Emissions
Test Report

EUT Name: Wireless Audio Amplifier

Model No.: Elite SuperAmp X

CFR 47 Part 15.247:2018 and RSS-247:2017

Prepared for:

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Revisions

Revision No.	Date MM/DD/YYYY	Reason for Change	Author
0	06/29/2018	Original Document	N/A

Note: Latest revision report will replace all previous reports.

Statement of Compliance

Manufacturer:	Voyetra Turtle Beach, Inc. 100 Summit Lake Drive, Suite 100 Valhalla, New York, 10595 USA
Requester / Applicant:	Tim Blaney
Name of Equipment:	Wireless Audio Amplifier
Model No.	Elite SuperAmp X (TB300-0085-01)
Type of Equipment:	Intentional Radiator
Application of Regulations:	CFR 47 Part 15.247:2018 and RSS-247:2017
Test Dates:	May 23, 2018 to June 4, 2018

Guidance Documents:

Emissions: ANSI C63.10-2013

Test Methods:

Emissions: ANSI C63.10-2013

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 Executive Summary 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 contains data that are not covered by A2LA accreditation. This report shall not be reproduced except in full, without the written authorization of TUV Rheinland of North America.

Jeremy Luong	June 29, 2018	Kerwinn Corpuz	June 29, 2018
Test Engineer	Date	Reviewer Signature	Date

Testing Cert #3331.02 **US1131** **2932M-1**

1 Executive Summary

1.1 Scope

This report is intended to document the status of conformance with the requirements of the CFR 47 Part 15.247:2018 and RSS-247:2017 based on the results of testing performed on May 23, 2018 to June 4, 2018 on the Wireless Audio Amplifier, Model: Elite SuperAmp X manufactured by Voyetra Turtle Beach, Inc. This report only applies to the specific samples tested under the stated test conditions. 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.

The report documents the 2.4 GHz Bluetooth radio characteristics for the Elite SuperAmp X.

1.3 Summary of Test Results

Table 1: Summary of Test Results

Test	Test Method ANSI C63.4:2014/ ANSI C63.10:2013	Test Parameters	Measured Value	Result
2402 MHz to 2480 MHz Band				
Spurious Emission in Transmitted Mode	CFR47 15.209, CFR47 15.247 (d) RSS-GEN Sect.8.9, RSS 247 Sect. 6.2.1.2	Class B	-1.30 dB (Margin)	**Complied**
Restricted Bands of Operation	CFR47 15.205, RSS-Gen Sect.8.10	Class B		**Complied**
AC Power Conducted Emission	CFR47 15.207, RSS-GenSect.8.8	Class B	-11.08 dB (Margin)	**N/A**
Occupied Bandwidth	CFR47 15.247 (a1), RSS GEN Sect.6.6	≥ 500 kHz	20dB BW = 1.02 MHz 99% BW = 1.00 MHz DTS BW = 506 kHz	**Complied**
Maximum Transmitted Power	CFR47 15.247 (b), RSS 247 Sect. 5.4.4, 6.2.4.1	30 dBm w/ 6 dBi antenna	2.72 mW (4.34 dBm)	**Complied**
Peak Power Spectral Density	CFR47 15.247 (e), RSS 247 Sect. 5.2.2	8 dBm/ 3 kHz	-12.45 dBm	**Complied**
Out of Band Emission	CFR47 15.247 (d), RSS 247 Sect. 5.5	< -20 dBr	- 24.55 dB Margin (-41.79 dBm @ 4.804 GHz)	**Complied**

Note: 1. Note: Since Elite SuperAmp X supports both BLE and FHSS Bluetooth, Elite SuperAmp X will demonstrate compliance to the rules required for DTS per KDB 453039.
2. This report is only documented for 2402 – 2480 MHz Bluetooth radio.

1.4 Special Accessories

No special accessories were necessary in order to achieve compliance.

1.5 Equipment Modifications

Changed the following component values in order to ensure that the radiated emissions had adequate margin below the Class B limits:

1) R156 = 0 ohms
2) L10 = 0 ohms

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). This reference number is the indication to the Industry Canada Certification Officers that the site meets the requirements of RSS 212, Issue 1 (Provisional). 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.

2.2.2 Immunity Test Facility

ESD, EFT, Surge, PQF: These tests are performed in an environmentally controlled room with a 3.7 m x 4.8 m x 3.175 mm thick aluminum floor connected to PE ground.

For ESD testing, tabletop equipment is placed on an insulated mat with a surface resistivity of 10^9 Ohms/square on a 1.6 m x 0.8 m x 0.8 m high non-conductive table with a 3.175 mm aluminum top (Horizontal Coupling Plane). The HCP is connected to the main ground plane via a low impedance ground strap through two 470-kΩ resistors. The Vertical Coupling Plane consists of an aluminum plate 50 cm x 50 cm x 3.175 mm thick. The VCP is connected to the main ground plane via a low impedance ground strap through two 470-kΩ resistors.

For EFT, Surge, PQF, the HCP and VCP are removed.

RF Field Immunity testing is performed in a 7.3m x 4.3m x 4.1m anechoic chamber.

RF Conducted and Magnetic Field Immunity testing is performed on a 4.8m x 3.7m x 3.175mm thick aluminum ground plane.

All test areas allow a minimum distance of 1 meter from the EUT to walls or conducting objects.

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 @ 5 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

Voltech PM6000A

The estimated combined standard uncertainty for harmonic current and flicker measurements is ± 5.0%.	Per CISPR 16-4-2 Methods

2.3.3 Measurement Uncertainty Immunity

The estimated combined standard uncertainty for ESD immunity measurements is ± 8.2%.	Per IEC 61000-4-2
The estimated combined standard uncertainty for radiated immunity measurements is ± 4.10 dB.	Per IEC 61000-4-3
The estimated combined standard uncertainty for conducted immunity measurements with CDN is ± 3.66 dB	Per IEC 61000-4-6
The estimated combined standard uncertainty for power frequency magnetic field immunity is ± 11.6%.	Per IEC 61000-4-8

Thermo KeyTek EMC Pro

The estimated combined standard uncertainty for EFT fast transient immunity measurements is ± 5.84%.
The estimated combined standard uncertainty for surge immunity measurements is ± 5.84 %.
The estimated combined standard uncertainty for voltage variation and interruption measurements is ± 3.48%.

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.

2.4 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 Elite SuperAMP X is an audio amplifier targeted towards eSports players on Xbox ONE, but will also work on PCs. It is an audio controller which includes Bluetooth mobile connectivity for both application control, music streaming and phone calls. The USB connection can be used for voice chat, Mic Mute, and SuperHuman Hearing configuration and control.

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 connected to rated power and allowed to reach intended operating conditions. The placement of the EUT system components was guided by the test standard and selected to represent typical installation conditions.

In the case of a EUT that can operate in more than one configuration, preliminary testing was performed to determine the configuration that produced maximum radiation.

The final configuration was selected to produce the worst case radiation for emissions testing and to place the EUT in the most susceptible state for immunity testing.

3.3 Operating Mode

A description of the operation mode is given in the Test Plan Section. In the case of a EUT that can operate in more than one state, preliminary testing was performed to determine the operating mode that produced maximum radiation.

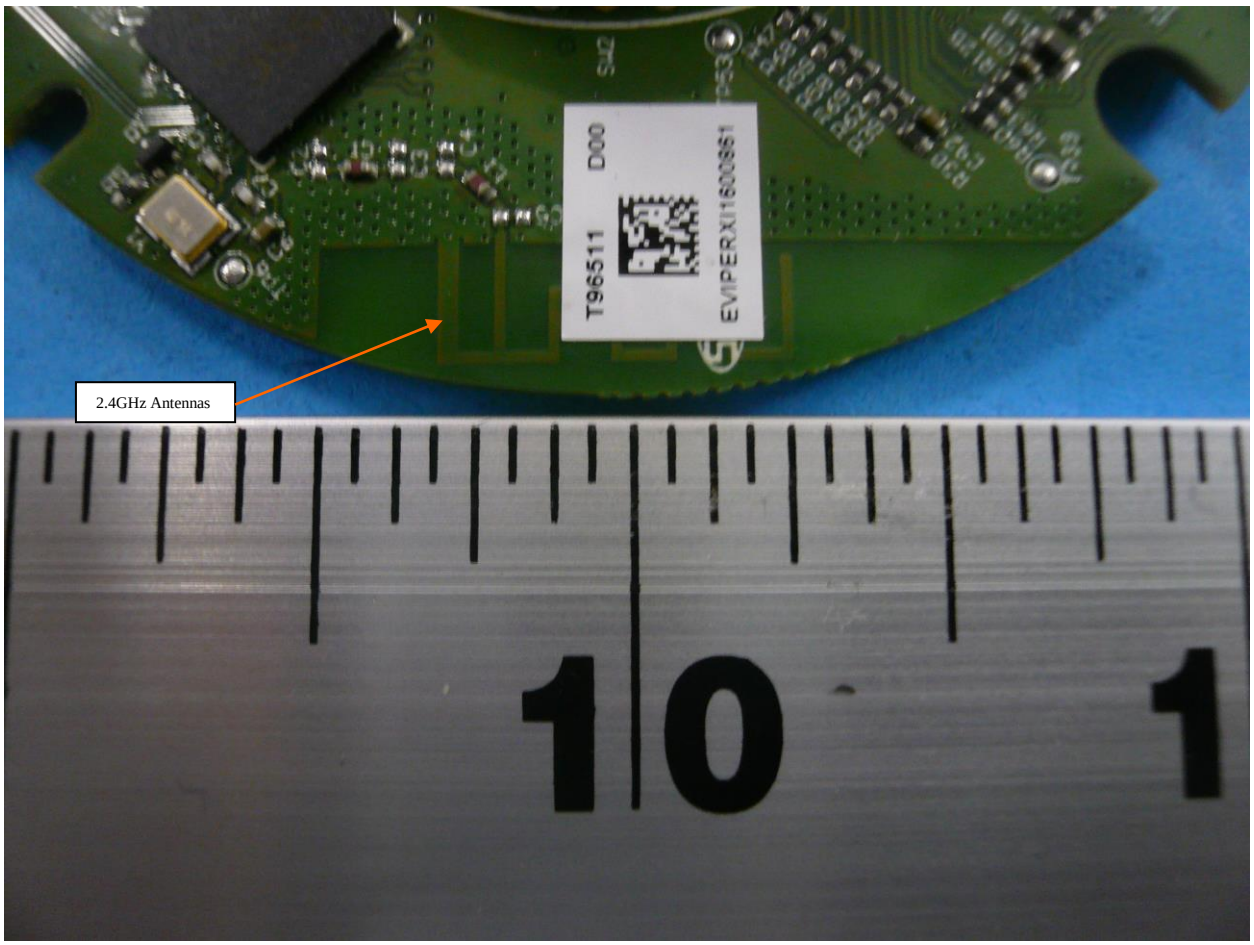
The final operating mode was selected to produce the worst case radiation for emissions testing and to place the EUT in the most susceptible state for immunity testing.

3.4 Unique Antenna Connector

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of CFR47 Parts 15.211, 15.213, 15.217, 15.219, or 15.221.

3.4.1 Results

The Elite SuperAmp X uses the permanently attached PCB trace antenna inside the device for operation at 2.4 GHz. See EUT Photo for details. There is no external antenna connection available.



3.5 Duty Cycle

The Elite SuperAmp X, SN: PP #1 was measured.

3.5.1 Results

Mode	Duty Cycle (%)	Duty Factor (dB)
DH1	30.43	5.17
DH3	65.47	1.84
DH5	76.92	1.14
2DH1	31.00	5.09
2DH3	65.57	1.83
2DH5	77.00	1.14
3DH1	30.99	5.09
3DH3	65.53	1.84
3DH5	77.06	1.13
BLE	15.08	8.22
Notes: These modes represent the maximum duty cycle; which the Bluetooth module will operate.		

4 Emission Requirements – 2400 MHz to 2483.5 MHz Band

Testing was performed in accordance with CFR 47 Part 15.247: 2018 and RSS 247 2017. These test methods are listed under the laboratory's A2LA Scope of Accreditation. This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices. Procedures described in Section 8 of the standard were used.

4.1 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.

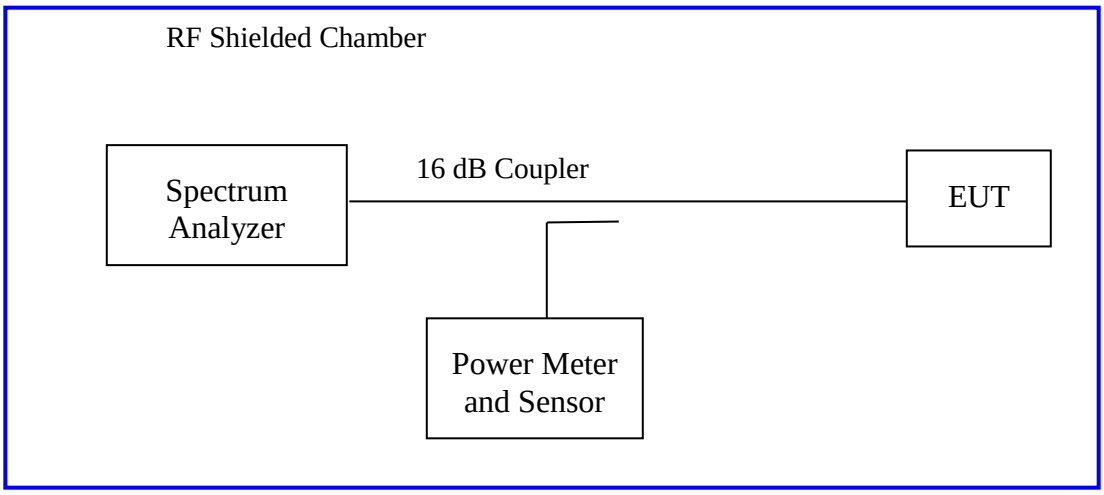
The maximum transmitted power in the band 2400-2483.5 MHz: 1 W

4.1.1 Test Method

The ANSI C63.10-2013 Section 11.9.2.2.2. Conducted method was used to measure the channel power output. The preliminary investigation was performed at different data rate to determine the highest power output for each mode. This test was conducted on 3 channels on Elite SuperAmp X, SN: PP #1. The worst mode result indicated below.

Note: Since Elite SuperAmp X supports both BLE and FHSS Bluetooth, Elite SuperAmp X will demonstrate compliance to the rules required for DTS per KDB 453039.

Test Setup:



4.1.2 Results

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

Table 2: RF Output Power at the Antenna Port – Test Results

Test Conditions: Conducted Measurement, Normal Temperature	**Date**: June 4, 2018
Antenna Type: Integrated Antenna	**Power Setting:** Fixed
Max. Antenna Gain: 1.6 dBi	**Signal State:** Modulated
Duty Cycle: See Sect. 3.5	**Data Rate:** BDR, EDR and BLE
Ambient Temp.: 23º C	**Relative Humidity:** 35 %RH

Results				
Mode	**Operating Channel**	**Limit [dBm]**	**Power [dBm]**	**Margin [dB]**
DH1	2402 MHz	+30.00	3.50	-26.50
	2442 MHz	+30.00	3.14	-26.86
	2480 MHz	+30.00	2.62	-27.38
DH3	2402 MHz	+30.00	3.42	-26.58
	2442 MHz	+30.00	3.07	-26.93
	2480 MHz	+30.00	2.54	-27.46
DH5	2402 MHz	+30.00	3.42	-26.58
	2442 MHz	+30.00	3.04	-26.96
	2480 MHz	+30.00	2.48	-27.52
2-DH1	2402 MHz	+30.00	3.96	-26.04
	2442 MHz	+30.00	3.61	-26.39
	2480 MHz	+30.00	3.05	-26.95
2-DH3	2402 MHz	+30.00	3.75	-26.25
	2442 MHz	+30.00	3.41	-26.59
	2480 MHz	+30.00	2.86	-27.14
2-DH5	2402 MHz	+30.00	3.68	-26.32
	2442 MHz	+30.00	3.30	-26.70
	2480 MHz	+30.00	2.73	-27.27

3-DH1	2402 MHz	+30.00	3.88	-26.12
	2442 MHz	+30.00	3.51	-26.49
	2480 MHz	+30.00	3.00	-27.00
3-DH3	2402 MHz	+30.00	3.72	-26.28
	2442 MHz	+30.00	3.35	-26.65
	2480 MHz	+30.00	2.79	-27.21
3-DH5	2402 MHz	+30.00	3.66	-26.34
	2442 MHz	+30.00	3.26	-26.74
	2480 MHz	+30.00	2.72	-27.28
BLE	2402 MHz	+30.00	4.34	-25.66
	2442 MHz	+30.00	4.01	-25.99
	2480 MHz	+30.00	3.51	-26.49
Note: The wireless audio amplifier is capable to transmit at BDR, EDR and BLE. The worst case condition at low, middle and high frequencies is shown below using a peak detector.				

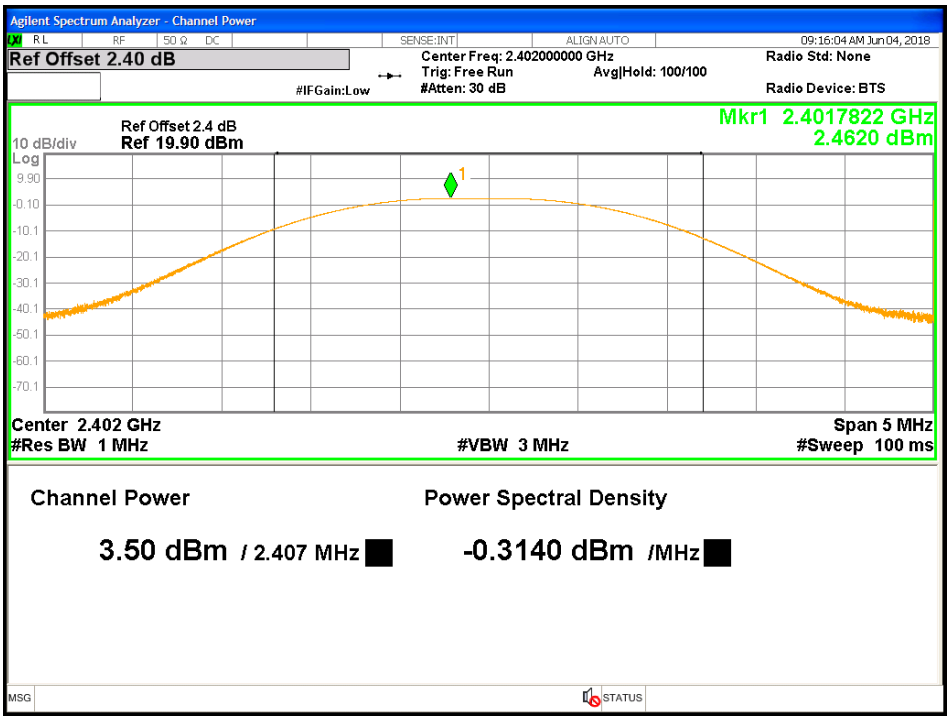


Figure 1: Maximum Transmitted Power at 2402 MHz, DH1

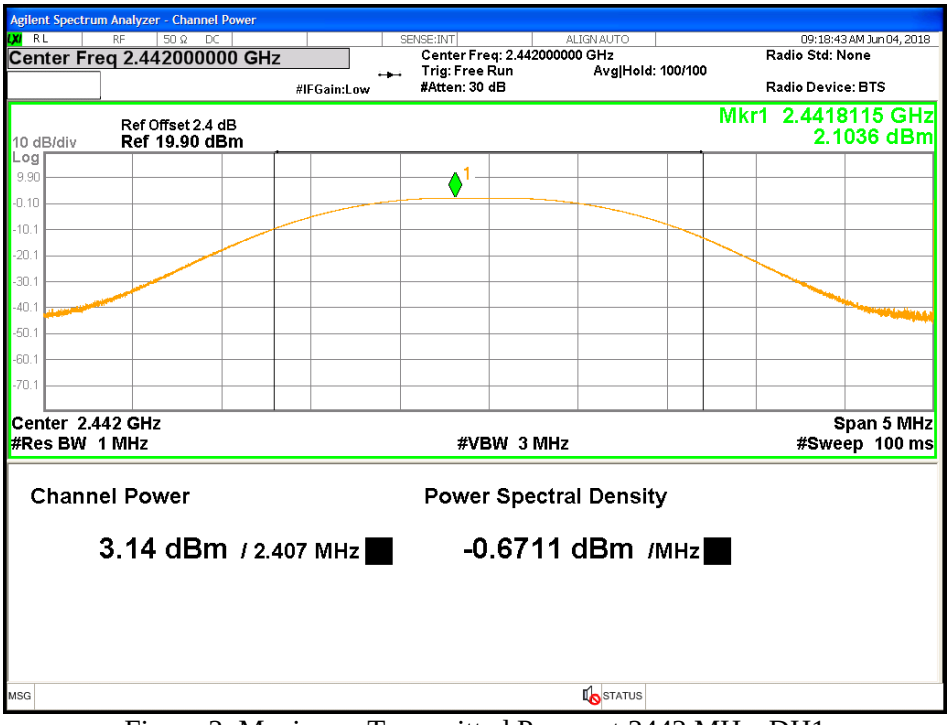


Figure 2: Maximum Transmitted Power at 2442 MHz, DH1

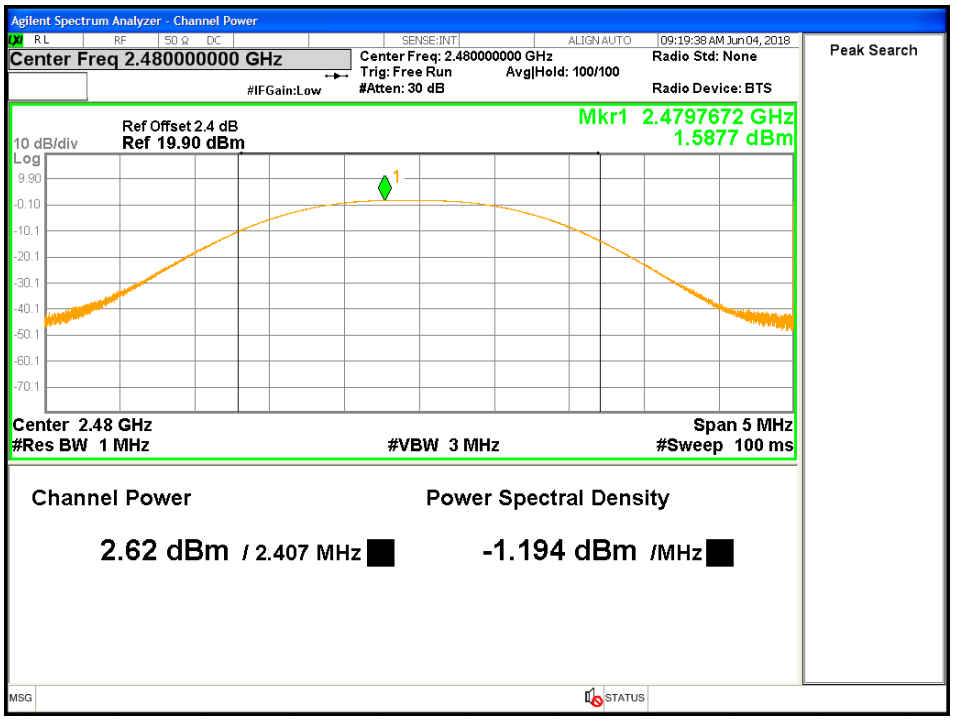


Figure 3: Maximum Transmitted Power at 2480 MHz, DH1

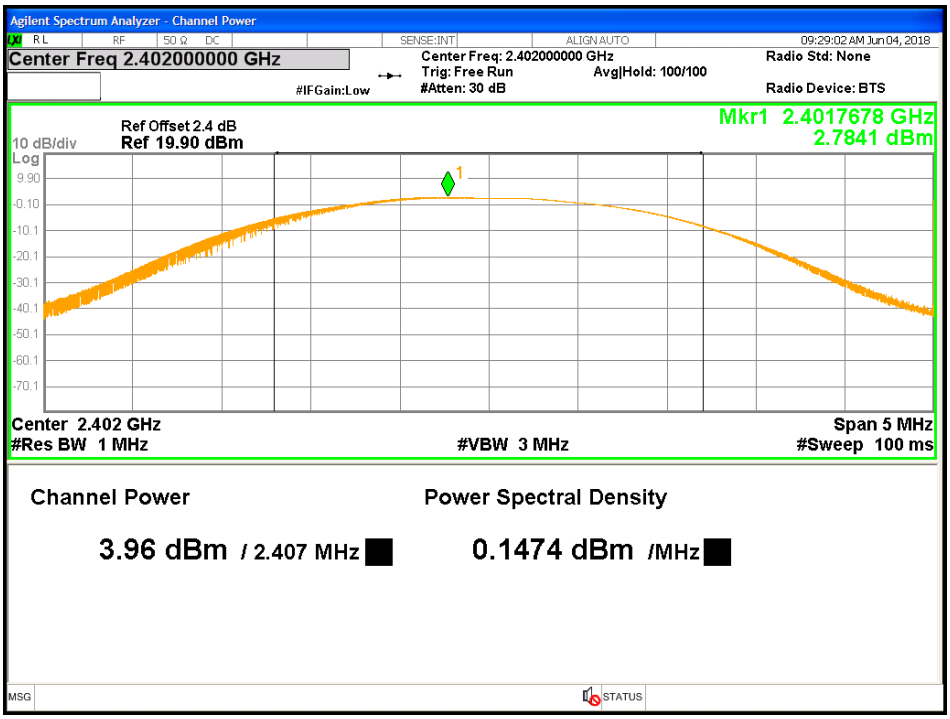


Figure 4: Maximum Transmitted Power at 2402 MHz, 2DH1

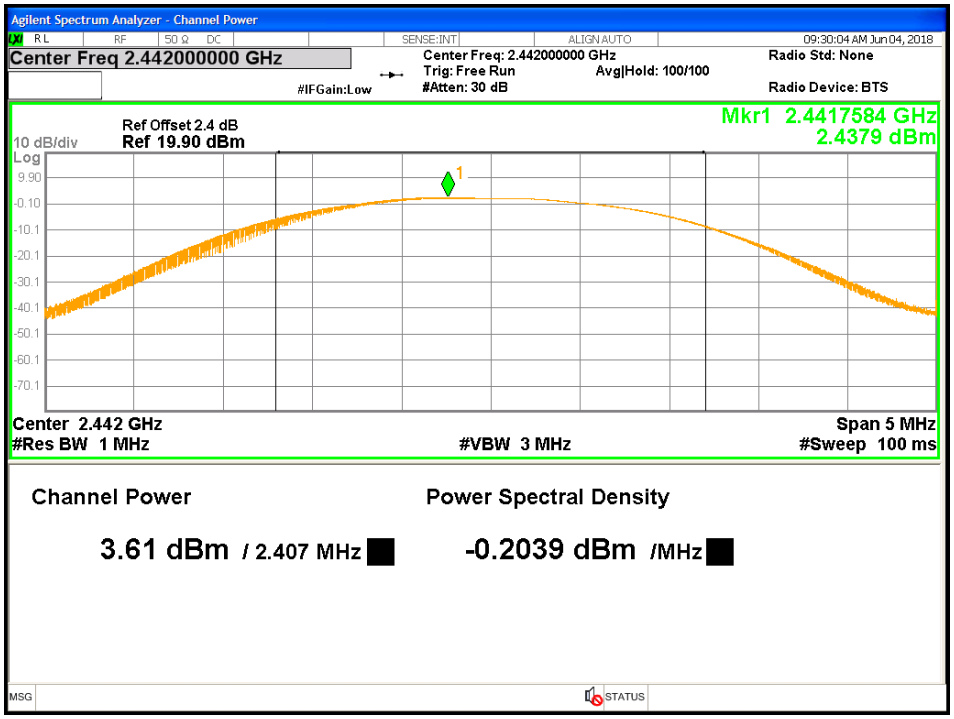


Figure 5: Maximum Transmitted Power at 2442 MHz, 2DH1

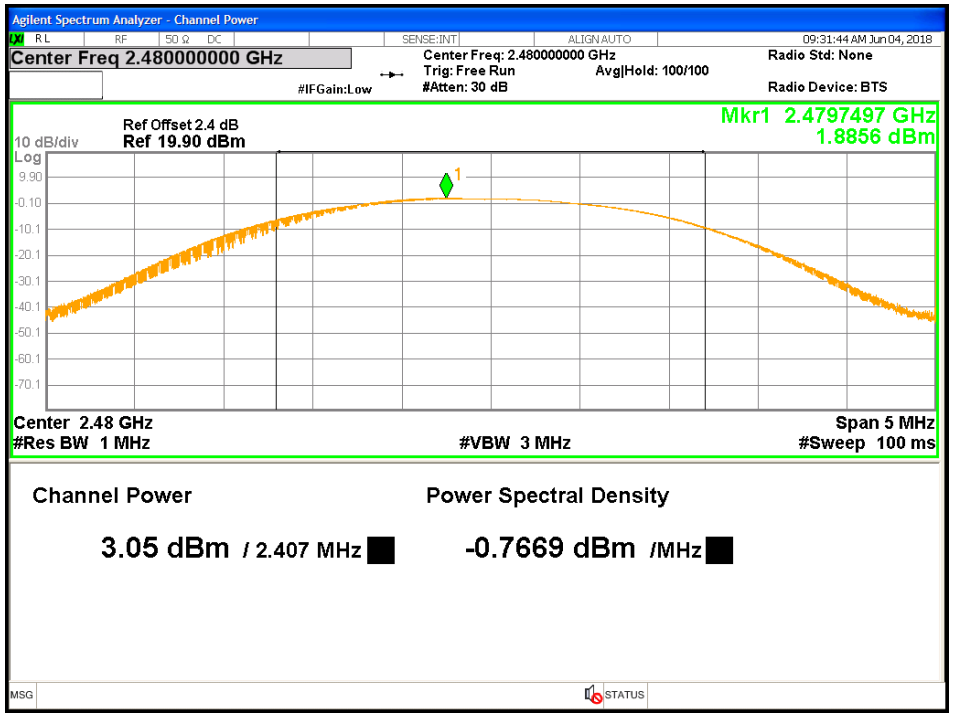


Figure 6: Maximum Transmitted Power at 2480 MHz, 2DH1

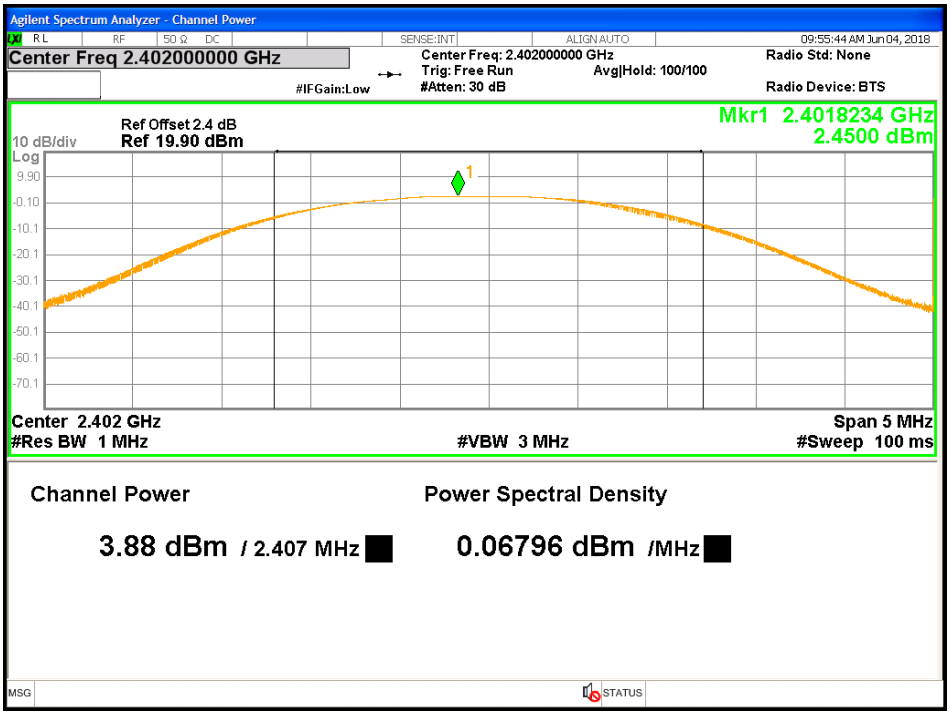


Figure 7: Maximum Transmitted Power at 2402 MHz, 3DH1

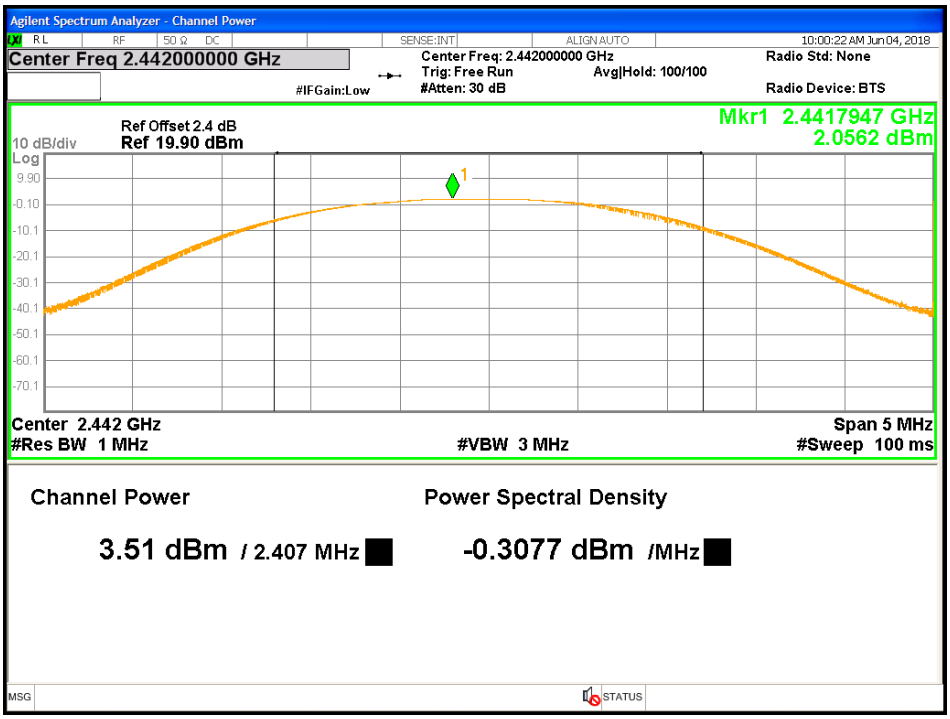


Figure 8: Maximum Transmitted Power at 2442 MHz, 3DH1

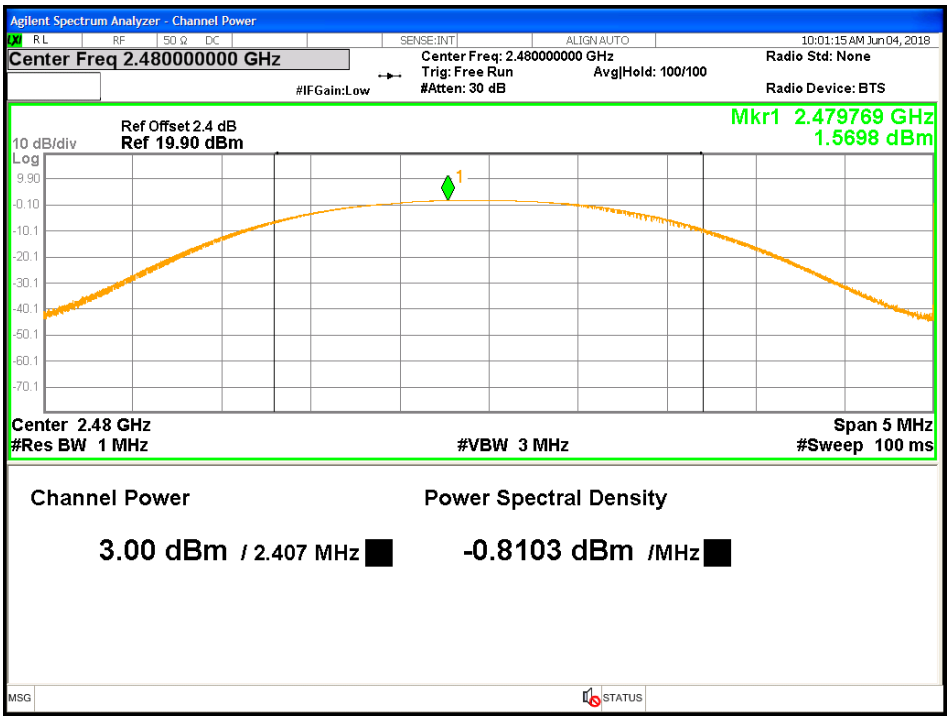


Figure 9: Maximum Transmitted Power at 2480 MHz, 3DH1

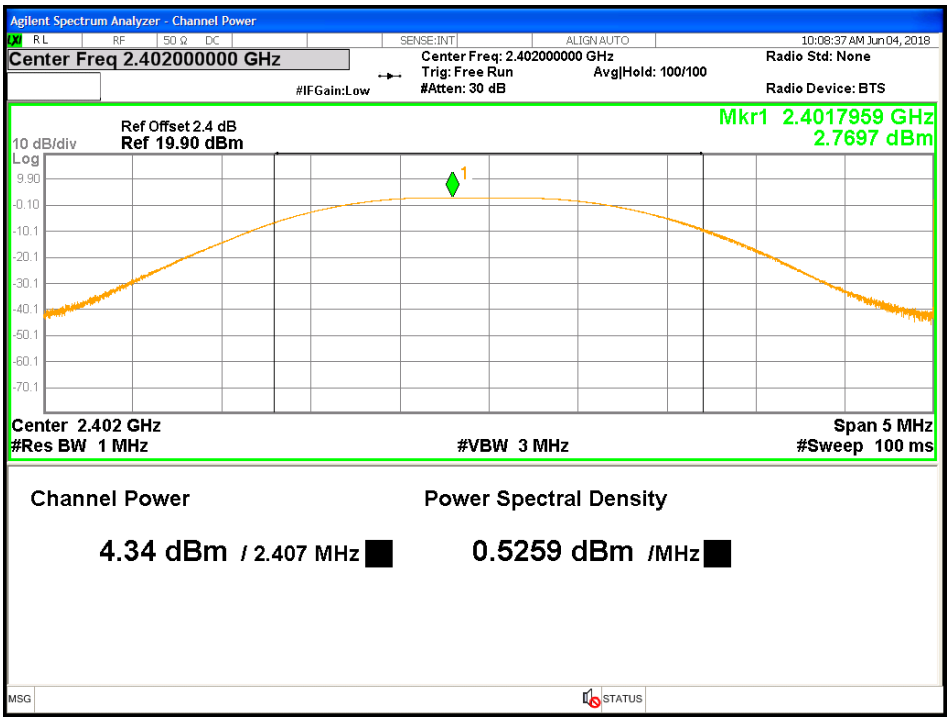


Figure 10: Maximum Transmitted Power at 2402 MHz, BLE

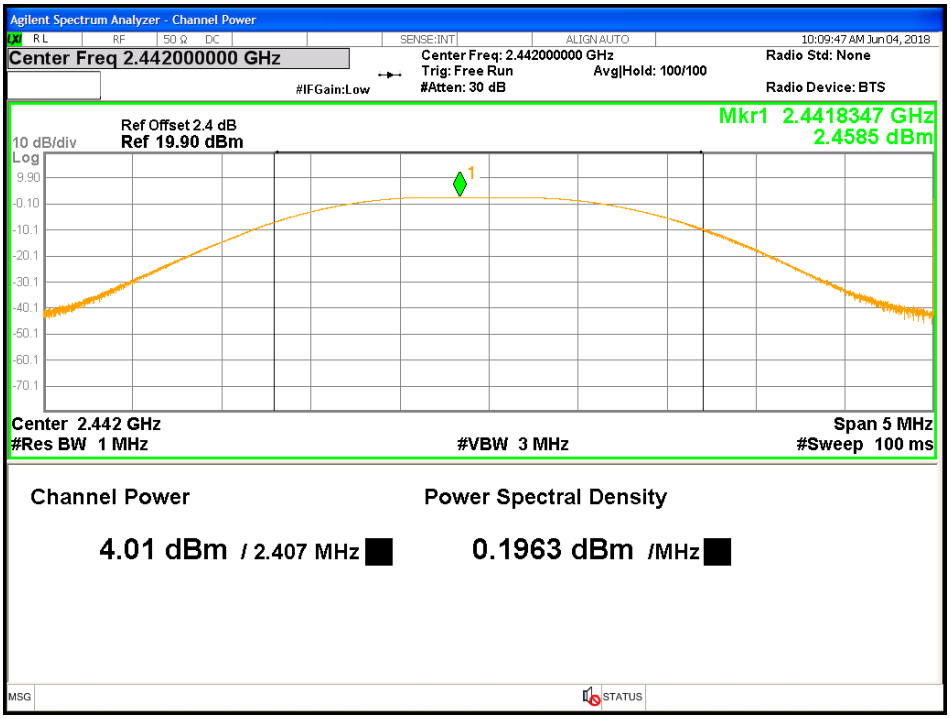


Figure 11: Maximum Transmitted Power at 2442 MHz, BLE

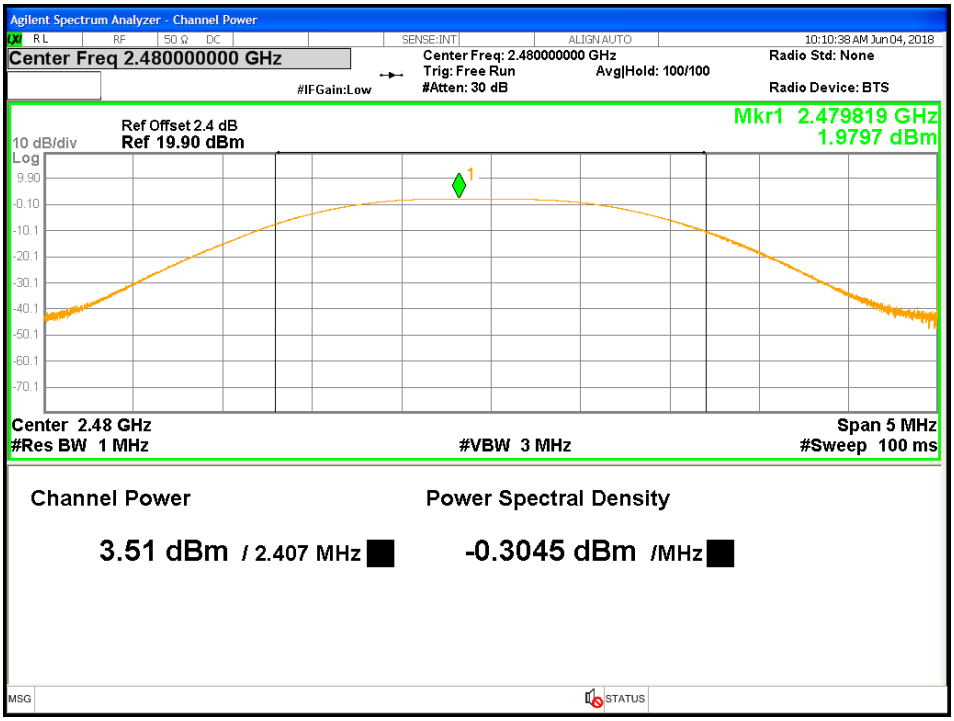


Figure 12: Maximum Transmitted Power at 2480 MHz, BLE

4.2 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.

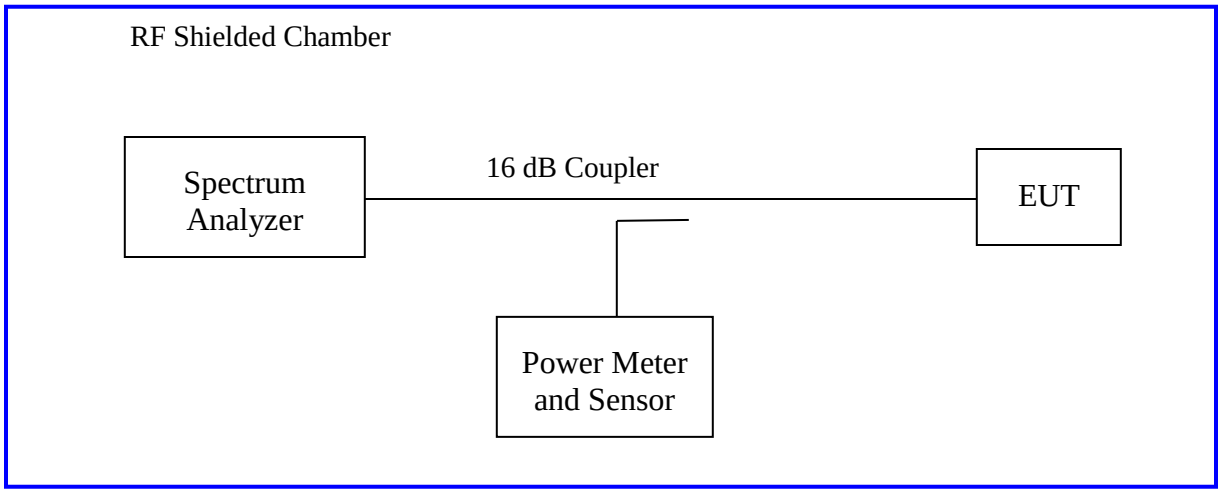
The minimum 6 dB bandwidth shall be at least 500 kHz per Section CFR47 15.247(a2) 2018 and RSS-247 Sect. 5.3(a) Issue 2, 2017.

4.2.1 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) 2018 and RSS Gen Sect. 6.6 2014. This test was conducted on 3 channels on Elite SuperAmp X, SN: PP #1. The worst sample test result is indicated below.

Note: Since Elite SuperAmp X supports both BLE and FHSS Bluetooth, Elite SuperAmp X will demonstrate compliance to the rules required for DTS per KDB 453039.

Test Setup:



4.2.2 Results

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

Table 3: Occupied Bandwidth – Test Results

Test Conditions: Conducted Measurement, Normal Temperature and Voltage only		**Date:** June 4, 2018	
Antenna Type: Integrated Antenna		**Power Setting:** Fixed.	
Max. Antenna Gain: +1.6 dBi		**Signal State:** Modulated	
Duty Cycle: See Sect. 3.5		**Data Rate:** see below	
Ambient Temp.: 23º C		**Relative Humidity:** 35 %RH	
Bandwidth for BDR and EDR			
Package	**Freq. (MHz)**	**20dB Bandwidth MHz**	**99% Bandwidth MHz**
DH1	2402	1.025	1.000
	2442	1.025	1.001
	2480	1.025	1.001
DH3	2402	1.027	1.005
	2442	1.027	1.004
	2480	1.026	1.003
DH5	2402	1.024	1.002
	2442	1.024	1.002
	2480	1.024	1.002
2-DH1	2402	1.188	1.153
	2442	1.187	1.153
	2480	1.187	1.154
2-DH3	2402	1.187	1.151
	2442	1.187	1.150
	2480	1.188	1.148
2-DH5	2402	1.173	1.140

	2442	1.172	1.141
	2480	1.172	1.141
3-DH1	2402	1.167	1.119
	2442	1.168	1.120
	2480	1.166	1.121
3-DH3	2402	1.134	1.096
	2442	1.132	1.095
	2480	1.133	1.095
3-DH5	2402	1.153	1.096
	2442	1.155	1.096
	2480	1.154	1.095
Note: 99% bandwidth and 20dB bandwidth measurements are for information only.			

Table 4: DTS Occupied Bandwidth – Test Results

Test Conditions: Conducted Measurement			**Date:** June 4, 2018	
Antenna Type: Integrated Antenna			**Power Setting:** Fixed.	
Max. Antenna Gain: +1.6 dBi			**Signal State:** Modulated	
Duty Cycle: See Sect. 3.5			**Data Rate:** see below	
Ambient Temp.: 23º C			**Relative Humidity:** 35 %RH	
Bandwidth (MHz) for BLE				
Frequency (MHz)	**Limit (MHz)**	**99% BW**	**6 dB BW**	**Results**
2402	0.500	1.035	0.513	Pass
2442	0.500	1.035	0.506	Pass
2480	0.500	1.036	0.507	Pass
Note: The DTS bandwidths were observed at BLE mode.				

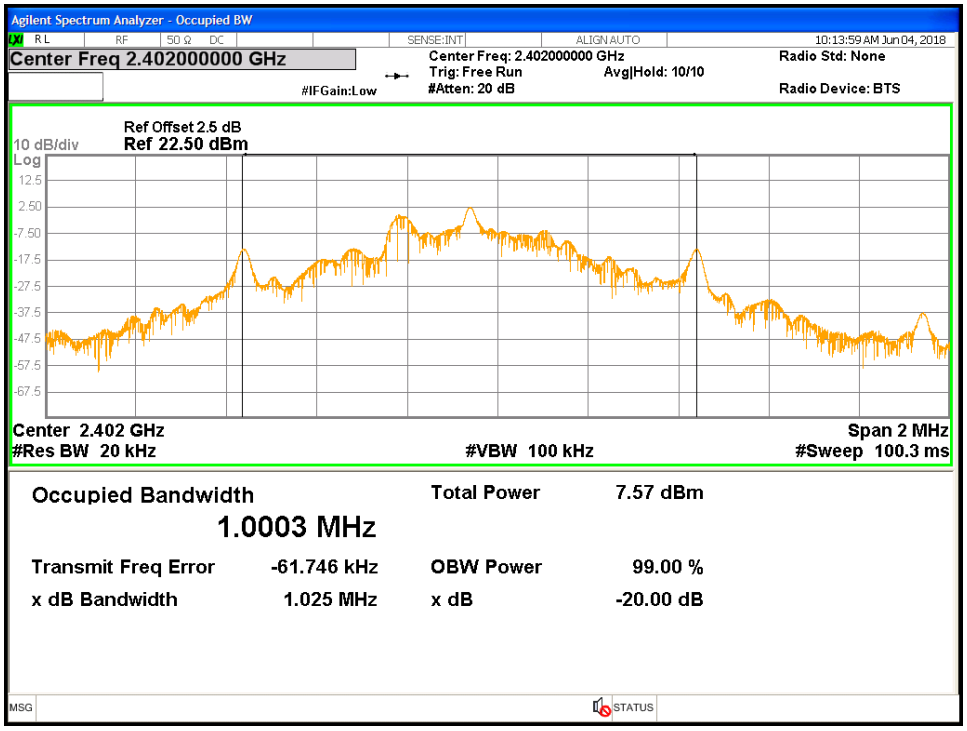


Figure 13: Occupied Bandwidth at 2402 MHz, DH1

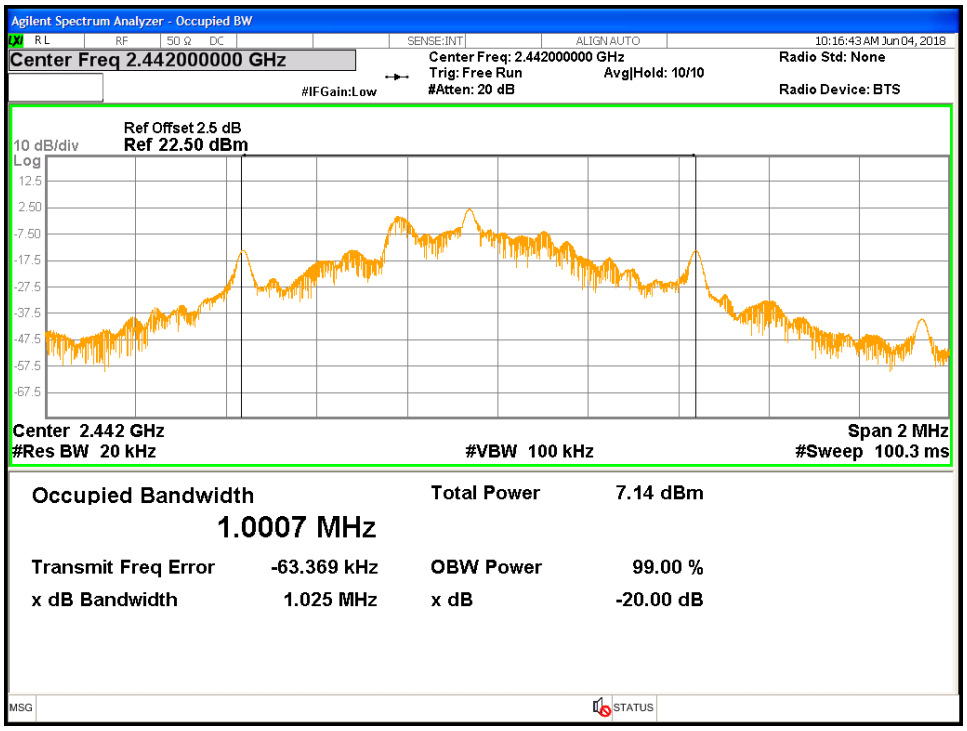


Figure 14: Occupied Bandwidth at 2442 MHz, DH1

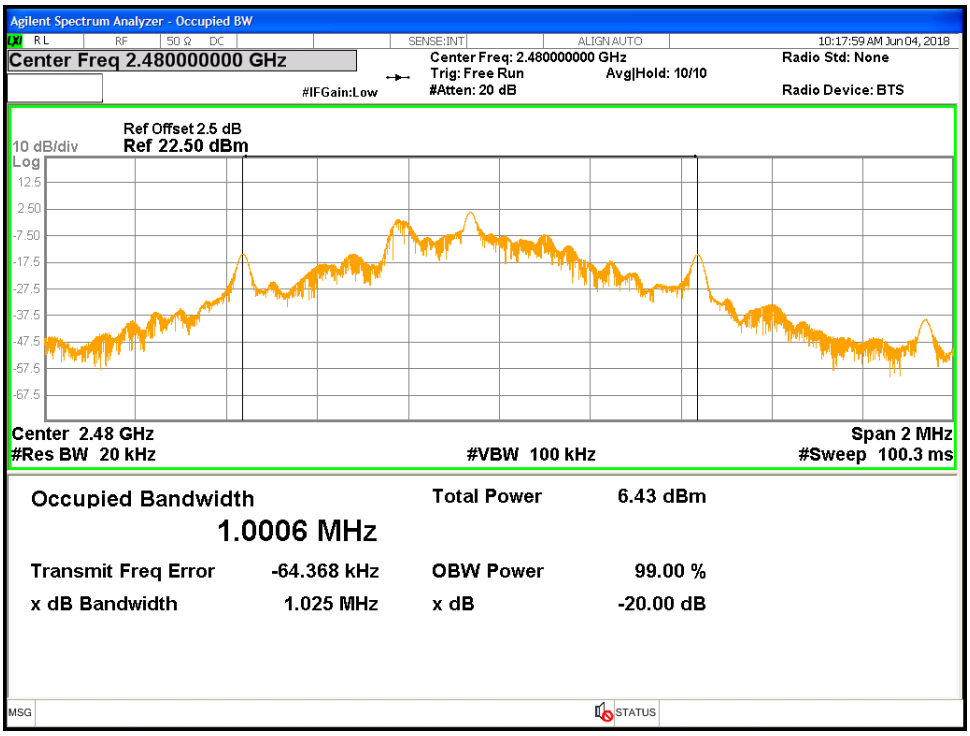


Figure 15: Occupied Bandwidth at 2480 MHz, DH1

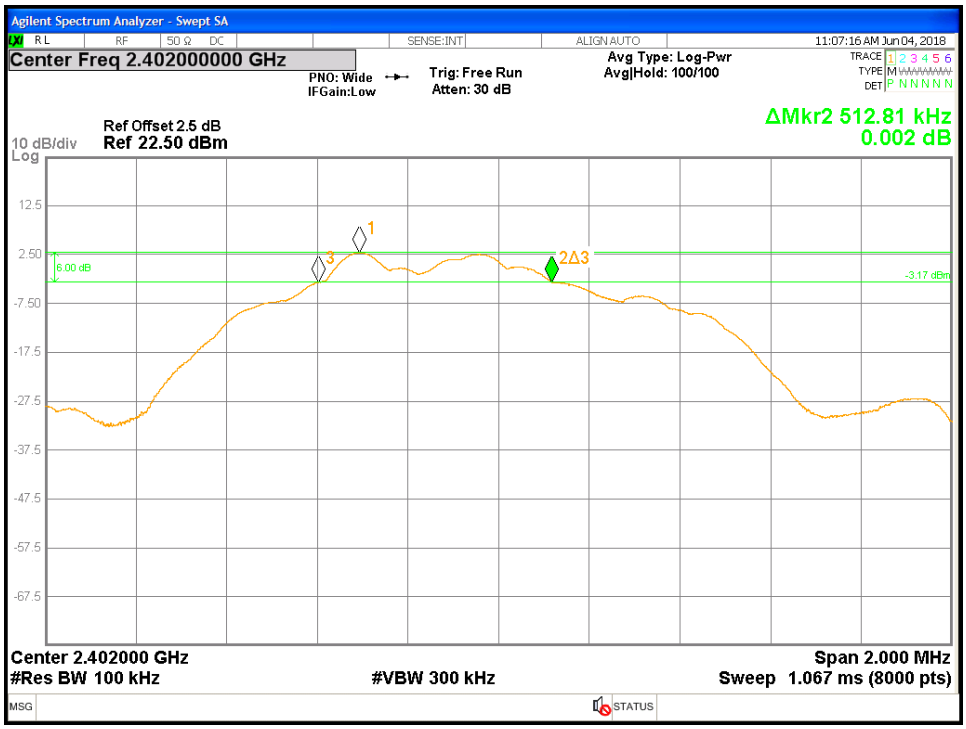


Figure 16: DTS Bandwidth-BLE-2402 MHz

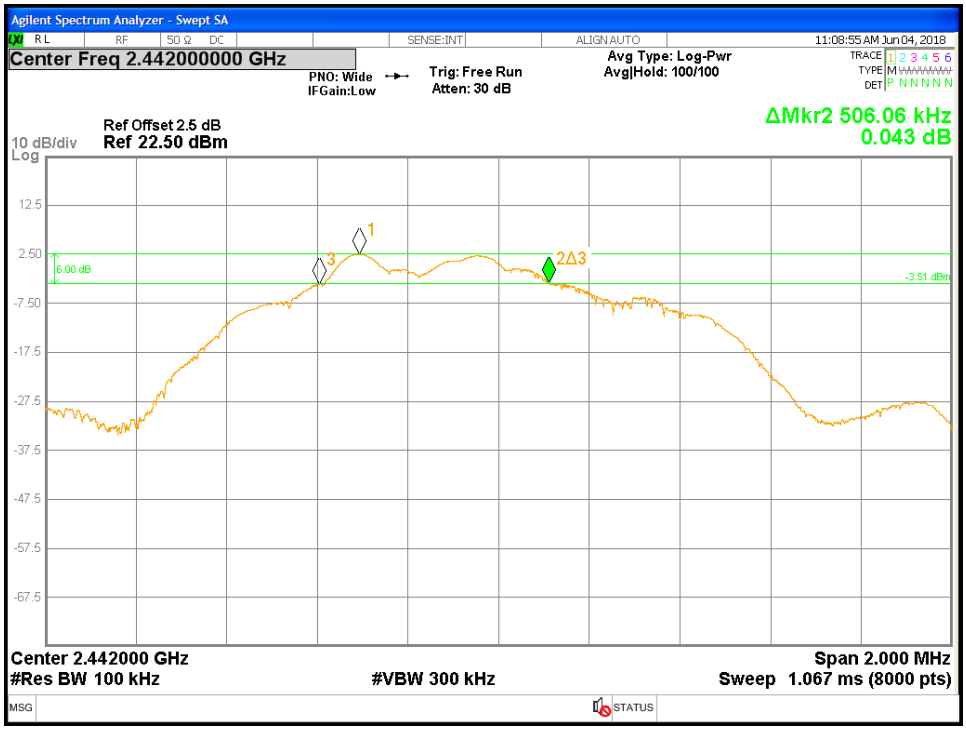


Figure 17: DTS Bandwidth-BLE-2442 MHz

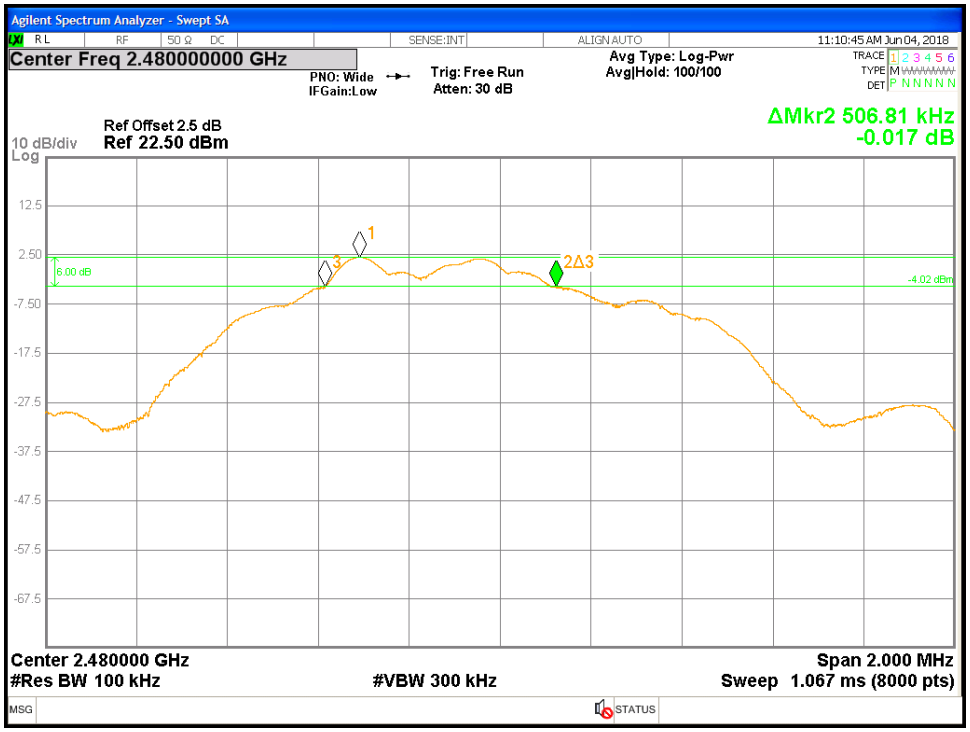


Figure 18: DTS Bandwidth-BLE-2480 MHz

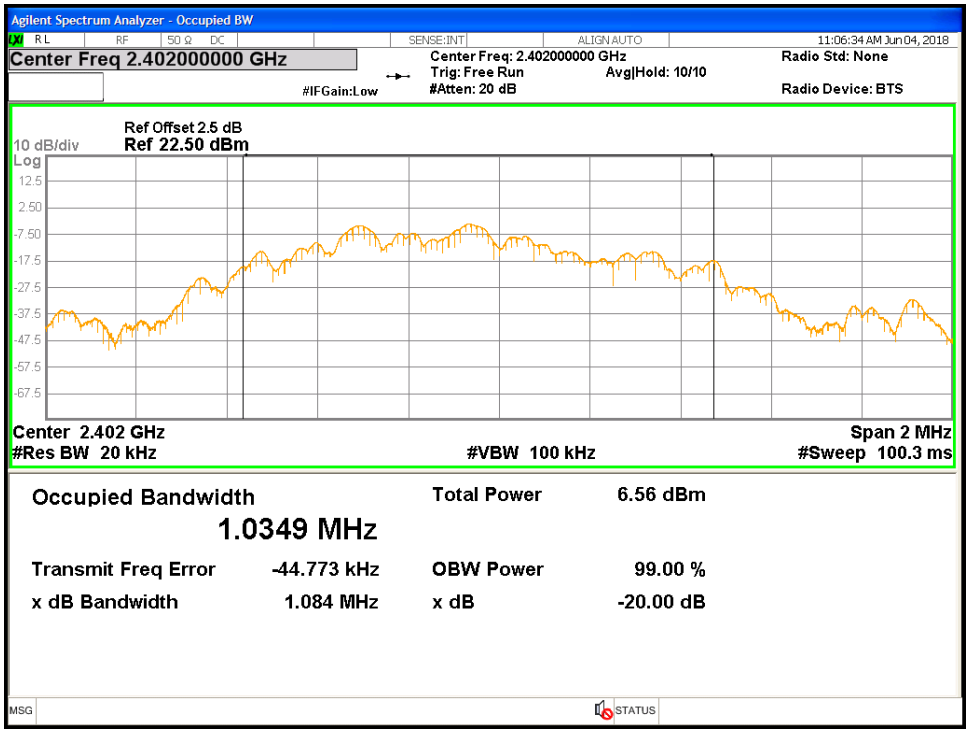


Figure 19: 99% Bandwidth-BLE-2402 MHz

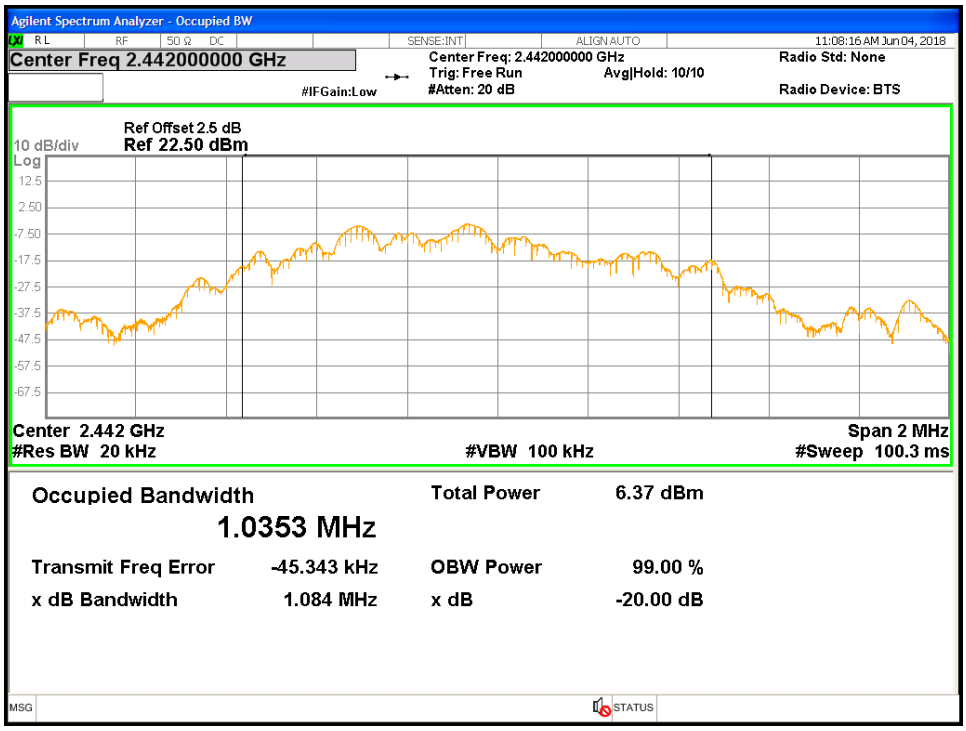


Figure 20: 99% Bandwidth-BLE-2442 MHz

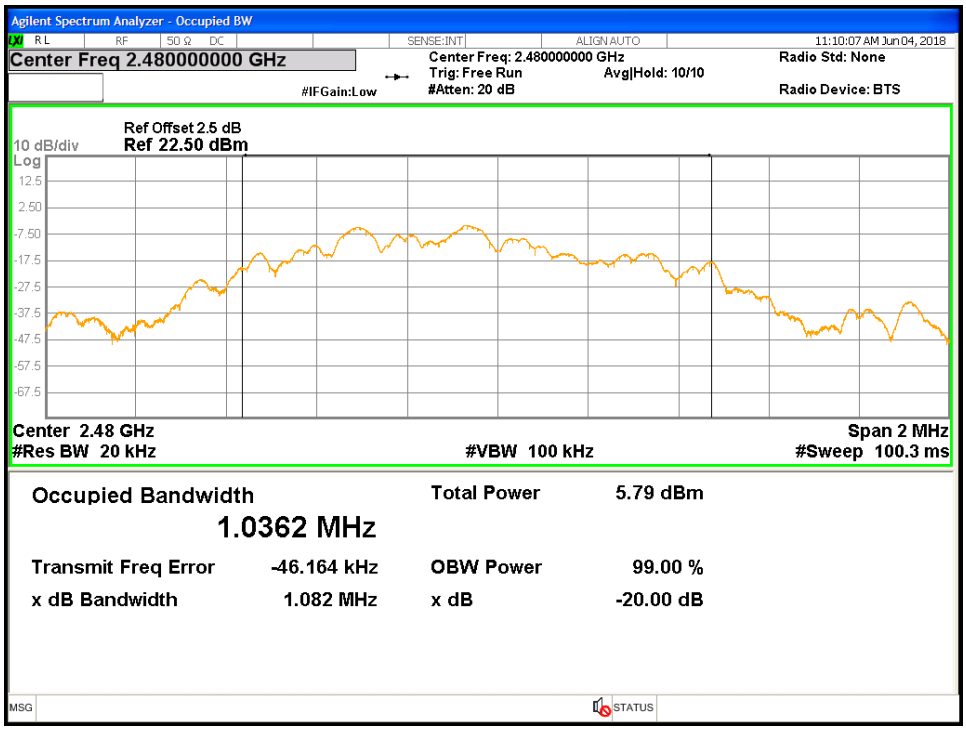


Figure 21: 99% Bandwidth-BLE-2480 MHz

4.3 Peak Power Spectral Density

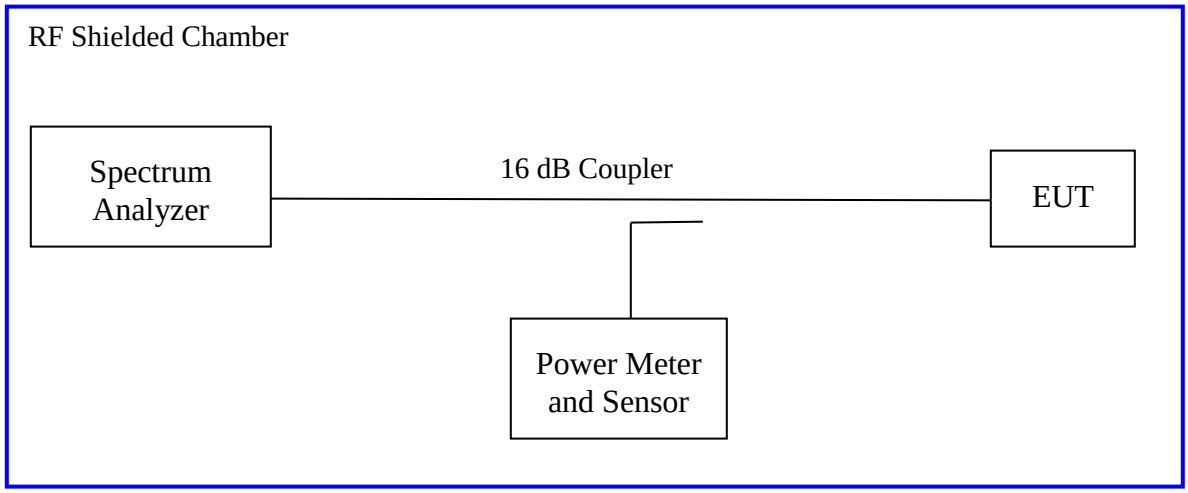
According to the CFR47 Part 15.247 (e) and RSS 247 Sect.5.2 (b), the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

4.3.1 Test Method

The conducted method was used to measure the channel power output per ANSI C63.10-2013 Section 11.10.3. The measurement was performed with modulation per CFR47 Part 15.247 (e) and RSS 247 Sect.5.2 (b). The pre-evaluation was performed to find the worst modes. The worst findings were conducted on 3 channels in each operating frequency range of 2400 MHz to 2483.5 MHz. The worst sample test result is indicated below.

Note: Since Elite SuperAmp X supports both BLE and FHSS Bluetooth, Elite SuperAmp X will demonstrate compliance to the rules required for DTS per KDB 453039.

Test Setup:



Method AVGSA-1 of "KDB 558074 – DTS Measurement Guidance v04" applies since the EUT continuously transmits with duty cycle greater than 98%. Sample detector was used.

4.3.2 Results

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

Table 5: Peak Power Spectral Density – Test Results

Test Conditions: Conducted Measurement, Normal Temperature and Voltage only	**Date:** June 4, 2018
Antenna Type: Integrated Antenna	**Power Setting:** Fixed
Max. Antenna Gain: +1.6 dBi	**Signal State:** Modulated
Duty Cycle: See Sect. 3.5	**Data Rate:** BDR, EDR, BLE
Ambient Temp.: 23º C	**Relative Humidity:** 35 %RH

Peak Power Spectral Density

Mode	Freq. (MHz)	Output [dBm]	CF [dB]	Max. PPSD [dBm]	Limit [dBm]	Margin [dB]
DH1	2402	2.52	-15.23	-12.71	8.00	-20.71
	2442	2.06	-15.23	-13.17	8.00	-21.17
	2480	1.53	-15.23	-13.70	8.00	-21.70
DH3	2402	2.35	-15.23	-12.88	8.00	-20.88
	2442	1.97	-15.23	-13.26	8.00	-21.26
	2480	1.44	-15.23	-13.79	8.00	-21.79
DH5	2402	2.26	-15.23	-12.97	8.00	-20.97
	2442	1.89	-15.23	-13.34	8.00	-21.34
	2480	1.36	-15.23	-13.87	8.00	-21.87
2DH1	2402	2.39	-15.23	-12.84	8.00	-20.84
	2442	2.04	-15.23	-13.19	8.00	-21.19
	2480	1.49	-15.23	-13.74	8.00	-21.74
2DH3	2402	2.35	-15.23	-12.88	8.00	-20.88
	2442	1.94	-15.23	-13.29	8.00	-21.29
	2480	1.40	-15.23	-13.83	8.00	-21.83
2DH5	2402	2.28	-15.23	-12.95	8.00	-20.95
	2442	1.92	-15.23	-13.31	8.00	-21.31
	2480	1.37	-15.23	-13.86	8.00	-21.86
3DH1	2402	2.37	-15.23	-12.86	8.00	-20.86
	2442	2.02	-15.23	-13.21	8.00	-21.21
	2480	1.48	-15.23	-13.75	8.00	-21.75
DH3	2402	2.30	-15.23	-12.93	8.00	-20.93
	2442	1.92	-15.23	-13.31	8.00	-21.31
	2480	1.40	-15.23	-13.83	8.00	-21.83
3DH5	2402	2.27	-15.23	-12.96	8.00	-20.96
	2442	1.89	-15.23	-13.34	8.00	-21.34
	2480	1.34	-15.23	-13.89	8.00	-21.89
BLE	2402	2.78	-15.23	-12.45	8.00	-20.45
	2442	2.47	-15.23	-12.76	8.00	-20.76
	2480	1.95	-15.23	-13.28	8.00	-21.28

Note: CF accounted for the measured RBW. The bandwidth ratio is 10*log (3kHz/100kHz) or -15.23 dB.
Peak detector was used.
The worst case plots are shown below.

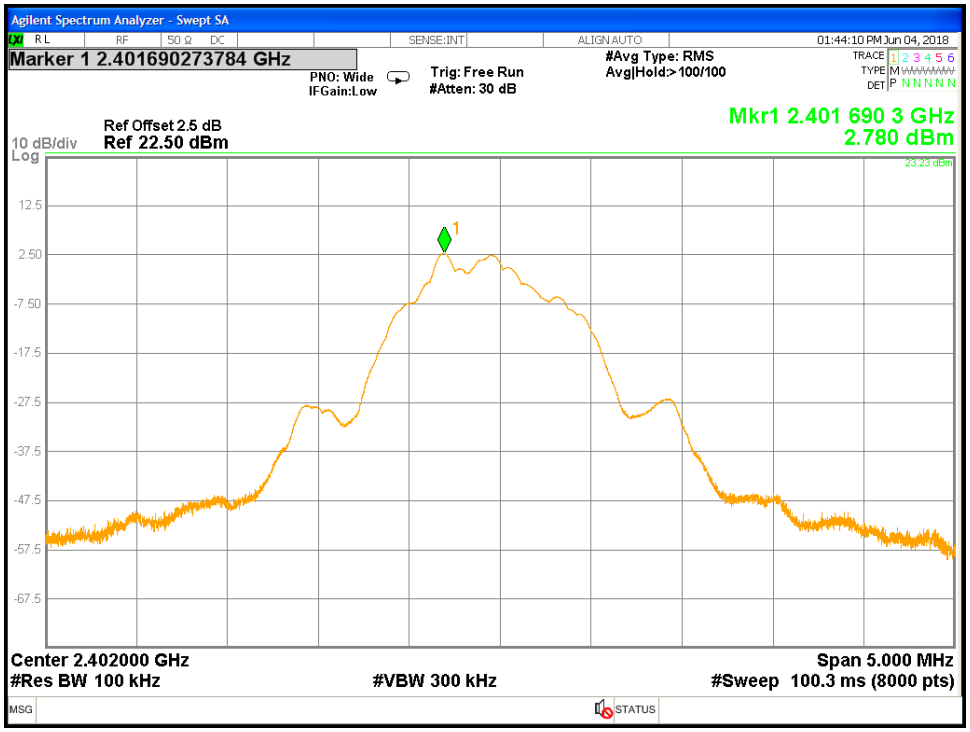


Figure 22: Maximum Power Spectral Density-2402 MHz-BLE

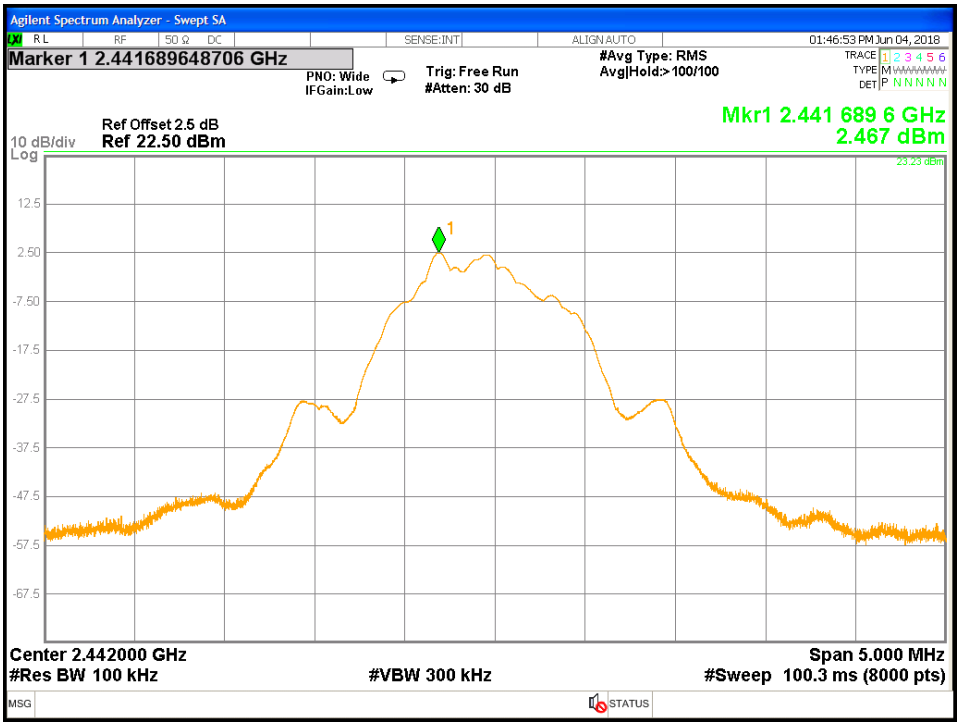


Figure 23: Maximum Power Spectral Density-2442 MHz-BLE

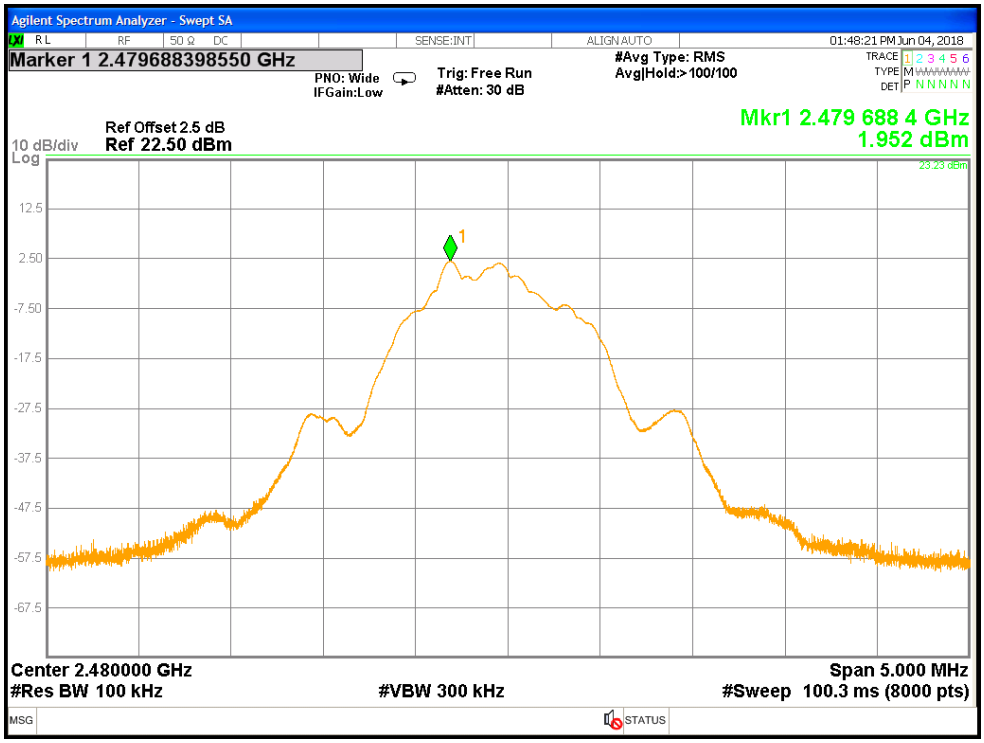


Figure 24: Maximum Power Spectral Density-2480 MHz-BLE

4.4 Out of Band Emission requirements

The setup was identical to RF output power measurement. 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.

Note: Since Elite SuperAmp X supports both BLE and FHSS Bluetooth, Elite SuperAmp X will demonstrate compliance to the rules required for DTS per KDB 453039.

The setup was identical to RF output power measurement.

This test was conducted on 3 channels on Elite SuperAmp X, SN: PP #1.

4.4.1 Results

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

Table 6: Band Edge Requirements – Test Results

Test Conditions: Conducted Measurement, Normal Temperature and Voltage only	**Date:** June 4, 2018
Antenna Type: Integrated Antenna	**Power Setting:** Fixed
Max. Antenna Gain: +1.6 dBi	**Signal State:** Modulated
Duty Cycle: See Sect. 3.5	**Data Rate:** see below
Ambient Temp.: 23º C	**Relative Humidity:** 35 %RH

-20 dBr Band Edge Results				
Mode	**Operating Freq.**	**Limit (dBm)**	**Measured Value (dBm)**	**Result**
DH1	2402 MHz	-17.60	-51.83	Pass
	2442 MHz	-17.98	-60.52	Pass
	2480 MHz	-18.58	-59.14	Pass
2-DH1	2402 MHz	-17.82	-54.09	Pass

	2442 MHz	-17.97	-59.52	Pass
	2480 MHz	-18.50	-60.50	Pass
3-DH1	2402 MHz	-17.68	-53.24	Pass
	2442 MHz	-18.95	-59.81	Pass
	2480 MHz	-18.42	-59.28	Pass
BLE	2402 MHz	-17.24	-52.19	Pass
	2442 MHz	-17.50	-60.26	Pass
	2480 MHz	-18.04	-58.62	Pass

Note: The stated limits for 20 dBr are relative to each individual output per KDB 662911 Method.
The worst case for each data rate is plotted below.

Out of Band Emission

Mode	Operating Freq.	Limit (dBm)	Measured Value (dBm)	Result
DH1	2402 MHz	-17.60	-44.63 dBm (4.803 GHz)	Pass
	2442 MHz	-17.98	-46.24 dBm (4.883 GHz)	Pass
	2480 MHz	-18.58	-46.98 dBm (23.809 GHz)	Pass
2-DH1	2402 MHz	-17.82	-44.24 dBm (4.804 GHz)	Pass
	2442 MHz	-17.97	-45.06 dBm (4.883 GHz)	Pass
	2480 MHz	-18.50	-47.33 dBm (25.837 GHz)	Pass
3-DH1	2402 MHz	-17.68	-43.34 dBm (4.804 GHz)	Pass
	2442 MHz	-18.95	-47.12 dBm (25.936 GHz)	Pass
	2480 MHz	-18.42	-47.14 dBm (4.959 GHz)	Pass
BLE	2402 MHz	-17.24	-41.79 dBm (4.804 GHz)	Pass
	2442 MHz	-17.50	-47.73 dBm (25.659 GHz)	Pass
	2480 MHz	-18.04	-47.26 dBm (25.977 MHz)	Pass

Note: The stated limits are relative to each individual output per KDB 662911 Method.

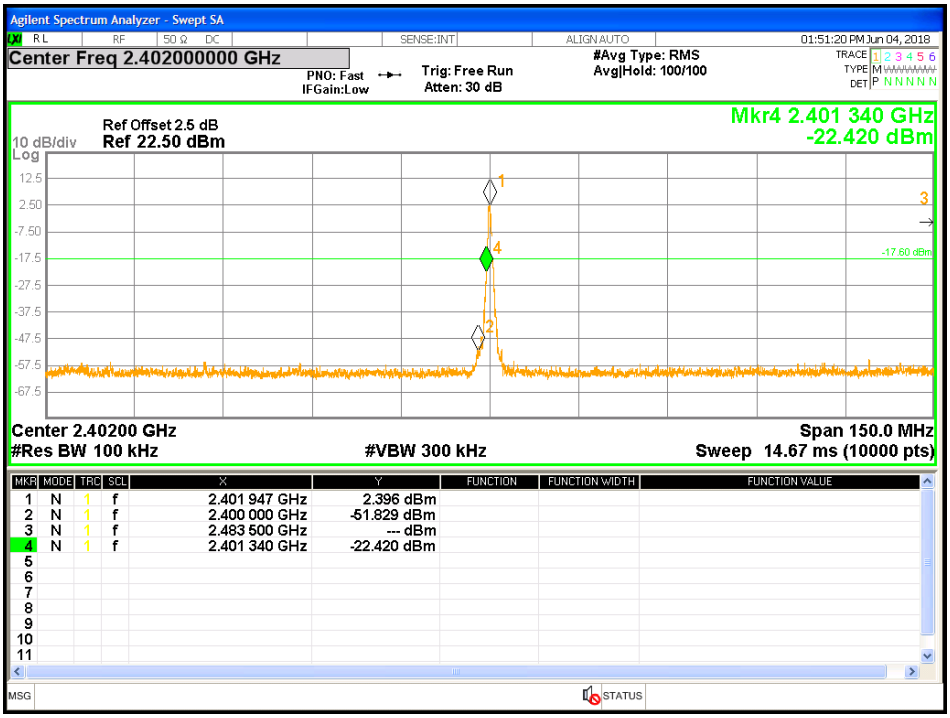


Figure 25: Band Edge Requirements at 2402 MHz – DH1

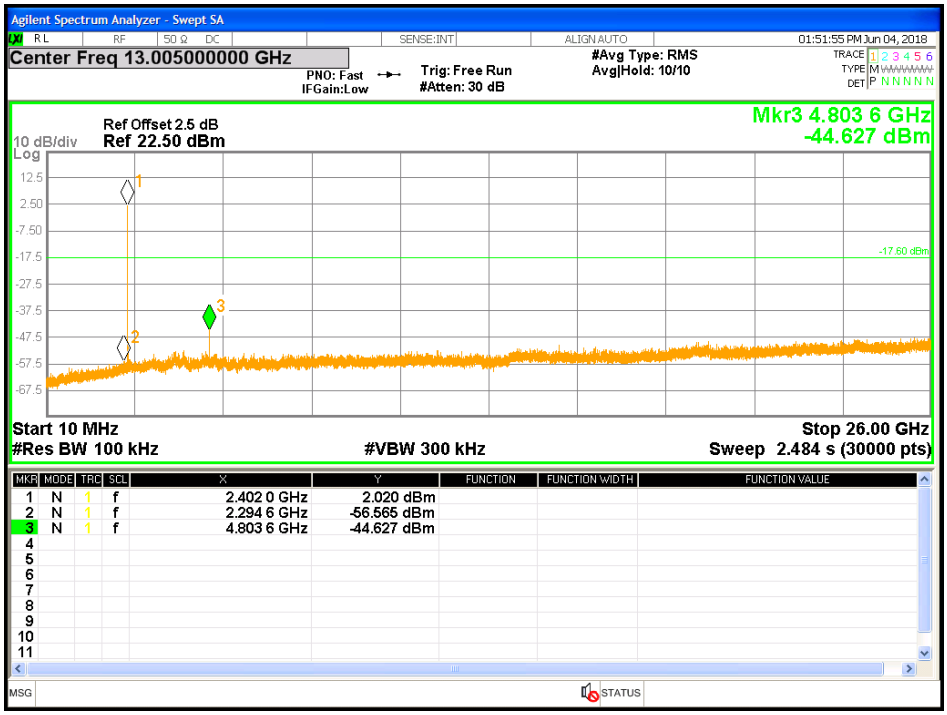


Figure 26: Out of Band Emission Requirements at 2402 MHz – DH1

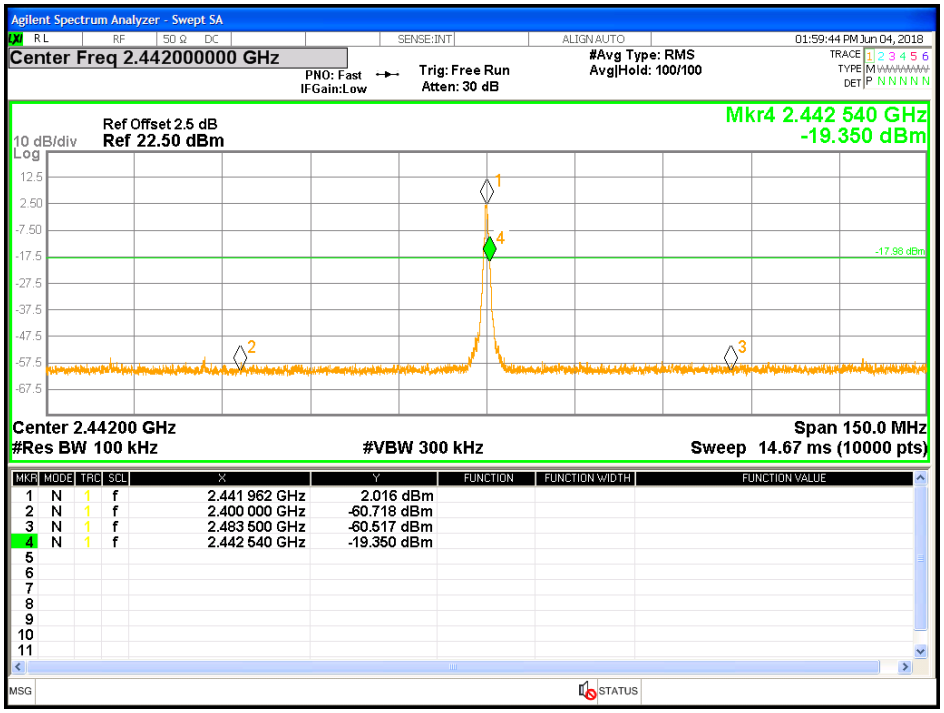


Figure 27: Band Edge Requirements at 2442 MHz – DH1

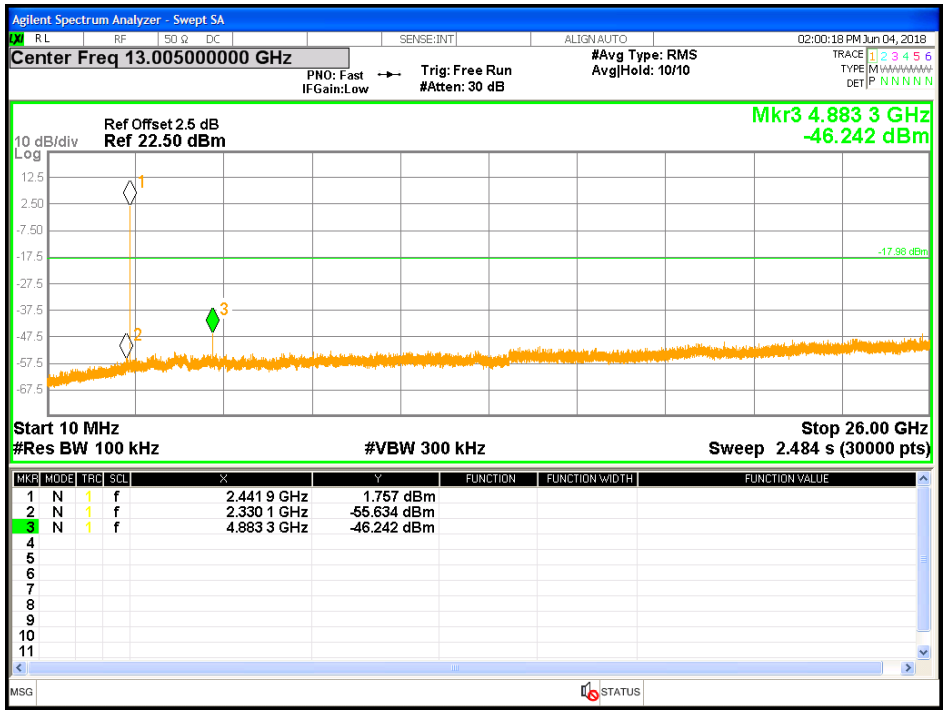


Figure 28: Out of Band Emission Requirements at 2442 MHz – DH1

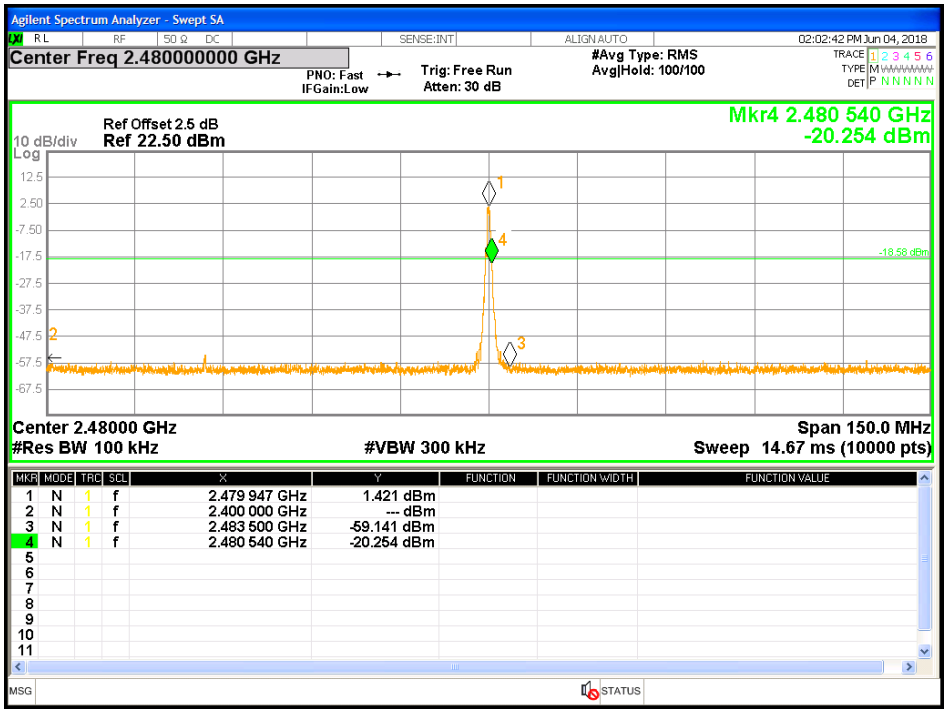


Figure 29: Band Edge Requirements at 2480 MHz – DH1

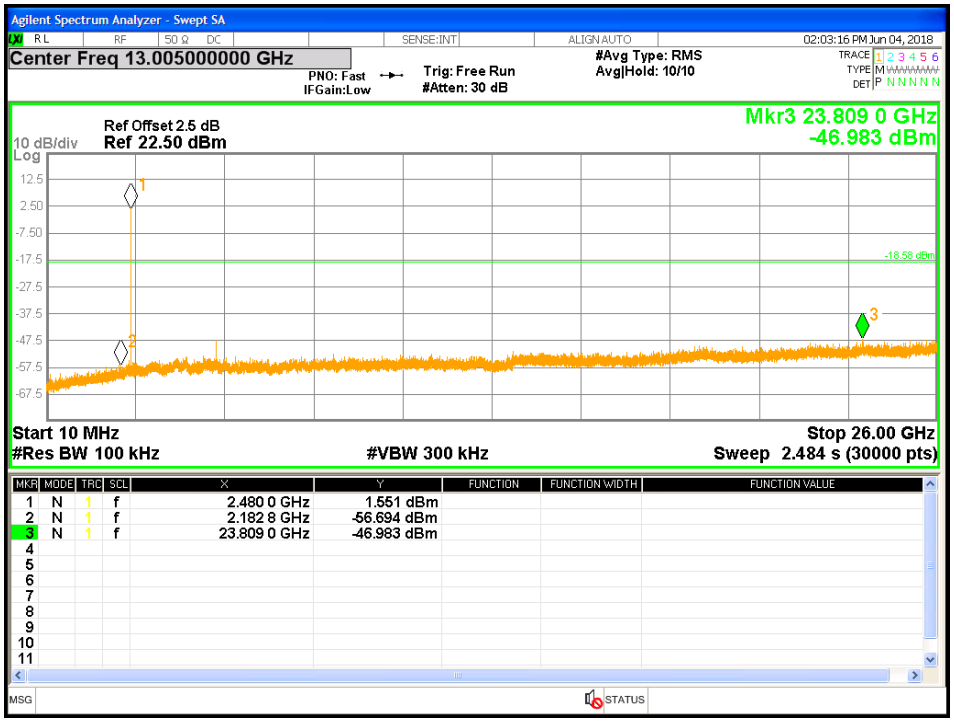


Figure 30: Out of Band Emission Requirements at 2480 MHz – DH1

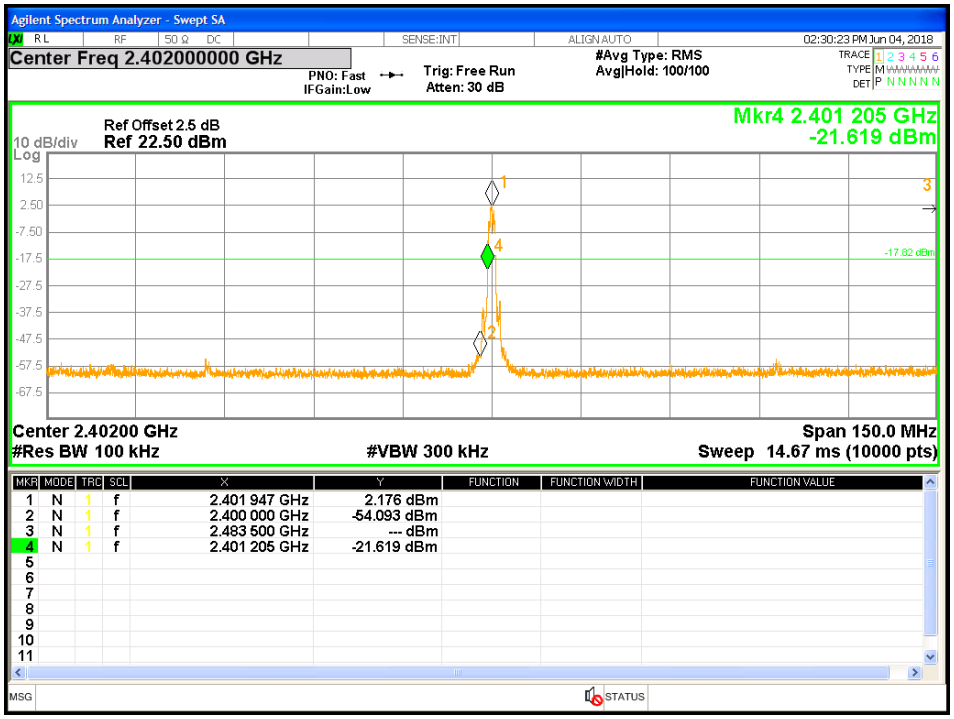


Figure 31: Band Edge Requirements at 2402 MHz – 2DH1

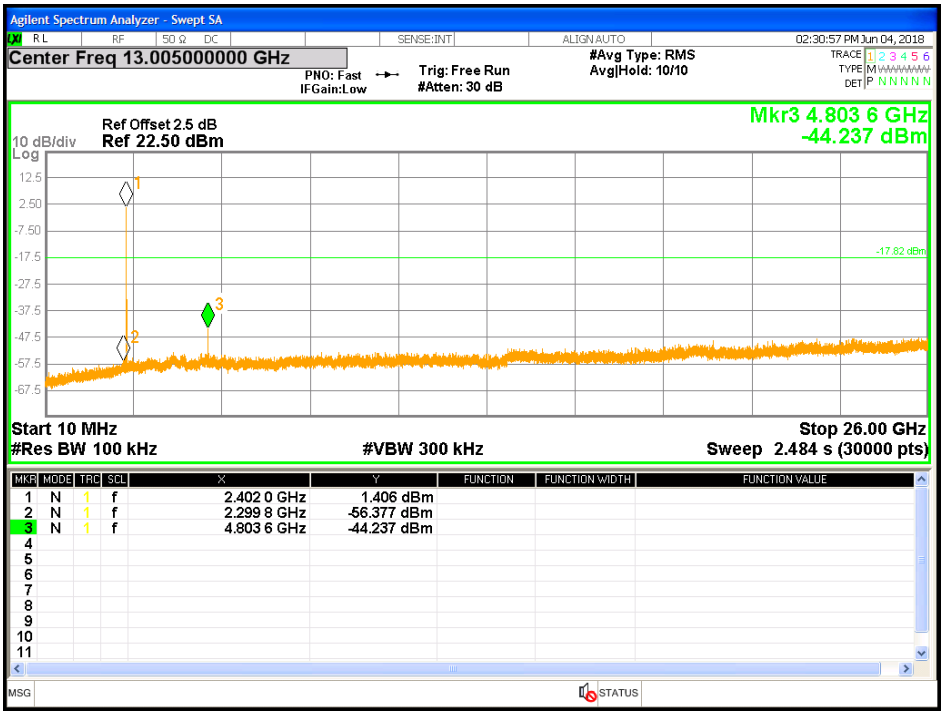


Figure 32: Out of Band Emission Requirements at 2402 MHz – 2DH1

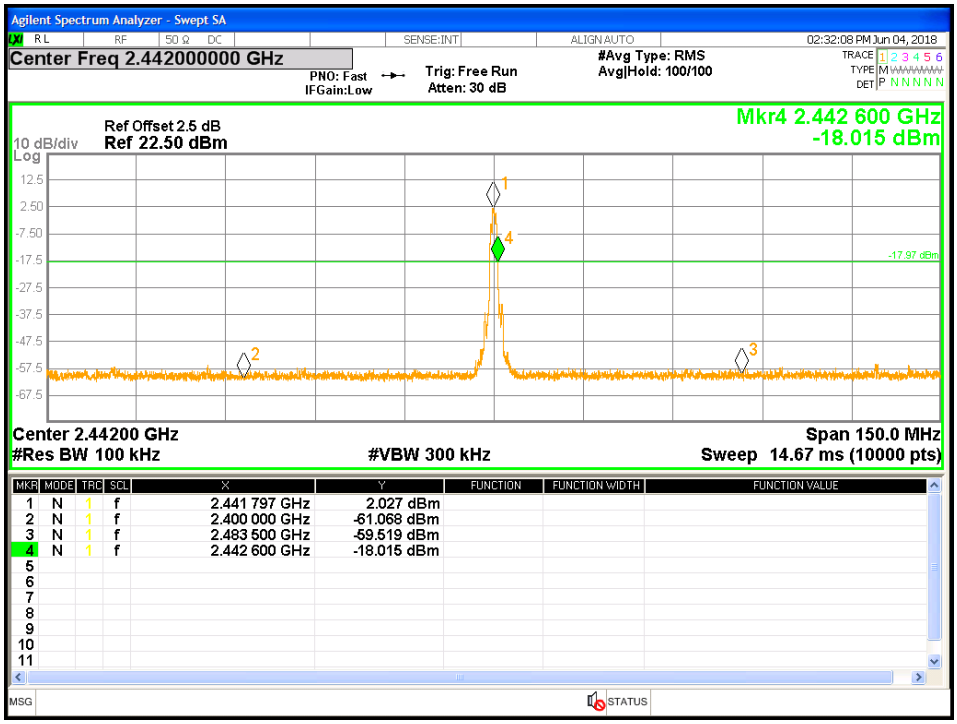


Figure 33: Band Edge Requirements at 2442 MHz – 2DH1

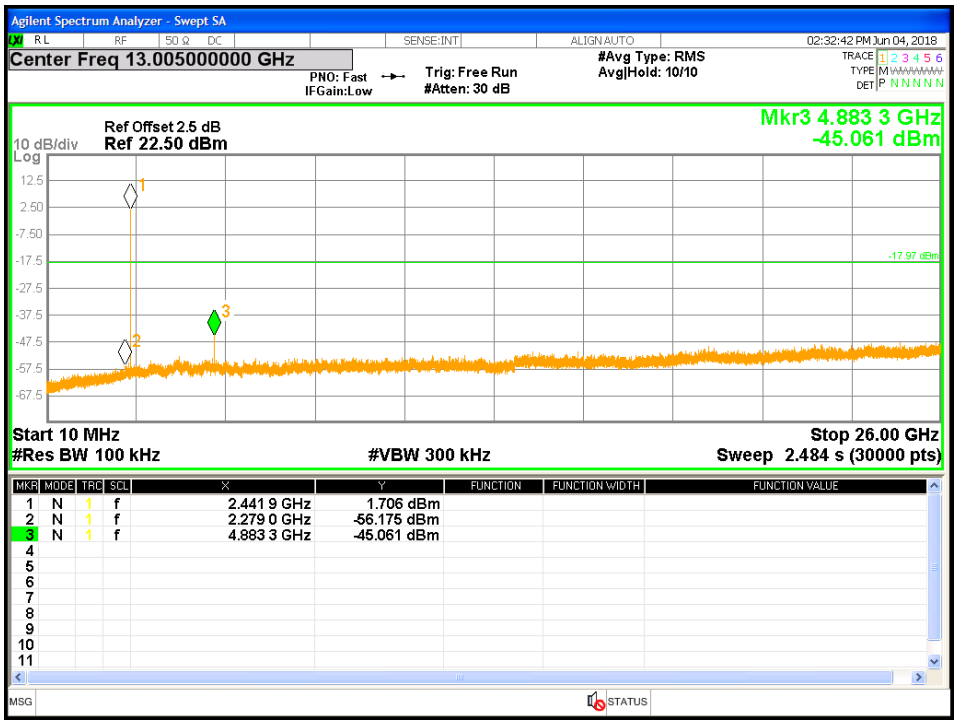


Figure 34: Out of Band Emission Requirements at 2442 MHz – 2DH1

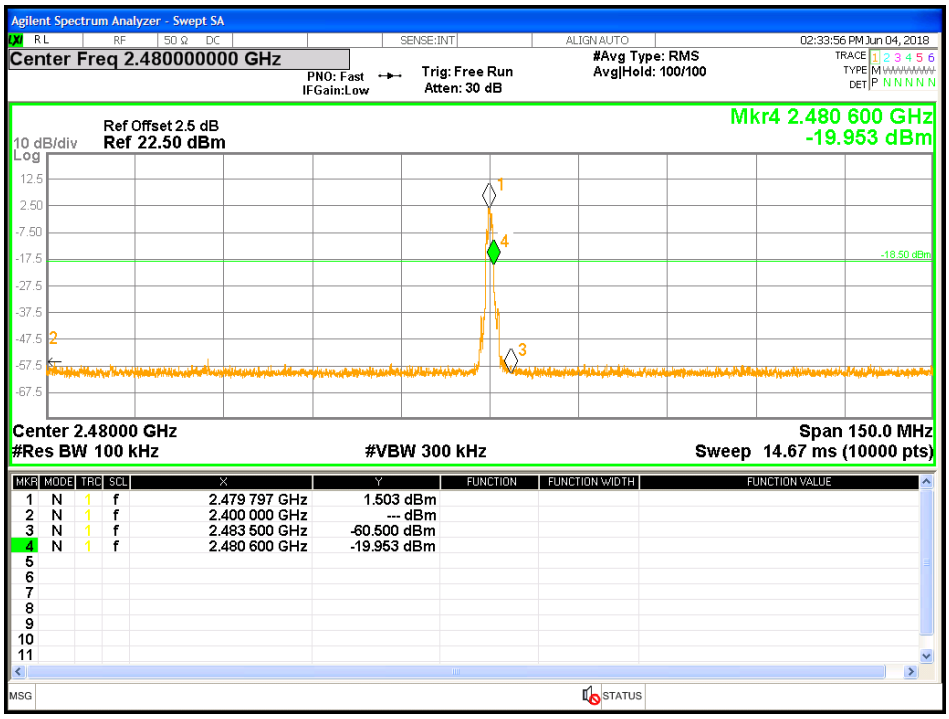


Figure 35: Band Edge Requirements at 2480 MHz – 2DH1

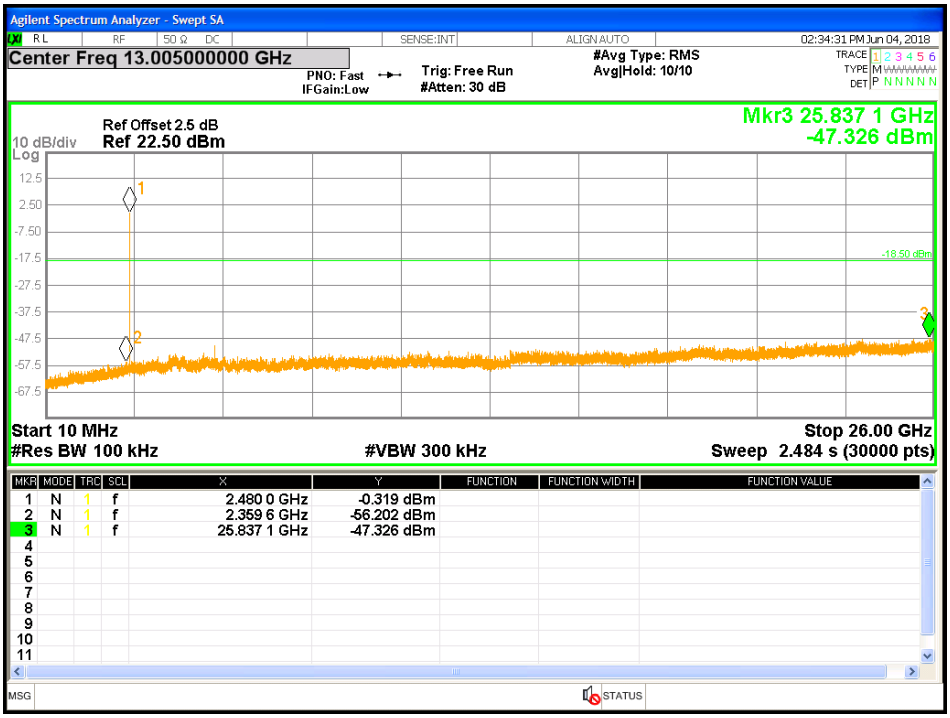


Figure 36: Out of Band Emission Requirements at 2480 MHz – 2DH1

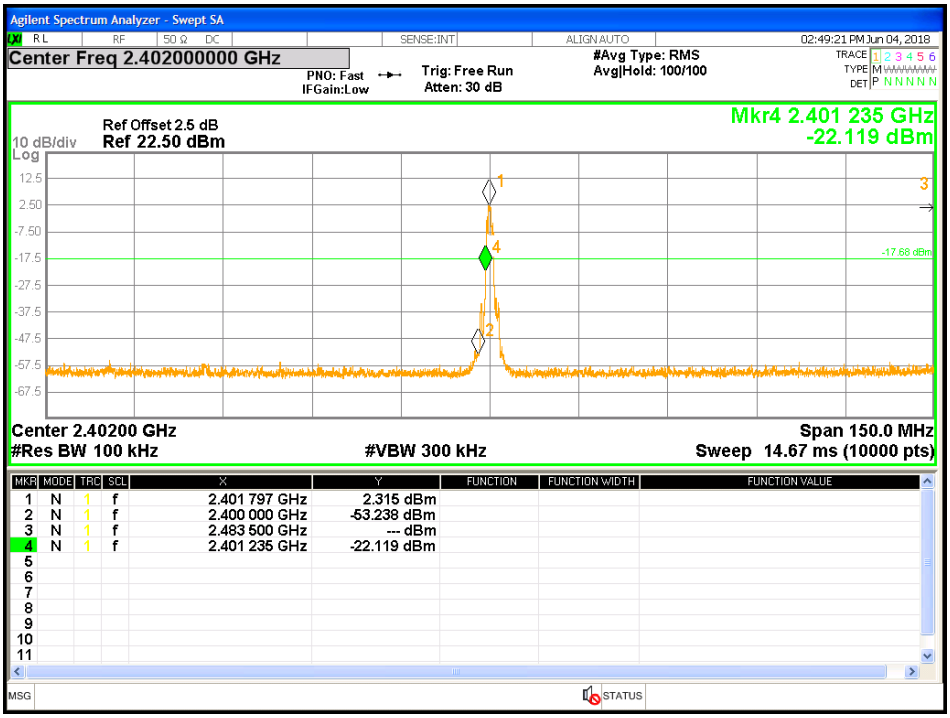


Figure 37: Band Edge Requirements at 2402 MHz – 3DH1

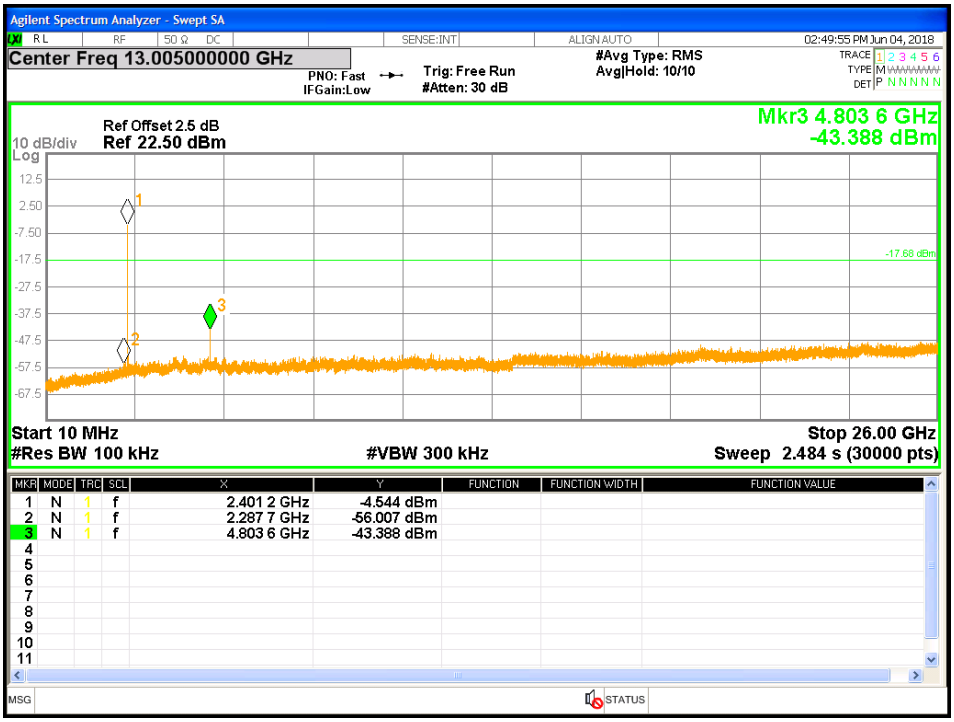


Figure 38: Out of Band Emission Requirements at 2402 MHz – 3DH1

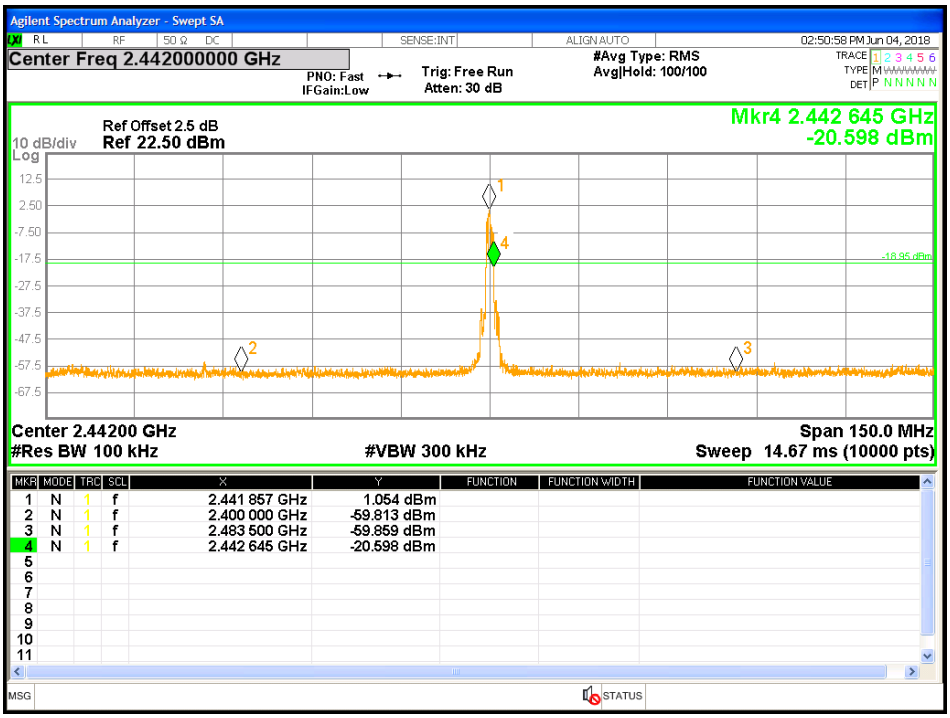


Figure 39: Band Edge Requirements at 2442 MHz – 3DH1

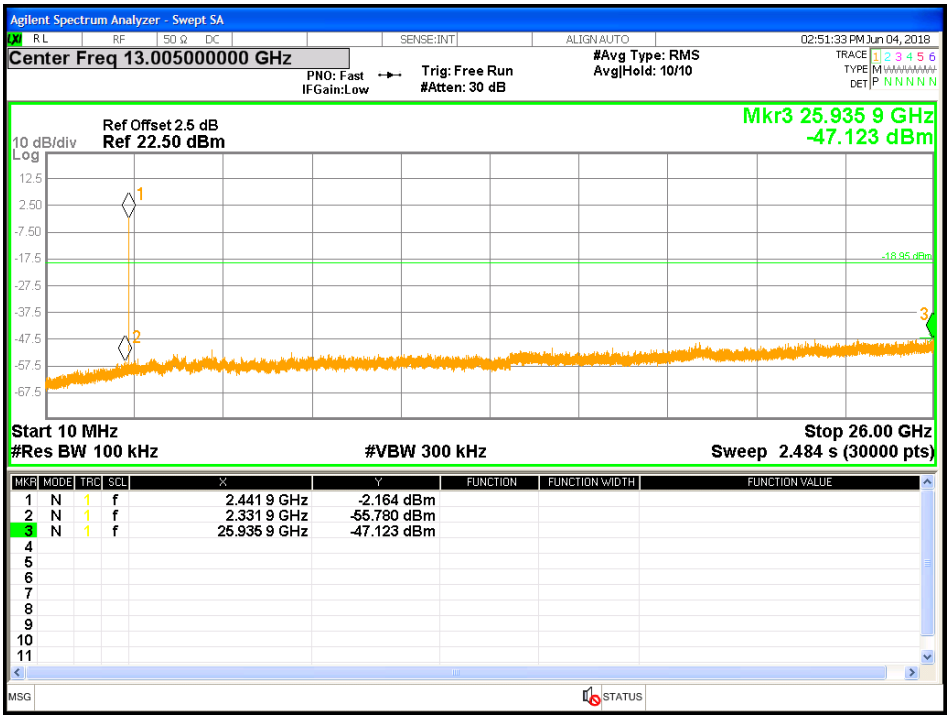


Figure 40: Out of Band Emission Requirements at 2442 MHz – 3DH1

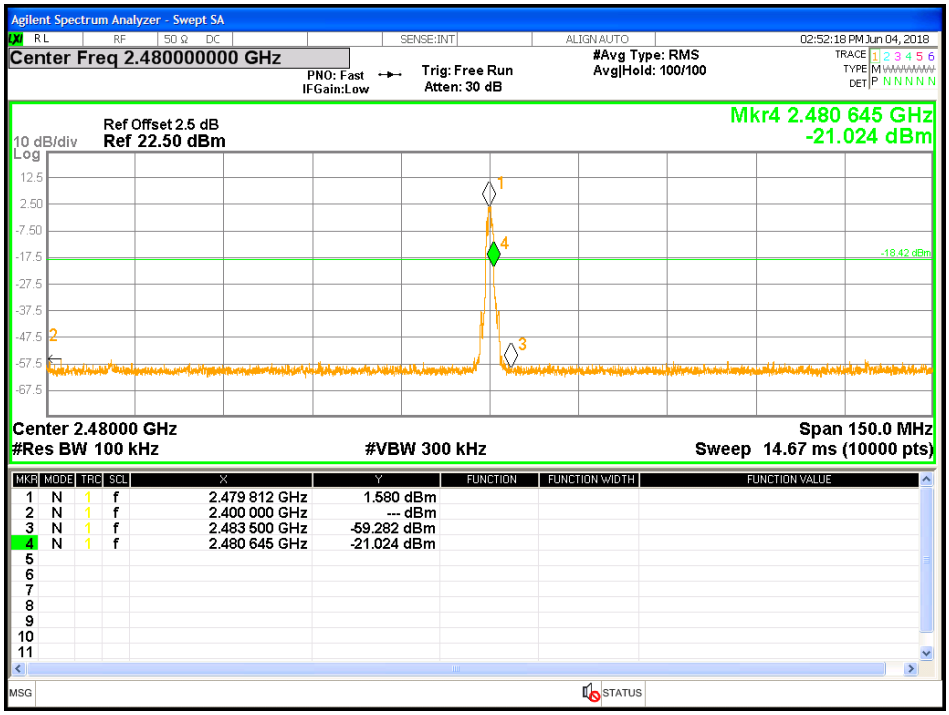


Figure 41: Band Edge Requirements at 2480 MHz – 3DH1

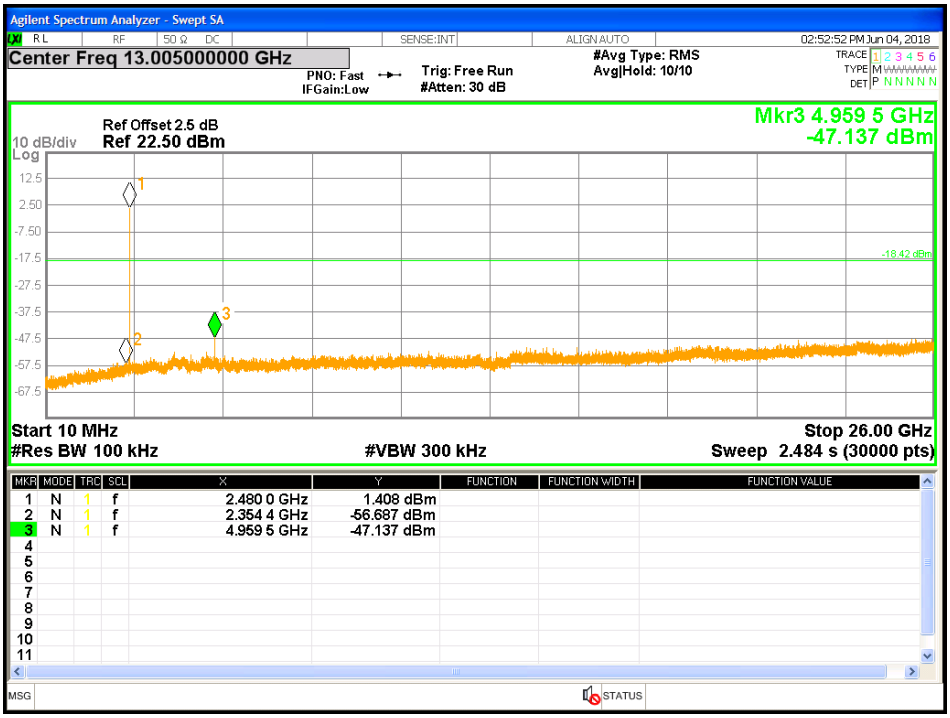


Figure 42: Out of Band Emission Requirements at 2480 MHz – 3DH1

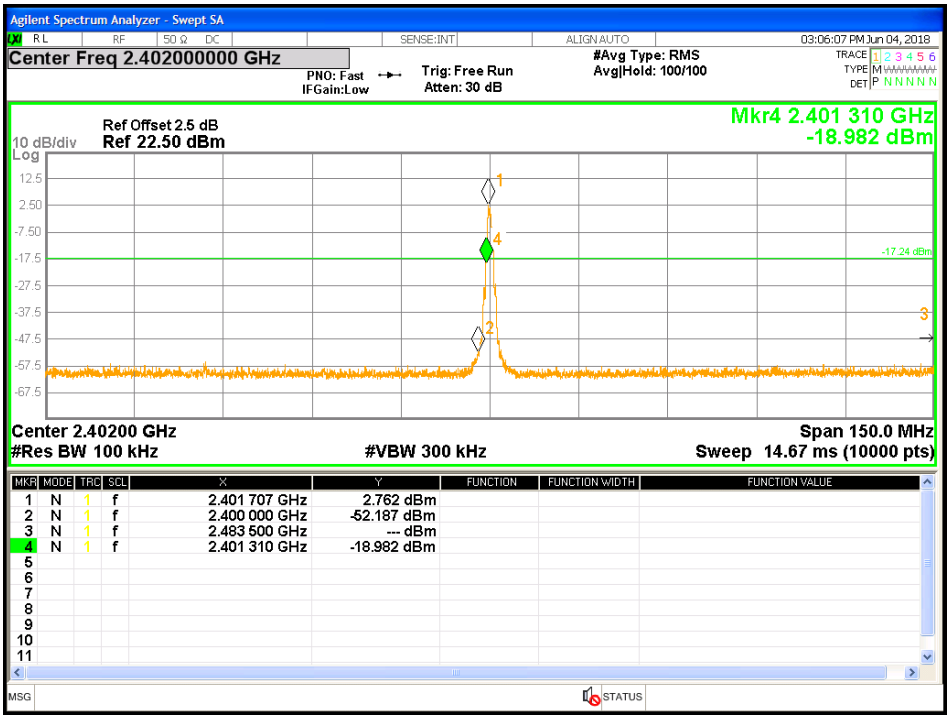


Figure 43: Band Edge Requirements at 2402 MHz – BLE

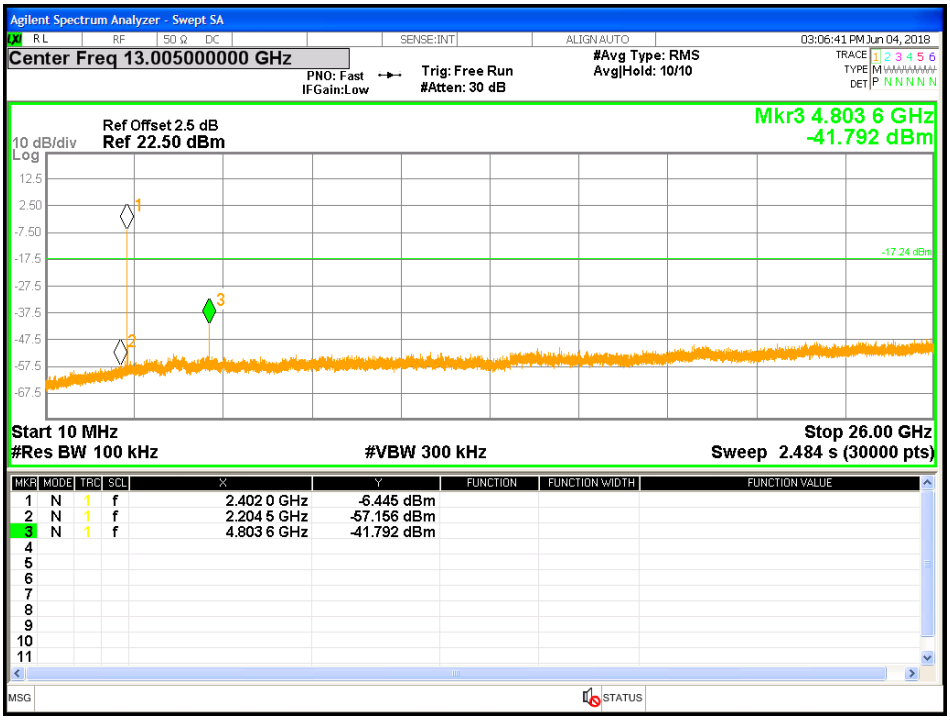


Figure 44: Out of Band Emission Requirements at 2402 MHz – BLE

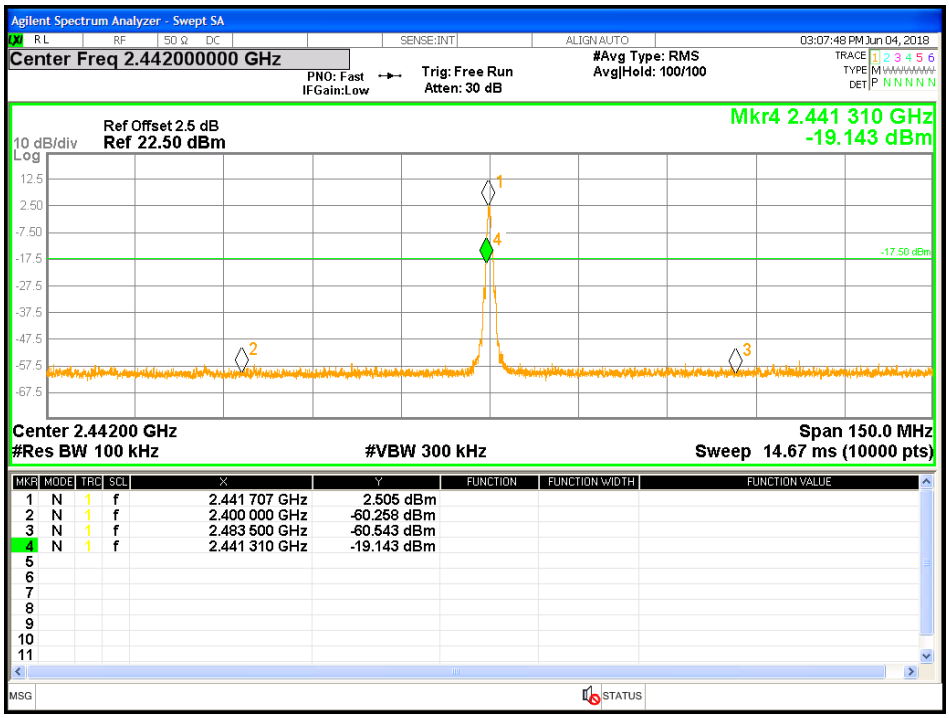


Figure 45: Band Edge Requirements at 2442 MHz – BLE

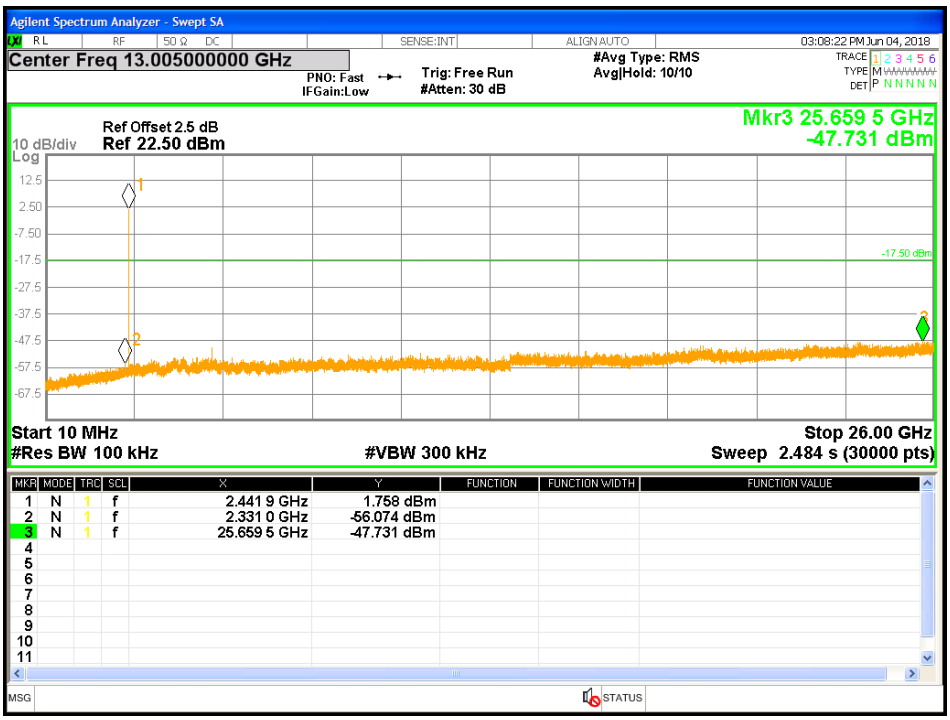


Figure 46: Out of Band Emission Requirements at 2442 MHz – BLE

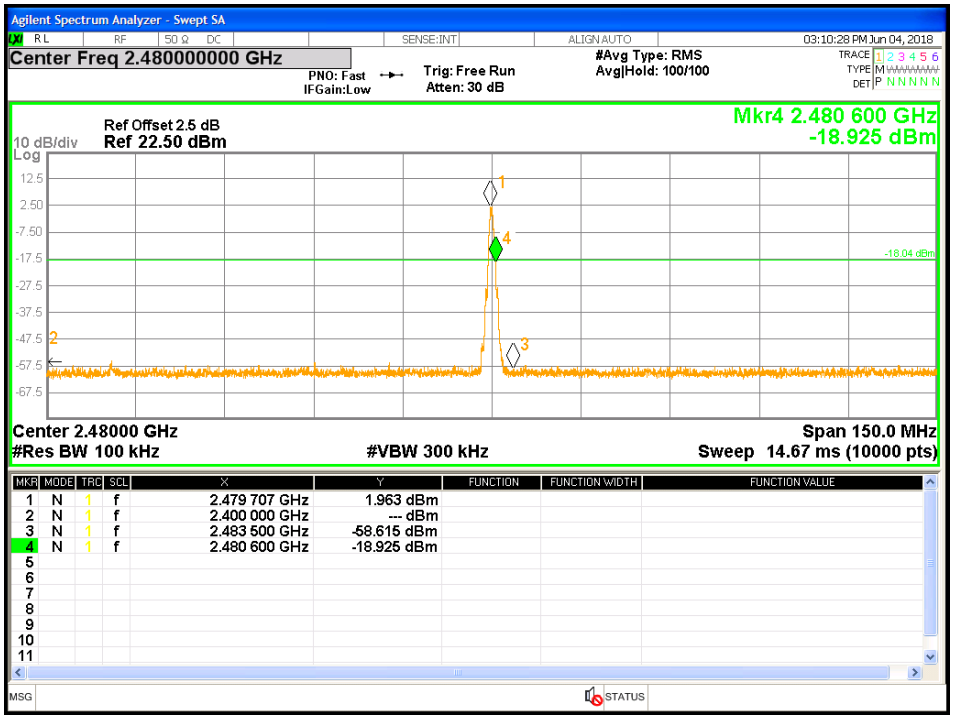


Figure 47: Band Edge Requirements at 2480 MHz – BLE

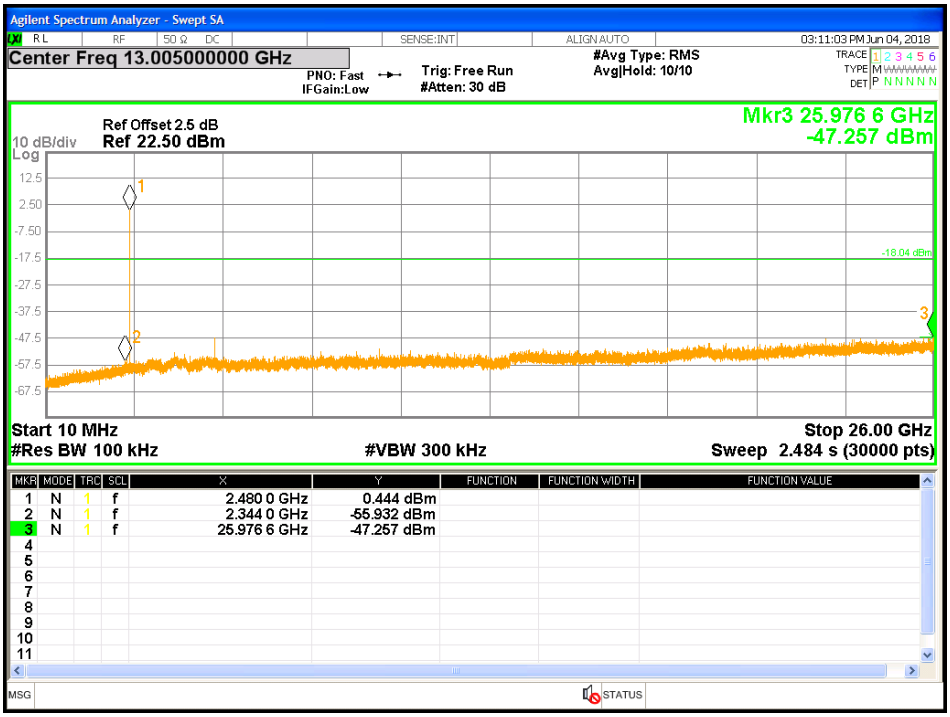


Figure 48: Out of Band Emission Requirements at 2480 MHz – BLE

4.5 Transmitter Spurious Emissions

Transmitter spurious emissions are emissions outside the frequency range of the equipment when the equipment is in transmitting mode; per requirement of CFR47 15.205, 15.209, 15.247(d), RSS-Gen Sect. 6.13

4.5.1 Test Methodology

4.5.1.1 Preliminary Test

A test program that controls instrumentation and data logging was used to automate the preliminary RF emission test procedure. The frequency range of interest was divided into sub-ranges to yield a frequency resolution of approximately 120 kHz and provide a reading at each frequency for no more than 12° of turntable rotation. For each frequency sub-range the turntable was rotated 360° while peak emission data was recorded and plotted over the frequency range of interest in horizontal and vertical antenna polarization's.

Preliminary emission profile testing was performed inside the anechoic chamber. The EUT was placed on a 1.0m x 1.5m non-conductive table, 80cm above the floor for 30 MHz to 1 GHz and 150cm above the floor for 1 GHz to 26 GHz. The EUT was positioned as shown in the setup photographs. The receiving antenna was placed at a distance of 3m at a fixed height of 1m. Measurement equipment was located outside of the chamber. A video camera was placed inside the chamber to view the EUT.

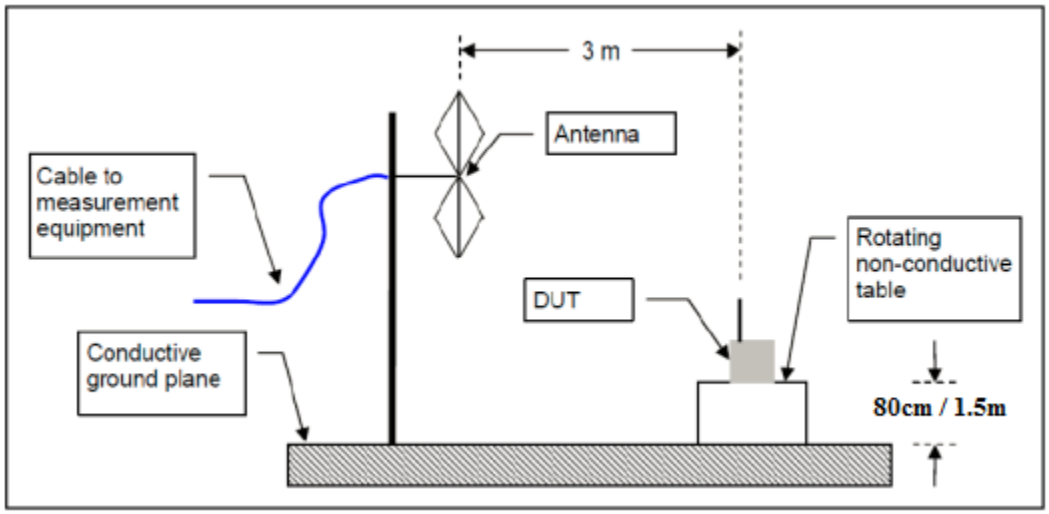
4.5.1.2 Final Test

For each frequency measured, the peak emission was maximized by manipulating the receiving antenna from 1 to 4 meters above the ground plane and placing it at the position that produced the maximum signal strength reading. The turntable was then rotated through 360° while observing the peak signal and placing the EUT at the position that produced maximum radiation. The six highest emissions relative to the limit were measured unless such emissions were more than 20 dB below the limit. If less than six emissions are within 20 dB of the limit, than the noise level of the receiver is measured at frequencies where emissions are expected. Multiples of all oscillator and microprocessor frequencies were also checked.

Final testing was performed on an NSA compliant test site. The EUT was placed on a 1.0m x 1.5m non-conductive table, 80cm above the floor for 30 MHz to 1 GHz and 150cm above the floor for 1 GHz to 26 GHz. The placement of EUT and cables were the same as for preliminary testing and is shown in the setup photographs.

The final scans performed on the worst axis, X-Axis, for three operating channels: 2402 MHz, 2442 MHz and 2480 MHz at BLE.

4.5.1.3 Test Setup



4.5.1.4 Deviations

None.

4.5.2 Transmitter Spurious Emission Limit

The spurious emissions of the transmitter shall not exceed the values in CFR47 Part 15.205, 15.209: 2018 and RSS –Gen Sect.6.13: 2014.

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	30
30-88.....	100 **	3
88-216.....	150 **	3
216-960.....	200 **	3
Above 960.....	500	3

All harmonics and spurious emission which are outside of the restricted band shall be 20 dB below the in-band emission.

4.5.3 Test Results

The final measurement data was taken under the worst case operating modes, configurations, and/or cable positions. It also reflects the results including any modifications and/or special accessories listed in Sections 1.4 and Test Plan.

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

Table 7: Transmit Spurious Emission at Restricted Band Edge Requirements

Test Conditions: Radiated Measurement at 3 meters	**Date:** May 23, 2018
Antenna Type: Integrated Antenna	**Power Setting:** Fixed.
Max. Antenna Gain: +1.6 dBi	**Signal State:** Modulated
Duty Cycle: See Section 3.5	**Data Rate:** see below
Ambient Temp.: 23º C	**Relative Humidity:** 33 %RH

Band Edge Results

Freq.	Level	Pol.	15.209/15.247		Detector	Azimuth	Height	Comments
MHz	dBuV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
2483.5	54.96	H	74.00	−19.04	Pk	45	183	BT-Hopping
2483.5	42.66	H	54.00	−11.34	Ave	45	183	BT-Hopping
2390.0	56.08	H	74.00	−17.92	Pk	45	183	BT-Hopping-2MHz Span
2390.0	43.08	H	54.00	−10.92	Ave	45	183	BT-Hopping-2MHz Span
2483.5	55.39	H	74.00	−18.61	Pk	45	183	BT-Hopping-2MHz Span
2483.5	42.66	H	54.00	−11.34	Ave	45	183	BT-Hopping-2MHz Span
2483.5	54.79	V	74.00	−19.21	Pk	135	168	BT-Hopping
2483.5	42.66	V	54.00	−11.34	Ave	135	168	BT-Hopping
2390.0	54.87	V	74.00	−19.13	Pk	135	168	BT-Hopping-2MHz Span
2390.0	43.08	V	54.00	−10.92	Ave	135	168	BT-Hopping-2MHz Span
2483.5	54.81	V	74.00	−19.19	Pk	135	168	BT-Hopping-2MHz Span
2483.5	42.66	V	54.00	−11.34	Ave	135	168	BT-Hopping-2MHz Span
2390.0	54.46	V	74.00	−19.54	Pk	140	231	BLE-2402MHz
2390.0	43.08	V	54.00	−10.92	Ave	140	231	BLE-2402MHz
2390.0	54.85	V	74.00	−19.15	Pk	140	231	BLE-2402MHz-2MHz Span
2390.0	43.08	V	54.00	−10.92	Ave	140	231	BLE-2402MHz-2MHz Span
2390.0	55.98	H	74.00	−18.02	Pk	47	127	BLE-2402MHz
2390.0	43.08	H	54.00	−10.92	Ave	47	127	BLE-2402MHz
2390.0	55.00	H	74.00	−19.00	Pk	47	127	BLE-2402MHz-2MHz Span
2390.0	43.08	H	54.00	−10.92	Ave	47	127	BLE-2402MHz-2MHz Span
2483.5	54.43	V	74.00	−19.57	Pk	28	178	BLE-2480MHz
2483.5	42.66	V	54.00	−11.34	Ave	28	178	BLE-2480MHz
2483.5	54.39	V	74.00	−19.61	Pk	28	178	BLE-2480MHz-2MHz Span
2483.5	42.66	V	54.00	−11.34	Ave	28	178	BLE-2480MHz-2MHz Span
2483.5	54.88	H	74.00	−19.12	Pk	49	171	BLE-2480MHz
2483.5	42.66	H	54.00	−11.34	Ave	49	171	BLE-2480MHz
2483.5	54.30	H	74.00	−19.70	Pk	49	171	BLE-2480MHz-2MHz Span
2483.5	42.66	H	54.00	−11.34	Ave	49	171	BLE-2480MHz-2MHz Span

Note: 1. FHSS, worst Case 2DH1 and BLE are evaluated.

2. Since the band-edge measurements have good margins in the presence of in-band leakage, the band-edge plots were captured with the spectrum analyzer's span wider than 2 MHz; showing additional sideband spurious emissions.
3. All the band-edge measurements met the restricted band requirements of CFR47 15.205.

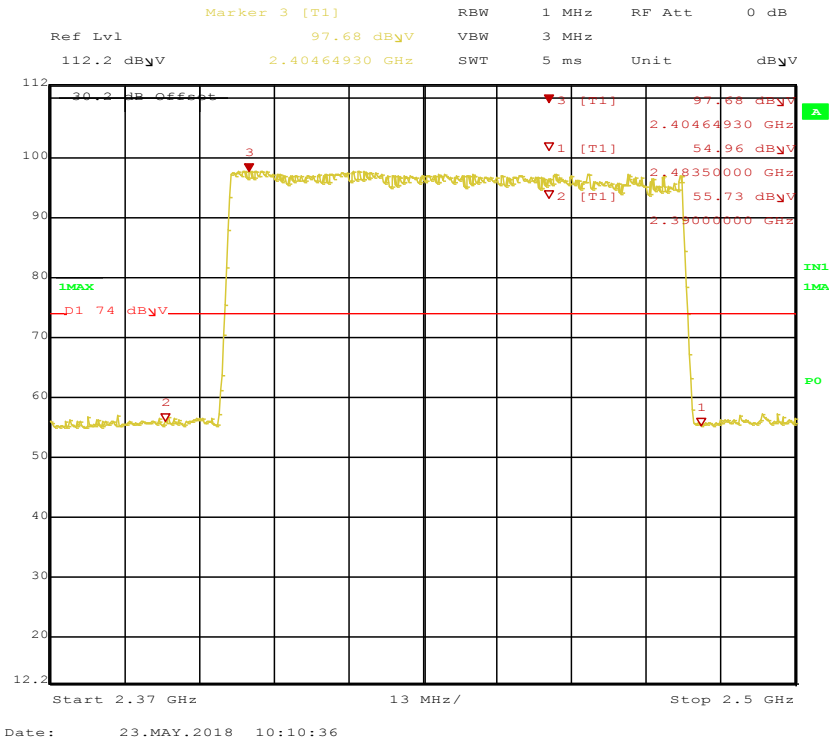


Figure 49: Radiated Emission at the Edge at 2DH1 Hopping – Horizontal (Peak)

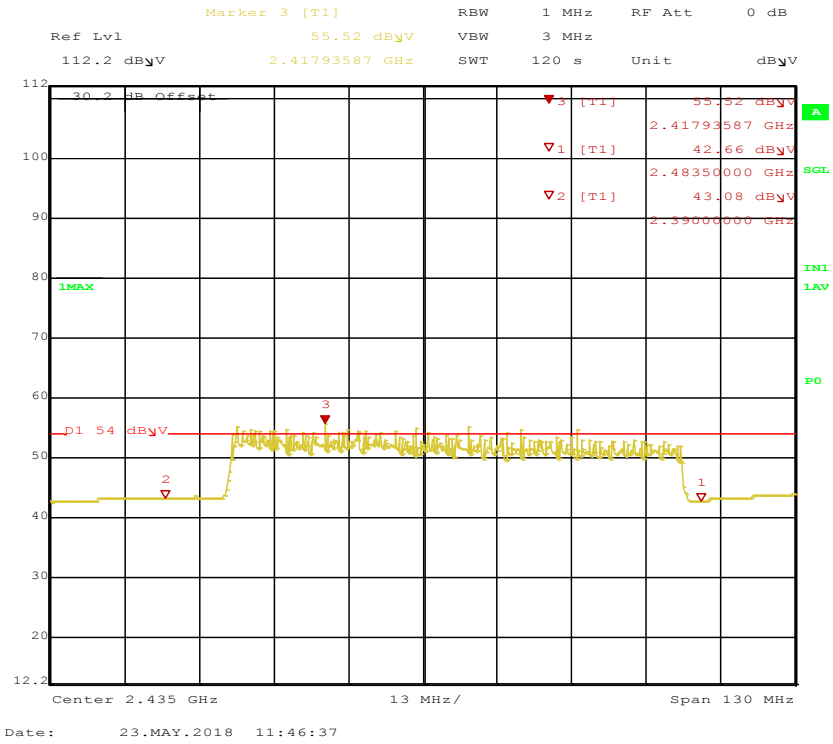


Figure 50: Radiated Emission at the Edge at 2DH1 Hopping – Horizontal (Avg)

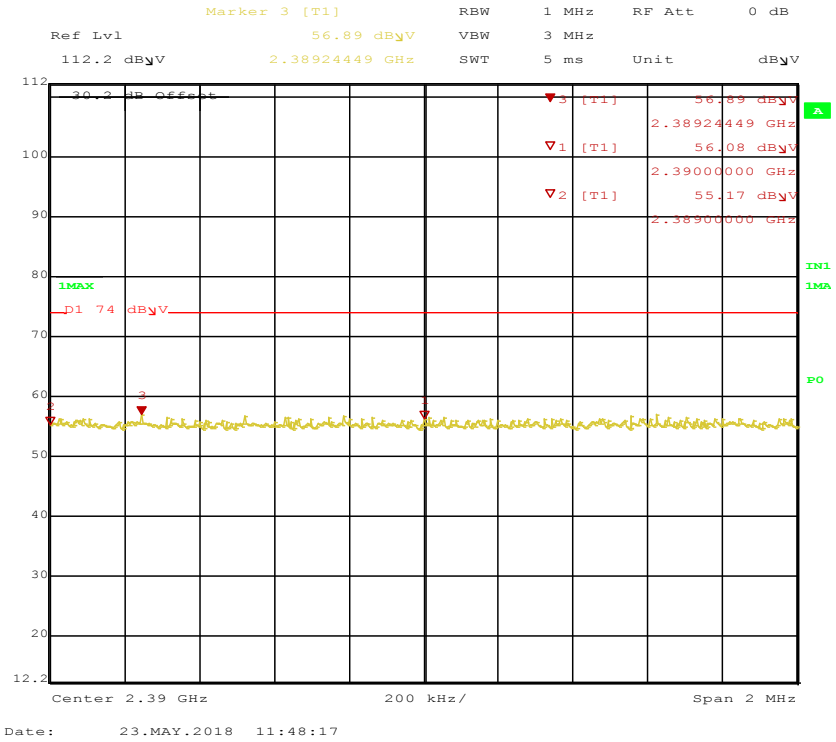


Figure 51: Radiated Emission at the Edge at 2DH1 Hopping, 2 MHz Span at 2390 MHz– Horz. (Peak)

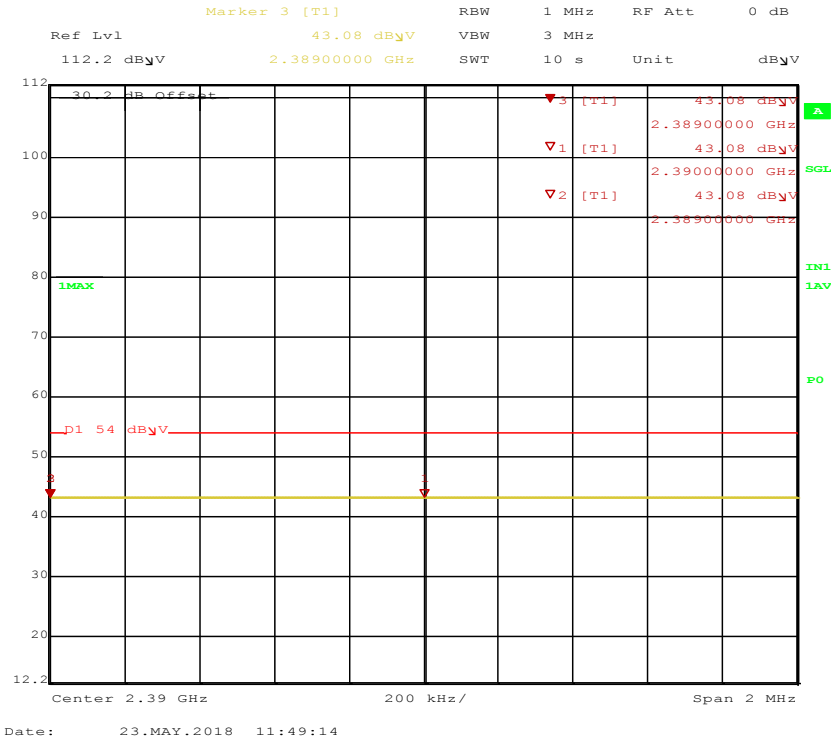


Figure 52: Radiated Emission at the Edge at 2DH1 Hopping, 2 MHz Span at 2390 MHz – Horz. (Avg)

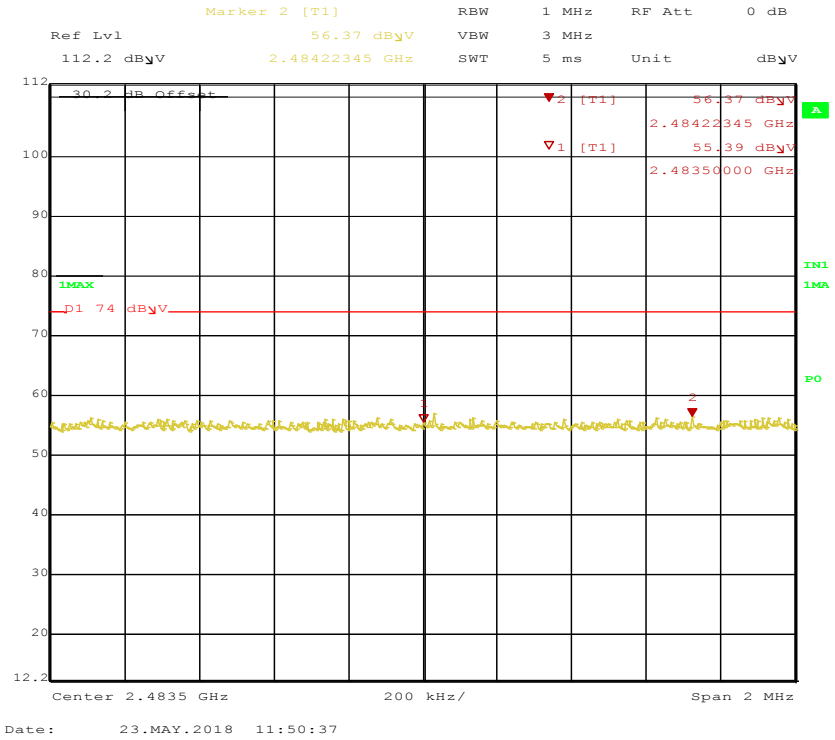


Figure 53: Radiated Emission at the Edge at 2DH1 Hopping, 2 MHz Span at 2483.5 MHz – Horz. (Peak)

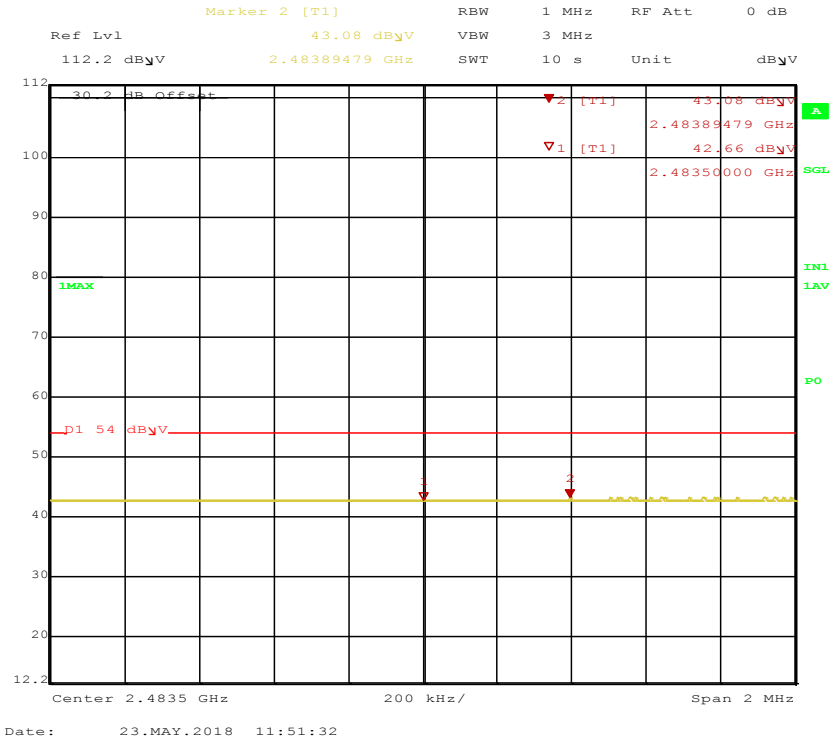


Figure 54: Radiated Emission at the Edge at 2DH1 Hopping, 2 MHz Span at 2483.5 MHz – Horz. (Avg)

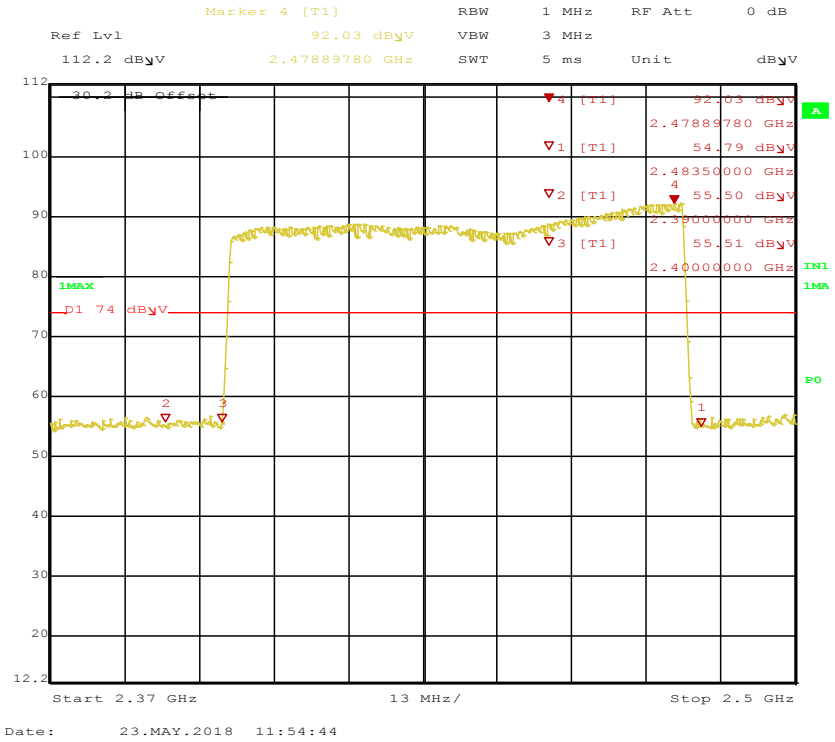


Figure 55: Radiated Emission at the Edge at 2DH1 Hopping – Vertical (Peak)

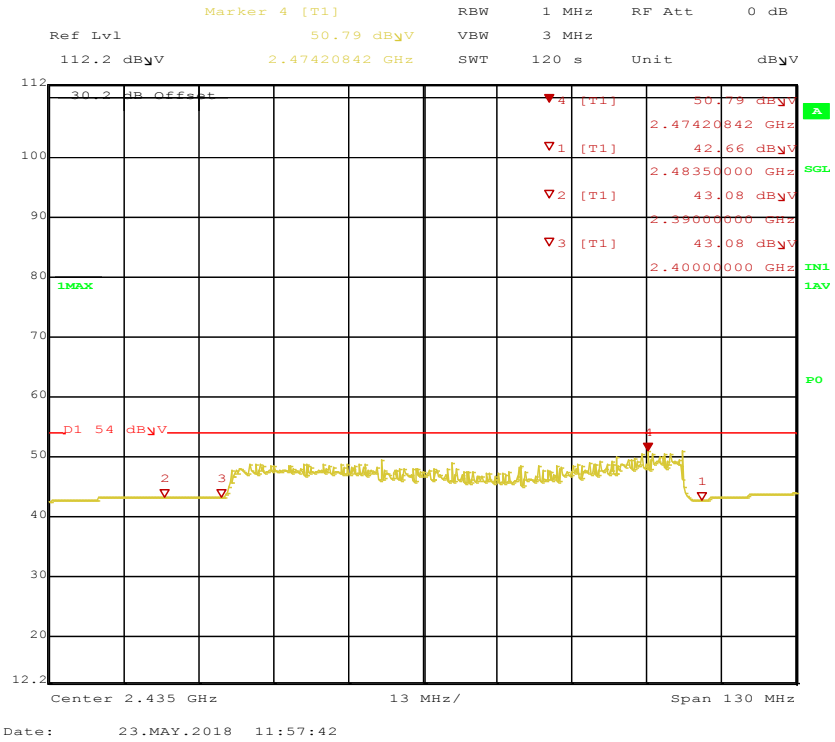


Figure 56: Radiated Emission at the Edge at 2DH1 Hopping – Vertical (Avg)

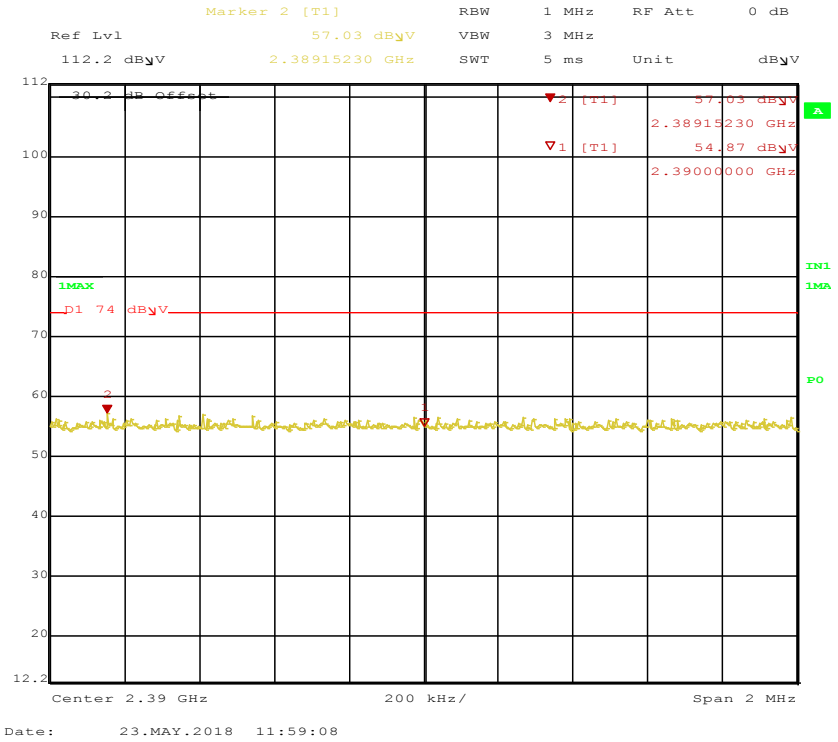


Figure 57: Radiated Emission at the Edge at 2DH1 Hopping, 2 MHz Span at 2390 MHz– Vertical (Peak)

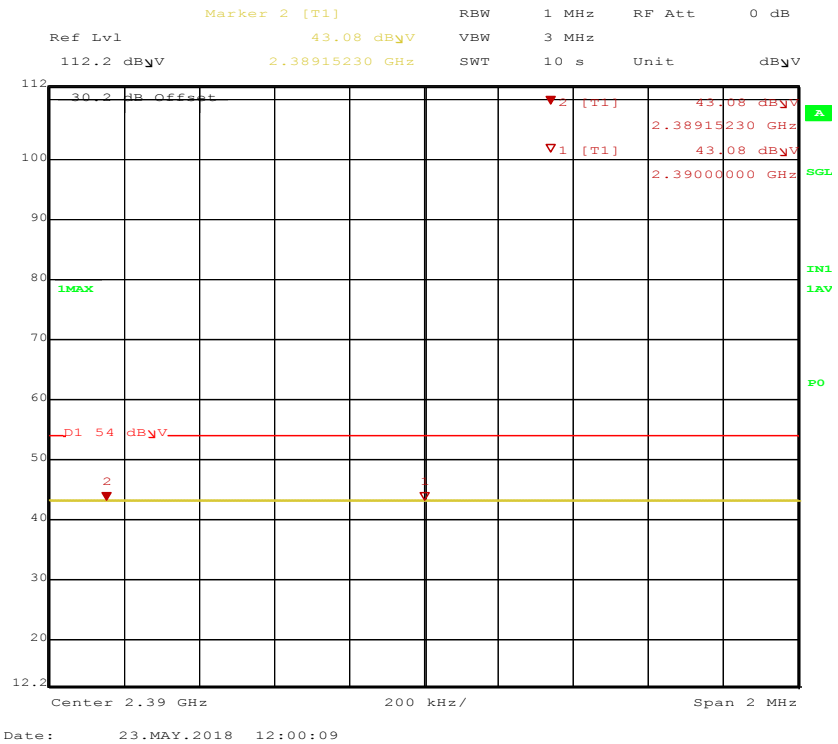


Figure 58: Radiated Emission at the Edge at 2DH1 Hopping, 2 MHz Span at 2390 MHz – Vertical (Avg)

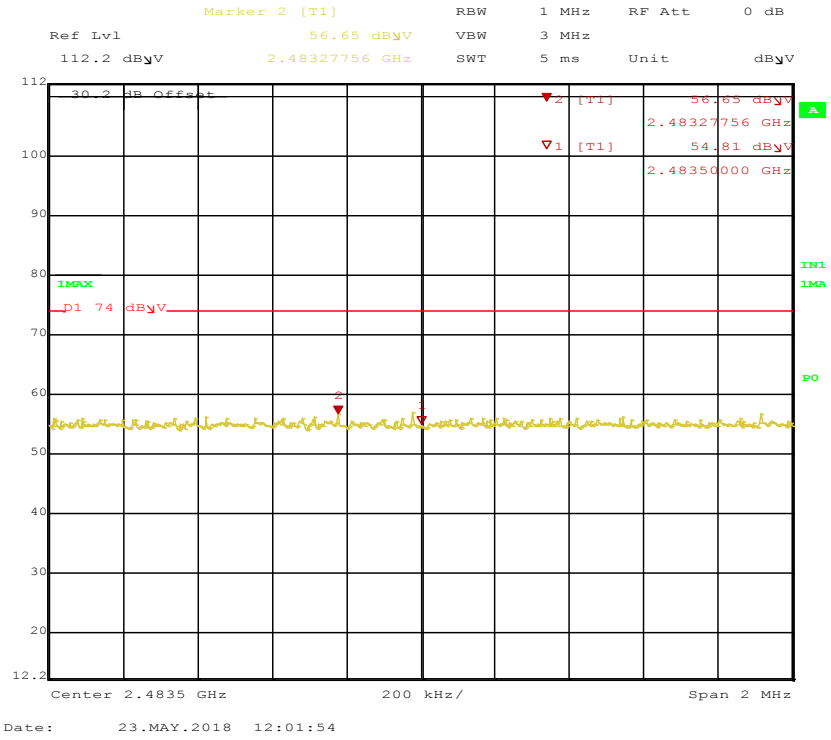


Figure 59: Radiated Emission at the Edge at 2DH1 Hopping, 2 MHz Span at 2483.5 MHz – Vertical (Peak)

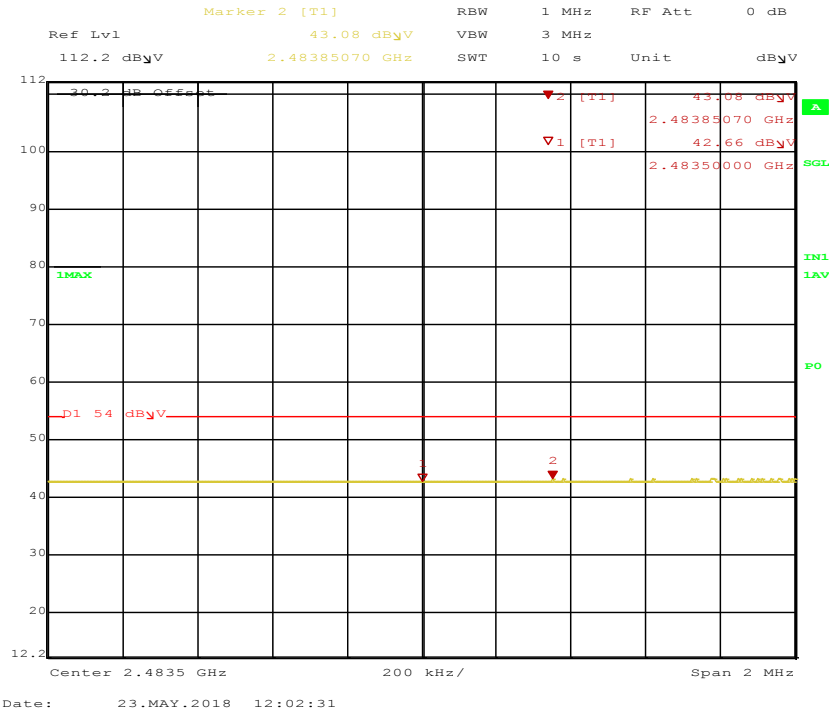


Figure 60: Radiated Emission at the Edge at 2DH1 Hopping, 2 MHz Span at 2483.5 MHz – Vertical (Avg)

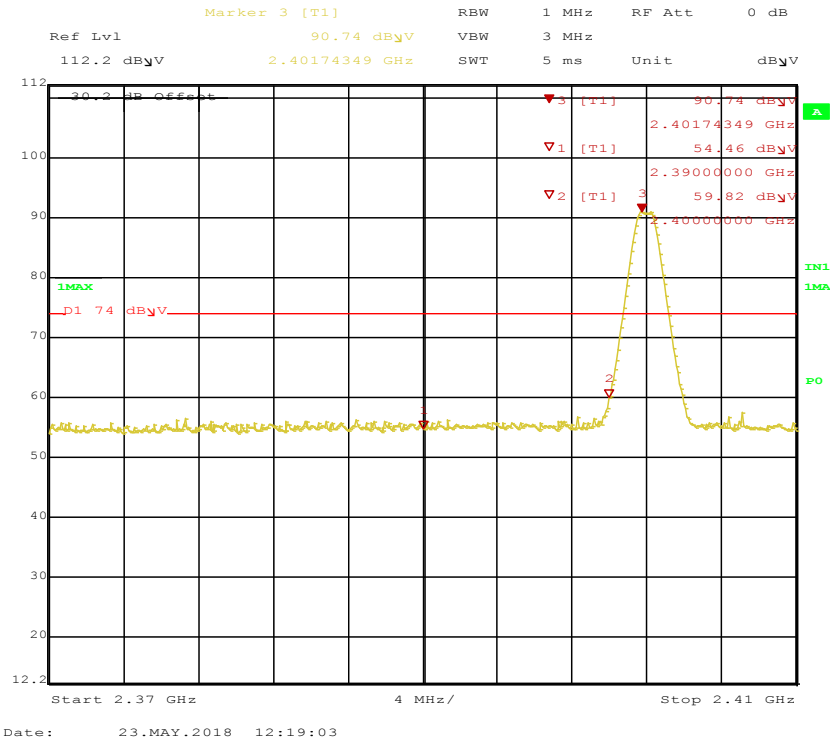


Figure 61: Radiated Emission at the Edge for BLE, 2402 MHz –Vertical (Pk)

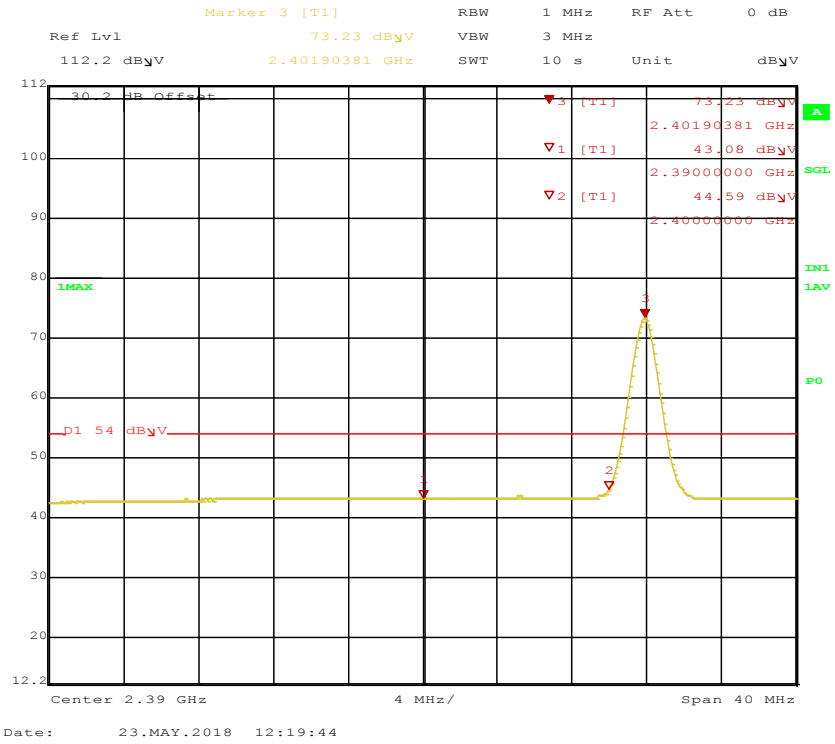


Figure 62: Radiated Emission at the Edge for BLE, 2402 MHz –Vertical (Avg)

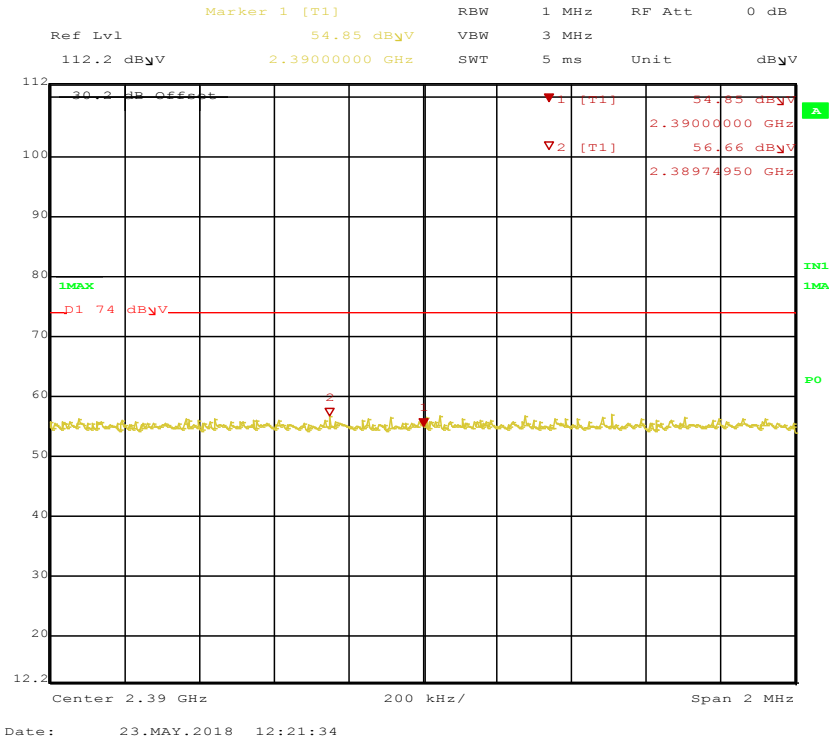


Figure 63: Radiated Emission at the Edge for BLE, 2402 MHz, 2 MHz Span – Vertical (Pk)

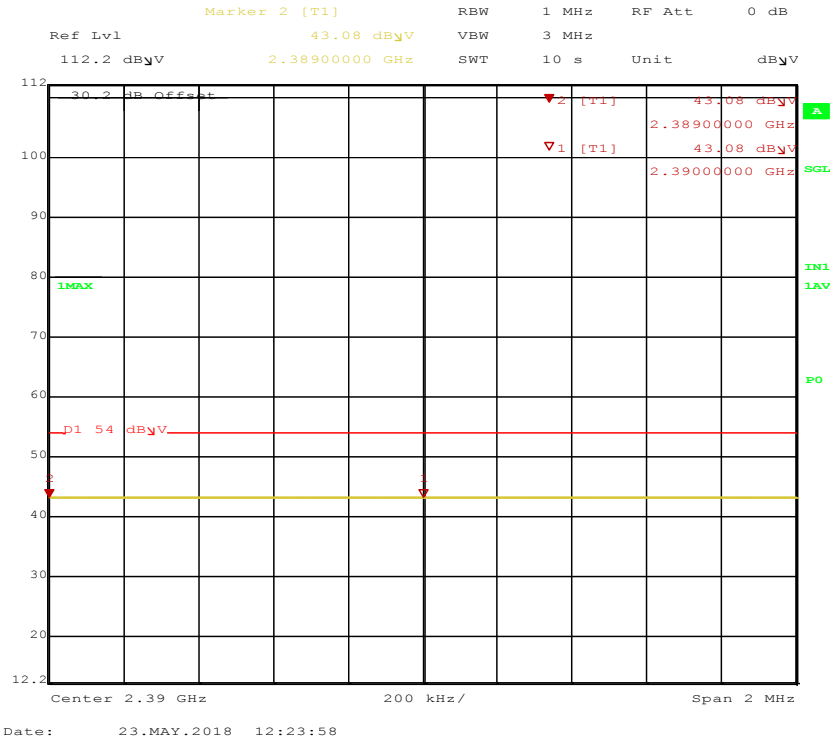


Figure 64: Radiated Emission at the Edge for BLE, 2402 MHz, 2 MHz Span – Vertical (Avg)

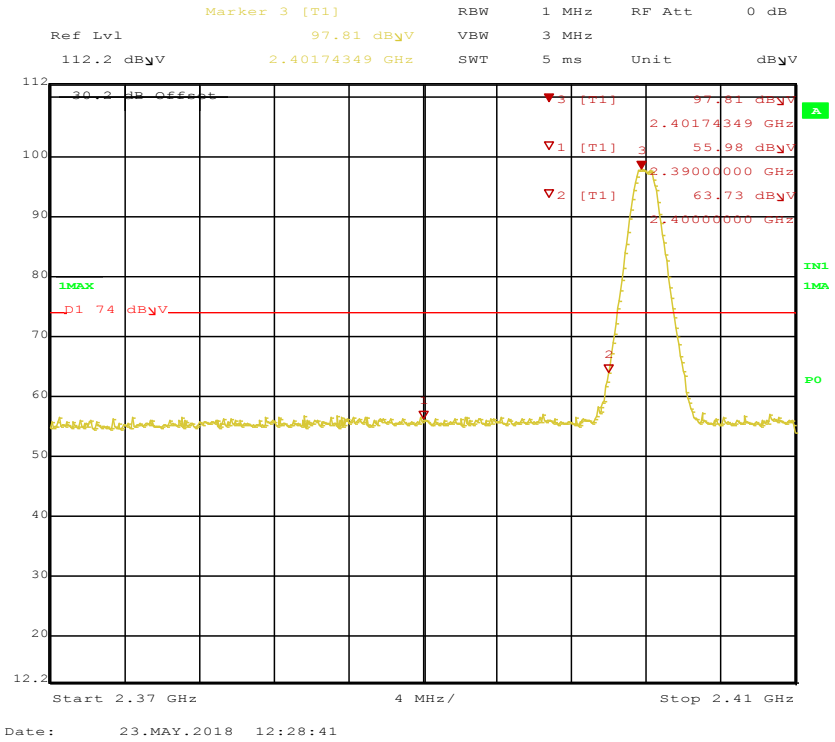


Figure 65: Radiated Emission at the Edge for BLE, 2402 MHz – Horizontal (Pk)

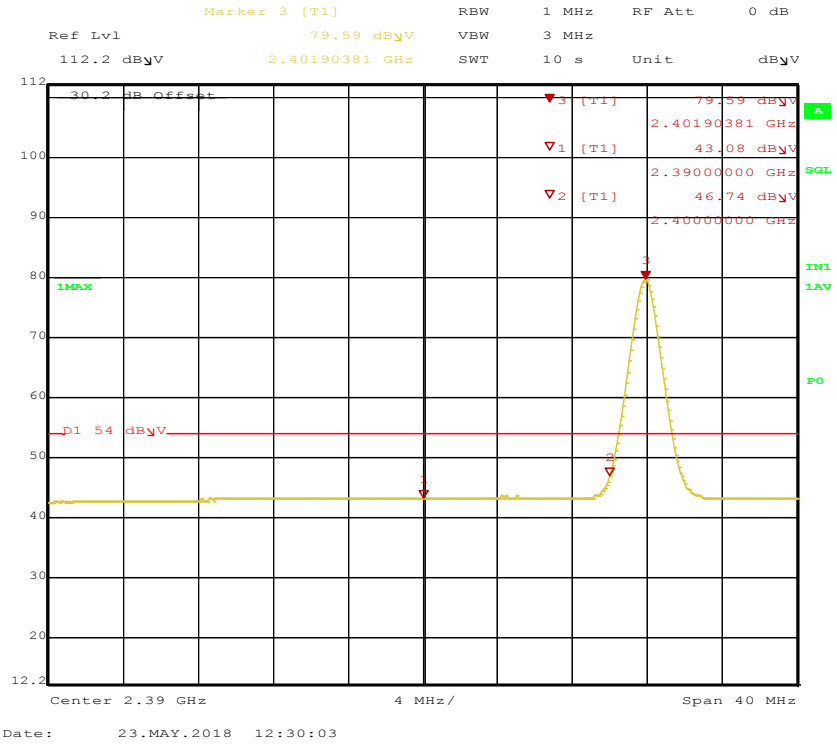


Figure 66: Radiated Emission at the Edge for BLE, 2402 MHz – Horizontal (Avg)

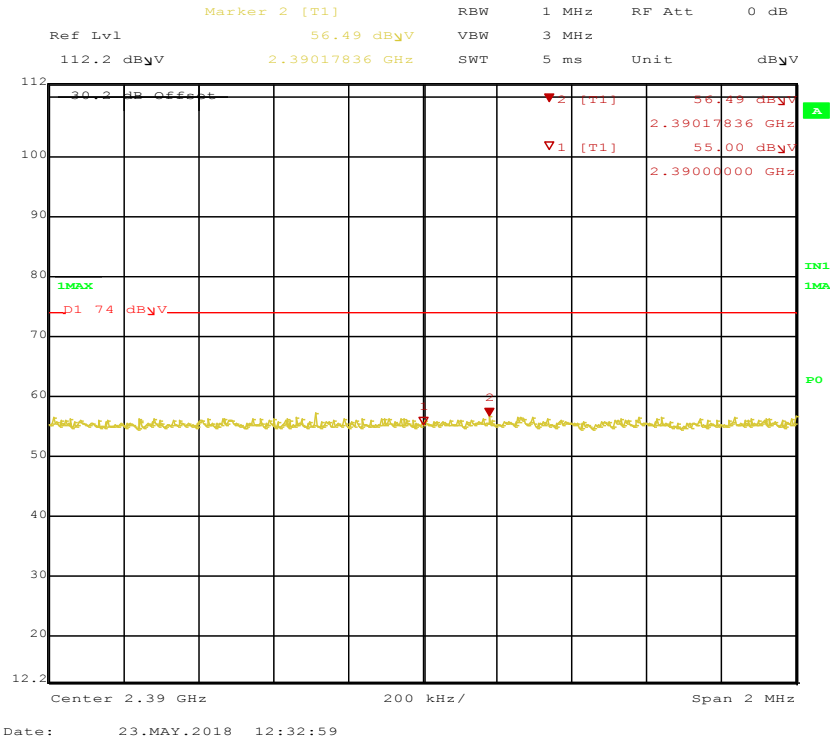


Figure 67: Radiated Emission at the Edge for BLE, 2402 MHz, 2 MHz Span – Horizontal (Pk)

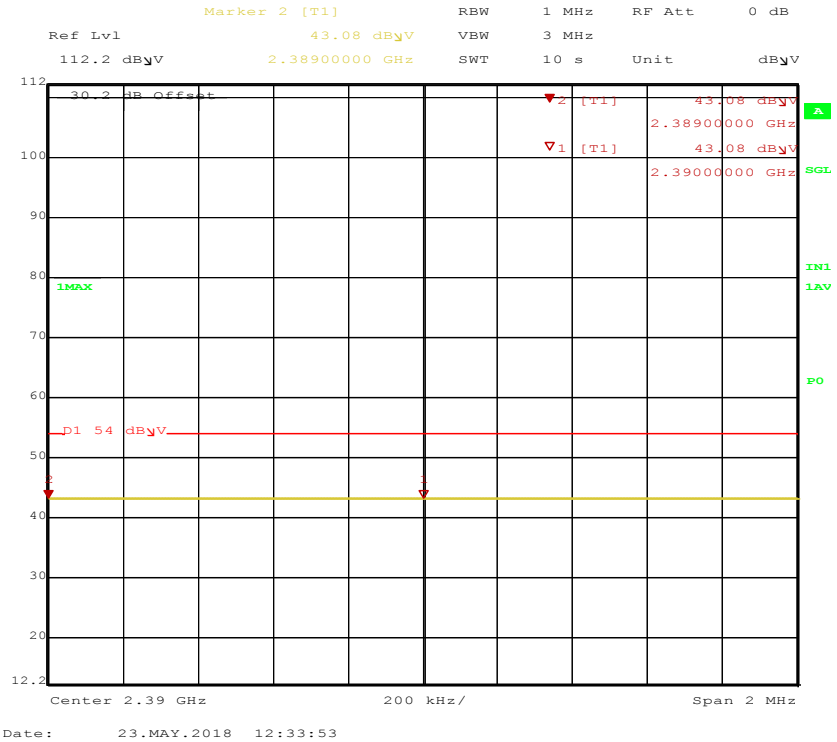


Figure 68: Radiated Emission at the Edge for BLE, 2402 MHz, 2 MHz Span – Horizontal (Avg)

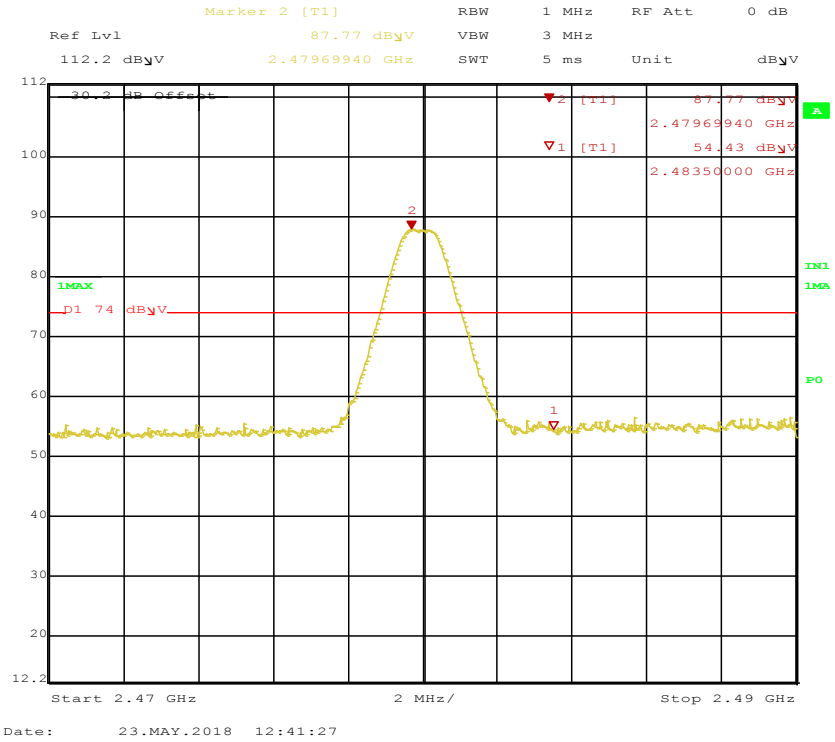


Figure 69: Radiated Emission at the Edge for BLE, 2483.5 MHz –Vertical (Pk)

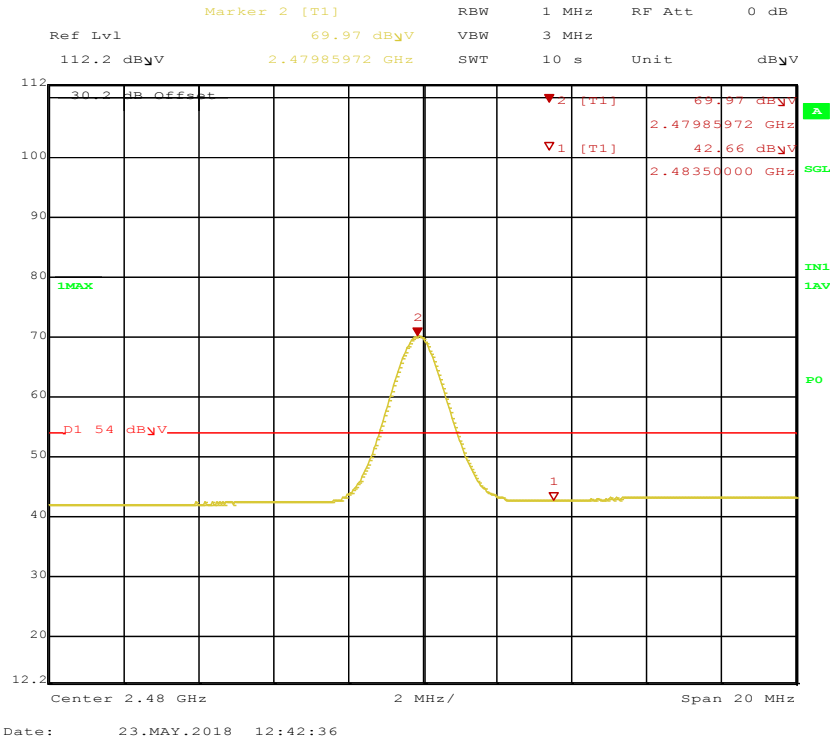


Figure 70: Radiated Emission at the Edge for BLE, 2483.5 MHz –Vertical (Avg)

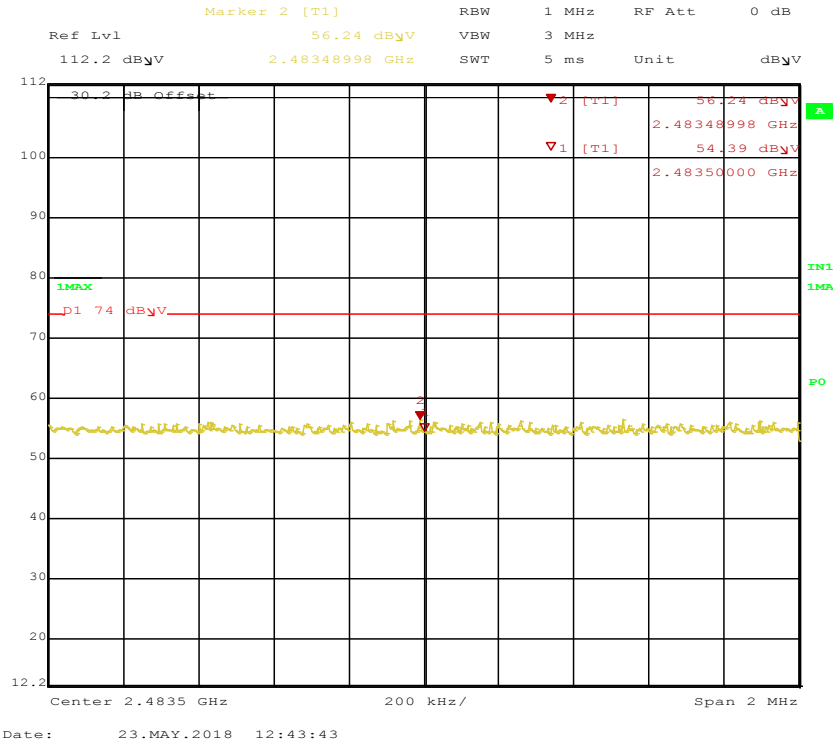


Figure 71: Radiated Emission at the Edge for BLE, 2483.5 MHz, 2 MHz Span – Vertical (Pk)

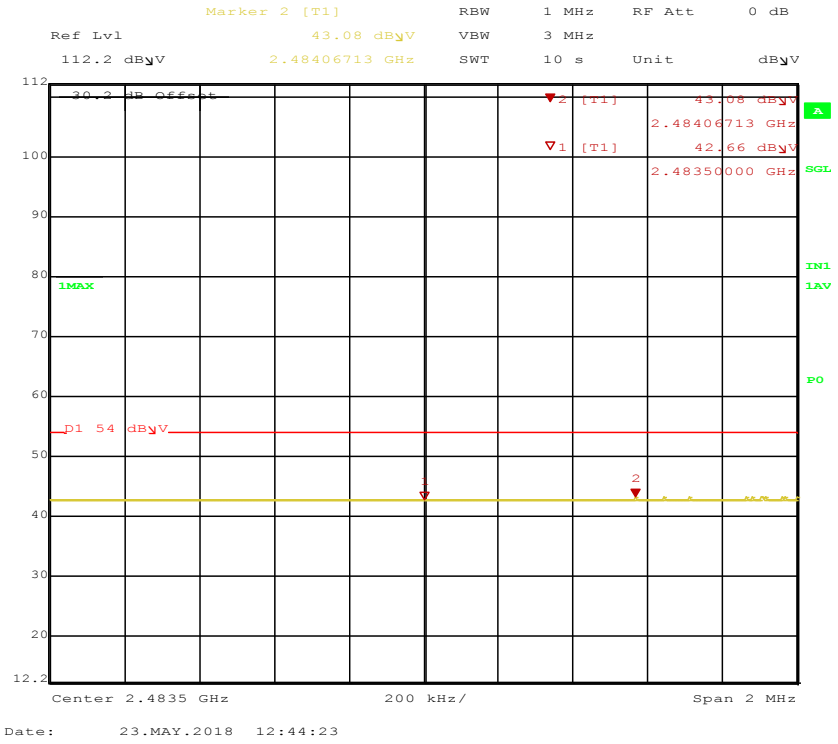


Figure 72: Radiated Emission at the Edge for BLE, 2483.5 MHz, 2 MHz Span – Vertical (Avg)

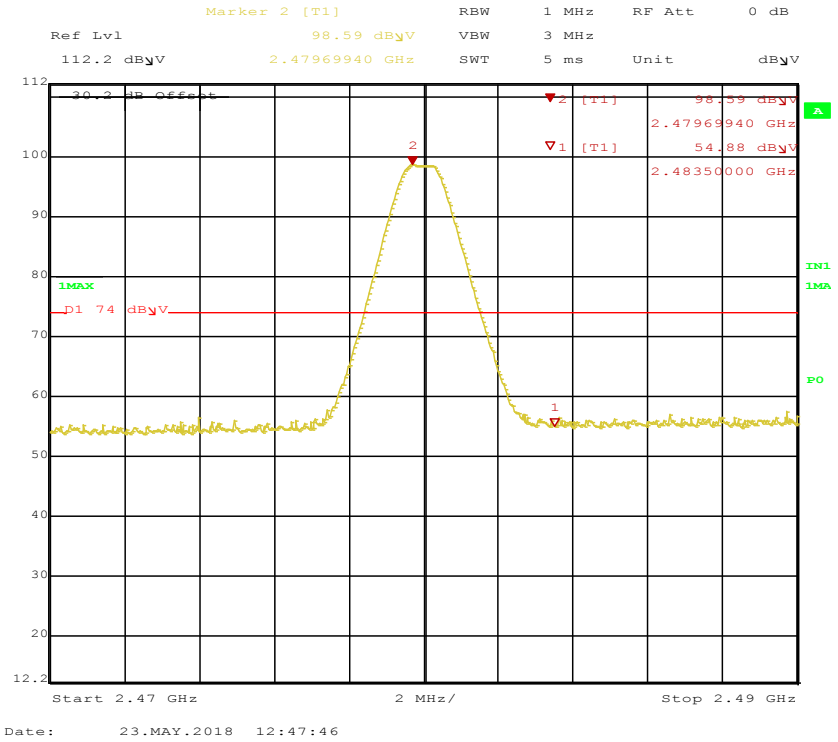


Figure 73: Radiated Emission at the Edge for BLE, 2483.5 MHz – Horizontal (Pk)

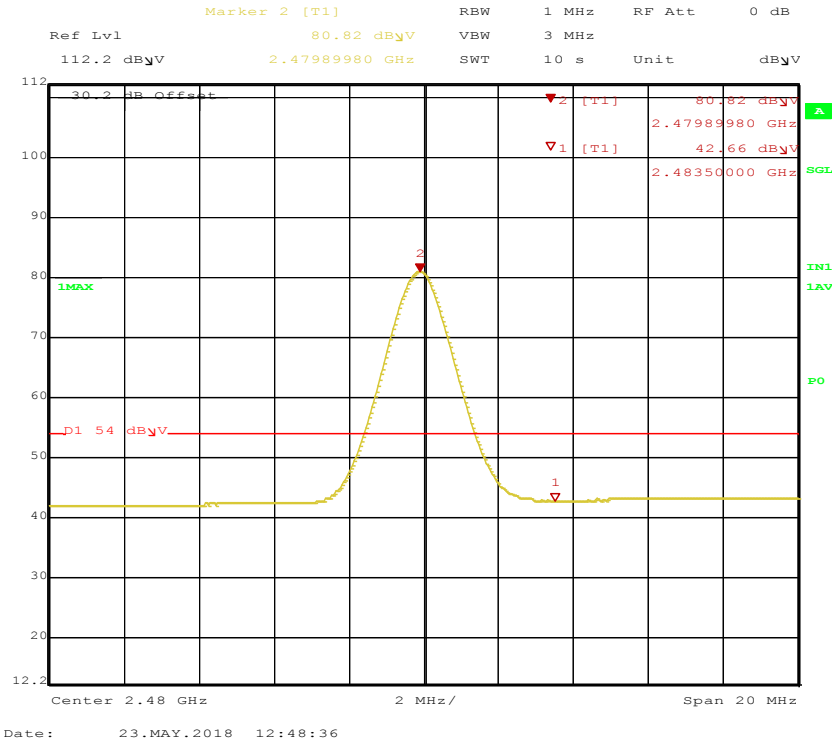


Figure 74: Radiated Emission at the Edge for BLE, 2483.5 MHz – Horizontal (Avg)

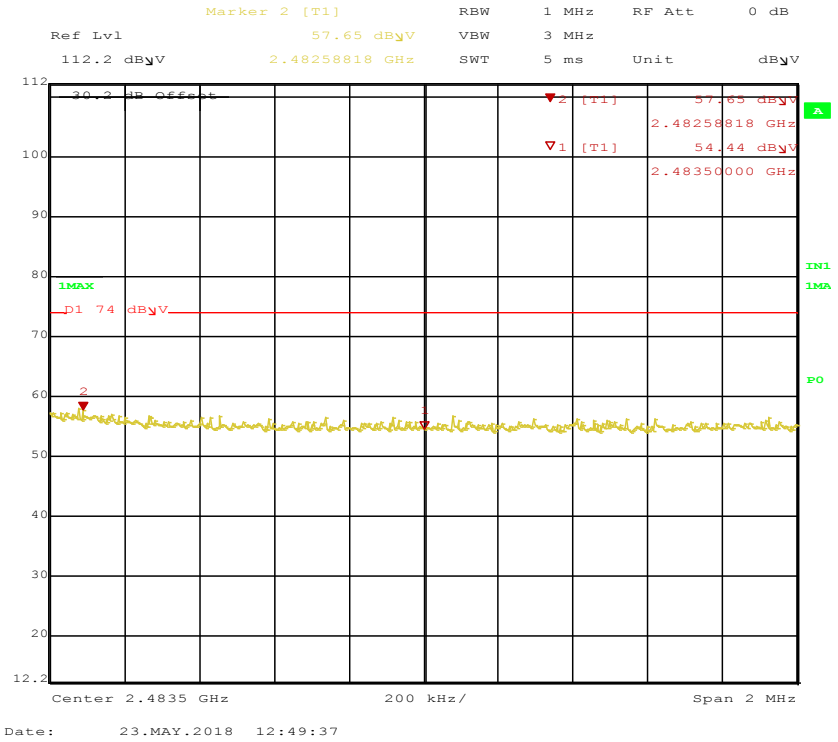


Figure 75: Radiated Emission at the Edge for BLE, 2483.5 MHz, 2 MHz Span – Horizontal (Pk)

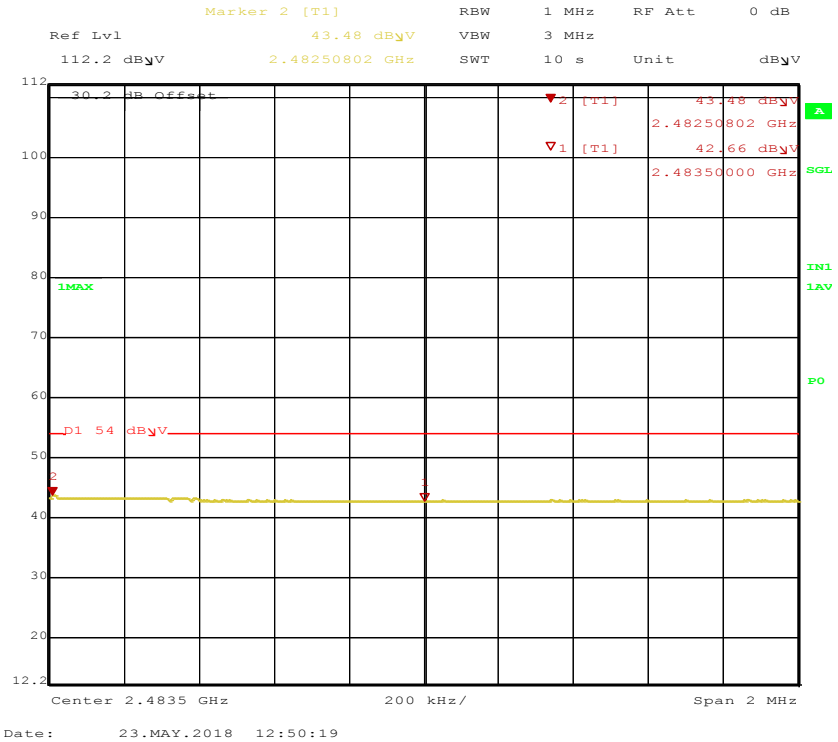


Figure 76: Radiated Emission at the Edge for BLE, 2483.5 MHz, 2 MHz Span – Horizontal (Avg)

SOP 1 Radiated Emissions

Tracking # 31861558.001 Page 1 of 6

EUT Name	Wireless Audio Amplifier	**Date**	May 24, 2018
EUT Model	Elite SuperAmp X	**Temp / Hum in**	23°C / 36%rh
EUT Serial	PP #2	**Temp / Hum out**	N/A
EUT Comfit.	Integrated Antenna on X-Axis	**Line AC / Freq**	5.0 VDC
Standard	CFR47 Part 15 Subpart C	**RBW / VBW**	120 kHz/300 kHz
Dist/Ant Used	3m /JB3	**Performed by**	Jeremy Luong

9 kHz -1000 MHz radiated emission at 2442 MHz

Freq	Raw	Cable	AF	Level	Detector	Pol	Hgt	Azt	Limit	Margin	Result
MHz	dBuV/m	dB	dB	dBuV/m	Peak	-	cm	Deg	dBuV	dB	
36.00	38.98	3.83	-11.38	31.42	QP	V	101	306	40.00	-8.58	Pass
39.96	31.12	3.89	-14.05	20.96	QP	V	203	0	40.00	-19.04	Pass
67.13	42.75	4.21	-20.26	26.71	QP	V	122	206	40.00	-13.30	Pass
72.00	54.50	4.30	-20.20	38.60	QP	V	110	206	40.00	-1.40	Pass
83.99	46.20	4.38	-20.85	29.73	QP	V	104	26	40.00	-10.27	Pass
120.00	52.00	4.70	-14.50	42.20	QP	V	106	136	43.50	-1.30	Pass

Spec Margin = Level – Limit, Level = Raw + Cable + AF ± Uncertainty
AF= Amp Gain + ANT Factor

Combined Standard Uncertainty $u_c(y)$ = ± 4.52 dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

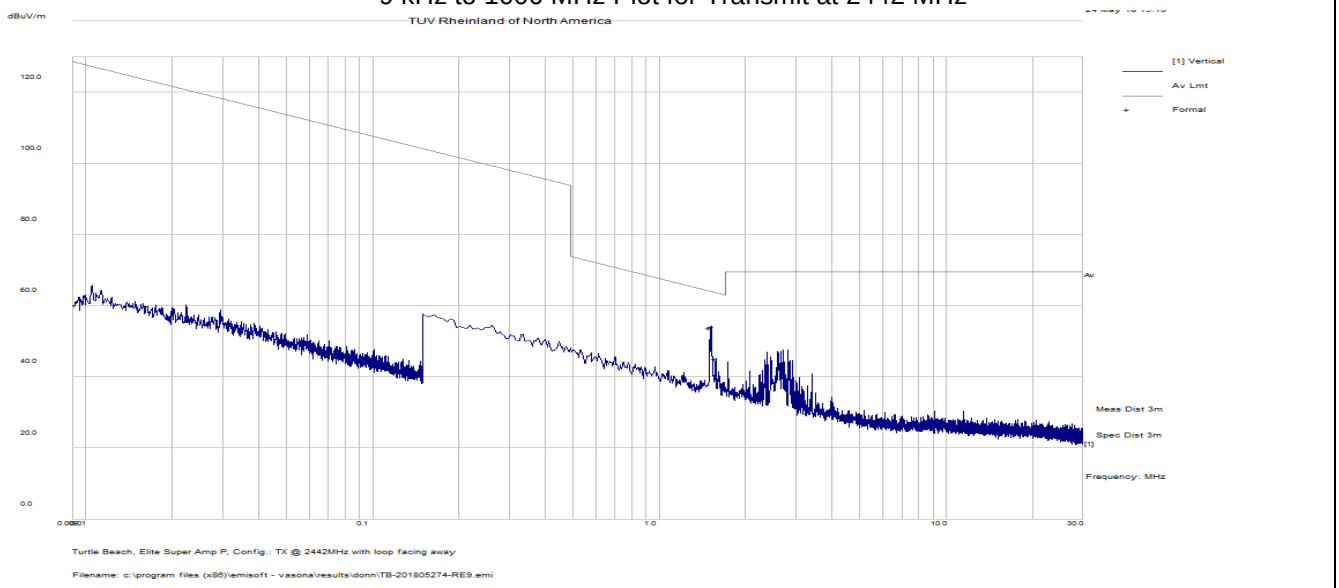
Note: 1. Worst case was observed on Mid channel of the Bluetooth radio.
2. No significant emission was observed below 30 MHz.

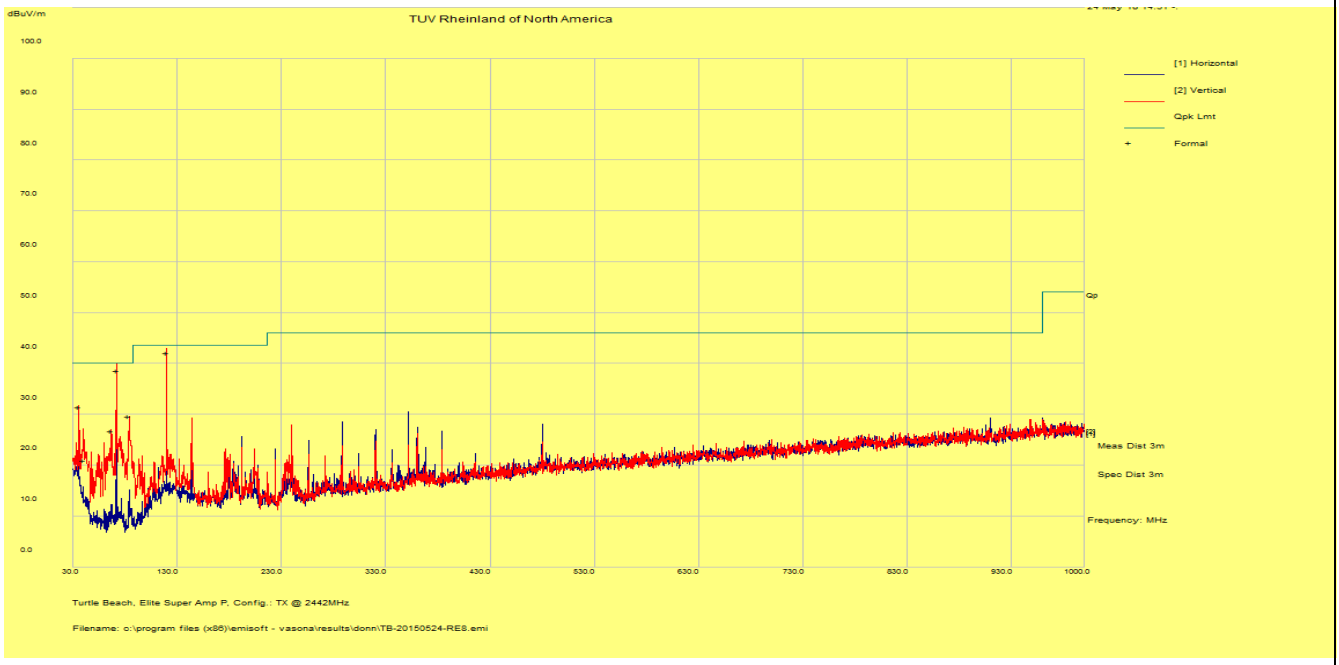
SOP 1 Radiated Emissions

Tracking # 31861558.001 Page 2 of 6

EUT Name	Wireless Audio Amplifier	**Date**	May 24, 2018
EUT Model	Elite SuperAmp X	**Temp / Hum in**	23°C / 36%rh
EUT Serial	PP #2	**Temp / Hum out**	N/A
EUT Comfit.	Integrated Antenna on X-Axis	**Line AC / Freq**	5.0 VDC
Standard	CFR47 Part 15 Subpart C	**RBW / VBW**	120 kHz/300 kHz
Dist/Ant Used	3m / 6505 and JB3	**Performed by**	Jeremy Luong

9 kHz to 1000 MHz Plot for Transmit at 2442 MHz





Note: Plot was scanned in the peak mode.

SOP 1 Radiated Emissions

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EUT Name	Wireless Audio Amplifier	**Date**	June 6, 2018
EUT Model	Elite SuperAmp X	**Temp / Hum in**	23°C / 38%rh
EUT Serial	PP #2	**Temp / Hum out**	N/A
EUT Comfit.	Integrated Antenna on X-Axis	**Line AC / Freq**	5.0 VDC
Standard	CFR47 Part 15 Subpart C	**RBW / VBW**	1 MHz /3 MHz
Dist/Ant Used	3m – DRH-118 / 1m - RA42-K-F-4B-C	**Performed by**	Jeremy Luong

Freq.	Raw	Cbl	AF	Level	Det.	Pol.	Hght.	Azt	Limit	Margin	Result
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB	
Above 1 GHz Radiated Emission at 2402 MHz, 2DH1											
1112.85	43.57	0.97	-26.53	18.01	Ave	H	157	338	54.00	-35.99	Pass
17871.27	38.39	4.22	-3.53	39.09	Ave	H	158	134	54.00	-14.92	Pass
4804.14	48.70	2.10	-18.00	32.90	Ave	V	168	232	54.00	-21.10	Pass
Above 1 GHz Radiated Emission at 2442 MHz, 2DH1											
4883.39	42.87	2.26	-17.86	27.27	Ave	H	236	266	54.00	-26.73	Pass
7395.54	39.24	2.65	-13.23	28.65	Ave	H	227	138	54.00	-25.35	Pass
9385.75	36.15	3.01	-9.48	29.69	Ave	H	200	316	54.00	-24.32	Pass
Above 1 GHz Radiated Emission at 2480 MHz, 2DH1											
4959.57	42.83	2.16	-18.09	26.90	Ave	H	138	360	54.00	-27.10	Pass
7400.30	39.16	2.66	-13.22	28.59	Ave	V	238	0	54.00	-25.41	Pass

Spec Margin = Level – Limit, Level = Raw + Cable + AF ± Uncertainty
AF= Amp Gain + ANT Factor

Combined Standard Uncertainty $u_c(y)$ = ± 4.52 dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Note Worst case was observed at 2DH1.
All emissions met restricted band limits.

SOP 1 Radiated Emissions

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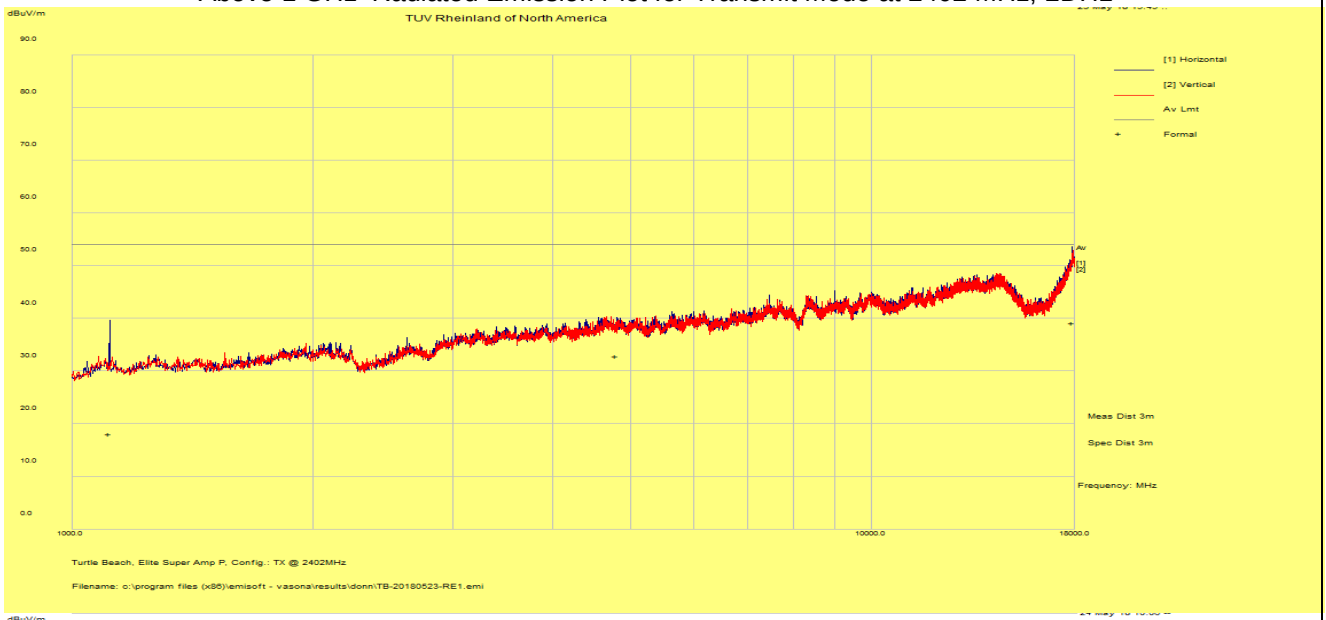
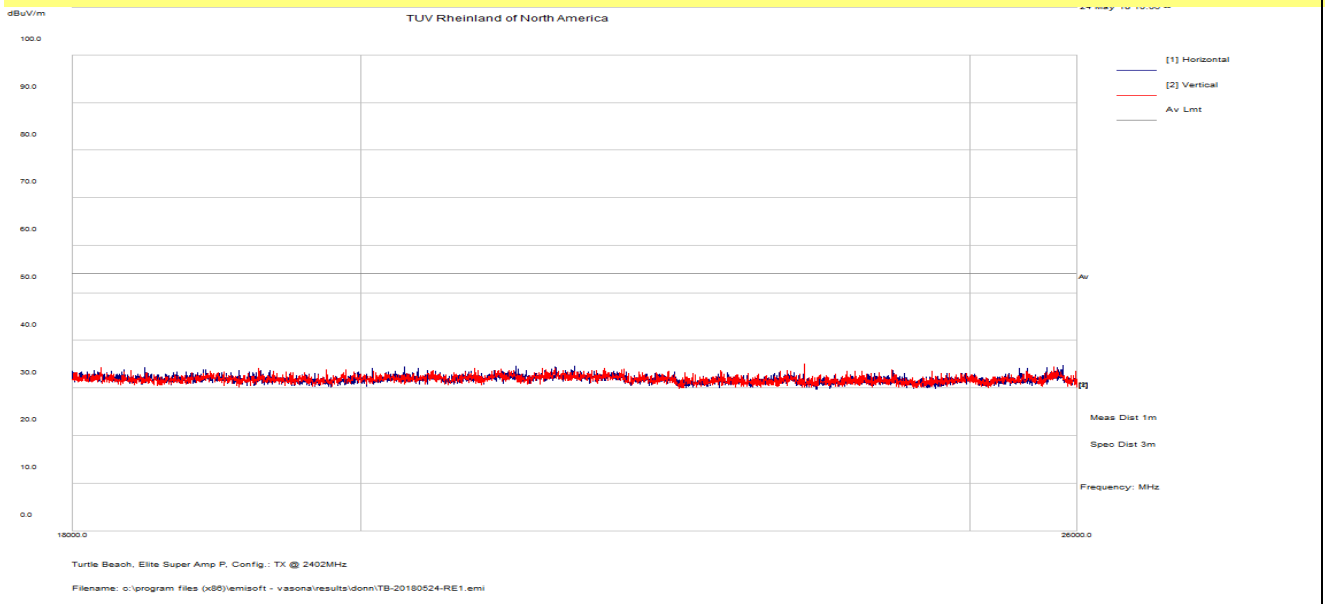
EUT Name	Wireless Audio Amplifier	**Date**	June 6, 2018
EUT Model	Elite SuperAmp X	**Temp / Hum in**	23°C / 38%rh
EUT Serial	PP #2	**Temp / Hum out**	N/A
EUT Config.	Integrated Antenna on X-Axis	**Line AC**	5.0 VDC
Standard	CFR47 Part 15 Subpart C	**RBW / VBW**	1 MHz/ 3 MHz
Dist/Ant Used	3m – DRH-118 / 1m - RA42-K-F-4B-C	**Performed by**	Jeremy Luong

Above 1 GHz Radiated Emission Plot for Transmit Mode at 2402 MHz, 2DH1





Notes: 1 GHz – 26 GHz was scanned at 1m distance.

SOP 1 Radiated Emissions

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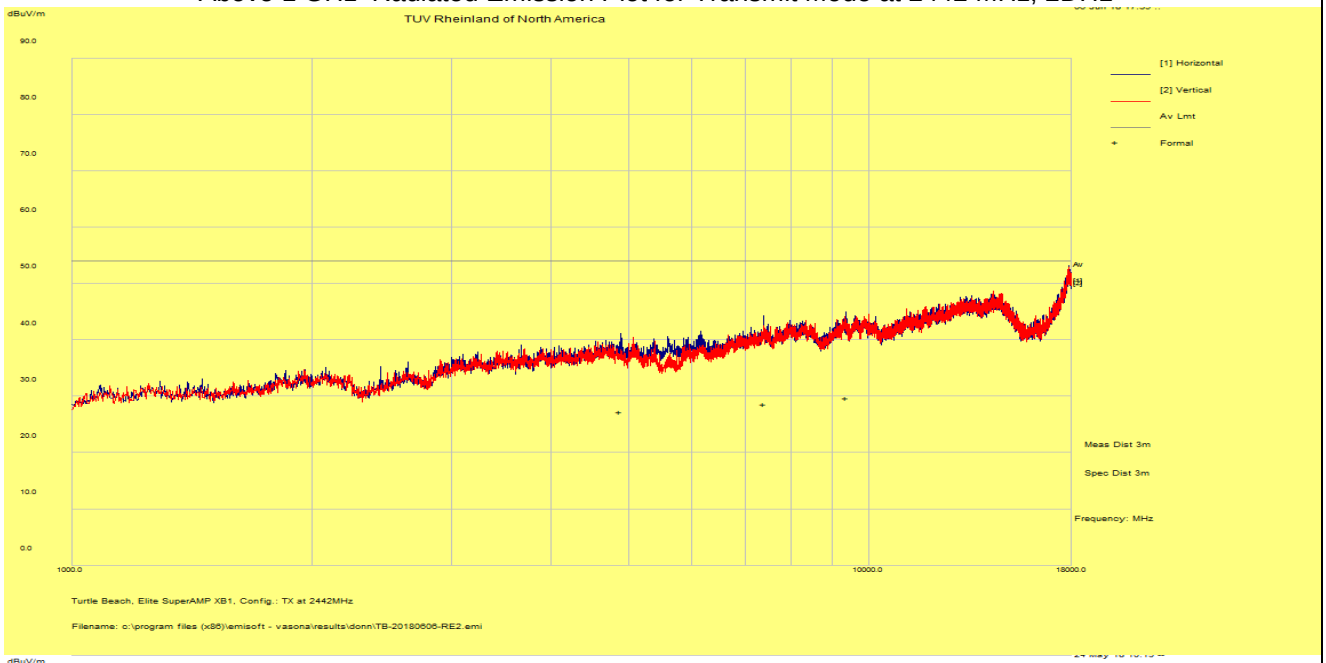
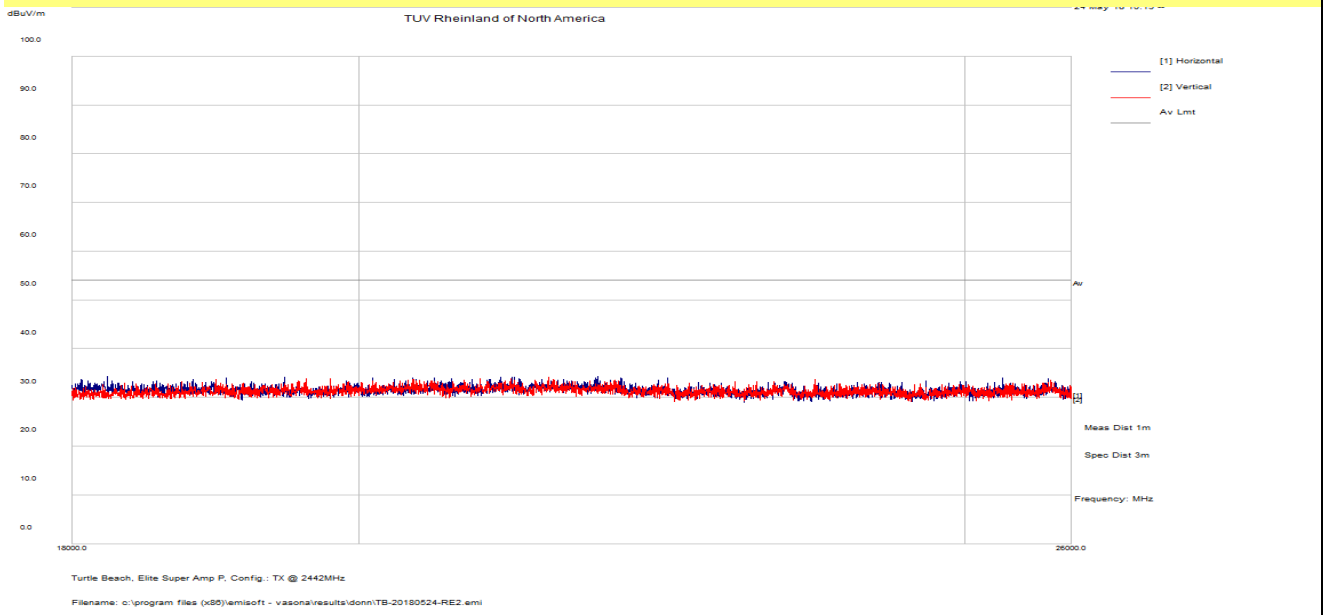
EUT Name	Wireless Audio Amplifier	**Date**	June 6, 2018
EUT Model	Elite SuperAmp X	**Temp / Hum in**	23°C / 38%rh
EUT Serial	PP #2	**Temp / Hum out**	N/A
EUT Config.	Integrated Antenna on X-Axis	**Line AC**	5.0 VDC
Standard	CFR47 Part 15 Subpart C	**RBW / VBW**	1 MHz/ 3 MHz
Dist/Ant Used	3m – DRH-118 / 1m - RA42-K-F-4B-C	**Performed by**	Jeremy Luong

Above 1 GHz Radiated Emission Plot for Transmit Mode at 2442 MHz, 2DH1





Notes: 1 GHz – 26 GHz was scanned at 1m distance.

SOP 1 Radiated Emissions

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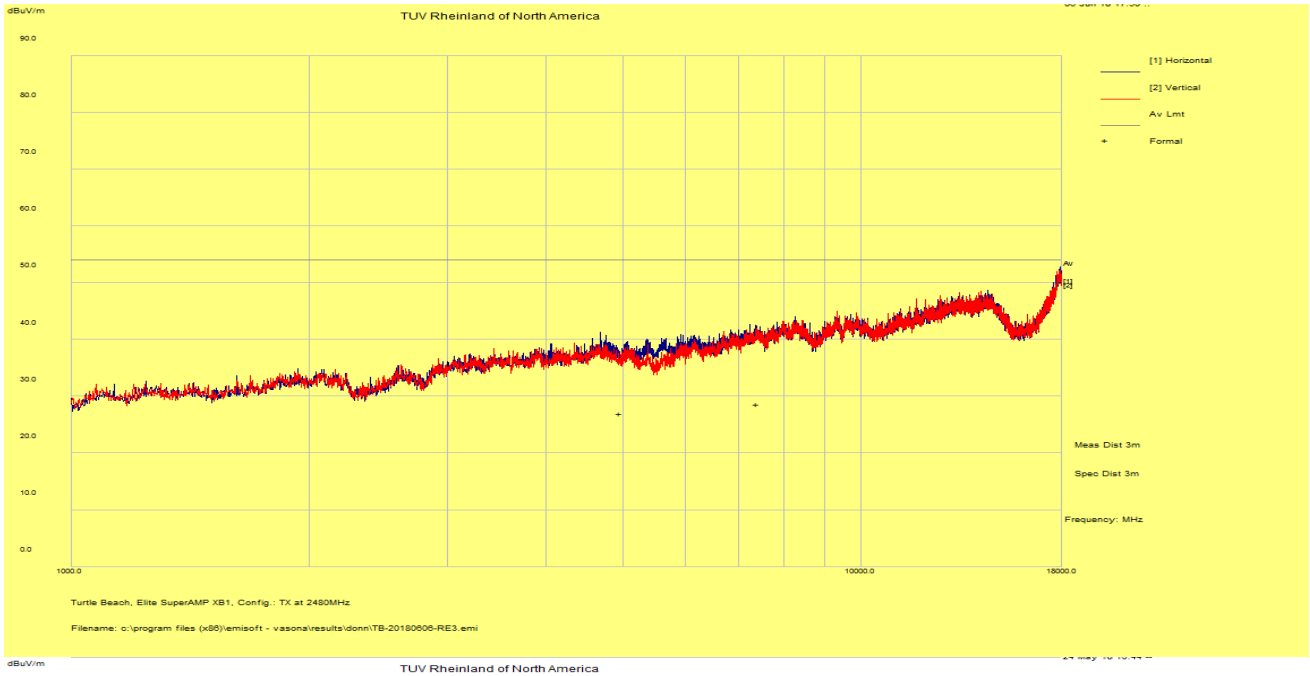
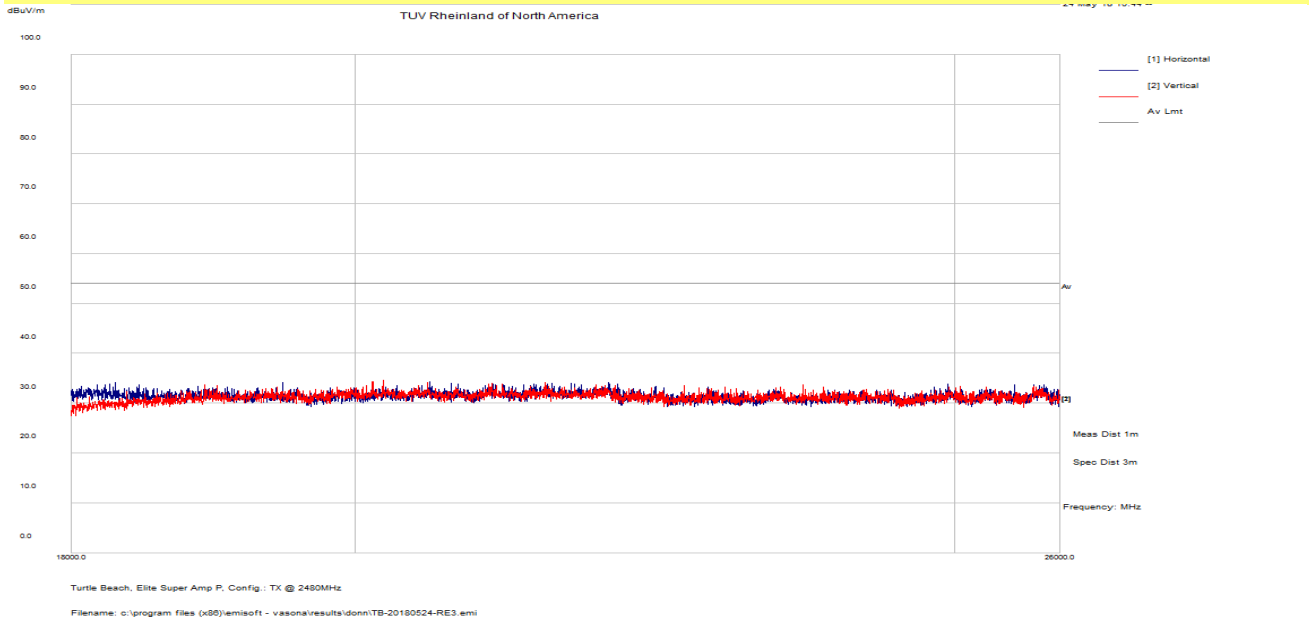
EUT Name	Wireless Audio Amplifier	**Date**	June 6, 2018
EUT Model	Elite SuperAmp X	**Temp / Hum in**	23°C / 38%rh
EUT Serial	PP #2	**Temp / Hum out**	N/A
EUT Config.	Integrated Antenna on X-Axis	**Line AC**	5.0 VDC
Standard	CFR47 Part 15 Subpart C	**RBW / VBW**	1 MHz/ 3 MHz
Dist/Ant Used	3m – DRH-118 / 1m - RA42-K-F-4B-C	**Performed by**	Jeremy Luong

Above 1 GHz Plots for Transmit Mode at 2480 MHz 2DH1





Notes: 1 GHz – 26 GHz was scanned at 1m distance.

4.5.4 Sample Calculation

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) = FIM - AMP + CBL + ACF

Where:

FIM = Field Intensity Meter (dBμV)
AMP = Amplifier Gain (dB)
CBL = Cable Loss (dB)
ACF = Antenna Correction Factor (dB/m)

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

4.6 AC 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 RSS-GEN. Sect. 8.8.

4.6.1 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 set of 50μH / 50Ω LISNs.

Testing is performed in Lab 5. The setup photographs clearly identify which site was used. The vertical ground plane used in the semi-anechoic chamber is a 2m x 2m solid aluminum frame and panel, and it is bonded to the horizontal ground plane.

In the case of tabletop equipment, the EUT is placed on a 1.0m x 1.5m non-conductive table 80cm above the ground plane and 40cm from a vertical ground reference plane. The rear of the EUT was positioned flush with the backside of the table and directly over the LISNs. The power and I/O cables were routed over the edge of the table and bundled approximately 40cm from the ground plane. Support equipment was powered from a separate LISN.

Preliminary test performed on all modes in the Elite SuperAmp X. The worst case observed at 2DH1.

4.6.1.1 Deviations

There were no deviations from this test methodology.

4.6.2 Test Results

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

Table 8: AC Conducted Emissions – Test Results

Test Conditions: Conducted Measurement at Normal Conditions only	**Date:** May 31, 2018
Antenna Type: Integrated	**Power Level:** See Test Plan
AC Power: 110 Vac/60 Hz at host device	**Configuration:** Tabletop
Ambient Temperature: 23° C	**Relative Humidity:** 34% RH

Configuration	Frequency Range	Test Result
Line 1 (Hot)	0.15 to 30 MHz	Pass
Line 2 (Neutral)	0.15 to 30 MHz	Pass

SOP 2 Conducted Emissions

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EUT Name	Wireless Audio Amplifier	**Date**	May 31, 2018
EUT Model	Elite SuperAmp X	**Temp / Hum in**	23° C / 34% rh
EUT Serial	PP#2	**Temp / Hum out**	N/A
EUT Config.	TX mode	**Line AC / Freq**	110Vac / 60Hz (host)
Standard	CFR47 Part 15.207 and RSS Gen	**RBW / VBW**	9 kHz / 30 kHz
Lab/LISN	Lab #5 /Com-Power, Line 1	**Performed by**	Jeremy Luong

Frequency	Raw	Limiter	Ins. Loss	Level	Detector	Line	Limit	Margin	Result
MHz	dBuV	dB	dB	dBuV			dBuV	dB	
0.167	33.88	9.82	0.05	43.75	QP	Live	65.12	-21.37	Pass
0.167	12.85	9.82	0.05	22.72	Ave	Live	55.12	-32.40	Pass
0.369	27.34	9.84	0.03	37.20	QP	Live	58.53	-21.33	Pass
0.369	10.45	9.84	0.03	20.32	Ave	Live	48.53	-28.21	Pass
0.421	30.04	9.84	0.03	39.91	QP	Live	57.43	-17.51	Pass
0.421	16.26	9.84	0.03	26.13	Ave	Live	47.43	-21.29	Pass
8.790	30.20	9.97	0.02	40.18	QP	Live	60.00	-19.82	Pass
8.790	11.22	9.97	0.02	21.21	Ave	Live	50.00	-28.79	Pass
9.054	31.37	9.97	0.02	41.36	QP	Live	60.00	-18.64	Pass
9.054	14.36	9.97	0.02	24.35	Ave	Live	50.00	-25.65	Pass
9.274	31.03	9.97	0.02	41.02	QP	Live	60.00	-18.98	Pass
9.274	11.22	9.97	0.02	21.21	Ave	Live	50.00	-28.79	Pass
9.327	30.05	9.97	0.02	40.04	QP	Live	60.00	-19.96	Pass
9.327	17.79	9.97	0.02	27.78	Ave	Live	50.00	-22.22	Pass

Spec Margin = QP./Ave. - Limit, ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.2 dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

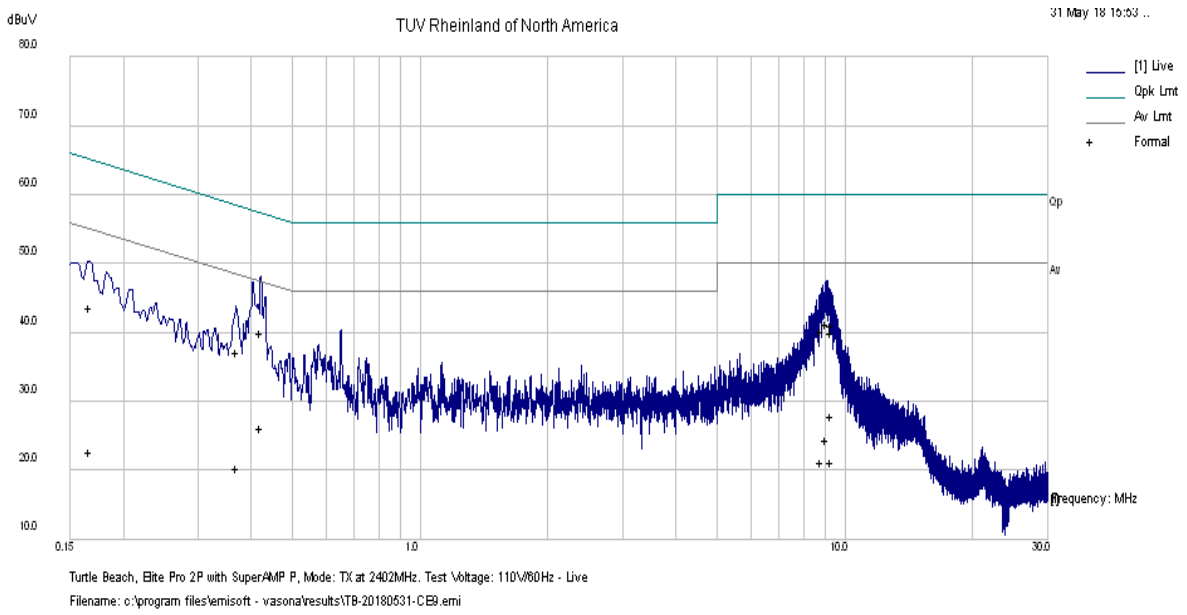
Notes: EUT was setup as table top equipment (worse case configuration).

SOP 2 Conducted Emissions

Tracking # 31861558.001 Page 2 of 4

EUT Name	Wireless Audio Amplifier	**Date**	May 31, 2018
EUT Model	Elite SuperAmp X	**Temp / Hum in**	23° C / 34% rh
EUT Serial	PP#2	**Temp / Hum out**	N/A
EUT Config.	TX mode	**Line AC**	110Vac / 60Hz (host)
Standard	CFR47 Part 15.207 and RSS Gen	**RBW / VBW**	9 kHz / 30 kHz
Lab/LISN	Lab #5 /Com-Power, Line 1	**Performed by**	Jeremy Luong

150 kHz to 30 MHz Plot for Line 1 (Live)



Note: Met FCC Class B limit.

SOP 2 Conducted Emissions

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EUT Name	Wireless Audio Amplifier	**Date**	May 31, 2018
EUT Model	Elite SuperAmp X	**Temp / Hum in**	23° C / 34% rh
EUT Serial	PP#2	**Temp / Hum out**	N/A
EUT Config.	TX mode	**Line AC / Freq**	110Vac / 60Hz (host)
Standard	CFR47 Part 15.207 and RSS Gen	**RBW / VBW**	9 kHz / 30 kHz
Lab/LISN	Lab #5 /Com-Power, Line 2	**Performed by**	Jeremy Luong

Frequency	Raw	Limiter	Ins. Loss	Level	Detector	Line	Limit	Margin	Result
MHz	dBuV	dB	dB	dBuV			dBuV	dB	
0.404	36.81	9.84	0.03	46.68	QP	Neutral	57.76	-11.08	Pass
0.404	24.01	9.84	0.03	33.88	Ave	Neutral	47.76	-13.89	Pass
0.444	30.20	9.84	0.03	40.07	QP	Neutral	57.00	-16.93	Pass
0.444	18.16	9.84	0.03	28.03	Ave	Neutral	47.00	-18.97	Pass
0.659	25.28	9.86	0.03	35.17	QP	Neutral	56.00	-20.83	Pass
0.659	15.20	9.86	0.03	25.08	Ave	Neutral	46.00	-20.92	Pass
9.177	30.66	9.97	0.02	40.65	QP	Neutral	60.00	-19.35	Pass
9.177	16.86	9.97	0.02	26.85	Ave	Neutral	50.00	-23.15	Pass
9.282	30.07	9.97	0.02	40.06	QP	Neutral	60.00	-19.94	Pass
9.282	15.66	9.97	0.02	25.65	Ave	Neutral	50.00	-24.35	Pass
9.366	29.36	9.97	0.02	39.35	QP	Neutral	60.00	-20.65	Pass
9.366	15.27	9.97	0.02	25.26	Ave	Neutral	50.00	-24.74	Pass
9.420	28.68	9.97	0.02	38.67	QP	Neutral	60.00	-21.33	Pass
9.420	15.35	9.97	0.02	25.34	Ave	Neutral	50.00	-24.66	Pass

Spec Margin = QP./Ave. - Limit, ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.2 dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

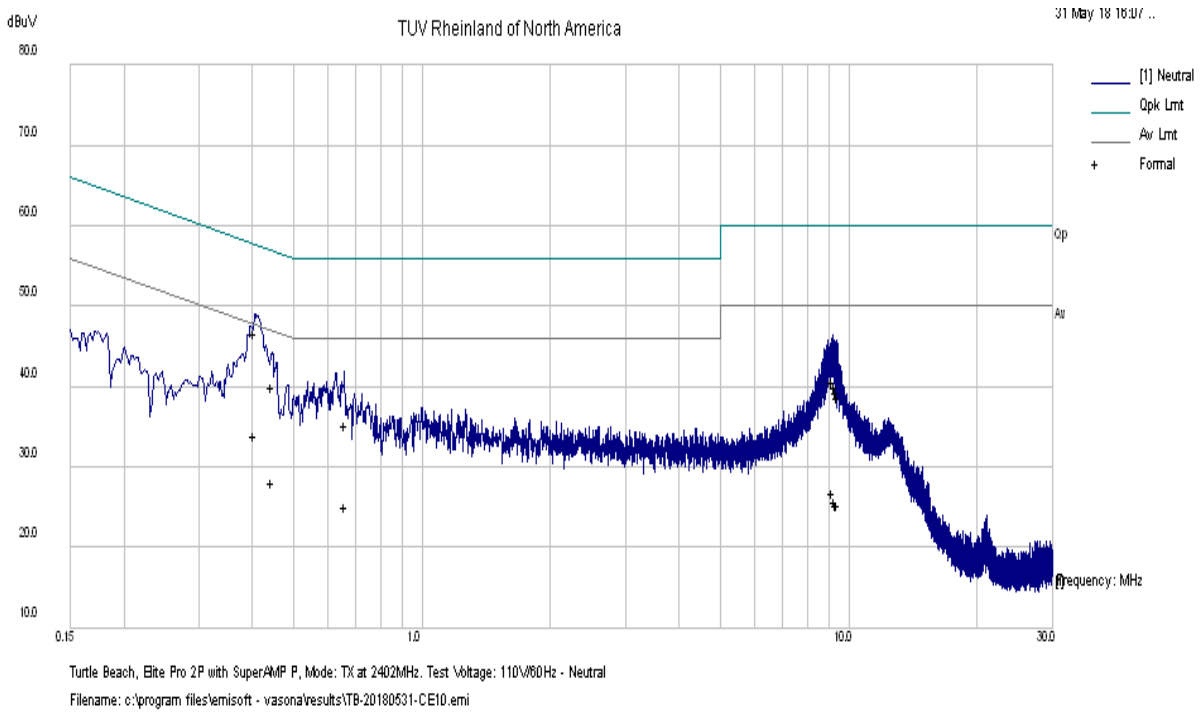
Notes: EUT was setup as table top equipment (worse case configuration).

SOP 2 Conducted Emissions

Tracking # 31861558.001 Page 4 of 4

EUT Name	Wireless Audio Amplifier	**Date**	May 31, 2018
EUT Model	Elite SuperAmp X	**Temp / Hum in**	23° C / 34% rh
EUT Serial	PP#2	**Temp / Hum out**	N/A
EUT Config.	TX mode	**Line AC**	110Vac / 60Hz (host)
Standard	CFR47 Part 15.207 and RSS Gen	**RBW / VBW**	9 kHz / 30 kHz
Lab/LISN	Lab #5 /Com-Power, Line 2	**Performed by**	Jeremy Luong

150 kHz to 30 MHz Plot for Line 2 (Neutral)



Note: Met FCC Class B Limit.

5 Test Equipment Use List

5.1 Equipment List

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal mm/dd/yyyy	Next Cal mm/dd/yyyy
Bilog Antenna	Sunol Sciences	JB3	A020502	03/27/2018	03/27/2019
Horn Antenna	EMCO	3115	9211-3969	05/16/2017	05/16/2019
Horn Antenna	Com-Power	AHA-840	105005	05/26/2017	05/26/2019
Loop Antenna	EMCO	6502	9110-2683	07/20/2017	07/20/2019
LISN	Com-Power	LI-215	12100	01/24/2018	01/24/2019
Spectrum Analyzer	Agilent	N9038A	MY552260210	01/22/2018	01/22/2019
Spectrum Analyzer	Rohde Schwarz	ESIB40	832427/002	01/22/2018	01/22/2019
Spectrum Analyzer	Rohde Schwarz	FSV40	1321.3008K40	09/19/2017	09/19/2018
Amplifier	Sonoma Instruments	310	165516	01/23/2018	01/23/2019
Amplifier	Miteq	TTA1800-30-HG	1842452	01/23/2018	01/23/2019
Amplifier	Rohde & Schwarz	TS-PR26	100011	11/04/2017	11/04/2018
Amplifier	Rohde & Schwarz	TS-PR40	100012	08/02/2017	08/02/2018
Power Meter	Agilent	E4418B	MY45103902	01/24/2018	01/24/2019
Power Sensor	Hewlett Packard	8482A	1925A04647	01/24/2018	01/24/2019
Thermo Chamber	Espec	BTZ-133	0613436	05/31/2018	05/31/2019
Multimeter	Fluke	177	92780312	01/22/2018	01/22/2019
DC Power Supply	Agilent	E3634A	MY400004331	01/25/2018	01/25/2019
Notch Filter	Micro-Tronics	BRM50702	037	VBU	VBU
Signal Generator	Anritsu	MG3694A	42803	03/20/2018	03/20/2019
Signal Generator	Rohde & Schwarz	SMF100A	1167.0000K02	09/19/2017	09/19/2018
Signal Generator	Rohde & Schwarz	SMBV100A	1407.6004K02	09/19/2017	09/19/2018
Power Sensors	Rohde & Schwarz	OSP120	1520.9010.02	09/19/2017	09/19/2018

* 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.

6 EMC Test Plan

6.1 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.

6.2 Customer

Table 9: Customer Information

Company Name	Voyetra Turtle Beach, Inc.
Address	100 Summit Lake Drive, Suite 100
City, State, Zip	Valhalla, New York 10595
Country	U.S.A.

Table 10: Technical Contact Information

Name	Tim Blaney
E-mail	tim@commcepts.net
Phone	(530) 277-3482

6.3 Equipment Under Test (EUT)

Table 11: EUT Specifications

EUT Specifications	
Dimensions	88.5 mm (3.5”) x 78 mm (3.1”) x 32.5 mm (1.3”)
DC Input	Audio Amplifier Input Voltage: 5.0 Vdc (via host USB)
Environment	Indoor
Operating Temperature Range:	0 to 50 degrees C
Multiple Feeds:	☐ Yes and how many ☒ No
Product Marketing Name (PMN)	Elite SuperAmp X
Hardware Version Identification Number (HVIN)	SuperAmp X
Firmware Version Identification Number (FVIN)	1.0.7
Bluetooth Radio	
Operating Mode	BDR, EDR and BLE
Transmitter Frequency Band	2402 MHz to 2480 MHz
Operating Bandwidth	1 MHz
Max. Power Output	4.34 dBm
Power Setting @ Operating Channel	Fixed
Antenna Type	1 integrated PCB antenna
Antenna Gain	1.6 dBi
Modulation Type	GFSK, π/4-DQPSK and 8DPSK
Data Rate	1 Mbps, 2 Mbps and 3 Mbps
Note: This report only documents the Bluetooth radio characteristics for the 2402 - 2480 MHz band and the RF output power is fixed for this chipset.	

Table 12: Antenna Information

Number	Antenna Type	Description	Max Gain (dBi)
Antenna 1	Integrated PCB	Max. peak gain at 2.4 GHz	+1.6

Table 13: 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	USB	☒ No	☒ Metric: 2.9 m	☒ M

Table 14: Supported Equipment

Equipment	Manufacturer	Model	Serial	Used for
Laptop	Dell	Latitude	35521341769	Setup EUT operating channel
Interface Board	Turtle Beach	N.A	N.A	Access 2.4 GHz radio chipset
Note: None.				

Table 15: Description of Sample used for Testing

Device	Serial	RF Connection	CFR47 Part 15.247
Elite SuperAmp X	PP #2	Integrated Antenna	TX Emissions, Rad. Band-edge.
	PP #1	Direct via SMA Connection	Transmit Power, Occupied Bandwidth, Out of Band Emission, Hopping Requirement

Table 16: Description of Test Configuration used for Radiated Measurement.

Device	Antenna	Mode	Setup Photo (X-Axis)	Setup Photo (Y-Axis)	Setup Photo (Z-Axis)
Elite SuperAmp X	Integrated	Transmit	EUT upright	N/A	N/A
Note: The Elite SuperAmp X is designed and intended to be upright as a tabletop device. All emission scans performed on the X-Axis; worst case configuration.					

Table 17: Final Test Mode for 2402 MHz to 2480MHz Channels

Test	802.11a
Occupied Bandwidth CFR 47 15.247(a1), RSS Gen Sect. 4.4.	2402, 2442, 2480 MHz at BDR, EDR, and BLE
Output Power CFR47 15.247 (b1), RSS 210 Sect. A.8.1	2402, 2442, 2480 MHz at BDR, EDR, and BLE
Out of Band Emission CFR47 15.247 (d), RSS 210 Sect. A.8.5	2402, 2442, 2480 MHz at BDR, EDR, and BLE
Hopping Requirements CFR47 15.247 (a1), RSS 210 Sect. A.8.1	2402, 2442, 2480 MHz at BDR and EDR
Band-Edge (Radiated) FCC Part 15.205, 15.209	2402, 2480 MHz at EDR and BLE
Transmitted Spurious Emission (30 MHz – 1GHz) FCC Part 15.205, 15.209	2442 MHz at 2DH1 (Worst Case)
Transmitted Spurious Emission (Above 1GHz) FCC Part 15.205, 15.209	2402, 2442, 2480 MHz at 2DH1 (Worst Case)
AC Conducted Emission FCC Part 15.207	Prescan both hopping mode and BLE. Perform on the worst case.

Note: 1. Pretest showed 2DH1 was the worst case configuration.
2. All radiated emission tests were performed on the X-Axis.
3. All tests were pre-scanned for worst case configuration before final testing.
4. Since Elite SuperAmp X supports both BLE and FHSS Bluetooth, Elite SuperAmp X will demonstrate compliance to the rules required for DTS per KDB 453039.

6.4 Test Specifications

Testing requirements

Table 18: Test Specifications

Emissions and Immunity	
Standard	Requirement
CFR 47 Part 15.247: 2018	All
RSS 247 Issue 2, 2017	All

END OF REPORT