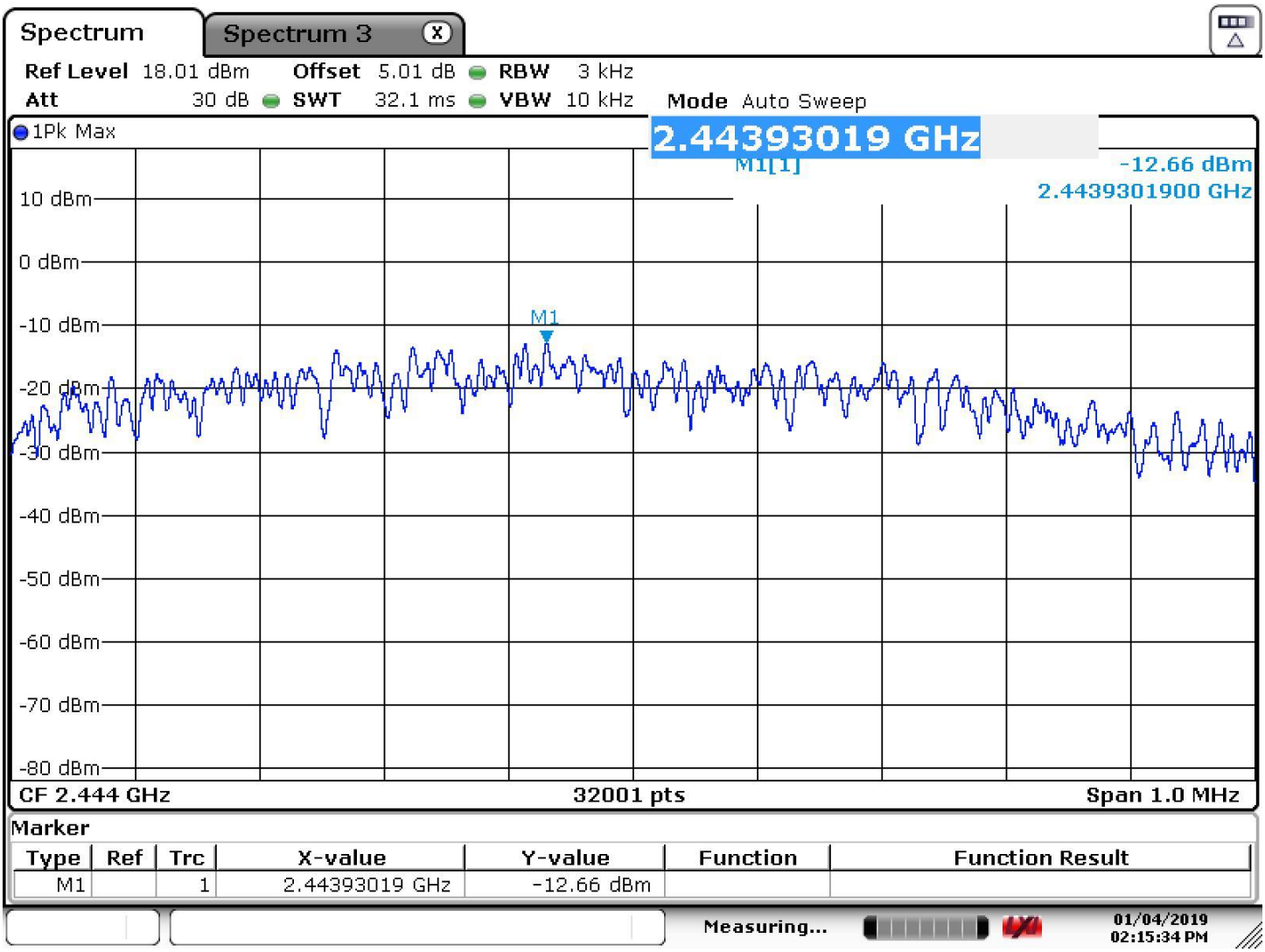
Test setup: A diagram of the test setup can be found in the test plan

Test Conditions: Conducted Measurement, Normal Temperature			**Date**: 01/04/2019	
Antenna Type: Integrated PIFA Antenna			**Power Setting:** Fixed	
Max. Antenna Gain: 0.39 dbi			**Signal State:** Modulated	
Duty Cycle: see section 4			**Data Rate:** 1 mbps	
Ambient Temp.: 23º C			**Relative Humidity:** 33 %RH	
Results				
Mode	**Operating Channel**	**dbm/3kHz**	**PPSD [dBm]**	**Comments**
BLE	2402 MHz	8	-12.95	
	2440 MHz	8	-12.66	
	2480 MHz	8	-13.24	



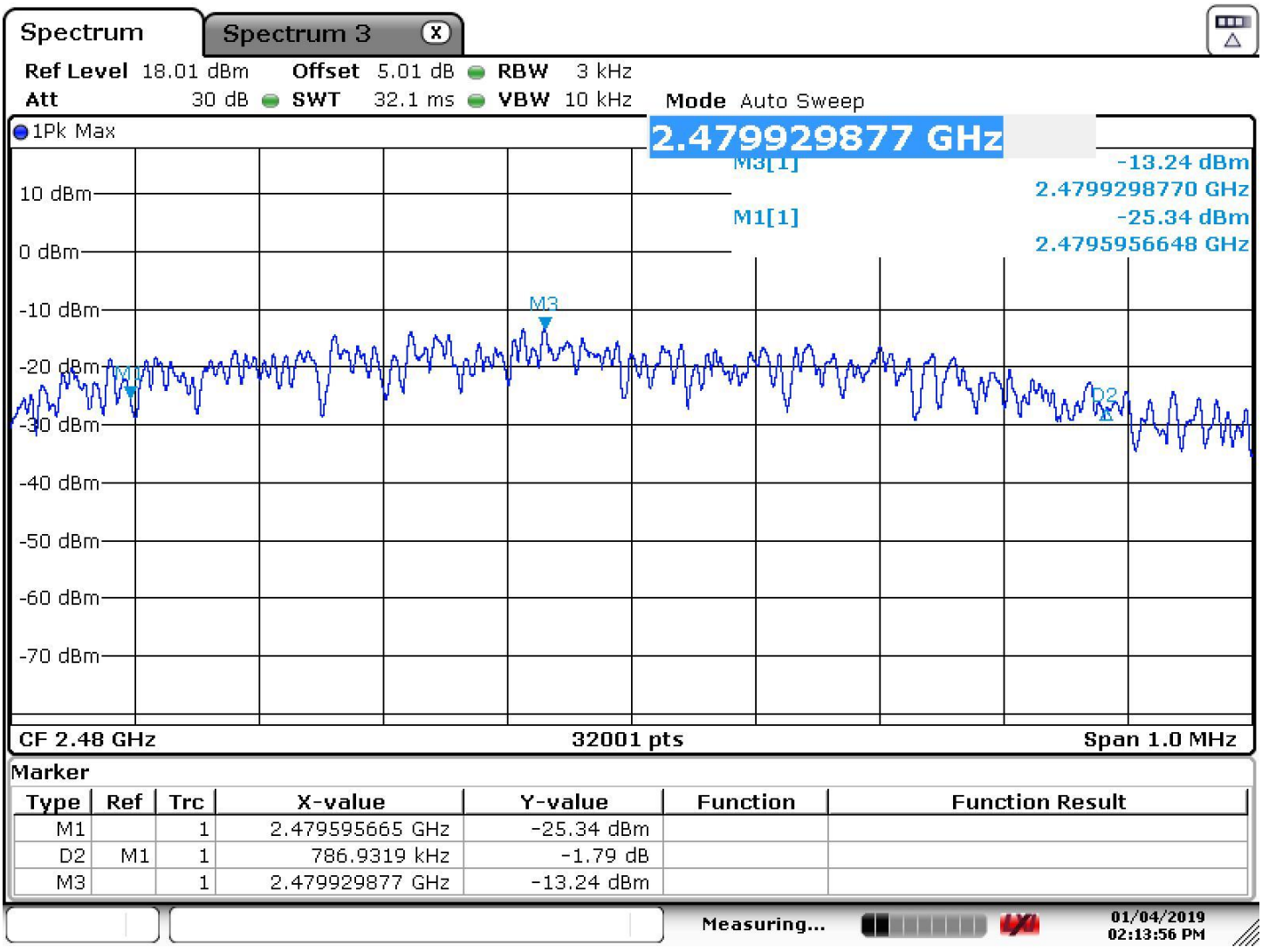
Date: 4.JAN.2019 14:16:39

Power Spectral Density BLE mode 2402 MHz.



Date: 4.JAN.2019 14:15:34

Power Spectral Density BLE mode 2444 MHz.



Date: 4.JAN.2019 14:13:57

Power Spectral Density BLE mode 2480 MHz.

8 Non-Restricted Band Emission requirements

Intentional radiators operating under the alternative provisions to the general emission limits, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If the frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

Any frequency outside the band of 2400 MHz to 2483.5 MHz, the power output level must be below 20 dB from the in-band transmitting signal; CFR 47 Part 15.215, 15.247(d) and RSS 247 Sect.5.5.

Tests were done in accordance with ANSI C63.10-2013 Section 11.11.1 (a)

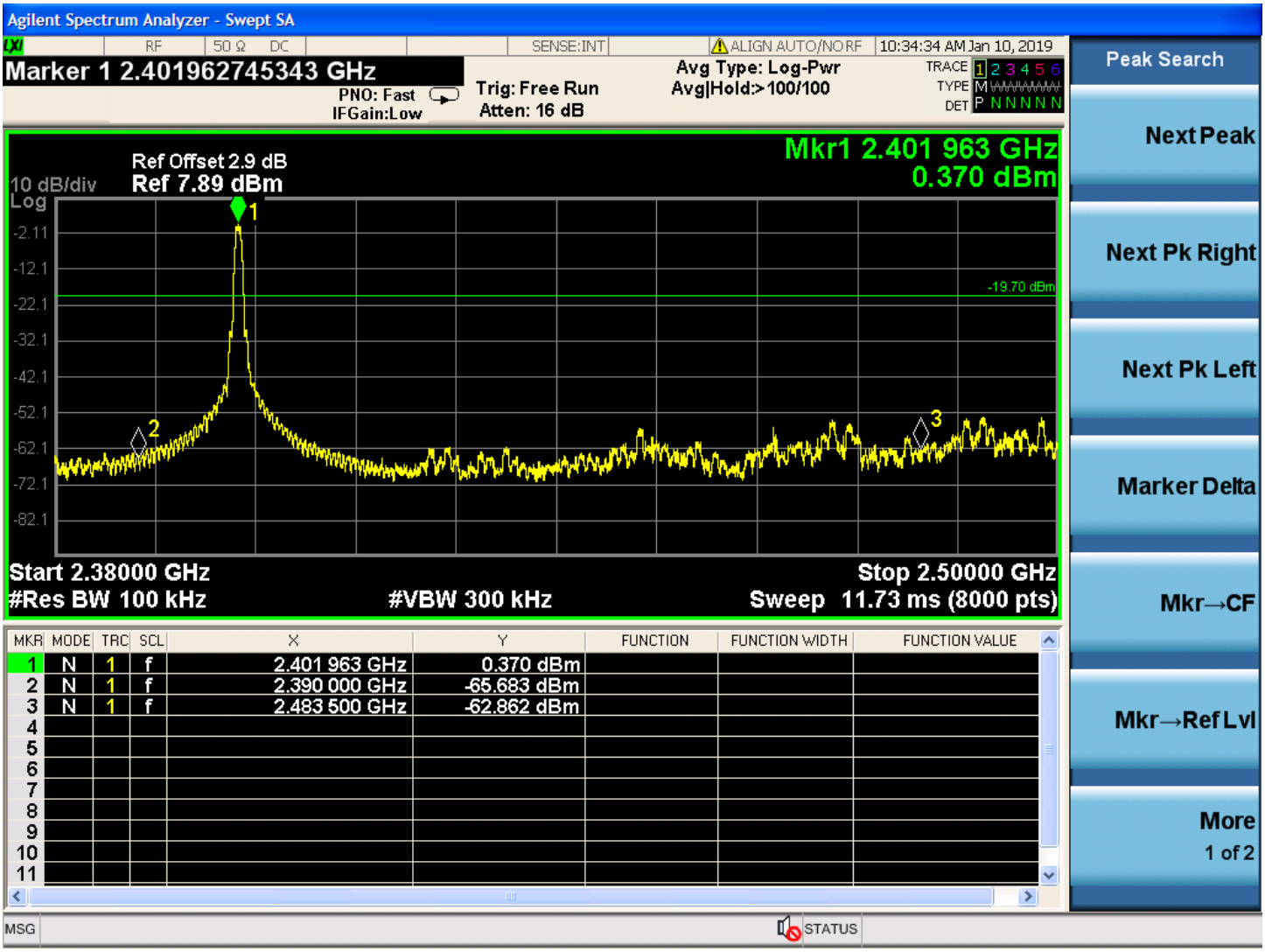
Set the center frequency and span to encompass frequency range to be measured.
Set the RBW = 100 kHz.
Set the VBW □ [3 × RBW].
Detector = peak.
Sweep time = auto couple.
Trace mode = max hold.

8.4.1 Results

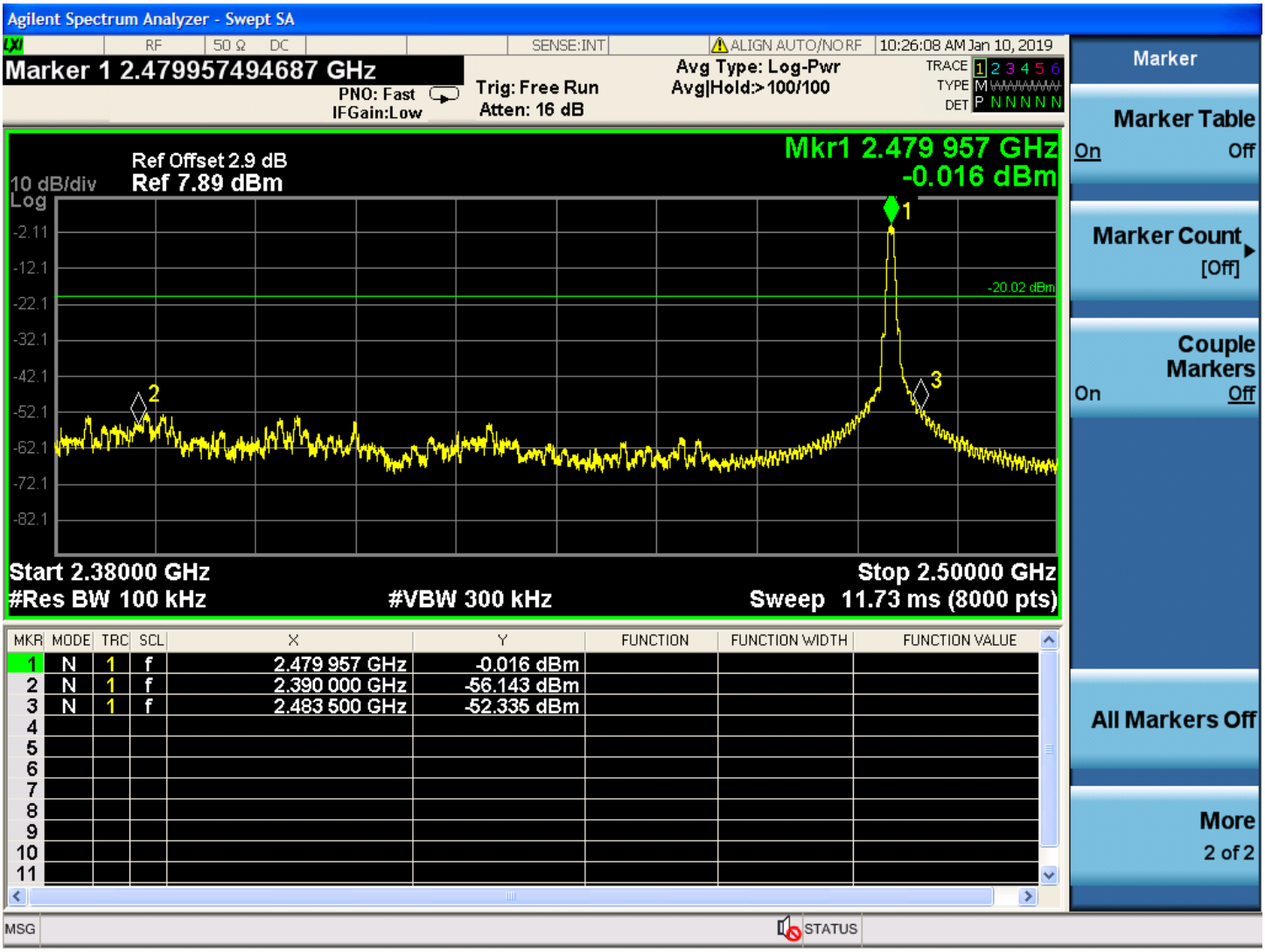
As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 3: Non-Restricted band emissions

Test Conditions: Conducted Measurement, Normal Temperature		**Date**: 01/08/2019		
Antenna Type: Integrated Antenna		**Power Setting:** Fixed		
Max. Antenna Gain: 0.39 dbi		**Signal State:** Modulated		
Duty Cycle: see section 4		**Data Rate:** 1 mbps		
Ambient Temp.: 22º C		**Relative Humidity:** 39 %RH		
Results				
Mode	**Operating Channel**	**Limit [dBm]**	**Final Result**	**Comments**
BLE	2402 MHz	-19.70	Pass	
	2480 MHz	-20.02	Pass	



Channel 2402 MHz.



Channel 2480 MHz.

9 Restricted Band Edges

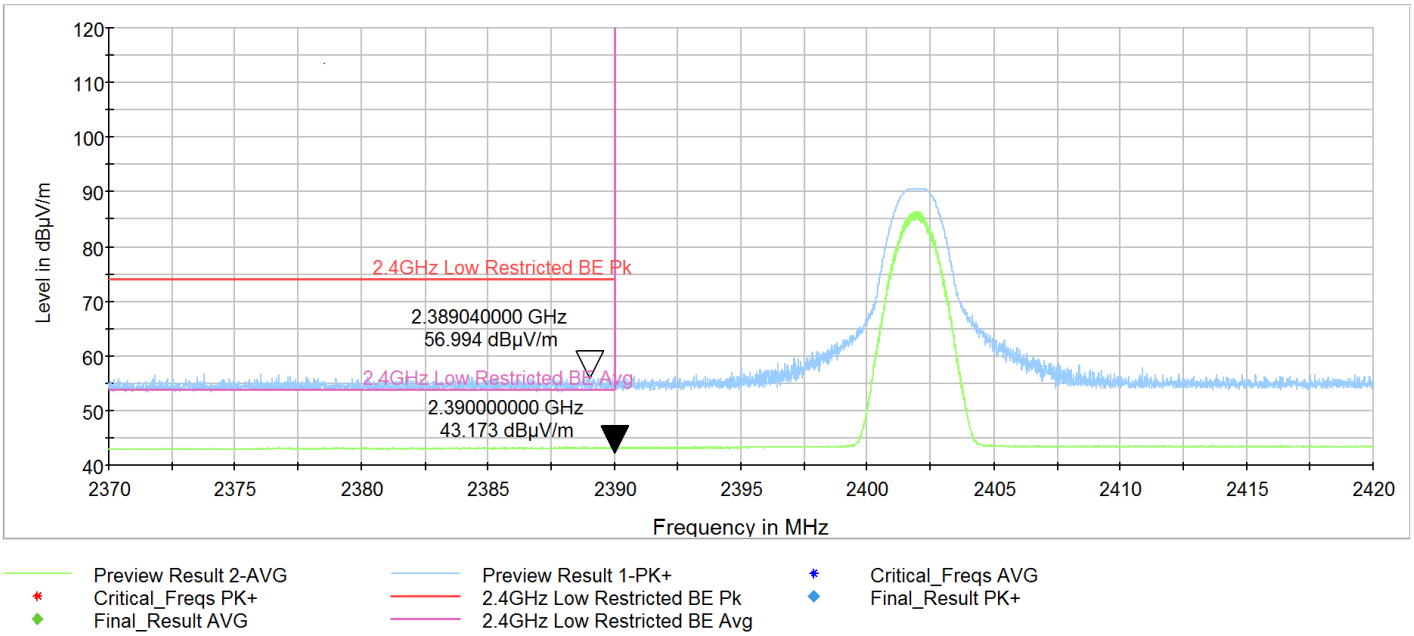
9.1.1 Peak Band edge Emissions

Test Method

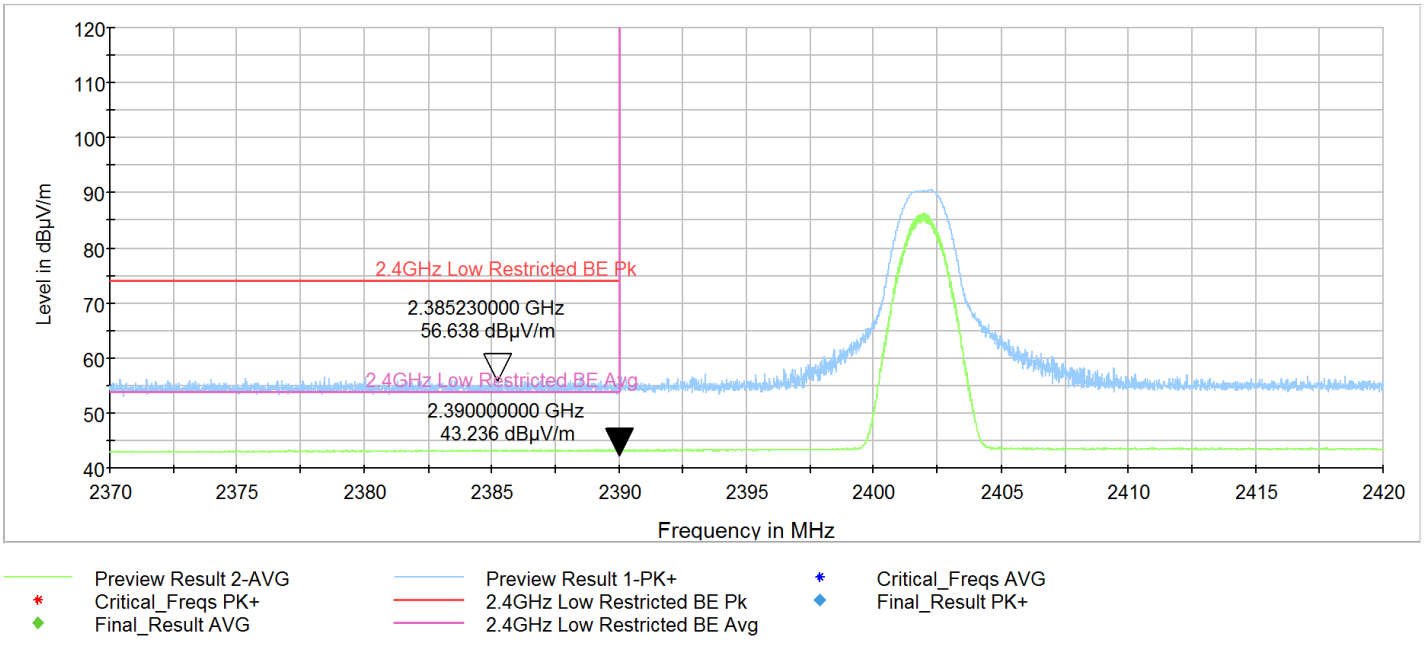
The ANSI C63.10-2013 Section 11.13.3.5 and 6.10.5 the procedure described was followed testing in an anechoic chamber. The preliminary investigation was not needed as the interface supports only one modulation and one power setting. A diag program was used to set the BT in continuous Tx mode and also to set the channel, only 1 power and data rate are available. This test was conducted on the edge channels.

Table 4: Restricted Band Edges results

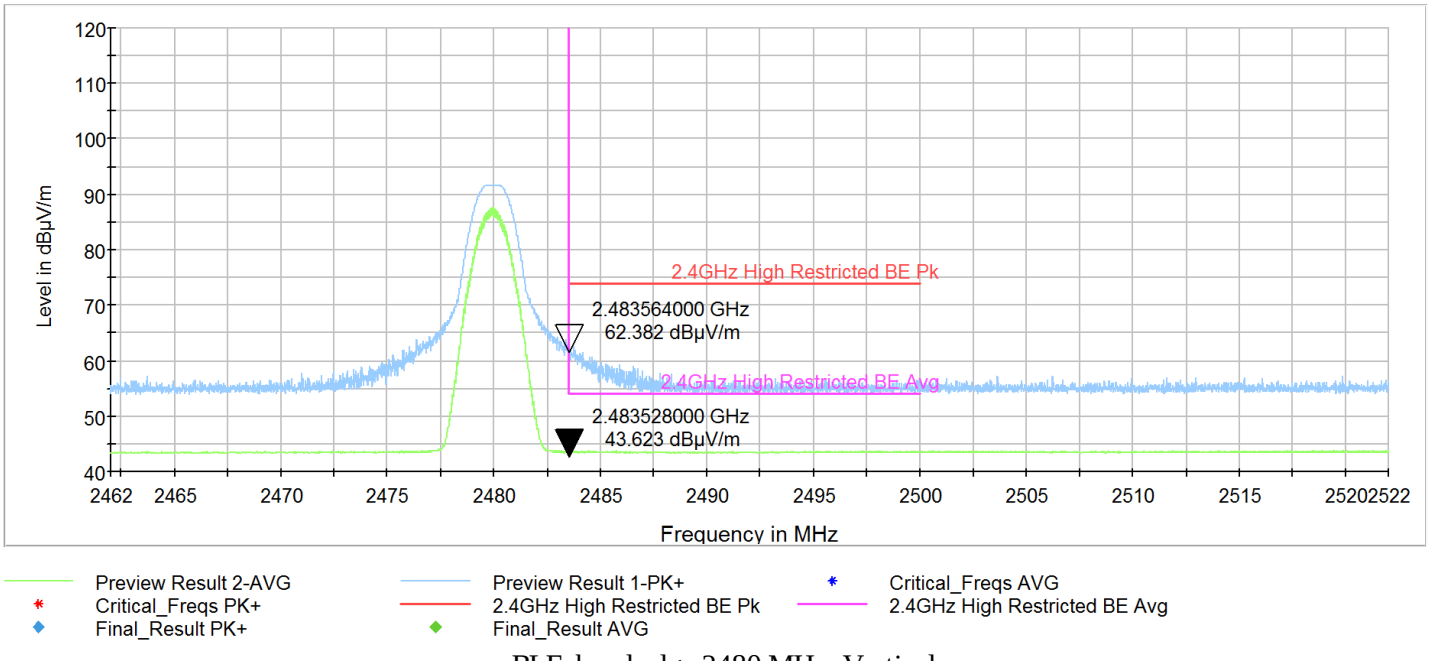
Mode	Operating Channel	Limit dbuV	Max Emission dbuV	Comments
Vertical Peak	2402 MHz.	74	56.99	
Horizontal Peak	2402 MHz.	74	56.63	
Vertical Average	2402 MHz.	**54**	**43.17**	
Horizontal Average	2402 MHz.	**54**	**43.23**	
Vertical Peak	2480 MHz.	74	**62.38**	
Horizontal Peak	2480 MHz.	74	**61.10**	
Vertical Average	2480 MHz.	54	**43.62**	
Horizontal Average	2480 MHz.	54	**43.58**	



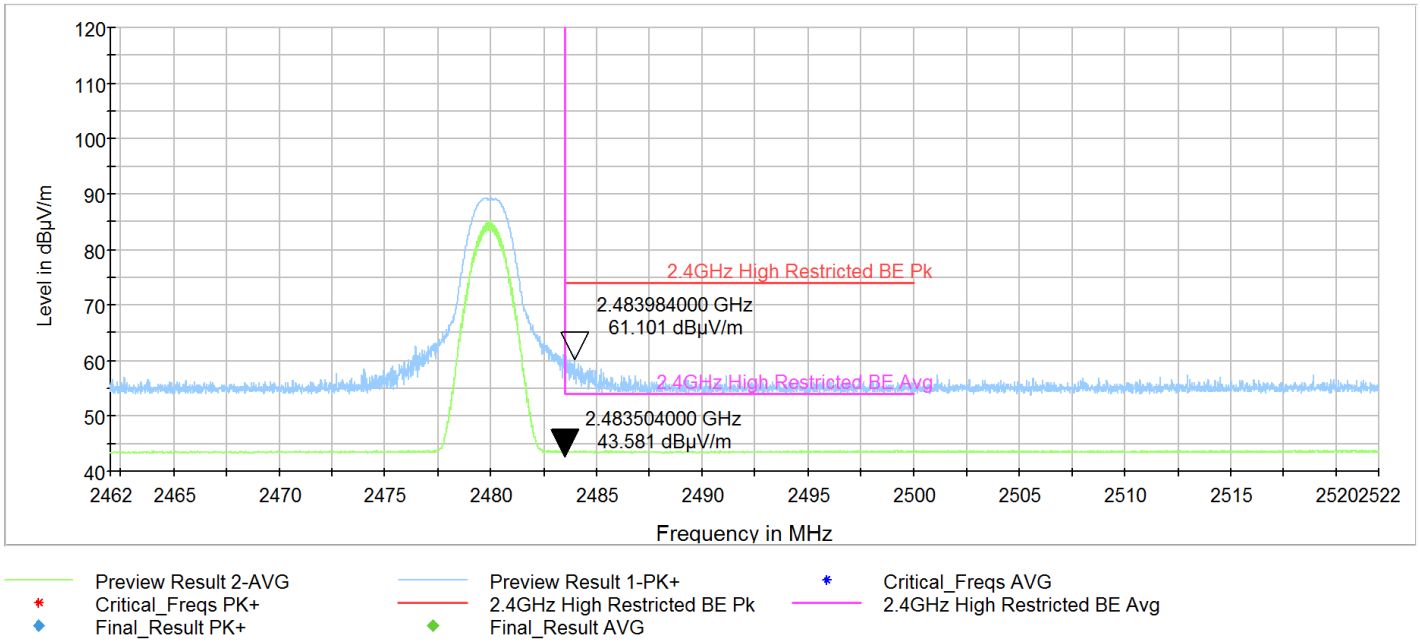
BLE band edge 2402 MHz. Vertical



BLE band edge 2402 MHz. Horizontal



BLE band edge 2480 MHz. Vertical

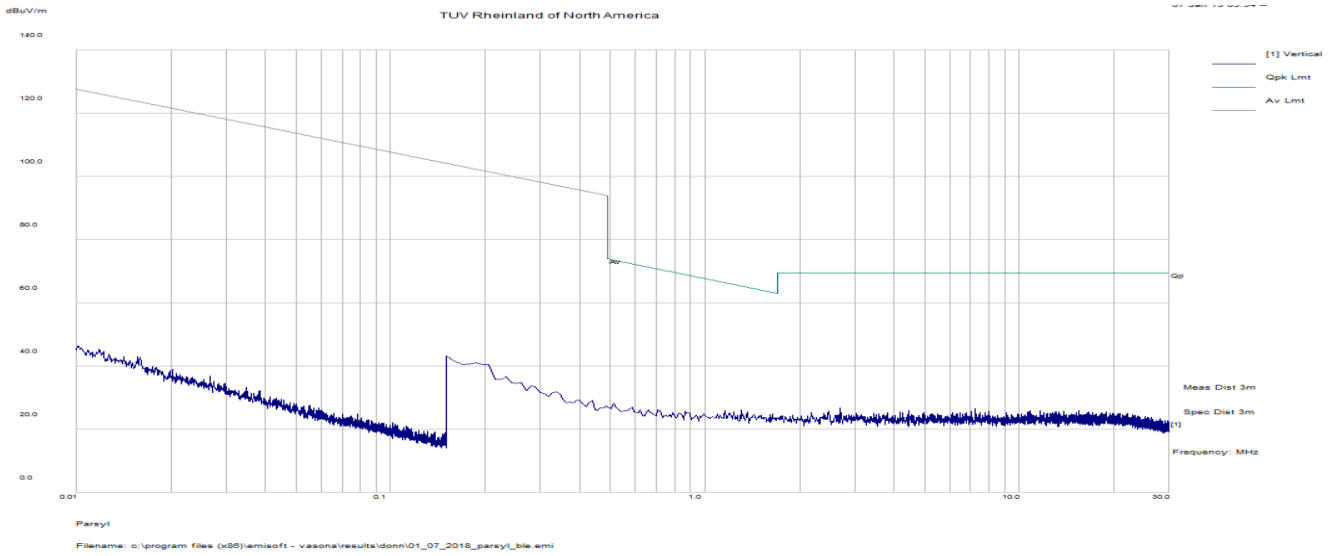


BLE band edge 2480 MHz. Horizontal

10 Restricted Band Emissions

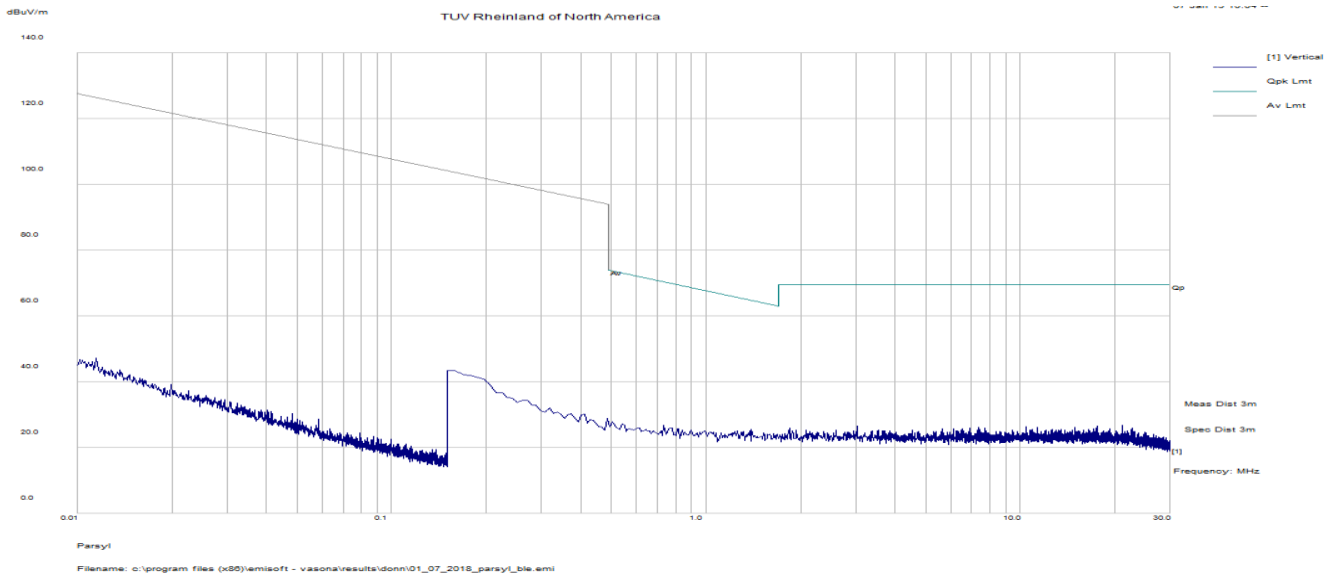
The system was tested in accordance CFR47 part 15.209 and RSS 247: sec 6.2. The emissions in the restricted band are required to meet the limits given for intentional radiators. The distance for 30-1000MHz. measurements is done at 5 meters and extrapolated from the limit at 10 meters in the software. The 3m distance in ANSI is extrapolated to 10 meter limit by reducing the limit by 20LOG(10/3).

9 kHz to 30 MHz



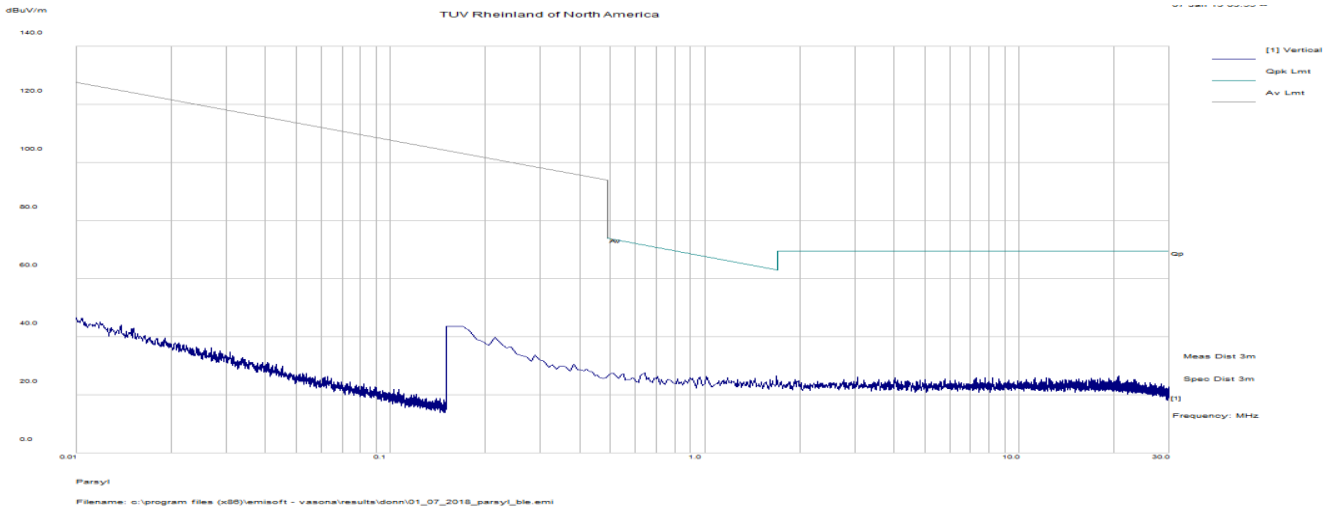
Channel 0 Parallel

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
0.15	30.51	2.19	10.38	43.08	Pk	V	125	62	90.00	-46.92	Pass	
0.23	24.25	2.21	10.26	36.73	Pk	V	125	126	83.94	-47.21	Pass	
0.34	19.31	2.24	10.20	31.75	Pk	V	125	233	78.98	-47.23	Pass	
0.59	14.20	2.27	10.40	26.87	Pk	V	125	138	72.24	-45.38	Pass	
7.23	13.49	2.41	10.70	26.60	Pk	V	125	44	69.50	-42.90	Pass	
23.43	12.09	2.48	9.81	24.38	Pk	V	125	118	69.50	-45.12	Pass	



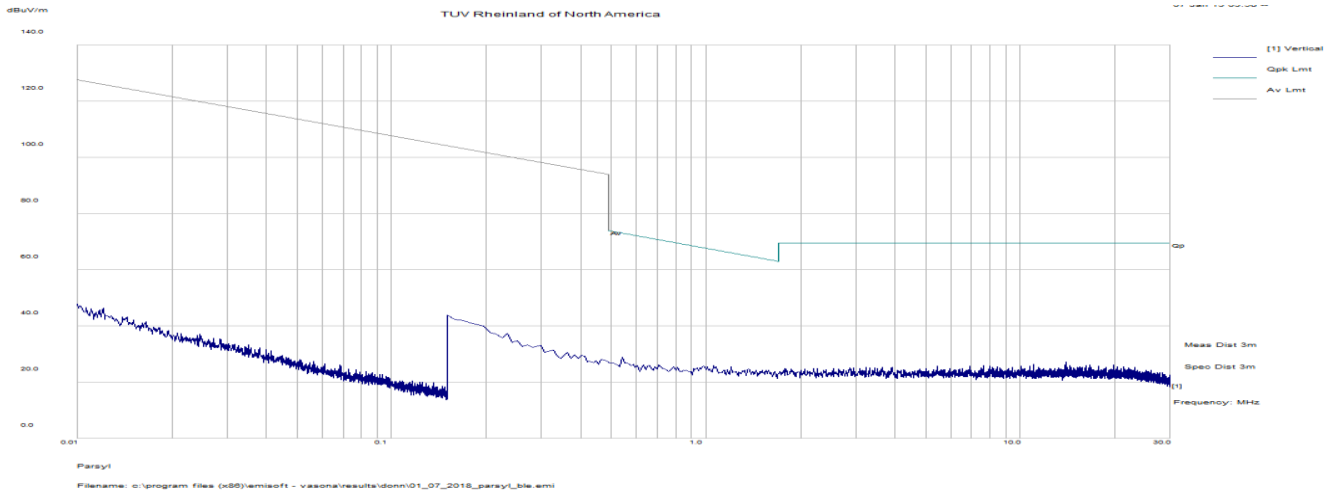
Channel 0 Perpendicular

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
Frequency MHz	Raw dBuV	Cable Loss	AF dB	vel dBuV/	surement	Pol	Hgt cm	Azt Deg	mit dBuV/	Margin d	ass /Fa	Comments
0.16	30.87	2.19	10.37	43.43	Pk	V	125	71	89.18	-45.75	Pass	
0.22	24.20	2.21	10.27	36.69	Pk	V	125	3	84.49	-47.81	Pass	
0.32	19.50	2.23	10.20	31.93	Pk	V	125	94	79.75	-47.83	Pass	
0.48	16.12	2.26	10.37	28.75	Pk	V	125	248	73.96	-45.21	Pass	
21.04	14.08	2.47	10.29	26.84	Pk	V	125	182	69.50	-42.66	Pass	
22.67	13.51	2.47	9.96	25.95	Pk	V	125	258	69.50	-43.55	Pass	
26.48	12.60	2.48	8.96	24.04	Pk	V	125	88	69.50	-45.46	Pass	



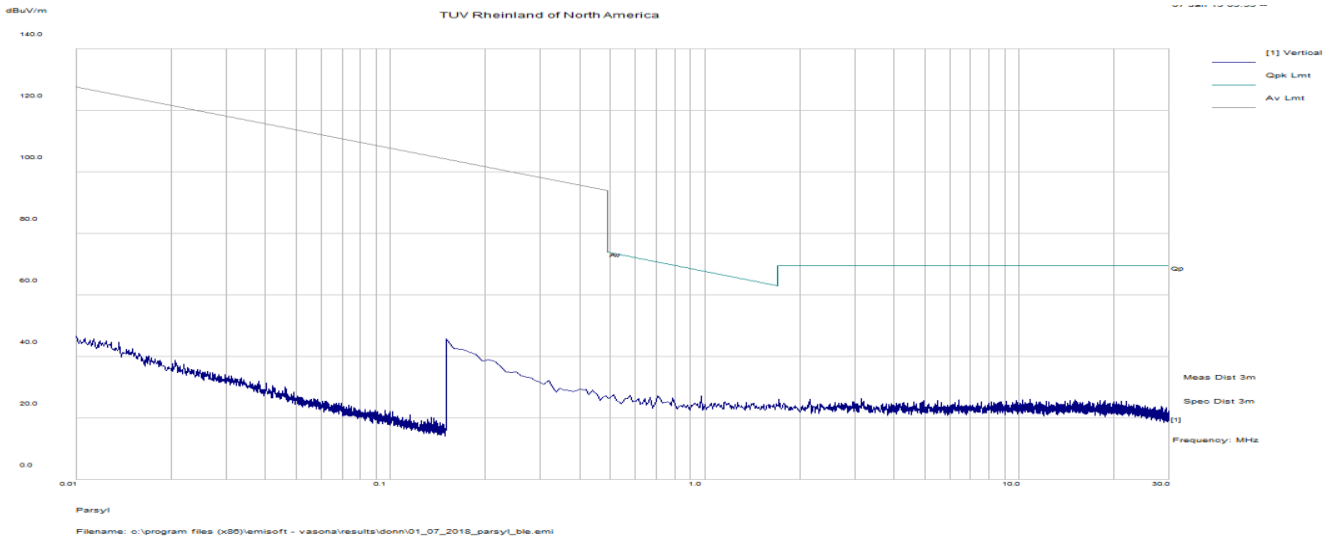
Channel 26 Parallel

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
0.17	31.14	2.20	10.35	43.68	Pk	V	125	192	88.40	-44.72	Pass	
0.21	27.38	2.21	10.28	39.88	Pk	V	125	128	85.07	-45.20	Pass	
0.29	21.26	2.23	10.21	33.70	Pk	V	125	10	81.01	-47.32	Pass	
0.64	14.92	2.27	10.40	27.59	Pk	V	125	297	71.46	-43.87	Pass	
20.82	13.75	2.47	10.32	26.53	Pk	V	125	98	69.50	-42.97	Pass	
23.05	12.92	2.48	9.89	25.29	Pk	V	125	192	69.50	-44.22	Pass	
29.97	12.33	2.49	7.91	22.73	Pk	V	125	181	69.50	-46.77	Pass	



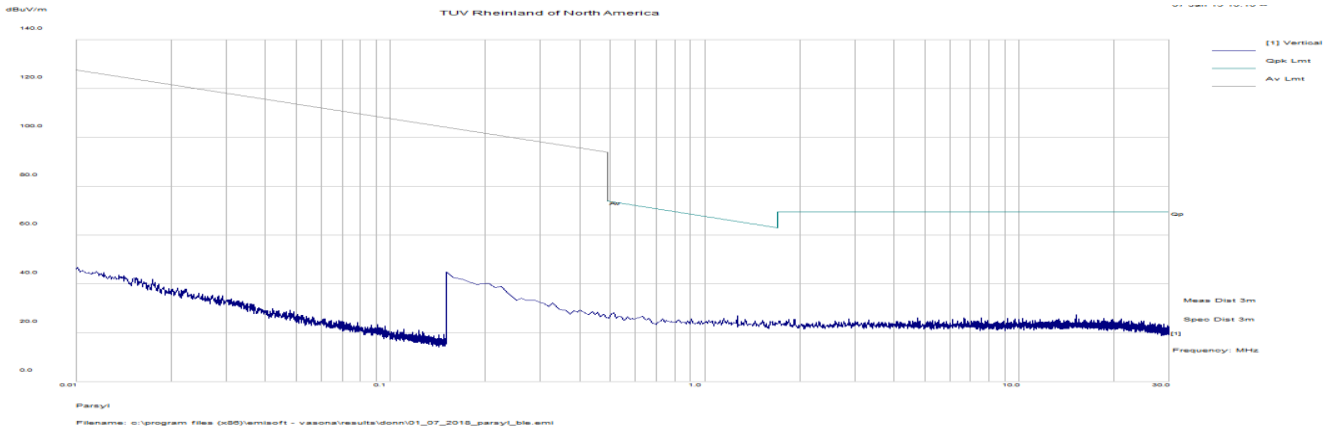
Channel 26 Perpendicular

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
0.15	31.25	2.19	10.38	43.83	Pk	V	125	360	90.00	-46.17	Pass	
0.23	24.69	2.21	10.26	37.17	Pk	V	125	287	83.94	-46.77	Pass	
0.33	18.88	2.23	10.20	31.32	Pk	V	125	258	79.36	-48.04	Pass	
13.92	13.90	2.45	10.80	27.14	Pk	V	125	355	69.50	-42.36	Pass	
19.83	13.23	2.47	10.42	26.12	Pk	V	125	86	69.50	-43.38	Pass	
26.06	12.57	2.48	9.08	24.13	Pk	V	125	358	69.50	-45.37	Pass	



Channel 39 Parallel

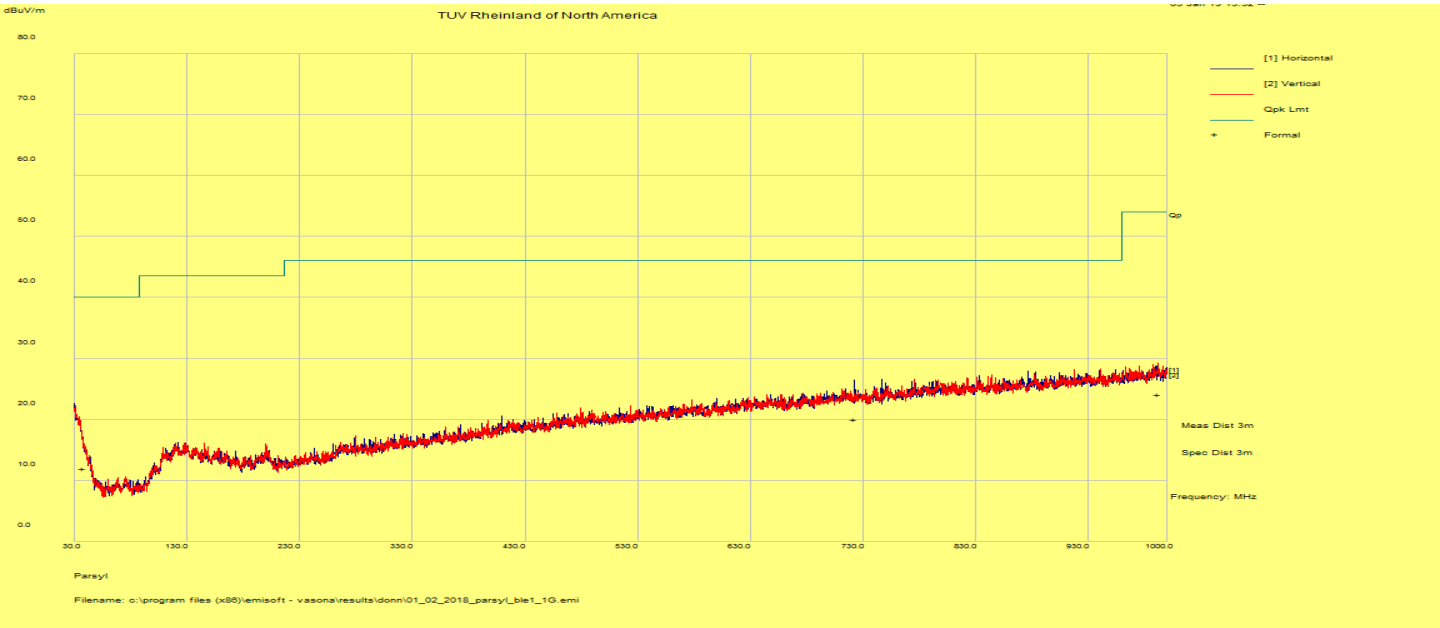
Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
0.15	33.16	2.19	10.38	45.73	Pk	V	125	316	90.00	-44.27	Pass	
0.21	26.55	2.21	10.29	39.05	Pk	V	125	81	85.68	-46.63	Pass	
0.32	19.76	2.23	10.20	32.20	Pk	V	125	156	79.75	-47.56	Pass	
0.51	14.89	2.26	10.40	27.55	Pk	V	125	181	73.42	-45.87	Pass	
3.15	13.31	2.36	10.62	26.29	Pk	V	125	233	69.50	-43.21	Pass	
28.23	12.94	2.49	8.43	23.85	Pk	V	125	230	69.50	-45.65	Pass	



Channel 39 Perpendicular

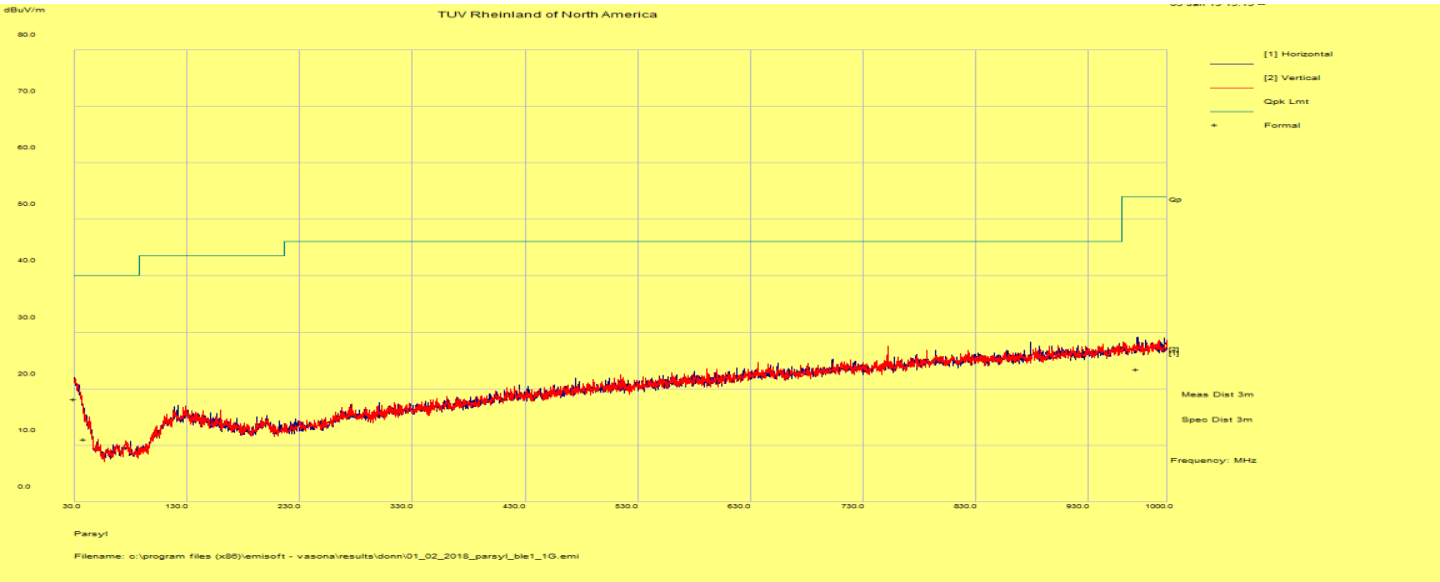
Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
0.15	32.37	2.19	10.38	44.94	Pk	V	125	75	90.00	-45.06	Pass	
0.22	26.37	2.21	10.27	38.85	Pk	V	125	151	84.49	-45.64	Pass	
0.33	19.86	2.23	10.20	32.29	Pk	V	125	2	79.36	-47.07	Pass	
0.51	15.52	2.26	10.40	28.18	Pk	V	125	246	73.42	-45.24	Pass	
15.15	14.21	2.45	10.79	27.45	Pk	V	125	318	69.50	-42.05	Pass	
18.62	12.97	2.46	10.50	25.93	Pk	V	125	248	69.50	-43.57	Pass	
27.12	12.64	2.48	8.76	23.89	Pk	V	125	59	69.50	-45.61	Pass	

30 to 1000 MHz



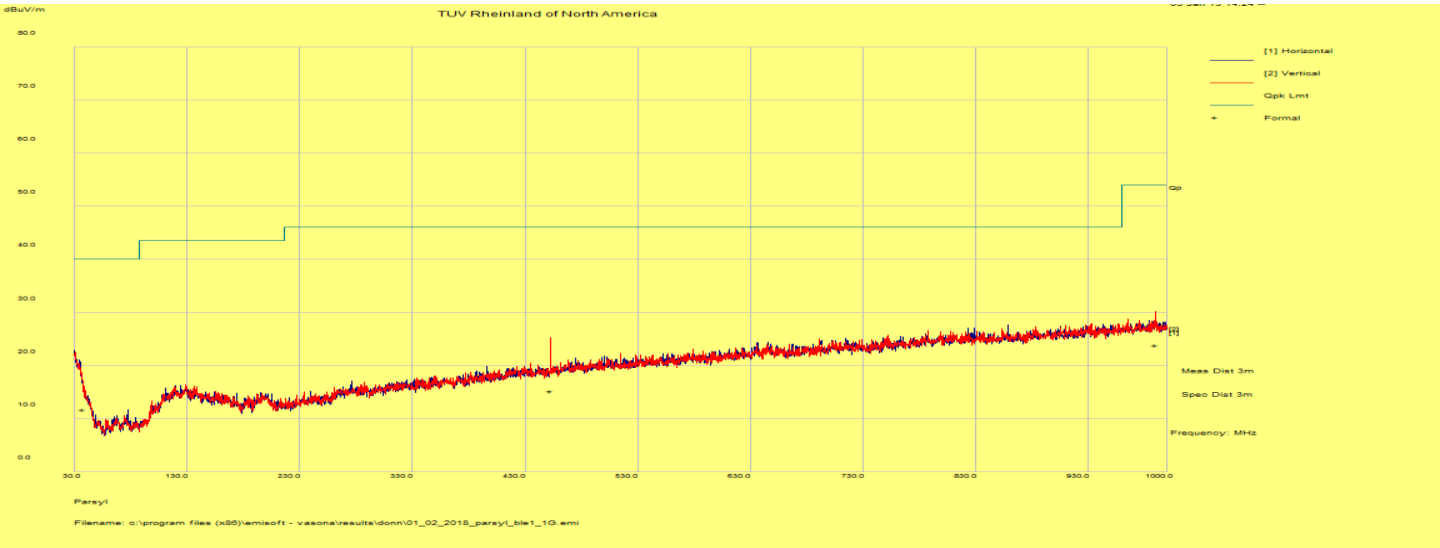
Channel 0

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
722.34	22.54	4.64	-7.09	20.09	QP	H	286	300	46.00	-25.91	Pass	
38.32	22.32	2.54	-12.90	11.96	QP	V	305	210	40.00	-28.04	Pass	
991.83	21.58	5.14	-2.64	24.08	QP	V	111	170	54.00	-29.92	Pass	



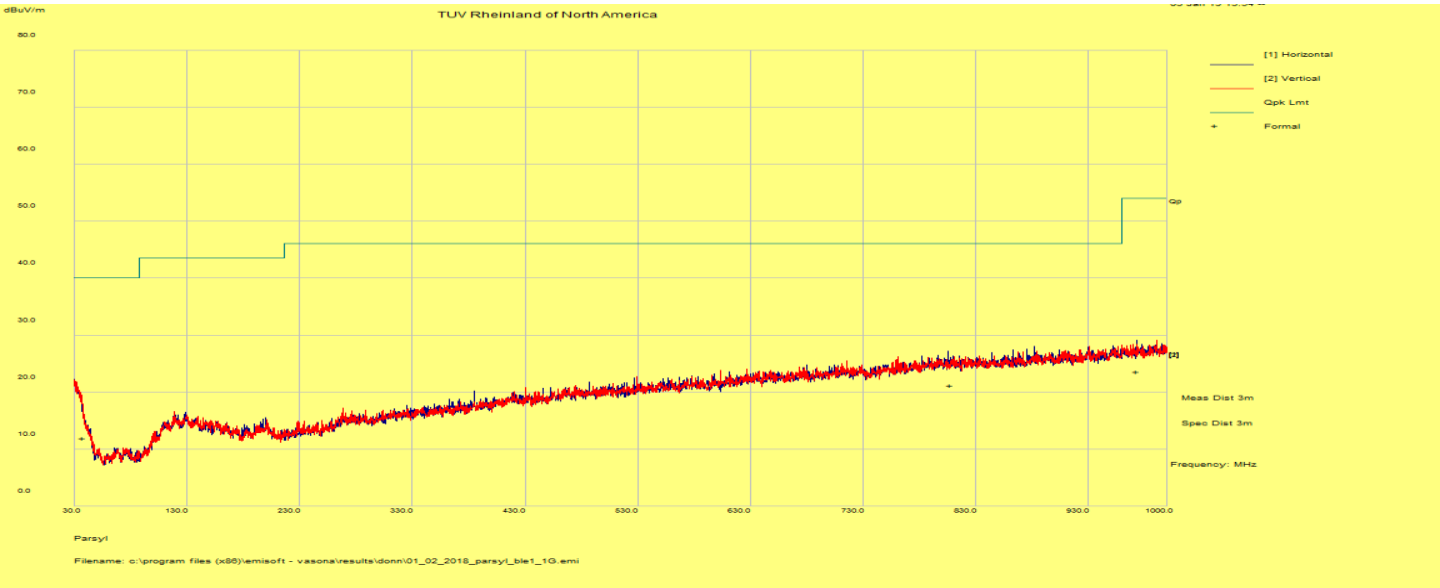
Channel 26

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
30.13	22.07	2.49	-6.37	18.19	QP	H	145	332	40.00	-21.82	Pass	
973.67	21.59	5.09	-3.12	23.55	QP	H	310	44	54.00	-30.45	Pass	
39.16	22.14	2.55	-13.51	11.18	QP	V	280	228	40.00	-28.82	Pass	



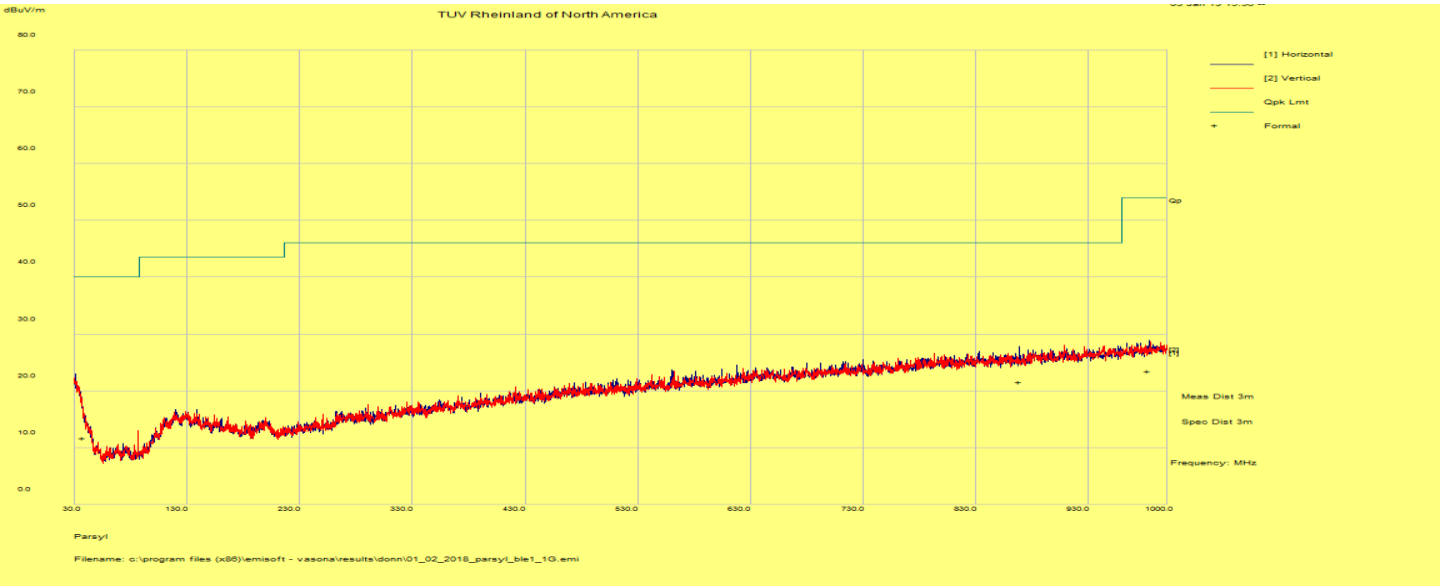
Channel 39

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
38.49	22.26	2.54	-13.02	11.78	QP	V	191	70	40.00	-28.22	Pass	
452.68	22.19	4.02	-11.04	15.17	QP	V	228	148	46.00	-30.83	Pass	
990.10	21.48	5.14	-2.75	23.87	QP	V	161	104	54.00	-30.13	Pass	



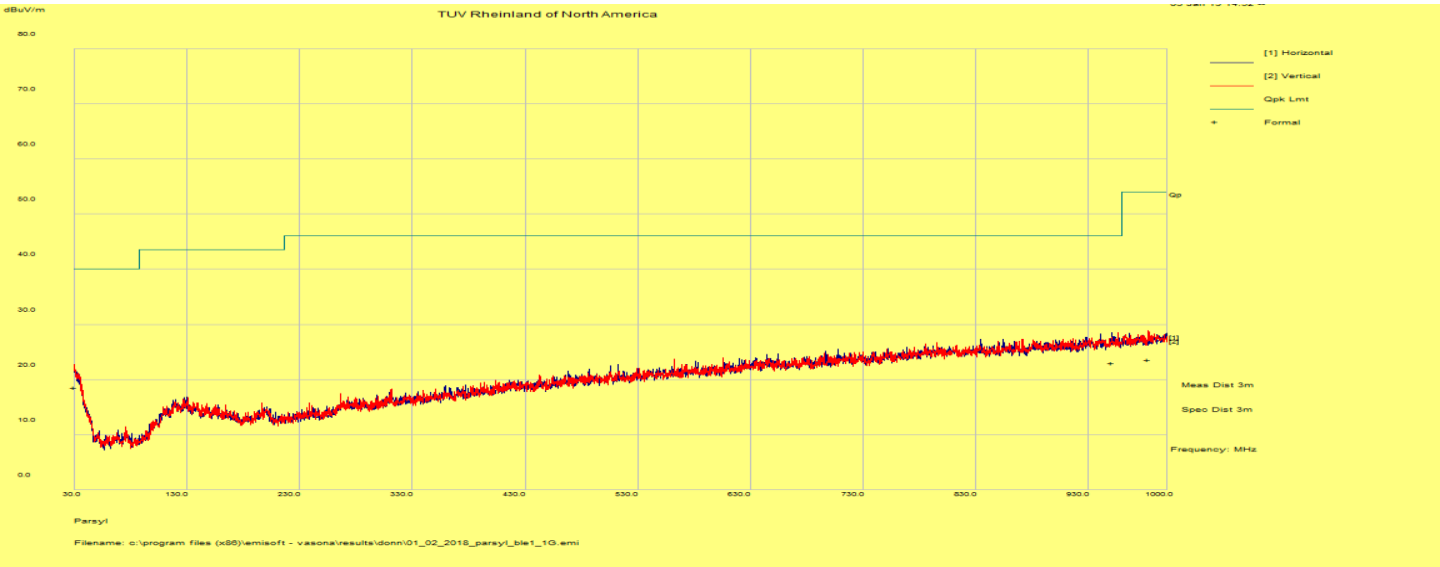
Channel 0 Vertical Orientation

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
807.63	22.30	4.78	-5.79	21.30	QP	H	277	16	46.00	-24.71	Pass	
972.90	21.65	5.09	-3.13	23.61	QP	H	240	4	54.00	-30.39	Pass	
38.33	22.35	2.54	-12.91	11.99	QP	V	328	304	40.00	-28.01	Pass	



Channel 26 Vertical Orientation

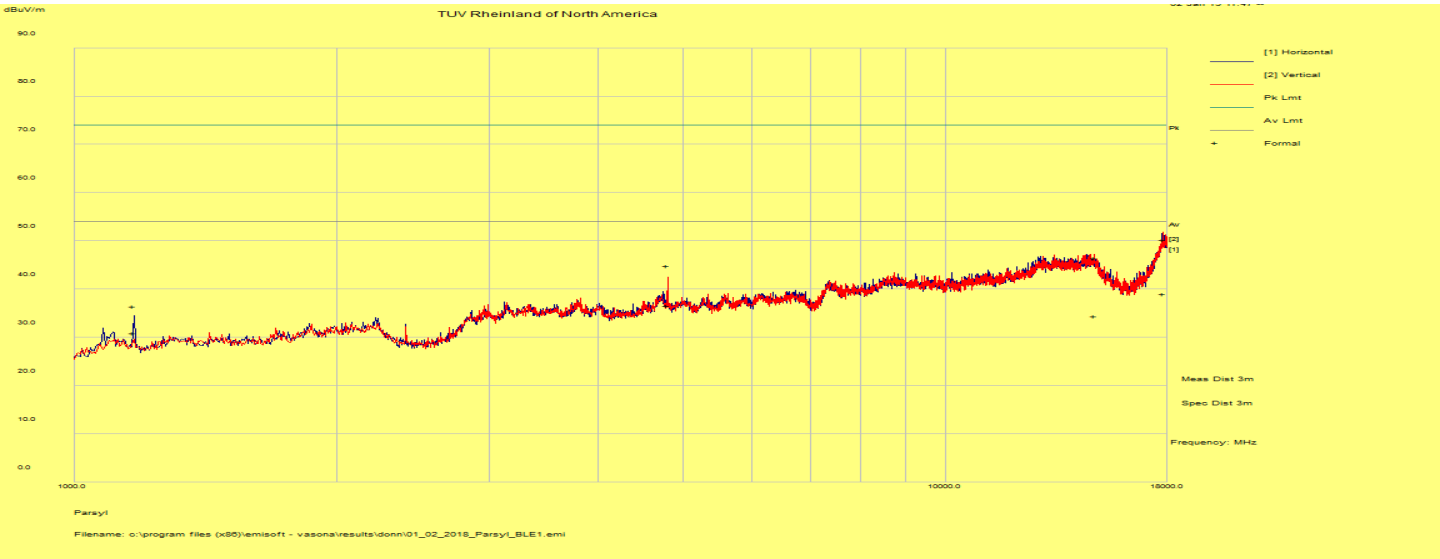
Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
868.86	21.81	4.90	-5.11	21.60	QP	H	280	286	46.00	-24.40	Pass	
983.41	21.29	5.09	-2.83	23.56	QP	H	313	346	54.00	-30.44	Pass	
38.49	22.27	2.54	-13.03	11.79	QP	V	170	268	40.00	-28.21	Pass	



Channel 39 Vertical Orientation

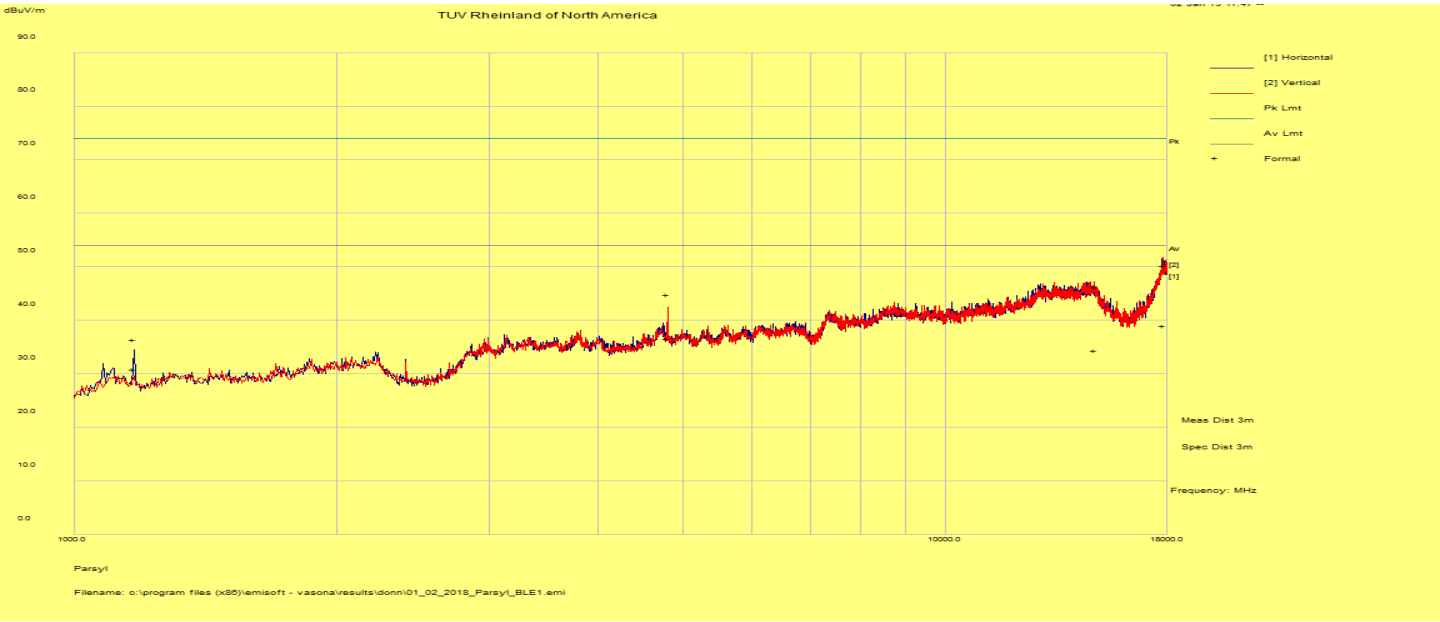
Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
951.48	21.52	5.04	-3.52	23.04	QP	H	132	320	46.00	-22.96	Pass	
30.00	22.41	2.49	-6.28	18.62	QP	V	346	136	40.00	-21.38	Pass	
982.83	21.41	5.09	-2.83	23.67	QP	V	266	78	54.00	-30.33	Pass	

1 to 18 GHz.



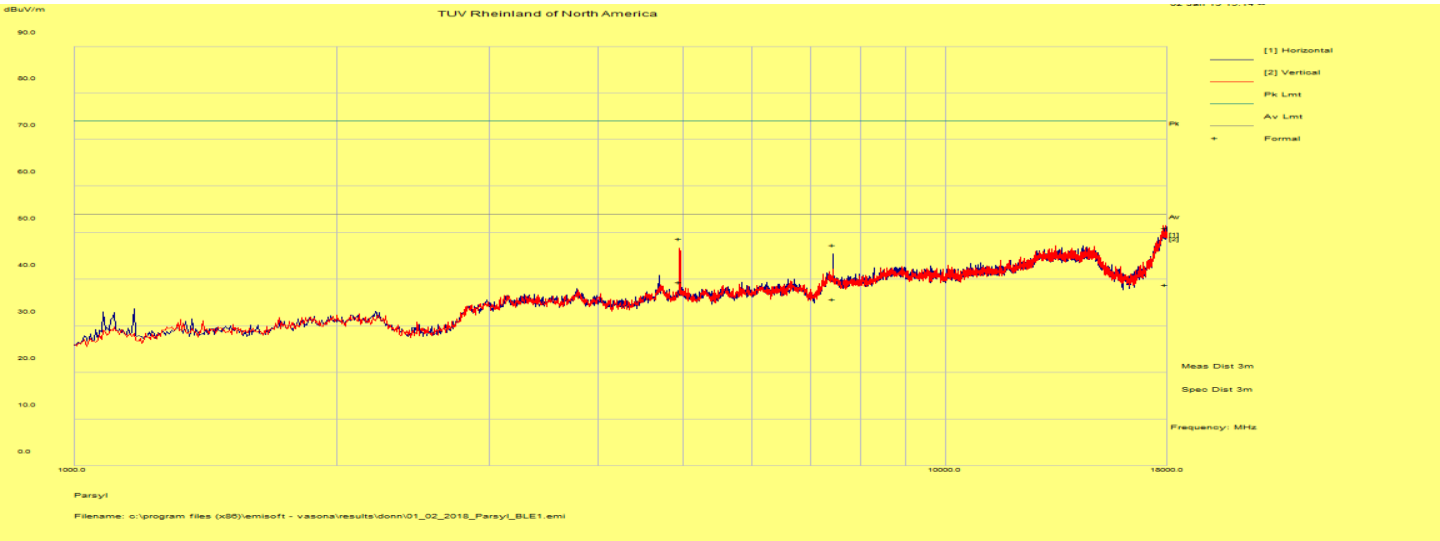
Channel 0 Horizontal Orientation

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
1170.07	72.86	1.74	-38.20	36.40	Peak Max	H	143	198	74.00	-37.60	Pass	
1170.07	67.37	1.74	-38.20	30.91	verage Ma	H	143	198	54.00	-23.09	Pass	
4803.89	69.65	3.50	-28.27	44.88	Peak Max	V	135	350	74.00	-29.12	Pass	
4803.89	61.41	3.50	-28.27	36.64	verage Ma	V	135	350	54.00	-17.36	Pass	
14847.69	61.68	6.40	-21.60	46.49	Peak Max	V	269	136	74.00	-27.51	Pass	
14847.69	49.63	6.40	-21.60	34.43	verage Ma	V	269	136	54.00	-19.57	Pass	
17809.72	59.91	6.80	-16.40	50.31	Peak Max	V	274	164	74.00	-23.69	Pass	
17809.72	48.63	6.80	-16.40	39.03	verage Ma	V	274	164	54.00	-14.97	Pass	



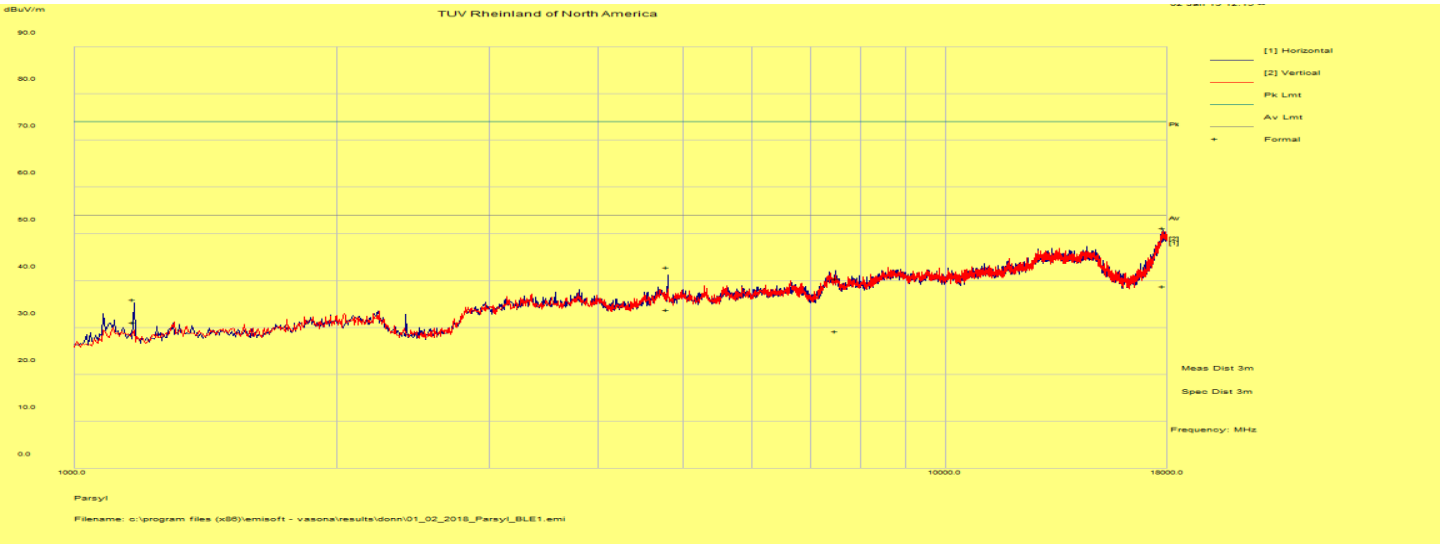
Channel 26 Horizontal Orientation

Frequency	Raw	able Los	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
7331.10	66.89	4.26	-24.97	46.18	Peak Max	H	117	360	74.00	-27.82	Pass	
7331.10	54.70	4.26	-24.97	33.99	verage Ma	H	117	360	54.00	-20.01	Pass	
17904.53	60.40	6.82	-16.12	51.09	Peak Max	H	242	26	74.00	-22.91	Pass	
17904.53	48.34	6.82	-16.12	39.04	verage Ma	H	242	26	54.00	-14.96	Pass	
4888.02	70.98	3.50	-28.27	46.22	Peak Max	V	170	266	74.00	-27.78	Pass	
4888.02	63.29	3.50	-28.27	38.52	verage Ma	V	170	266	54.00	-15.48	Pass	



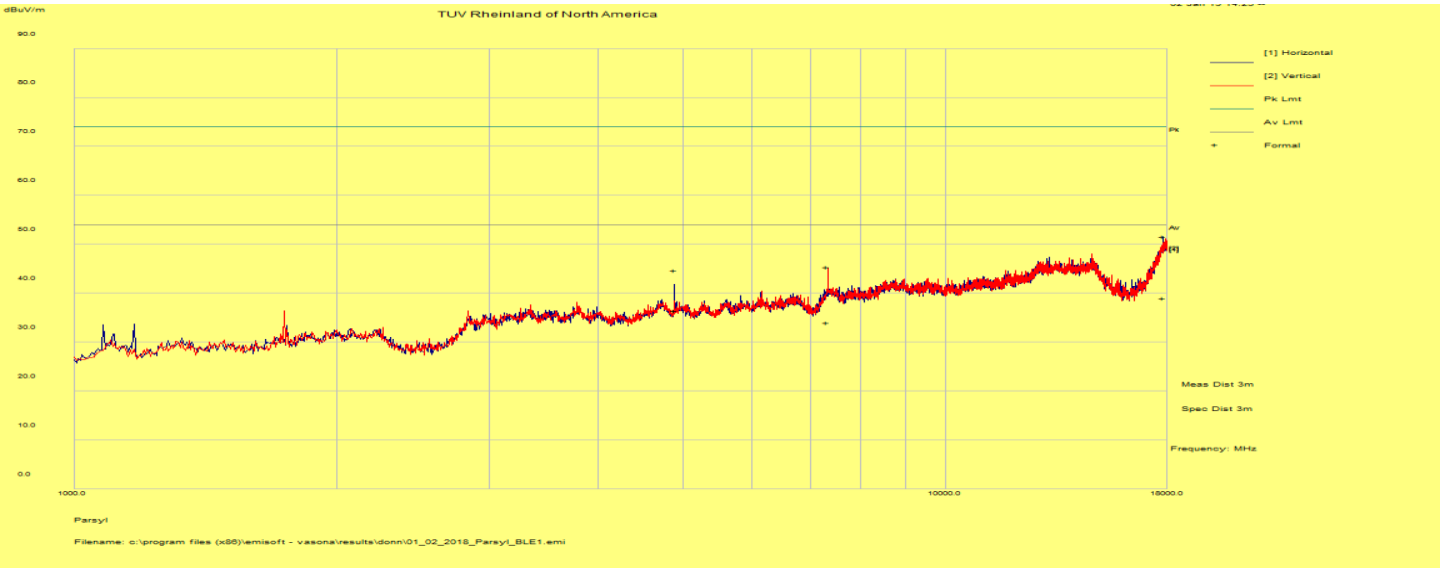
Channel 39 Horizontal Orientation

Frequency	Raw	able Los	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
7438.99	68.00	4.30	-24.83	47.47	Peak Max	H	119	98	74.00	-26.53	Pass	
7438.99	56.28	4.30	-24.83	35.75	verage Ma	H	119	98	54.00	-18.25	Pass	
4959.38	73.80	3.52	-28.54	48.78	Peak Max	V	107	360	74.00	-25.22	Pass	
4959.38	64.53	3.52	-28.54	39.51	verage Ma	V	107	360	54.00	-14.49	Pass	
17918.61	60.31	6.87	-16.07	51.12	Peak Max	V	218	176	74.00	-22.88	Pass	
17918.61	48.13	6.87	-16.07	38.94	verage Ma	V	218	176	54.00	-15.06	Pass	



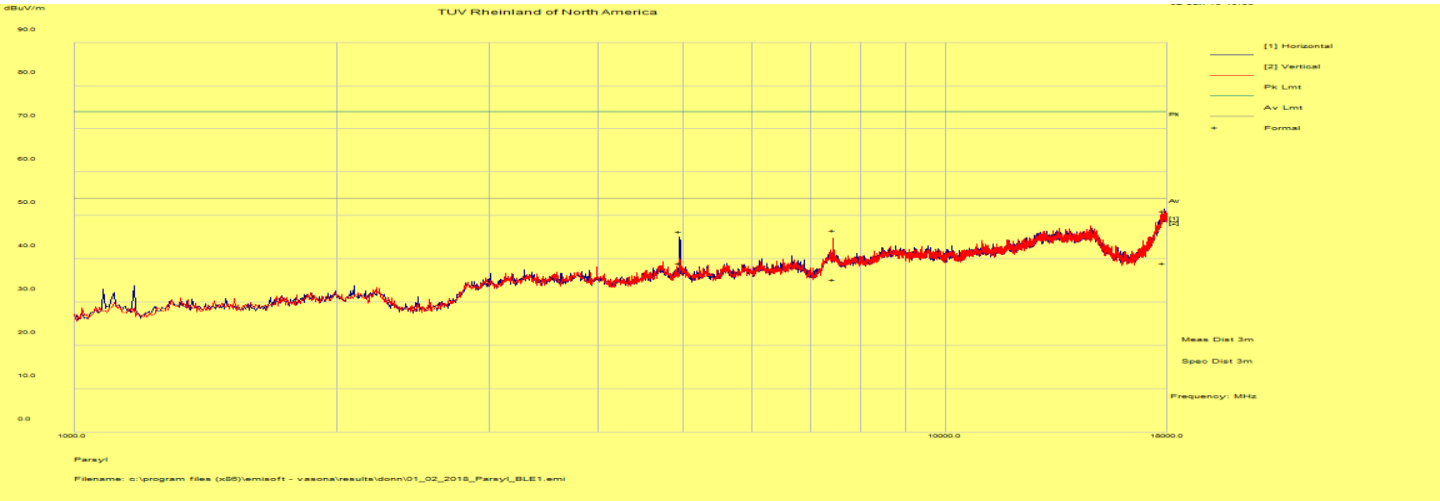
Channel 0 Vertical Orientation

Frequency	Raw	able Los	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
1170.04	72.57	1.74	-38.20	36.11	Peak Max	H	170	266	74.00	-37.89	Pass	
1170.04	67.72	1.74	-38.20	31.26	verage Ma	H	170	266	54.00	-22.75	Pass	
4804.05	67.71	3.50	-28.27	42.94	Peak Max	H	277	264	74.00	-31.06	Pass	
4804.05	58.62	3.50	-28.27	33.86	verage Ma	H	277	264	54.00	-20.14	Pass	
7490.68	60.94	4.38	-24.83	40.48	Peak Max	H	244	350	74.00	-33.52	Pass	
7490.68	49.76	4.38	-24.83	29.30	verage Ma	H	244	350	54.00	-24.70	Pass	
17809.73	60.99	6.80	-16.40	51.39	Peak Max	H	256	316	74.00	-22.61	Pass	
17809.73	48.56	6.80	-16.40	38.96	verage Ma	H	256	316	54.00	-15.04	Pass	



Channel 26 Vertical orientation

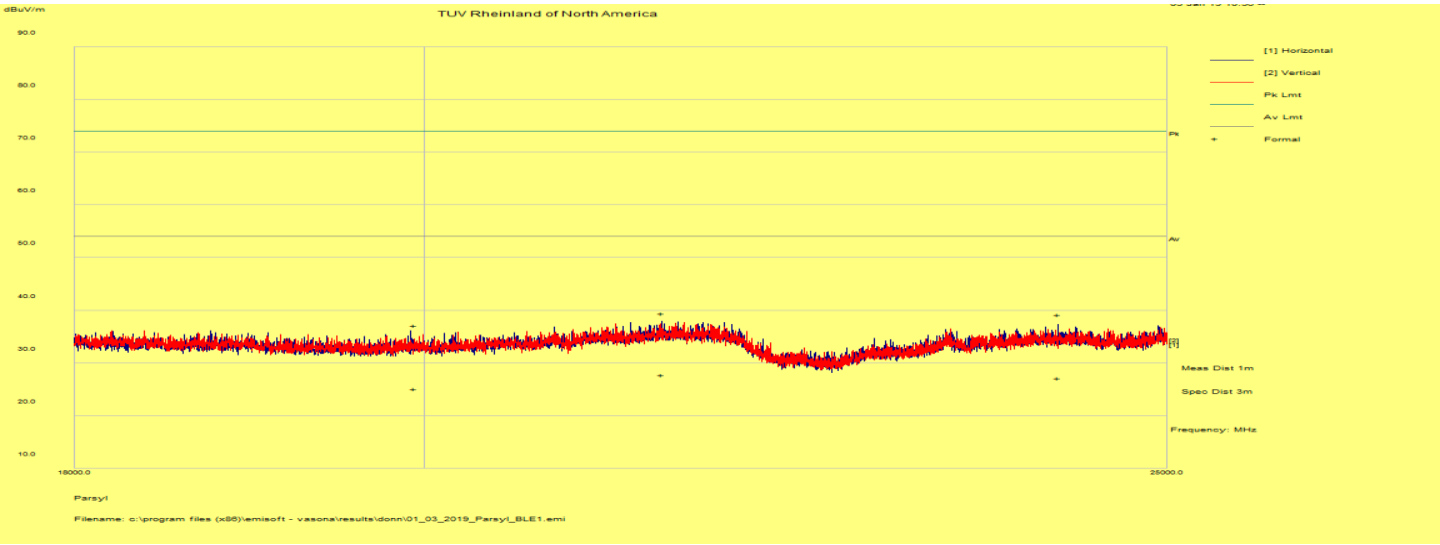
Frequency	Raw	able Los	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
4887.85	69.50	3.50	-28.27	44.74	Peak Max	H	259	60	74.00	-29.26	Pass	
4887.85	61.21	3.50	-28.27	36.45	verage Ma	H	259	60	54.00	-17.56	Pass	
17796.54	61.44	6.79	-16.57	51.66	Peak Max	H	308	264	74.00	-22.34	Pass	
17796.54	48.87	6.79	-16.57	39.09	verage Ma	H	308	264	54.00	-14.91	Pass	
7331.23	66.12	4.26	-24.97	45.41	Peak Max	V	299	272	74.00	-28.59	Pass	
7331.23	54.80	4.26	-24.97	34.09	verage Ma	V	299	272	54.00	-19.91	Pass	



Channel 39 Vertical Orientation

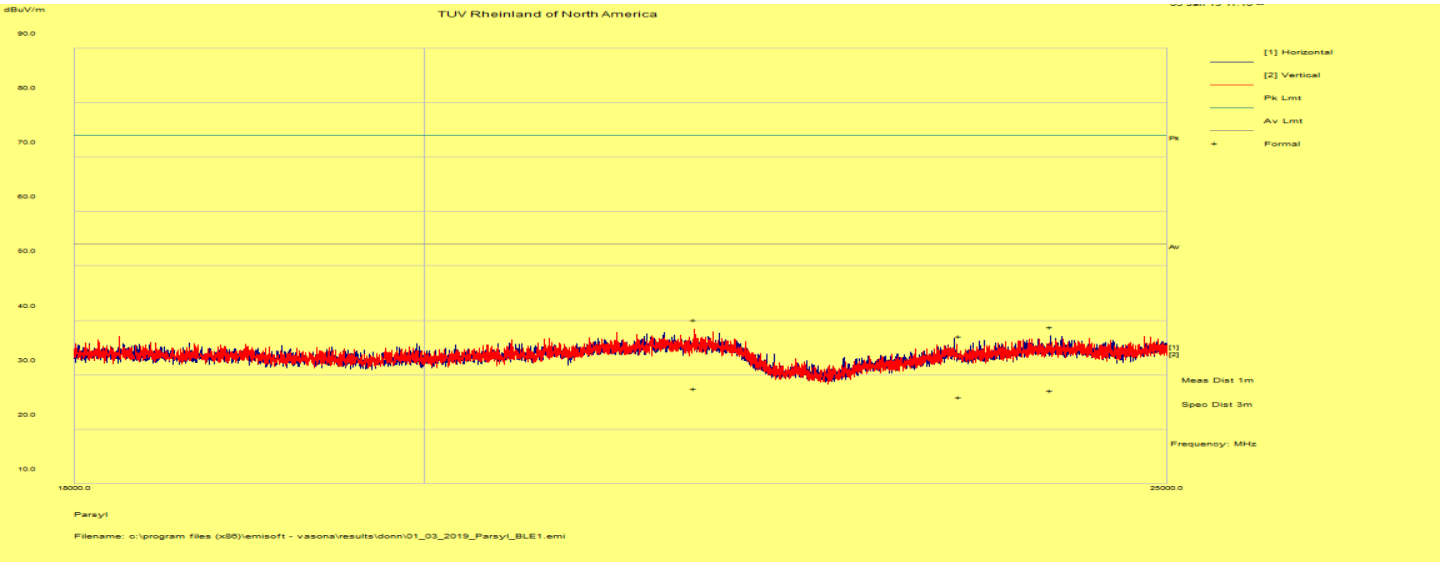
Frequency	Raw	able Los	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
4959.79	71.29	3.52	-28.54	46.27	Peak Max	H	329	272	74.00	-27.73	Pass	
4959.79	64.09	3.52	-28.54	39.07	verage Ma	H	329	272	54.00	-14.93	Pass	
17839.53	60.40	6.80	-16.17	51.03	Peak Max	H	317	336	74.00	-22.97	Pass	
17839.53	48.35	6.80	-16.17	38.98	verage Ma	H	317	336	54.00	-15.02	Pass	
7439.13	67.08	4.30	-24.83	46.55	Peak Max	V	285	88	74.00	-27.45	Pass	
7439.13	55.74	4.30	-24.83	35.21	verage Ma	V	285	88	54.00	-18.79	Pass	

18 to 26 GHz.



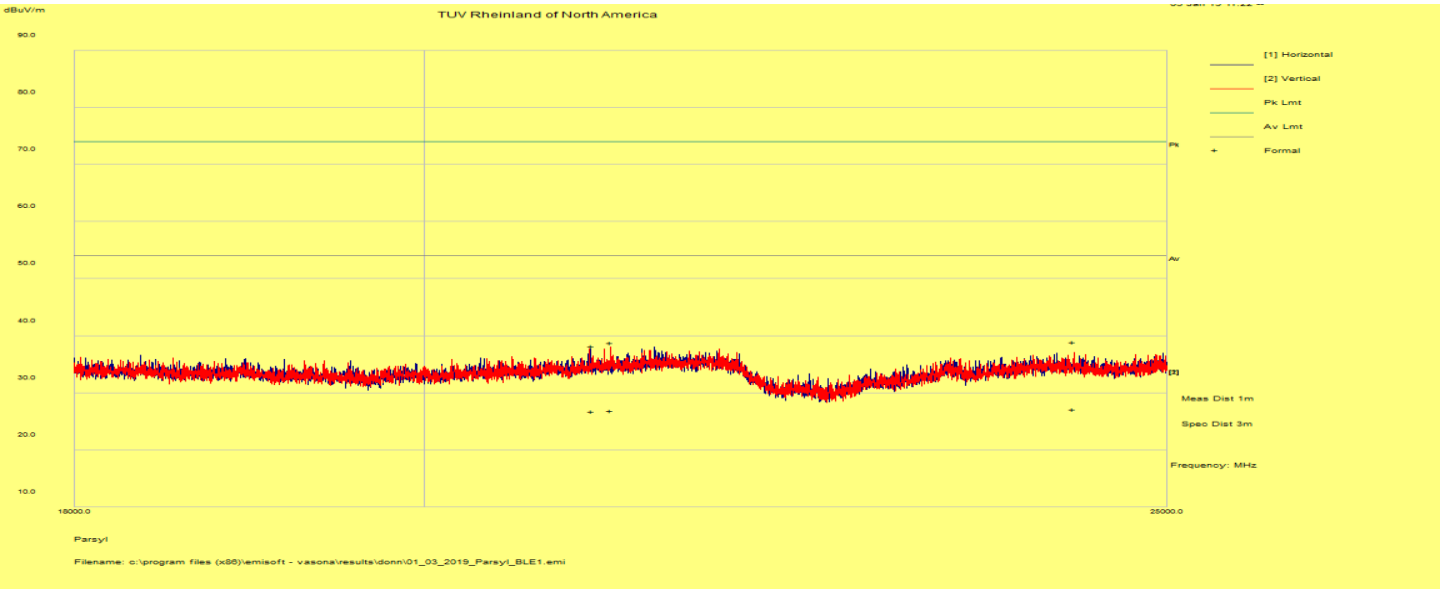
Channel 0 Horizontal Orientation

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
21478.60	41.26	7.70	-9.55	39.41	Peak Max	H	150	332	74.00	-34.59	Pass	
21478.60	29.66	7.70	-9.55	27.81	verage Ma	H	150	332	54.00	-26.19	Pass	
24195.13	43.45	8.10	-12.38	39.17	Peak Max	H	150	86	74.00	-34.83	Pass	
24195.13	31.44	8.10	-12.38	27.16	verage Ma	H	150	86	54.00	-26.84	Pass	
19941.04	38.94	7.40	-9.24	37.11	Peak Max	V	150	130	74.00	-36.89	Pass	
19941.04	26.93	7.40	-9.24	25.09	verage Ma	V	150	130	54.00	-28.91	Pass	



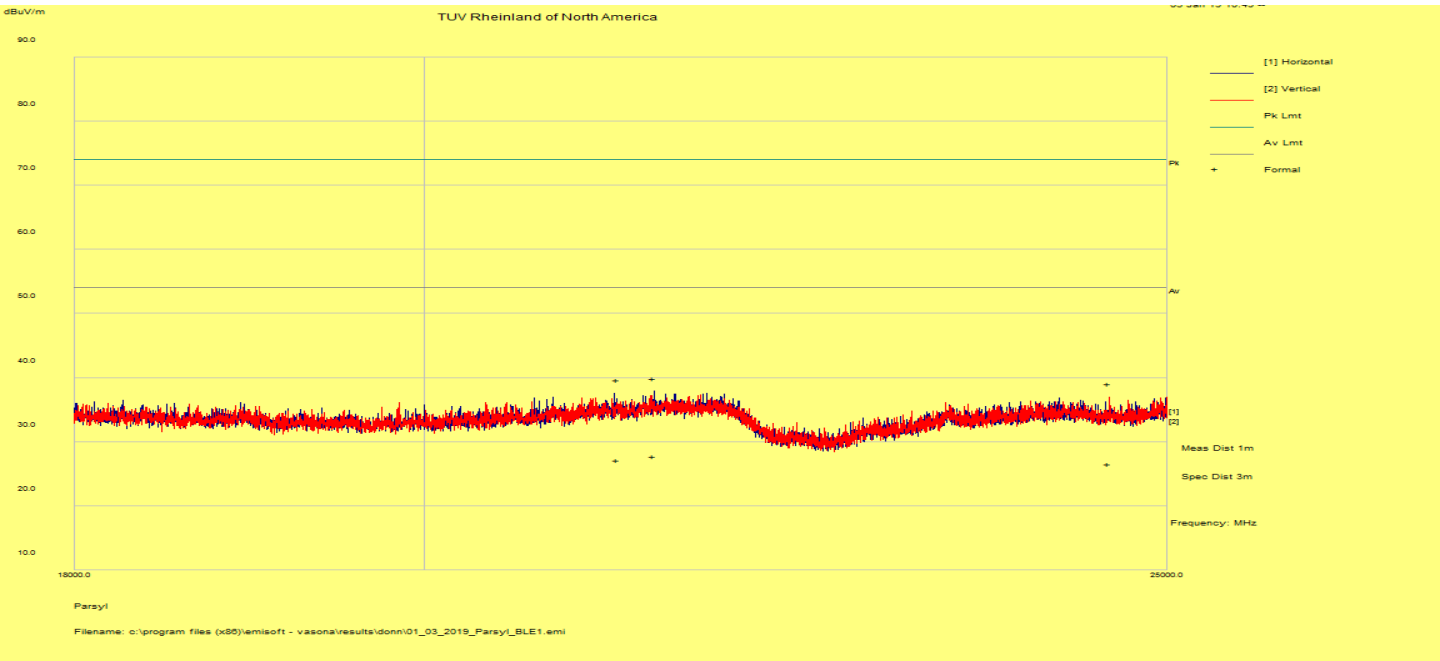
Channel 26 Horizontal Orientation

Frequency	Raw	able Los	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
24137.79	43.07	8.09	-12.31	38.86	Peak Max	H	150	240	74.00	-35.14	Pass	
24137.79	31.34	8.09	-12.31	27.13	verage Ma	H	150	240	54.00	-26.87	Pass	
21688.59	42.15	7.72	-9.79	40.08	Peak Max	V	150	244	74.00	-33.92	Pass	
21688.59	29.61	7.72	-9.79	27.54	verage Ma	V	150	244	54.00	-26.47	Pass	
23485.32	40.94	7.81	-11.58	37.17	Peak Max	V	150	74	74.00	-36.83	Pass	
23485.32	29.73	7.81	-11.58	25.96	verage Ma	V	150	74	54.00	-28.04	Pass	



Channel 39 Horizontal Orientation

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
21030.60	39.87	7.60	-9.25	38.22	Peak Max	V	150	345	74.00	-35.78	Pass	
21030.60	28.46	7.60	-9.25	26.81	verage Ma	V	150	345	54.00	-27.19	Pass	
21149.48	40.49	7.60	-9.33	38.76	Peak Max	V	150	186	74.00	-35.24	Pass	
21149.48	28.64	7.60	-9.33	26.91	verage Ma	V	150	186	54.00	-27.09	Pass	
24308.07	43.21	8.24	-12.51	38.94	Peak Max	V	150	212	74.00	-35.07	Pass	
24308.07	31.47	8.24	-12.51	27.19	verage Ma	V	150	212	54.00	-26.81	Pass	



Channel 26 Vertical Orientation

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin	Result	Comments
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB		
21423.20	41.75	7.70	-9.51	39.94	Peak Max	H	150	124	74.00	-34.06	Pass	
21423.20	29.55	7.70	-9.51	27.74	Average Max	H	150	124	54.00	-26.26	Pass	
21188.62	41.39	7.60	-9.36	39.63	Peak Max	V	150	74	74.00	-34.37	Pass	
21188.62	28.94	7.60	-9.36	27.18	Average Max	V	150	74	54.00	-26.82	Pass	
24565.30	43.59	8.17	-12.78	38.99	Peak Max	V	150	0	74.00	-35.01	Pass	
24565.30	31.11	8.17	-12.78	26.50	Average Max	V	150	0	54.00	-27.50	Pass	

10.6 Conducted Emissions

Testing was performed in accordance with ANSI C63.10: 2013. These test methods are listed under the laboratory's A2LA Scope of Accreditation.

This test measures the levels emanating from the EUT's AC input port, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices.

The AC conducted emissions of equipment under test shall not exceed the values in CFR47 Part 15.207 and RSS247

10.6.1 Test Methodology

A test program that controls instrumentation and data logging was used to automate the AC Power Line Conducted emission test procedure. The frequency range of interest was divided into sub-ranges such as to yield a frequency resolution of 9 kHz. Each phase and neutral of the AC power line were measured with respect to ground. Measurements were performed using a 50µH / 50Ω LISNs.

10.6.1.1 Deviations

There were no deviations from this test methodology.

Note: The system is battery operated testing is not applicable.

11 Test Equipment Use List

11.1 Equipment List

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal mm/dd/yyyy	Next Cal mm/dd/yyyy
Bilog Antenna	Sunol Sciences	JB3	A102606	11/20/2017	11/20/2019
Horn Antenna	Sunol Science	DRH118	A040806	03/05/2018	03/05/2019
Horn Antenna	Com-Power	AHA-840	105005	05/26/2017	05/26/2019
Amplifier	Sonoma Instruments	310	165516	01/25/2018	01/25/2019
Spectrum Analyzer	Agilent	MXE	52260210	1/22/2018	1/22/2019
Spectrum Analyzer	Agilent	PXA	US513358291	01/22/2019	01/22/2019
Spectrum Analyzer	Rohde & Schwarz	ESI	1088.7490	01/22/2018	01/22/2019
Active loop antenna	Emco	6502	00062531	06/08/2018	06/08/2019
Preamplifier	Miteq	TTA1800-30-HG	2020728	01/23/2018	01/23/2019
Preamplifier	Sonoma Instruments	310N	185516	01/25/2018	01/25/2018

* Calibration of equipment past due for re-calibration will be performed expeditiously. If any equipment is found to be out of tolerance at that time, affected customers will be notified accordingly.

12 EMC Test Plan

12.1 Introduction

This section provides a description of the Equipment Under Test (EUT), configurations, operating conditions, and performance acceptance criteria. It is an overview of information provided by the manufacturer so that the test laboratory may perform the requested testing.

12.2 Customer

Customer Information

Company Name	Parsyl Inc.
Address	2714 Walnut Street
City, State, Zip	Denver CO 80205
Country	USA

Technical Contact Information

Contact	Thayer Hirsh
E-mail	thirsh@parsyl.com
Phone	(720) 613-8717

12.3 Test configurations

The reader will be set to continuously transmit at low, mid, and high channel of the BLE 2.4GHz. band

1 The tracker will be placed in the chamber on the table and tested lying flat on the table which will be referred to as horizontal and scanned for emissions. The tracker will then be placed on its long dimension edge which will be referred to as vertical and scanned for emissions per the manufacturers test documentation.
2 The tracker radio board will be modified at the antenna port to enable it to be connected to a spectrum analyzer directly from its port.

12.4 Equipment Under Test (EUT)

Table 5: EUT Specifications

EUT Specifications	
Dimensions	10cm x 3.5cm x 3cm
DC Input	3.0 VDC Battery
Environment	Indoor/Outdoor
Operating Temperature Range:	-40/+60° C
Multiple Feeds:	☐ Yes and how many ☒ No
Product Marketing Name (PMN)	Parsyl Trek
Hardware Version Identification Number (HVIN)	TrekA1 v1.1
Firmware Version Identification Number (FVIN)	n/a
Bluetooth Radio	
Operating Mode	BLE
Transmitter Frequency Band	2402 MHz to 2480 MHz
Operating Bandwidth	1 MHz
Max. Power Output	2.0 dbm
Power Setting @ Operating Channel	Max
Antenna Type	1 integrated PIFA antenna
Antenna Gain	0.39 dbi
Modulation Type	GFSK
Data Rate	1 Mbps

Table 6: Antenna Information

Number	Antenna Type	Description	Max Gain (dBi)
Antenna 1	Integrated PIFA	Max. peak gain at 2.4 GHz	0.39

Table 7: Interface Specifications

Interface Type	Cabled with what type of cable?	Is the cable shielded?	Maximum potential length of the cable?	Metallic (M), Coax (C), Fiber (F), or Not Applicable?
USB serial	USB to serial	☐ No	24”	☒ M

Table 8: Support Equipment

Equipment	Manufacturer	Model	Serial	Used for
Laptop	Dell	Inspiron	DC3BZN2	Communicating with the radio
USB to serial Adapter	Segger	JLink	260100532	Communicating with the radio
Note: None.				

Table 9: Description of Sample used for Testing

Device	Serial	RF Connection	CFR47 Part 15.247
Parsyl Trek	proto	Integrated Antenna	TX Emissions, RSE, band edge
	proto	Direct connection	TX power,OBW,PPSD,duty cycle, NR band emissions

Table 10: Description of Test Configuration used for Radiated Measurement.

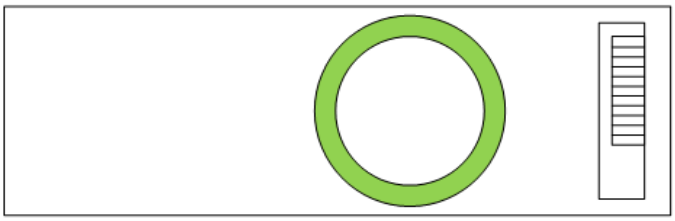
Device	Antenna	Mode	Setup (X-Axis)	Setup (Y-Axis)	Setup (Z-Axis)
Parsyl Trek	Integrated	Transmit	See Block Diag	See Block Diag	N/A
Note:					

Table 11: Final Test Mode for 2402 MHz to 2480MHz Channels

Test	802.15.4
Occupied Bandwidth CFR 47 15.247(a1), RSS247:2017	2402,2444, 2480 MHz BLE
Output Power CFR47 15.247 (b1), RSS247:2017	2402,2444, 2480 MHz BLE
Peak Power Spectral Density CFR47 15.247 (b1), RSS247:2017	2402,2444, 2480 MHz BLE
Out of Band Emission CFR47 15.247 (d), RSS247:2017	2402,2444, 2480 MHz BLE
Band-Edge FCC Part 15.205, 15.209 RSS247:2017	2402, 2480 MHz BLE
Transmitted Spurious Emission (30 MHz – 1GHz) FCC Part 15.205, 15.209 RSS247:2017	2402,2444, 2480 MHz BLE
Transmitted Spurious Emission (Above 1GHz) FCC Part 15.205, FCC Part 15.209, RSS247:2017	2402,2444, 2480 MHz BLE
AC Conducted Emission FCC Part 15.207 RSS-GEN	3.0 VDC Battery (no test required)
Note:	

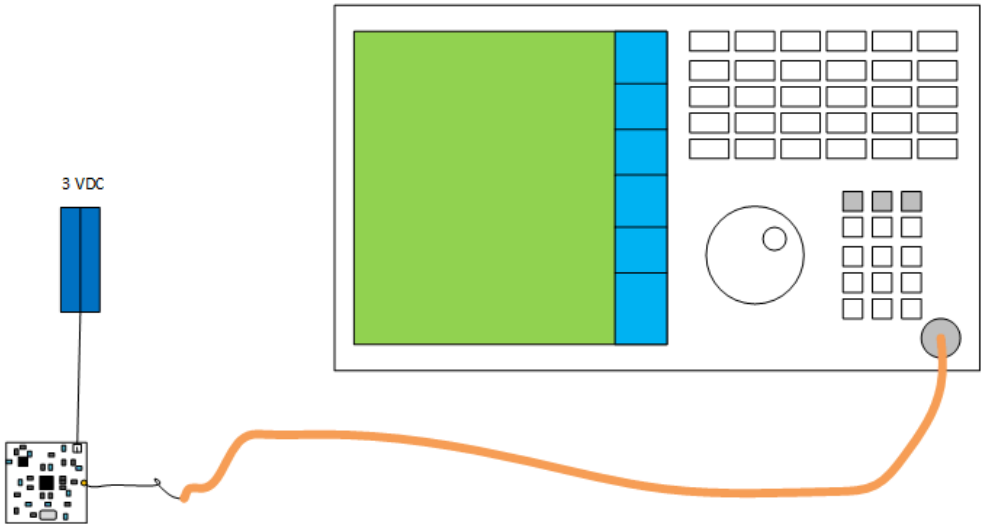
12.5 Block Diagram

Radiated Emissions test orientations



Vertical

Horizontal



12.6 Test Specifications

Testing requirements

Emissions	
Standard	Requirement
CFR 47 Part 15.247: 2018, RSS 247 Issue 2, 2017	OBW, PSD, Output power, Tx emissions
CFR 47 Part 15.205, RSS Gen	Band edge