# Emissions
# Test Report

**EUT Name:** SoClean 3

**Model No.:** SC1400

CFR 47 Part 15.247: 2019 and RSS 247: 2017

*Prepared for:*

SoClean Inc.
12 Vose farm road
Petersborough, NH, 03458 U.S.A.

*Prepared by:*

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*Report/Issue Date:* July 10, 2020
*Job #* 234107543
*Report Number:* 31965017.001

# Revisions

| Revision No. | Date MM/DD/YYYY | Reason for Change | Author |
|---|---|---|---|
| 0 | 5/12/20 | Original Document | OC |
| 1 | 7/2/20 | Customer Review | OC |
| 1.1 | 7/10/20 | Customer Review | OC |
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Note: Latest revision report will replace all previous reports.

# Statement of Compliance

| | |
|---|---|
| *Manufacturer:* | SoClean Inc.<br>12 Vose farm road<br>Petersborough, NH, 03458 |
| *Requester / Applicant:* | SoClean Inc. |
| *Name of Equipment:* | SoClean 3 |
| *Model No.* | SC1400 |
| *Type of Equipment:* | Intentional Radiator |
| *Application of Regulations:* | CFR 47 Part 15.247: 2019 and RSS 247: 2017 |
| *Test Dates:* | November 1st 2019 to November 12th, 2019 |

*Guidance Documents:*

Emissions: ANSI C63.10-2013, KDB 558074 D01 DTS Measurement Guidance v05r02, KDB 662911 D01 Multiple Transmitter Output v02r01

*Test Methods:*

Emissions: ANSI C63.10-2013, KDB 558074 D01 DTS Measurement Guidance v05r02, KDB 662911 D01 Multiple Transmitter Output v02r01

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 shall not be reproduced except in full, without the written authorization of TUV Rheinland of North America.

| | | | |
|---|---|---|---|
| Osvaldo Casorla | | Rachana Khanduri | |
| Test Engineer | Date July 10, 2020 | A2LA Signatory | Date July 10, 2020 |

**Testing Cert #3331.02** **US1131** **2932D**

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# 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: 2019 and RSS 247: 2017 based on the results of testing performed on November 1st 2019 to November 12th, 2019 on the SoClean 3 Model SC1400 manufactured by SoClean 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 2402 MHz to 2480 MHz frequency band for Bluetooth, Low Energy is covered in this document.

## 1.3 Summary of Test Results

**Table 1:** Summary of Test Results

| Test | Test Method ANSI C 63.10 & C63.4 | Worse Case (Measured) | Result |
|---|---|---|---|
| Maximum Output Power | CFR47 15.247 (b), RSS 247 Sect. 5.4 (d) | 5.09dBm @ 2402MHz Channel, 1Mbps | **Complied** |
| DTS Bandwidth (6dB) | CFR47 15.247 (a)(2), RSS 247 Sect. 5.2 (a) | 0.858MHz @ 2402MHz Channel, 1Mbps | **Complied** |
| Peak Power Spectral Density | CFR47 15.247 (e), RSS 247 Sect. 5.2 (b) | -6.56 dBm/ kHz @ 2402MHz channel, 1Mbps | **Complied** |
| Out of Band Emissions: Non-Restricted | CFR47 15.247 (d), RSS 247 Sect.5.5 | -33.03 dBc @ 2400 MHz, Lower Band Edge | **Complied** |
| Out of Band Emissions: Restricted | CFR47 15.247 (d), RSS 247 Sect.5.5 | -3.20dB margin @ 2274.115 MHz, Average | **Complied** |
| Transmitter Spurious Emissions | CFR47 15.247 (d), RSS 247 Sect.5.5 | -2.99dB Margin @ 120 MHz, QuasiPeak | **Complied** |
| AC Power Conducted Emission | CFR47 15.207, RSS-GEN Sect.8.8 | Class B | **Complied** |

Note 1: This test report covers 2400 MHz to 2480 MHz band. * = summed power.

Note 2: Class B limits were applied where applicable.

## 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 EMC test facilities located at 1279 Quarry Lane, Ste. A, Pleasanton, CA, 94566, and 5015 Brandin Ct, Fremont, CA 94538, are 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 (Registration No. US1131). The laboratory Scopes of Accreditation include Title 47 CFR Parts 15, 18 and 90. The accreditations are updated every three 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 17025:2017. The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated annually.

### 2.1.3 Canada – Industry Canada

Industry Canada Industrie Canada

The Pleasanton 5-meter Semi-Anechoic Chamber, Registration No. 2932M-1, has been accepted by Industry Canada to perform testing to 3 and 5 meters based on the test procedures described in ANSI C63.4-2014. The Fremont 10-meter Semi-Anechoic Chamber, Registration No. 2932D-1, has been accepted by Industry Canada to perform testing to 3 and 10 meters based on the test procedures described in ANSI C63.4-2014.

### 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 EMC test facilities located at 1279 Quarry Lane, Ste. A, Pleasanton, CA, 94566, and 5015 Brandin Ct, Fremont, CA 94538, have been assessed and approved in accordance with the Regulations for Voluntary Control Measures.

VCCI Registration No. for Pleasanton: A-0326

VCCI Registration No. for Fremont: A-0327

### 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*

Test facilities are located at 5015 Brandin Ct, Fremont, California, 94538, USA and 1279 Quarry Lane, Pleasanton, California 94566, USA (Fremont is the Pleasanton Annex).

### 2.2.1 Emission Test Facility

The Semi-Anechoic Chambers and AC Line Conducted measurement facilities used to collect radiated and conducted emissions data have been constructed in accordance with ANSI C63.7:1992. The Fremont 10 meter semi-anechoic chamber has been measured in accordance with and verified to comply with the theoretical volumetric normalized site attenuation of ANSI C63.4:2014 and SVSWR requirements of CISPR 16-1-4 Consol. Ed. 3.0 (2010-04), at test distances of 3 and 10 meters. This site has been described in reports dated November 1st, 2006, submitted to the FCC, and accepted by letter dated November 28, 2006. The site is listed with the FCC and accredited by A2LA (Testing Certificate #3331.02). The Pleasanton 5 meter semi-anechoic chamber has been verified to comply with the theoretical volumetric normalized site attenuation of ANSI C63.4:2009 and SVSWR requirements of CISPR 16-1-4 Consol. Ed. 3.0 (2010-04) at a test distance of 3 meters. This site has been described in reports dated November 1st, 2006, submitted to the FCC, and accepted by letter dated November 28, 2006. The site is listed with the FCC and accredited by A2LA (Testing Certificate #3331.02).

## *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.

*The Expanded Uncertainty* defines an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurement and the fraction may be viewed as the coverage probability or level of confidence of the interval.

### 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

| **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 |

## 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 17025:2017. Equipment calibration records are kept on file at the test facility.

# 3 Product Information

## 3.1 Product Description

The Model SC1400 is a SoClean 3 utilizing Bluetooth. The EUT will be in compliance with regulatory standards of regions it will be operating in.

## 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 an 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 an 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.

## 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

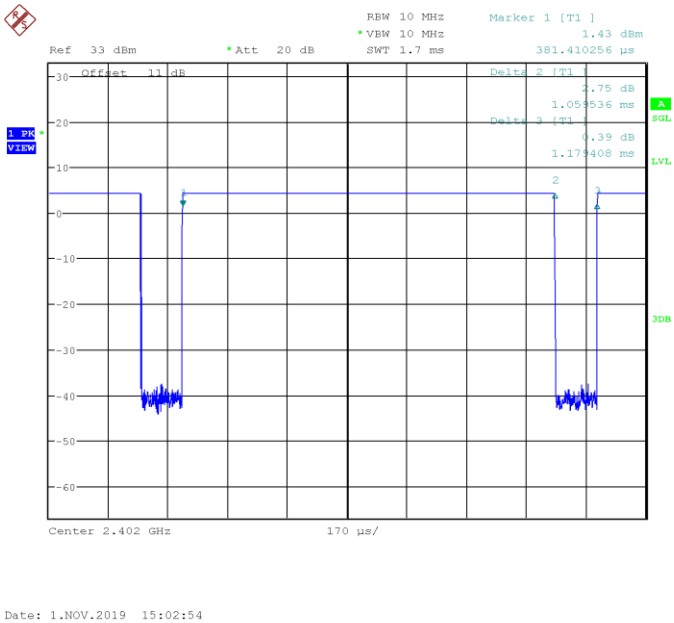
The SoClean 3 has 1 PCB trace antenna dedicated Bluetooth antenna that has maximum gain of 0 dBi. It is connected via RF connector that is not easily accessible to the end user.

Refer to Table 12 for additional antenna information.

## 3.5 Duty Cycle

Duty cycles were measured by the spectrum analyzer used for measurements in section 4.1 of this report.

| Mode | Measured Duty Cycle | Duty Cycle Correction Factor (dB) |
|---|---|---|
| BLE | 90% | 0.46 |




**Plot 1:** Duty Cycle for BLE

# 4 Emissions

Testing was performed in accordance with CFR 47 Part 15.247: 2019 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.*

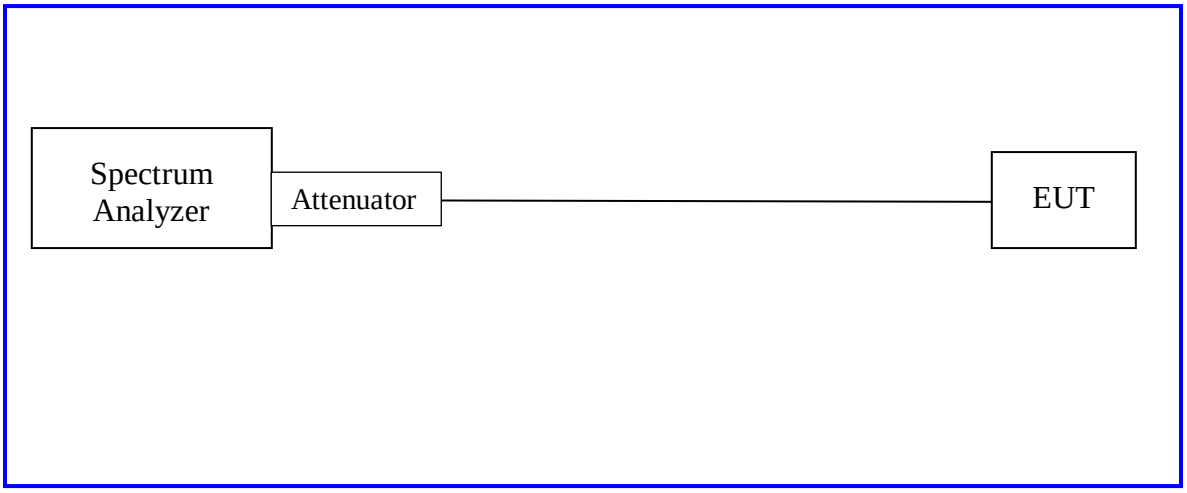
*The maximum output power and harmonics shall not exceed CFR47 Part 15.247 (b) and RSS 247 5.4 (d).*

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

### 4.1.1 Test Method

Conducted method was used to measure the channel power output according to ANSI C63.10:2013 Section 11.9.1.1. The worst findings were conducted on 3 channels in each operating range per CFR47 Part 15.247(b) and RSS 247 Sect. 5.4(d); 2400 MHz to 2483.5 MHz. The worst mode results indicated below.

Test Setup:



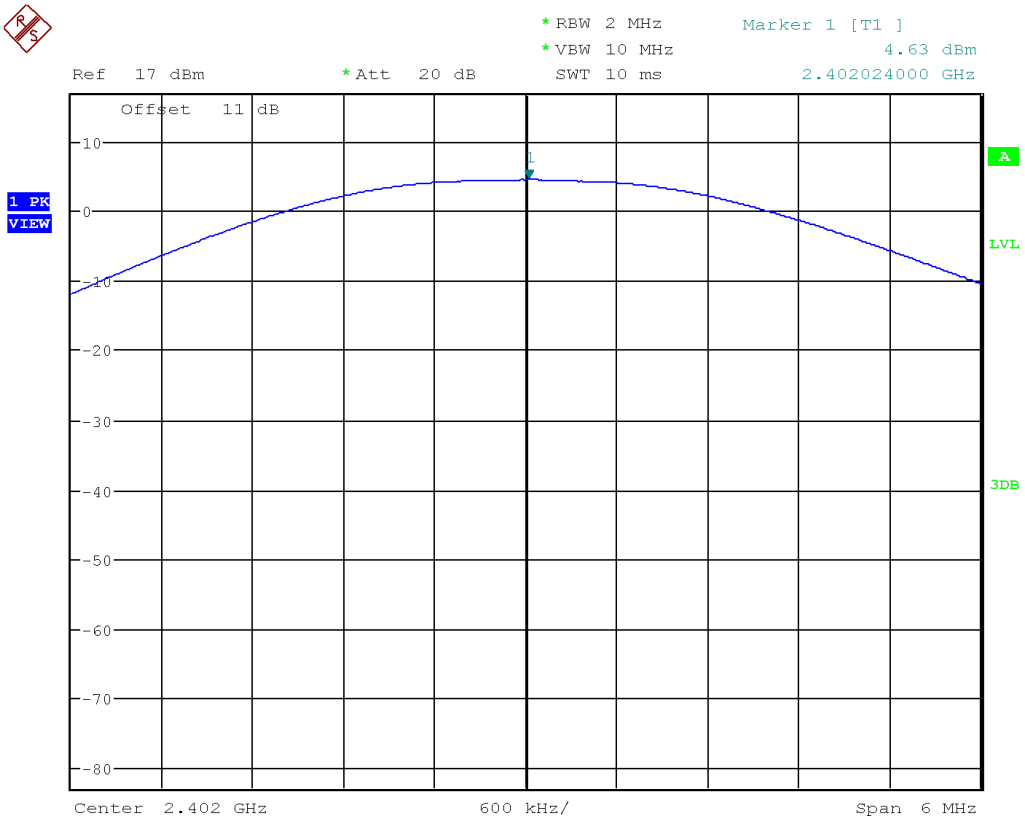
### 4.1.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s). Worse case data for each mode reported below. Plots of highest power included for low, medium, and high channels.

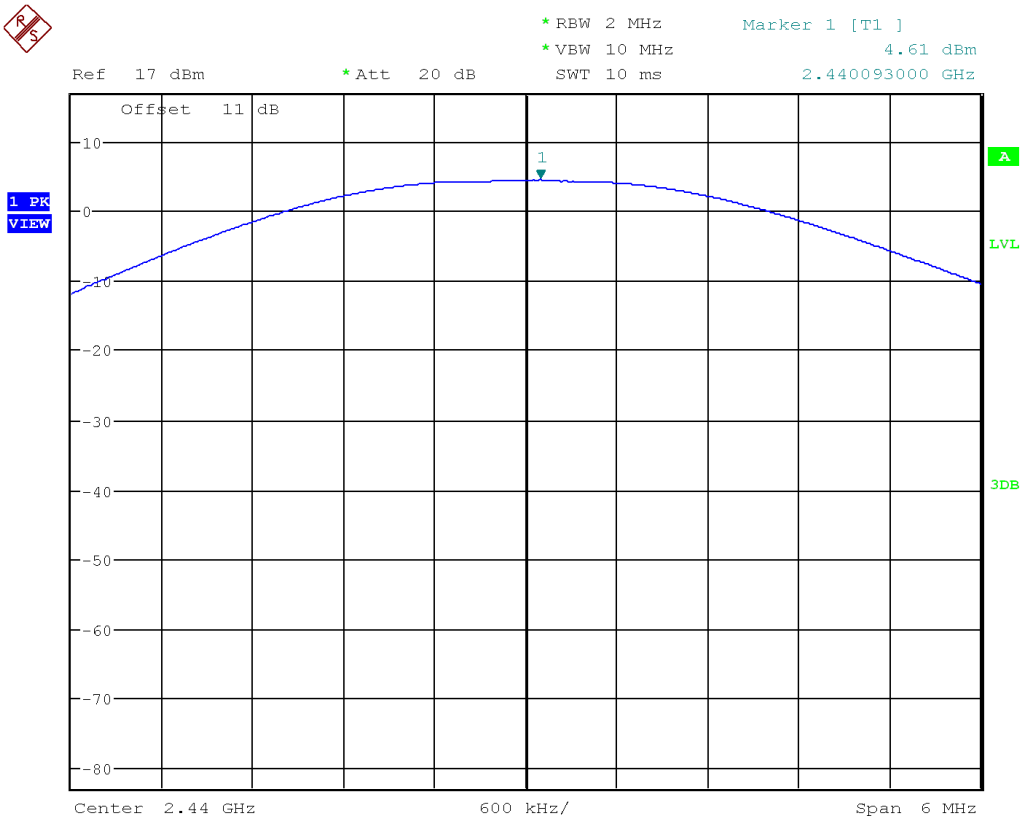
ANSI C63.10:2013 Section 11.9.1.1

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

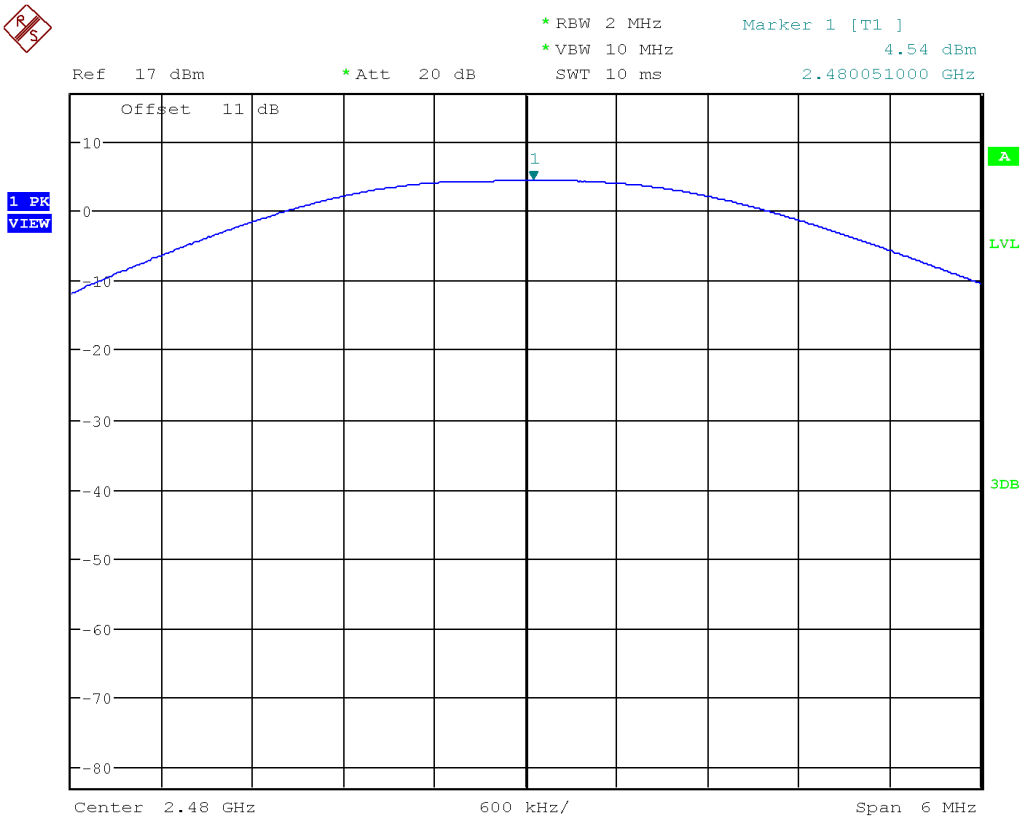
| **Test Conditions:** Conducted Measurement, Normal Temperature | | | |
|---|---|---|---|
| **Antenna Type:** PCB trace antenna | | | |
| **Max. Antenna Gain:** 0 dBi | | | |
| **Operating Channel (MHz)** | **Limit [dBm]** | **Total Power [dBm]** | **Margin [dB]** |
| 2402.00 | 30.00 | 5.09 | -24.91 |
| 2440.00 | 30.00 | 5.07 | -24.93 |
| 2480.00 | 30.00 | 5.00 | -25.00 |
| Note: Duty Cycle Correction Factor = [10 log (1/duty cycle)] | | | |




**Plot 2**. Maximum Conducted Power, 2402MHz




**Plot 3.** Maximum Conducted Power, 2440MHz




**Plot 4.** Maximum Conducted Power, 2480MHz

## *4.2 DTS Bandwidth (6dB) and 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.*

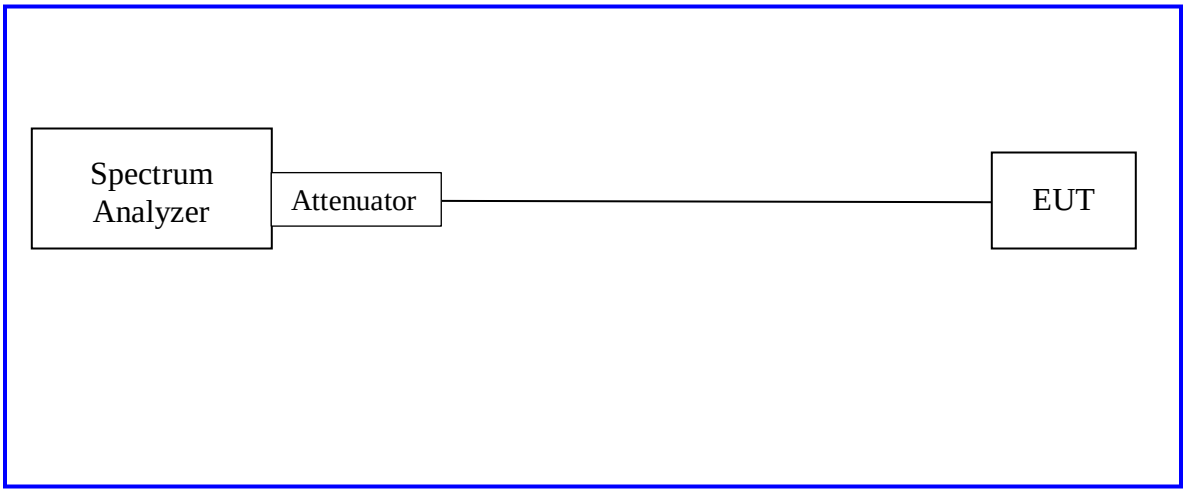
*The 99% bandwidth is the bandwidth in which 99% of the transmitted power occupied.*

*The minimum 6 dB bandwidth shall be at least 500 kHz.*

### 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) and RSS Gen Sect. 6.6. Measurements were performed on the low, middle and high channels of the operating frequency range; 2400 MHz to 2483.5 MHz.

Test Setup:

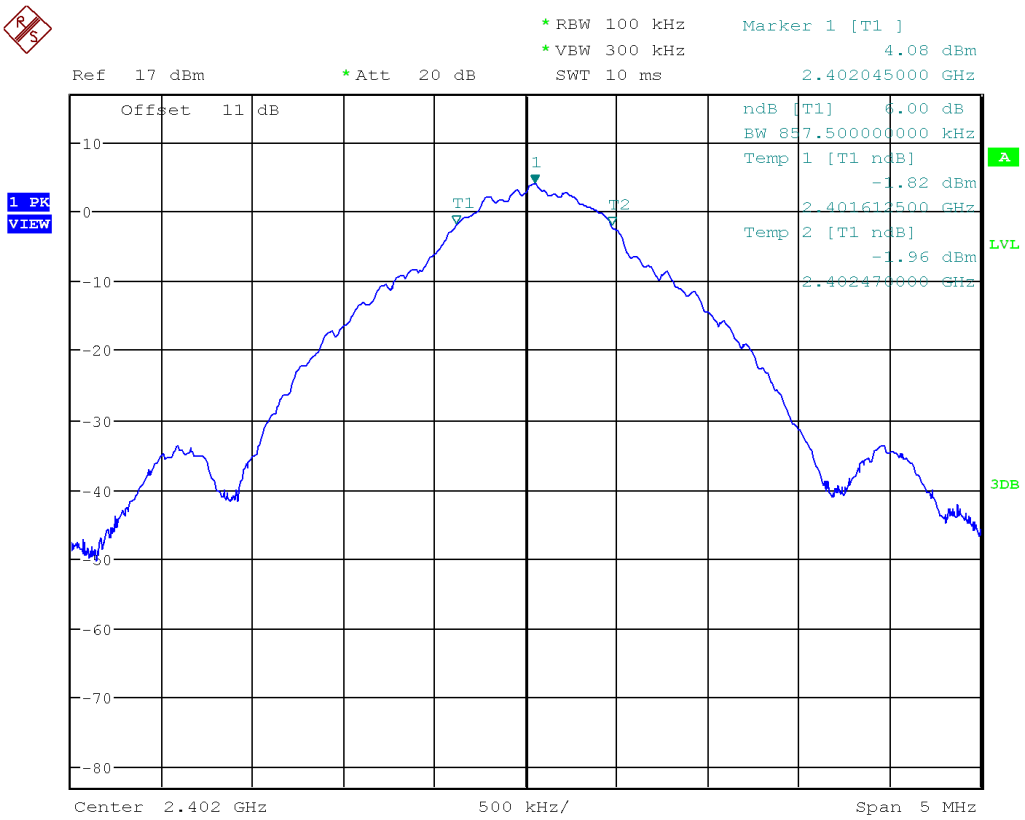



Results
As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

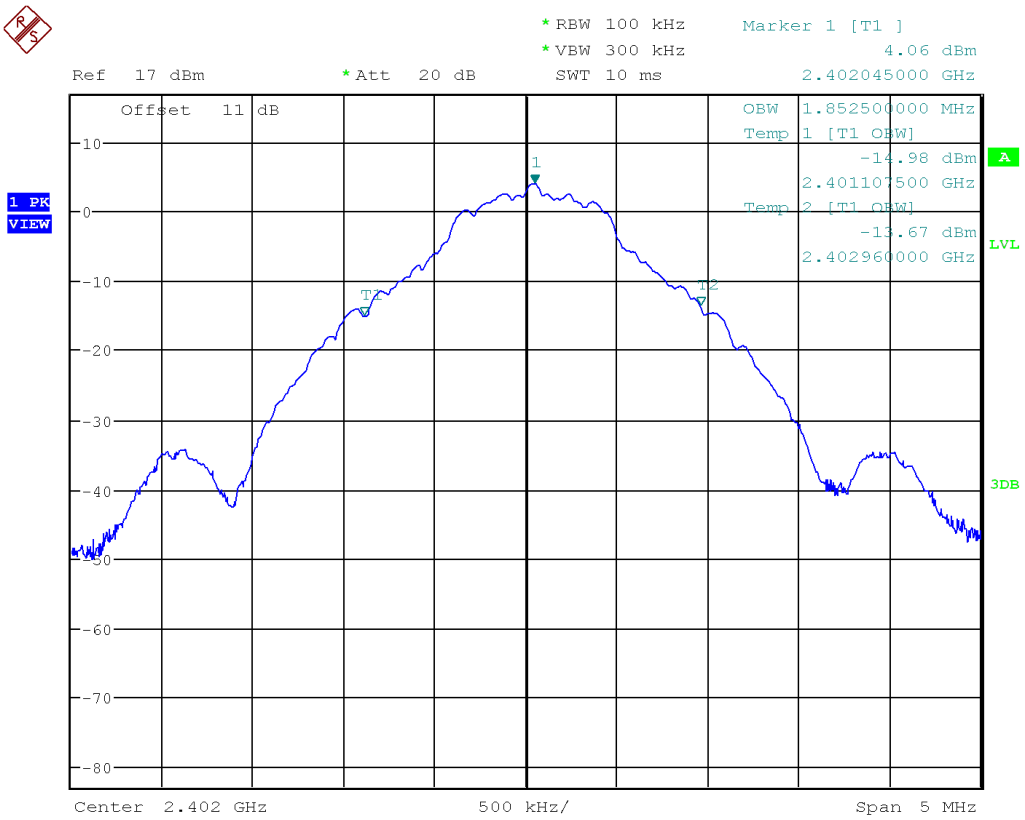
**Table 3:** Occupied Bandwidth – Test Results

| **Test Conditions:** Conducted Measurement, Normal Temperature |
|---|

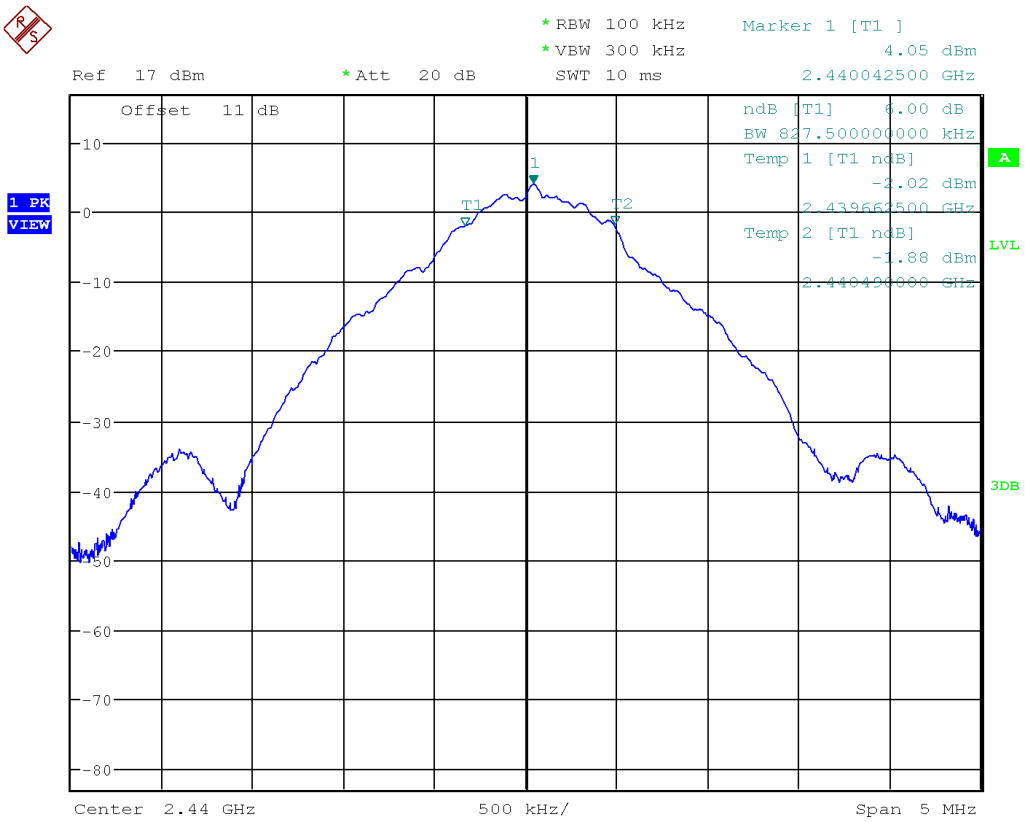
| **Bandwidth (MHz)** | | |
|---|---|---|
| **Freq. (MHz)** | **99% Bandwidth (MHz)** | **6dB (DTS) Bandwidth (MHz)** |
| 2402 | 1.85 | 0.858 |
| 2440 | 1.83 | 0.828 |
| 2480 | 1.87 | 0.855 |
| **Note:** None | | |



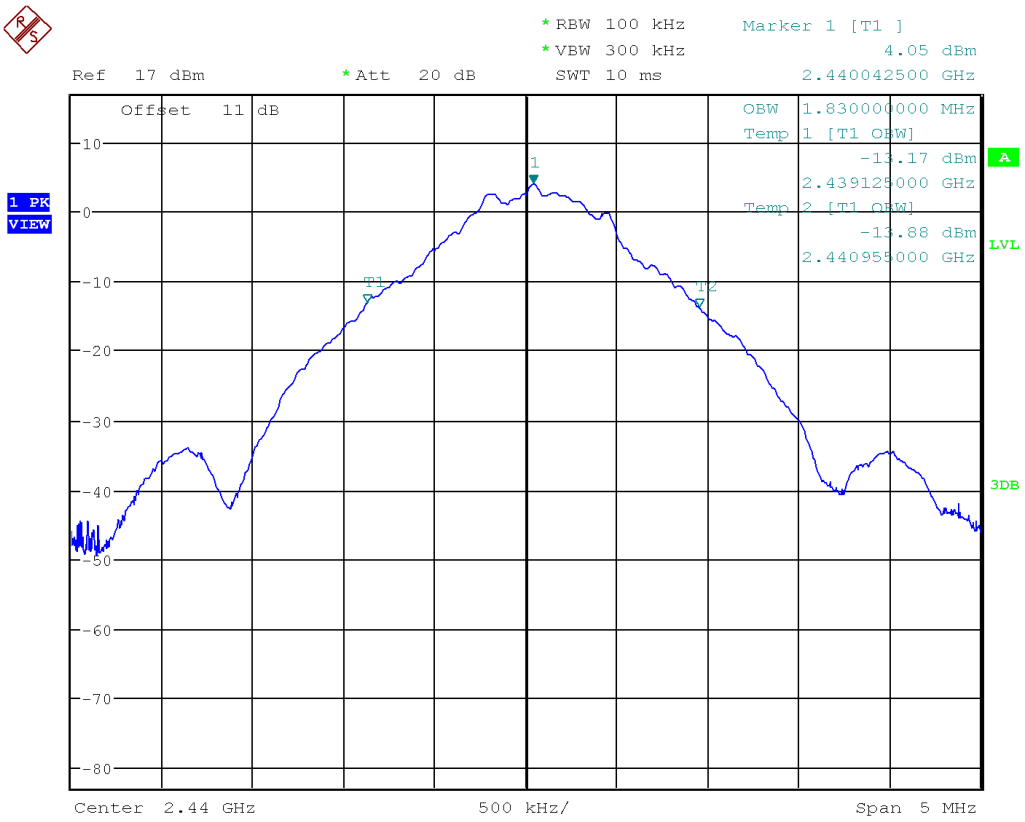

**Plot 5.** 2402MHz, 6dB Bandwidth



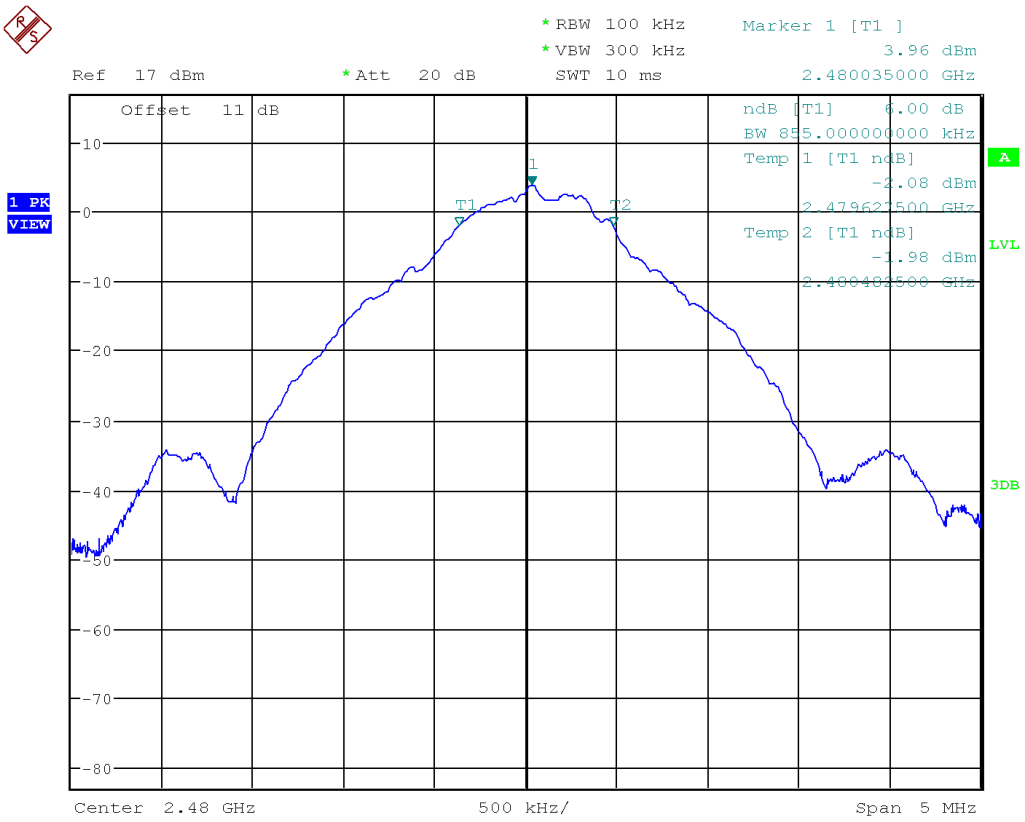

**Plot 6.** 2402MHz, 99% Bandwidth



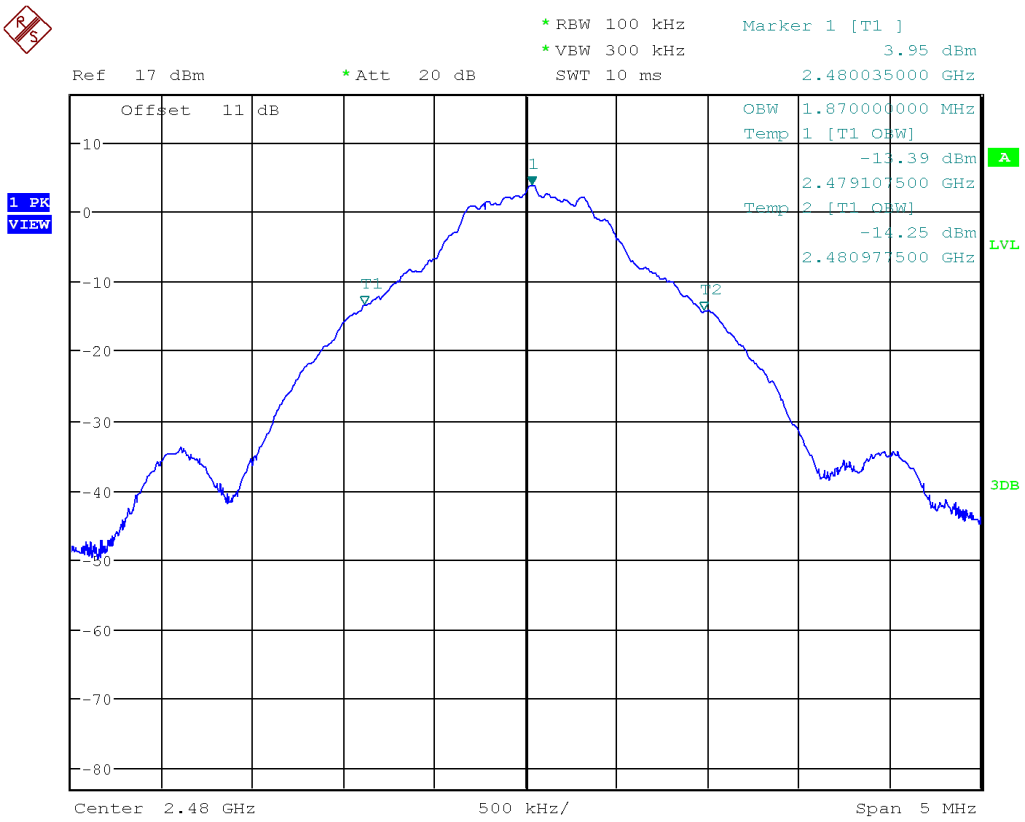

**Plot 7.** 2440MHz, 6dB Bandwidth




**Plot 8.** 2440MHz, 99% Bandwidth




**Plot 9.** 2480MHz, 6dB Bandwidth




**Plot 10.** 2480MHz, 99% Bandwidth

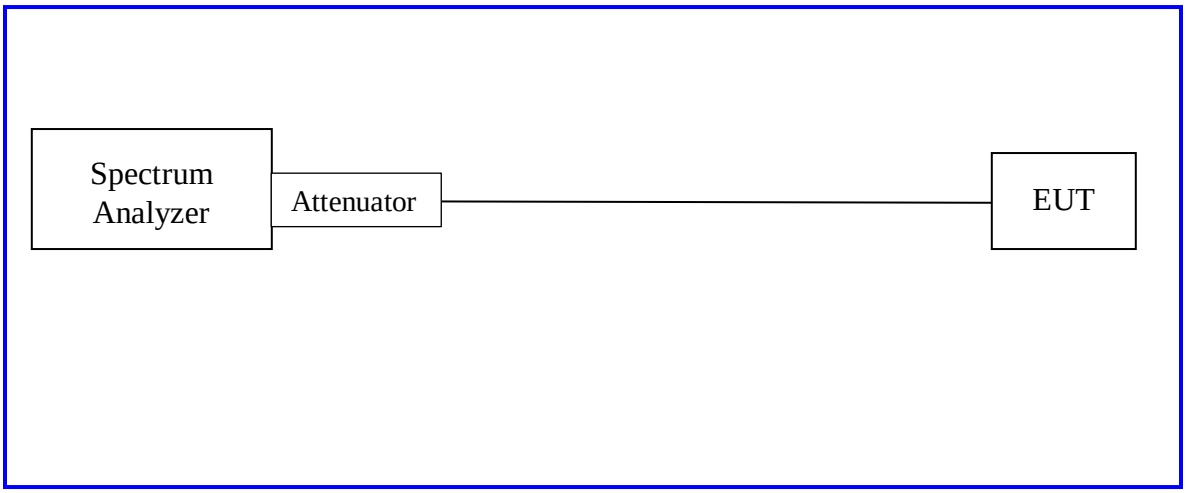
## *4.3 Peak Power Spectral Density*

*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 11.10.2. The measurement was performed with modulation per CFR47 Part 15.247 (e) and RSS 247 Sect.5.2 (b). The worst findings were conducted on 3 channels in each operating frequency range of 2400 MHz to 2483.5 MHz.

Test Setup:




*Method PKPSD of "KDB 558074 – DTS Measurement Guidance v04" was used.*

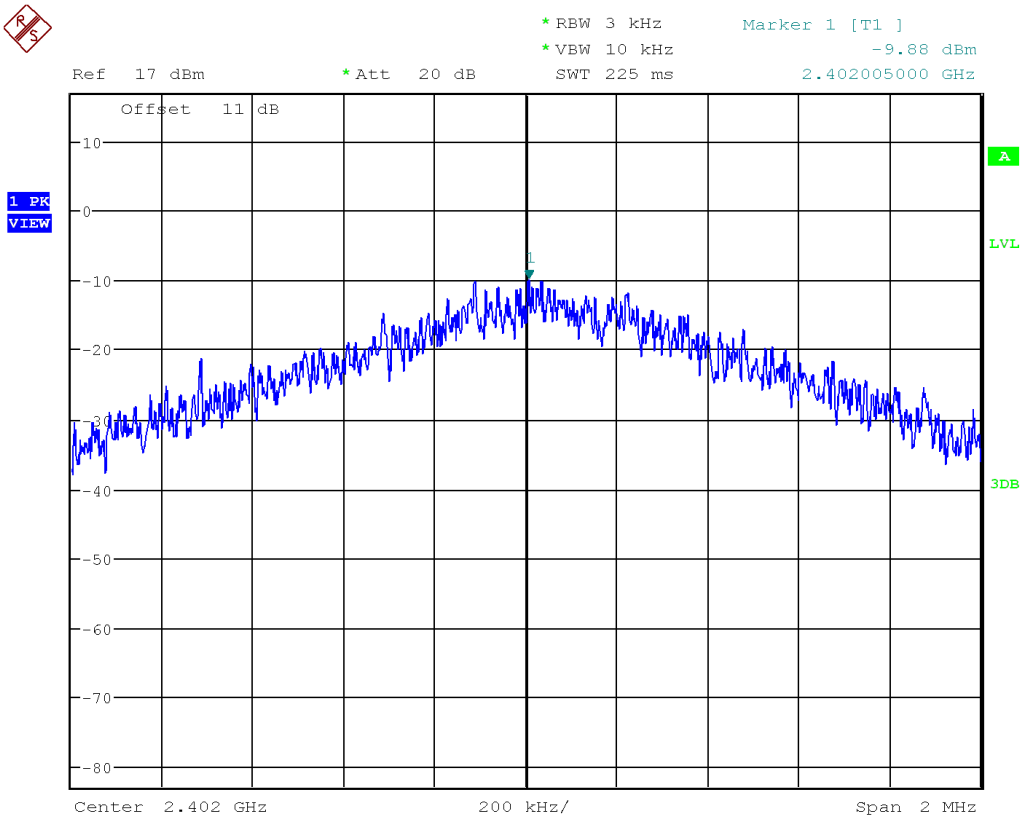
### 4.3.2 Results

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

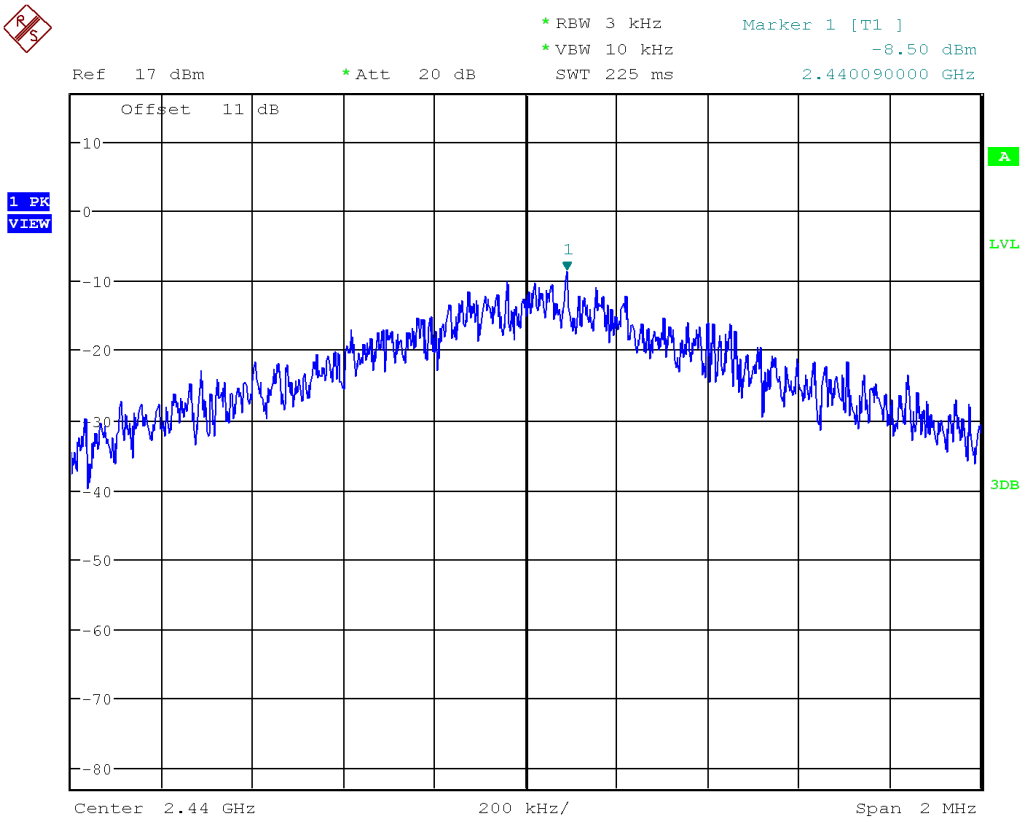
**Table 4:** Peak Power Spectral Density – Test Results

| |
|---|
| **Test Conditions:** Conducted Measurement, Normal Temperature |

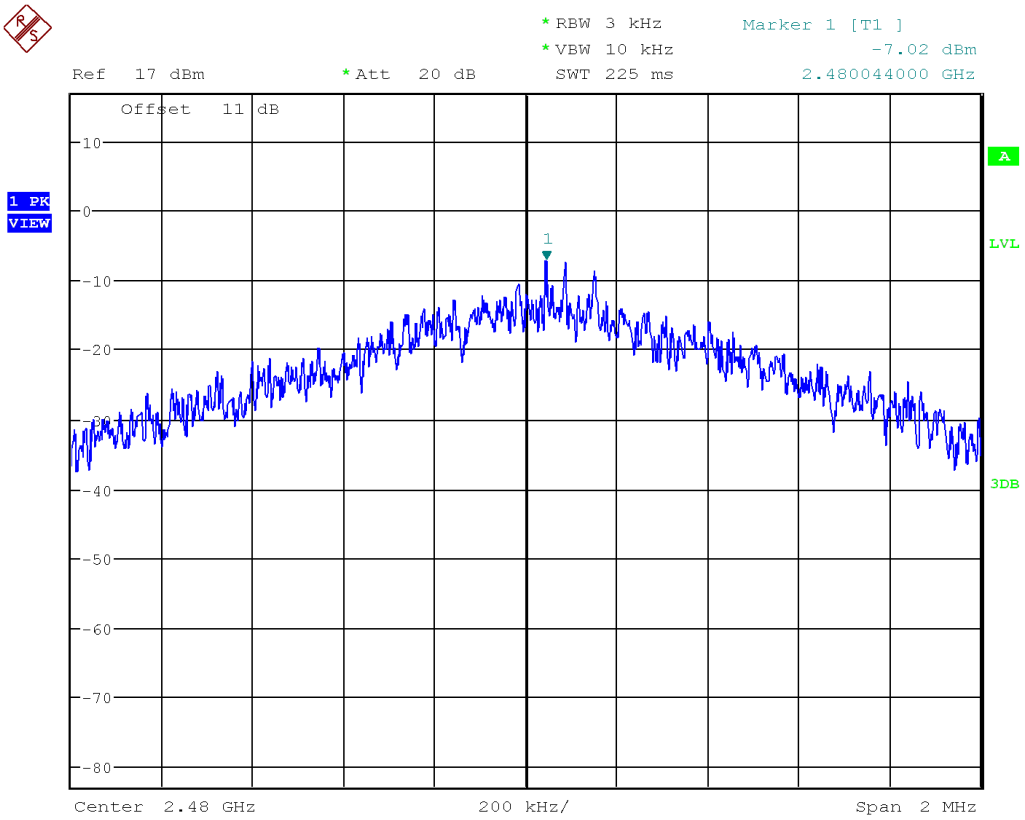
| Peak Power Spectral Density | | | |
|---|---|---|---|
| **Freq. (MHz)** | **Total PSD [dBm]** | **Limit [dBm/kHz]** | **Margin [dB]** |
| 2402 | -9.42 | 8.0 dBm /3 kHz | -17.42 |
| 2440 | -8.04 | 8.0 dBm /3 kHz | -16.04 |
| 2480 | -6.56 | 8.0 dBm /3 kHz | -14.56 |
| Note: Duty Cycle Correction Factor = [10 log (1/duty cycle)] | | | |




**Plot 11.** 2402MHz PSD




**Plot 12.** 2440MHz PSD




**Plot 13.** 2480MHz PSD

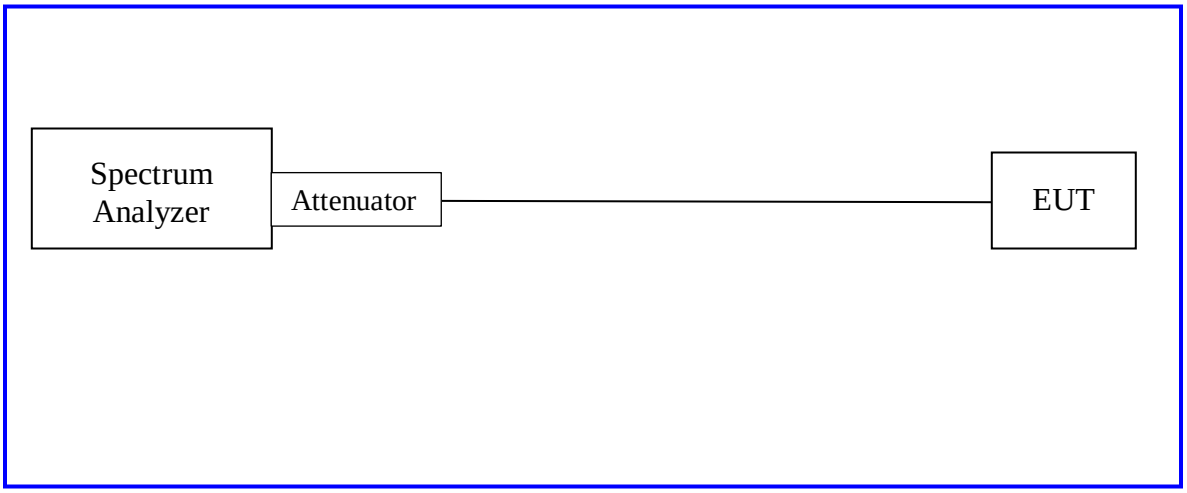
## 4.4 Out of Band Emissions: Non-Restricted Bands

*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-247 Sect. 5.5, RSS-GEN Sect. 8.9 and 8.10.*

### 4.4.1 Test Method

Conducted measurements per ANSI C63.10-2013 Sections 6.10, 11.11, 14.3.3 were used to measure the undesirable emission requirement in non-restricted bands. The measurement was performed with modulation. The measurement was conducted from 30MHz to 26.5GHz on 3 channels in each mode on the EUT. Reference level was established on the channel with highest measured PSD (2402MHz) as stated in ANSI C63.10-2013 Section 11.11.2. Band edge tests were conducted on the low and high channel of each mode. The worst case measurement of each mode is recorded in this report.

Test Setup:

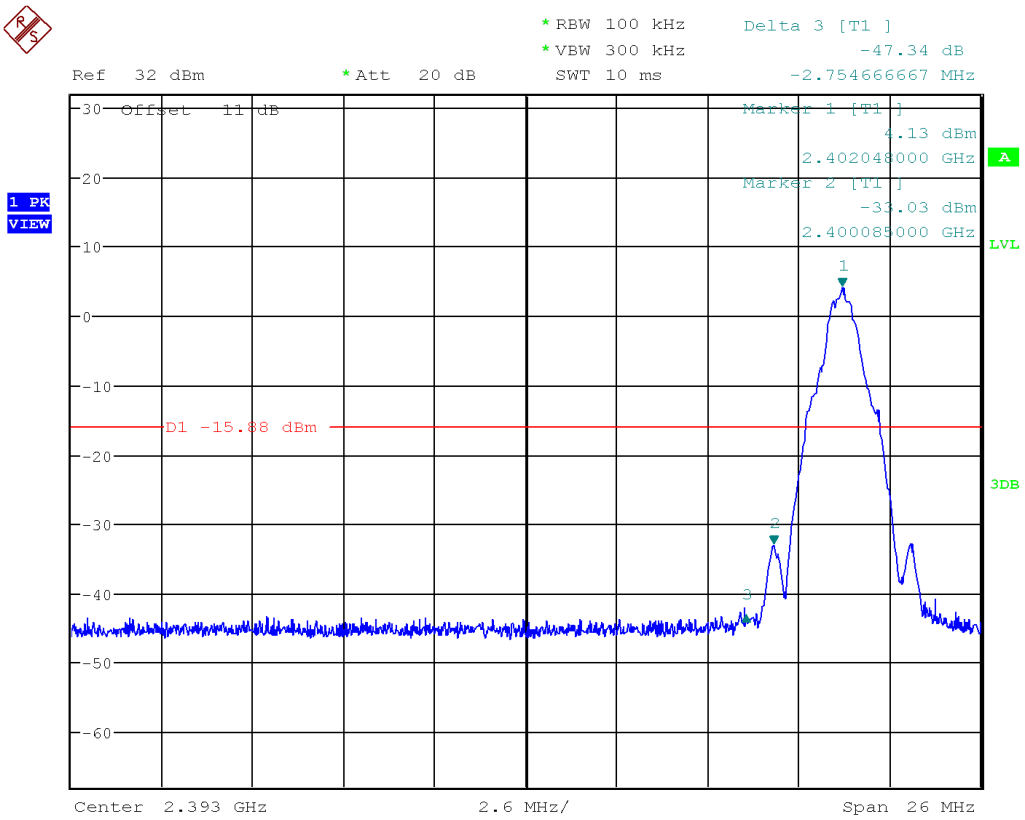


### 4.4.2 Results

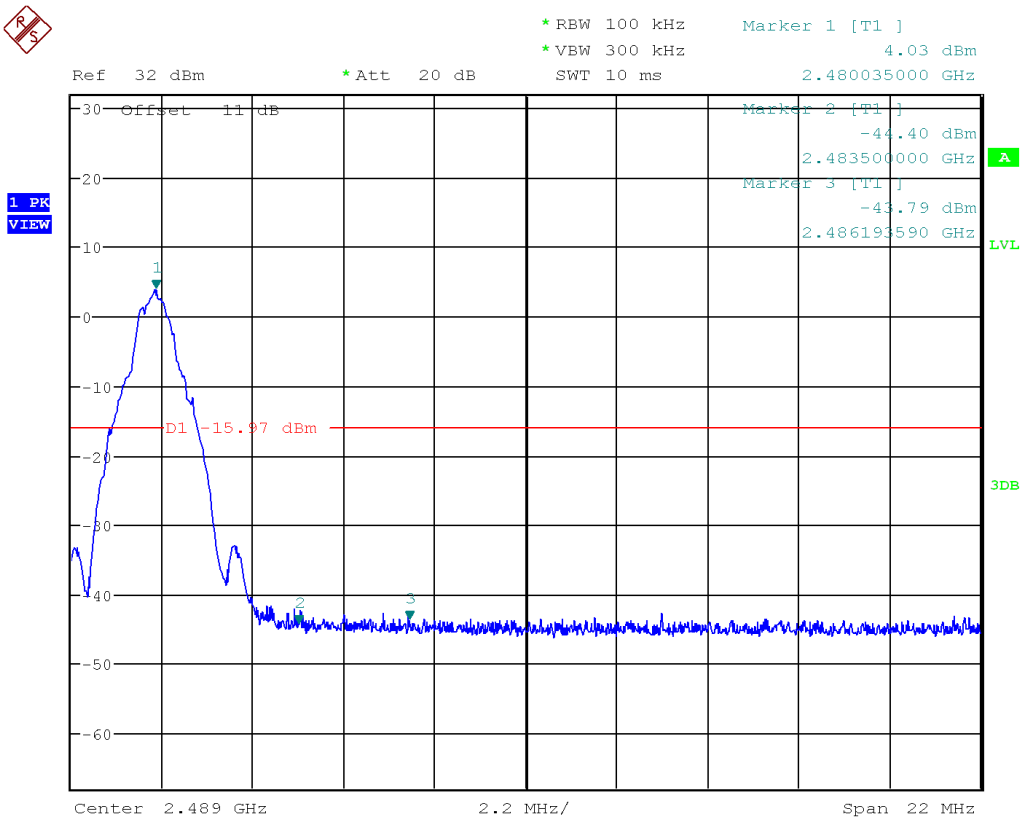
As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

**Table 5:** Emissions at the Band-Edge, Non-Restricted Bands – Test Results

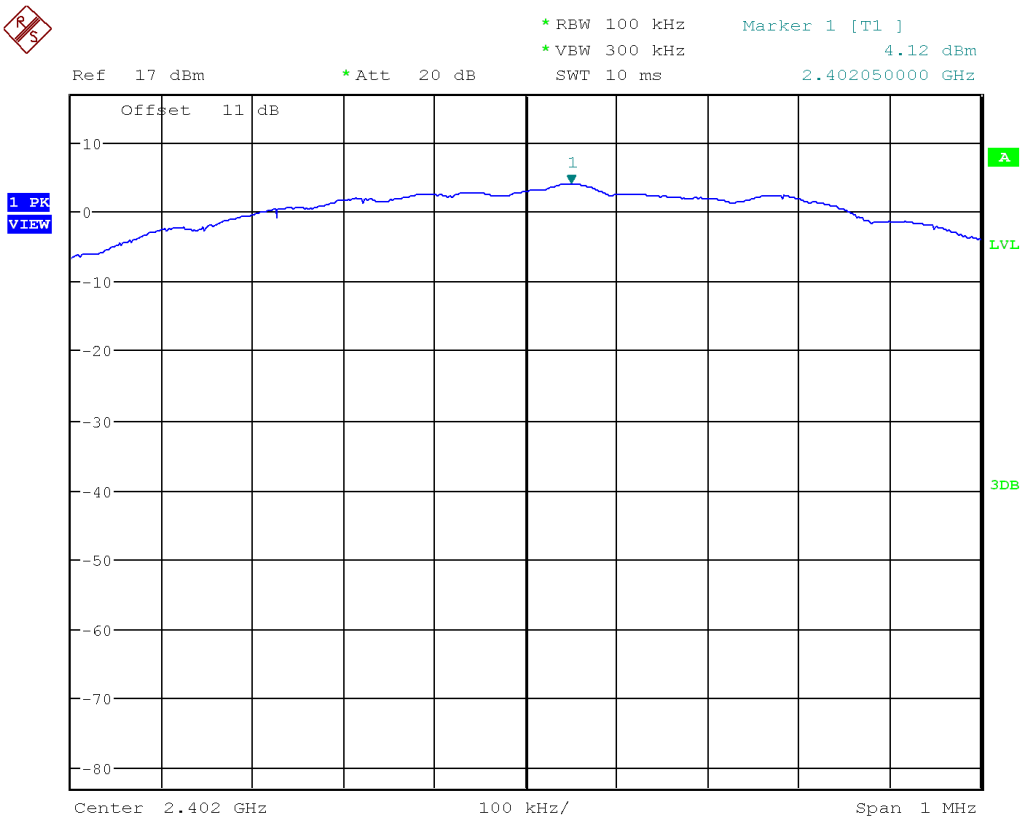
| **Test Conditions:** Conducted Measurement, Normal Temperature and Voltage only | | | | | |
|---|---|---|---|---|---|
| **Non-Restricted Frequency Band Edge Emissions – Worse Case** | | | | | |
| **Band Edge** | **Center Freq (MHz)** | **Measured (dBc)** | **Limit (dBc)** | **Freq (MHz)** | **Results** |
| Low | 2402 | -33.03 | 20 | 2400.0 | Pass |
| High | 2480 | -44.40 | 20 | 2483.5 | Pass |
| **Note:** | | | | | |



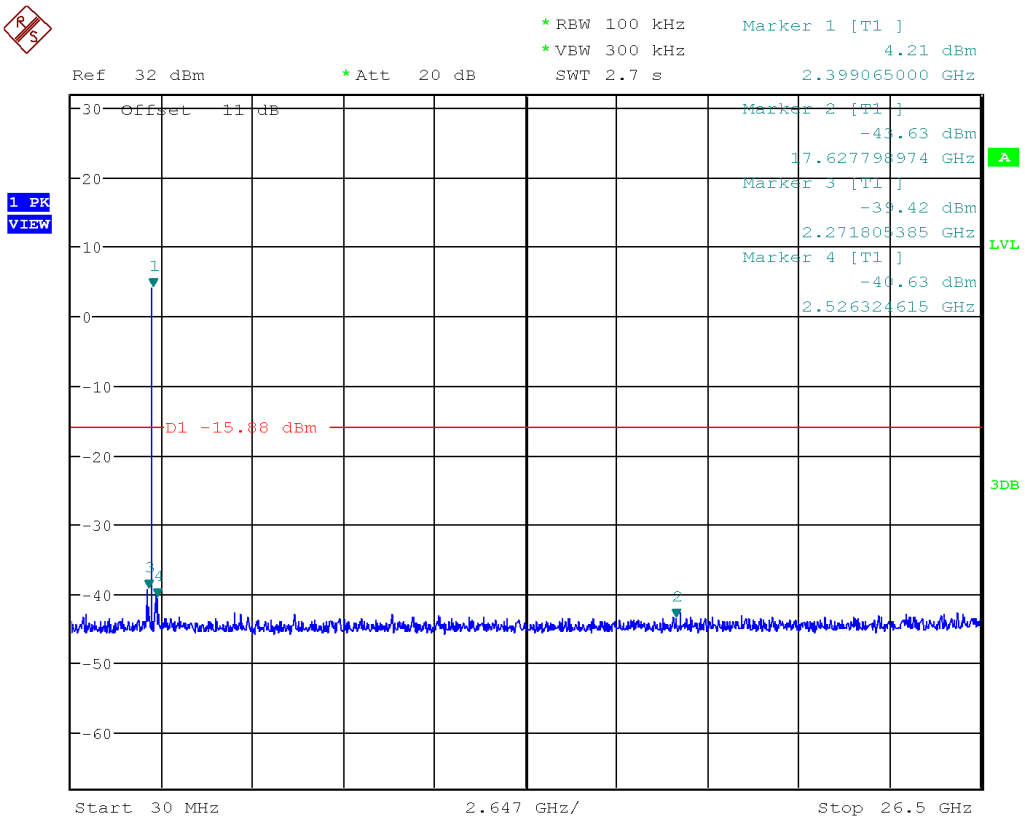

**Plot 14.** 2402MHz Lower Band Edge



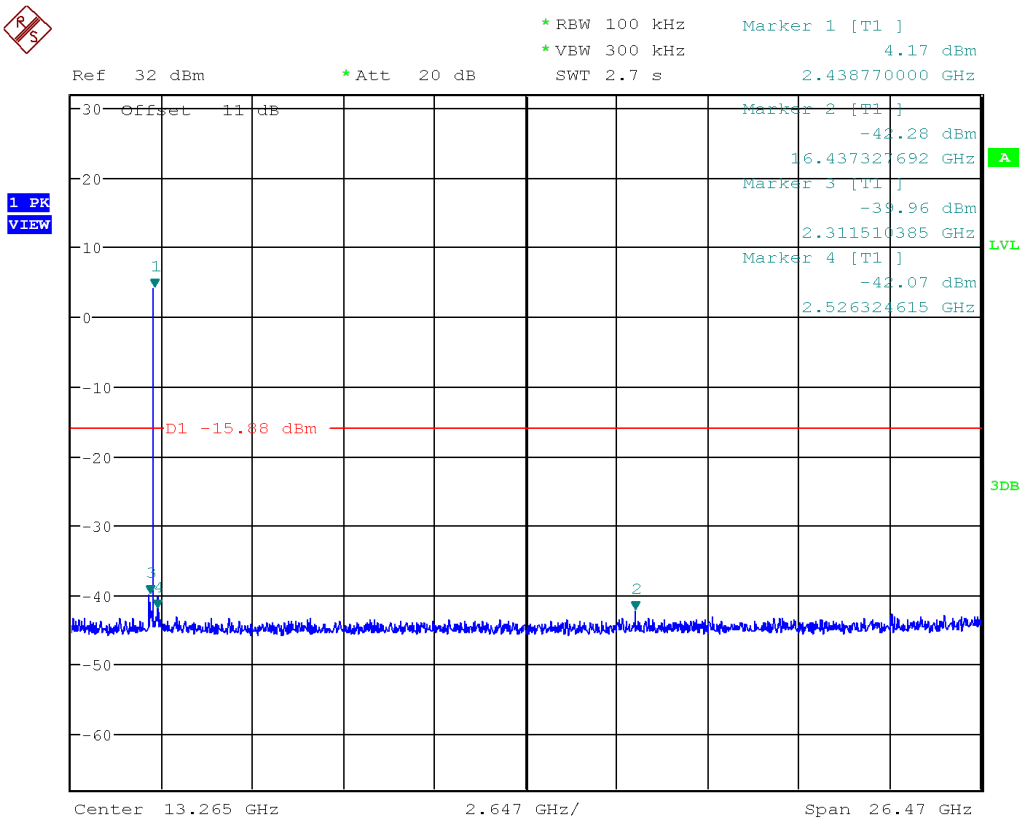

**Plot 15.** 2480MHz Upper Band Edge



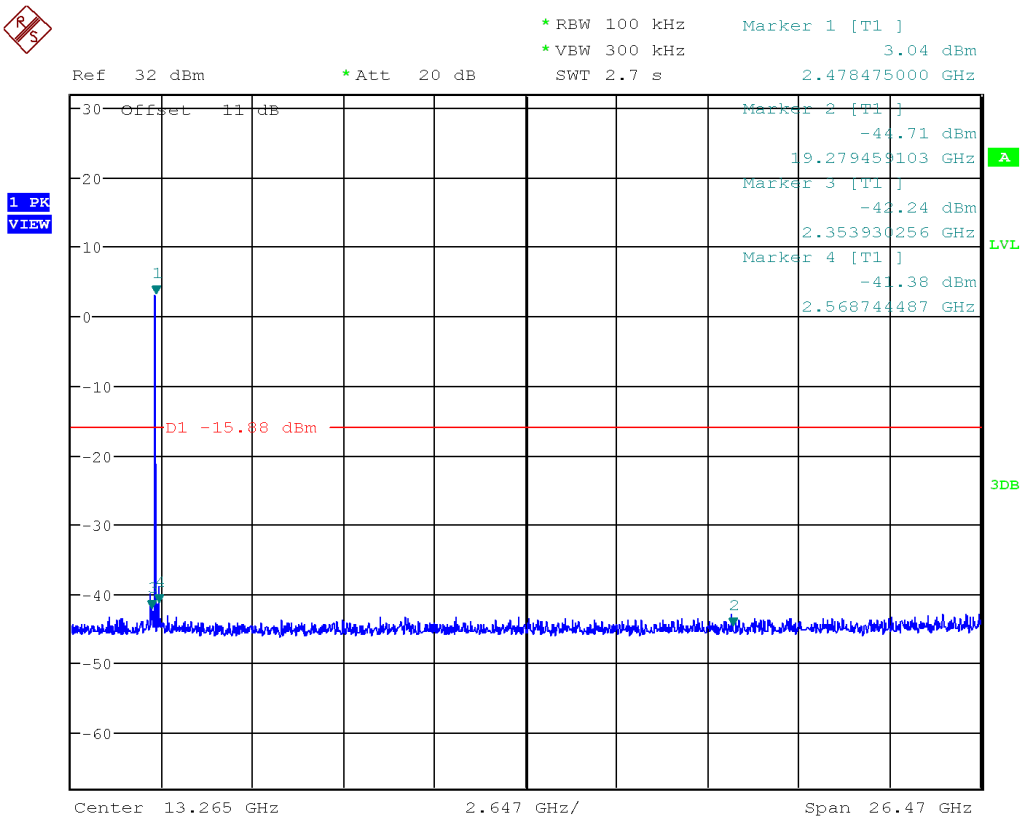

**Plot 16.** Non-Restricted Reference Measurement, 2402MHz




**Plot 17.** 2402MHz 30MHz-26GHz Spurious




**Plot 18.** 2440MHz 30MHz-26GHz Spurious




**Plot 19.** 2480MHz 30MHz-26GHz Spurious

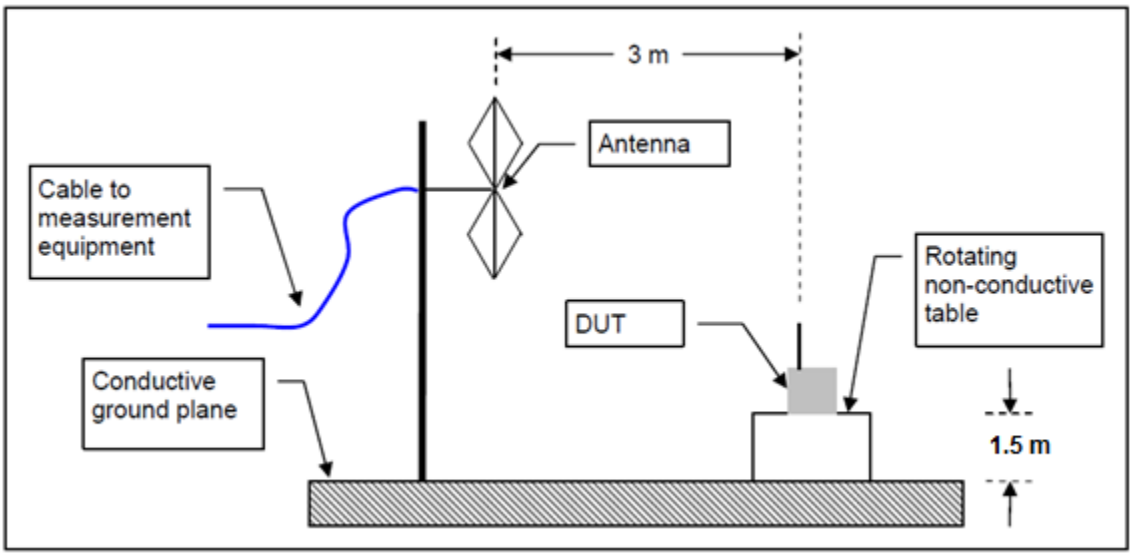
## *4.5 Out of Band Emissions: Restricted Band Edge*

*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-247 Sect. 5.5, RSS-GEN Sect. 8.9 and 8.10.*

### 4.5.1 Test Method

Radiated measurements per ANSI C63.10-2013 Section 6.10.5 were used to measure the undesirable emission requirement in restricted bands. Peak points were found and RMS Average was taken for each point found. The measurement was performed with modulation. This test was conducted on 3 channels in each mode on the EUT. The worst case measurement of each channel is recorded in this report. All channels were tested at highest power settings.
RBW=1 MHz, VBW=3 MHz for Above 1GHz.

### Test Setup

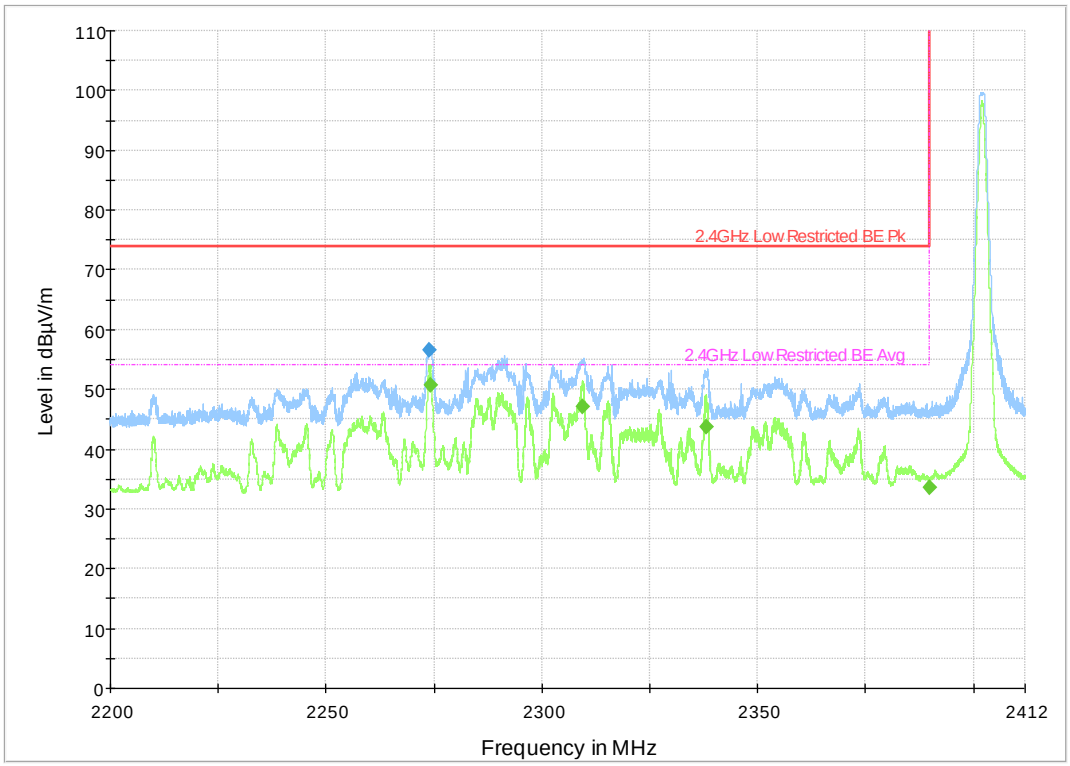



The DUT was stimulated by manufacturer provided test software that is not available to the end user.

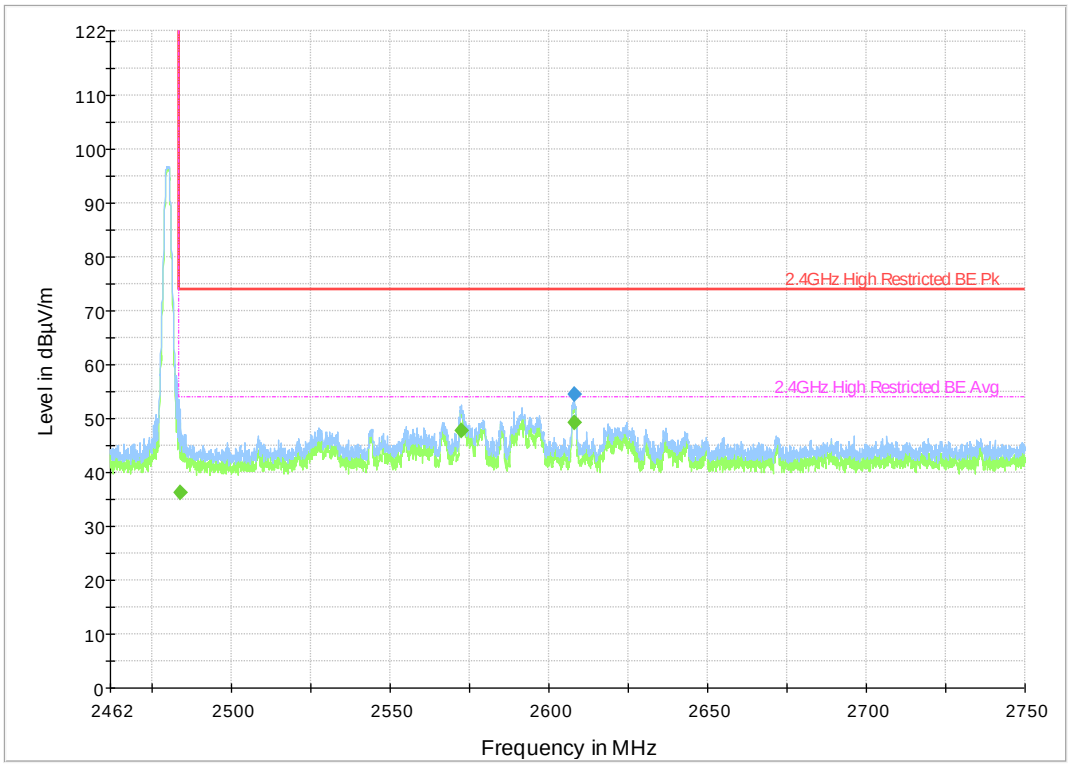
### 4.5.2 Test Results

**Table 6:** Emissions at the Band-Edge, Restricted Bands – Test Results

| **Test Conditions:** Radiated Measurement, Normal Temperature and Voltage | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Lower Restricted Band Edge** | | | | | | | |
| **Freq. (MHz)** | **Mode** | **Center Freq (MHz)** | **Detector (Average/ Peak)** | **Measured (dBuV/m)** | **Limit (dBuV/m)** | **Margin** | **Results** |
| 2274.115 | BLE GFSK 1Mbps | 2402 | Average | 50.80 | 54 | -3.20 | Pass |
| 2273.988 | BLE GFSK 1Mbps | 2402 | Peak | 56.60 | 74 | -17.40 | Pass |
| **Upper Restricted Band Edge** | | | | | | | |
| **Freq. (MHz)** | **Mode** | **Center Freq (MHz)** | **Detector (Average/ Peak)** | **Measured (dBuV/m)** | **Limit (dBuV/m)** | **Margin** | **Results** |
| 2607.958 | BLE GFSK 1Mbps | 2480 | Average | 49.33 | 54 | -4.67 | Pass |
| 2607.958 | BLE GFSK 1Mbps | 2480 | Peak | 54.38 | 74 | -19.62 | Pass |
| **Note:** 1. The DCCF (Average Detector) is included in this table, the following plots are of peak values | | | | | | | |




**Plot 20.** 2402MHz, Lower Band Edge, Restricted




**Plot 21.** 2480MHz, Upper Band Edge, Restricted

## *4.6 Transmitter Spurious Emissions*

*Transmitter spurious emissions are emissions outside the frequency range of the equipment when the equipment is in transmit mode; per requirement of CFR47 15.205, 15.209, 15.247(d), RSS 247 Sect.5.5, RSS-GEN Sect. 8.9 and 8.10.*

### 4.6.1 Test Methodology

#### *4.6.1.1 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 (<1 GHz) and 150cm (>1 GHz) above the floor. 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.

Pre-scans were performed to determine the worst data rate / chains.

#### *4.6.1.2 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 (<1 GHz) and 150cm (>1 GHz) above the ground plane. The placement of EUT and cables were the same as for preliminary testing and is shown in the setup photographs.
RBW is set to 200 Hz and VBW is set to 1 kHz for 9 kHz-150 kHz.
RBW is set to 9 kHz and VBW is set to 30 kHz for 150 kHz-30 MHz
RBW is set to 100 kHz, VBW is set to 300 kHz for 30 MHz-1 GHz.
RBW is set to 1 MHz, VBW is set to 3 MHz for above 1 GHz.

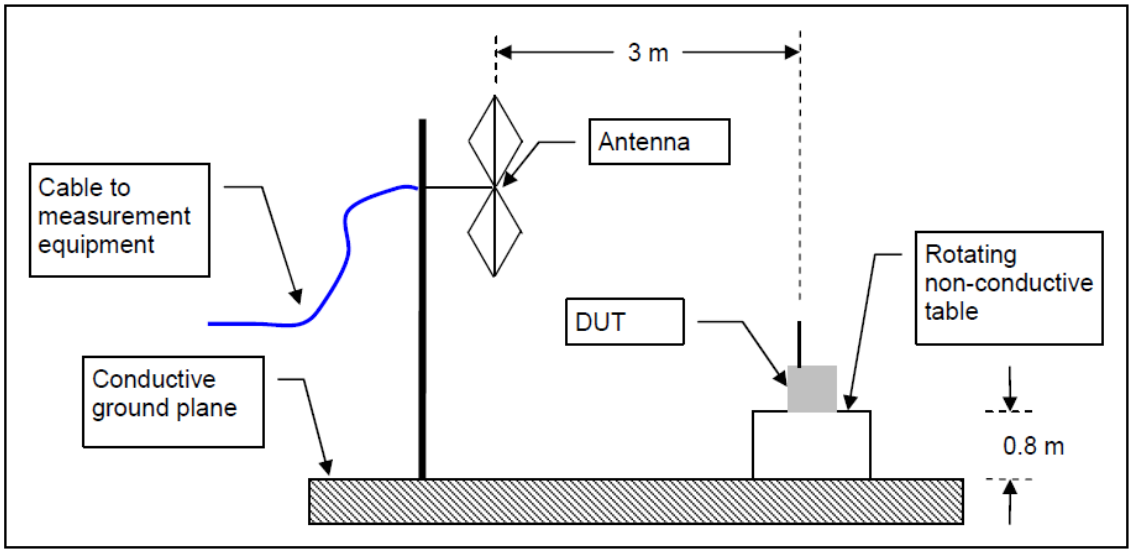
#### *4.6.1.3 Deviations*

None.

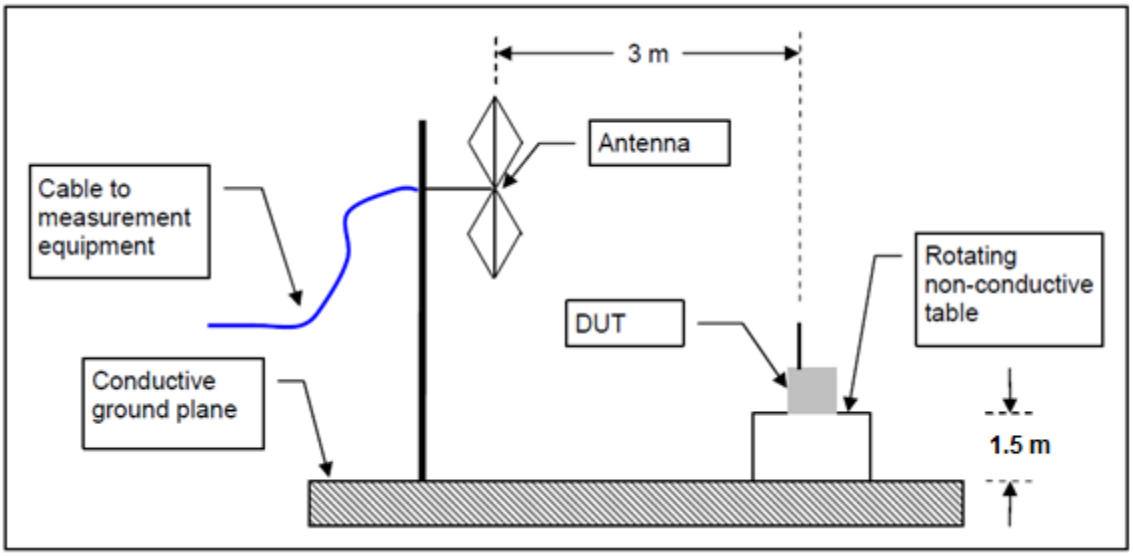
### 4.6.2 Test Setup:

All tests were conducted at full power on low, middle, and high channels. The DUT was stimulated by manufacturer provided test software that is not available to the end user.

***30MHz-1GHz***




***1-26GHz***



### 4.6.3 Transmitter Spurious Emission Limit

The spurious emissions of the transmitter shall not exceed the values in CFR47 Part 15.205, 15.209: 2015 and RSS Gen Sect. 8.9 and 8.10: 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 |

### 4.6.4 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.

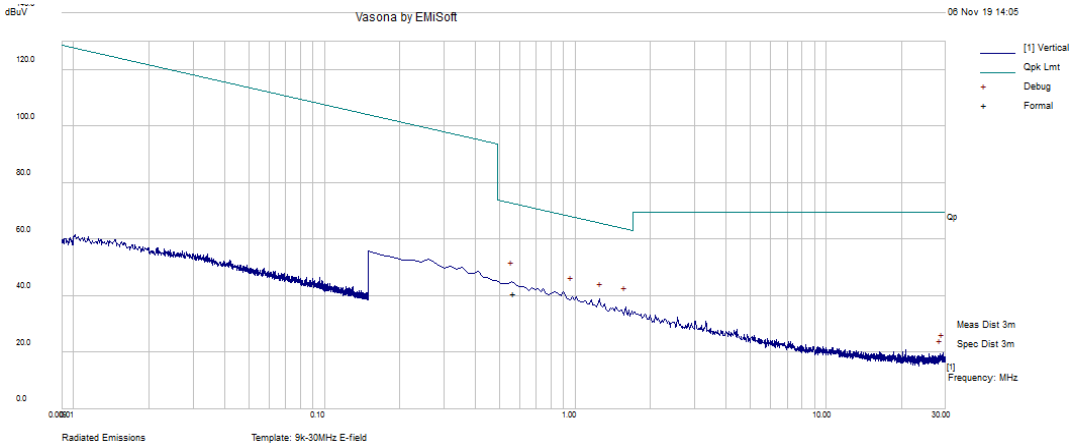
As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Note: Below 30 MHz was investigated and no emissions was found above noise floor.

Note: The 2.4 GHz notch filter was used to protect the front end of the pre-amp.

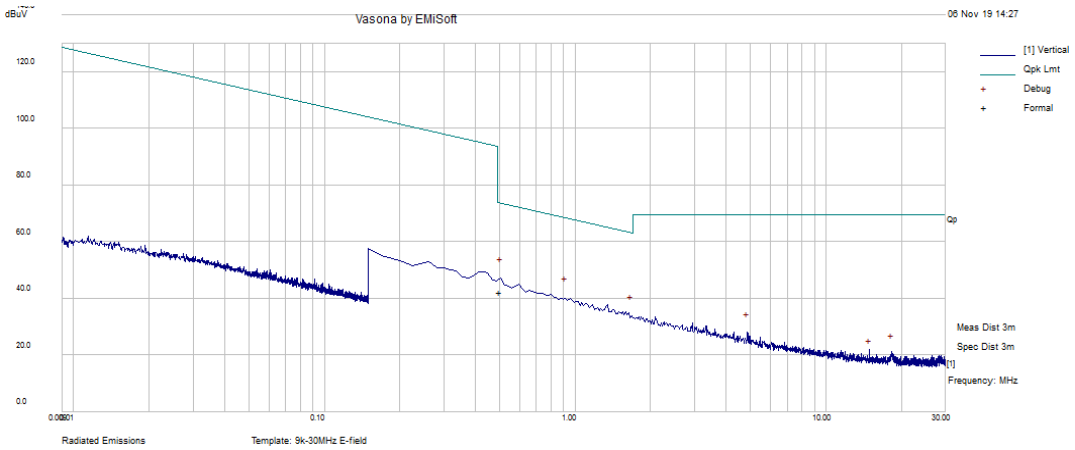
### *4.6.4.1 Plots*

| No | Frequency | Raw dBu\ | Cable Los | AF dB | Level dBu | Measuren | Pol | Hgt cm | Azt Deg | Limit dBu' | Margin dE | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 (9) | 0.560438 | 32.67 | 1.02 | 11.4 | 45.09 | Peak [Scar | V | 103 | 0 degrees | 72.63 | -27.54 | Pass | |
| 2 (10) | 1.586531 | 23.17 | 1.1 | 11.63 | 35.91 | Peak [Scar | V | 103 | 0 degrees | 63.6 | -27.69 | Pass | |
| 3 (11) | 0.970875 | 26.81 | 1.07 | 11.64 | 39.52 | Peak [Scar | V | 103 | 0 degrees | 67.86 | -28.34 | Pass | |
| 4 (12) | 1.263 | 24.76 | 1.09 | 11.67 | 37.51 | Peak [Scar | V | 103 | 0 degrees | 65.58 | -28.07 | Pass | |
| 5 (13) | 29.293 | 9.34 | 1.6 | 8.51 | 19.45 | Peak [Scar | V | 103 | 0 degrees | 69.54 | -50.09 | Pass | |
| 6 (14) | 28.522 | 6.74 | 1.59 | 8.69 | 17.03 | Peak [Scar | V | 103 | 0 degrees | 69.54 | -52.51 | Pass | |



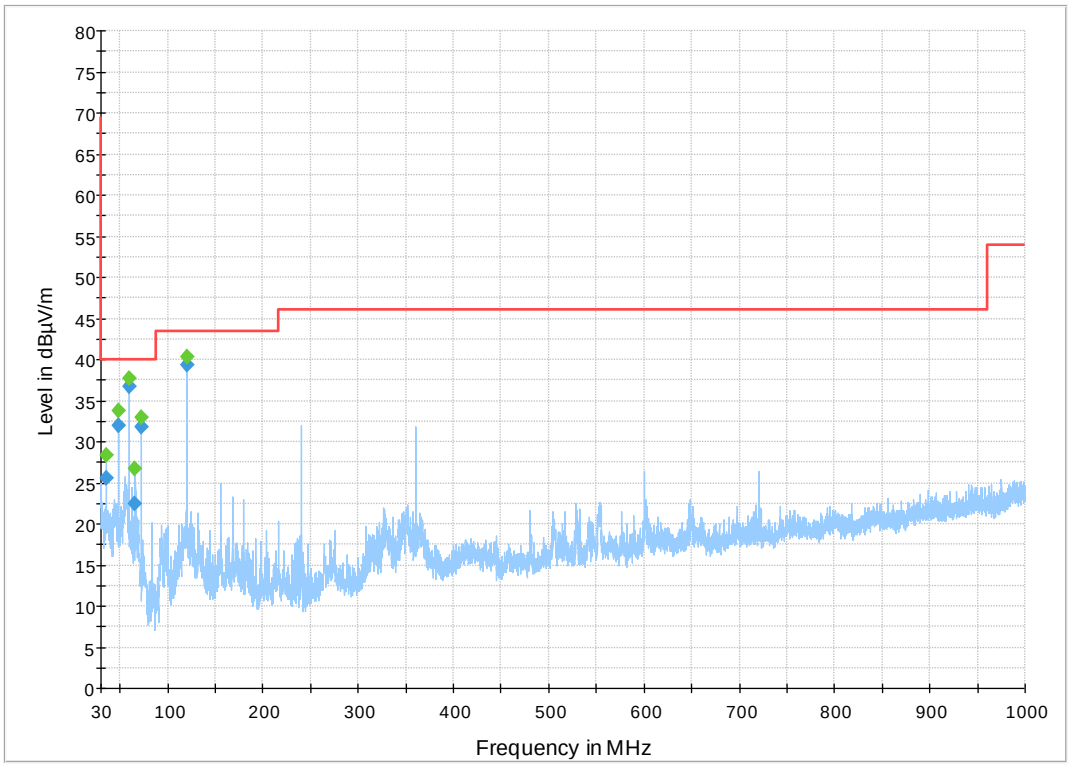

**Plot 22.** 9 kHz-30 MHz, 2402 MHz 0 degrees

| No | Frequency | Raw dBu\ | Cable Los | AF dB | Level dBu | Measuren | Pol | Hgt cm | Azt Deg | Limit dBu' | Margin dE | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 (15) | 0.504469 | 34.66 | 1 | 11.4 | 47.06 | Peak [Scar | V | 103 | 90 degree | 73.55 | -26.48 | Pass | |
| 2 (16) | 0.914906 | 27.48 | 1.07 | 11.53 | 40.08 | Peak [Scar | V | 103 | 90 degree | 68.38 | -28.29 | Pass | |
| 3 (17) | 1.679813 | 21.1 | 1.11 | 11.63 | 33.83 | Peak [Scar | V | 103 | 90 degree | 63.1 | -29.27 | Pass | |
| 4 (18) | 18.33 | 8.41 | 1.46 | 10.37 | 20.24 | Peak [Scar | V | 103 | 90 degree | 69.54 | -49.3 | Pass | |
| 5 (19) | 15.003 | 6.43 | 1.41 | 10.6 | 18.44 | Peak [Scar | V | 103 | 90 degree | 69.54 | -51.1 | Pass | |
| 6 (20) | 4.882 | 15.27 | 1.23 | 11.22 | 27.72 | Peak [Scar | V | 103 | 90 degree | 69.54 | -41.82 | Pass | |



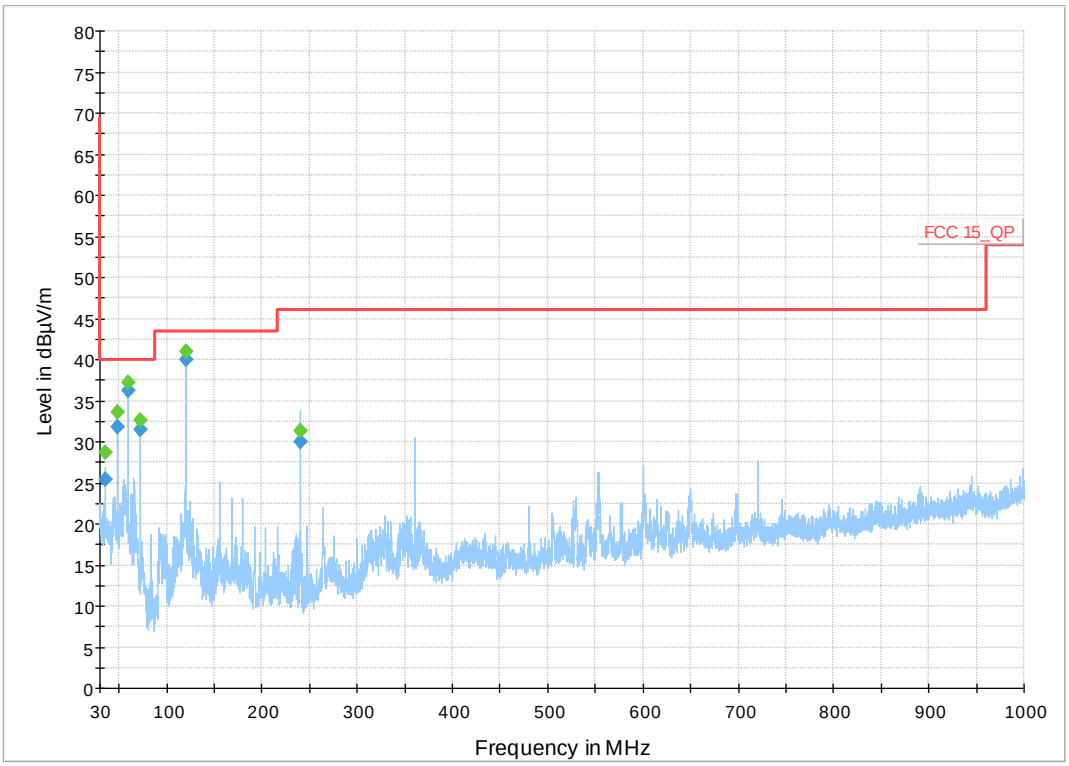

**Plot 23.** 9 kHz-30 MHz, 2402 MHz 90 degrees

| Frequency (MHz) | QuasiPeak (dBµV/m) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 36.00304 | 25.64 | --- | 40 | 14.36 | 1000 | 120 | 101 | V | 96 | -11 | |
| 36.00304 | --- | 28.32 | --- | --- | 1000 | 120 | 101 | V | 96 | -11 | |
| 48.00104 | --- | 33.76 | --- | --- | 1000 | 120 | 101 | V | 175 | -17.6 | |
| 48.00104 | 31.91 | --- | 40 | 8.09 | 1000 | 120 | 101 | V | 175 | -17.6 | |
| 60.00156 | 36.65 | --- | 40 | 3.35 | 1000 | 120 | 100 | V | 18 | -17.1 | |
| 60.00156 | --- | 37.78 | --- | --- | 1000 | 120 | 100 | V | 18 | -17.1 | |
| 65.98064 | --- | 26.77 | --- | --- | 1000 | 120 | 101 | V | 175 | -17.2 | |
| 65.98064 | 22.44 | --- | 40 | 17.56 | 1000 | 120 | 101 | V | 175 | -17.2 | |
| 72.00792 | 31.82 | --- | 40 | 8.18 | 1000 | 120 | 100 | V | 53 | -18.1 | |
| 72.00792 | --- | 32.98 | --- | --- | 1000 | 120 | 100 | V | 53 | -18.1 | |
| 120.00192 | 39.33 | --- | 43.51 | 4.18 | 1000 | 120 | 100 | V | -12 | -10.6 | |
| 120.00192 | --- | 40.34 | --- | --- | 1000 | 120 | 100 | V | -12 | -10.6 | |



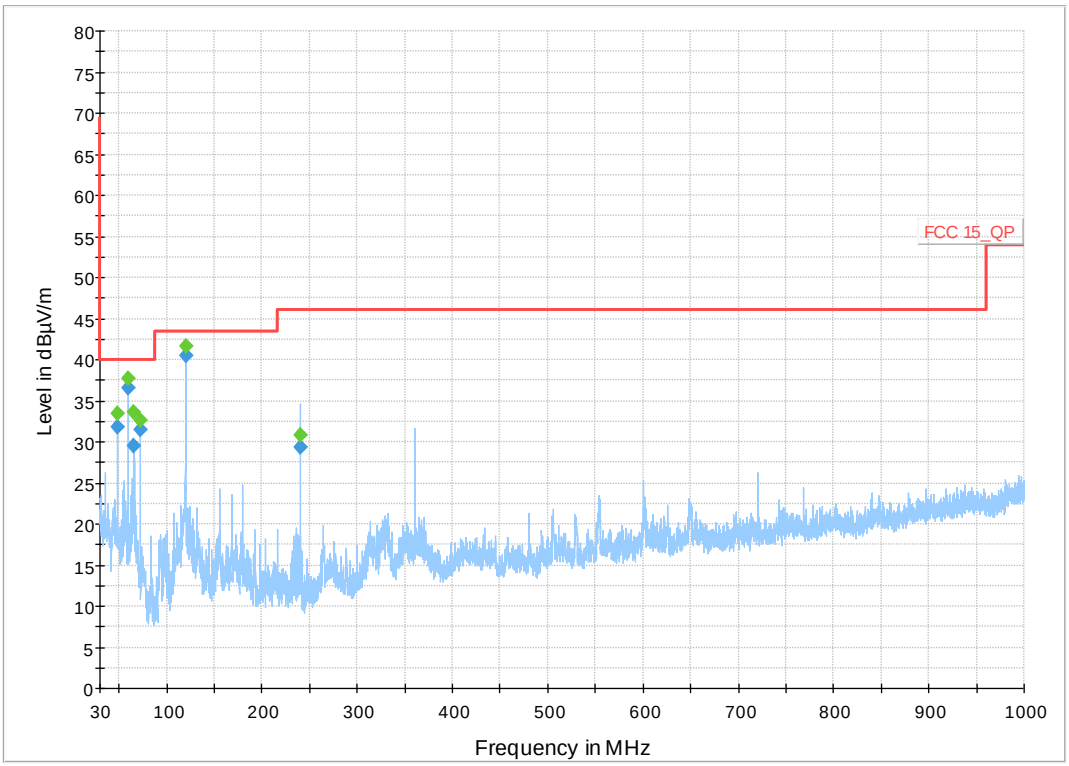

**Plot 24.** 30 MHz-1 GHz, 2402 MHz

| Frequency (MHz) | QuasiPeak (dBµV/m) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 36.016 | 25.44 | --- | 40 | 14.56 | 1000 | 120 | 100 | V | 164 | -11.1 | |
| 36.016 | --- | 28.67 | --- | --- | 1000 | 120 | 100 | V | 164 | -11.1 | |
| 48.00488 | --- | 33.54 | --- | --- | 1000 | 120 | 100 | V | 164 | -17.6 | |
| 48.00488 | 31.8 | --- | 40 | 8.2 | 1000 | 120 | 100 | V | 164 | -17.6 | |
| 59.99676 | 36.16 | --- | 40 | 3.84 | 1000 | 120 | 100 | V | 51 | -17.1 | |
| 59.99676 | --- | 37.19 | --- | --- | 1000 | 120 | 100 | V | 51 | -17.1 | |
| 71.9988 | --- | 32.67 | --- | --- | 1000 | 120 | 100 | V | 81 | -18.1 | |
| 71.9988 | 31.51 | --- | 40 | 8.49 | 1000 | 120 | 100 | V | 81 | -18.1 | |
| 120.00504 | 40.08 | --- | 43.51 | 3.44 | 1000 | 120 | 100 | V | 57 | -10.6 | |
| 120.00504 | --- | 41.05 | --- | --- | 1000 | 120 | 100 | V | 57 | -10.6 | |
| 240.00572 | 30.05 | --- | 46 | 15.95 | 1000 | 120 | 100 | H | 58 | -14.7 | |
| 240.00572 | --- | 31.29 | --- | --- | 1000 | 120 | 100 | H | 58 | -14.7 | |



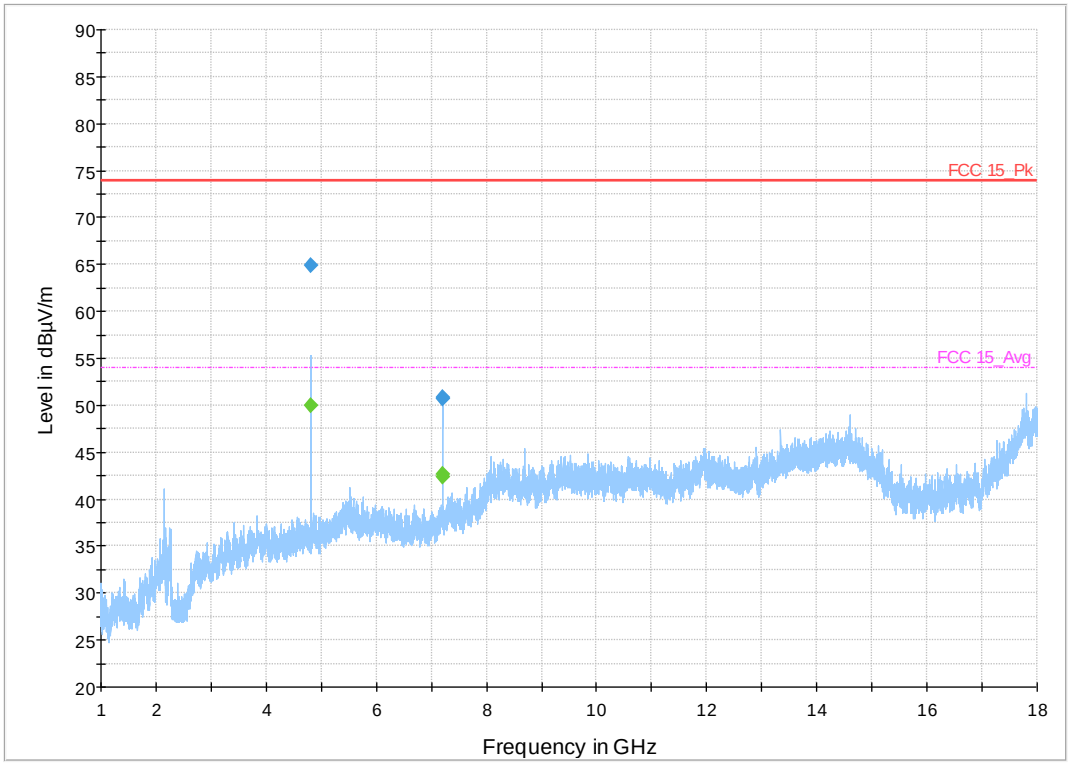

**Plot 25**. 30 MHz-1 GHz, 2440 MHz

| Frequency (MHz) | QuasiPeak (dBµV/m) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 47.99048 | --- | 33.45 | --- | --- | 1000 | 120 | 100 | V | 175 | -17.6 | |
| 47.99048 | 31.73 | --- | 40 | 8.27 | 1000 | 120 | 100 | V | 175 | -17.6 | |
| 59.99952 | --- | 37.68 | --- | --- | 1000 | 120 | 100 | V | -175 | -17.1 | |
| 59.99952 | 36.51 | --- | 40 | 3.49 | 1000 | 120 | 100 | V | -175 | -17.1 | |
| 65.9978 | --- | 33.65 | --- | --- | 1000 | 120 | 100 | V | 175 | -17.2 | |
| 65.9978 | 29.55 | --- | 40 | 10.45 | 1000 | 120 | 100 | V | 175 | -17.2 | |
| 72.00288 | --- | 32.65 | --- | --- | 1000 | 120 | 100 | V | 114 | -18.1 | |
| 72.00288 | 31.49 | --- | 40 | 8.51 | 1000 | 120 | 100 | V | 114 | -18.1 | |
| 120.0024 | 40.52 | --- | 43.51 | 2.99 | 1000 | 120 | 100 | V | -75 | -10.6 | |
| 120.0024 | --- | 41.66 | --- | --- | 1000 | 120 | 100 | V | -75 | -10.6 | |
| 240.01276 | 29.33 | --- | 46 | 16.67 | 1000 | 120 | 100 | H | 53 | -14.7 | |
| 240.01276 | --- | 30.82 | --- | --- | 1000 | 120 | 100 | H | 53 | -14.7 | |



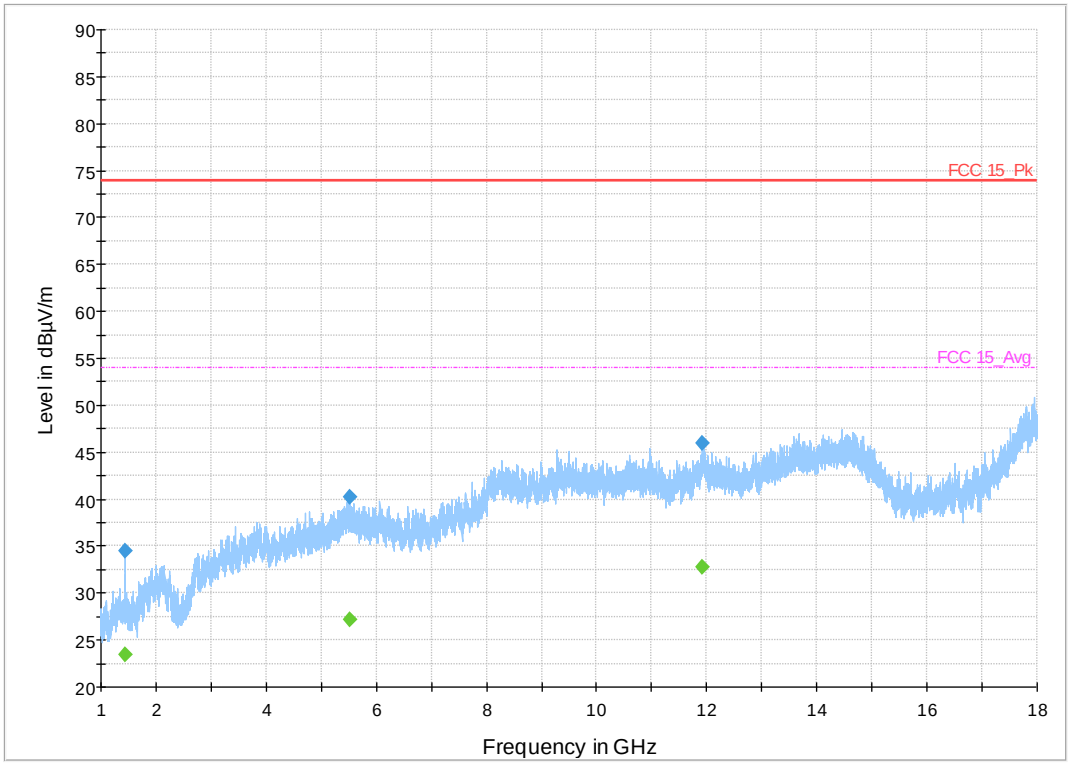

**Plot 26** 3 0MHz-1 GHz, 2480 MHz

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4803.872 | --- | 49.93 | 54 | 4.07 | 1000 | 1000 | 193 | H | -169 | -24.2 | |
| 4803.872 | 64.84 | --- | 74 | 9.16 | 1000 | 1000 | 193 | H | -169 | -24.2 | |
| 7205.7485 | --- | 42.36 | 54 | 11.64 | 1000 | 1000 | 141 | V | 19 | -20.4 | |
| 7205.7485 | 50.88 | --- | 74 | 23.12 | 1000 | 1000 | 141 | V | 19 | -20.4 | |
| 7206.701 | --- | 42.62 | 54 | 11.38 | 1000 | 1000 | 140 | V | 19 | -20.4 | |
| 7206.701 | 50.73 | --- | 74 | 23.27 | 1000 | 1000 | 140 | V | 19 | -20.4 | |



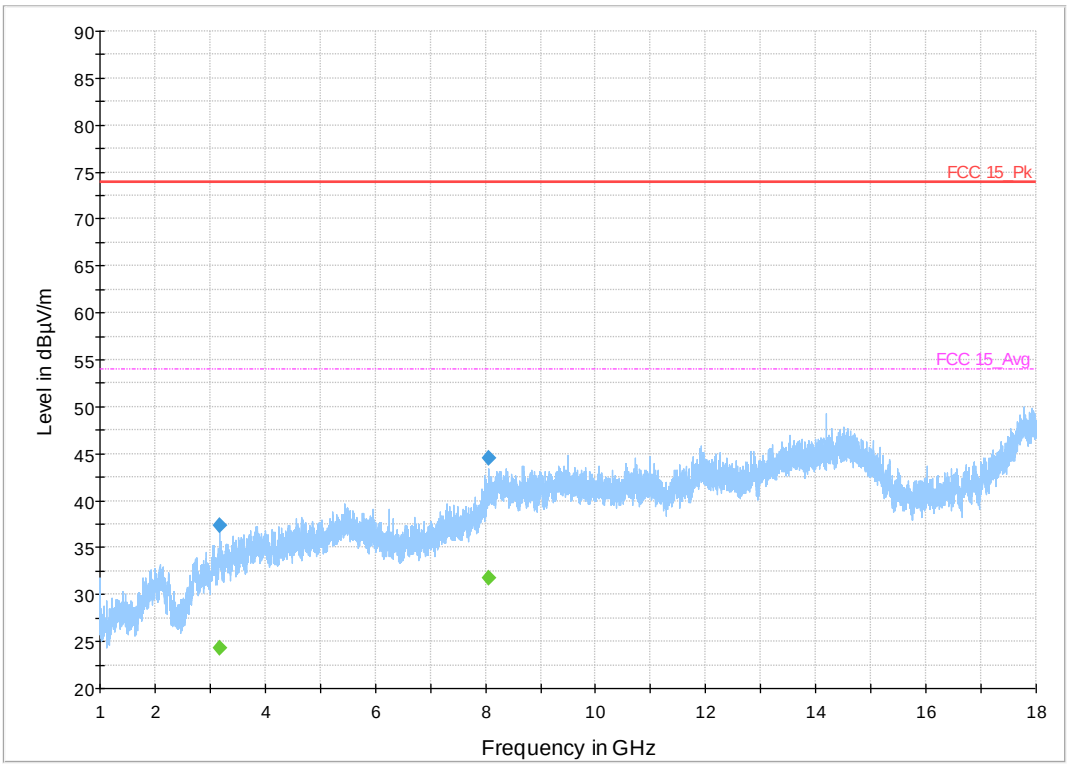

**Plot 27**. 1-18 GHz, 2402 MHz

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1439.9085 | --- | 23.37 | 54 | 30.63 | 1000 | 1000 | 167 | V | 123 | -35 | |
| 1439.9085 | 34.54 | --- | 74 | 39.46 | 1000 | 1000 | 167 | V | 123 | -35 | |
| 5521.167 | 40.16 | --- | 74 | 33.84 | 1000 | 1000 | 300 | V | -105 | -22 | |
| 5521.167 | --- | 27.21 | 54 | 26.79 | 1000 | 1000 | 300 | V | -105 | -22 | |
| 11918.251 | 45.99 | --- | 74 | 28.01 | 1000 | 1000 | 300 | V | -162 | -13.7 | |
| 11918.251 | --- | 32.82 | 54 | 21.18 | 1000 | 1000 | 300 | V | -162 | -13.7 | |



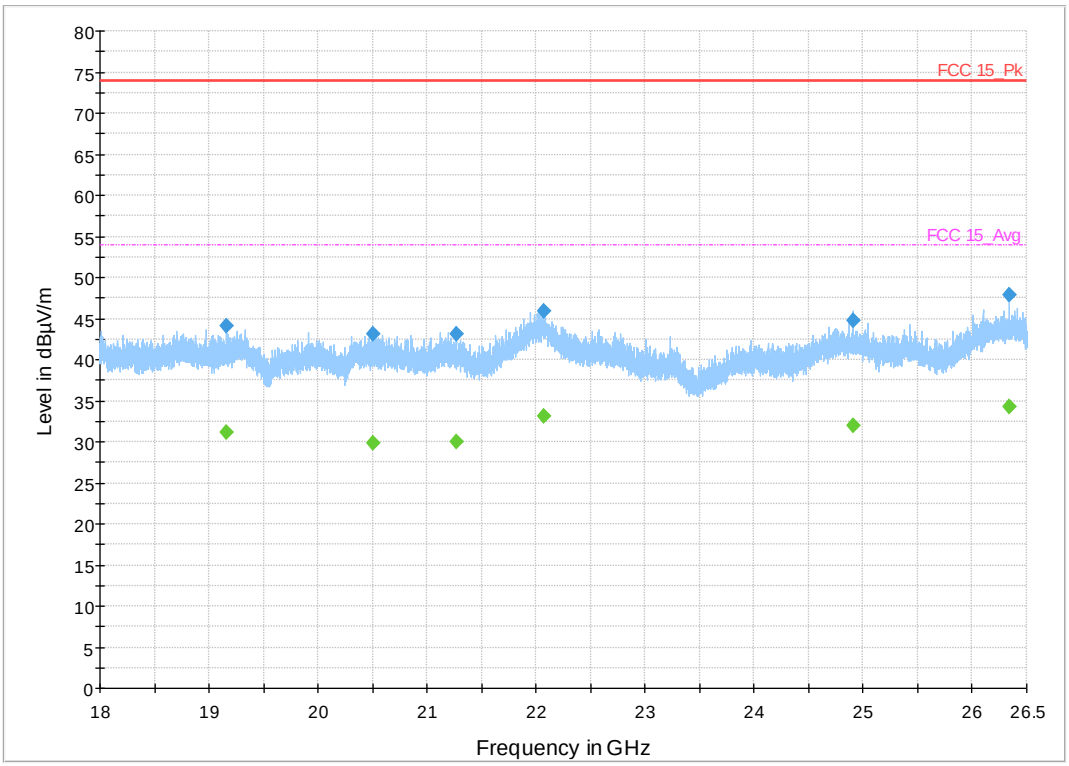

**Plot 28**. 1-18 GHz, 2440 MHz

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3170.8 | --- | 24.35 | 54 | 29.65 | 1000 | 1000 | 200 | H | 97 | -27.3 | |
| 3170.8 | 37.41 | --- | 74 | 36.59 | 1000 | 1000 | 200 | H | 97 | -27.3 | |
| 8050.711 | --- | 31.72 | 54 | 22.28 | 1000 | 1000 | 300 | V | -64 | -17.6 | |
| 8050.711 | 44.59 | --- | 74 | 29.41 | 1000 | 1000 | 300 | V | -64 | -17.6 | |



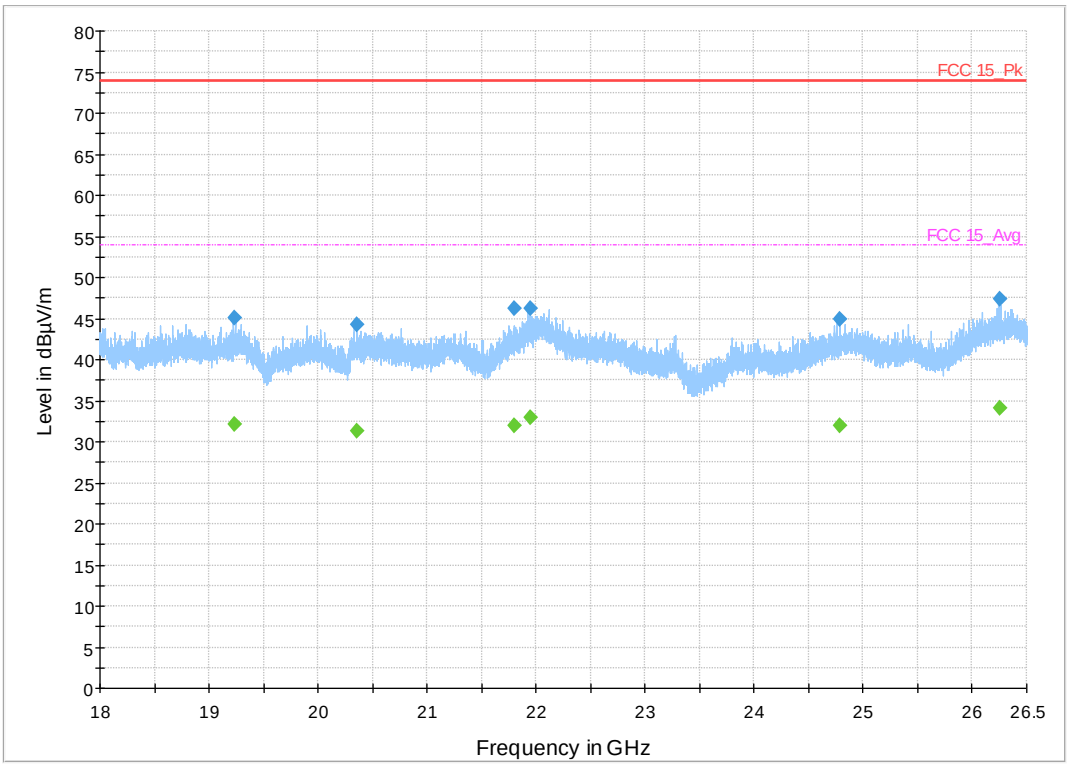

**Plot 29**. 1-18 GHz, 2480 MHz

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 19163.071 | 44.14 | --- | 74 | 29.86 | 1000 | 1000 | 196 | H | 65 | 11.6 | |
| 19163.071 | --- | 31.21 | 54 | 22.79 | 1000 | 1000 | 196 | H | 65 | 11.6 | |
| 20500.374 | --- | 29.87 | 54 | 24.13 | 1000 | 1000 | 245 | V | -91 | 12 | |
| 20500.374 | 43.1 | --- | 74 | 30.9 | 1000 | 1000 | 245 | V | -91 | 12 | |
| 21265.798 | 43.07 | --- | 74 | 30.93 | 1000 | 1000 | 210 | V | 62 | 12 | |
| 21265.798 | --- | 30.06 | 54 | 23.94 | 1000 | 1000 | 210 | V | 62 | 12 | |
| 22075.628 | --- | 33.06 | 54 | 20.94 | 1000 | 1000 | 236 | V | 133 | 12.2 | |
| 22075.628 | 45.86 | --- | 74 | 28.14 | 1000 | 1000 | 236 | V | 133 | 12.2 | |
| 24906.251 | 44.73 | --- | 74 | 29.27 | 1000 | 1000 | 223 | H | 26 | 12.1 | |
| 24906.251 | --- | 31.93 | 54 | 22.07 | 1000 | 1000 | 223 | H | 26 | 12.1 | |
| 26335.333 | 47.83 | --- | 74 | 26.17 | 1000 | 1000 | 195 | H | 164 | 13.7 | |
| 26335.333 | --- | 34.27 | 54 | 19.73 | 1000 | 1000 | 195 | H | 164 | 13.7 | |



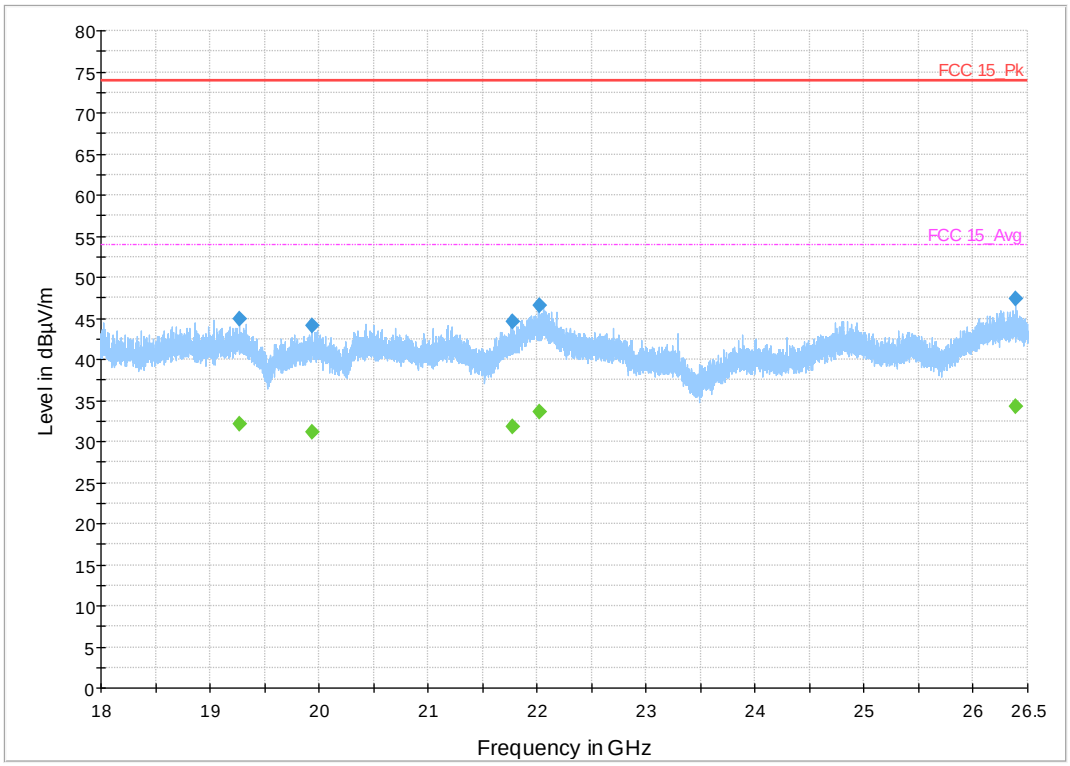

**Plot 30**. 18-26.5 GHz, 2402 MHz

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 19236.356 | --- | 32.07 | 54 | 21.93 | 1000 | 1000 | 210 | V | 78 | 11.8 | |
| 19236.356 | 45.15 | --- | 74 | 28.85 | 1000 | 1000 | 210 | V | 78 | 11.8 | |
| 20353.283 | --- | 31.32 | 54 | 22.68 | 1000 | 1000 | 245 | V | 15 | 12.1 | |
| 20353.283 | 44.33 | --- | 74 | 29.67 | 1000 | 1000 | 245 | V | 15 | 12.1 | |
| 21802.258 | 46.28 | --- | 74 | 27.72 | 1000 | 1000 | 196 | V | -58 | 12.3 | |
| 21802.258 | --- | 32.04 | 54 | 21.96 | 1000 | 1000 | 196 | V | -58 | 12.3 | |
| 21945.05 | 46.2 | --- | 74 | 27.8 | 1000 | 1000 | 195 | H | 76 | 12.1 | |
| 21945.05 | --- | 33.03 | 54 | 20.97 | 1000 | 1000 | 195 | H | 76 | 12.1 | |
| 24782.714 | 44.87 | --- | 74 | 29.13 | 1000 | 1000 | 195 | V | -129 | 12.1 | |
| 24782.714 | --- | 31.92 | 54 | 22.08 | 1000 | 1000 | 195 | V | -129 | 12.1 | |
| 26258.826 | 47.31 | --- | 74 | 26.69 | 1000 | 1000 | 210 | V | -155 | 13.7 | |
| 26258.826 | --- | 34.14 | 54 | 19.86 | 1000 | 1000 | 210 | V | -155 | 13.7 | |




**Plot 31**. 18-26.5 GHz, 2440 MHz

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 19275.696 | 44.85 | --- | 74 | 29.15 | 1000 | 1000 | 245 | V | -74 | 11.8 | |
| 19275.696 | --- | 32.13 | 54 | 21.87 | 1000 | 1000 | 245 | V | -74 | 11.8 | |
| 19932.688 | 44.11 | --- | 74 | 29.89 | 1000 | 1000 | 196 | H | -2 | 11.6 | |
| 19932.688 | --- | 31.08 | 54 | 22.92 | 1000 | 1000 | 196 | H | -2 | 11.6 | |
| 21771.562 | --- | 31.81 | 54 | 22.19 | 1000 | 1000 | 195 | H | -180 | 12 | |
| 21771.562 | 44.65 | --- | 74 | 29.35 | 1000 | 1000 | 195 | H | -180 | 12 | |
| 22018.782 | 46.49 | --- | 74 | 27.51 | 1000 | 1000 | 245 | V | 59 | 12.2 | |
| 22018.782 | --- | 33.61 | 54 | 20.39 | 1000 | 1000 | 245 | V | 59 | 12.2 | |
| 26388.769 | 47.35 | --- | 74 | 26.65 | 1000 | 1000 | 196 | H | -76 | 13.8 | |
| 26388.769 | --- | 34.3 | 54 | 19.7 | 1000 | 1000 | 196 | H | -76 | 13.8 | |




**Plot 32**. 18-26.5 GHz, 2480 MHz

## 4.7 AC Conducted Emissions

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

### 4.7.1 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 Lab1. 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.

#### *4.7.1.1 Deviations*

There were no deviations from this test methodology.

### 4.7.2 Test Results

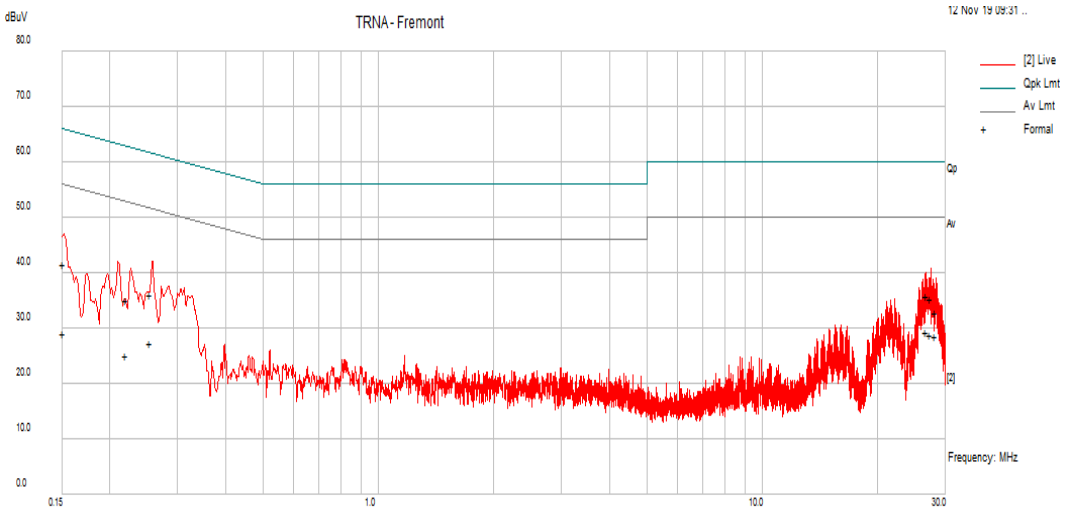
As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

**Table 7:** AC Conducted Emissions – Test Results

| | | |
|---|---|---|
| **Test Conditions:** Conducted Measurement at Normal Conditions only | | |
| **Antenna Type:** PCB trace antenna | **Power Level:** See Table 11 | |
| **AC Power:** 120 Vac/60 Hz | **Configuration:** Tabletop | |
| **Configuration** | **Frequency Range** | **Test Result** |
| Line 1 (Live) | 0.15 to 30 MHz | Pass |
| Line 2 (Neutral) | 0.15 to 30 MHz | Pass |

### 4.7.2.1 Live Line

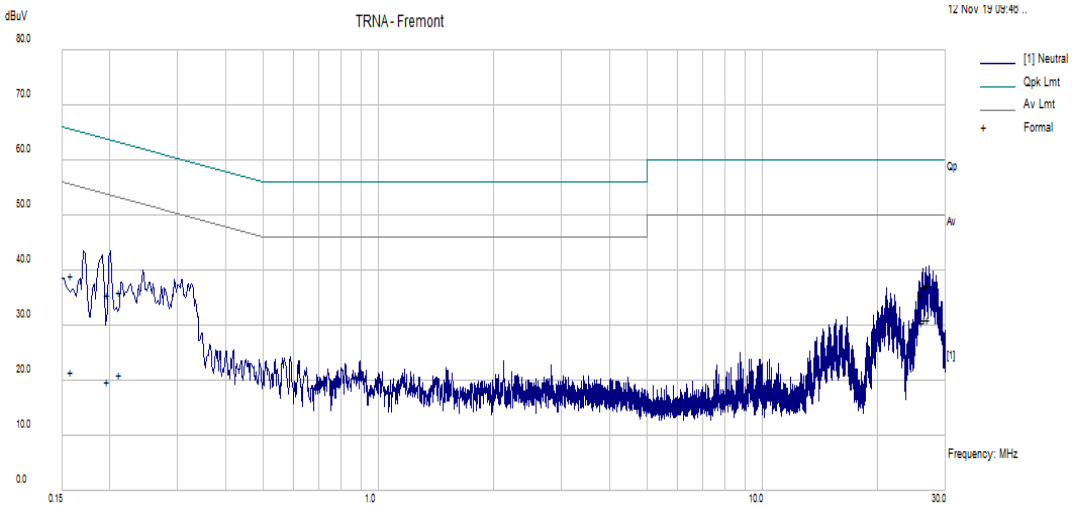
| No | Frequency | Raw dBuV | Cable Los | Factors dB | Level dBu | Measurement Type | Line | Limit dBuV | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 (92) | 0.15 | 17.82 | 11.12 | 0.09 | 29.03 | Average | Live | 55.93 | -26.89 | Pass | |
| 2 (92) | 0.15 | 30.39 | 11.12 | 0.09 | 41.60 | Quasi Peak | Live | 65.93 | -24.33 | Pass | |
| 3 (98) | 0.22 | 14.86 | 10.20 | 0.06 | 25.12 | Average | Live | 52.83 | -27.71 | Pass | |
| 4 (98) | 0.22 | 24.72 | 10.20 | 0.06 | 34.99 | Quasi Peak | Live | 62.83 | -27.85 | Pass | |
| 5 (94) | 0.25 | 17.21 | 10.17 | 0.05 | 27.43 | Average | Live | 51.61 | -24.18 | Pass | |
| 6 (94) | 0.25 | 25.78 | 10.17 | 0.05 | 36.00 | Quasi Peak | Live | 61.61 | -25.61 | Pass | |
| 7 (95) | 26.69 | 25.44 | 10.62 | -0.27 | 35.79 | Quasi Peak | Live | 60.00 | -24.21 | Pass | |
| 8 (95) | 26.69 | 19.04 | 10.62 | -0.27 | 29.39 | Average | Live | 50.00 | -20.61 | Pass | |
| 9 (93) | 27.41 | 24.99 | 10.64 | -0.29 | 35.34 | Quasi Peak | Live | 60.00 | -24.66 | Pass | |
| 10 (93) | 27.41 | 18.46 | 10.64 | -0.29 | 28.81 | Average | Live | 50.00 | -21.19 | Pass | |
| 11 (97) | 28.25 | 22.60 | 10.66 | -0.31 | 32.94 | Quasi Peak | Live | 60.00 | -27.06 | Pass | |
| 12 (97) | 28.25 | 18.27 | 10.66 | -0.31 | 28.62 | Average | Live | 50.00 | -21.38 | Pass | |




**Plot 33**. 0.15 - 30 MHz, Live Line

### 4.7.2.2 Neutral Line

| No | Frequency | Raw dBuV | Cable Los | Factors dB | Level dBu | Measurement Type | Line | Limit dBuV | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 (147) | 0.16 | 28.35 | 10.70 | 0.08 | 39.13 | Quasi Peak | Neutral | 65.53 | -26.40 | Pass | |
| 2 (147) | 0.16 | 10.93 | 10.70 | 0.08 | 21.71 | Average | Neutral | 55.53 | -33.82 | Pass | |
| 3 (146) | 0.20 | 25.37 | 10.23 | 0.07 | 35.67 | Quasi Peak | Neutral | 63.71 | -28.05 | Pass | |
| 4 (146) | 0.20 | 9.55 | 10.23 | 0.07 | 19.85 | Average | Neutral | 53.71 | -33.86 | Pass | |
| 5 (140) | 0.21 | 25.74 | 10.21 | 0.06 | 36.01 | Quasi Peak | Neutral | 63.12 | -27.11 | Pass | |
| 6 (140) | 0.21 | 10.96 | 10.21 | 0.06 | 21.24 | Average | Neutral | 53.12 | -31.88 | Pass | |
| 7 (139) | 26.16 | 20.29 | 10.61 | -0.26 | 30.64 | Average | Neutral | 50.00 | -19.36 | Pass | |
| 8 (139) | 26.16 | 25.32 | 10.61 | -0.26 | 35.67 | Quasi Peak | Neutral | 60.00 | -24.33 | Pass | |
| 9 (138) | 26.62 | 20.68 | 10.62 | -0.27 | 31.03 | Average | Neutral | 50.00 | -18.97 | Pass | |
| 10 (138) | 26.62 | 26.87 | 10.62 | -0.27 | 37.22 | Quasi Peak | Neutral | 60.00 | -22.78 | Pass | |
| 11 (137) | 27.11 | 26.93 | 10.63 | -0.28 | 37.28 | Quasi Peak | Neutral | 60.00 | -22.72 | Pass | |
| 12 (137) | 27.11 | 20.72 | 10.63 | -0.28 | 31.07 | Average | Neutral | 50.00 | -18.93 | Pass | |




**Plot 34**. 0.15 - 30 MHz, Neutral Line

# 5 Test Equipment List

## 5.1 Equipment List

| Equipment | Manufacturer | Model # | Serial/Inst # | Last Cal mm/dd/yyyy | Next Cal mm/dd/yyyy |
|---|---|---|---|---|---|
| Spectrum Analyzer | Rohde & Schwarz | FSU26.5 | 200050 | 11/20/2018 | 11/20/2019 |
| Spectrum Analyzer | Rohde & Schwarz | FSU8 | 101358 | 12/07/2018 | 12/07/2019 |
| EMI Receiver | Rohde & Schwarz | ESIB40 | 100180 | 05/31/2018 | 05/31/2020 |
| L.I.S.N. | Com-Power | LI-215 | 192000 | 01/16/2019 | 01/16/2020 |
| Transient Limiter | Com-Power | LIT-930 | 531582 | 01/16/2019 | 01/16/2020 |
| EMI Receiver | Agilent | MXE N9038A | MY51210195 | 01/16/2019 | 01/16/2020 |
| Preamplifier, 9 kHz – 1 GHz | Sonoma | 310N | 213221 | 01/16/2019 | 01/16/2020 |
| Active Loop Antenna | EMCO | 6502 | 00062531 | 07/01/2019 | 07/01/2021 |
| Bilog Antenna | Sunol Sciences | JB3 | A060502 | 05/27/2018 | 05/27/2020 |
| Amplifier | Miteq | TTA1800-30-HG | 1842452 | 01/15/2019 | 01/15/2020 |
| Horn Antenna | Sunol Sciences | DRH-118 | A040806 | 03/05/2019 | 03/05/2020 |
| Amplifier | HP | 8449B | 3008A01013 | 01/15/2019 | 01/15/2020 |
| Amplifier | Sonoma | 310N | 185516 | N/A (See Note) | |
| 1.6 GHz Low Pass Filter | K&L Microwave | 8L120-X1600-0/09135-0249 | UA691-35 | N/A (See Note) | |
| 3.5 GHz High Pass Filter | Hewlett Packard | 84300-80038 | 820004 | N/A (See Note) | |
| 2.4 GHz Notch Filter | Micro-Tronics | BRM50702 | 009 | 01/15/2019 | 01/15/2020 |

Note: Equipment is characterized before use.

# 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 8:** Customer Information

| | |
|---|---|
| **Company Name** | SoClean Inc. |
| **Address** | 12 Vose farm road |
| **City, State, Zip** | Petersborough, NH, 03458 |
| **Country** | USA |

**Table 9:** Technical Contact Information

| | |
|---|---|
| **Name** | Courtney Medeiros |
| **E-mail** | cmedeiros@baycomp.com |

## 6.3 Equipment Under Test (EUT)

The information provided in the following table should be listed as it should appear in the final report. For those products that have only a model name, list the model number as *non-applicable* and vice-versa.

**Table 10**: EUT Designation

| | |
|---|---|
| Product Name | SoClean 3 |
| Model Number | SC1400 |
| System Name | SoClean 3 |
| Product Description | The SoClean 3 is a CPAP cleaner and sanitizing machine. |

## 6.4 Product Specifications

**Table 11:** EUT Specifications

| EUT Specifications | |
|---|---|
| AC Input | AC/DC medical wall wart 120VAC-240VAC in 12V nominal 10-14V out |
| Environment | Indoor |
| Operating Temperature Range: | 10°C - 38°C |
| Multiple Feeds: | ☐ Yes and how many<br>☒ No |
| Product Marketing Name (PMN) | SoClean 3 |
| Hardware Version Identification Number (HVIN) | Rev 10 |
| Firmware Version Identification Number (FVIN) | 1.1.5 |
| RF Test Software Version | 1.1.5 |
| Operating Modes | BT Low Energy, 1Mbps |
| Transmitter Frequency Band | 2.4 GHz – 2.480 GHz |
| Power Setting @ Operating Channel | 0dBm |
| Modulation | FSK |
| TX/RX Chain (s) | N/A |
| Type of Equipment | ☒ Table Top ☐ Wall-mount ☐ Floor standing cabinet<br>☐ Other: |
| **Note:** EUT will be on / transmitted at all times with the highest power levels and antenna gains per channel. | |

**Table 12:** Antenna Information

| Number | Antenna Type | Description | Max Gain (dBi) |
|---|---|---|---|
| Antenna 0 | PCB trace antenna | Bluetooth Low Energy | 0 |

**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 | Yes | < 3m | M |

**Table 14:** Accessory Equipment

| Equipment | Manufacturer | Model | Serial | Comment |
|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A |
| | | | | |

**Table 15**: Ancillary Equipment (used for test purposes only)

| Equipment | Manufacturer | Model | Serial | Used for |
|---|---|---|---|---|
| Laptop | Dell | Inspiron 15-5548 | N/A | Setup EUT operating modes/ channels via a USB connection to pins in EUT |
| **Note:** None. | | | | |

**Table 16:** Description of Sample used for Testing

| Sample Number | Device | Serial Number | Configuration | Used For |
|---|---|---|---|---|
| 1 | SC1400 | SC14001907011 0007 | Radiated/ Conducted Sample | TX Spurious Emissions, Bandedge |
| 2 | SC1400 | SC14001907011 0007 | Radiated/ Conducted Sample | AC Mains Conducted Emissions |
| 3 | SC1400 | SC14001907011 0007 | Radiated/ Conducted Sample | All other conducted Measurments |
| **Note**: None. | | | | |

**Table 17:** Description of Test Configuration used for Radiated Measurement.

| Device | Antenna | Mode | Setup Photo (X-Axis) | Setup Photo (Y-Axis) | Setup Photo (Z-Axis) |
|---|---|---|---|---|---|
| SC1400 | PCB trace antenna | Transmit | EUT upright | N/A | N/A |
| **Note:** | | | | | |

## *6.5 Test Specifications*

**Table 18:** Test Specifications

| Emissions and Immunity | |
|---|---|
| **Standard** | **Requirement** |
| CFR 47 Part 15.247: 2019 | All |
| RSS 247 Issue 2, 2017 | All |

# END OF REPORT