# Emissions
# Test Report

**EUT Name:** Ember Mug

**Model No.:** TM15

CFR 47 Part 15.247: 2015 and RSS 247: 2015

*Prepared for:*

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*Report/Issue Date:* October 5, 2016
*Job #* 0000136548
*Report Number:* 31662400.002

# Revisions

| Revision No. | Date MM/DD/YYYY | Reason for Change | Author |
|---|---|---|---|
| 0 | 09/15/2016 | Original Document | N/A |
| 1 | 10/5/2016 | Updated KDB references to include the document version.<br>Updated SAR exemption calculation to omit antenna gain.<br>Removed irrelevant power data from OBW plots | E. Mariscal |
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Note: Latest revision report will replace all previous reports.

# Statement of Compliance

| | |
|---|---|
| *Manufacturer:* | Ember Technologies, Inc.<br>4607 Lakeview Canyon Rd., #500<br>Westlake Village, CA 91361<br>(858) 603-4951 |
| *Requester / Applicant:* | Chris Wakeham |
| *Name of Equipment:* | Ember Mug |
| *Model No.* | TM15 |
| *Type of Equipment:* | Intentional Radiator |
| *Application of Regulations:* | CFR 47 Part 15.247: 2015 and RSS 247: 2015 |
| *Test Dates:* | 08 Sept 2016 to 13 Sept 2016 |

*Guidance Documents:*

Emissions: ANSI C63.10-2013, KDB 558074 D01 DTS Measurement Guidance v03r05

*Test Methods:*

Emissions: ANSI C63.10-2013, KDB 558074 D01 DTS Measurement Guidance v03r05

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.

| | | | |
|---|---|---|---|
| Eddie Mariscal | | David Spencer | |
| Test Engineer | Date October 5, 2016 | A2LA Signatory | Date October 5, 2016 |

**Testing Cert #3331.02** **US5254** **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: 2015 and RSS 247: 2015 based on the results of testing performed on 08 Sept 2016 to 13 Sept 2016 on the Ember Mug Model TM15 manufactured by Ember Technologies, 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 2400 MHz to 2483.5 MHz frequency band is covered in this document.

## 1.3 Summary of Test Results

**Table 1:** Summary of Test Results

| Test | Test Method ANSI C63.4 | Test Parameters (Measured) | Result |
|---|---|---|---|
| Spurious Emission in Transmit Mode | CFR47 15.209, RSS-GEN Sect.8.9 | Class B | **Complied** |
| Restricted Bands of Operation | CFR47 15.205, RSS GEN Sect.8.10 | Class B | **Complied** |
| AC Power Conducted Emission | CFR47 15.207, RSS-GEN Sect.8.8 | Class B | **Complied** |
| Occupied Bandwidth | CFR47 15.247 (a2), RSS 247 Sect. 5.2.1 | See plots | **Complied** |
| Maximum Output Power | CFR47 15.247 (b), RSS 247 Sect. 5.4.4 | 2.74dBm | **Complied** |
| Peak Power Spectral Density | CFR47 15.247 (e), RSS 247 Sect. 5.2.2 | 2.64dBm/3kHz | **Complied** |
| Out of Band Emission | CFR47 15.247 (d), RSS 247 Sect.5.5 | 30 MHz - 25 GHz < -17.36 dBm/100kHz | **Complied** |
| RF Exposure | CFR47 15.247 (i), 2.1093 RSS-102 Issue 5 | General Population | **Complied** |

Note: This test report covers 2400 MHz to 2483.5 MHz band.

## 1.4 Special Accessories

No special accessories were necessary in order to achieve compliance.

## 1.5 Equipment Modifications

None

# 2 Laboratory Information

## *2.1 Accreditations & Endorsements*

### 2.1.1 US Federal Communications Commission

TUV Rheinland of North America at 1279 Quarry Ln, Pleasanton, CA 94566 is recognized by the commission for performing testing services for the general public on a fee basis. These laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (US5254). 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 17025:1999 and ISO 9002 (Lab Code Testing Cert #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-0031

VCCI Registration No. for Santa Clara: A-0032

### 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. The 2305 Mission College, Santa Clara, 95054, USA location is considered a Pleasanton annex.

### 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 Testing Cert #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

| **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 |

**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 ± 2.9%. | Per IEC 61000-4-8 |

**Thermo KeyTek EMC Pro**

| |
|---|
| The estimated combined standard uncertainty for EFT fast transient immunity measurements is ± 2.6%. |
| The estimated combined standard uncertainty for surge immunity measurements is ± 2.6%. |
| The estimated combined standard uncertainty for voltage variation and interruption measurements is ± 1.74%. |

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. Equipment calibration records are kept on file at the test facility.

# 3 Product Information

## 3.1 Product Description

The Model TM15, Ember Mug, is a portable, self-heating coffee mug capable of operating in the 2.4 GHz frequency band utilizing BLE technology.

## 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 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 Ember Mug employs a single integral antenna inaccessible to the end user. The antenna has a declared maximum gain of +6dBi.

Refer to Table 13 for additional antenna information.

# 4 Emissions

Testing was performed in accordance with CFR 47 Part 15.247: 2015 and RSS 247: 2015. 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):2015 and RSS 247: 2015 Sect. 5.4.4.*

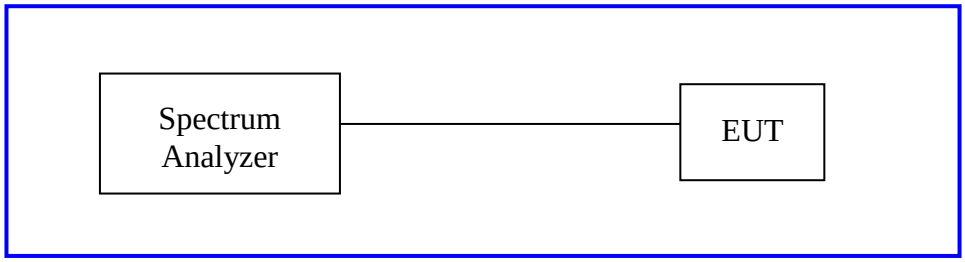
*The maximum transmitted powers are:*

*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 measurements were conducted on 3 channels in each operating range per CFR47 Part 15.247(b): 2015 and RSS 247 Sect. 5.4.4; 2400 MHz to 2483.5 MHz

Test Setup:




*The method described in section 9.1.1 of "KDB 558074 – DTS Measurement Guidance v03r05" applies and was used.*

### 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 | | | |
| **Antenna Type:** Custom Integrated | | **Power Setting:** See test plan | |
| **Max. Directional Gain:** +6 dBi | | | |
| **Signal State:** Modulated at 100%. | | | |
| **Ambient Temp.:** 24° C | | **Relative Humidity:**39% | |
| **BLE 4.0** | | | |
| **Operating Channel (MHz)** | **Measured Power [dBm]** | **Limit [dBm]** | **Margin [dB]** |
| 2402.00 | 2.54 | 30.00 | -27.46 |
| 2440.00 | 2.74 | 30.00 | -27.26 |
| 2480.00 | 2.61 | 30.00 | -27.39 |
| **Note: Note:** All insertion loss corrections are accounted for in the measurement plots. | | | |

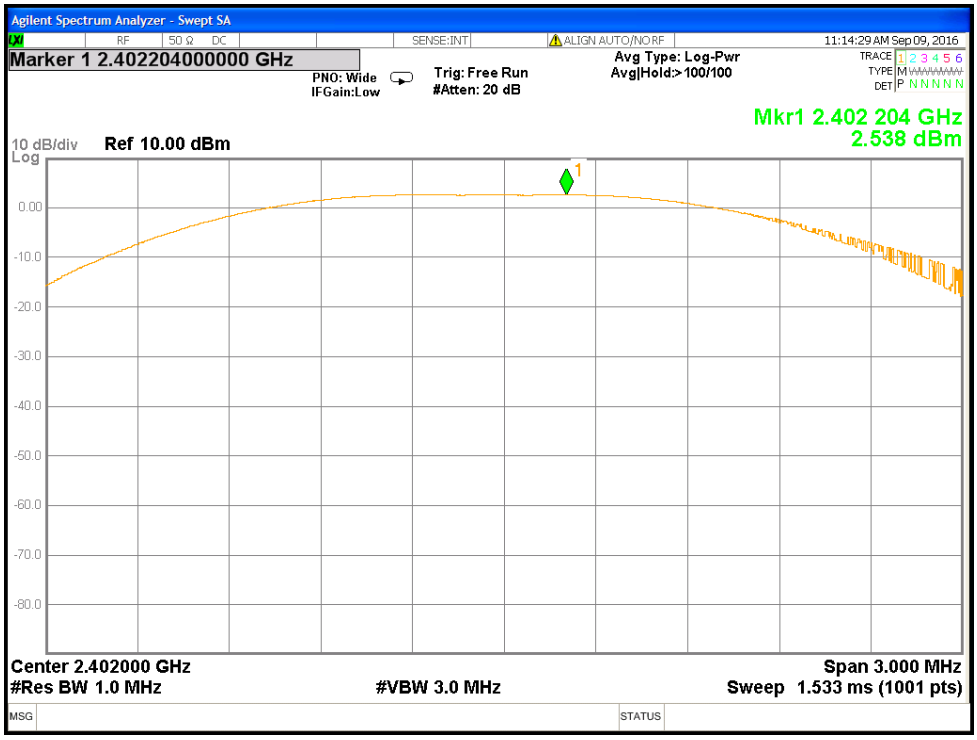



**Figure 1** : Maximum peak conducted output power, 2402MHz

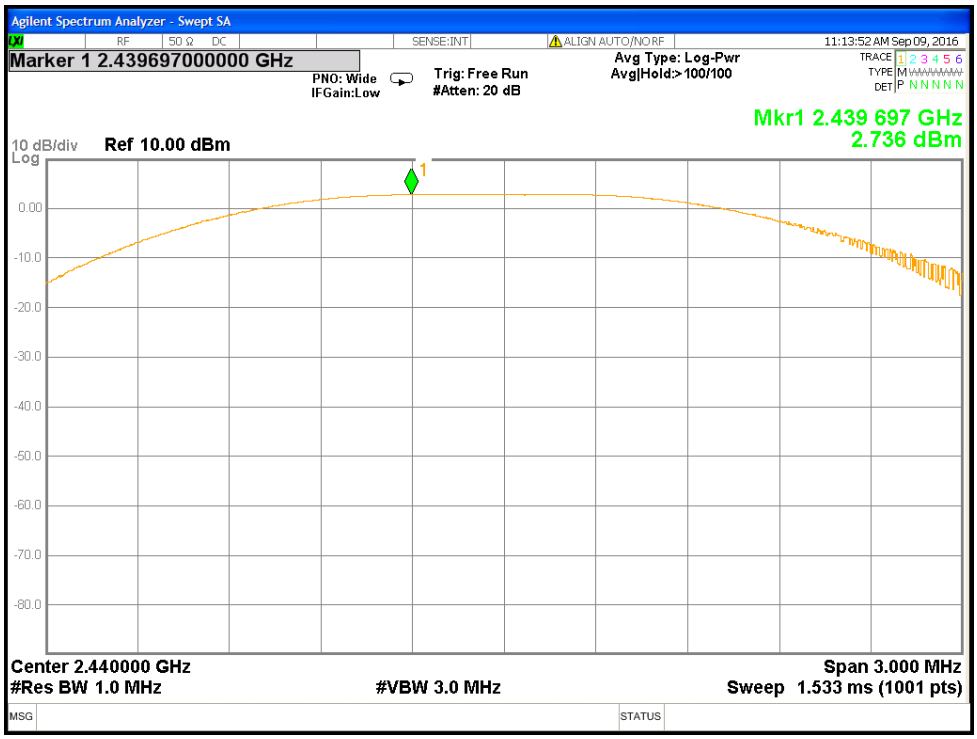



**Figure 2** : Maximum peak conducted output power, 2440MHz

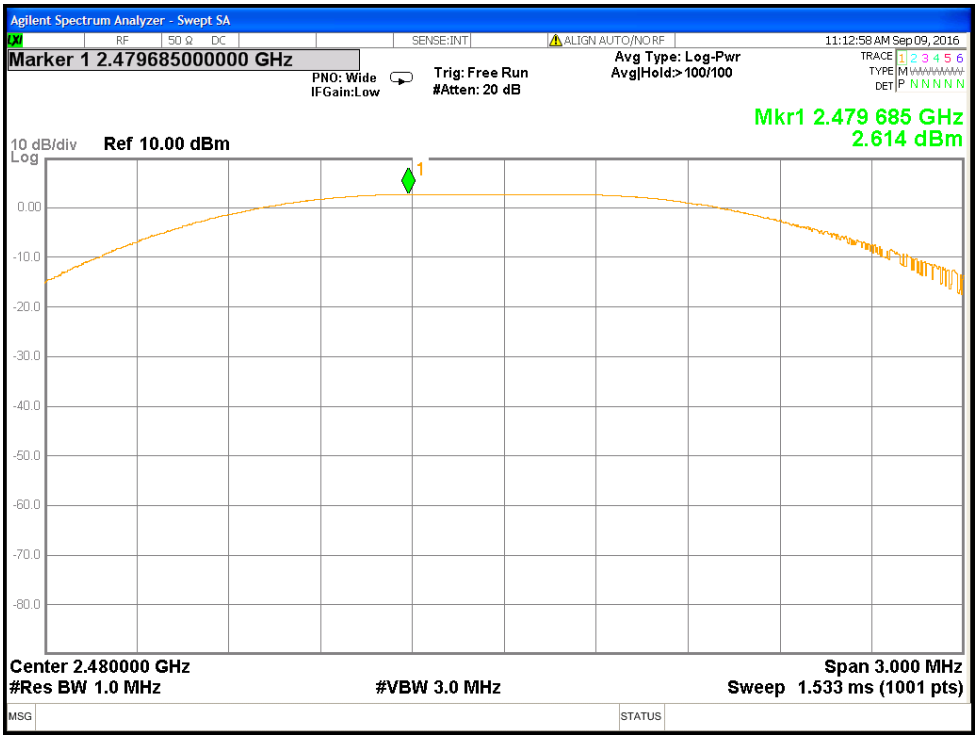



**Figure 3** : Maximum peak conducted output power, 2480MHz

## *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.*

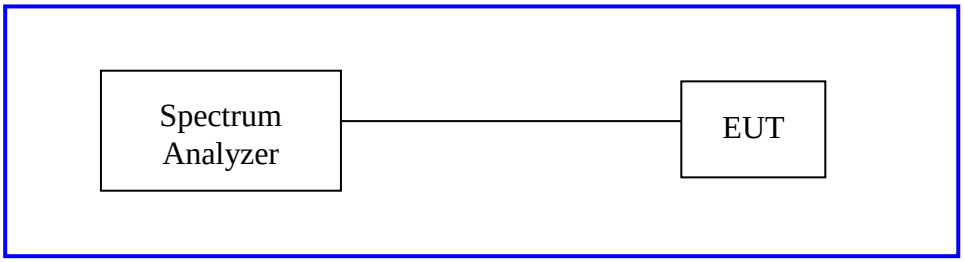
*The 99% bandwidth is the bandwidth in which 99% of the transmitted power occupied.*

*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) 2015 and RSS 247 Sect. 5.2.1:2015. Measurements were performed on 3 channels in each operating frequency range; 2400 MHz to 2483.5 MHz, a 6 dB bandwidth was used.

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 | | |
| **Antenna Type:** Custom Integrated | | **Power Setting:** See test plan |
| **Max. Directional Gain:** +6 dBi | | |
| **Signal State:** Modulated at 100%. | | |
| **Ambient Temp.:** 24° C | | **Relative Humidity:**39% |
| **Bandwidth (MHz) for BLE 4.0** | | |
| **Freq. (MHz)** | **6dB Bandwidth (kHz)** | **99% Bandwidth (MHz)** |
| 2402 | 695.6 | 1.0595 |
| 2440 | 693.8 | 1.0650 |
| 2480 | 702.1 | 1.0660 |
| **Note:** None | | |

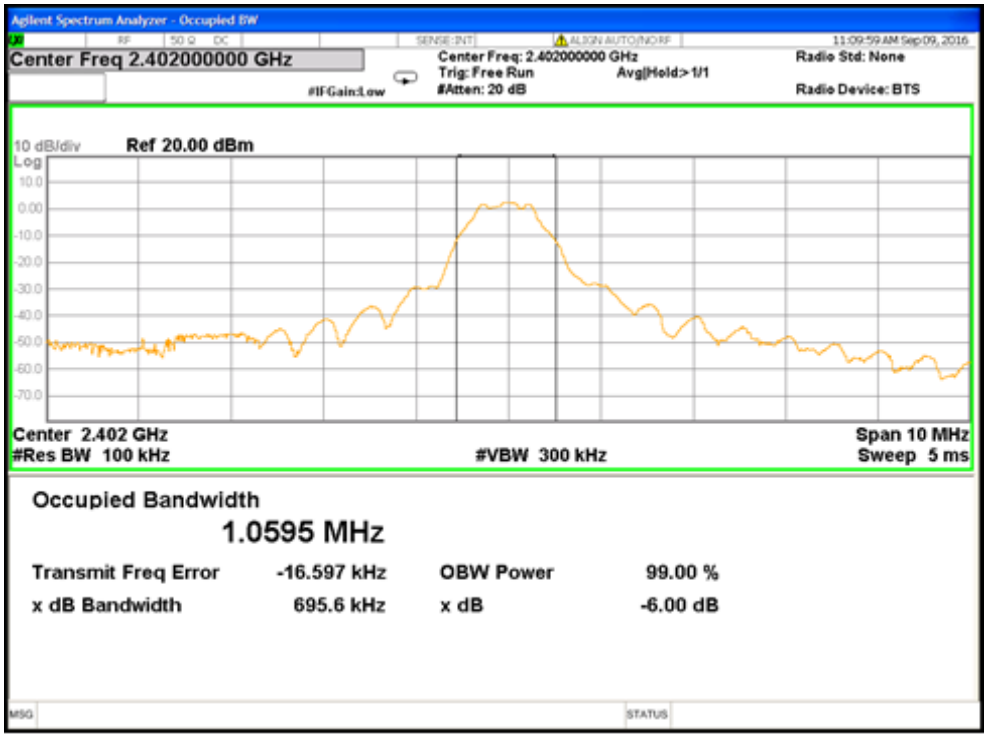



**Figure 4** : 6dB & 99% Occupied Bandwidth, 2402MHz

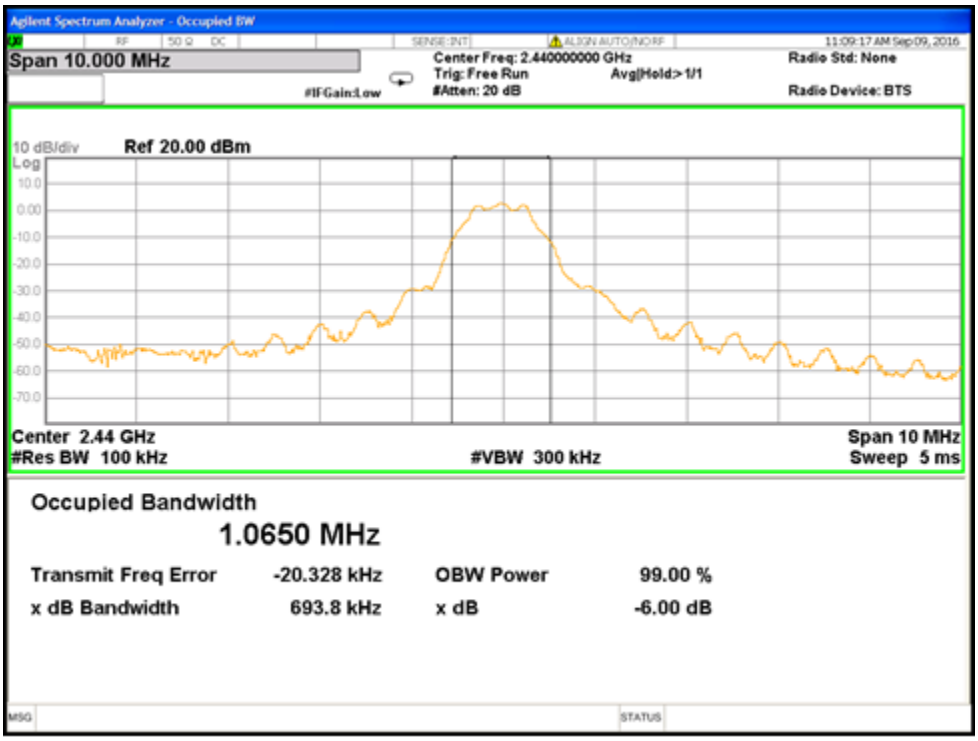



**Figure 5** : 6dB & 99% Occupied Bandwidth, 2440MHz

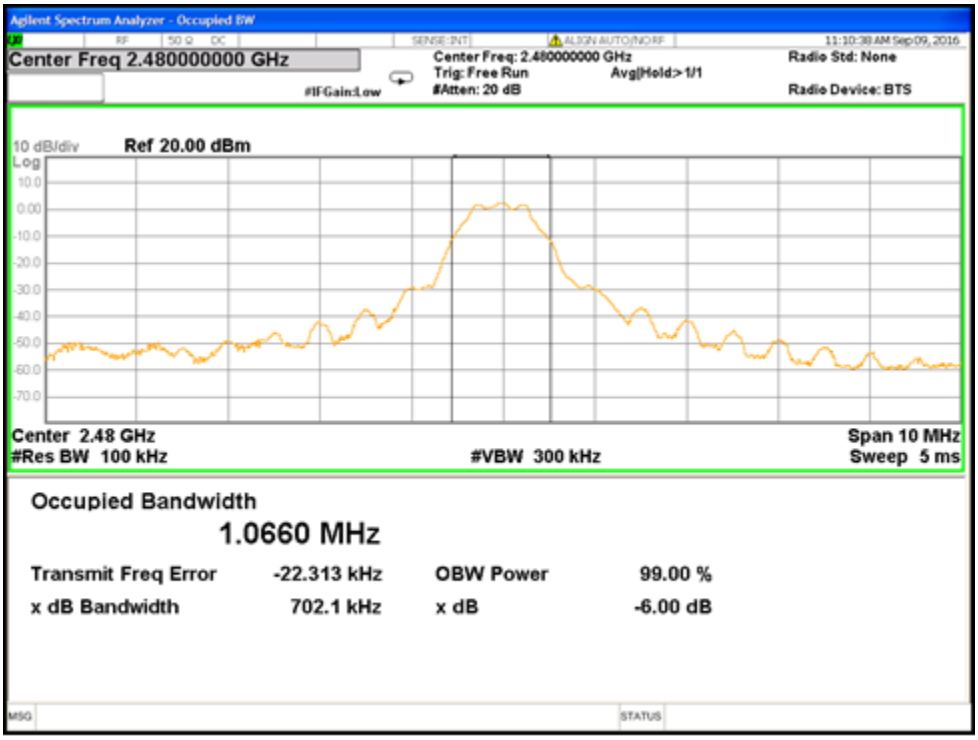



**Figure 6** : 6dB & 99% Occupied Bandwidth, 2480MHz

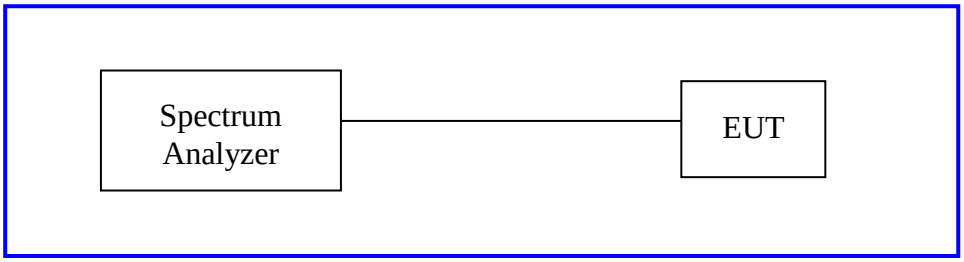
## *4.3 Peak Power Spectral Density*

*According to the CFR47 Part 15.247 (e) and RSS 247 Sect.5.2.2, 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.5.2.2.

Test Setup:




### 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 | | | | |
| **Antenna Type:** Custom Integrated | | | **Power Setting:** See test plan | |
| **Max. Directional Gain:** +6 dBi | | | | |
| **Signal State:** Modulated at 100%. | | | | |
| **Ambient Temp.:** 24° C | | | **Relative Humidity:**39% | |
| **Peak Power Spectral Density** | | | | |
| **BLE 4.0** | | | | |
| **Freq. (MHz)** | **Measured PSD [dBm/100kHz]** | **Calculated PSD [dBm/3kHz]** | **Limit [dBm/3kHz]** | **Margin [dB]** |
| 2402 | 2.50 | -12.73 | 8 | -20.73 |
| 2440 | 2.64 | -12.59 | 8 | -20.59 |
| 2480 | 2.52 | -12.71 | 8 | -20.71 |
| **Note:** All insertion loss corrections are accounted for in the measurement plots.<br>2. PSD (dBm/100kHz) is used to calculate PSD (dBm/3kHz) using the following formula:<br>PSD (dBm/3kHz) = PSD (dBm/100kHz) – 15.23dB. | | | | |

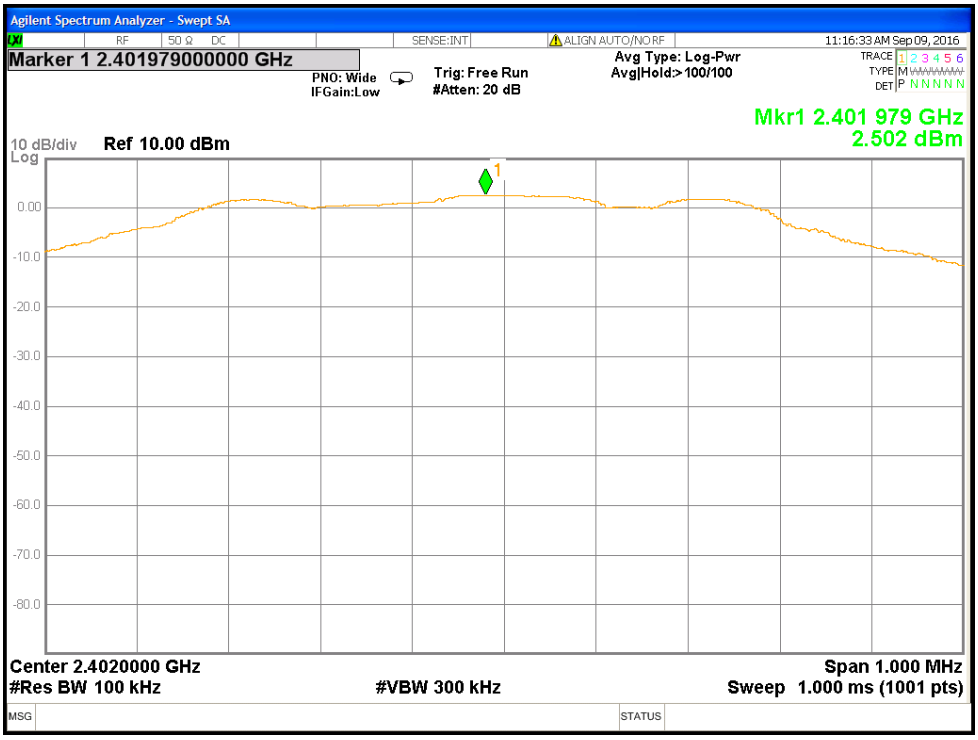



**Figure 7**: Power Spectral Density, 2402 MHz

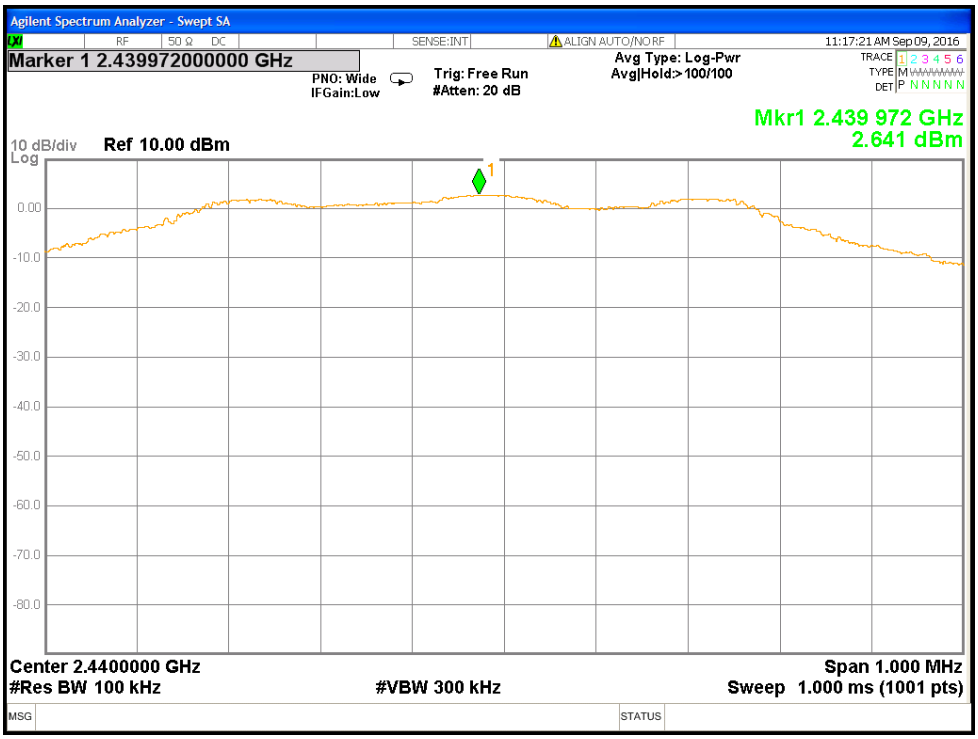



**Figure 8**: Power Spectral Density, 2440 MHz

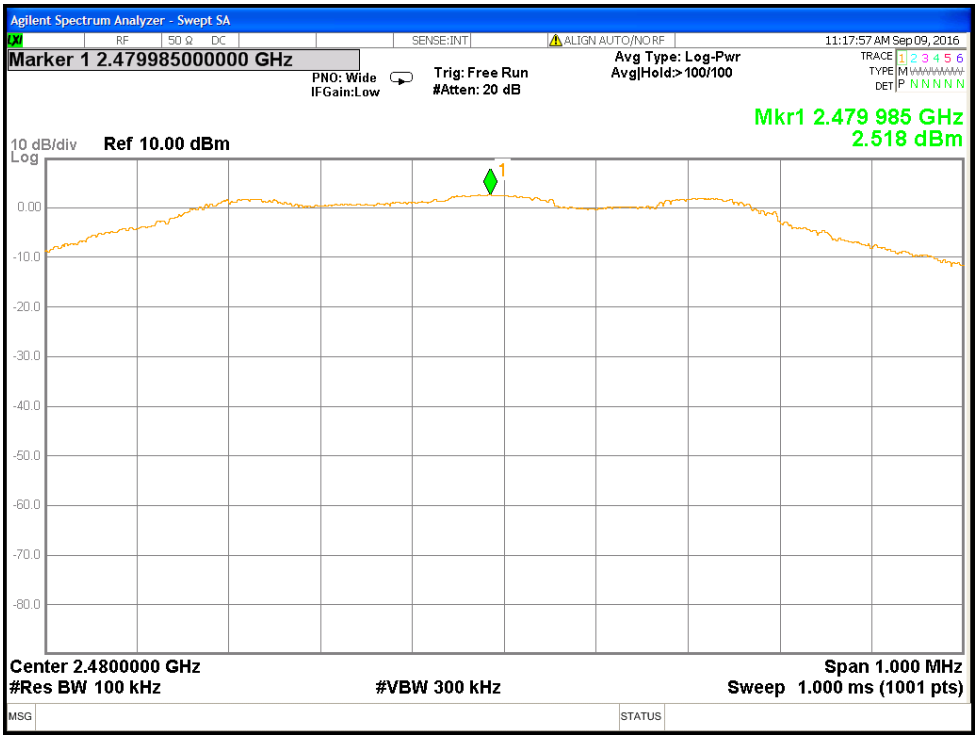



**Figure 9**: Power Spectral Density, 2480 MHz

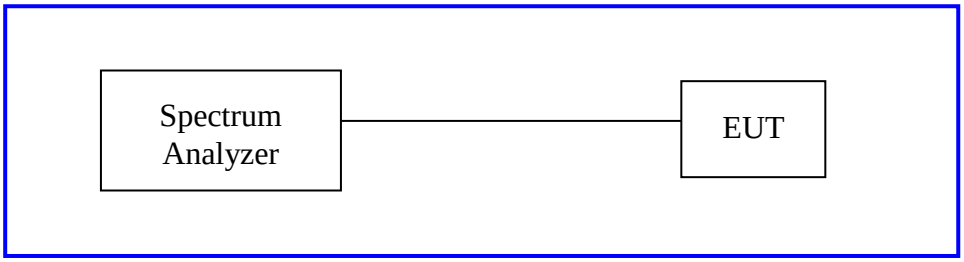
## *4.4 Out of Band Emissions*

*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-247 Sect. 5.5.*

### 4.4.1 Test Method

The conducted method was used to measure the undesirable emission requirement. The measurement was performed with modulation.

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:** Out of Band Emissions including the Band-Edge – Test Results

| **Test Conditions:** Conducted Measurement, Normal Temperature | | | | | |
|---|---|---|---|---|---|
| **Antenna Type:** Custom Integrated | | **Power Setting:** See test plan | | | |
| **Max. Directional Gain:** +6 dBi | | **Highest Level in 100kHz BW:** 2.64 dBm | | | |
| **Signal State:** Modulated | | | | | |
| **Ambient Temp.:** 24° C | | **Relative Humidity:**39% | | | |
| **Non-Restricted Frequency Band Emissions** | | | | | |
| **Operating Freq. (MHz)** | **Measured Freq. (MHz)** | **Measured (dBm)** | **Limit (dBm)** | **Plot** | **Result** |
| 2400 | 676.02 | -67.11 | -17.36 | 12 | Pass |
| 2400 | 525.67 | -69.30 | -17.36 | 12 | Pass |
| 2440 | 686.69 | -67.50 | -17.36 | 13 | Pass |
| 2440 | 533.43 | -68.76 | -17.36 | 13 | Pass |
| 2480 | 697.36 | -67.26 | -17.36 | 14 | Pass |
| 2480 | 542.16 | -67.54 | -17.36 | 14 | Pass |
| 2400 | 2371.72 | -42.75 | -17.36 | 15 | Pass |
| 2400 | 2315.14 | -43.53 | -17.36 | 15 | Pass |
| 2400 | 1201.48 | -53.39 | -17.36 | 15 | Pass |
| 2440 | 1219.8 | -53.46 | -17.36 | 16 | Pass |
| 2440 | 2363.6 | -65.96 | -17.36 | 16 | Pass |
| 2480 | 1239.4 | -53.43 | -17.36 | 17 | Pass |
| 2480 | 2092.0 | -67.80 | -17.36 | 17 | Pass |
| 2402 | 2400.0 | -40.72 | -17.36 | 10 | Pass |
| 2480 | 2483.5 | -51.20 | -17.36 | 11 | Pass |
| 2480 | 2494.0 | -38.33 | -17.36 | 11 | Pass |
| **Note:** 1. The stated limits are -20dBc relative to the max output measured in a 100kHz band per | | | | | |

**Table 6:** Out of Band Emissions including the Band-Edge – Test Results-Continued

| **Test Conditions:** Conducted Measurement, Normal Temperature | | | | | |
|---|---|---|---|---|---|
| **Antenna Type:** Custom Integrated | | **Power Setting:** See test plan | | | |
| **Max. Directional Gain:** +6 dBi | | **Highest Level in 100kHz BW:** 2.64 | | | |
| **Signal State:** Modulated | | | | | |
| **Ambient Temp.:** 24° C | | **Relative Humidity:**39% | | | |
| **Non-Restricted Frequency Band Emissions** | | | | | |
| **Operating Freq. (MHz)** | **Measured Freq. (MHz)** | **Measured (dBm)** | **Limit (dBm)** | **Plot** | **Result** |
| 2400 | 4803.0 | -40.57 | -17.36 | 18 | Pass |
| 2400 | 7212.0 | -56.69 | -17.36 | 18 | Pass |
| 2440 | 4870.0 | -49.79 | -17.36 | 19 | Pass |
| 2440 | 7325.0 | -54.29 | -17.36 | 19 | Pass |
| 2400 | 4952.5 | -41.53 | -17.36 | 20 | Pass |
| 2400 | 7450.0 | -47.36 | -17.36 | 20 | Pass |
| **Note:** 1. The stated limits are -20dBc relative to the max output measured in a 100kHz band per | | | | | |

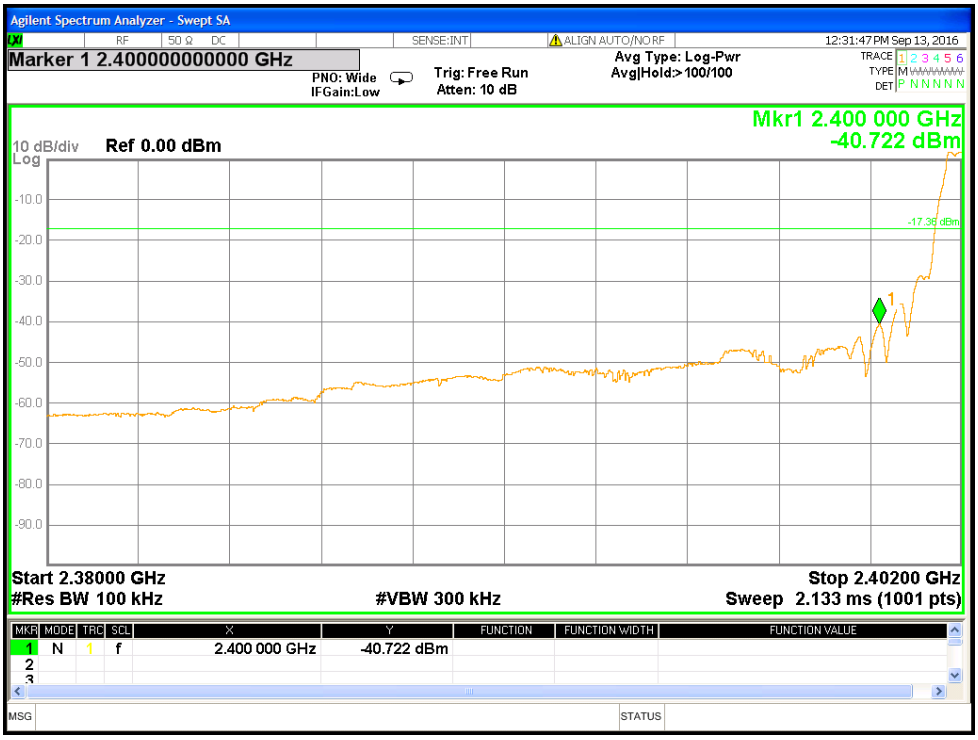



**Figure 10:** Measured Low Bandedge at 2402MHz

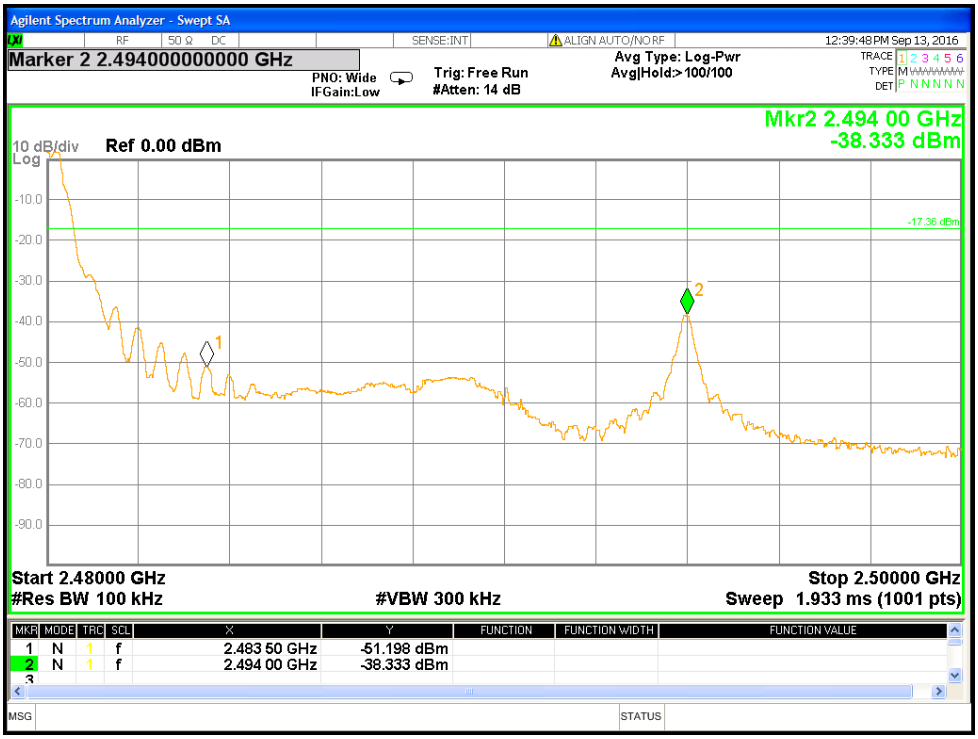



**Figure 11:** Measured High Bandedge at 2480MHz

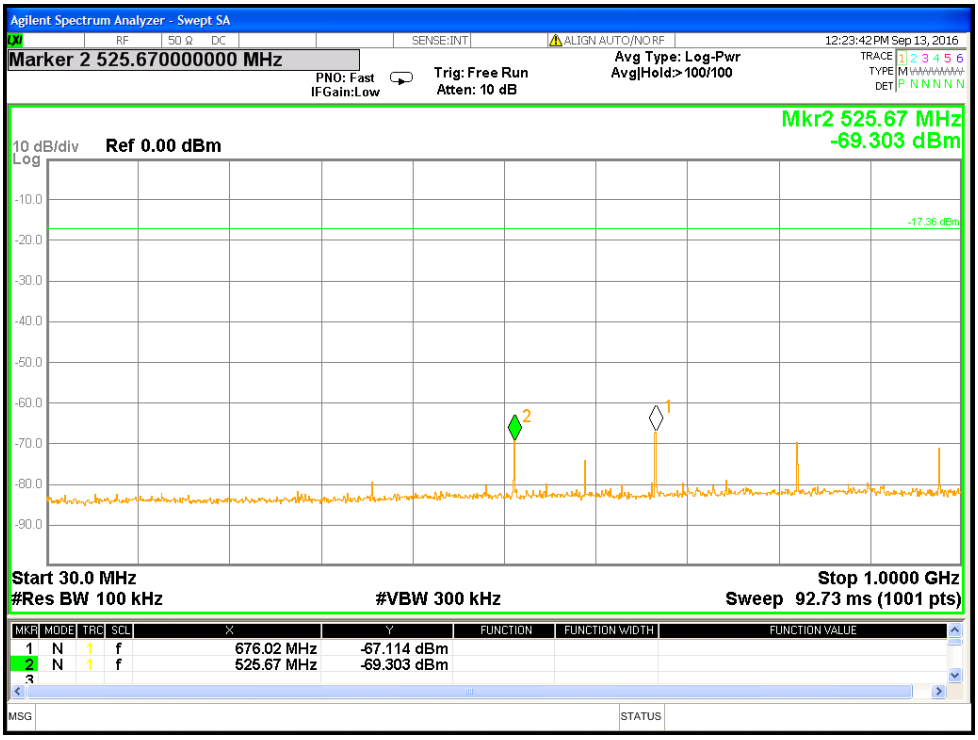



**Figure 12:** Out of Band Emissions at 2402 MHz, 30-1000MHz

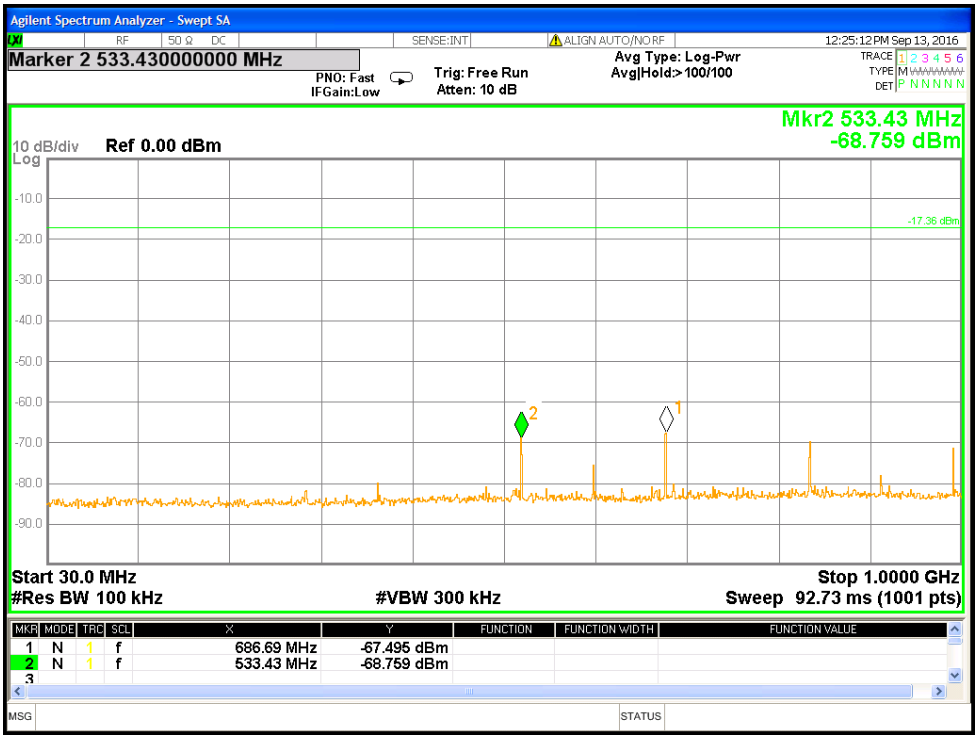



**Figure 13:** Out of Band Emissions at 2440 MHz, 30-1000MHz

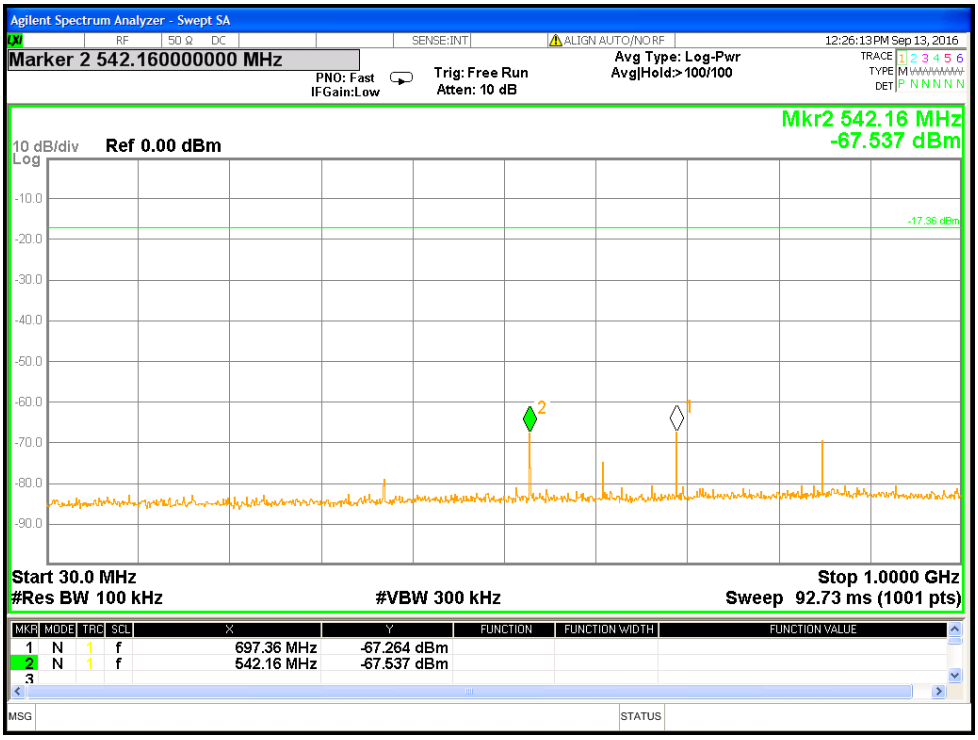



**Figure 14:** Out of Band Emissions at 2480 MHz, 30-1000MHz

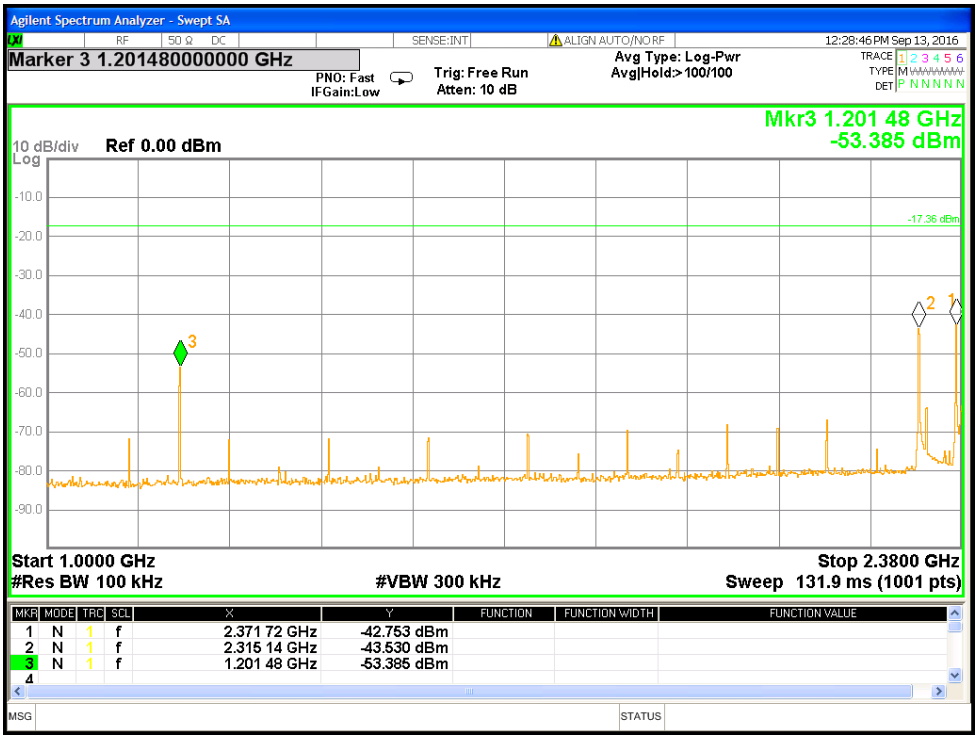



**Figure 15:** Out of Band Emissions at 2402 MHz, 1000-2380MHz

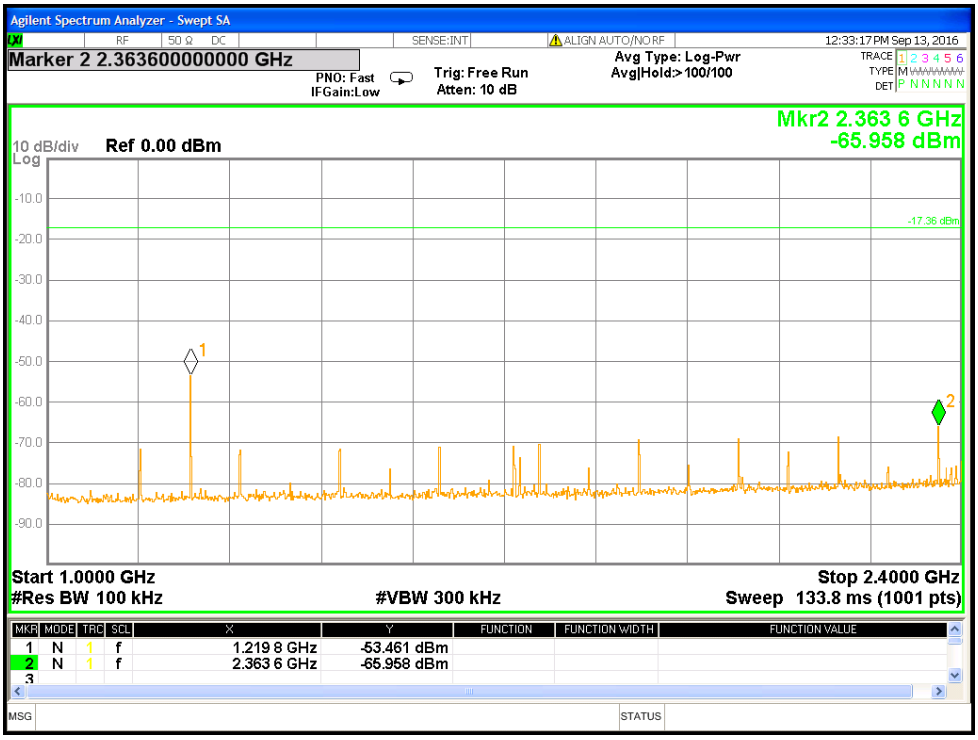



**Figure 16:** Out of Band Emissions at 2440 MHz, 1000-2400MHz

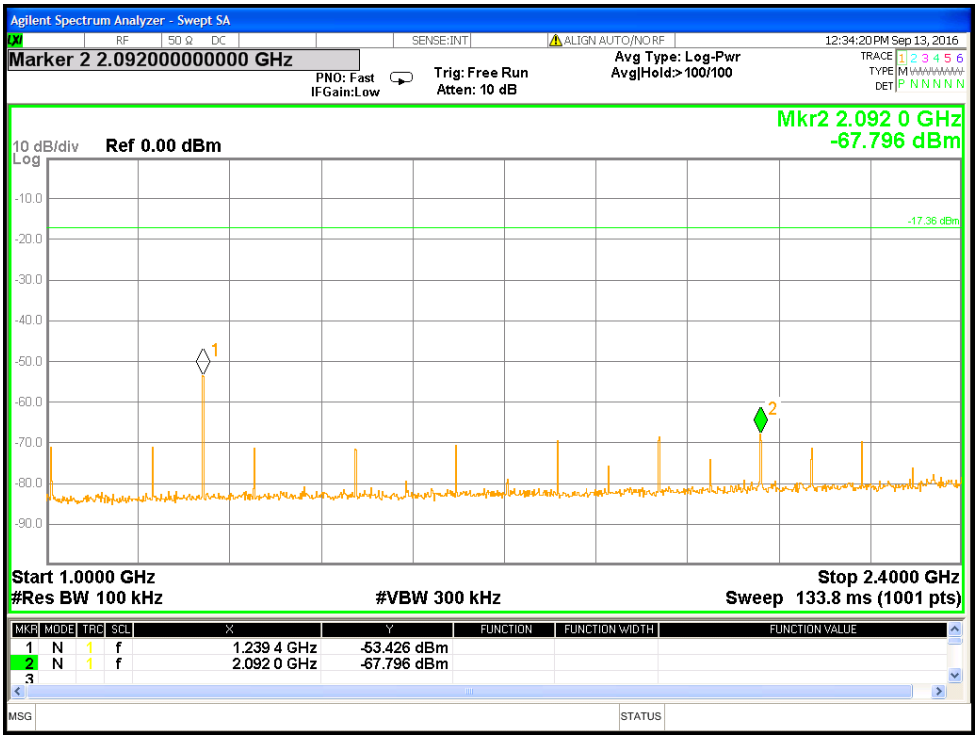



**Figure 17:** Out of Band Emissions at 2480 MHz, 1000-2400MHz

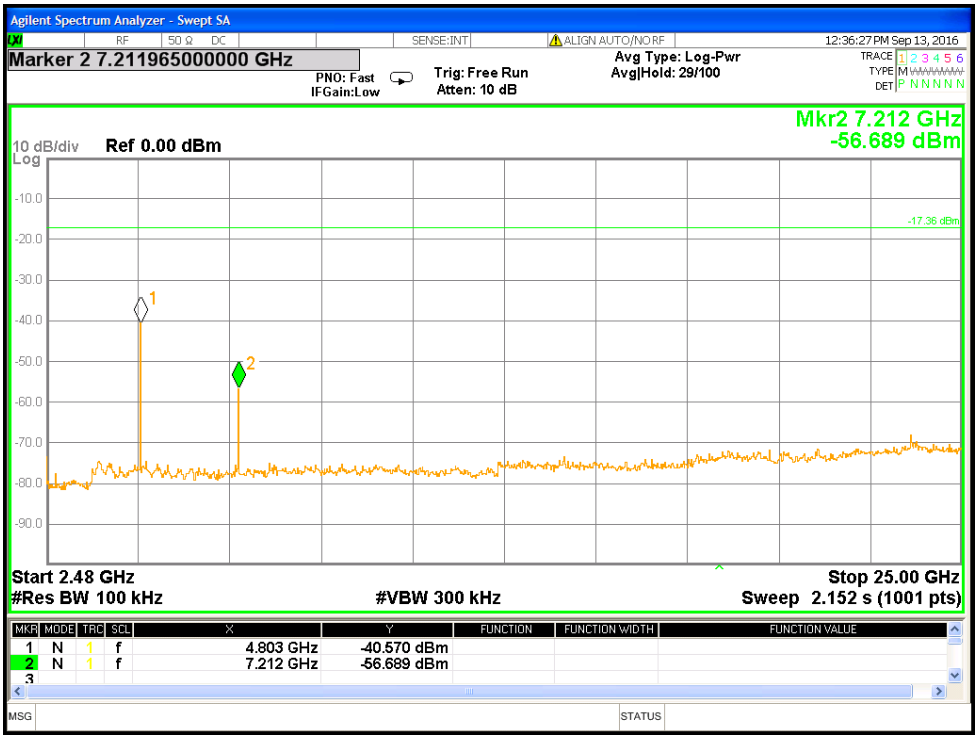



**Figure 18:** Out of Band Emissions at 2402 MHz, 2483.5 - 25000MHz

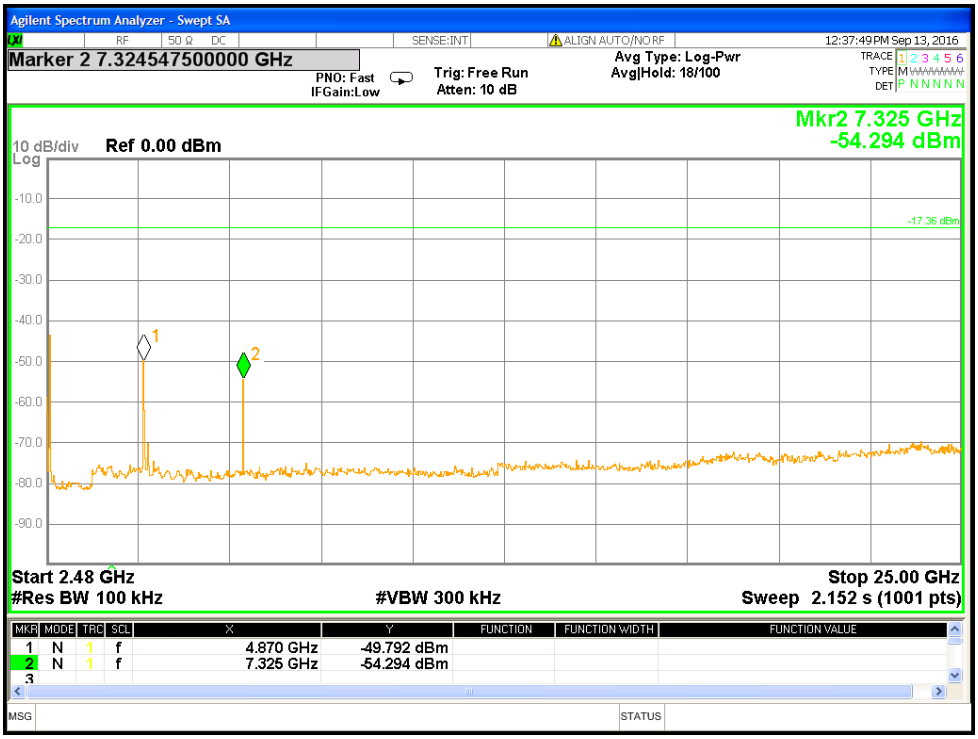



**Figure 19:** Out of Band Emissions at 2440 MHz, 2483.5-25000MHz

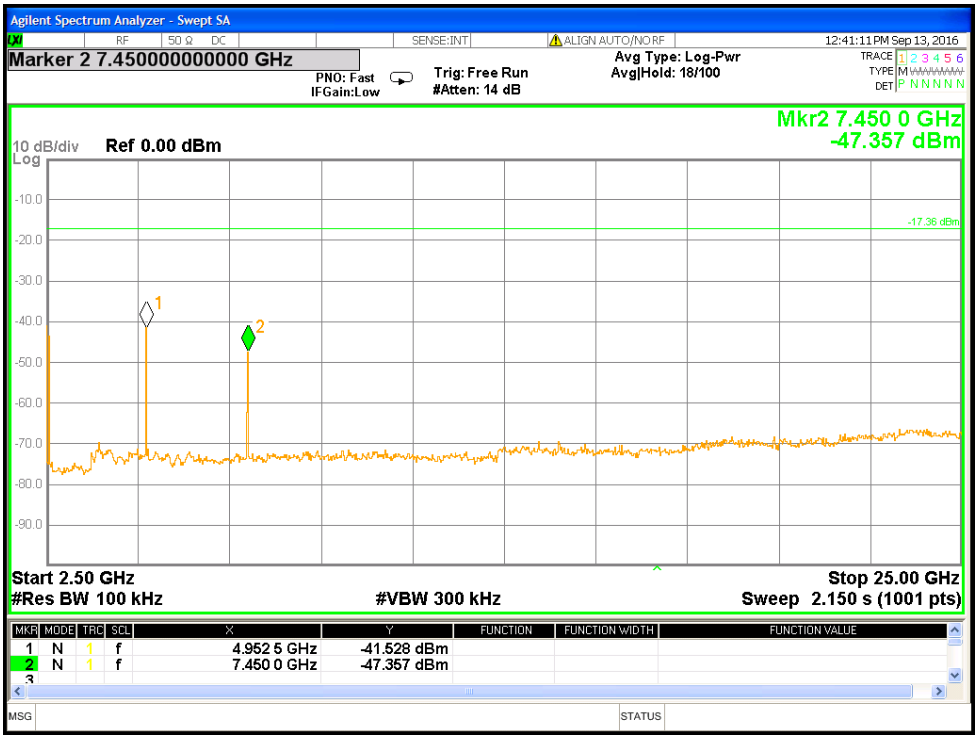



**Figure 20:** Out of Band Emissions at 2480 MHz, 2500-25000MHz

## *4.5 Transmit 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.*

### 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 (<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.

#### *4.5.1.2 Final Test*

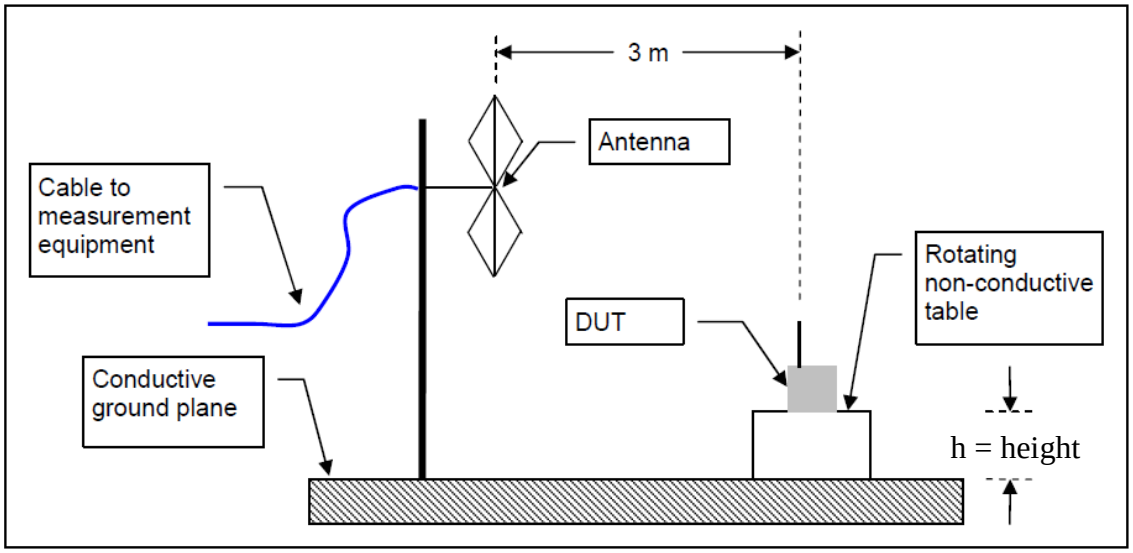
For each frequency measured, the peak emission was maximized by manipulating the receiving antenna from 1 to 4 meters above the ground plane and placing it at the position that produced the maximum signal strength reading. The turntable was then rotated through 360° while observing the peak signal and 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 (<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.

#### *4.5.1.3 Deviations*

None.

**Test Setup:**




Where h = 80cm for <1GHz and 150cm for >1GHz

### 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: 2015 and RSS Gen Sect. 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 |

All harmonics and spurious emission which are outside of the restricted band shall be 20dB 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 Band-Edge Requirements

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Test Conditions:** Radiated Measurement | | | | | | | | | |
| **Antenna Type:** Custom Integrated | | | | **Power Setting:** See test plan | | | | | |
| **Max. Directional Gain:** +6dBi | | | | | | | | | |
| **Signal State:** Modulated at 100%. | | | | | | | | | |
| **Ambient Temp.:** 24° C | | | | **Relative Humidity:**37% | | | | | |
| **Band-Edge Results** | | | | | | | | | |
| Channel | Freq (MHz) | Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Pol. (H/V) | Det. | Table Deg. | Tower (cm) | Note |
| 1 | 2387.36 | 58.03 | 74 | -15.97 | V | Pk | 84 | 139.8 | |
| 1 | 2389.14 | 47.34 | 54 | -6.66 | V | Ave | 84 | 139.8 | |
| 1 | 2386.92 | 58.65 | 74 | -15.35 | H | Pk | 256 | 174.9 | |
| 1 | 2387.73 | 47.36 | 54 | -6.64 | H | Ave | 256 | 174.9 | |
| 39 | 2483.94 | 56.86 | 74 | -17.14 | V | Pk | 101 | 161.6 | |
| 39 | 2483.88 | 48.01 | 54 | -5.99 | V | Ave | 101 | 161.6 | |
| 39 | 2483.68 | 57.49 | 74 | -16.51 | H | Pk | 251 | 169.9 | |
| 39 | 2483.68 | 48.06 | 54 | -5.94 | H | Ave | 251 | 169.9 | |
| **Note:** 1. The emissions were measured at the adjacent restricted band of the fundamental signal.<br>2. All the band-edge measurements met the restricted band requirements of CFR47 15.205. | | | | | | | | | |

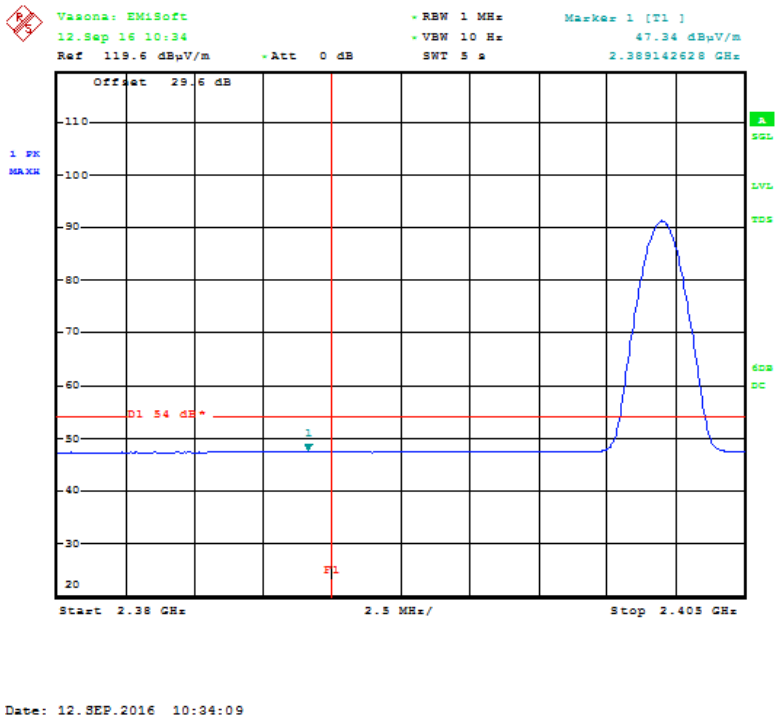



**Figure 21**: Radiated Emission at 2390 MHz Edge – 2380-2405MHz – Vert. (Ave)

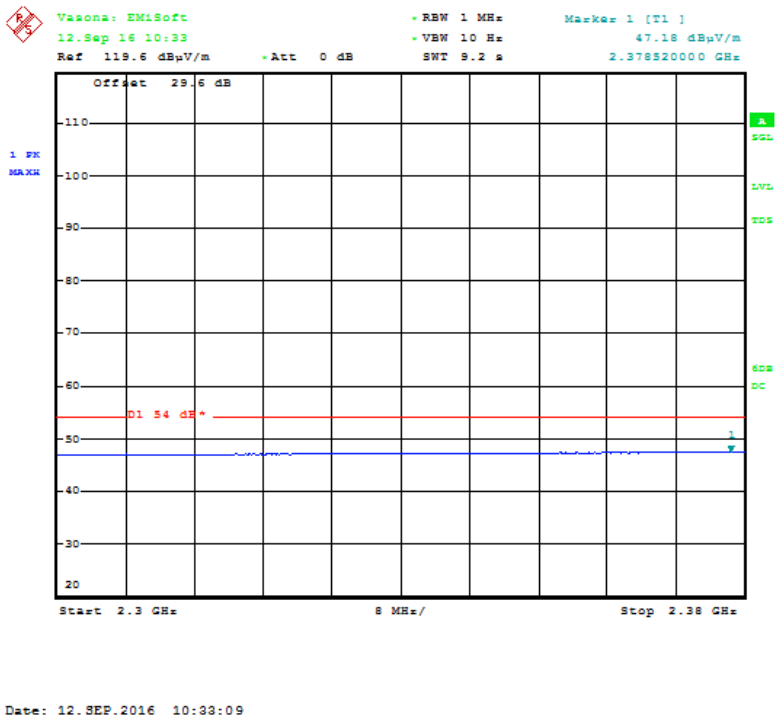



**Figure 22**: Radiated Emission at 2390 MHz Edge – 2300-2380MHz– Vert. (Ave)

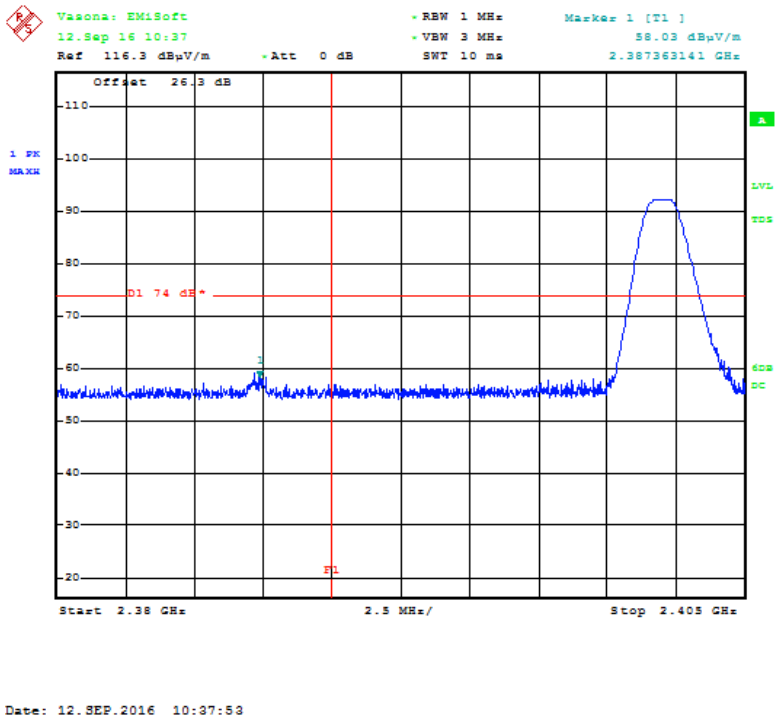



**Figure 23**: Radiated Emission at 2390 MHz Edge – 2380-2405MHz – Vert. (Peak)

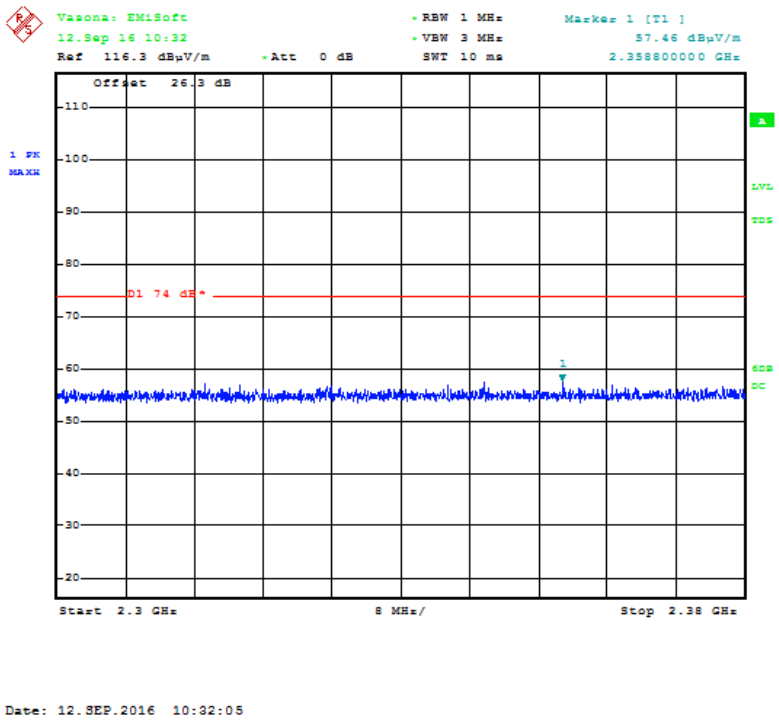



**Figure 24**: Radiated Emission at 2390 MHz Edge – 2300-2380MHz – Vert. (Peak)

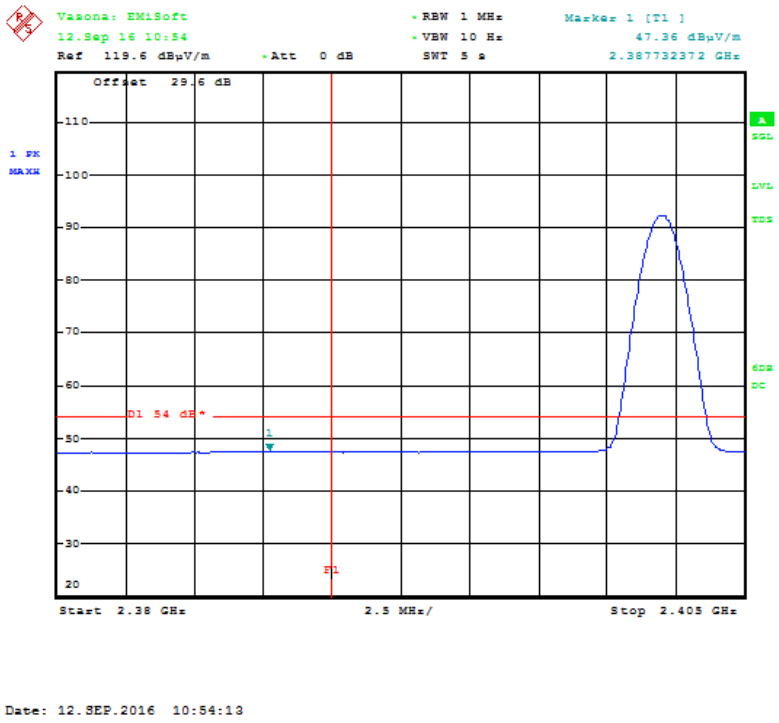



**Figure 25**: Radiated Emission at 2390 MHz Edge – 2380-2405MHz – Horz. (Ave)

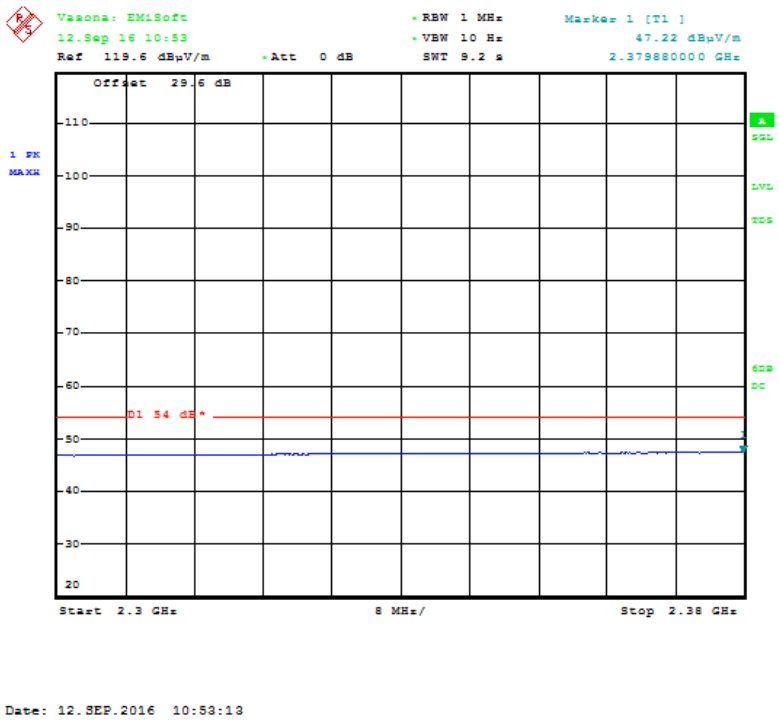



**Figure 26**: Radiated Emission at 2390 MHz Edge – 2300-2380MHz – Horz. (Ave)

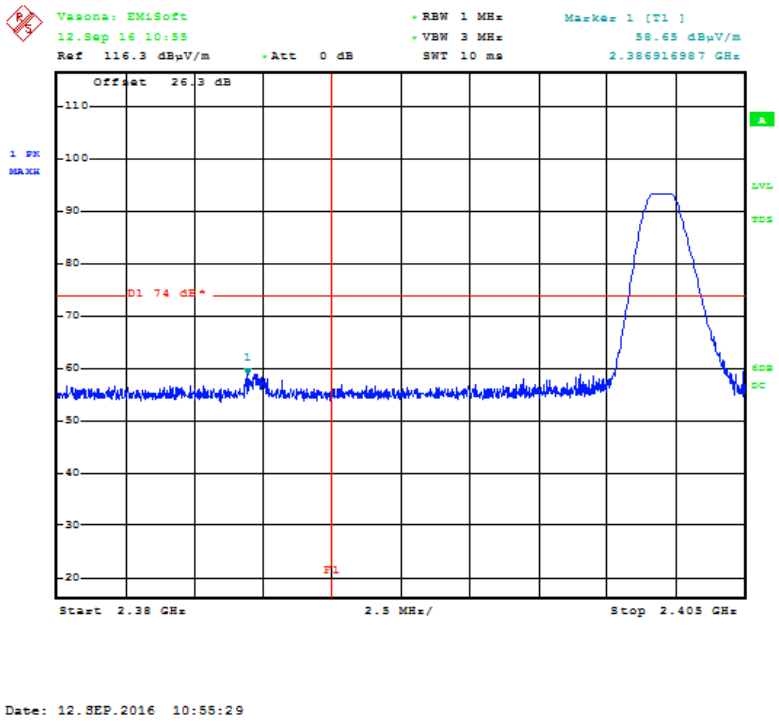



**Figure 27**: Radiated Emission at 2390 MHz Edge – 2380-2405MHz – Horz. (Peak)

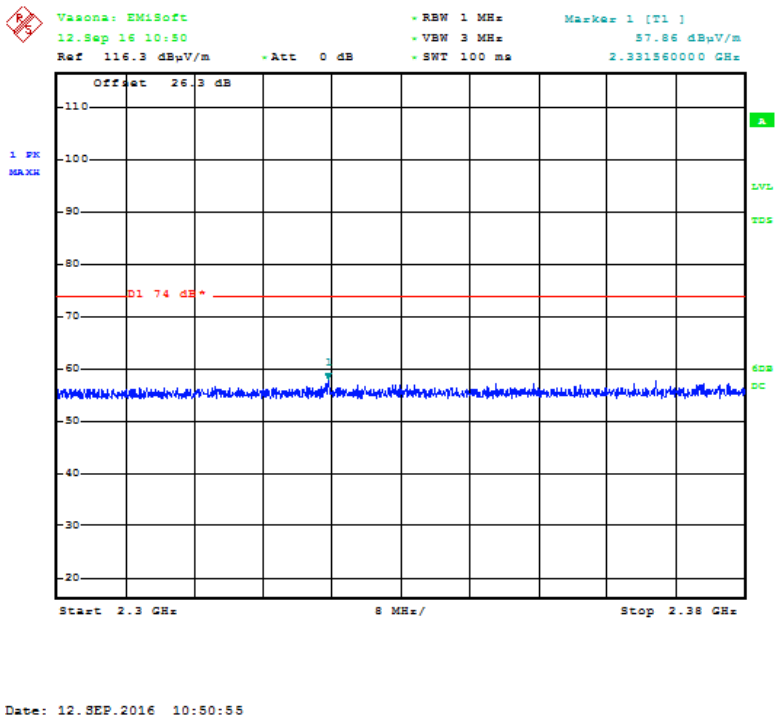



**Figure 28**: Radiated Emission at 2390 MHz Edge – 2300-2380MHz – Horz. (Peak)

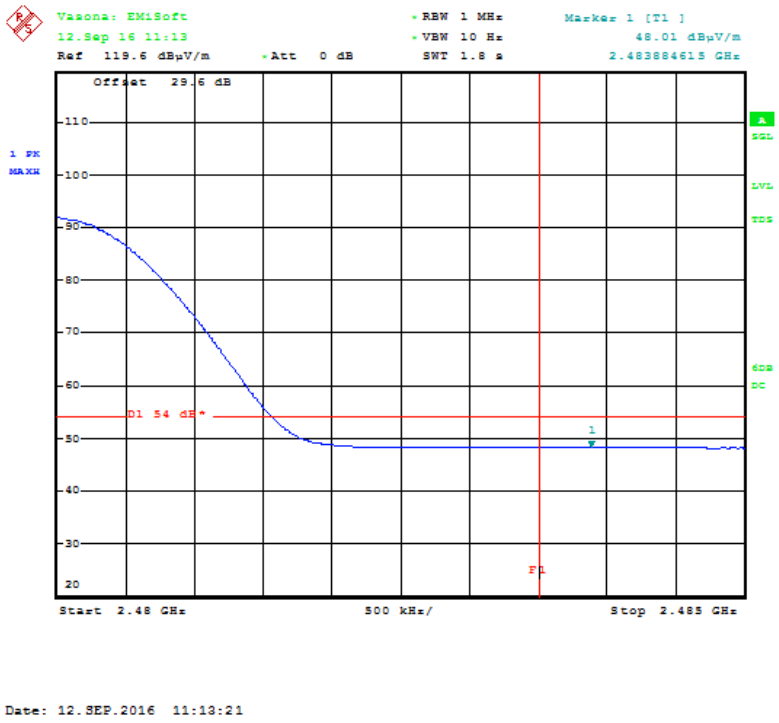



**Figure 29**: Radiated Emission at 2483.5 MHz Edge – 2480-2485MHz – Vert. (Ave)

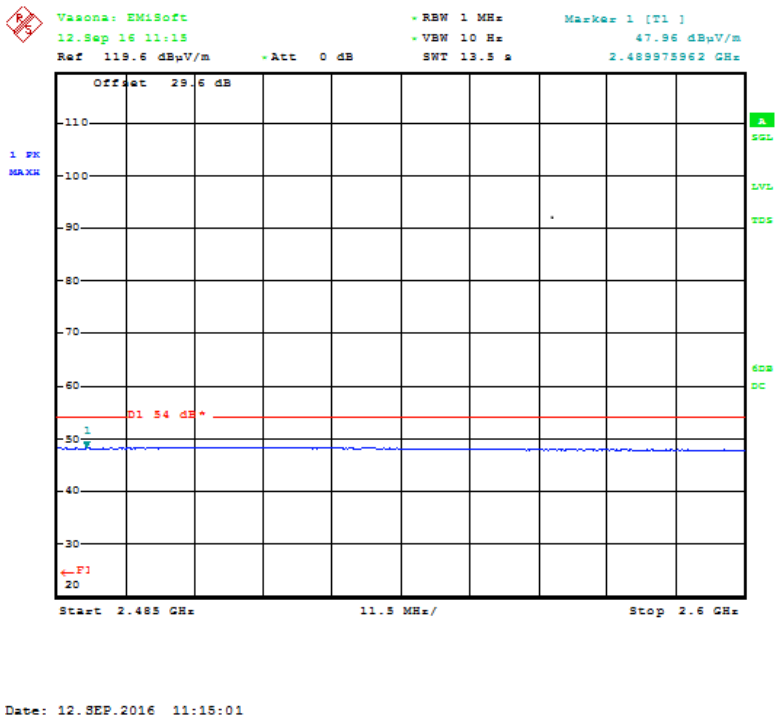



**Figure 30**: Radiated Emission at 2483.5 MHz Edge – 2485-2600MHz – Vert. (Ave)

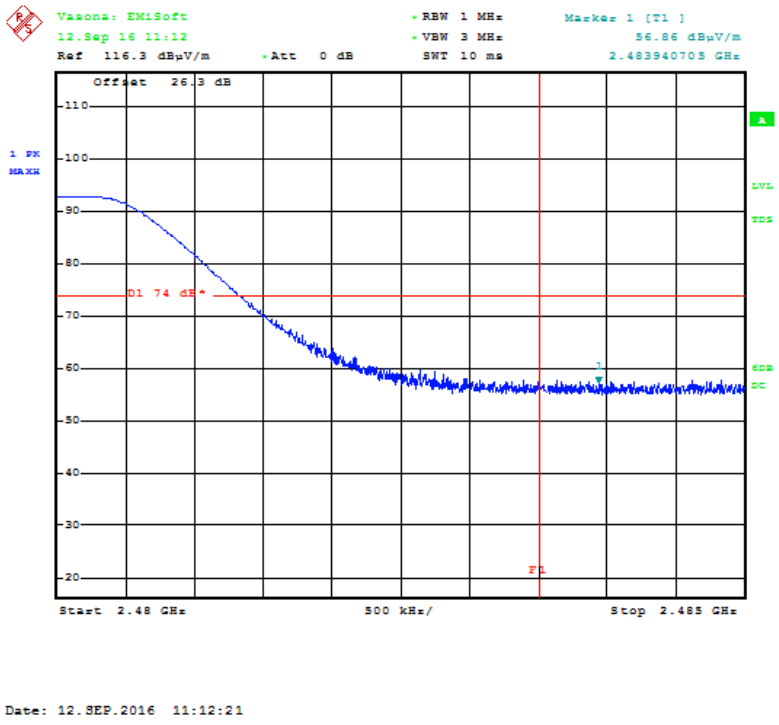



**Figure 31**: Radiated Emission at 2483.5 MHz Edge – 2480-2485MHz – Vert. (Peak)

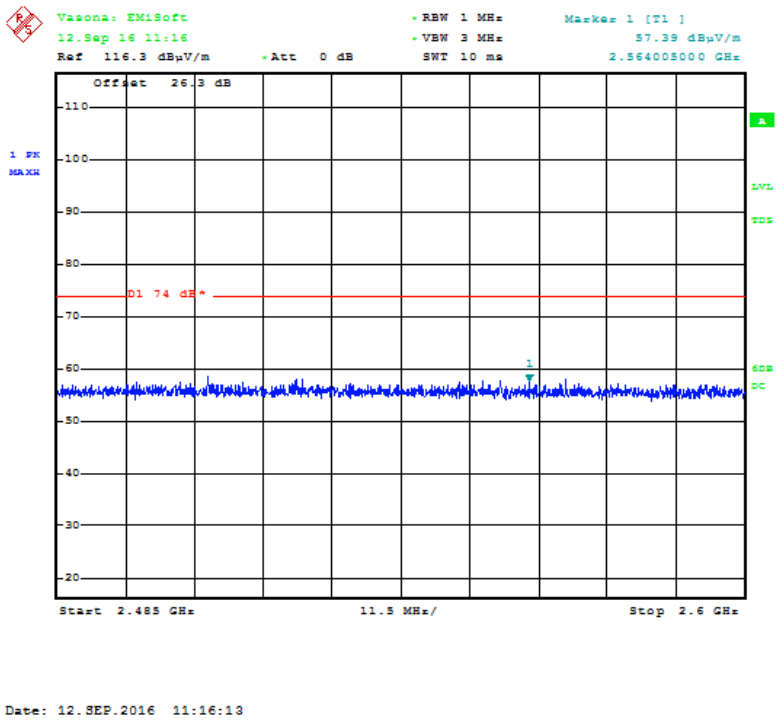



**Figure 32**: Radiated Emission at 2483.5 MHz Edge – 2485-2600MHz – Vert. (Peak)

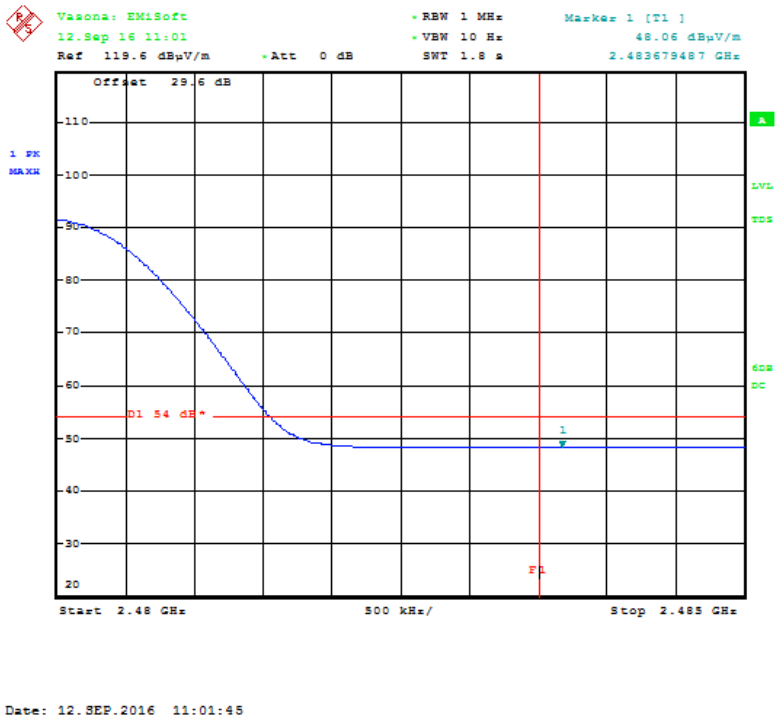



**Figure 33**: Radiated Emission at 2483.5 MHz Edge – 2480-2485MHz – Horz. (Ave)

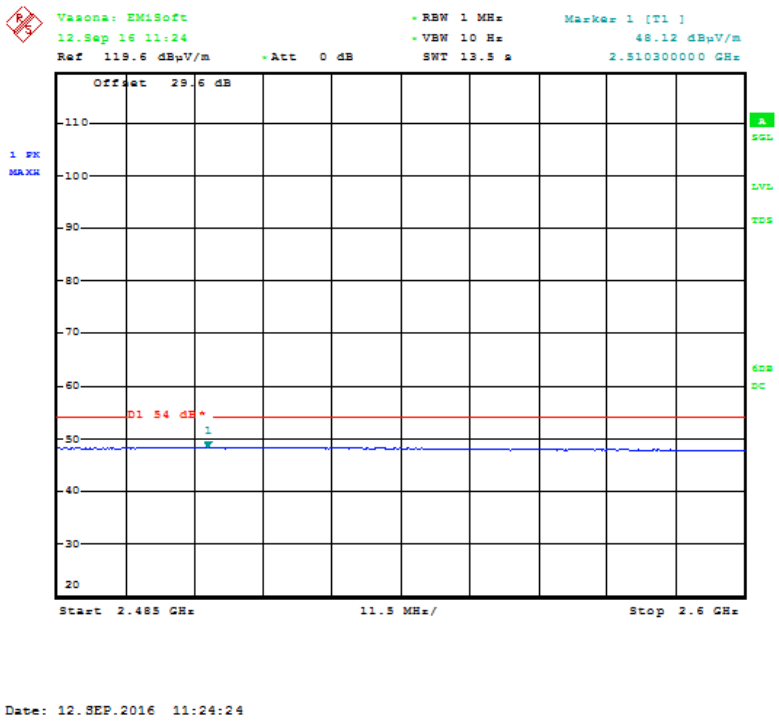



**Figure 34**: Radiated Emission at 2483.5 MHz Edge – 2485-2600MHz – Horz. (Ave)

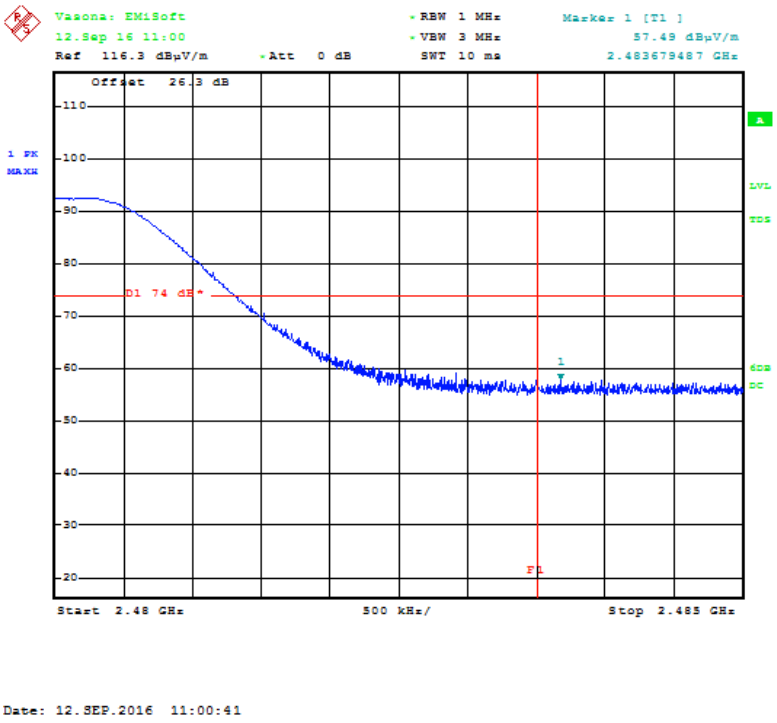



**Figure 35**: Radiated Emission at 2483.5 MHz Edge – 2480-2485MHz – Horz. (Peak)

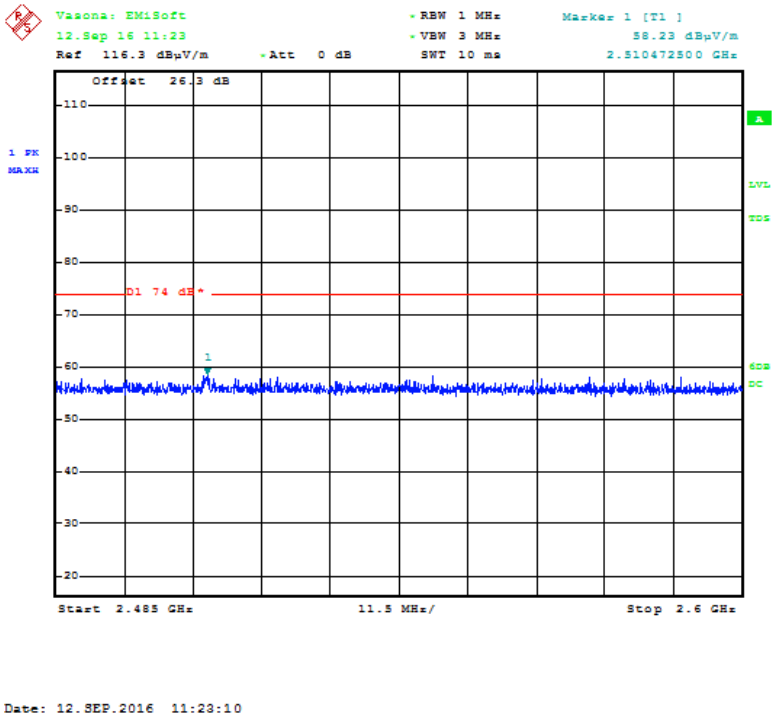


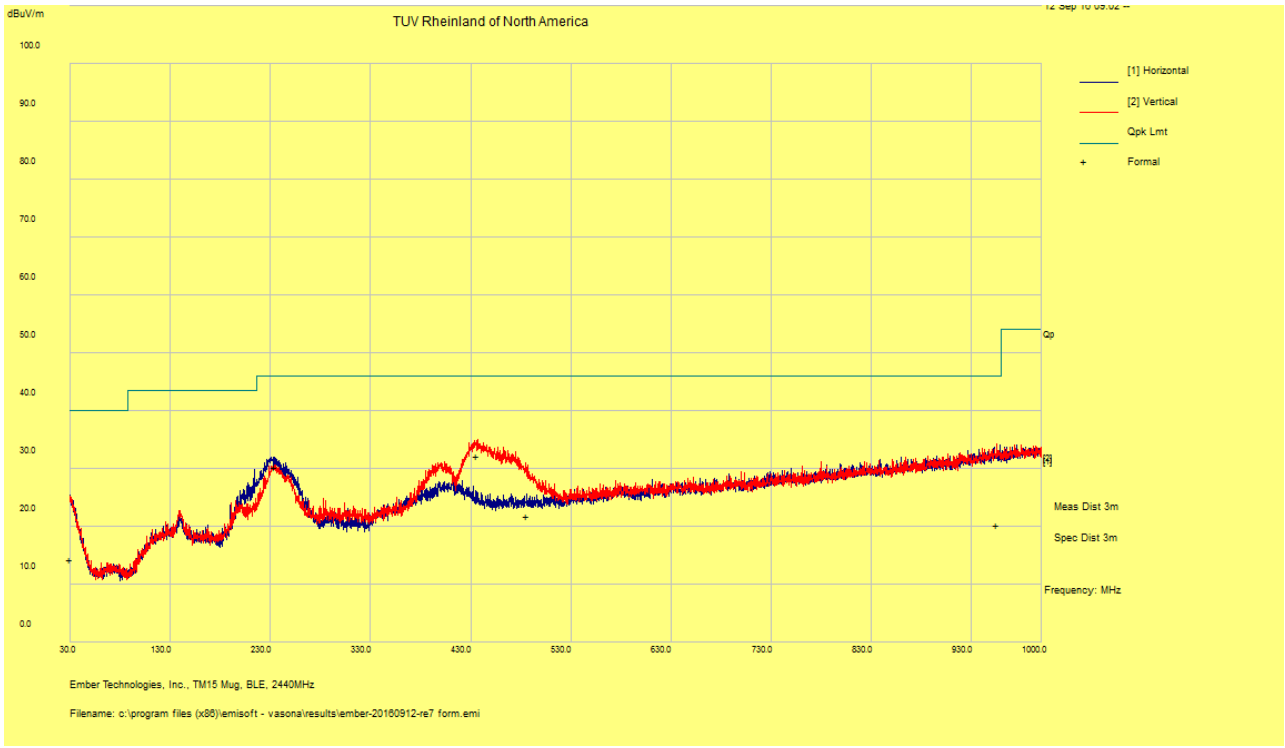

**Figure 36**: Radiated Emission at 2483.5 MHz Edge – 2485-2600MHz – Horz. (Peak)

**SOP 1** Radiated Emissions — Tracking # 31662400.002 Page 1 of 10

| | | | |
|---|---|---|---|
| **EUT Name** | Ember Mug | **Date** | Sept 12, 2016 |
| **EUT Model** | TM15 | **Temp / Hum in** | 24° C / 34%rh |
| **EUT Serial** | 6290083 | **Temp / Hum out** | N/A |
| **EUT Config.** | 2440MHz - BLE | **Line AC / Freq** | 120 Vac / 60 Hz |
| **Standard** | CFR47 Part 15 Subpart C, RSS-247, RSS-GEN | **RBW / VBW** | 120 kHz/ 300 kHz |
| **Dist/Ant Used** | 3m / JB3 | **Performed by** | Eddie Mariscal |

30 MHz – 1 GHz Transmit at 2440 MHz

| Frequency | Raw | Cable Loss | AF | Level | Detector | Polarity | Height | Azimuth | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV/m | dB | dB | dBuV/m | | H/V | cm | deg | dBuV/m | dB |
| 436.475 | 40.45 | 3.04 | -11.16 | 32.33 | QP | V | 111 | 312 | 46 | -13.67 |
| 955.7355 | 19.29 | 4.1 | -3.07 | 20.32 | QP | V | 163 | 64 | 46 | -25.68 |
| 30.14075 | 20.26 | 1.56 | -7.36 | 14.47 | QP | H | 157 | 268 | 40 | -25.53 |
| 234.482 | 43.89 | 2.48 | -16.06 | 30.31 | QP | H | 123 | 254 | 46 | -15.69 |
| 486.6385 | 28.78 | 3.16 | -10.05 | 21.89 | QP | V | 184 | 314 | 46 | -24.11 |




Spec Margin = E-Field QP - Limit, E-Field QP = FIM QP+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

Note: 1. Center channel was determined to be the worst-case.

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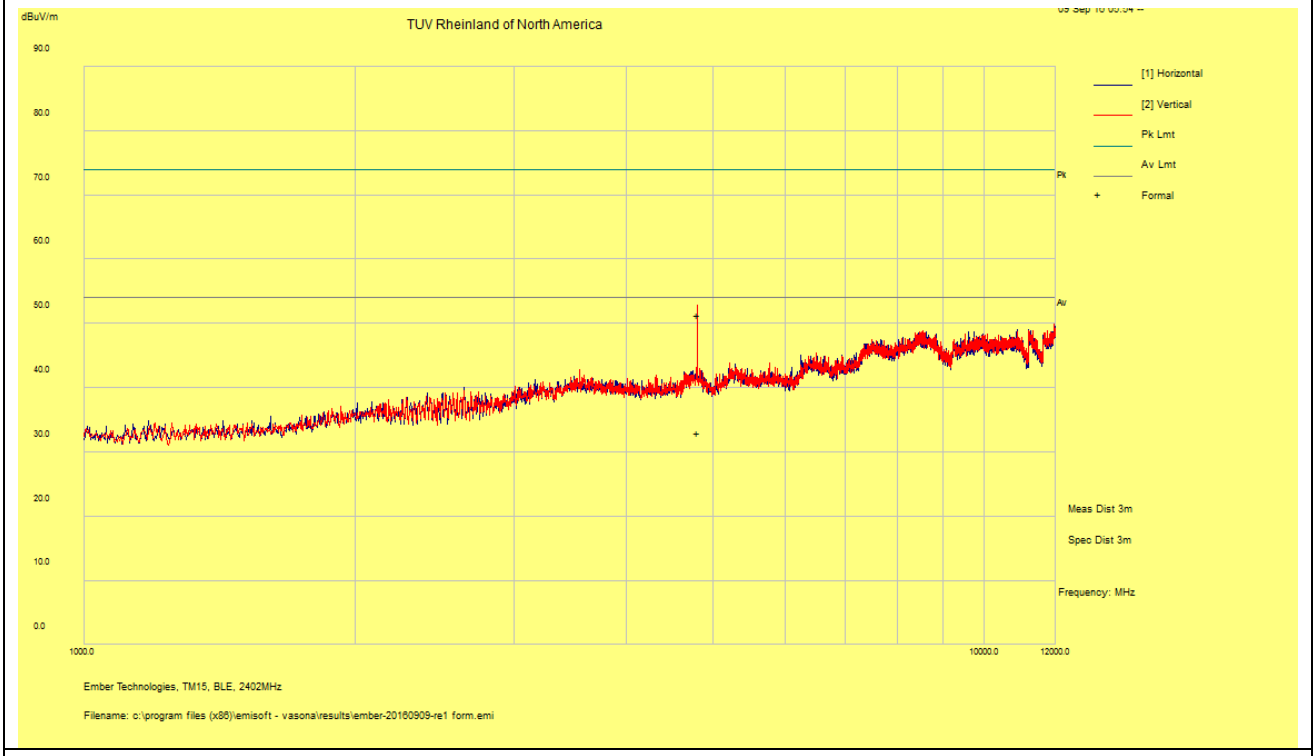
| | | | |
|---|---|---|---|
| **EUT Name** | Ember Mug | **Date** | Sept 9, 2016 |
| **EUT Model** | TM15 | **Temp / Hum in** | 21° C / 37%rh |
| **EUT Serial** | 6290083 | **Temp / Hum out** | N/A |
| **EUT Config.** | 2402MHz - BLE | **Line AC / Freq** | 120 Vac / 60 Hz |
| **Standard** | CFR47 Part 15 Subpart C, RSS-247, RSS-GEN | **RBW / VBW** | 1 MHz/ 3 MHz |
| **Dist/Ant Used** | 3m – EMCO3115 | **Performed by** | Eddie Mariscal |

1 – 12 GHz Transmit at 2402 MHz (Low Channel)

| Frequency | Raw | Cable Loss | AF | Level | Detector | Polarity | Height | Azimuth | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV/m | dB | dB | dBuV/m | | H/V | cm | deg | dBuV/m | dB |
| 4803.831 | 53.47 | 2.5 | -4.64 | 51.33 | Peak | V | 143 | 58 | 74 | -22.67 |
| 4803.831 | 35.15 | 2.5 | -4.64 | 33.01 | Ave | V | 143 | 58 | 54 | -17.63 |




Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

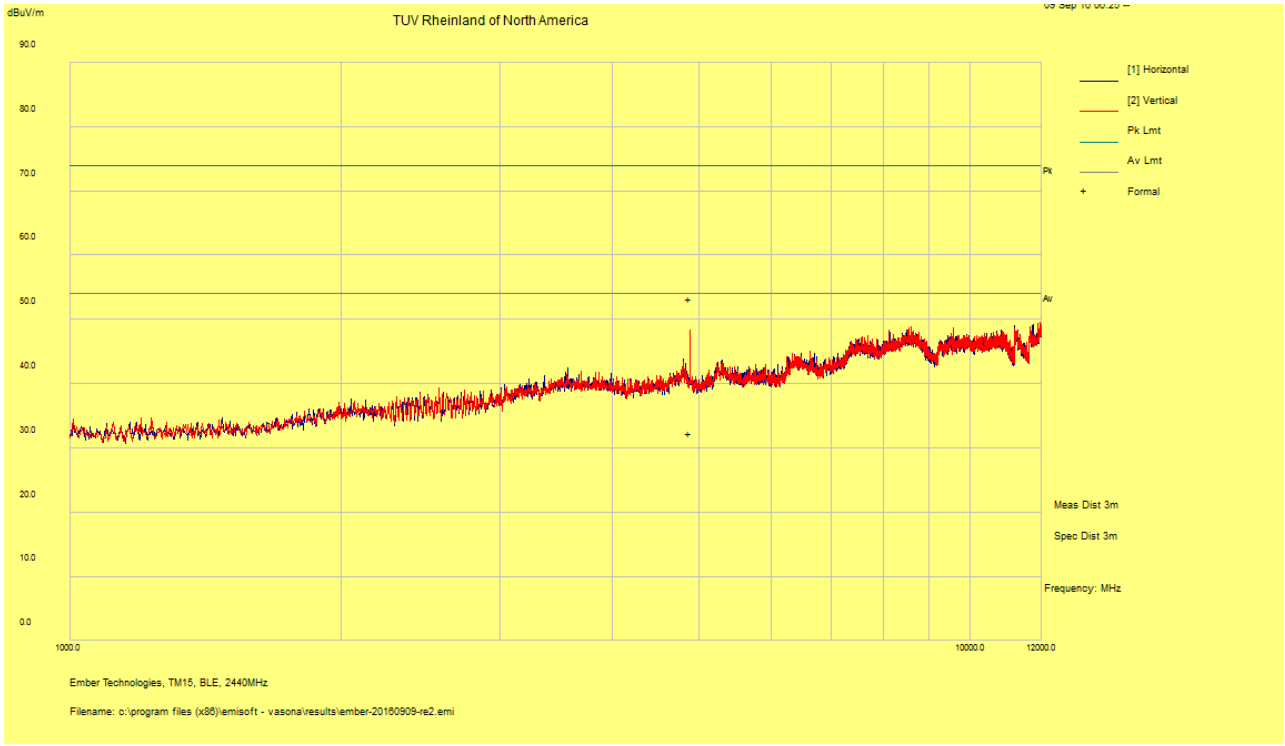
Note:

**SOP 1** Radiated Emissions — Tracking # 31662400.002 Page 3 of 10

| | | | |
|---|---|---|---|
| **EUT Name** | Ember Mug | **Date** | Sept 9, 2016 |
| **EUT Model** | TM15 | **Temp / Hum in** | 21° C / 37%rh |
| **EUT Serial** | 6290083 | **Temp / Hum out** | N/A |
| **EUT Config.** | 2440MHz - BLE | **Line AC / Freq** | 120 Vac / 60 Hz |
| **Standard** | CFR47 Part 15 Subpart C, RSS-247, RSS-GEN | **RBW / VBW** | 1 MHz/ 3 MHz |
| **Dist/Ant Used** | 3m – EMCO3115 | **Performed by** | Eddie Mariscal |

1 – 12 GHz Transmit at 2440 MHz (Mid Channel)

| Frequency | Raw | Cable Loss | AF | Level | Detector | Polarity | Height | Azimuth | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV/m | dB | dB | dBuV/m | | H/V | cm | deg | dBuV/m | dB |
| 4880.218 | 55.36 | 2.52 | -4.65 | 53.23 | Peak | V | 122 | 328 | 74 | -20.77 |
| 4880.218 | 34.5 | 2.52 | -4.65 | 32.37 | Ave | V | 122 | 328 | 54 | -18.27 |




Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

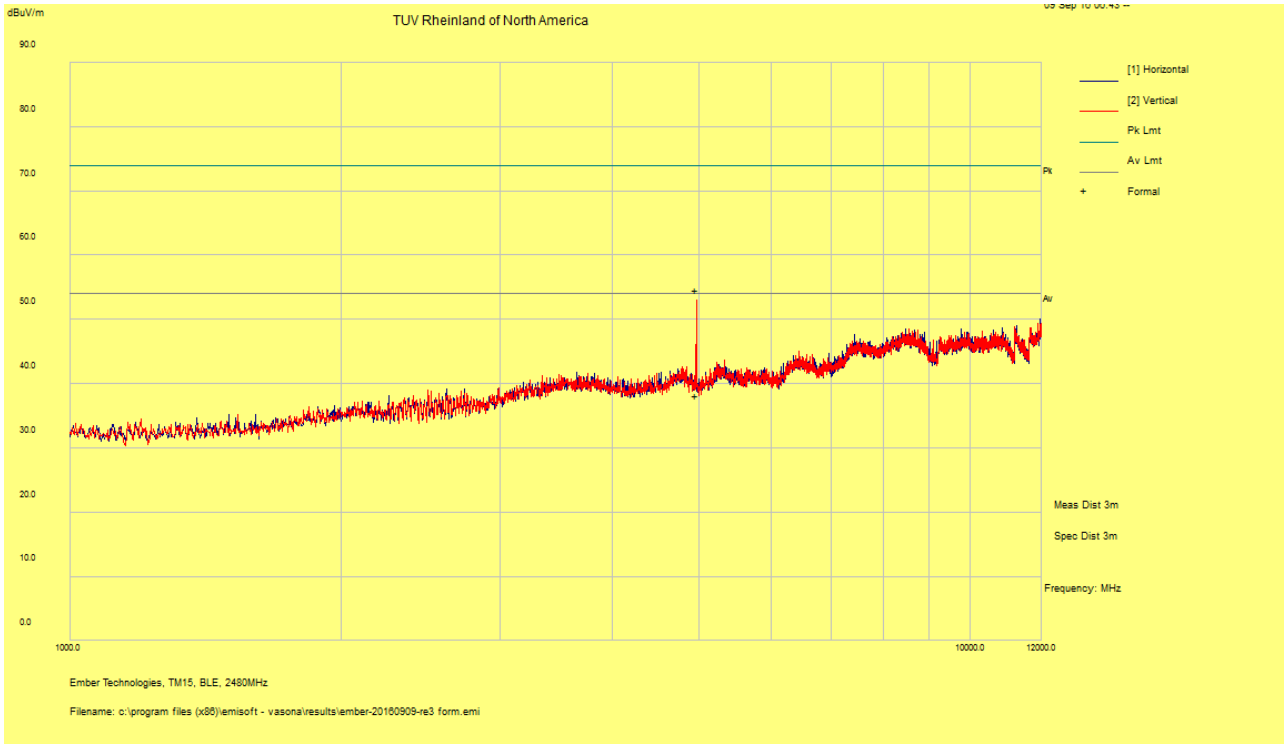
Note:

**SOP 1** Radiated Emissions — Tracking # 31662400.002 Page 4 of 10

| | | | |
|---|---|---|---|
| **EUT Name** | Ember Mug | **Date** | Sept 9, 2016 |
| **EUT Model** | TM15 | **Temp / Hum in** | 21° C / 37%rh |
| **EUT Serial** | 6290083 | **Temp / Hum out** | N/A |
| **EUT Config.** | 2480MHz - BLE | **Line AC / Freq** | 120 Vac / 60 Hz |
| **Standard** | CFR47 Part 15 Subpart C, RSS-247, RSS-GEN | **RBW / VBW** | 1 MHz/ 3 MHz |
| **Dist/Ant Used** | 3m – EMCO3115 | **Performed by** | Eddie Mariscal |

1 – 12 GHz Transmit at 2480 MHz (High Channel)

| Frequency | Raw | Cable Loss | AF | Level | Detector | Polarity | Height | Azimuth | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV/m | dB | dB | dBuV/m | | H/V | cm | deg | dBuV/m | dB |
| 4960.688 | 56.81 | 2.55 | -4.66 | 54.7 | Peak | V | 236 | 286 | 74 | -19.3 |
| 4960.688 | 40.23 | 2.55 | -4.66 | 38.11 | Ave | V | 236 | 286 | 54 | -12.53 |




Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

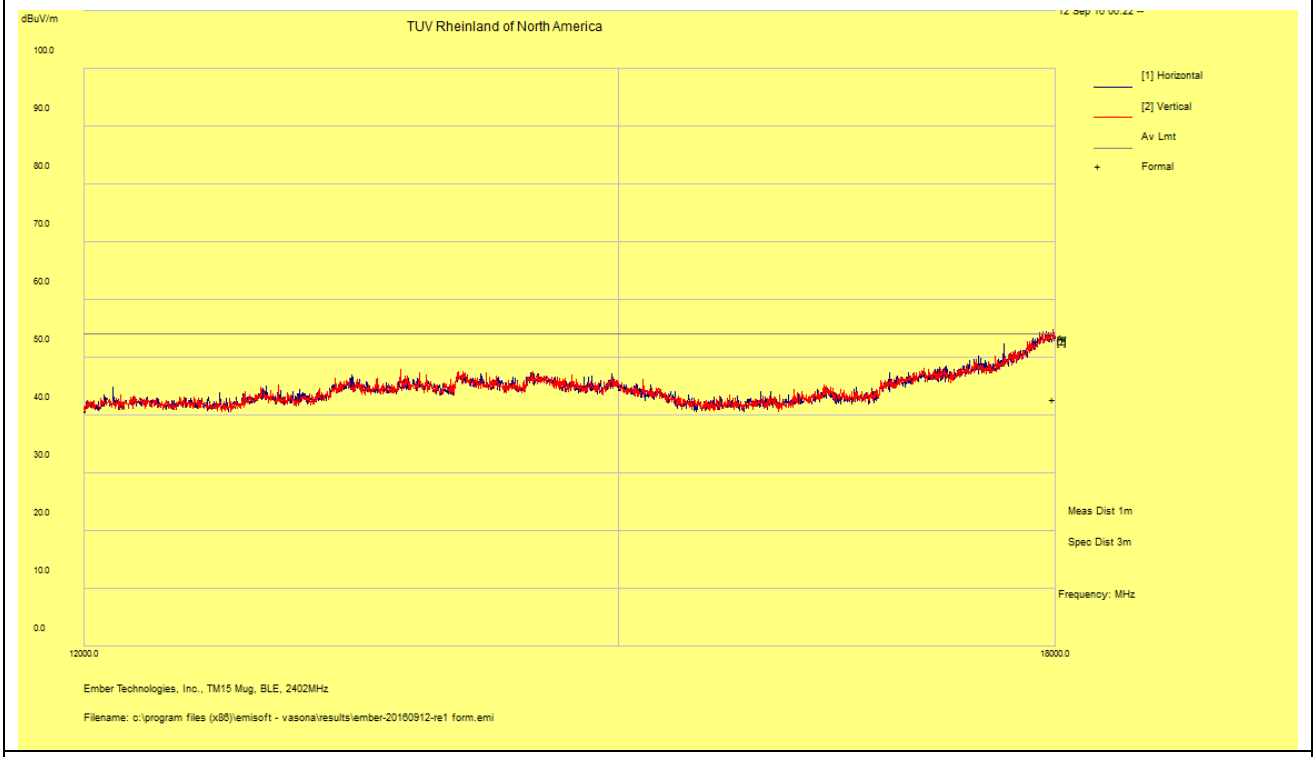
Note:

| **SOP 1** Radiated Emissions | | Tracking # 31662400.002 Page 5 of 10 | |
|---|---|---|---|
| **EUT Name** | Ember Mug | **Date** | Sept 12, 2016 |
| **EUT Model** | TM15 | **Temp / Hum in** | 20° C / 34%rh |
| **EUT Serial** | 6290083 | **Temp / Hum out** | N/A |
| **EUT Config.** | 2402MHz - BLE | **Line AC / Freq** | 120 Vac / 60 Hz |
| **Standard** | CFR47 Part 15 Subpart C, RSS-247, RSS-GEN | **RBW / VBW** | 1 MHz/ 3 MHz |
| **Dist/Ant Used** | 1m – EMCO3115 | **Performed by** | Eddie Mariscal |

12-18GHz Transmit at 2402 MHz (Low Channel)

| Frequency | Raw | Cable Loss | AF | Level | Detector | Polarity | Height | Azimuth | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV/m | dB | dB | dBuV/m | | H/V | cm | deg | dBuV/m | dB |

No EUT emissions were detected above the noise floor from 12-18GHz.




Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

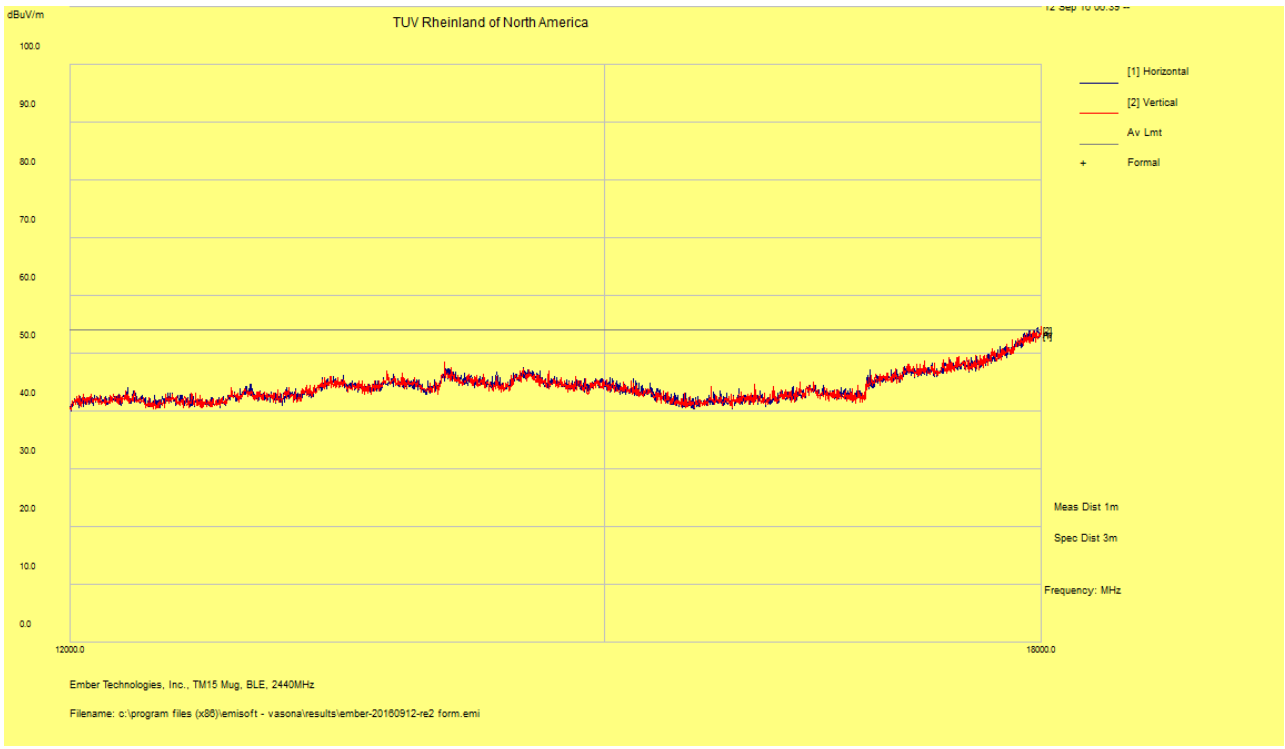
Note:

| **SOP 1** Radiated Emissions | | Tracking # 31662400.002 Page 6 of 10 | |
|---|---|---|---|
| **EUT Name** | Ember Mug | **Date** | Sept 12, 2016 |
| **EUT Model** | TM15 | **Temp / Hum in** | 20° C / 34%rh |
| **EUT Serial** | 6290083 | **Temp / Hum out** | N/A |
| **EUT Config.** | 2440MHz - BLE | **Line AC / Freq** | 120 Vac / 60 Hz |
| **Standard** | CFR47 Part 15 Subpart C, RSS-247, RSS-GEN | **RBW / VBW** | 1 MHz/ 3 MHz |
| **Dist/Ant Used** | 1m – EMCO3115 | **Performed by** | Eddie Mariscal |

12 – 18GHz Transmit at 2440 MHz (Mid Channel)

| Frequency | Raw | Cable Loss | AF | Level | Detector | Polarity | Height | Azimuth | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV/m | dB | dB | dBuV/m | | H/V | cm | deg | dBuV/m | dB |

No EUT emissions were detected above the noise floor from 12-18GHz.




Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

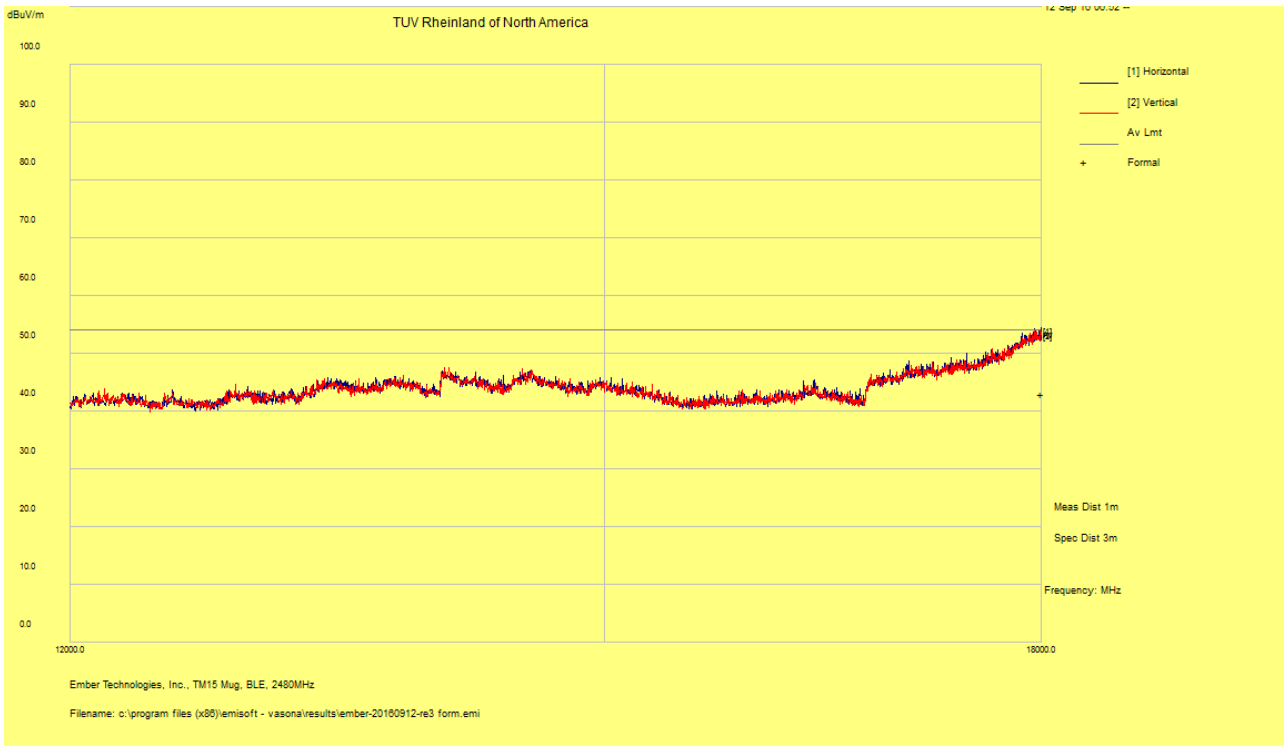
Note:

| **SOP 1** Radiated Emissions | | Tracking # 31662400.002 Page 7 of 10 | |
|---|---|---|---|
| **EUT Name** | Ember Mug | **Date** | Sept 12, 2016 |
| **EUT Model** | TM15 | **Temp / Hum in** | 20° C / 34%rh |
| **EUT Serial** | 6290083 | **Temp / Hum out** | N/A |
| **EUT Config.** | 2480MHz - BLE | **Line AC / Freq** | 120 Vac / 60 Hz |
| **Standard** | CFR47 Part 15 Subpart C, RSS-247, RSS-GEN | **RBW / VBW** | 1 MHz/ 3 MHz |
| **Dist/Ant Used** | 1m – EMCO3115 | **Performed by** | Eddie Mariscal |

12 – 18GHz Transmit at 2480 MHz (High Channel)

| Frequency | Raw | Cable Loss | AF | Level | Detector | Polarity | Height | Azimuth | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV/m | dB | dB | dBuV/m | | H/V | cm | deg | dBuV/m | dB |

No EUT emissions were detected above the noise floor from 12-18GHz.




Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

Note:

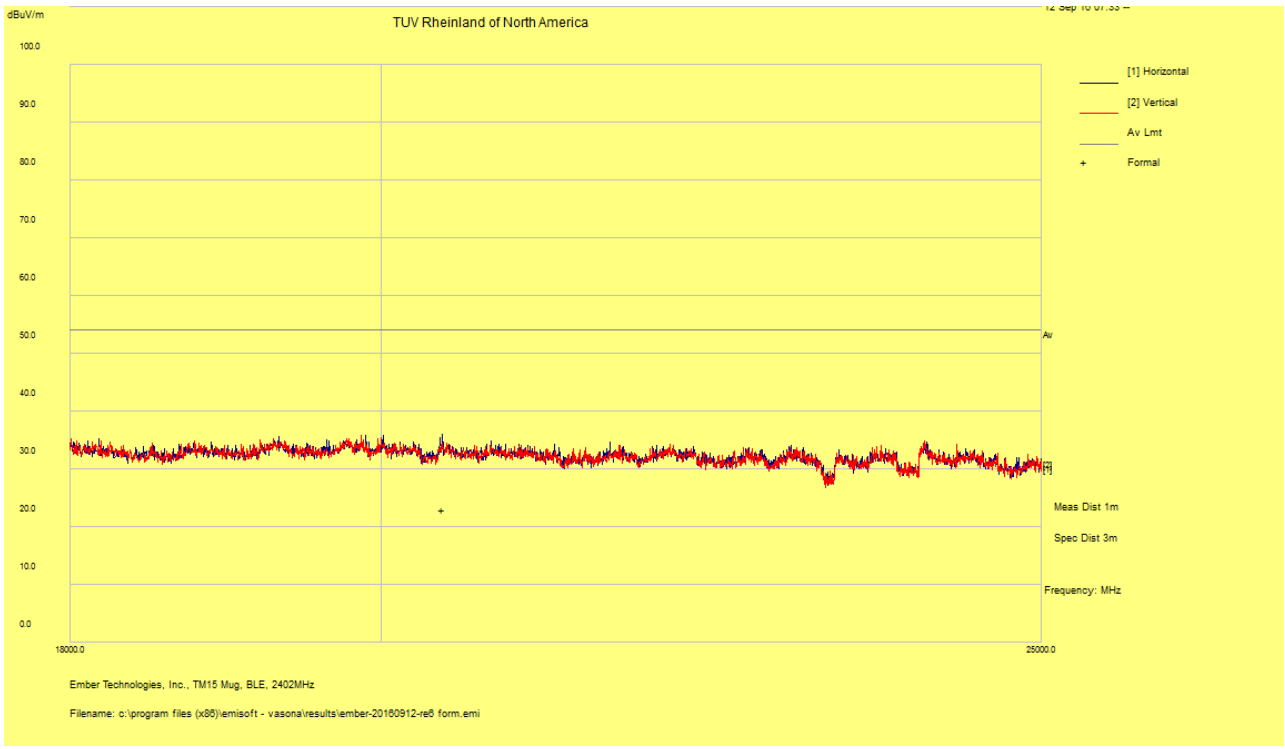
**SOP 1** Radiated Emissions — Tracking # 31662400.002 Page 8 of 10

| | | | |
|---|---|---|---|
| **EUT Name** | Ember Mug | **Date** | Sept 12, 2016 |
| **EUT Model** | TM15 | **Temp / Hum in** | 20° C / 34%rh |
| **EUT Serial** | 6290083 | **Temp / Hum out** | N/A |
| **EUT Config.** | 2402MHz - BLE | **Line AC / Freq** | 120 Vac / 60 Hz |
| **Standard** | CFR47 Part 15 Subpart C, RSS-247, RSS-GEN | **RBW / VBW** | 1 MHz/ 3 MHz |
| **Dist/Ant Used** | 1m – AHA-840 | **Performed by** | Eddie Mariscal |

18 – 25 GHz Transmit at 2402 MHz (Low Channel)

| Frequency | Raw | Cable Loss | AF | Level | Detector | Polarity | Height | Azimuth | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV/m | dB | dB | dBuV/m | | H/V | cm | deg | dBuV/m | dB |

No EUT emissions were detected above the noise floor from 18-25GHz.




Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

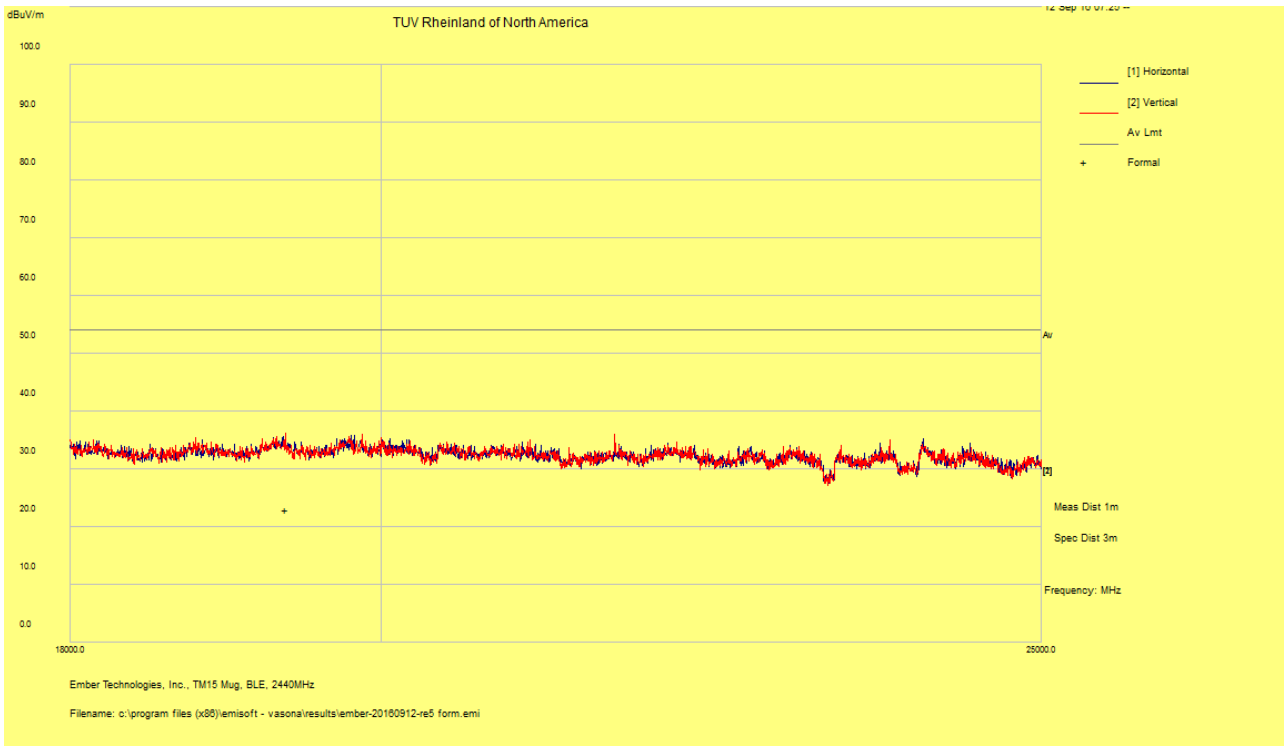
Note:

| **SOP 1** Radiated Emissions | | Tracking # 31662400.002 Page 9 of 10 | |
|---|---|---|---|
| **EUT Name** | Ember Mug | **Date** | Sept 12, 2016 |
| **EUT Model** | TM15 | **Temp / Hum in** | 20° C / 34%rh |
| **EUT Serial** | 6290083 | **Temp / Hum out** | N/A |
| **EUT Config.** | 2440MHz - BLE | **Line AC / Freq** | 120 Vac / 60 Hz |
| **Standard** | CFR47 Part 15 Subpart C, RSS-247, RSS-GEN | **RBW / VBW** | 1 MHz/ 3 MHz |
| **Dist/Ant Used** | 1m – AHA-840 | **Performed by** | Eddie Mariscal |

18 – 25 GHz Transmit at 2437 MHz (Mid Channel)

| Frequency | Raw | Cable Loss | AF | Level | Detector | Polarity | Height | Azimuth | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV/m | dB | dB | dBuV/m | | H/V | cm | deg | dBuV/m | dB |

No EUT emissions were detected above the noise floor from 18-25GHz.




Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

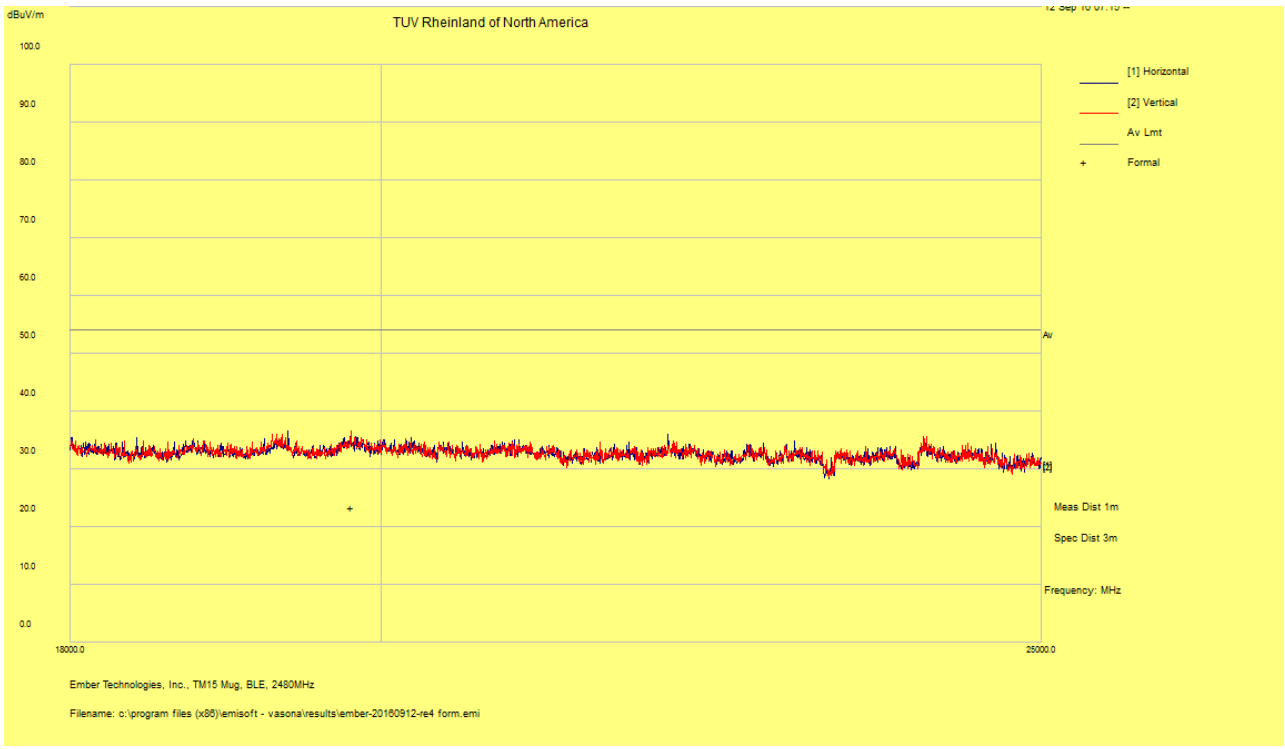
Note:

| **SOP 1** Radiated Emissions | | Tracking # 31662400.002 Page 10 of 10 | |
|---|---|---|---|
| **EUT Name** | Ember Mug | **Date** | Sept 12, 2016 |
| **EUT Model** | TM15 | **Temp / Hum in** | 20° C / 34%rh |
| **EUT Serial** | 6290083 | **Temp / Hum out** | N/A |
| **EUT Config.** | 2480MHz - BLE | **Line AC / Freq** | 120 Vac / 60 Hz |
| **Standard** | CFR47 Part 15 Subpart C, RSS-247, RSS-GEN | **RBW / VBW** | 1 MHz/ 3 MHz |
| **Dist/Ant Used** | 1m – AHA-840 | **Performed by** | Eddie Mariscal |

18 – 25 GHz Transmit at 2480 MHz (High Channel)

| Frequency | Raw | Cable Loss | AF | Level | Detector | Polarity | Height | Azimuth | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV/m | dB | dB | dBuV/m | | H/V | cm | deg | dBuV/m | dB |

No EUT emissions were detected above the noise floor from 18-25GHz.




Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

Note: No significant emissions were observed above the spectrum noise floor.

## 4.6 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: 2015 and RSS Gen: 2015 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.

#### *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 | | |
|---|---|---|
| **Antenna Type:** Custom Integrated | **Power Level:** See Test Plan | |
| **AC Power:** 120 Vac/60 Hz | **Configuration:** Tabletop | |
| **Ambient Temperature:** 22° C | **Relative Humidity:** 37% 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

Tracking # 31662400.002 Page 1 of 4

| | | | |
|---|---|---|---|
| **EUT Name** | Ember Mug | **Date** | 04 Aug 2016 |
| **EUT Model** | TM15 | **Temp / Hum in** | 23° C / 37% rh |
| **EUT Serial** | TM15DBBA63000051 | **Temp / Hum out** | N/A |
| **EUT Config.** | Normal Operating mode | **Line AC / Freq** | 120Vac / 60Hz |
| **Standard** | CFR47 Part 15.207 and RSS Gen | **RBW / VBW** | 9 kHz / 30 kHz |
| **Lab/LISN** | Lab #5 /Com-Power, Line 1 | **Performed by** | Eddie Mariscal |

| Frequency | Raw | Limiter | Ins. Loss | Level | Detector | Line | Limit | Margin | Result |
|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV | dB | dB | dBuV | | Line | dBuV | dB | |
| 0.15 | 38.84 | 9.97 | 0.25 | 49.06 | QP | Live | 66 | -16.94 | Pass |
| 0.16 | 39.77 | 9.98 | 0.23 | 49.97 | QP | Live | 65.23 | -15.26 | Pass |
| 0.18 | 33.57 | 9.97 | 0.21 | 43.75 | QP | Live | 64.31 | -20.56 | Pass |
| 0.90 | 21.56 | 10.06 | 0.07 | 31.69 | QP | Live | 56 | -24.31 | Pass |
| 1.18 | 23.37 | 10.07 | 0.06 | 33.51 | QP | Live | 56 | -22.49 | Pass |
| 0.92 | 22.19 | 10.06 | 0.07 | 32.32 | QP | Live | 56 | -23.68 | Pass |
| 0.15 | 16.42 | 9.97 | 0.25 | 26.64 | Ave | Live | 56 | -29.36 | Pass |
| 0.16 | 16.02 | 9.98 | 0.23 | 26.22 | Ave | Live | 55.23 | -29.01 | Pass |
| 0.18 | 14.1 | 9.97 | 0.21 | 24.28 | Ave | Live | 54.31 | -30.03 | Pass |
| 0.90 | 11.67 | 10.06 | 0.07 | 21.8 | Ave | Live | 46 | -24.2 | Pass |
| 1.18 | 11.05 | 10.07 | 0.06 | 21.18 | Ave | Live | 46 | -24.82 | Pass |
| 0.92 | 10.39 | 10.06 | 0.07 | 20.52 | Ave | Live | 46 | -25.48 | Pass |

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

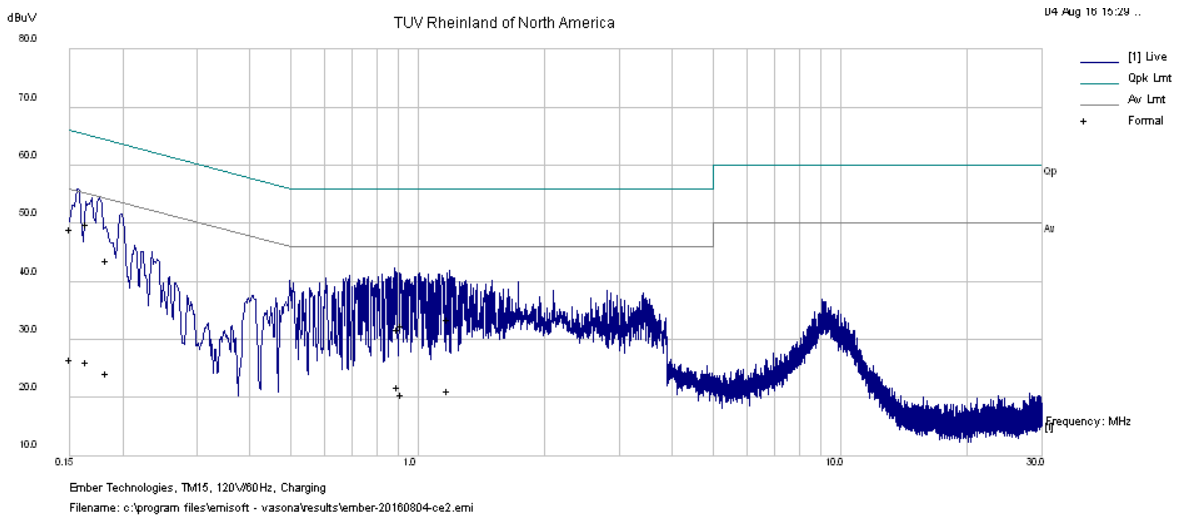
Combined Standard Uncertainty $u_c(y)$ = ± 1.2 dB Expanded Uncertainty $U = ku_c(y)$ $k$ = 2 for 95% confidence

Notes: EUT was setup as table top equipment and continuously transmitting to support iPod.

**SOP 2** Conducted Emissions — Tracking # 31662400.002 Page 2 of 4

| | | | |
|---|---|---|---|
| **EUT Name** | Ember Mug | **Date** | 08 Aug 2016 |
| **EUT Model** | TM15 | **Temp / Hum in** | 23° C / 37% rh |
| **EUT Serial** | TM15DBBA63000051 | **Temp / Hum out** | N/A |
| **EUT Config.** | Normal Operating mode | **Line AC** | 120Vac / 60Hz |
| **Standard** | CFR47 Part 15.207 and RSS Gen | **RBW / VBW** | 9 kHz / 30 kHz |
| **Lab/LISN** | Lab #5 /Com-Power, Line 1 | **Performed by** | Eddie Mariscal |

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




Note: Met FCC Class B limit.

**SOP 2** Conducted Emissions

Tracking # 31662400.002 Page 3 of 4

| | | | |
|---|---|---|---|
| **EUT Name** | Ember Mug | **Date** | 08 Aug 2016 |
| **EUT Model** | TM15 | **Temp / Hum in** | 23° C / 37% rh |
| **EUT Serial** | TM15DBBA63000051 | **Temp / Hum out** | N/A |
| **EUT Config.** | Normal Operating mode | **Line AC / Freq** | 120Vac / 60Hz |
| **Standard** | CFR47 Part 15.207 and RSS Gen | **RBW / VBW** | 9 kHz / 30 kHz |
| **Lab/LISN** | Lab #5 /Com-Power, Line 2 | **Performed by** | Eddie Mariscal |

| Frequency | Raw | Limiter | Ins. Loss | Level | Detector | Line | Limit | Margin | Result |
|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV | dB | dB | dBuV | | Line | dBuV | dB | |
| 0.15 | 42.13 | 9.97 | 0.25 | 52.35 | QP | Neutral | 66 | -13.65 | Pass |
| 0.15 | 40.91 | 9.97 | 0.24 | 51.12 | QP | Neutral | 65.78 | -14.66 | Pass |
| 0.16 | 39.69 | 9.98 | 0.23 | 49.89 | QP | Neutral | 65.37 | -15.47 | Pass |
| 0.18 | 37.57 | 9.97 | 0.21 | 47.75 | QP | Neutral | 64.54 | -16.79 | Pass |
| 0.20 | 33.61 | 9.98 | 0.19 | 43.78 | QP | Neutral | 63.56 | -19.79 | Pass |
| 1.02 | 23.41 | 10.06 | 0.07 | 33.54 | QP | Neutral | 56 | -22.46 | Pass |
| 0.15 | 25.68 | 9.97 | 0.25 | 35.9 | Ave | Neutral | 56 | -20.1 | Pass |
| 0.15 | 25.3 | 9.97 | 0.24 | 35.52 | Ave | Neutral | 55.78 | -20.26 | Pass |
| 0.16 | 23.37 | 9.98 | 0.23 | 33.58 | Ave | Neutral | 55.37 | -21.79 | Pass |
| 0.18 | 22.72 | 9.97 | 0.21 | 32.9 | Ave | Neutral | 54.54 | -21.64 | Pass |
| 0.20 | 21.77 | 9.98 | 0.19 | 31.94 | Ave | Neutral | 53.56 | -21.62 | Pass |
| 1.02 | 10.79 | 10.06 | 0.07 | 20.93 | Ave | Neutral | 46 | -25.07 | Pass |
| 0.15 | 42.13 | 9.97 | 0.25 | 52.35 | QP | Neutral | 66 | -13.65 | Pass |
| 0.15 | 40.91 | 9.97 | 0.24 | 51.12 | QP | Neutral | 65.78 | -14.66 | 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

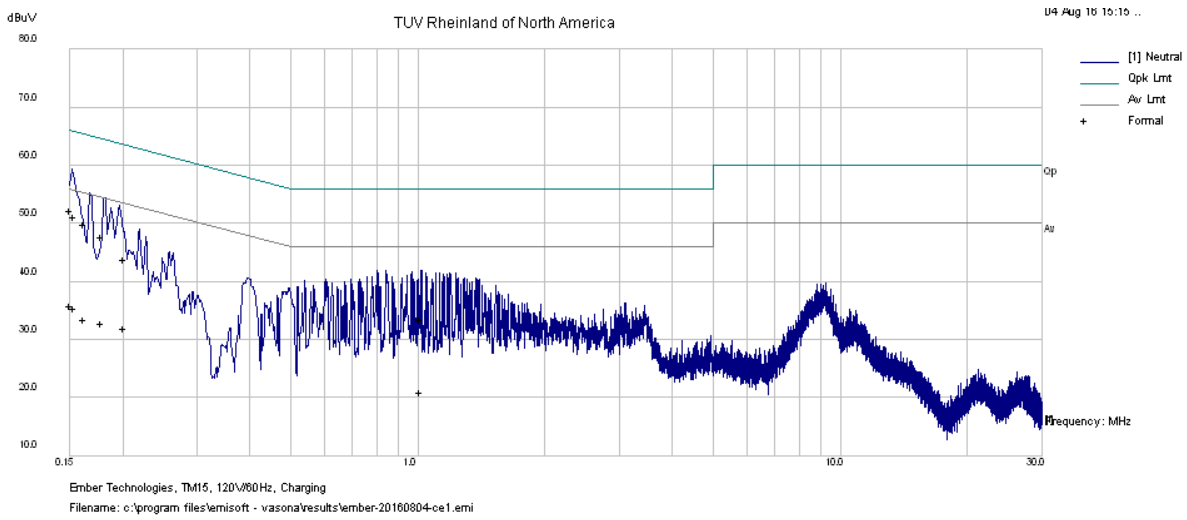
Notes: EUT was setup as table top equipment and continuously transmitting to support iPod.

## **SOP 2** Conducted Emissions

Tracking # 31662400.002 Page 4 of 4

| | | | |
|---|---|---|---|
| **EUT Name** | Ember Mug | **Date** | 08 Aug 2016 |
| **EUT Model** | TM15 | **Temp / Hum in** | 23° C / 37% rh |
| **EUT Serial** | TM15DBBA63000051 | **Temp / Hum out** | N/A |
| **EUT Config.** | Normal Operating mode | **Line AC** | 120Vac / 60Hz |
| **Standard** | CFR47 Part 15.207 and RSS Gen | **RBW / VBW** | 9 kHz / 30 kHz |
| **Lab/LISN** | Lab #5 /Com-Power, Line 2 | **Performed by** | Eddie Mariscal |

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




Note: Met FCC Class B Limit.

## *4.7 Maximum Permissible Exposure*

### 4.7.1 Test Methodology

In this section, we try to prove the safety of radiation harmfulness to the human body for our product. The KDB 447498 D01v06 General RF Exposure Guidance is followed. The Gain of the antenna used in this calculation is declared by the manufacturer, and the maximum average power input to the antenna is measured. Using the general SAR test exclusion guidance in Section 4.3 of KDB 447498 D01v06, we show the device meeting the SAR exclusion threshold.

ISED accepts the KDB 447498 D01v06 Procedure.

### 4.7.2 FCC KDB 447498 D01v06 – General SAR Test Exclusion Guidance

The SAR exclusion threshold conditions are listed:
1) The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by the following formula:

$$\text{Exclusion Threshold} = [\ P / d\ ] * [\sqrt{f}]$$

Where

P = max power of channel (including tune-up tolerance) in mW
d = min. test separation distance in mm
f = the RF channel transmit frequency in GHz
Power and distance are rounded to the nearest mW and mm before calculation
The result is rounded to one decimal place for comparison

Limits: ≤ 3.0 for 1-g SAR ≤ 7.5 for 10-g extremity SAR

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

### 4.7.3 EUT Operating Condition

The software provided by the manufacturer enabled the EUT to transmit data at lowest, middle and highest channel individually.

### 4.7.4 Classification

The antenna of the product, under normal use condition, is less than 20cm away from the body of the user. This device is classified as a **Portable Device**.

### 4.7.5 SAR Test Exclusion Threshold

***SAR Exclusion Threshold Calculation***

| Mode | Frequency (GHz) | Max Power (dBm) | Max Power (mW) | Min. Distance (mm) | Cal. Excl. Threshold | 1-g SAR Limit | 10-g extremity SAR Limit | Result |
|---|---|---|---|---|---|---|---|---|
| Modulated | 2.44 | 2.74 | 1.879 | 5 | 0.6 | ≤3.0 | ≤7.5 | Exempted * |

Note:
1. Since EUT can operate at distance less than 50 mm, the minimum distance, 5 mm, was used for calculation per condition #1 of SAR Exclusion Threshold.
2. The maximum output power was taken from Table 2 of "Ember – FCC-IC 2.4GHz Report - 31662400.001".
3. (*) The calculated threshold is less than 3.0; therefore, EUT is SAR exempted for head and body usage.

# 5 Test Equipment 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 | A102606 | 06/15/2016 | 06/15/2017 |
| Horn Ant. (1-18GHz) | EMCO | 3115 | 9710-5301 | 10/08/2015 | 10/08/2017 |
| Antenna (18-40 GHz) | Com-Power | AHA-840 | 105005 | 07/08/2015 | 07/08/2017 |
| Spectrum Analyzer | Agilent | N9030A | MY52350885 | 05/17/2016 | 05/17/2017 |
| EMI Receiver | Rohde & Schwarz | ESU | 100364 | 04/21/2016 | 04/21/2017 |
| Preamplifier | Sonoma Instruments | 310 | 185516 | 01/10/2016 | 01/10/2017 |
| Preamplifier | HP | 8449B | 3008A01014 | 01/20/2016 | 01/20/2017 |
| Notch Filter | Micro-Tronics | BRM50716 | 037 | 07/29/2016 | 07/29/2017 |

# 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** | Ember Technologies, Inc. |
| **Address** | 4607 Lakeview Canyon Rd., #500 |
| **City, State, Zip** | Westlake Village, CA 91361 |
| **Country** | USA |
| **Phone** | (858) 603-4951 |

**Table 10:** Technical Contact Information

| | |
|---|---|
| **Name** | Chris Wakeham |
| **E-mail** | chris.wakeham@embertech.com |
| **Phone** | (858) 603-4951 |

## 6.3 Equipment Under Test (EUT)

**Table 11:** EUT Specifications

| EUT Specifications | |
|---|---|
| Dimensions | Diameter: 3.125in (80mm)<br>Height: 7.75in (200mm) |
| AC Input | Charging Coaster: 100-240V AC, 50 – 60 Hz |
| Environment | Home/Indoor/Outdoor |
| Operating Temperature Range: | 0 to 30 degrees C |
| Multiple Feeds: | ☐ Yes and how many<br>☒ No |
| Hardware Version | |
| Firmware Version | |
| RF Software Version | Nordic s110_nrf51_8.0.0 |
| Operating Mode | BLE 4.0 |
| Transmitter Frequency Band | 2.4 GHz – 2.4835 GHz |
| Max. Rated Power Output | See Channel Planning Table. |
| Power Setting @ Operating Channel | See Channel Planning Table. |
| Antenna Type | Qty 1: Meandered PIFA on Main PCBA |
| Antenna Gain | +6 dBi |
| Modulation Type | ☐ AM ☐ FM ☐ DSSS ☐ OFDM<br>☒ Other describe: GFSK |
| Data Rate | 1Mbps |
| TX/RX Chain (s) | Single |
| Type of Equipment | ☒ Table Top ☐ Wall-mount ☐ Floor standing cabinet<br>☒ Other: Portable |
| **Note:** | |

**Table 12:** Antenna Information

| Number | Antenna Type | Description | Max Gain (dBi) |
|---|---|---|---|
| Antenna 1 | Meandered PIFA | 2.4GHz Integral Antenna | +6.0 |

**Table 13:** EUT Channel Power Specifications

**Max Power for single chain**

| TP Setting | No. | Frequency (MHz) | Target Power Value dBm | | | |
|---|---|---|---|---|---|---|
| | | | BLE 4.0 | | | |
| 4 | 1 | 2402 | 4.0 | | | |
| 4 | 19 | 2440 | 4.0 | | | |
| 4 | 39 | 2480 | 4.0 | | | |
| **Note:** 1. The adjusted power target values are updated at the evaluated frequencies. | | | | | | |

**Table 14:** 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? |
|---|---|---|---|---|
| None | - | - | - | - |

**Table 15**: Support Equipment

| Equipment | Manufacturer | Model | Serial | Used for |
|---|---|---|---|---|
| Laptop | Dell | P54G | HMWT362 | Configure channel, power, etc. |
| **Note:** None. | | | | |

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

| Device | Serial | RF Connection | CFR47 Part 15.247 |
|---|---|---|---|
| Travel Mug TM15 | TM15DBBA 63000051 | Integrated Antenna | AC Conducted Emissions |
| | 6290083 | Integrated Antenna | Radiated Bandedge Emissions, Radiated Spurious Emissions |
| | 629005Z | Female SMA | Peak Transmit Power, Peak Power Spectral Density, Occupied Bandwidth, Band-Edge, Out-of-Band Emissions |

**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) |
|---|---|---|---|---|---|
| Travel Mug TM15 | Custom Integrated | Transmit | EUT Upright | EUT lying down with display perpendicular to ground plane | EUT lying down with display parallel to ground plane |
| **Note:** Y-Axis was determined to be the worst-case. | | | | | |

## *6.4 Test Specifications*

**Table 18:** Test Specifications

| Emissions and Immunity | |
|---|---|
| **Standard** | **Requirement** |
| CFR 47 Part 15.247: 2015 | All |
| RSS 247 Issue 1, 2015 | All |

# END OF REPORT