Emissions
Test Report

EUT Name: Wi-Fi Router

Model No.: D010001 (USA), D010002 (IC)

CFR 47 Part 15.247: 2016 and RSS 247: 2017

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Statement of Compliance

Manufacturer:	eero inc. 500 Howard Street, Suite 900 San Francisco, CA 94105 (415) 738-7972
Requester / Applicant:	Clifford Clarke
Name of Equipment:	Wi-Fi Router
Model No.	D010001 (USA), D010002 (IC)
Type of Equipment:	Intentional Radiator
Application of Regulations:	CFR 47 Part 15.247: 2016 and RSS 247: 2017
Test Dates:	01 May 2017 to 04 May 2017

Guidance Documents:

Emissions: ANSI C63.10-2013, KDB 558074 D01 DTS Measurement Guidance v03r05, KDB 662911 D01 Multiple Transmitter Output v02r01

Test Methods:

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

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Kerwinn Corpuz	David Spencer
Test Engineer Date May 05, 2017	A2LA Signatory Date May 05, 2017

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

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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: 2016 and RSS 247: 2017 based on the results of testing performed on 01 May 2017 to 04 May 2017 on the Wi-Fi Router Model D010001 (USA), D010002 (IC) manufactured by eero 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 LE, 2405 MHz to 2475 MHz frequency band for Thread (Zigbee) and 2412 MHz to 2462 MHz frequency band for WiFi are 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 Transmitted 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 (a1), RSS GEN Sect.6.6	See plots	**Complied**
Maximum Output Power	CFR47 15.247 (b), RSS 247 Sect. 5.4 (d)	18.65 dBm (Thread)	**Complied**
Peak Power Spectral Density	CFR47 15.247 (e), RSS 247 Sect. 5.2 (b)	< 8 dBm/3kHz	**Complied**
Out of Band Emission	CFR47 15.247 (d), RSS 247 Sect.5.5	30 MHz - 26 GHz < 20 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 (US1131). The laboratory scope of accreditation includes: Title 47 CFR Parts 15, 18, and 90. The accreditation is updated every 3 years.

2.1.2 NIST / A2LA

TUV Rheinland of North America is accredited by the National Voluntary Laboratory Accreditation Program, which is administered under the auspices of the National Institute of Standards and Technology. The laboratory has been assessed and accredited in accordance with ISO Guide 17025:1999 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-0261

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 D010001 (USA), D010002 (IC), Wi-Fi Router, is a Wi-Fi router for the home capable of operating in the 2.4 GHz and 5 GHz frequency bands over 20 MHz, 40 MHz and 80 MHz channels.

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 Wi-Fi Router has five FPCB antennas. The 2.4GHz band uses Flex Printed Circuit Board (FPCB) dipole antennas (Antenna 3, Antenna 4 and Antenna 5) and has maximum gain +4.08 dBi for WiFi and +4.14 dBi for BLE and Thread (Zigbee). Antenna 5 is used independently for Bluetooth LE / Thread (Zigbee) and has no beam forming capability.

Refer to Table 11 for additional antenna information.

There is no additional antenna available.

4 Emissions

Testing was performed in accordance with CFR 47 Part 15.247: 2016 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.

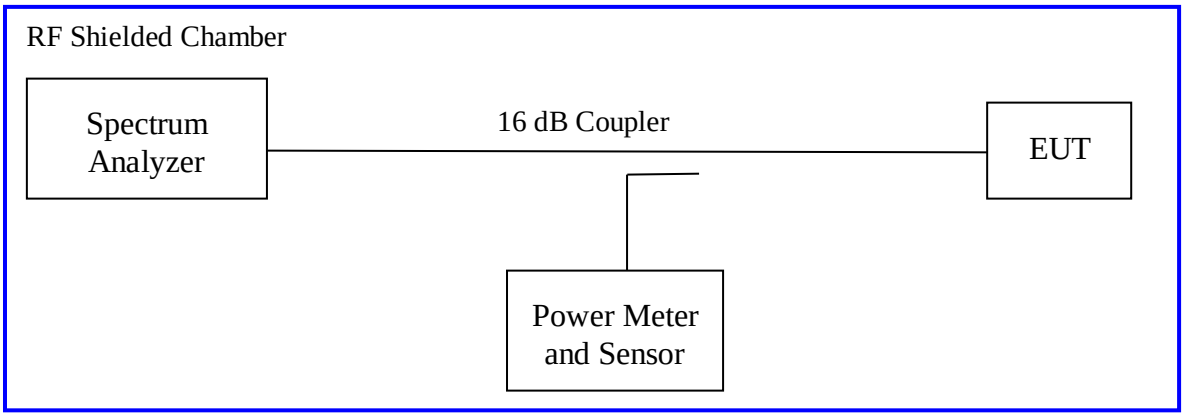
The maximum output power and harmonics shall not exceed CFR47 Part 15.247 (b):2016 and RSS 247: 2017 Sect. 5.4 (d).

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

4.1.1 Test Method

The ANSI C63.10-2013 Section 11.9.2.2.2. Conducted method was used to measure the channel power output. The preliminary investigation was performed at different data rate / chain to determine the highest power output for each mode. 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:



Method AVGSA-1 of "KDB 558074 – DTS Measurement Guidance v03r05" applies since the EUT continuously transmits with duty cycle greater than 98%. Sample detector was used.

Each chain was measured individually and applied the measure-and-sum approach per KDB662911.

The total directional gain (6.87 dBi) was calculated by summing Antenna 3 (4.08 dBi) and Antenna 4 (3.64 dBi).

The duty cycle, CF = 10Log(1/duty cycle), was applied for BLE.

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 – Non Beamforming

Test Conditions: Conducted Measurement, Normal Temperature				
Antenna Type: FPCB		**Power Setting:** See test plan		
Max. Directional Gain: Antenna 3 = + 4.08 dBi (WiFi); Antenna 4 = + 3.64 dBi (WiFi); Antenna 5 = + 4.14 dBi (BLE and Thread)				
Signal State: Modulated at 100%.				
Ambient Temp.: 22° C		**Relative Humidity:**38%		
802.15.4				
Operating Channel (MHz)	**Packet**	**Limit [dBm]**	**Max. Power [dBm]**	**Margin [dB]**
2405.00	Thread	30.00	18.65	-11.35
2440.00	Thread	30.00	18.49	-11.51
2475.00	Thread	30.00	17.26	-12.74
Note: 1. The highest output power was observed at Thread, 1 Data Streams. 2. Plots for all the measurements stated above were taken, to reduce complexity and bulkiness of the report Highlighted Plots are placed in the report.				

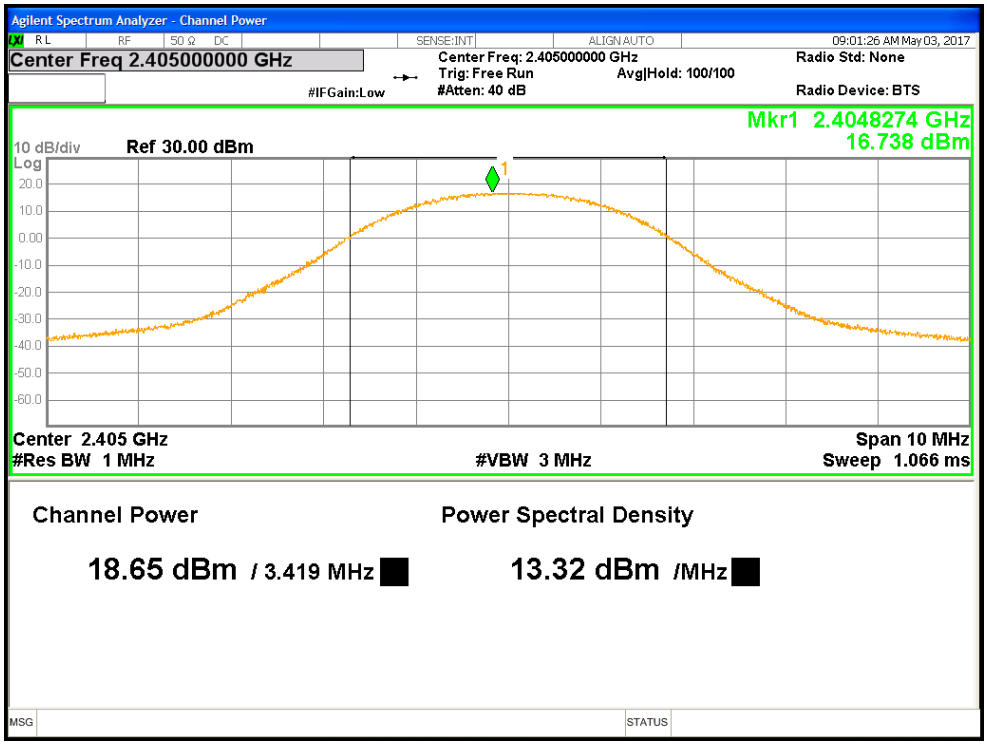


Figure 1: Maximum Transmitted Power, 2405 MHz for Thread

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.

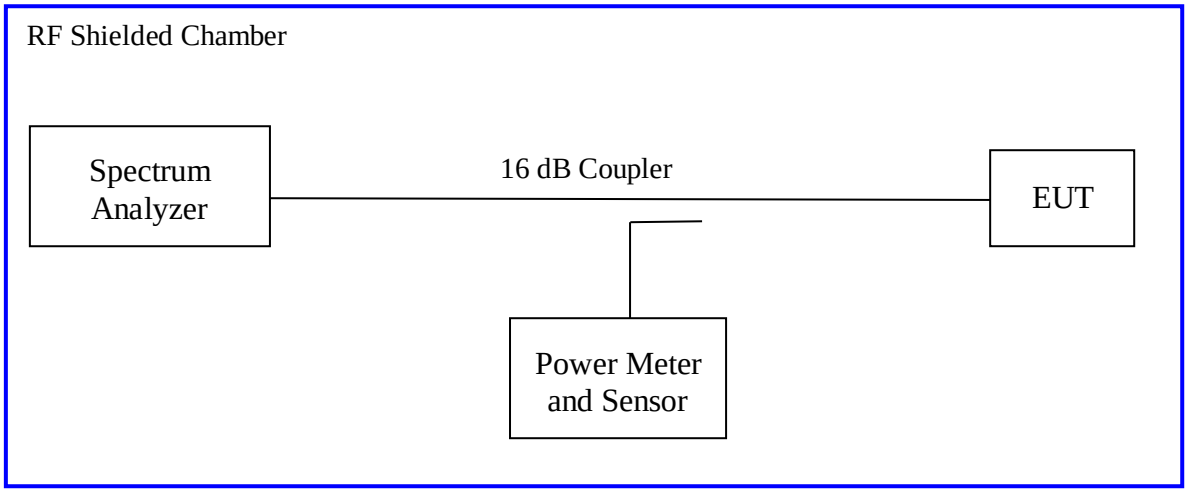
The 99% bandwidth is the bandwidth in which 99% of the transmitted power occupied.

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) 2016 and RSS Gen Sect. 6.6 2014. The preliminary investigation was performed to find the narrowest 26 dB bandwidth for each operational mode at different data rates. This worst finding was performed on 3 channels in each operating frequency range; 2400 MHz to 2483.5 MHz, a 6 dB bandwidth was used. The worst results indicated below.

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: FPCB		**Power Setting:** See test plan	
Total Directional Gain: + 6.87 dBi (WiFi) **Max. Directional Gain:** Antenna 3 = + 4.08 dBi (WiFi); Antenna 4 = + 3.64 dBi (WiFi); Antenna 5 = + 4.14 dBi (BLE and Thread)			
Signal State: Modulated at 100%.			
Ambient Temp.: 22° C		**Relative Humidity:**39%	
Bandwidth (MHz) for 802.15.4			
Freq. (MHz)	**Packet**	**6dB Bandwidth (MHz)**	**99% Bandwidth (MHz)**
2405	Thread	1.637	2.2664
2440	Thread	1.636	2.2628
2475	Thread	1.631	2.2775
Note: 1. The bandwidth was measured at Thread, 1 Data Streams. 2. Plots for all the measurements stated above were taken, to reduce complexity and bulkiness of the report Highlighted Plots are placed in the report.			

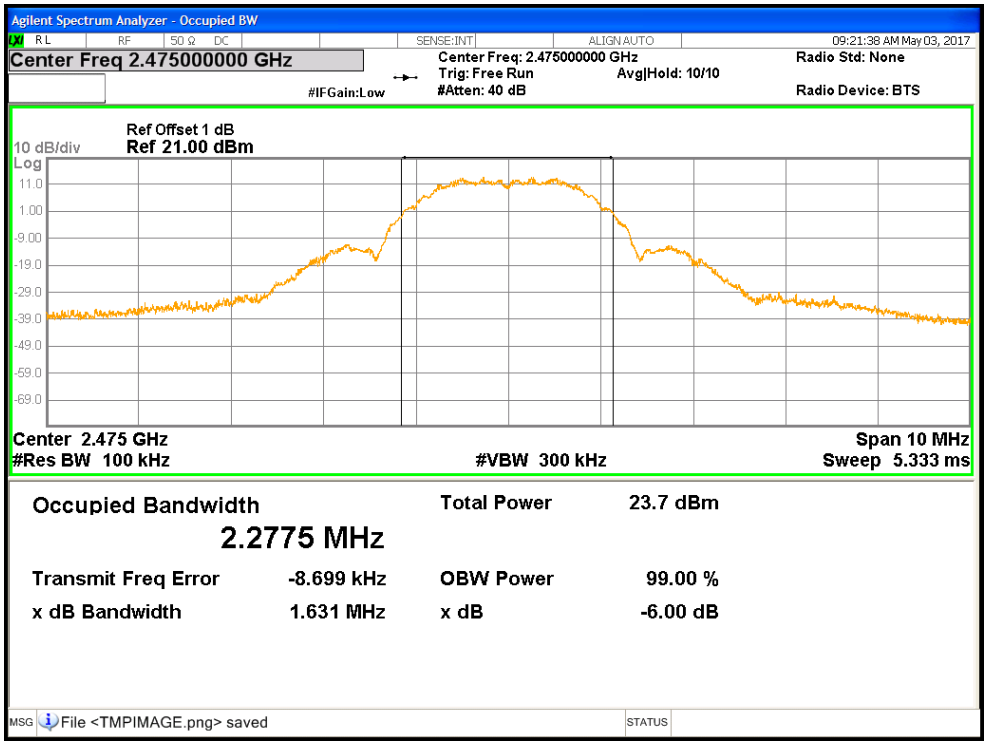


Figure 2: 6dB & 99% Occupied Bandwidth, 2475 MHz for Thread

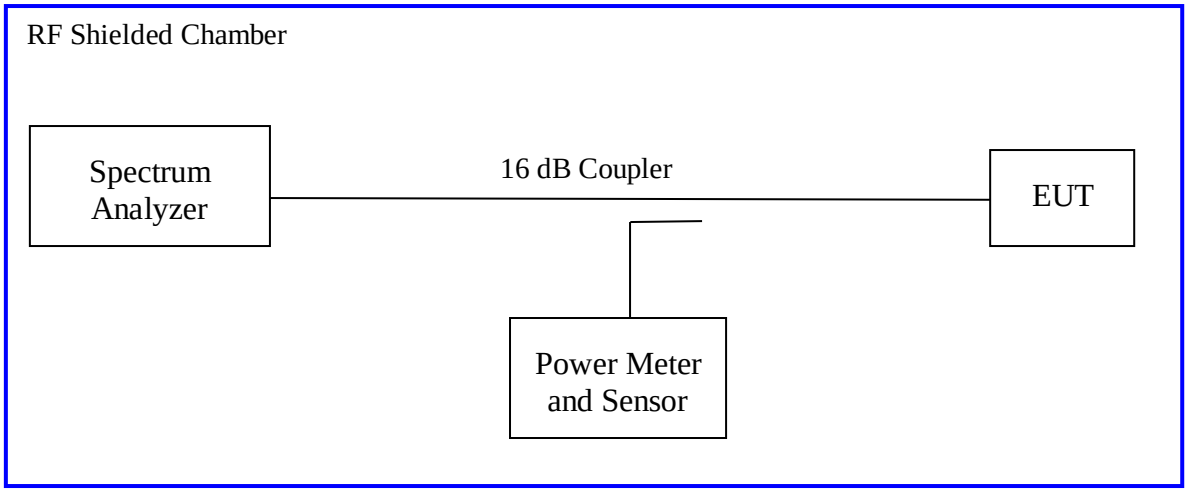
4.3 Peak Power Spectral Density

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

4.3.1 Test Method

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

Test Setup:



Method AVGSA-1 of "KDB 558074 – DTS Measurement Guidance v03r05" applies since the EUT continuously transmits with duty cycle greater than 98%. Sample detector was used.

Each chain was measured individually and applied the measure-and-sum approach per KDB662911.

The total directional gain (6.87 dBi) was calculated by summing Antenna 3 (4.08 dBi) and Antenna 4 (3.64 dBi).

The duty cycle, CF = 10Log(1/duty cycle), was applied for BLE.

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 – Non Beamforming

Test Conditions: Conducted Measurement, Normal Temperature				
Antenna Type: FPCB		**Power Setting:** See test plan		
Max. Directional Gain: Antenna 3 = + 4.08 dBi (WiFi); Antenna 4 = + 3.64 dBi (WiFi); Antenna 5 = + 4.14 dBi (BLE and Thread)				
Signal State: Modulated at 100%.				
Ambient Temp.: 22° C		**Relative Humidity:**39%		
Peak Power Spectral Density				
802.15.4				
Freq. (MHz)	**Packet**	**Max. PSD [dBm]**	**Limit [dBm]**	**Margin [dB]**
2405	Thread	-4.757	8.000	-12.757
2440	Thread	-4.834	8.000	-12.834
2475	Thread	-6.132	8.000	-14.132
Note: 1. The highest peak output power was observed at **Thread** per data stream. 2. Limited number of plots are placed in the report.				

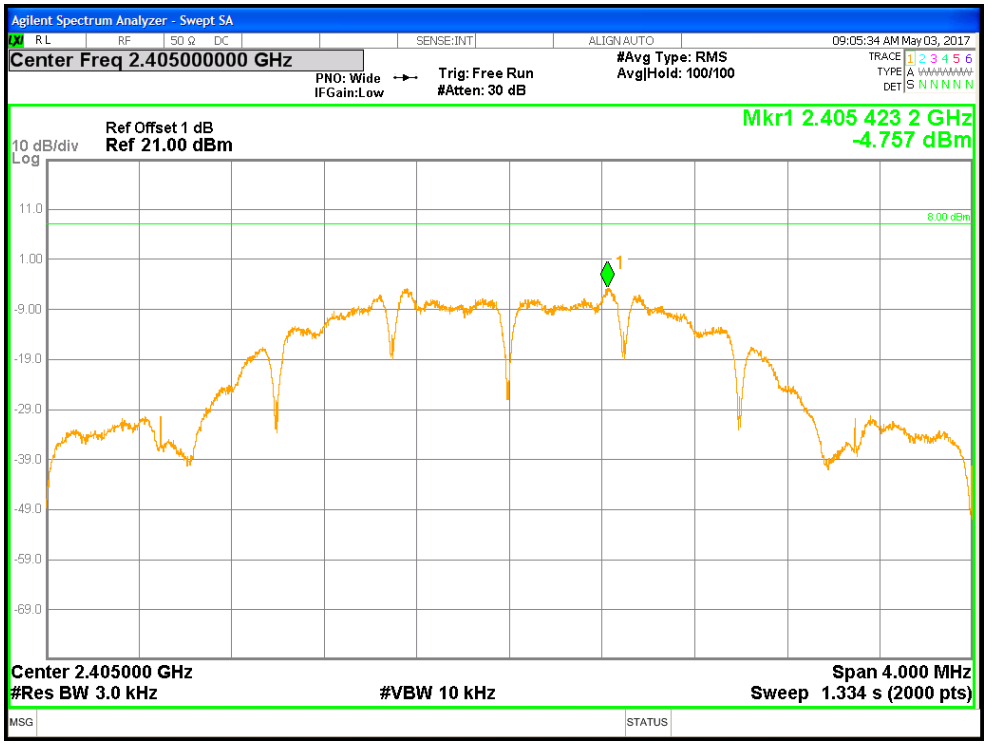


Figure 3: Power Spectral Density, 2452 MHz for Thread

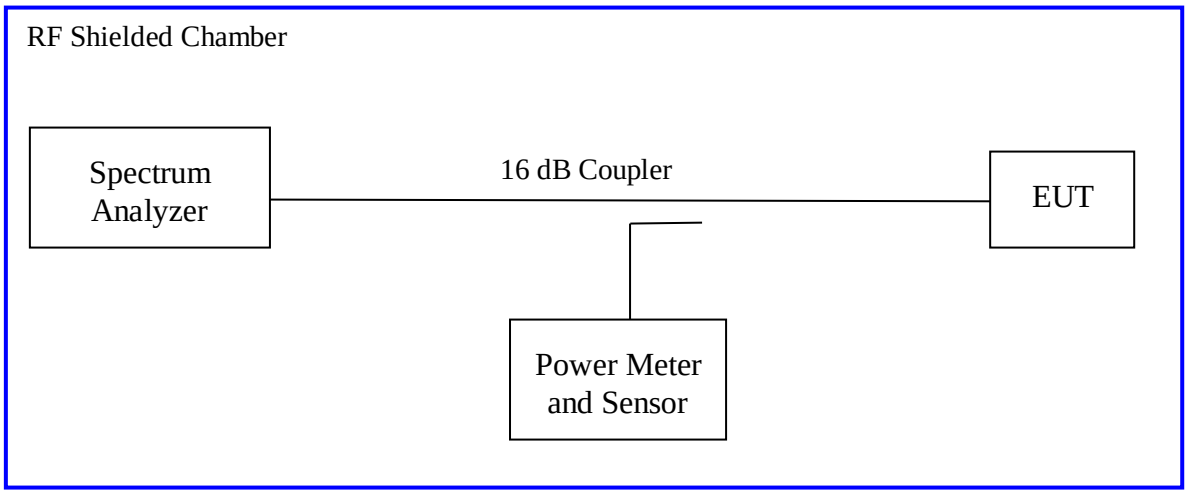
4.4 Out of Band Emissions

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, RSS-GEN Sect. 8.9 and 8.10.

4.4.1 Test Method

The conducted method was used to measure the undesirable emission requirement. The measurement was performed with modulation. This test was conducted on 3 channels of Sample in each mode on Sample. The worst sample result indicated below.

Test Setup:



Measurement Procedure AVG2 of KDB 662911

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 – Test Results

Test Conditions: Conducted Measurement, Normal Temperature and Voltage only						
Antenna Type: FPCB			**Power Setting:** See test plan			
Total Directional Gain: + 6.87 dBi (WiFi) **Max. Directional Gain:** Antenna 3 = + 4.08 dBi (WiFi); Antenna 4 = + 3.64 dBi (WiFi); Antenna 5 = + 4.14 dBi (BLE and Thread)						
Signal State: Modulated at 100%.						
Ambient Temp.: 22° C			**Relative Humidity:**39%			
Non-Restricted Frequency Band Emissions						
Freq. (MHz)	**Mode**	**Chain**	**Measured (dBm)**	**Limit (dBm)**	**Plots**	**Results**
2400	Thread	0	-38.82	-14.66	Fig. 4, 5	Pass
2483.5	Thread	0	-49.12	-16.00	Fig. 6, 7	Pass
Note: 1. The stated limits for 30 dBr are relative to each individual output per KDB 662911 Method. 2. The worst case of each data rate is recorded.						

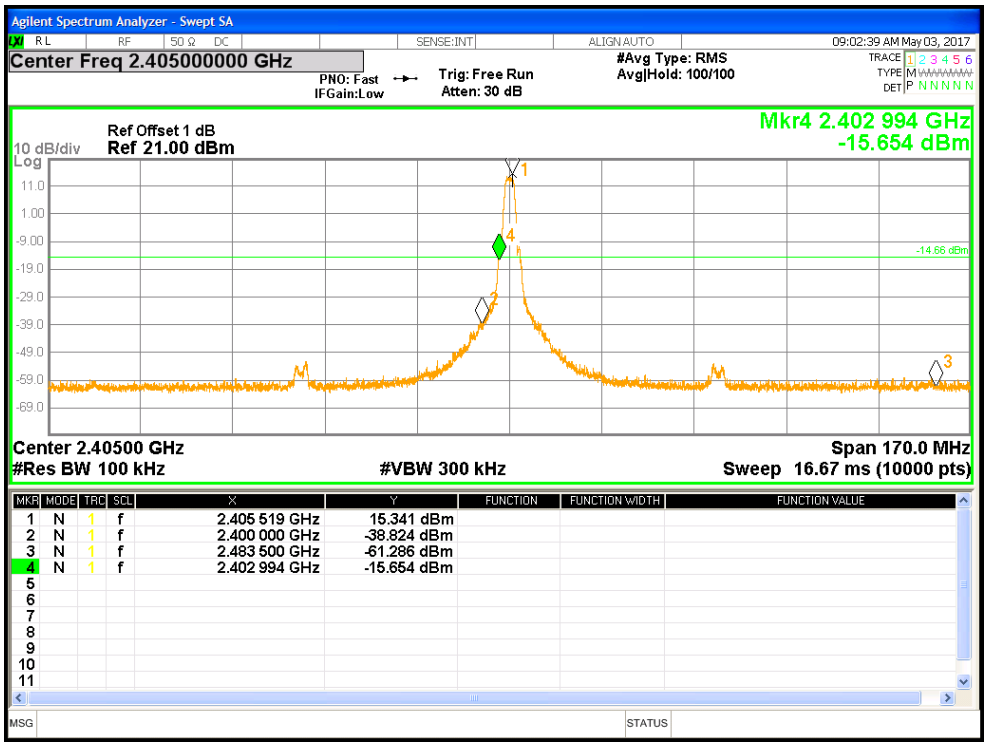


Figure 4: Measured Bandedge for Thread at 2405 MHz

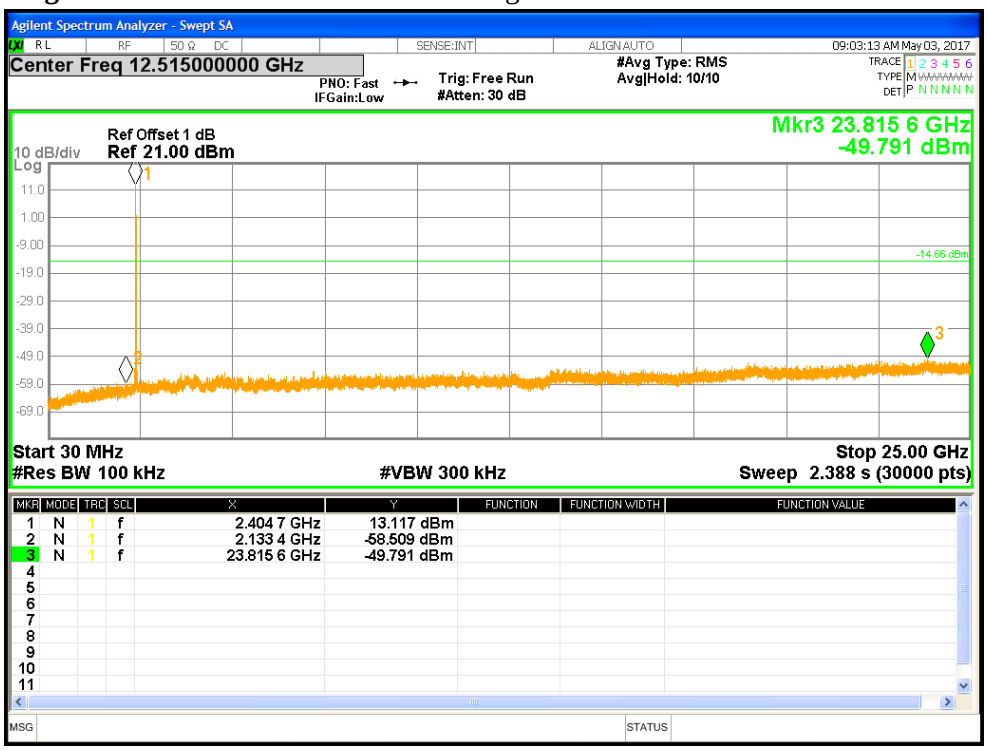


Figure 5: Out of Band Emissions for Thread at 2405 MHz

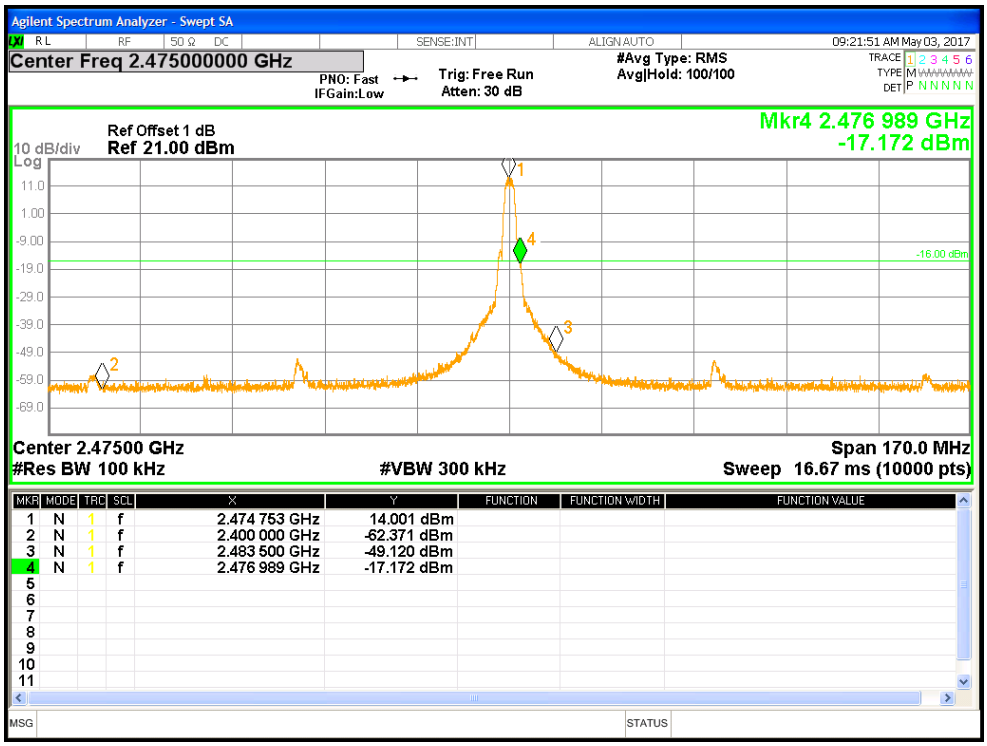


Figure 6: Measured Bandedge for Thread at 2475 MHz

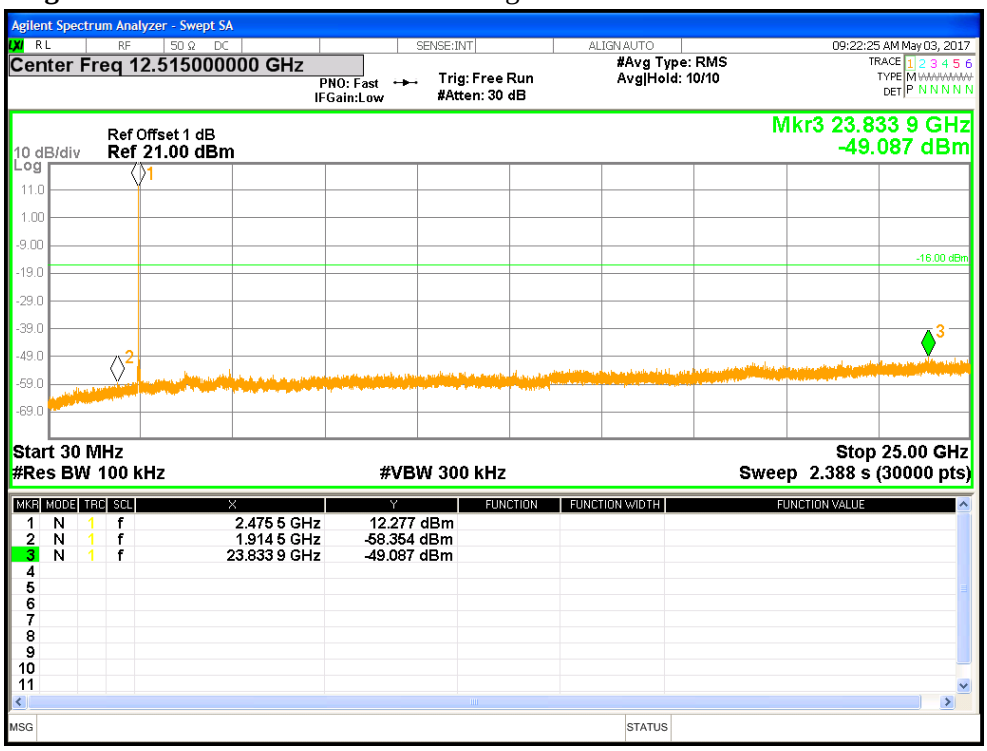


Figure 7: Out of Band Emissions for Thread at 2475 MHz

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, RSS-GEN Sect. 8.9 and 8.10.

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.

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

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.

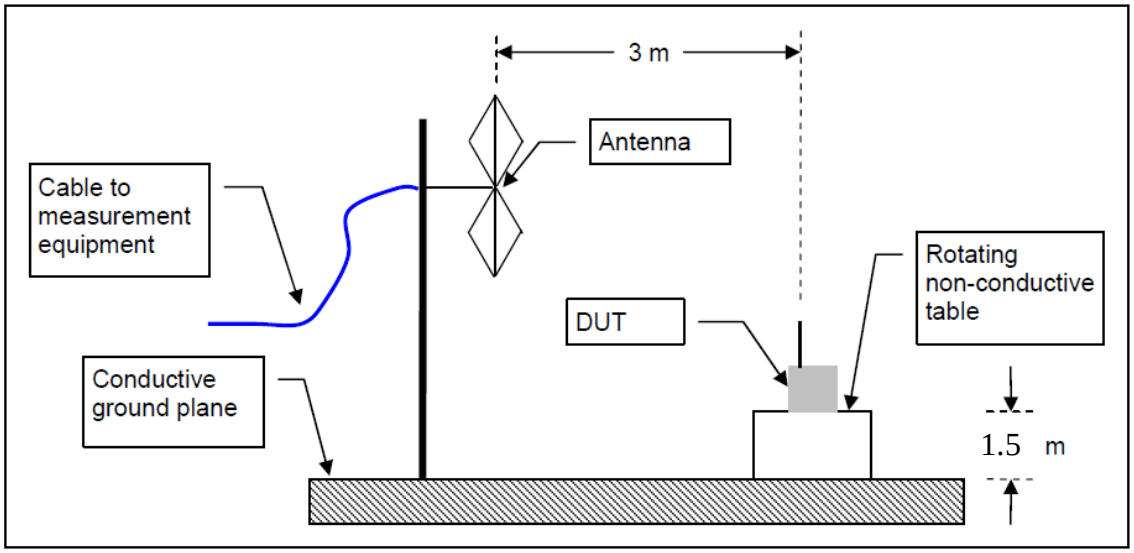
Final testing was performed on an NSA compliant test site. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm (<1 GHz) and 150cm (>1 GHz) above the ground plane. The placement of EUT and cables were the same as for preliminary testing and is shown in the setup photographs.

Final results are: 802.11g (Chain 0 and Chain 1) and HT40 (Chain 0 and Chain 1). 20MHz channel BW worse case is 802.11g and covers HT20.

4.5.1.3 Deviations

None.

Test Setup:



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. 8.9 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

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 6: Transmit Spurious Emission at Band-Edge Requirements

Test Conditions: Radiated Measurement, Normal Temperature and Voltage only

Antenna Type: FPCB **Power Setting:** See test plan

Total Directional Gain: + 6.87 dBi (WiFi)
Max. Directional Gain: Antenna 3 = + 4.08 dBi (WiFi); Antenna 4 = + 3.64 dBi (WiFi); Antenna 5 = + 4.14 dBi (BLE and Thread)

Signal State: Modulated at 100%.

Ambient Temp.: 21° C **Relative Humidity:**44%

Band-Edge Results

Freq. (MHz)	Level (dBuV/m)	Pol. (H/V)	Limit (dBuV/m)	Margin (dB)	Det.	Table Deg.	Tower (cm)	Note
2390	56.39	H	74	-17.61	Pk	1	241	PLOT 8: Thread-2405MHz-TP19
2390	42.53	H	54	-11.47	Ave	1	241	PLOT 9: Thread-2405MHz-TP19
2390	54.61	V	74	-19.39	Pk	214	150	PLOT 10: Thread-2405MHz-TP19
2390	42.09	V	54	-11.91	Ave	214	150	PLOT 11: Thread-2405MHz-TP19
2483.5	55.78	V	74	-18.22	Pk	224	328	PLOT 12: Thread-2475MHz-TP19
2483.5	43.28	V	54	-10.72	Ave	223	331	PLOT 13: Thread-2475MHz-TP19
2483.5	58.56	H	74	-15.44	Pk	359	247	PLOT 14: Thread-2475MHz-TP19
2483.5	45.92	H	54	-8.08	Ave	359	247	PLOT 15: Thread-2475MHz-TP19

Note: 1. The emissions were measured at the adjacent restricted band of the fundamental signal.
2. All the band-edge measurements met the restricted band requirements of CFR47 15.205.

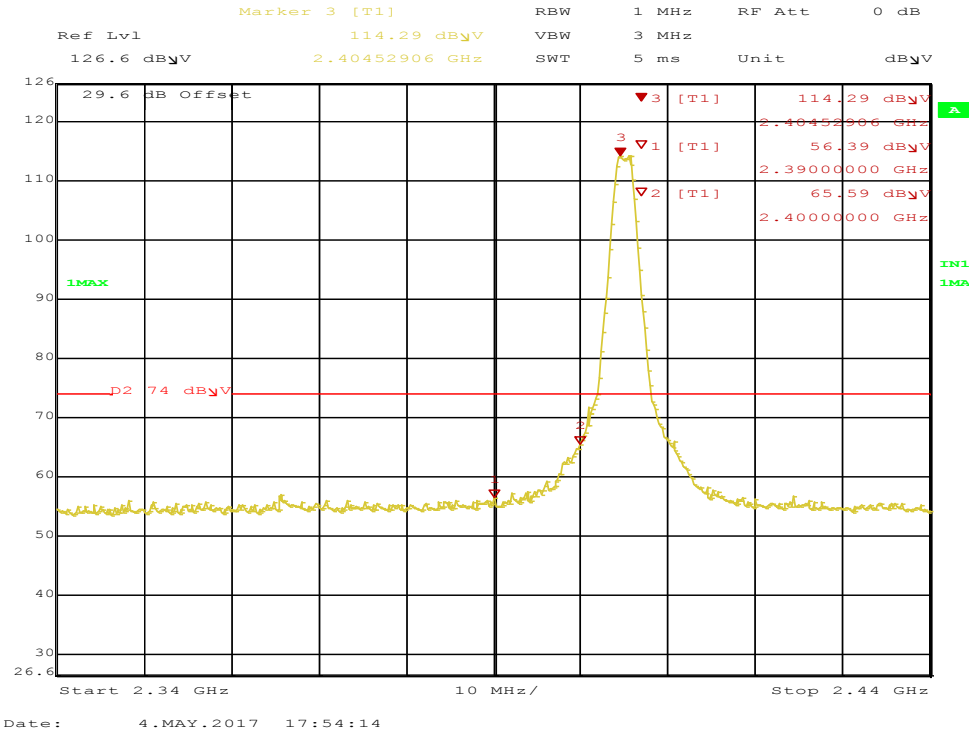


Figure 8: Thread Radiated Emission at the Edge for 2390 MHz – Horz. (Pk)

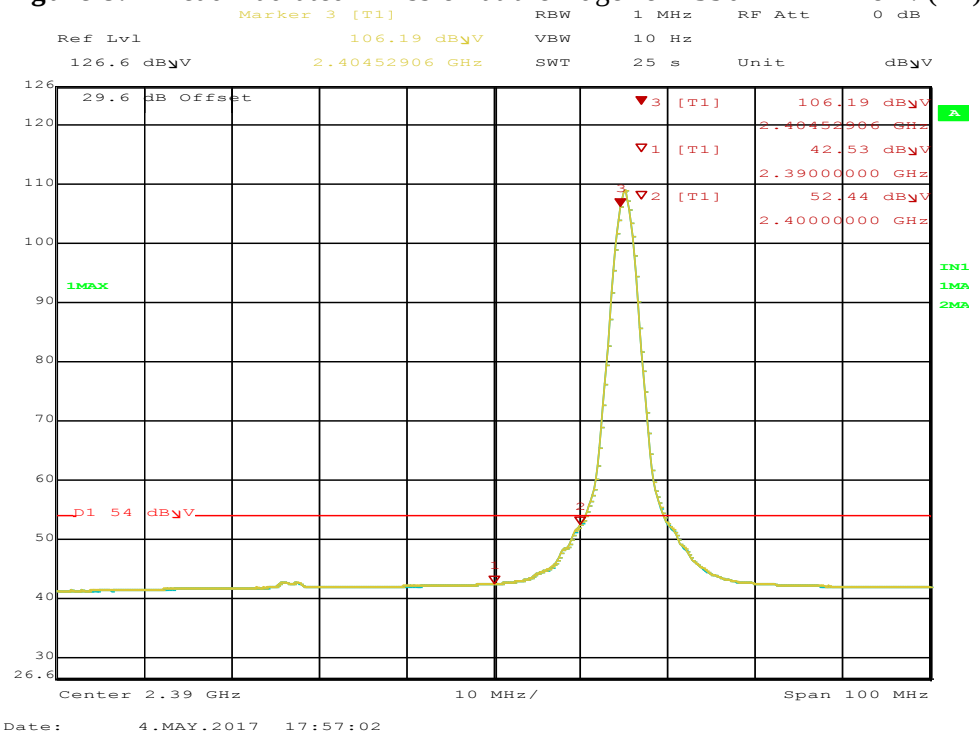


Figure 9: Thread Radiated Emission at the Edge for 2390 MHz – Horz. (Ave)

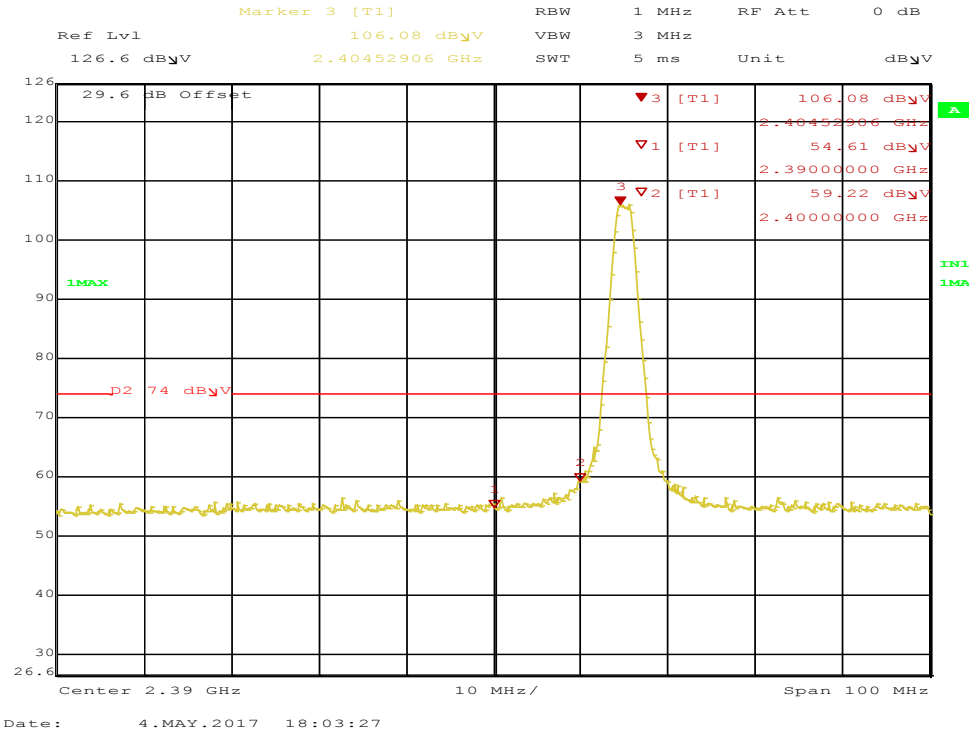


Figure 10: Thread Radiated Emission at the Edge for 2390 MHz – Vert. (Pk)

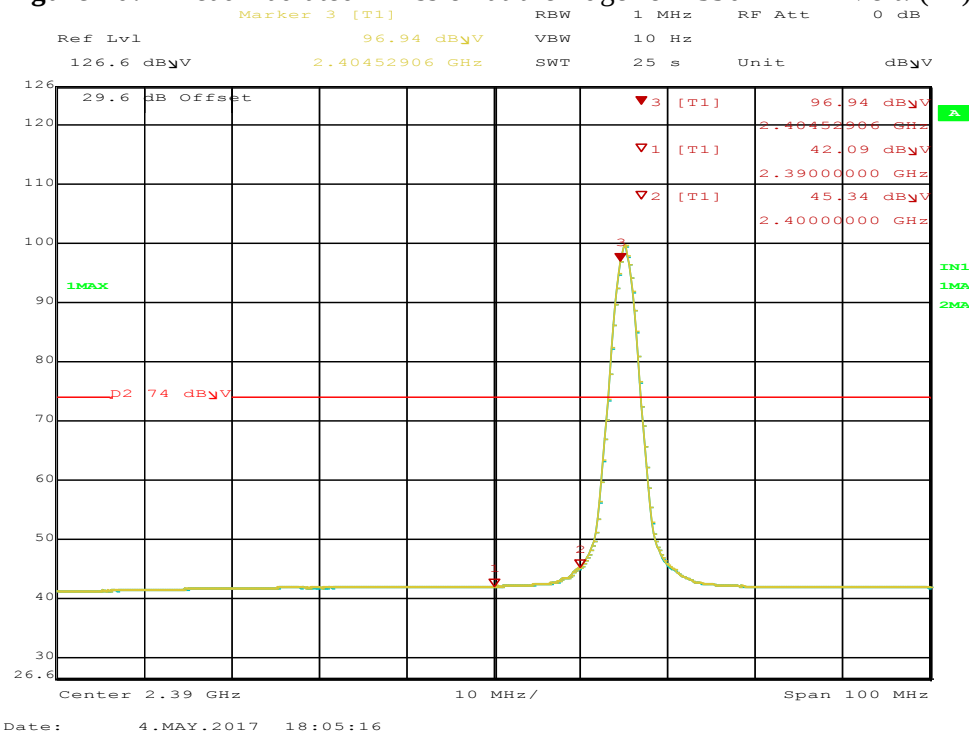


Figure 11: Thread Radiated Emission at the Edge for 2390 MHz – Vert. (Ave)

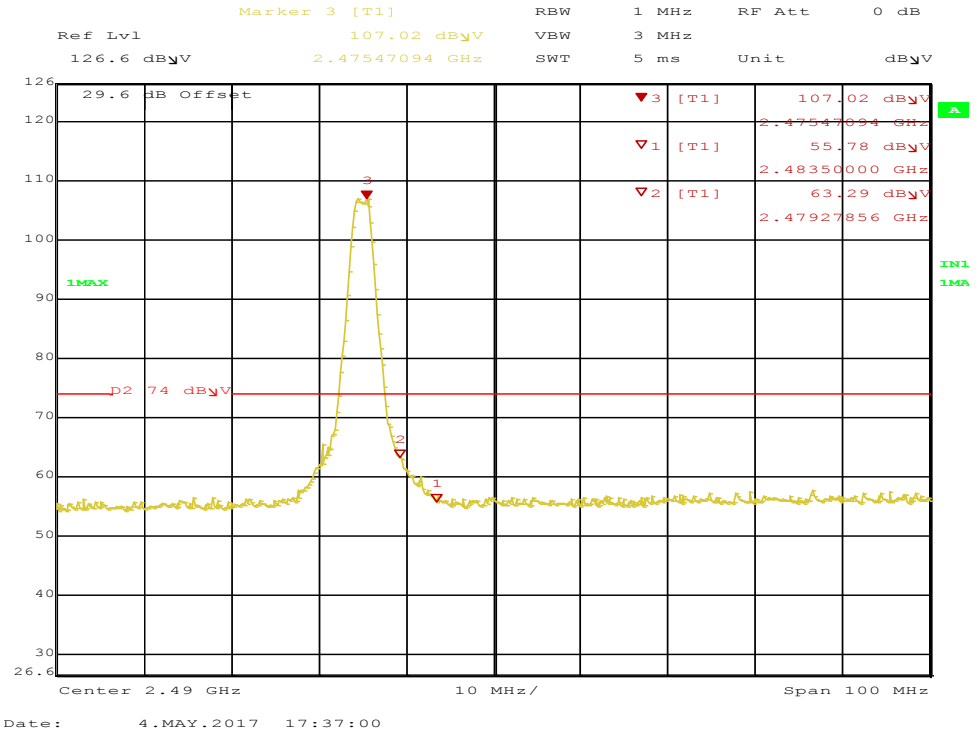


Figure 12: Thread Radiated Emission at the Edge for 2483.5 MHz – Vert. (Pk)

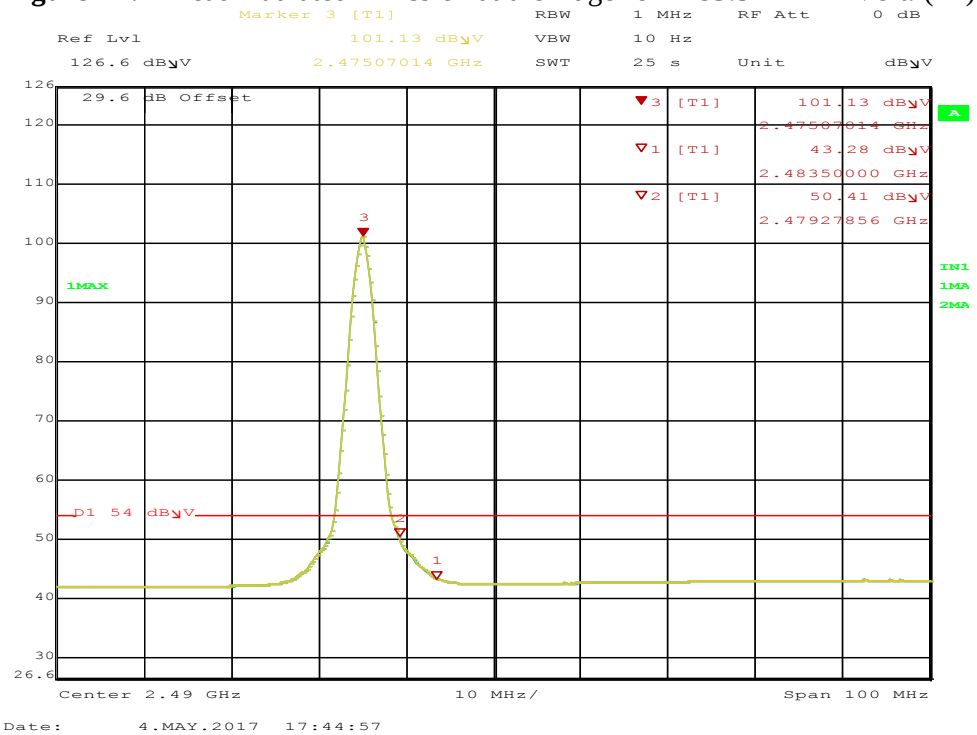


Figure 13: Thread Radiated Emission at the Edge for 2483.5 MHz – Vert. (Ave)

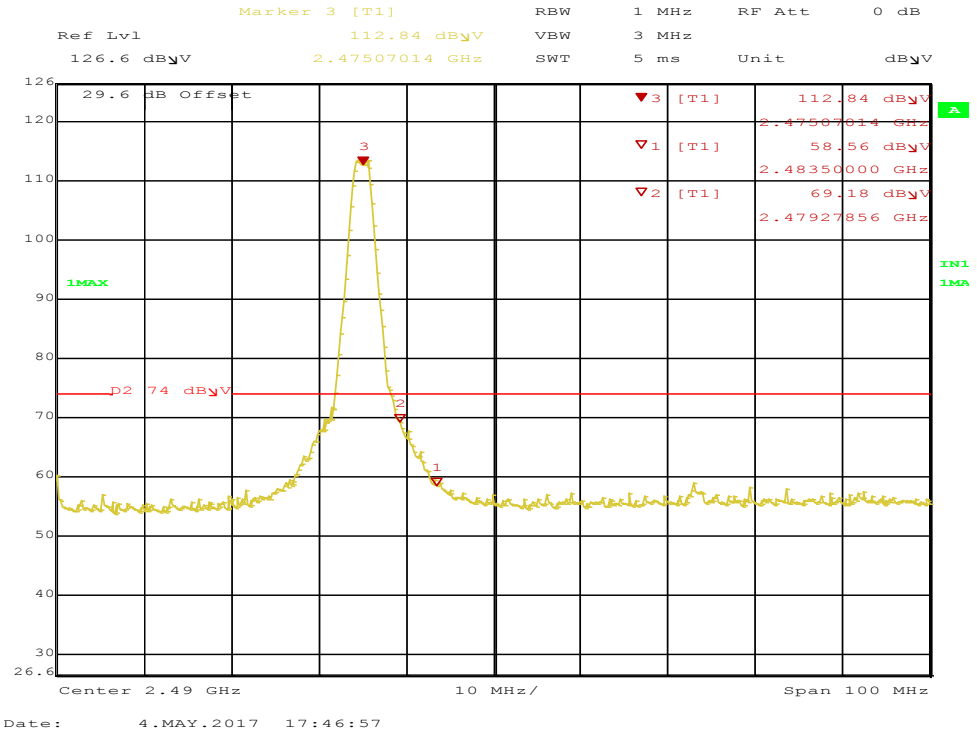


Figure 14: Thread Radiated Emission at the Edge for 2483.5 MHz – Horz. (Pk)

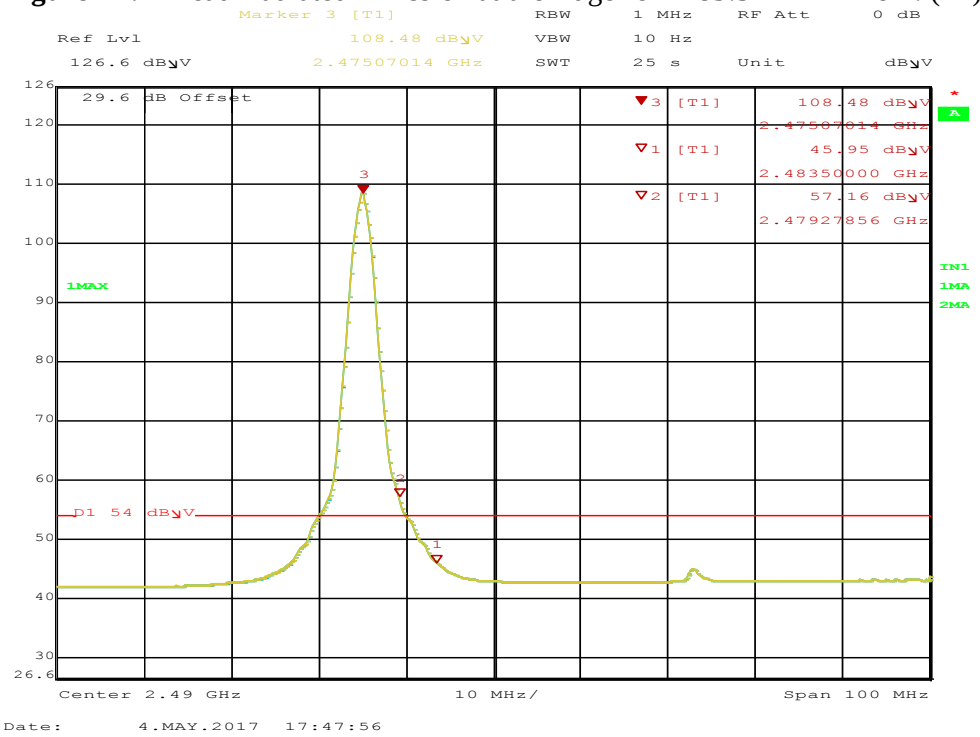
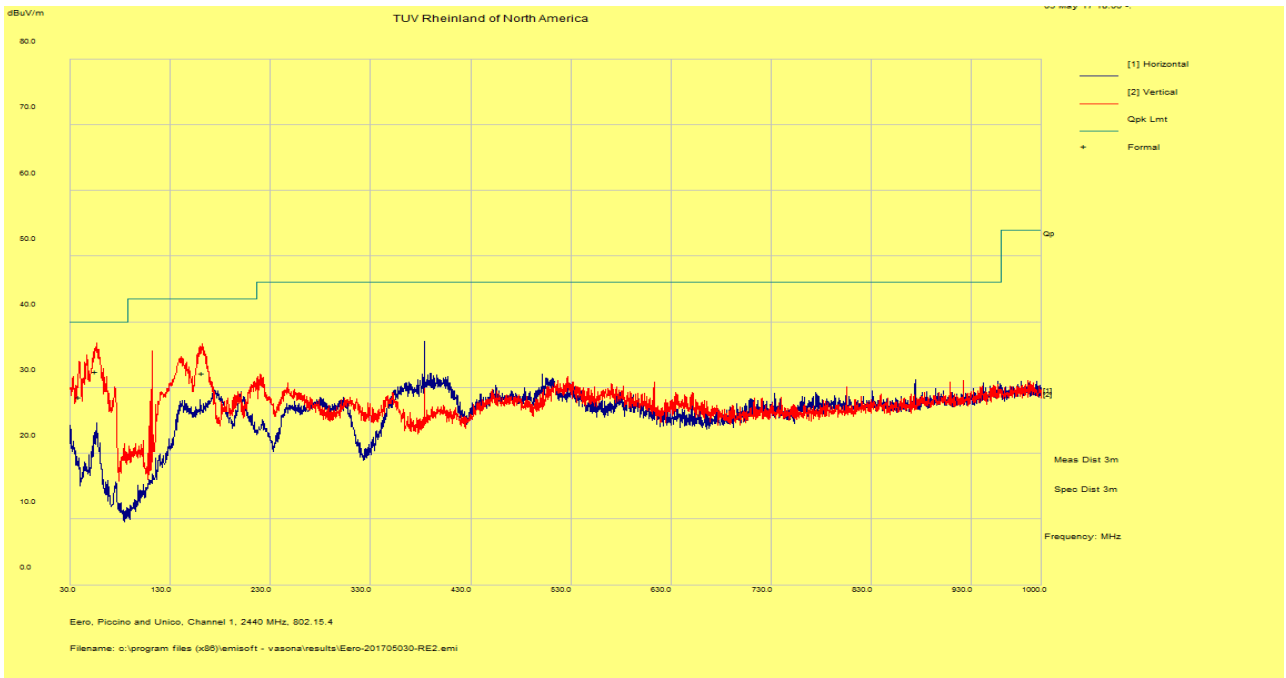


Figure 15: Thread Radiated Emission at the Edge for 2483.5 MHz – Horz. (Ave)

SOP 1 Radiated Emissions		Tracking # 31760707.001 Page 1 of 7	
EUT Name	Wi-Fi Router	**Date**	May 3, 2017
EUT Model	D010001 (USA), D010002 (IC)	**Temp / Hum in**	22° C / 40%rh
EUT Serial	MF701114110316 (Piccino), SPE28JY (Unico)	**Temp / Hum out**	N/A
EUT Config.	802.15.4 (Thread)	**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**	Colton Aliff

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
39.29	39.46	2.64	-13.54	28.56	QP	V	113	150	40.00	-11.44
56.21	50.41	2.78	-20.74	32.45	QP	V	158	346	40.00	-7.55
162.41	44.62	3.38	-15.74	32.26	QP	V	110	358	43.50	-11.24
66.07	49.17	2.86	-20.31	31.72	Pk	V	100	270	40.00	-8.28
384.05	45.42	4.20	-12.52	37.10	Pk	H	100	1	46.00	-8.90
111.84	47.72	3.13	-15.21	35.64	Pk	V	100	360	43.50	-7.86



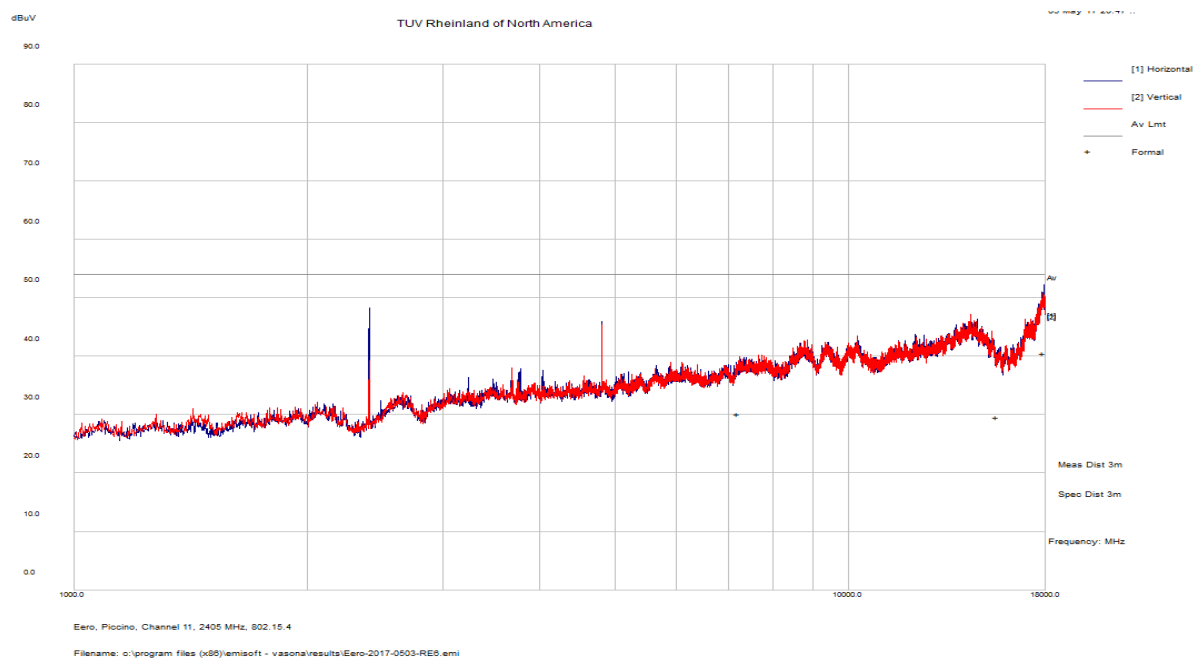
Spec Margin = E-Field QP - Limit, E-Field QP = FIM QP+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

Note: 1. Worst case was observed on Mid channel of Thread mode.
2. No significant emission was observed below 30MHz.
3. To reduce complexity and bulkiness of the report Worst case Plots is placed in the report.

SOP 1 Radiated Emissions		Tracking # 31760707.001 Page 2 of 7	
EUT Name	Wi-Fi Router	**Date**	May 3, 2017
EUT Model	D010001 (USA), D010002 (IC)	**Temp / Hum in**	22° C / 40%rh
EUT Serial	MF701114110316 (Piccino), SPE28JY (Unico)	**Temp / Hum out**	N/A
EUT Config.	802.15.4 (Thread)	**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 / 1m – AHA-840	**Performed by**	Colton Aliff

1 – 18 GHz Transmit at 2405 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
7213.12	44.31	2.20	-16.45	30.05	Ave	H	216	250	54.00	-23.95
15549.27	38.65	3.42	-12.51	29.56	Ave	V	189	168	54.00	-24.45
17892.03	40.15	3.72	-3.41	40.45	Ave	V	141	36	54.00	-13.55



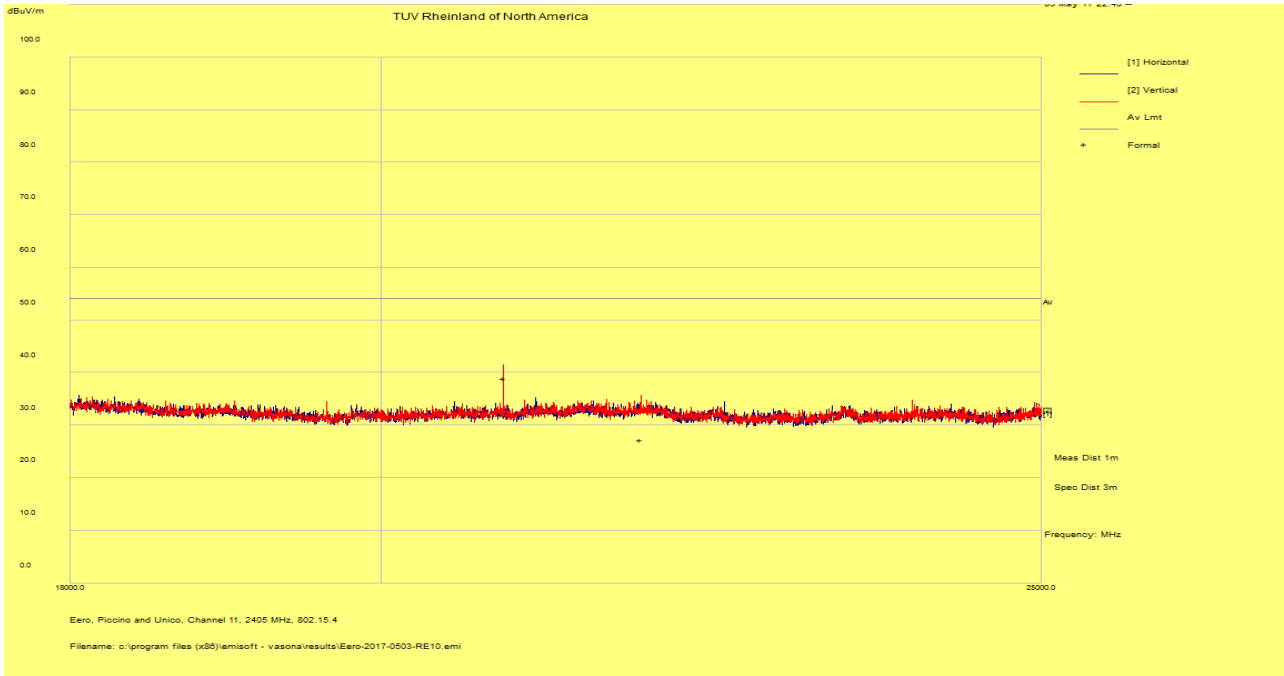
Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

Note: Worst case was observed on Thread.

SOP 1 Radiated Emissions		Tracking # 31760707.001 Page 3 of 7	
EUT Name	Wi-Fi Router	**Date**	May 3, 2017
EUT Model	D010001 (USA), D010002 (IC)	**Temp / Hum in**	22° C / 40%rh
EUT Serial	MF701114110316 (Piccino), SPE28JY (Unico)	**Temp / Hum out**	N/A
EUT Config.	802.15.4 (Thread)	**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 / 1m – AHA-840	**Performed by**	Colton Aliff

18 – 25 GHz Transmit at 2405 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
20839.91	40.54	7.44	-9.09	38.89	Ave	V	120	360	54.00	-15.11
21829.22	29.49	7.68	-9.97	27.20	Ave	V	194	18	54.00	-26.80



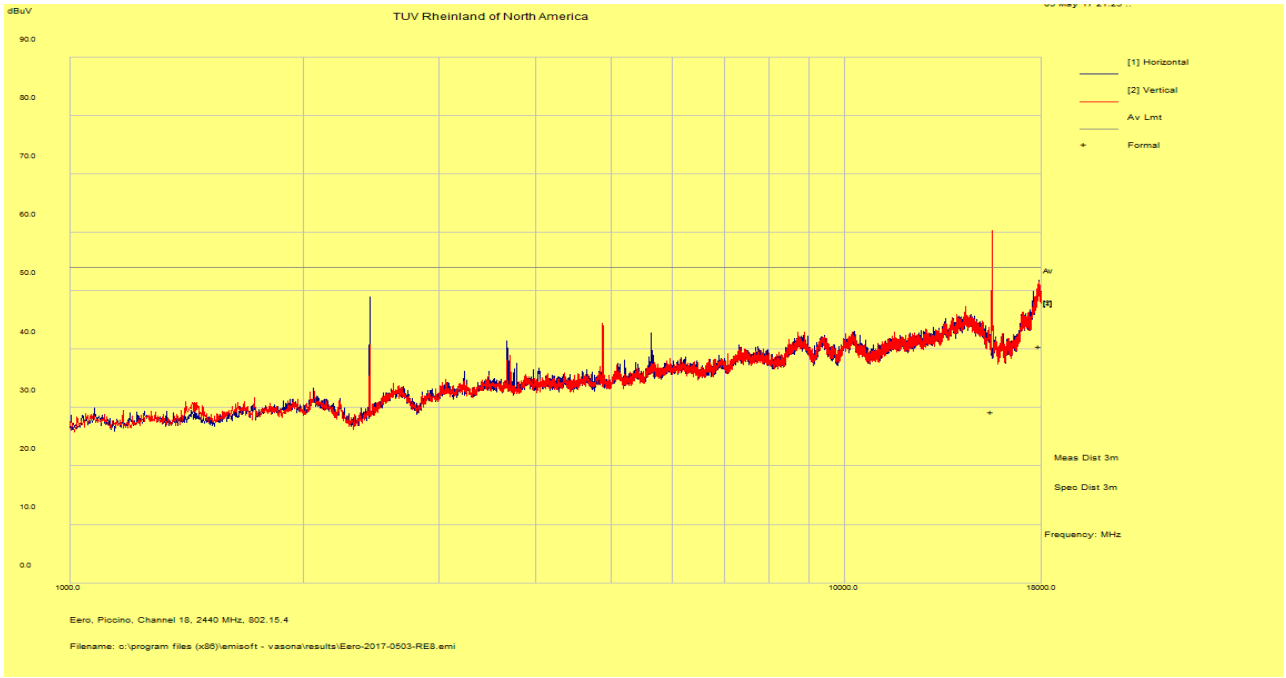
Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

Note: Worst case was observed on Thread.

SOP 1 Radiated Emissions		Tracking # 31760707.001 Page 4 of 7	
EUT Name	Wi-Fi Router	**Date**	May 3, 2017
EUT Model	D010001 (USA), D010002 (IC)	**Temp / Hum in**	22° C / 40%rh
EUT Serial	MF701114110316 (Piccino), SPE28JY (Unico)	**Temp / Hum out**	N/A
EUT Config.	802.15.4 (Thread)	**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 / 1m – AHA-840	**Performed by**	Colton Aliff

1 – 18 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
17874.15	40.37	3.71	-3.51	40.56	Ave	H	205	26	54.00	-13.44
15534.67	38.29	3.43	-12.48	29.24	Ave	V	153	180	54.00	-24.77



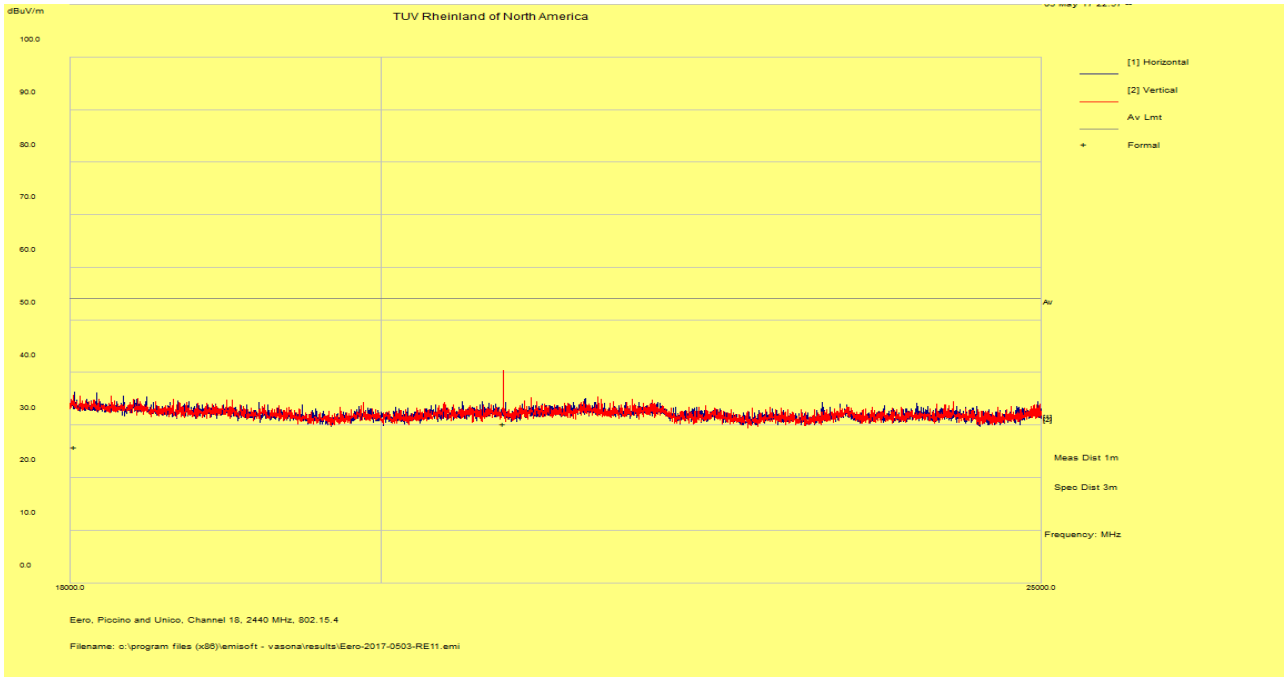
Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

Note: Worst case was observed on Thread.

SOP 1 Radiated Emissions		Tracking # 31760707.001 Page 5 of 7	
EUT Name	Wi-Fi Router	**Date**	May 3, 2017
EUT Model	D010001 (USA), D010002 (IC)	**Temp / Hum in**	22° C / 40%rh
EUT Serial	MF701114110316 (Piccino), SPE28JY (Unico)	**Temp / Hum out**	N/A
EUT Config.	802.15.4 (Thread)	**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 / 1m – AHA-840	**Performed by**	Colton Aliff

18 – 25 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
18026.39	25.99	6.91	-7.05	25.85	Ave	V	184	20	54.00	-28.16
20839.99	31.85	7.44	-9.09	30.20	Ave	V	185	46	54.00	-23.80



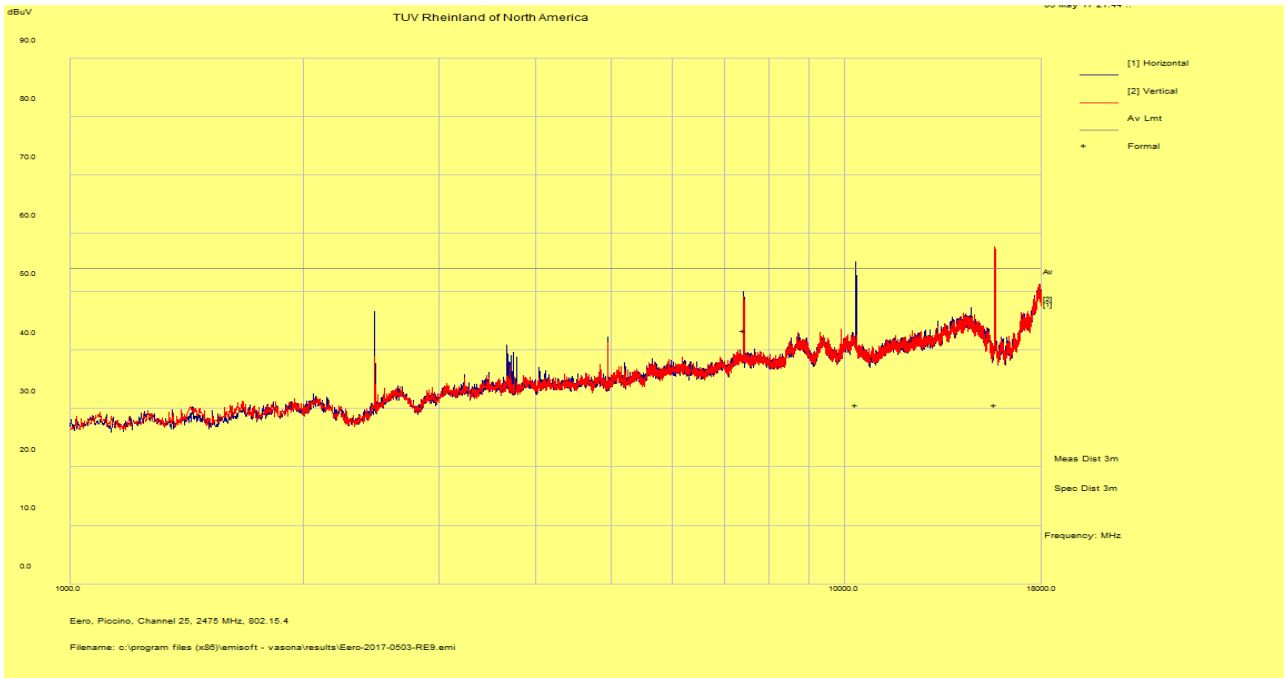
Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

Note: Worst case was observed on Thread.

SOP 1 Radiated Emissions		Tracking # 31760707.001 Page 6 of 7	
EUT Name	Wi-Fi Router	**Date**	May 3, 2017
EUT Model	D010001 (USA), D010002 (IC)	**Temp / Hum in**	22° C / 40%rh
EUT Serial	MF701114110316 (Piccino), SPE28JY (Unico)	**Temp / Hum out**	N/A
EUT Config.	802.15.4 (Thread)	**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 / 1m – AHA-840	**Performed by**	Colton Aliff

1 – 18 GHz Transmit at 2475 MHz (Hi 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
7423.37	56.67	2.23	-15.56	43.34	Ave	H	227	262	54.00	-10.66
10361.96	40.69	2.68	-12.75	30.62	Ave	H	176	84	54.00	-23.39
15663.84	39.92	3.46	-12.72	30.66	Ave	V	189	94	54.00	-23.34



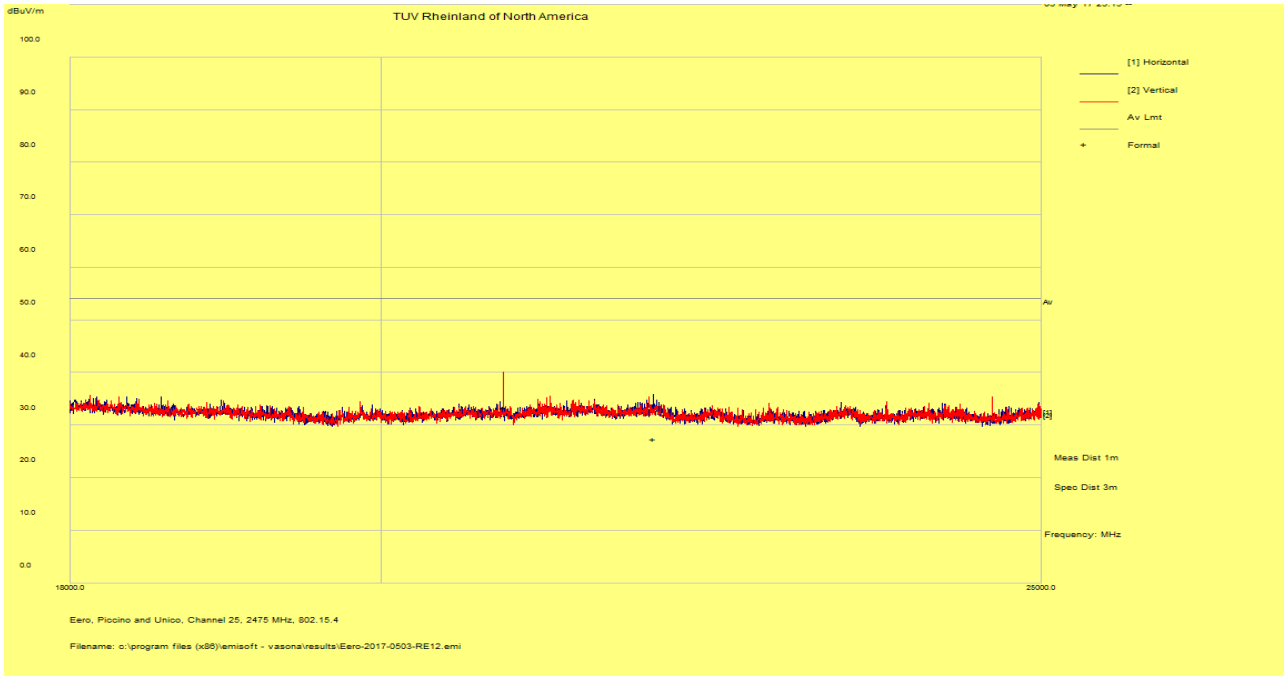
Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

Note: Worst case was observed on Thread.

SOP 1 Radiated Emissions		Tracking # 31760707.001 Page 7 of 7	
EUT Name	Wi-Fi Router	**Date**	May 3, 2017
EUT Model	D010001 (USA), D010002 (IC)	**Temp / Hum in**	22° C / 40%rh
EUT Serial	MF701114110316 (Piccino), SPE28JY (Unico)	**Temp / Hum out**	N/A
EUT Config.	802.15.4 (Thread)	**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 / 1m – AHA-840	**Performed by**	Colton Aliff

18 – 25 GHz Transmit at 2475 MHz (Hi 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
20839.95	35.01	7.44	-9.09	33.36	Ave	V	130	20	54.00	-20.64
21927.34	29.84	7.62	-10.09	27.38	Ave	V	130	50	54.00	-26.62



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

Note: Worst case was observed on Thread.

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 and RSS-GEN. Sect. 8.8.

4.6.1 Test Methodology

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

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

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

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 7: AC Conducted Emissions – Test Results

Test Conditions: Conducted Measurement at Normal Conditions only		
Antenna Type: FPCB	**Power Level:** See Test Plan	
AC Power: 120 Vac/60 Hz	**Configuration:** Tabletop	
Ambient Temperature: 22° C	**Relative Humidity:** 44% RH	
Configuration	**Frequency Range**	**Test Result**
Line 1 (Hot)	0.15 to 30 MHz	Pass
Line 2 (Neutral)	0.15 to 30 MHz	Pass

SOP 2 Conducted Emissions

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EUT Name	Wi-Fi Router	**Date**	Mar 16, 2017
EUT Model	D010001 (USA), D010002 (IC)	**Temp / Hum in**	22° C / 44% rh
EUT Serial	F719-0354-25CT-KJ8T	**Temp / Hum out**	N/A
EUT Config.	TX mode (chain 0 & 1) / Chicony PSU	**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**	Kerwinn Corpuz

Frequency	Raw	Limiter	Ins. Loss	Level	Detector	Line	Limit	Margin	Result
MHz	dBuV	dB	dB	dBuV			dBuV	dB	
0.160	49.19	9.98	0.23	59.40	QP	Live	65.44	-6.05	Pass
0.160	22.00	9.98	0.23	32.21	Avg	Live	55.44	-23.24	Pass
0.186	45.47	9.98	0.20	55.65	QP	Live	64.22	-8.57	Pass
0.186	21.84	9.98	0.20	32.02	Avg	Live	54.22	-22.20	Pass
0.246	40.54	9.99	0.15	50.68	QP	Live	61.88	-11.20	Pass
0.246	18.55	9.99	0.15	28.69	Avg	Live	51.88	-23.19	Pass
0.306	38.86	9.99	0.13	48.98	QP	Live	60.07	-11.09	Pass
0.306	15.70	9.99	0.13	25.82	Avg	Live	50.07	-24.25	Pass
0.358	33.98	10.00	0.12	44.10	QP	Live	58.77	-14.66	Pass
0.358	12.59	10.00	0.12	22.71	Avg	Live	48.77	-26.06	Pass
0.391	31.76	10.01	0.11	41.88	QP	Live	58.05	-16.17	Pass
0.391	11.86	10.01	0.11	21.98	Avg	Live	48.05	-26.07	Pass
0.422	32.69	10.01	0.11	42.81	QP	Live	57.41	-14.60	Pass
0.422	10.61	10.01	0.11	20.73	Avg	Live	47.41	-26.68	Pass
0.482	29.30	10.02	0.10	39.42	QP	Live	56.31	-16.90	Pass
0.482	12.84	10.02	0.10	22.96	Avg	Live	46.31	-23.35	Pass
0.493	29.45	10.02	0.10	39.57	QP	Live	56.12	-16.55	Pass
0.493	13.56	10.02	0.10	23.68	Avg	Live	46.12	-22.44	Pass
0.553	25.31	10.03	0.09	35.42	QP	Live	56.00	-20.58	Pass
0.553	11.73	10.03	0.09	21.85	Avg	Live	46.00	-24.15	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 transmitted at 2437 MHz in 802.11g at 6Mbps (worse case).

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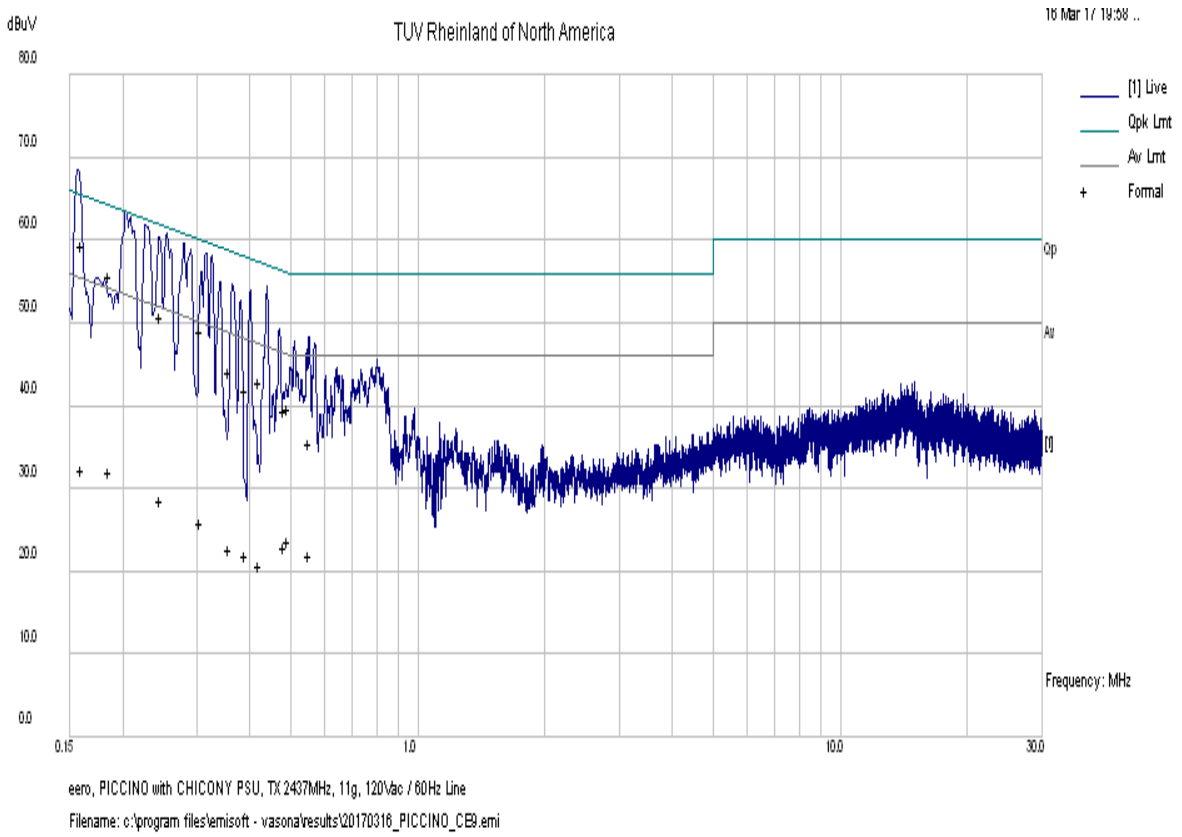
EUT Name	Wi-Fi Router	**Date**	Mar 16, 2017
EUT Model	D010001 (USA), D010002 (IC)	**Temp / Hum in**	22° C / 44% rh
EUT Serial	F719-0354-25CT-KJ8T	**Temp / Hum out**	N/A
EUT Config.	TX mode (chain 0 & 1) / Chicony PSU	**Line AC**	120Vac / 60Hz
Standard	CFR47 Part 15.207 and RSS Gen	**RBW / VBW**	9 kHz / 30 kHz
Lab/LISN	Lab #5 /Com-Power, Line 1	**Performed by**	Kerwinn Corpuz

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



Note: Met FCC Class B limit.

SOP 2 Conducted Emissions

Tracking # 31760707.001 Page 3 of 8

EUT Name	Wi-Fi Router	**Date**	Mar 16, 2017
EUT Model	D010001 (USA), D010002 (IC)	**Temp / Hum in**	22° C / 44% rh
EUT Serial	F719-0354-25CT-KJ8T	**Temp / Hum out**	N/A
EUT Config.	TX mode (chain 0 & 1) / Chicony PSU	**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**	Kerwinn Corpuz

Frequency	Raw	Limiter	Ins. Loss	Level	Detector	Line	Limit	Margin	Result
MHz	dBuV	dB	dB	dBuV			dBuV	dB	
0.163	47.12	9.98	0.23	57.33	QP	Neutral	65.30	-7.97	Pass
0.163	21.11	9.98	0.23	31.32	Avg	Neutral	55.30	-23.98	Pass
0.174	46.75	9.97	0.22	56.94	QP	Neutral	64.76	-7.82	Pass
0.174	21.73	9.97	0.22	31.91	Avg	Neutral	54.76	-22.85	Pass
0.193	45.03	9.98	0.20	55.21	QP	Neutral	63.91	-8.70	Pass
0.193	18.82	9.98	0.20	29.00	Avg	Neutral	53.91	-24.91	Pass
0.256	39.95	9.99	0.15	50.08	QP	Neutral	61.57	-11.49	Pass
0.256	17.26	9.99	0.15	27.39	Avg	Neutral	51.57	-24.18	Pass
0.327	34.77	10.00	0.12	44.89	QP	Neutral	59.53	-14.63	Pass
0.327	13.56	10.00	0.12	23.68	Avg	Neutral	49.53	-25.85	Pass
0.386	30.72	10.01	0.11	40.84	QP	Neutral	58.14	-17.30	Pass
0.386	10.95	10.01	0.11	21.07	Avg	Neutral	48.14	-27.07	Pass
0.388	32.14	10.01	0.11	42.26	QP	Neutral	58.10	-15.84	Pass
0.388	11.04	10.01	0.11	21.16	Avg	Neutral	48.10	-26.94	Pass
0.446	26.10	10.01	0.10	36.21	QP	Neutral	56.95	-20.74	Pass
0.446	13.23	10.01	0.10	23.35	Avg	Neutral	46.95	-23.61	Pass
0.532	27.16	10.02	0.09	37.28	QP	Neutral	56.00	-18.72	Pass
0.532	14.46	10.02	0.09	24.58	Avg	Neutral	46.00	-21.42	Pass
0.617	23.33	10.03	0.09	33.45	QP	Neutral	56.00	-22.55	Pass
0.617	14.12	10.03	0.09	24.24	Avg	Neutral	46.00	-21.76	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 transmitted at 2437 MHz in 802.11g at 6Mbps (worse case).

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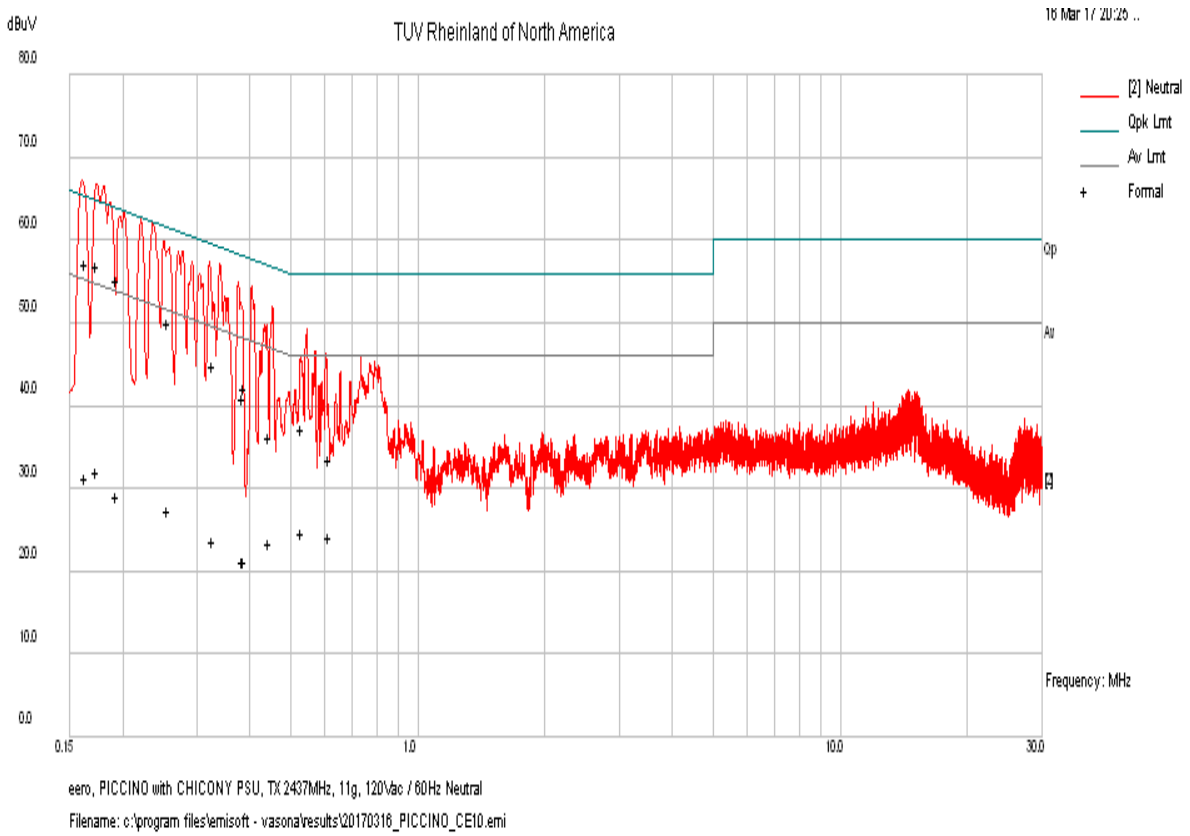
EUT Name	Wi-Fi Router	**Date**	Mar 16, 2017
EUT Model	D010001 (USA), D010002 (IC)	**Temp / Hum in**	22° C / 44% rh
EUT Serial	F719-0354-25CT-KJ8T	**Temp / Hum out**	N/A
EUT Config.	TX mode (chain 0 & 1) / Chicony PSU	**Line AC**	120Vac / 60Hz
Standard	CFR47 Part 15.207 and RSS Gen	**RBW / VBW**	9 kHz / 30 kHz
Lab/LISN	Lab #5 /Com-Power, Line 2	**Performed by**	Kerwinn Corpuz

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



Note: Met FCC Class B Limit.

SOP 2 Conducted Emissions

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EUT Name	Wi-Fi Router	**Date**	Mar 16, 2017
EUT Model	D010001 (USA), D010002 (IC)	**Temp / Hum in**	22° C / 44% rh
EUT Serial	XF0113M120094	**Temp / Hum out**	N/A
EUT Config.	TX mode (chain 0 & 1) / FoxLink PSU	**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**	Kerwinn Corpuz

Frequency	Raw	Limiter	Ins. Loss	Level	Detector	Line	Limit	Margin	Result
MHz	dBuV	dB	dB	dBuV			dBuV	dB	
0.150	51.40	9.97	0.25	61.62	QP	Live	66.00	-4.38	Pass
0.150	26.39	9.97	0.25	36.61	Avg	Live	56.00	-19.39	Pass
0.193	48.60	9.98	0.20	58.77	QP	Live	63.91	-5.14	Pass
0.193	21.88	9.98	0.20	32.06	Avg	Live	53.91	-21.86	Pass
0.219	47.53	9.98	0.17	57.69	QP	Live	62.86	-5.17	Pass
0.219	20.46	9.98	0.17	30.62	Avg	Live	52.86	-22.24	Pass
0.260	44.31	9.99	0.15	54.44	QP	Live	61.43	-6.99	Pass
0.260	25.28	9.99	0.15	35.42	Avg	Live	51.43	-16.01	Pass
0.303	42.58	9.99	0.13	52.70	QP	Live	60.16	-7.46	Pass
0.303	20.82	9.99	0.13	30.94	Avg	Live	50.16	-19.22	Pass
0.403	38.28	10.01	0.11	48.40	QP	Live	57.78	-9.39	Pass
0.403	16.83	10.01	0.11	26.95	Avg	Live	47.78	-20.84	Pass
0.537	34.45	10.02	0.09	44.57	QP	Live	56.00	-11.43	Pass
0.537	24.25	10.02	0.09	34.36	Avg	Live	46.00	-11.64	Pass
0.652	29.43	10.03	0.08	39.54	QP	Live	56.00	-16.46	Pass
0.652	13.51	10.03	0.08	23.62	Avg	Live	46.00	-22.38	Pass
0.719	27.97	10.03	0.08	38.09	QP	Live	56.00	-17.91	Pass
0.719	12.15	10.03	0.08	22.26	Avg	Live	46.00	-23.74	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: The EUT was set horizontally on the table top and transmitted at 2437 MHz in 802.11g at 6Mbps (worse case).

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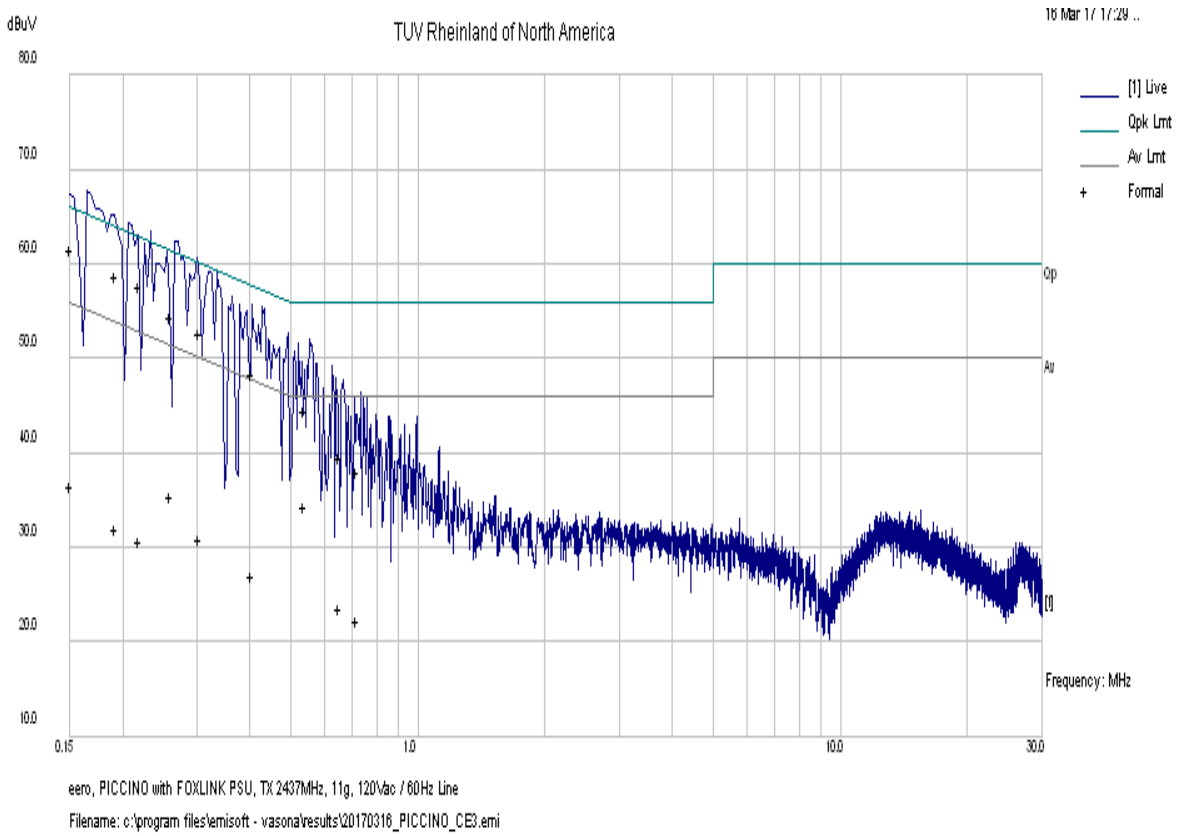
EUT Name	Wi-Fi Router	**Date**	Mar 16, 2017
EUT Model	D010001 (USA), D010002 (IC)	**Temp / Hum in**	22° C / 44% rh
EUT Serial	XF0113M120094	**Temp / Hum out**	N/A
EUT Config.	TX mode (chain 0 & 1) / FoxLink PSU	**Line AC**	120Vac / 60Hz
Standard	CFR47 Part 15.207 and RSS Gen	**RBW / VBW**	9 kHz / 30 kHz
Lab/LISN	Lab #5 /Com-Power, Line 1	**Performed by**	Kerwinn Corpuz

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



Note: Met FCC Class B limit.

SOP 2 Conducted Emissions

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EUT Name	Wi-Fi Router	**Date**	Mar 16, 2017
EUT Model	D010001 (USA), D010002 (IC)	**Temp / Hum in**	22° C / 44% rh
EUT Serial	XF0113M120094	**Temp / Hum out**	N/A
EUT Config.	TX mode (chain 0 & 1) / FoxLink PSU	**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**	Kerwinn Corpuz

Frequency	Raw	Limiter	Ins. Loss	Level	Detector	Line	Limit	Margin	Result
MHz	dBuV	dB	dB	dBuV			dBuV	dB	
0.150	51.84	9.97	0.25	62.06	QP	Neutral	66.00	-3.94	Pass
0.150	13.00	9.97	0.25	23.22	Avg	Neutral	56.00	-32.78	Pass
0.201	48.17	9.98	0.19	58.34	QP	Neutral	63.55	-5.21	Pass
0.201	19.18	9.98	0.19	29.34	Avg	Neutral	53.55	-24.21	Pass
0.242	44.98	9.98	0.16	55.12	QP	Neutral	62.02	-6.90	Pass
0.242	18.21	9.98	0.16	28.35	Avg	Neutral	52.02	-23.67	Pass
0.301	41.14	9.99	0.13	51.26	QP	Neutral	60.20	-8.94	Pass
0.301	12.80	9.99	0.13	22.92	Avg	Neutral	50.20	-27.29	Pass
0.378	38.16	10.01	0.11	48.29	QP	Neutral	58.31	-10.03	Pass
0.378	13.20	10.01	0.11	23.33	Avg	Neutral	48.31	-24.99	Pass
0.469	34.26	10.02	0.10	44.38	QP	Neutral	56.54	-12.16	Pass
0.469	14.42	10.02	0.10	24.53	Avg	Neutral	46.54	-22.00	Pass
0.515	24.46	10.02	0.10	34.58	QP	Neutral	56.00	-21.42	Pass
0.515	20.98	10.02	0.10	31.10	Avg	Neutral	46.00	-14.90	Pass
0.547	30.76	10.02	0.09	40.87	QP	Neutral	56.00	-15.13	Pass
0.547	20.35	10.02	0.09	30.47	Avg	Neutral	46.00	-15.53	Pass
0.618	29.72	10.03	0.09	39.83	QP	Neutral	56.00	-16.17	Pass
0.618	15.17	10.03	0.09	25.28	Avg	Neutral	46.00	-20.72	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: The EUT was set horizontally on the table top and transmitted at 2437 MHz in 802.11g at 6Mbps (worse case).

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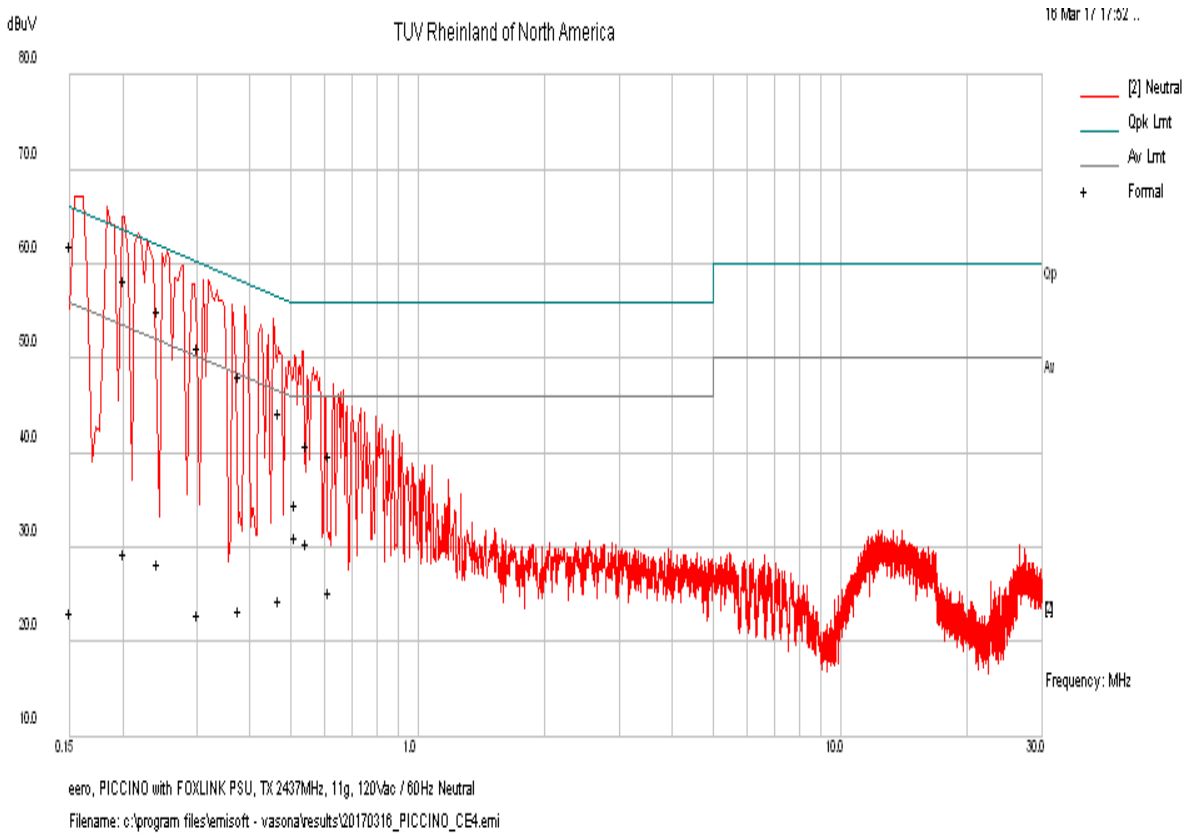
EUT Name	Wi-Fi Router	**Date**	Mar 16, 2017
EUT Model	D010001 (USA), D010002 (IC)	**Temp / Hum in**	22° C / 44% rh
EUT Serial	XF0113M120094	**Temp / Hum out**	N/A
EUT Config.	TX mode (chain 0 & 1) / FoxLink PSU	**Line AC**	120Vac / 60Hz
Standard	CFR47 Part 15.207 and RSS Gen	**RBW / VBW**	9 kHz / 30 kHz
Lab/LISN	Lab #5 /Com-Power, Line 2	**Performed by**	Kerwinn Corpuz

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 document, we try to prove the safety of radiation harmfulness to the human body for our product. The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1310 is followed. The Gain of the antenna used in this calculation is declared by the manufacturer, and the maximum total power input to the antenna is measured. Through the Friis transmission formula and the maximum gain of the antenna, we can calculate the distance, away from the product, where the limit of MPE is reached.

Although the Friis transmission formula is a far field assumption, the calculated result of that is an over-prediction for near field power density. We will take that as the worst case to specify the safety range.

4.7.2 RF Exposure Limit

According to FCC 1.1310 table 1: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b)

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm2)	Average Time (minutes)
(A)Limits For Occupational / Control Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f^2)	6
30–300	…	…	1.0	6
300 - 1500	…	…	f/300	6
1500 - 100,000	…	…	5	6
(B)Limits For General Population / Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/ f^2)	30
30–300	27.5	0.037	0.2	30
300 - 1500	…	…	f/1500	30
1500 - 100,000	…	…	1.0	30

F = Frequency in MHz
* = Plane-wave equivalent power density

4.7.3 EUT Operating Condition

The software provided by 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 at least 20cm away from the body of the user. Warning statement to the user for keeping at least 20cm or more separation distance with the antenna should be included in user's manual. So, this device is classified as a **Mobile Device**.

See below calculation for 2.437 GHz RF Exposure at a distance of 20cm.

4.7.5 Test Results

4.7.5.1 Antenna Gain

The 2.405 GHz transmitting max antenna gain is +4.14 dBi or 2.59 (numeric).

4.7.5.2 Output Power into Antenna & RF Exposure value at distance 20cm:

Calculations for this report are based on highest power measurement.

Limit for MPE (from FCC part 1.1310 table1) is 1.0 mW/cm^2

The highest measured power is +18.65 dBm or 73.28 mW.

Using the Friss transmission formula, the EIRP is Pout*G, and R is 20cm.

Pd = (73.28*2.59) / (1600π) = 0.0378 mW/cm^2, which is 0.9622 mW/cm^2 below to the limit.

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

4.7.6 Sample Calculation

The Friss transmission formula: $Pd = (Pout*G) / (4*\pi*R^2)$

Where;

Pd = power density in mW/cm^2
Pout = output power to antenna in mW
G = gain of antenna in linear scale
$\pi \approx 3.1416$
R = distance between observation point and center of the radiator in cm

Ref. : David K. Cheng, *Field and Wave Electromagnetics*, Second Edition, Page 640, Eq. (11-133).

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	06/15/2018
Horn Antenna	Sunol Sciences	3115	9710-5301	10/08/2015	10/08/2017
Antenna (18-40 GHz)	Com-Power	AHA-840	105005	07/08/2015	07/08/2017
Loop Antenna	EMCO	6502	9110-2683	06/13/2016	06/13/2017
Spectrum Analyzer	Rohde & Schwarz	FSL6	100169	01/13/2017	01/13/2018
Spectrum Analyzer	Agilent	N9038A	MY552260210	01/16/2017	01/16/2018
Spectrum Analyzer	Agilent	N9030A	MY52350885	05/17/2016	05/17/2017
Spectrum Analyzer	Rohde Schwarz	ESIB40	832427/002	01/16/2017	01/16/2018
Spectrum Analyzer	Rohde Schwarz	FSV40	1321.3008K40	08/30/2016	08/30/2017
Amplifier	Sonoma Instruments	310	165516	01/19/2017	01/19/2018
Amplifier	Miteq	TTA1800-30-HG	2020728	11/12/2016	11/12/2017
Amplifier	Rohde & Schwarz	TS-PR26	100011	11/04/2017	11/04/2018
Amplifier	Rohde & Schwarz	TS-PR40	100012	08/02/2017	08/02/2017
Power Meter	Agilent	E4418B	MY45103902	01/11/2017	01/11/2018
Power Sensor	Hewlett Packard	8482A	1925A04647	01/01/2017	01/01/2018
Thermometer	Fluke	52II	88650033	11/04/2016	11/04/2017
Thermo Chamber	Espec	BTZ-133	0613436	NCR	NCR
Multimeter	Fluke	177	92780312	01/11/2017	01/11/2018
DC Power Supply	Agilent	E3634A	MY400004331	01/12/2017	01/12/2018
Notch Filter	Micro-Tronics	BRM50702	037	07/18/2016	07/18/2017
Signal Generator	Anritsu	MG3694A	42803	01/13/2017	01/13/2018
Signal Generator	Rohde & Schwarz	SMF100A	1167.0000K02	09/06/2016	09/06/2017
Signal Generator	Rohde & Schwarz	SMBV100A	1407.6004K02	09/06/2016	09/06/2017
Power Sensors	Rohde & Schwarz	OSP120	1520.9010.02	09/06/2016	09/06/2017

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

NCR = No Calibration Required

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	eero inc.
Address	500 Howard Street, Suite 900
City, State, Zip	San Francisco, CA 94105
Country	USA
Phone	(415) 738-7972
Fax	

Table 9: Technical Contact Information

Name	Clifford Clarke
E-mail	cliff@eero.com
Phone	(415) 738-7972
Fax	

6.3 Equipment Under Test (EUT)

Table 10: EUT Specifications

EUT Specifications	
Dimensions	W: 2.875in (73mm) x D: 4.750in (121mm) x H: 1.188in (30mm)
AC Input	100-240V AC, 50 – 60 Hz
Environment	Indoor
Operating Temperature Range:	0 to 35 degrees C
Multiple Feeds:	☐ Yes and how many ☒ No
Product Marketing Name (PMN)	D010001 (USA), D010002 (IC)
Hardware Version Identification Number (HVIN)	D010001 (USA), D010002 (IC)
Firmware Version Identification Number (FVIN)	3.0.0
802.11-radio modules	
Operating Mode	802.15.1, 802.15.4, 802.11g, 802.11n (HT20 and HT40)
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 5 – 3 custom antennas at 2.4GHz. See Table 11 for details
Antenna Gain	Antenna 3 = +4.08 dBi, Antenna 4 = +3.64 dBi, Antenna 5 = +4.14 dBi
Modulation Type	☒ Thread (Zigbee) ☒ BLE ☒ DSSS ☒ OFDM ☒ Other describe: 16QAM and 64 QAM
Data Rate	Thread (Zigbee): 250 kbps BLE: 1-2 Mbps 802.11g: 2 Spatial Streams: 6, 9, 12, 18, 24, 36, 48, 54 Mbps 802.11n HT20: 2 Spatial Streams: 13, 26, 39, 52, 78, 104, 117, 130 /156 Mbps (LGI) 802.11n HT40: 2 Spatial Streams: 27, 54, 81, 108, 162, 216, 243, 270 / 324, 370 Mbps (LGI)
TX/RX Chain (s)	MIMO (2x2); single for BLE and Thread (Zigbee)

EUT Specifications	
Directional Gain Type	☐ Correlated ☒ Beam-Forming ☐ Other describe:
Type of Equipment	☐ Table Top ☐ Wall-mount ☐ Floor standing cabinet ☒ Other: Wall-mount at AC outlet
Note: All 2 chains will be on / transmitted at all time.	

Table 11: Antenna Information

Number	Antenna Type	Description	Max Gain (dBi)
Antenna 1	Flex PCB	5 GHz Wi-Fi U-NII-1 Band, Chain 0	6.29
Antenna 2	Flex PCB	5 GHz Wi-Fi U-NII-1 Band, Chain 1	4.97
Antenna 1	Flex PCB	5 GHz Wi-Fi U-NII-2A Band, Chain 0	5.96
Antenna 2	Flex PCB	5 GHz Wi-Fi U-NII-2A Band, Chain 1	4.86
Antenna 1	Flex PCB	5 GHz Wi-Fi U-NII-2C Band, Chain 0	4.74
Antenna 2	Flex PCB	5 GHz Wi-Fi U-NII-2C Band, Chain 1	5.13
Antenna 1	Flex PCB	5 GHz Wi-Fi U-NII-3 Band, Chain 0	4.94
Antenna 2	Flex PCB	5 GHz Wi-Fi U-NII-3 Band, Chain 1	5.22
Antenna 3	Flex PCB	2.4 GHz Wi-Fi Chain 0	4.08
Antenna 4	Flex PCB	2.4 GHz Wi-Fi Chain 1	3.64
Antenna 5	Flex PCB	Bluetooth LE and Thread (Zigbee)	4.14

Table 12: EUT Channel Power Specifications

Total Power (Summed 2 Chains) for Non-Beamforming Mode

No.	Frequency (MHz)	Target Power Value dBm					
		802.11g	802.11n HT20	802.11n HT40	BLE	Thread (zigbee)	
1	2412	26.94**	27.00**				
3	2422			24.50*			
5	2432						
6	2437	29.89****	29.84****	29.66***			
9	2452			24.88*			
11	2462	28.63****	28.62****				
0	2402				12.78*****		
20	2442				12.45*****		
39	2480				12.00*****		
11	2405					18.65******	
18	2440					18.49******	
25	2475					17.26******	

Note: 1. The adjusted power target values are updated at the evaluated frequencies.
2. TP setting: * = 21, ** = 24, *** = 26, **** = 27, ***** = 14, ****** = 19.
3. BLE and Thread (Zigbee) are Max Power measured.

Total Power (Summed 2 Chains) for Beamforming Mode

No.	Frequency (MHz)	Target Power Value dBm					
		802.11b	802.11g	802.11n HT20	802.11n HT40		
1	2412		26.94**	27.00**			
3	2422				24.50*		
5	2432						
6	2437		28.85****	28.79****	28.86***		
9	2452				24.88*		
11	2462		28.63****	28.62****			

Note: 1. The adjusted power target values are updated at the evaluated frequencies.
2. TP setting: * = 21, ** = 24, *** = 25.5, **** = 26, ***** = 15.

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?
Ethernet	RJ45	☒ No	☒ Metric: 2 m	☐ N/A

Table 14: Supported Equipment

Equipment	Manufacturer	Model	Serial	Used for
Laptop	Dell	Latitude	35521341769	Setup EUT operating channel
Note: None.				

Table 15: Description of Sample used for Testing

Device	Serial	RF Connection	CFR47 Part 15.247
Wi-Fi Router	MF701114110316 (Piccino) & SPE28JY (Unico)	FPCB Antenna	TX Emissions, AC Conducted Emission
		Direct Connection	Peak Transmit Power, Peak Power Spectral Density, Occupied Bandwidth Band-Edge Out-of-Band Emission
Note: 1. Chicony PSU S/N: F719-0354-25CT-KJ8T, FoxLink PSU S/N: XF70113M120094			

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

Device	Antenna	Mode	Setup Photo (X-Axis)	Setup Photo (Y-Axis)	Setup Photo (Z-Axis)
Wi-Fi Router	FPCB	Transmit	N/A	EUT standing up	N/A
Note: N/A.					

6.4 Test Specifications

Table 17: Test Specifications

Emissions and Immunity	
Standard	**Requirement**
CFR 47 Part 15.247: 2016	All
RSS 247 Issue 2, 2017	All

END OF REPORT