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Emissions
Test Report

EUT Name: PMT (HDT)

Model No.: PMT (HDT)

CFR 47 Part 15.247:2020 and RSS 247:2017

Prepared for:

Actall Corporation
2017 Curtis St.
Denver, CO 80205 USA

Prepared by:

TUV Rheinland of North America, Inc.
5015 Brandin Ct
Fremont, CA 94538 U.S.A.
Tel: (925) 249-9123
Fax: (925) 249-9124
http://www.tuv.com/

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Revisions

Revision No.	Date MM/DD/YYYY	Reason for Change	Author
0	07/10/2020	Original Document	RK

Note: Latest revision report will replace all previous reports.

Statement of Compliance

Applicant:	Actall Corporation 2017 Curtis St Denver, CO 80205 USA
Requester / Applicant:	Actall Corporation
Name of Equipment:	PMT (HDT)
Model No.	PMT (HDT)
Type of Equipment:	Intentional Radiator
Application of Regulations:	CFR 47 Part 15.247:2020 and RSS 247:2017
Test Dates:	June 29th, 2020 to July 3rd, 2020

Guidance Documents:

Emissions: ANSI C63.10-2013, KDB 558074 D01 15.247 Measurement Guidance v05

Test Methods:

Emissions: ANSI C63.10-2013, KDB 558074 D01 15.247 Measurement Guidance v05

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.

Rachana Khanduri	7/10/2020	Osvaldo Casorla	7/10/2020
Test Engineer	Date	Laboratory Signature	Date

Testing Cert #3331.02 **US1131** **US0185**

1 Executive Summary

1.1 Scope

This report is intended to document the status of conformance with the requirements of the CFR 47 Part 15.247:2020 and RSS 247:2017 and RSS 247: 2017 based on the results of testing performed on June 29th, 2020 to July 3rd, 2020 on the PMT (HDT) manufactured by Actall Corporation 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 were performed to evaluate the EMC performance of the EUT in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report.

The report documents the custom 2.4GHz solution from TI based on the CC2500 chip radio characteristics for the PMT (HDT).

1.3 Summary of Test Results

Table 1: Summary of Test Results

Test	Test Method ANSI C63.10:2013	Test Parameters	Measured Value (Worse Case)	Result
2400 MHz to 2483.5 MHz Band				
Spurious Emission in Transmitted Mode	CFR47 15.209, CFR47 15.247 (d), RSS 247 Sect.5.5	Class B	5.92dB (Margin)	**Complied**
Restricted Bands of Operation	CFR47 15.205, RSS 247 Sect.5.5	Class B		**Complied**
AC Power Conducted Emission	CFR47 15.207, RSS-GEN Sect.8.8	Class B	Battery Powered	**N/A**
Occupied Bandwidth	CFR47 15.247 (a1), RSS 247 Sect. 5.1(a)	N/A	20dB BW = 416.667 KHz	**Complied**
Channel Separation	CFR47 15.247 (a1), RSS 247 Sect. 5.1(b)	> Two-Third 20dB BW	4246.79 kHz	**Complied**
Number of Hopping Channels	CFR47 15.247 (a1)(iii), RSS 247 Sect. 5.1(d)	>15	16 Channels	**Complied**
Average time occupancy of Channel	CFR47 15.247 (a1), RSS 247 Sect. 5.1(d)	< 0.4 sec	142.4359 ms	**Complied**
Maximum Transmitted Power	CFR47 15.247 (a1), RSS 247 Sect. 5.1 (b)	<125 mWatts	0.527 mW	**Complied**
Out of Band Emission	CFR47 15.247 (d), RSS 247 Sect. 5.5	< -20 dBr	-33.69dBc @ 2608.97MHz,High	**Complied**

Note: 1. Meet restricted band emission requirements.
2. This report is only documented for 2400 – 2483.5MHz.

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, and 5015 Brandin Ct, Fremont, CA 94538 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 17025:2017. The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated annually.

2.1.3 ISED

The Pleasanton 5-meter Semi-Anechoic Chamber, has been accepted by ISED to perform testing to 3 and 5 meters based on the test procedures described in ANSI C63.4-2014. The Fremont 10-meter Semi-Anechoic Chamber, has been accepted by ISED to perform testing to 3 and 10 meters based on the test procedures described in ANSI C63.4-2014. Under 2932D

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 and 5015 Brandin Ct, Fremont, CA 94538 has been assessed and approved in accordance with the Regulations for Voluntary Control Measures.

VCCI Registration No. for Pleasanton: A-0326

VCCI Registration No. for Fremont: A-0327

2.1.5 Acceptance by Mutual Recognition Arrangement

The United States has an established agreement with specific countries under the Asia Pacific Laboratory Accreditation Corporation (APLAC) Mutual Recognition Arrangement. Under this agreement, all TUV Rheinland at 1279 Quarry Ln, Pleasanton, CA 94566 and 5015 Brandin Ct, Fremont, CA 94538 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 and 5015 Brandin Ct, Fremont, CA 94538 USA.

2.2.1 Emission Test Facility

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

2.3 Measurement Uncertainty

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

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

2.3.1 Sample Calculation – radiated & conducted emissions

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

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

Where: RAW = Measured level before correction (dBμV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

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

Sample radiated emissions calculation @ 30 MHz

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

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

2.3.2 Measurement Uncertainty Emissions

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

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 17025:2017.

3 Product Information

3.1 Product Description

The Model PMT (HDT) has wireless capability, custom 2.4GHz, operating in the 2400-2483.5 MHz Band.

3.2 Equipment Configuration

A description of the equipment configuration is given in the Test Plan Section. The EUT was tested as called for in the test standard and was configured and operated in a manner consistent with its intended use. The EUT was connected to rated power and allowed to reach intended operating conditions. The placement of the EUT system components was guided by the test standard and selected to represent typical installation conditions.

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

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

3.3 Operating Mode

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

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

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 PMT (HDT) has 1 dedicated chip antenna that has maximum gain of -1.2 dBi. It is integrated into the EUT PCB and is not easily accessible to the end user.

4 Emission

Testing was performed in accordance with CFR 47 Part 15.247:2020 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.

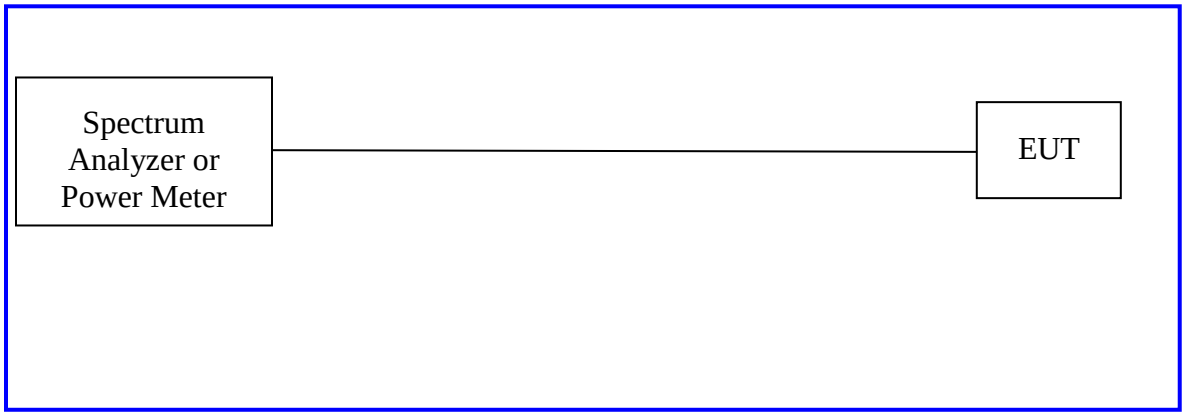
The maximum output power and harmonics shall not exceed CFR47 Part 15.247 (a)(1) and RSS 247 Sect. 5.1(b)

Frequency hopping systems in the 2400-2483.5 MHz band: 125 mW.

4.1.1 **Test Method**

The conducted method was used to measure the channel power output according to ANSI C63.10:2013 Section 11.9.1.1. The measurement was performed with modulation per CFR47 Part 15.247 (a)(1) and RSS-247 Sect. 5.4. This test was conducted on 3 channels. The worst mode result indicated below.

Test Setup:

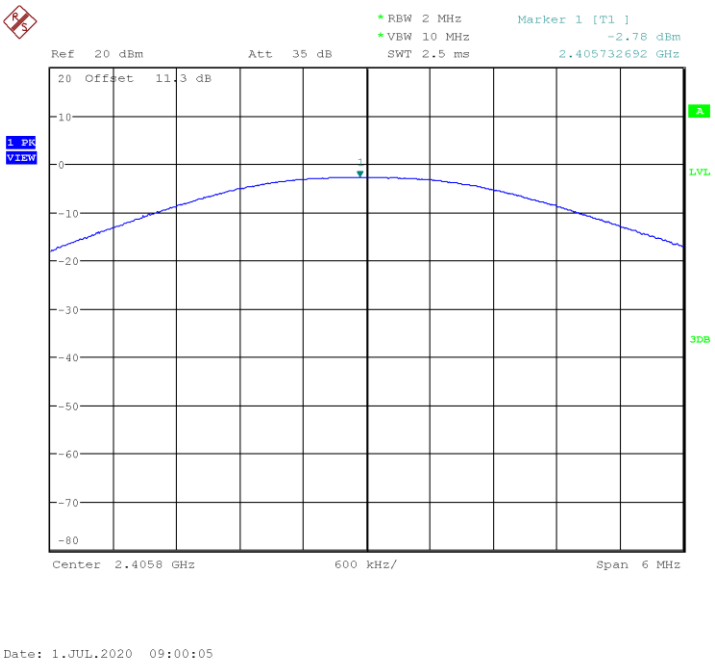


4.1.2 **Results**

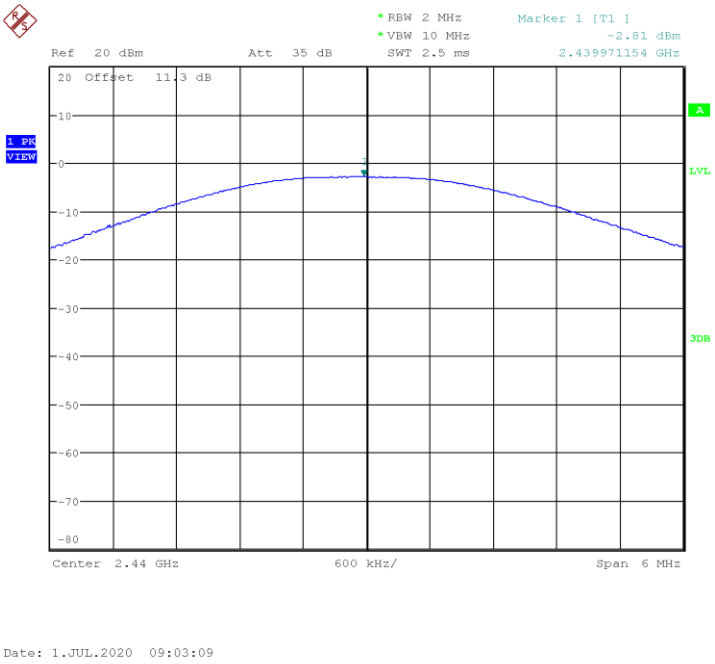
As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

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

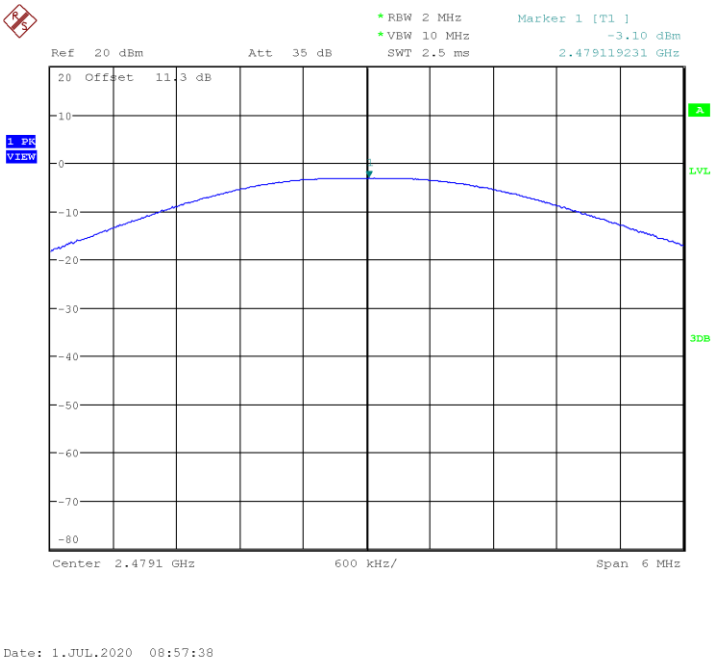
Conducted Output Power			
Operating Channel	**Limit [dBm]**	**Power [dBm]**	**Margin [dB]**
2405.8 MHz	+21.00	-2.78	-23.78
2440.0 MHz	+21.00	-2.81	-23.81
2479.1 MHz	+21.00	-3.10	-24.10
Note: The worst-case modes at low, middle, and high frequencies were investigated.			



Plot 1. Output Power- 2405.8MHz



Plot 2. Output Power- 2440MHz



Plot 3. Output Power- 2479.1MHz

4.2 Occupied Bandwidth

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

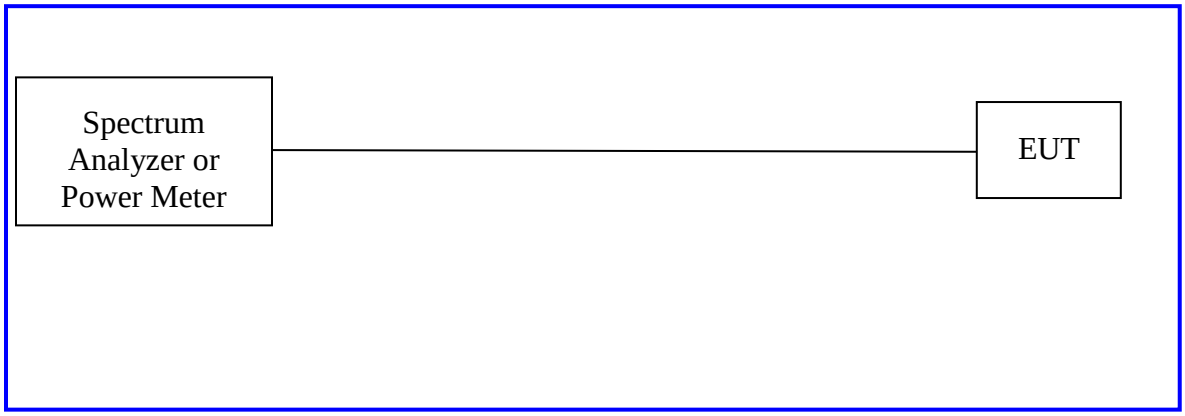
The 99% bandwidth is the bandwidth in which 99% of the transmitted power occupied.

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

4.2.1 Test Method

The conducted method was used to measure the occupied bandwidth. The measurement was performed with modulation per CFR47 15.247 (a)(1) and RSS 247 Sect. 5.1(a). This test was conducted on 3 channels. The worst sample result indicated below.

Test Setup:

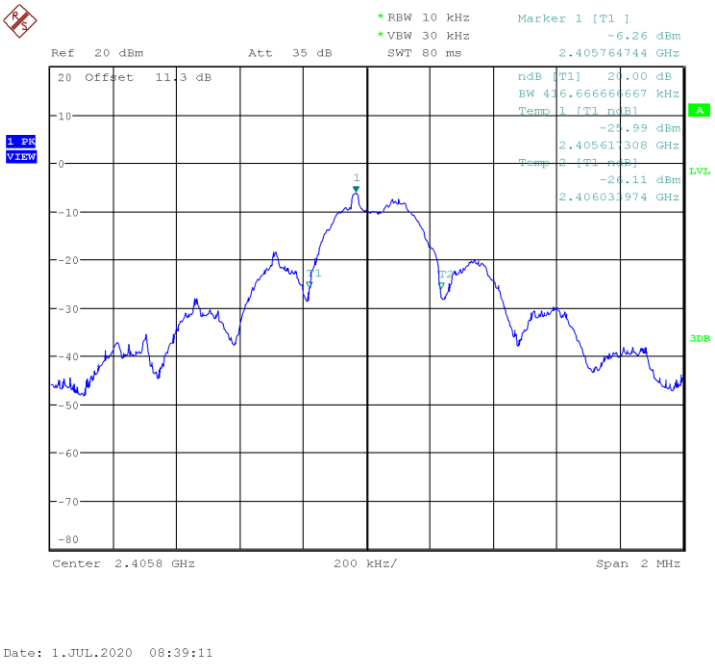


4.2.2 **Results**

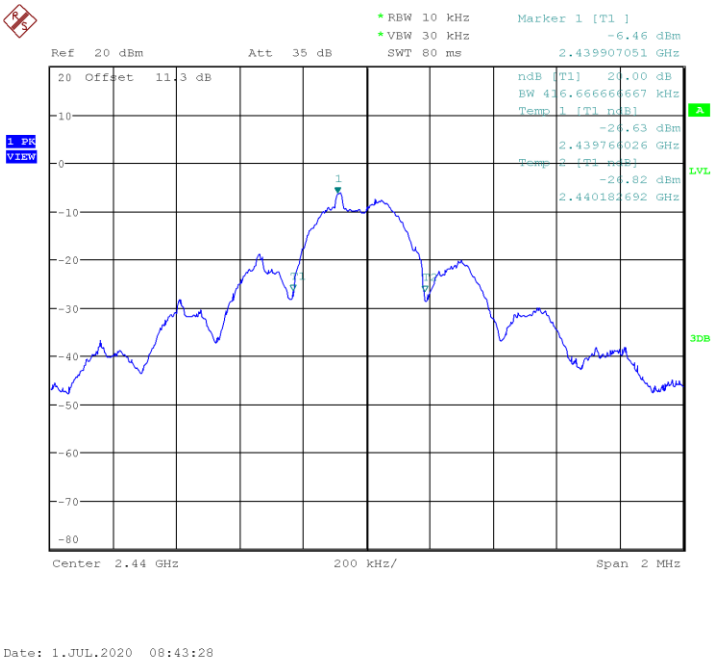
These measurements were used for information only

Table 3: Occupied Bandwidth – Test Results

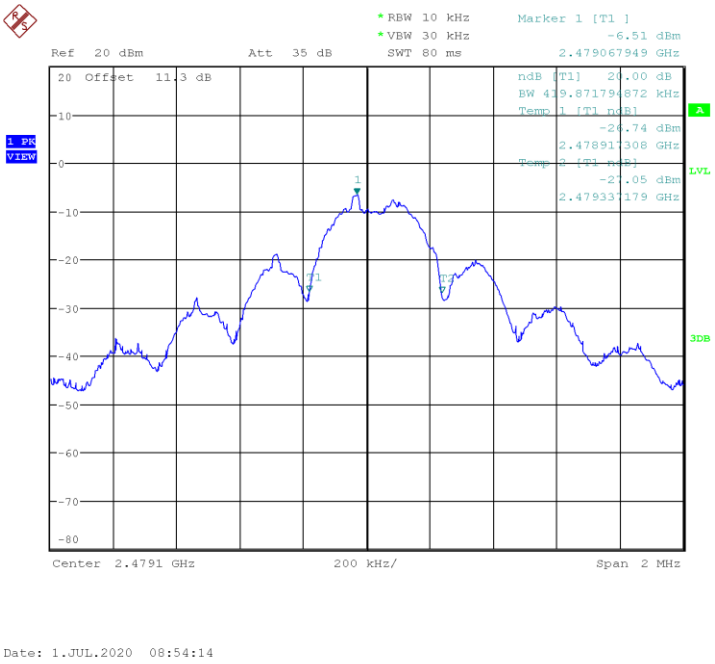
Occupied Bandwidth (MHz)		
Freq. (MHz)	**20dB Bandwidth KHz**	**99% Bandwidth KHz**
2405.8	416.667	785.256
2440.0	416.667	772.436
2479.1	419.872	798.077
Note: The worst-case modes at low, middle, and high frequencies were investigated.		



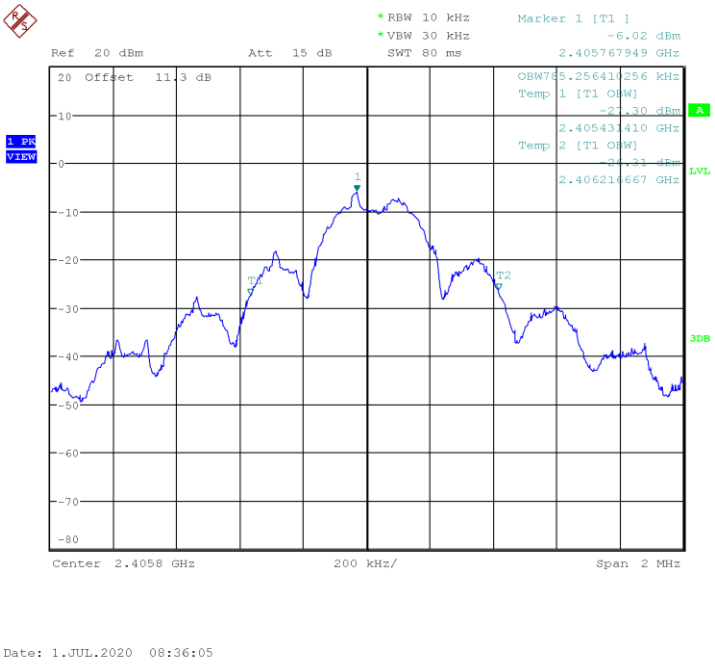
Plot 4. 20dB Bandwidth – 2405.8 MHz



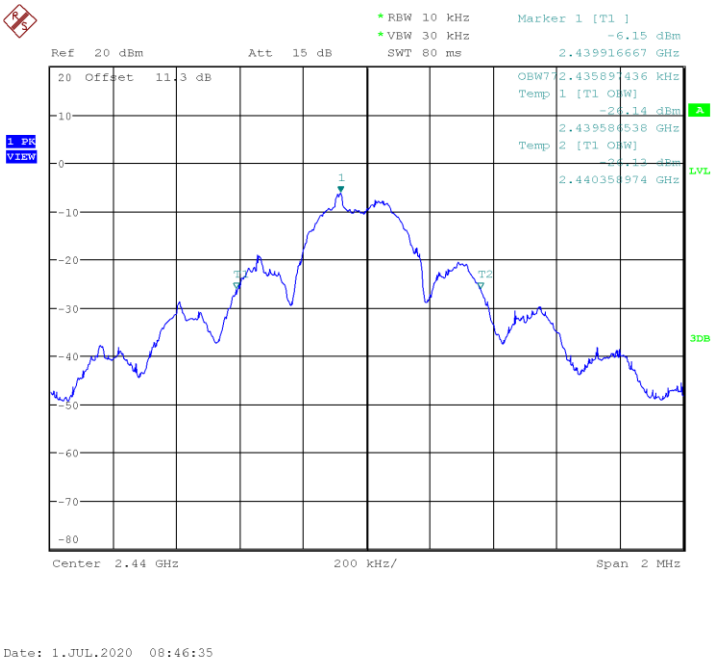
Plot 5. 20dB Bandwidth – 2440 MHz



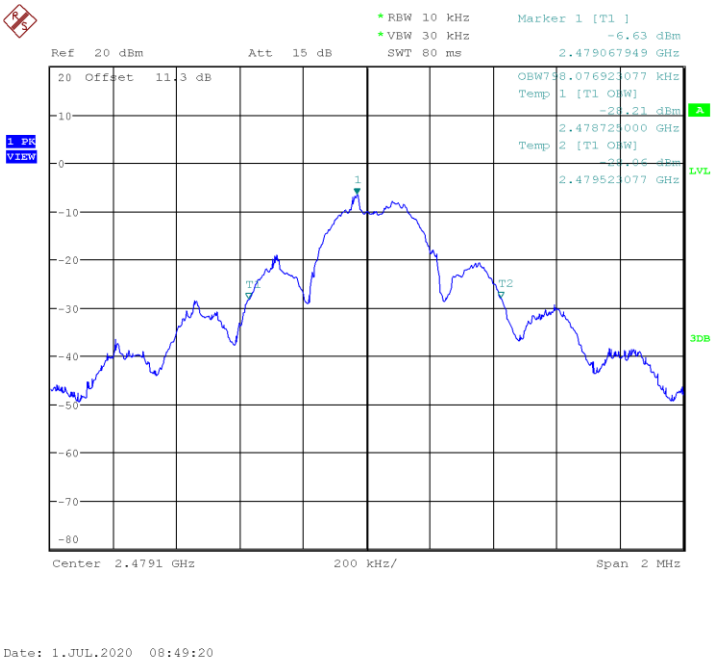
Plot 6. 20dB Bandwidth – 2479.1 MHz



Plot 7. 99% Occupied Bandwidth – 2405.8 MHz



Plot 8. 99% Occupied Bandwidth – 2440 MHz



Plot 9. 99% Occupied Bandwidth – 2479.1 MHz

4.3 Hopping Frequency Requirements

The Frequency Hopping Requirements are applicable to the equipment using Frequency Hopping Spread Spectrum (FHSS) modulation.

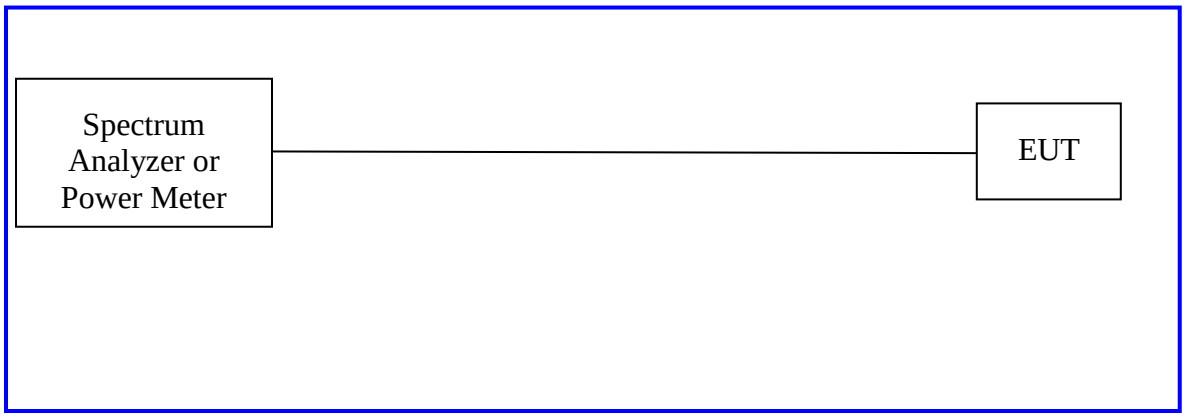
Per CFR47 15.247 (a)(1)(iii), RSS 247 Sect.5.1(b) and 5.1(d), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

4.3.1 **Test Method**

The conducted method were used to measure the carrier frequency separation according to ANSI C63.10:2013 Section 7.8.2, frequency hopping system in Sect. 7.8.3, and time of occupancy in Sect. 7.8.4. The measurement was performed with the EUT set to hop to channel frequencies. Results indicated below.

Test Setup:

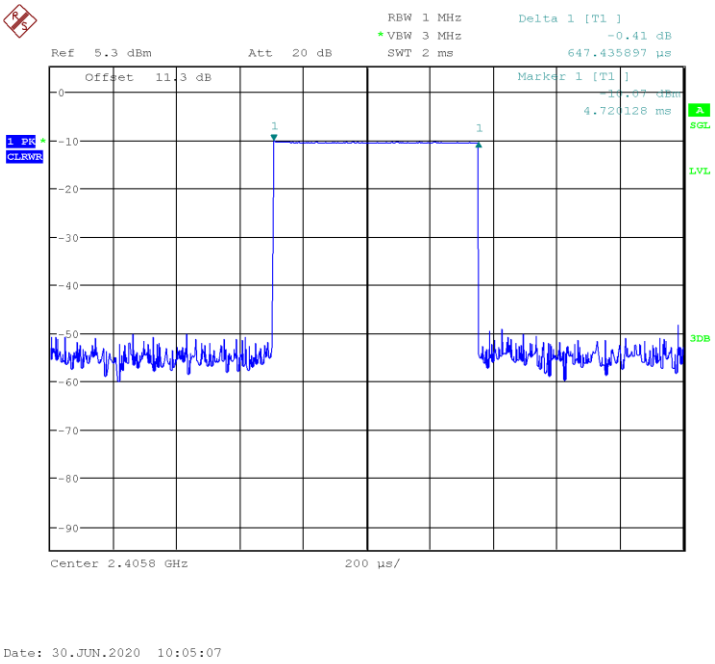


4.3.2 Results

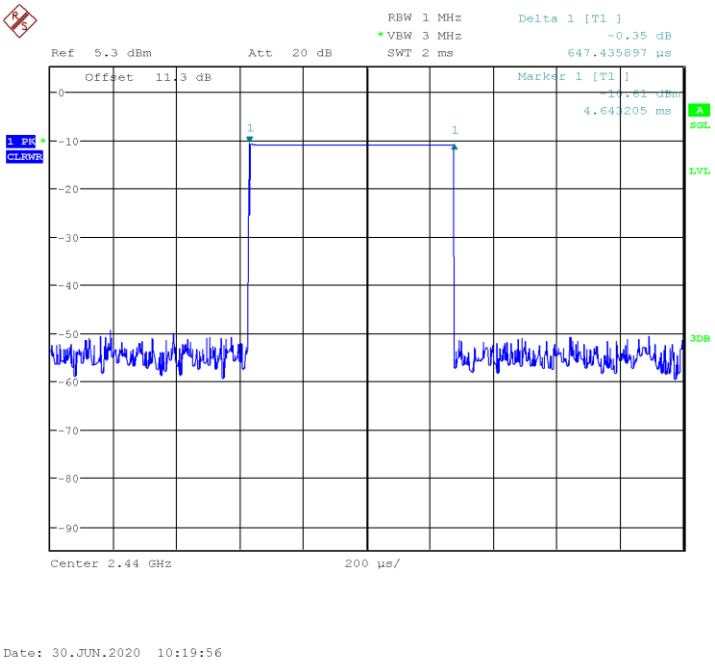
As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 4: Frequency Hopping Requirements

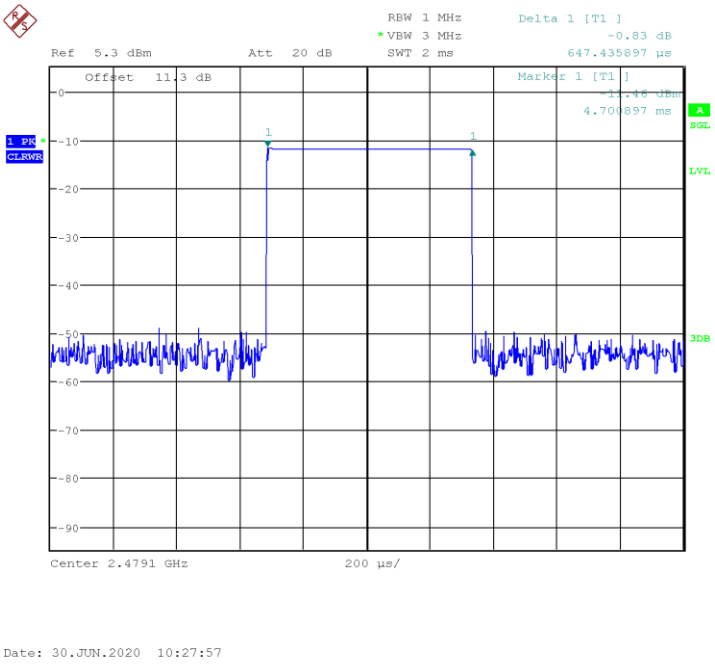
Average Occupancy Time					
Frequency (MHz)	**Pulse Width (ms)**	**# of Pulses (0.64s)**	**Ave. Time (ms)**	**Limit (ms)**	**Result**
2405.8	0.647436	21	135.9616	<400	Pass
2440.0	0.647436	22	142.4359	<400	Pass
2479.1	0.647436	22	142.4359	<400	Pass
Note: The dwell time in each channel must be less than 0.4 seconds. The total time for 16 hopping channels is 0.4 x 16 = 6.4 seconds. To determine the average dwell time, low, mid and high frequency was sample in 0.64 second, an $1/10^{th}$ of the total 16 hopping channels dwell time.					
Minimum Channel Separation					
Frequency (MHz)	**Hopping Separation (kHz)**	**20dB Bandwidth (kHz)**	**Two-Third of 20dB Bandwidth Limit (kHz)**		**Result**
2405.8	4423.08	416.667	>277.778		Pass
2440.0	5016.03	416.667	>277.778		Pass
2479.1	4246.79	419.872	>279.915		Pass
Note 1: The channel separation was measured at the low, middle and high channel. Two-Third of the highest 20dB bandwidth was used. **Note 2:** For 20 dB Occupied Bandwidth plot, refer to Section 4.2 of this test report.					
Minimum Number of Channels					
Range (2400MHz -2483.5MHz)		**Min. Channel Limit**			**Result**
16		15			Pass
Note: The EUT was hopping randomly all 16 operating channels.					



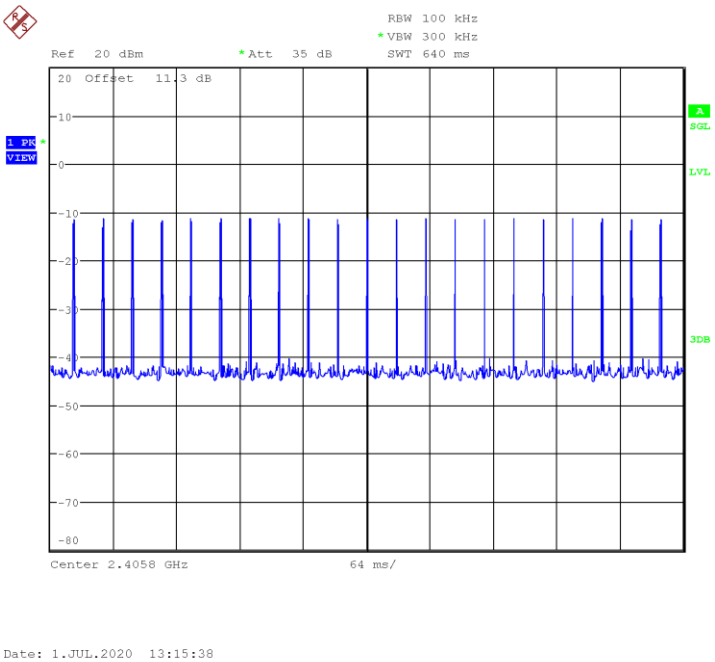
Plot 10. Pulse Width for 2405.8 MHz



Plot 11. Pulse Width for 2440 MHz

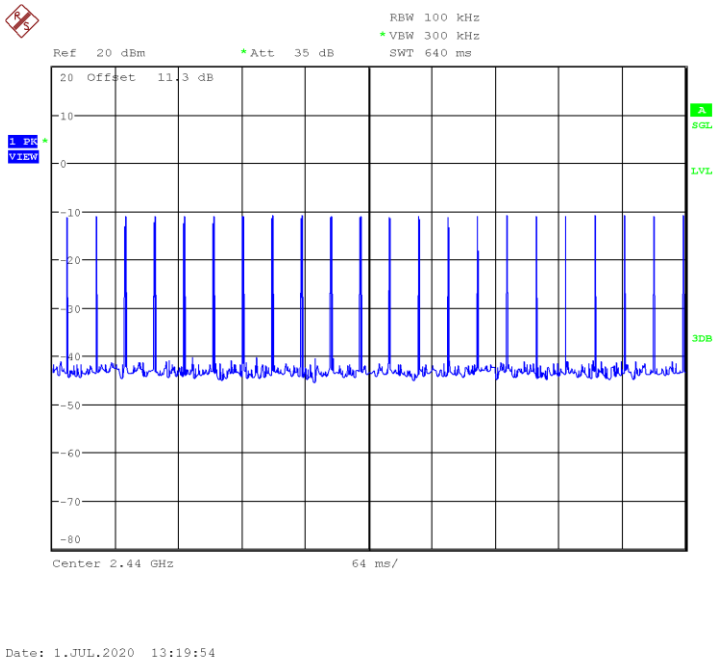


Plot 12. Pulse Width for 2479.1 MHz



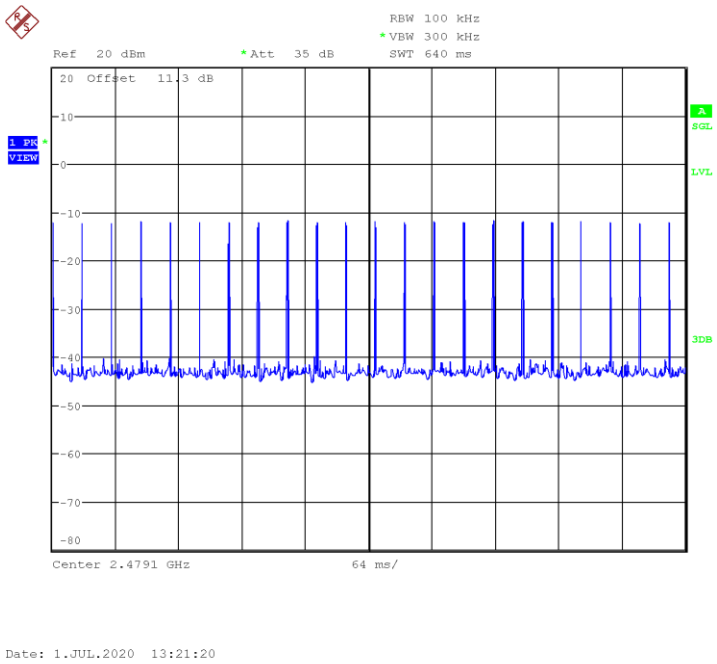
Plot 13. Number of Pulses in 0.64 sec for 2405.8 MHz

Note: There are 21 pulses in 0.64 seconds.



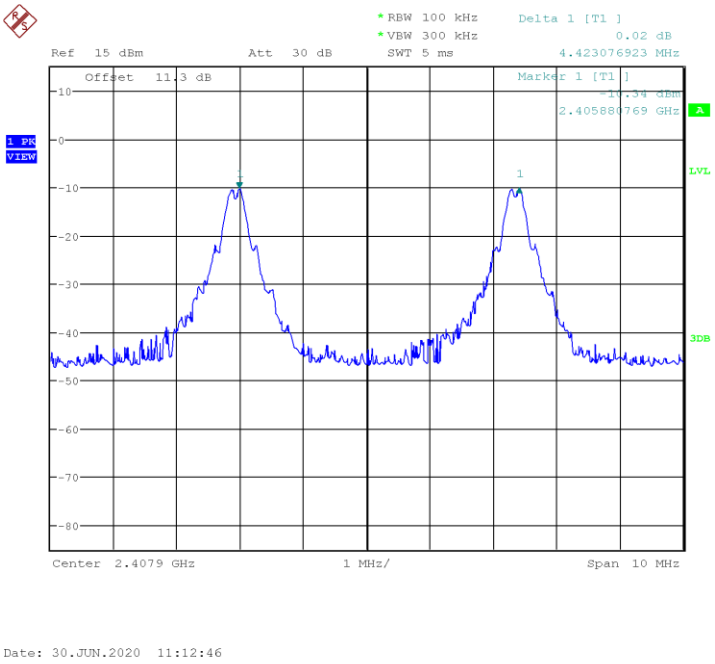
Plot 14. Number of Pulses in 0.64 sec for 2440 MHz

Note: There are 22 pulses in 0.64 seconds.

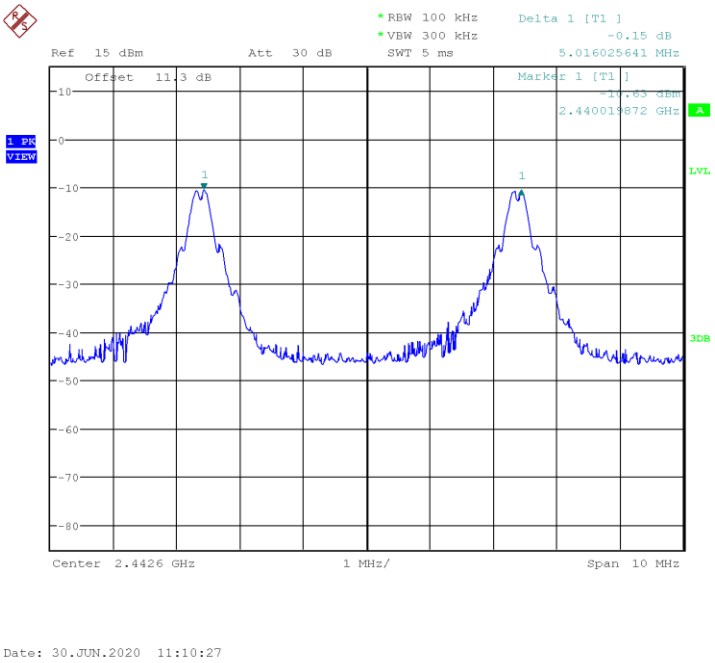


Plot 15. Number of Pulses in 0.64 sec for 2479.1 MHz

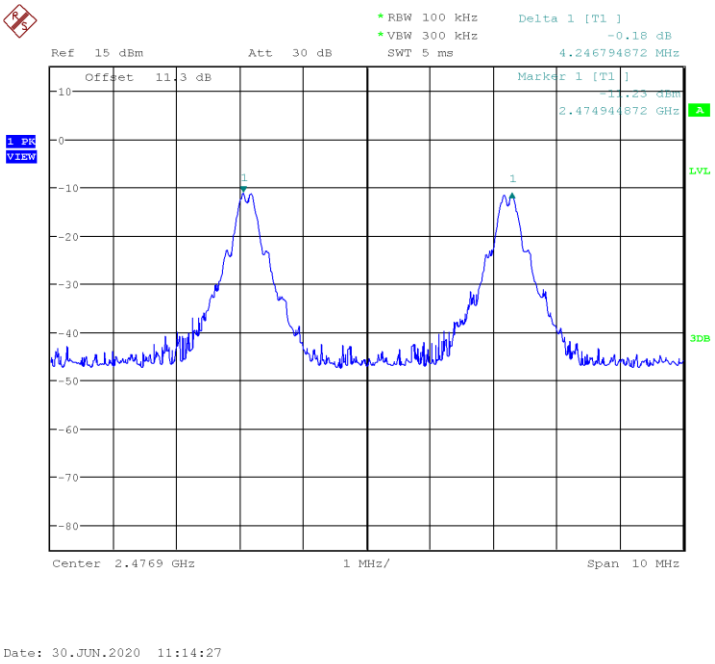
Note: There are 22 pulses in 0.64 seconds.



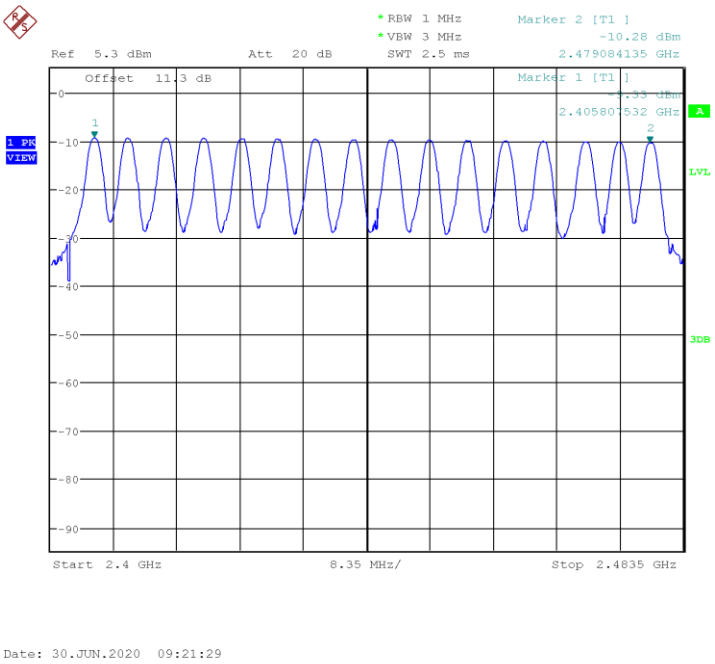
Plot 16. Hopping Separation - 2405.8 MHz



Plot 17. Hopping Separation – 2440 MHz



Plot 18. Hopping Separation – 2479.1 MHz



Plot 19. Number of Operating Channels (16)

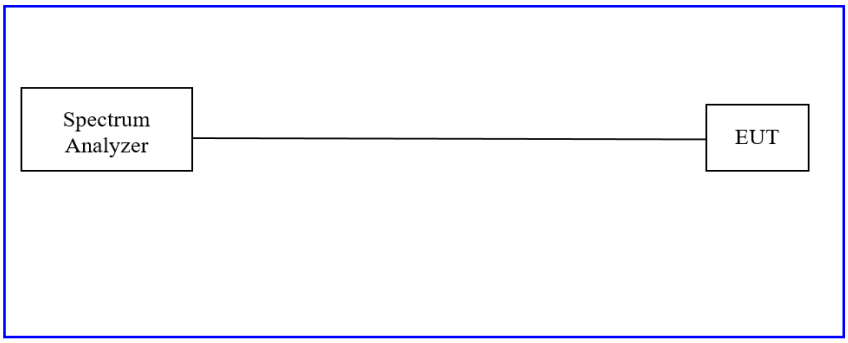
4.4 Out of Band Emissions: Non-Restricted Bands

Any frequency outside the band of 2400 MHz to 2483.5 MHz, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under the regulation, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. ; CFR 47 Part 15.247(d) and RSS 247 Sect. 5.5.

4.4.1 **Test Method**

Conducted measurements per ANSI C63.10-2013 Sections 6.10, 11.11, 14.3.3 were used to measure the undesirable emission requirement in non-restricted bands. The measurement was performed with modulation. The measurement was conducted from 30MHz to 26.5GHz on 3 channels on the EUT. Band edge tests were conducted on the low and high channel. The worst-case measurement is recorded in this report.

Test setup:

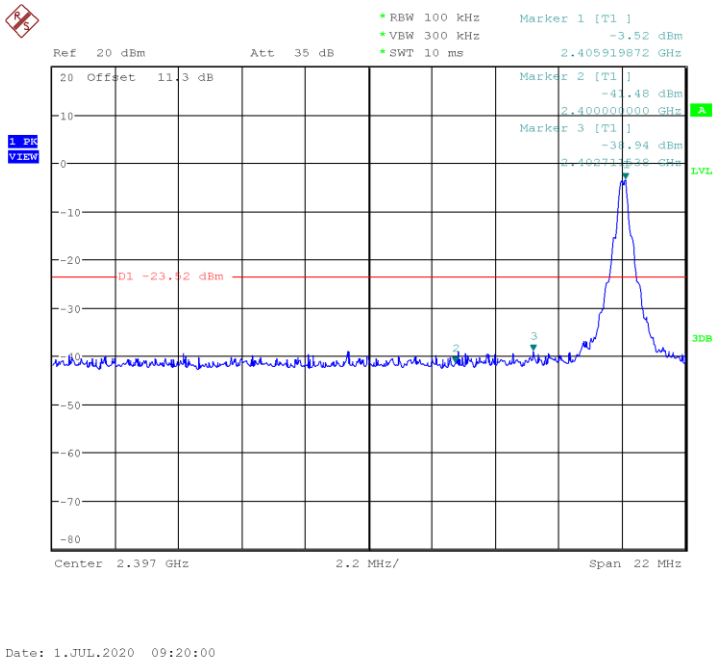


4.4.2 **Results**

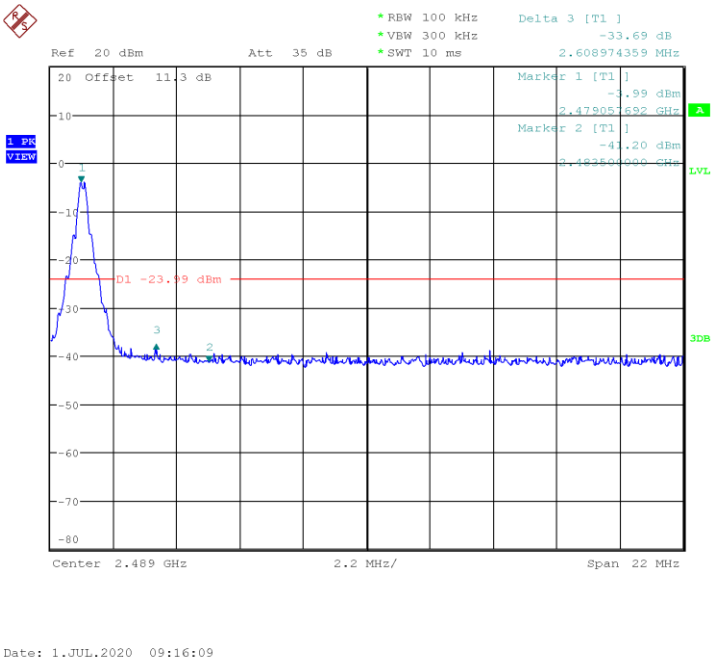
As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 5: Band Edge Requirements – Test Results

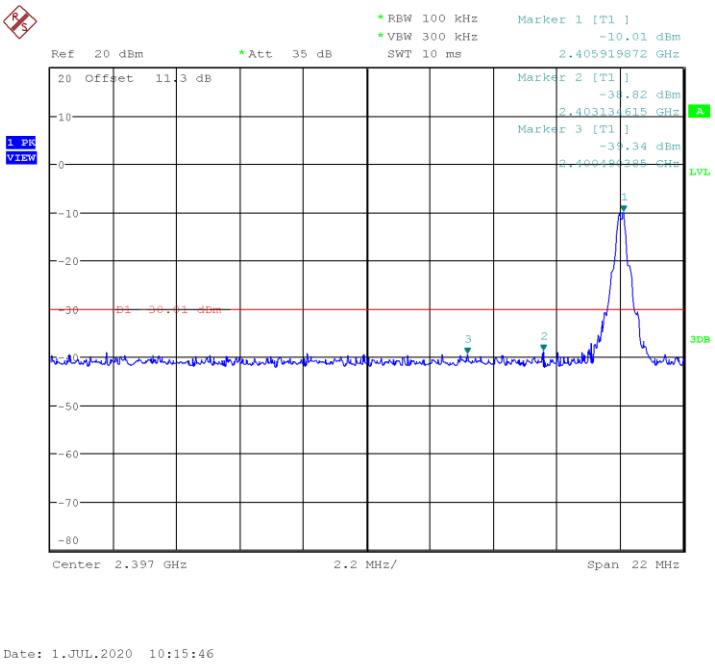
Non-Restricted Frequency Band Edge Emissions					
Band Edge	**Operating Freq. (MHz)**	**Measured (dBc)**	**Limit (dBc)**	**Frequency (MHz)**	**Result**
Low	2405.8	-38.94	>20	2402.71	Pass
High	2479.1	-33.69	>20	2608.97	Pass
Note 1: The stated limits for 20 dBc are relative to each individual output per KDB 662911 Method. The worst case test data is recorded.					



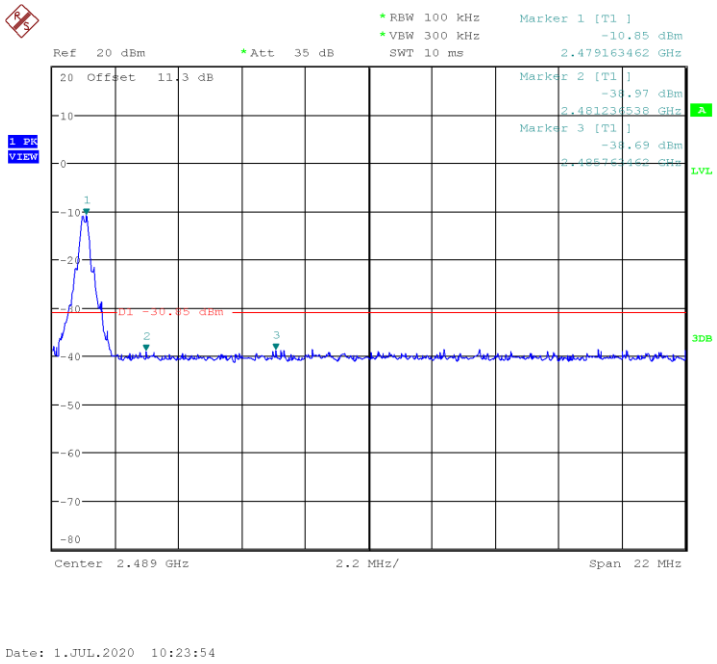
Plot 20. 2405.8MHz Lower Band edge



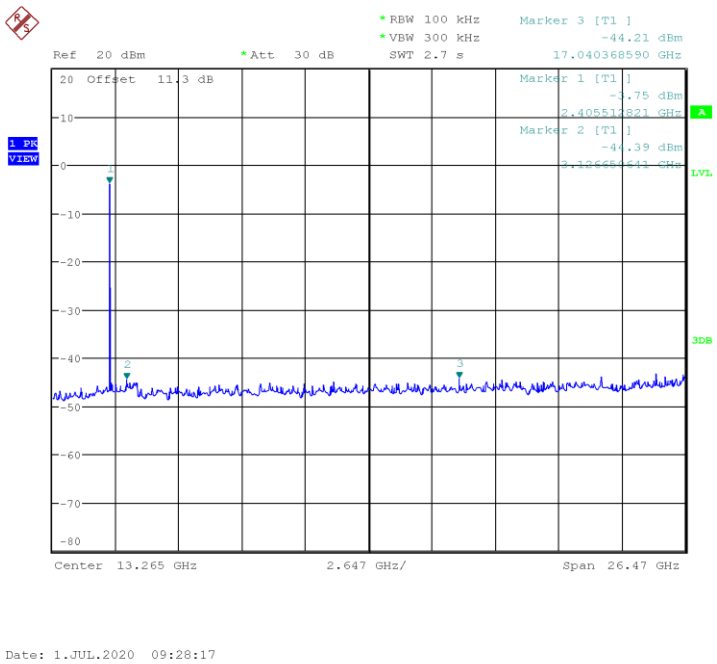
Plot 21. 2479.1MHz Upper Band Edge



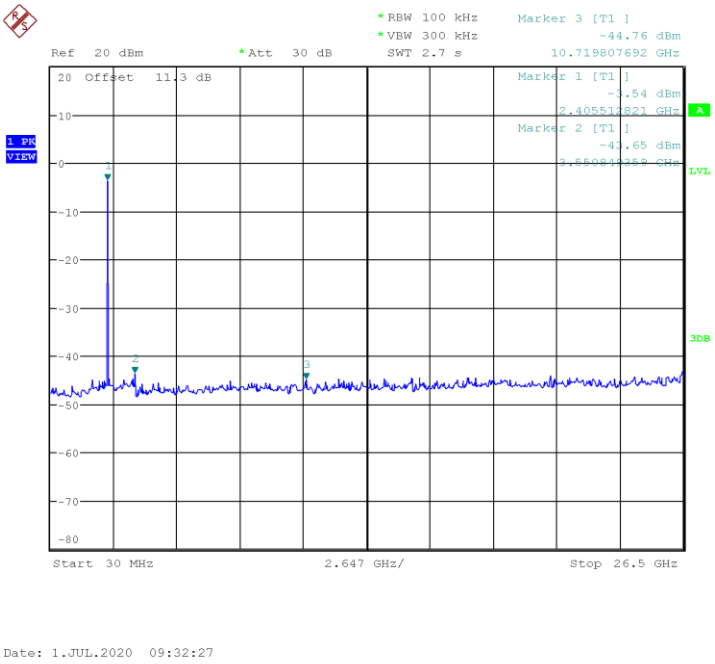
Plot 22. 2405.8MHz - Hopping Lower Band Edge



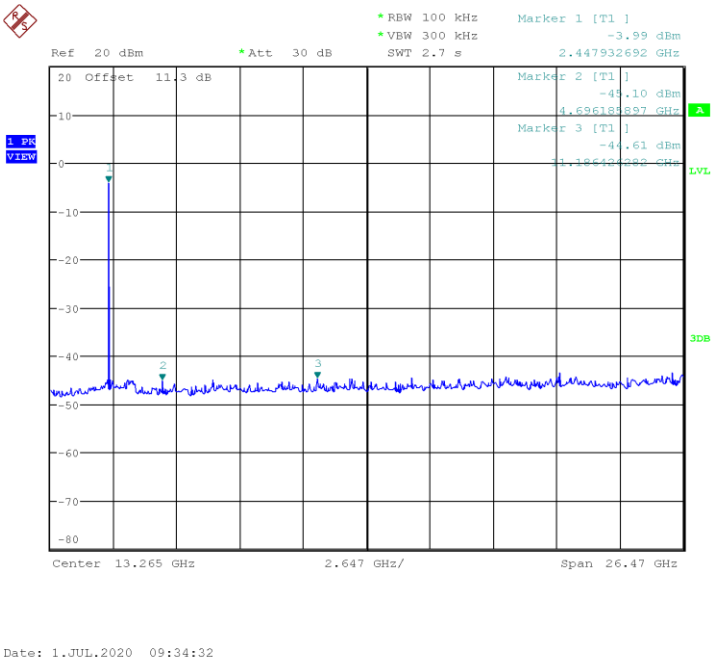
Plot 23. 2479.1MHz - Hopping Upper Band Edge



Plot 24. 2405.8MHz, 30MHz-26.5GHz Spurious



Plot 25. 2440MHz, 30MHz-26.5GHz Spurious



Plot 26. 2479.1MHz, 30MHz-26.5GHz Spurious

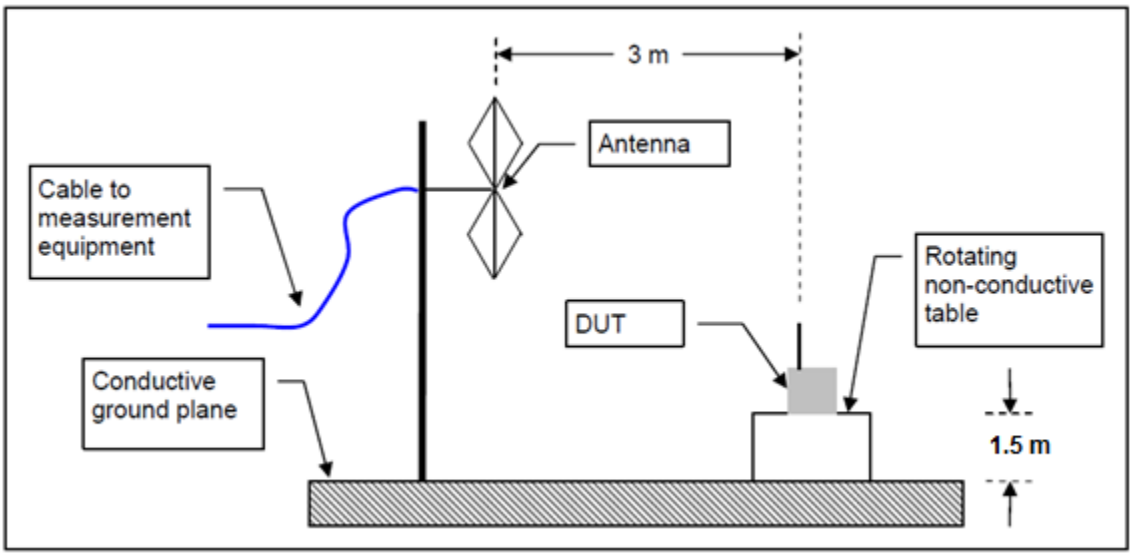
4.5 Out of Band Emissions: Restricted Band Edge

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

4.5.1 **Test Method**

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

Test Setup



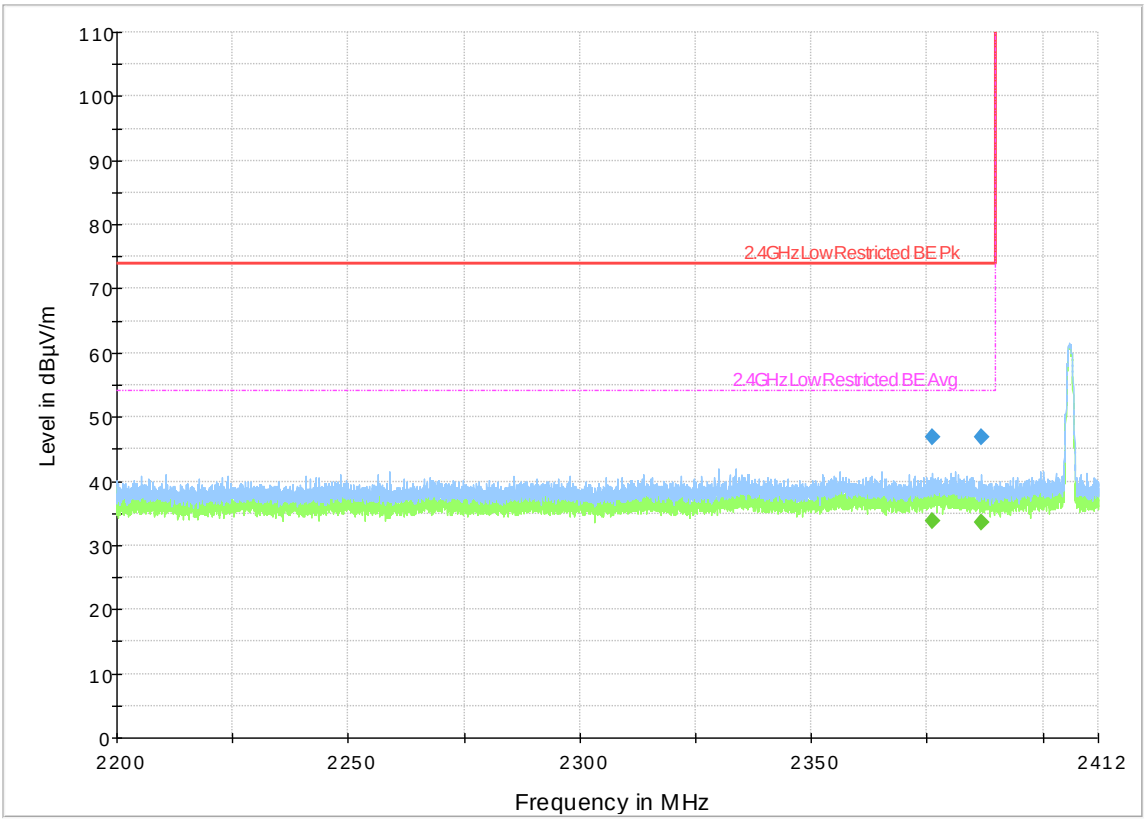
The DUT was stimulated by manufacturer provided test software that is not available to the end user.

4.5.2 Test Results

Table 6: Transmit Spurious Emission at Restricted Band Edge Requirements

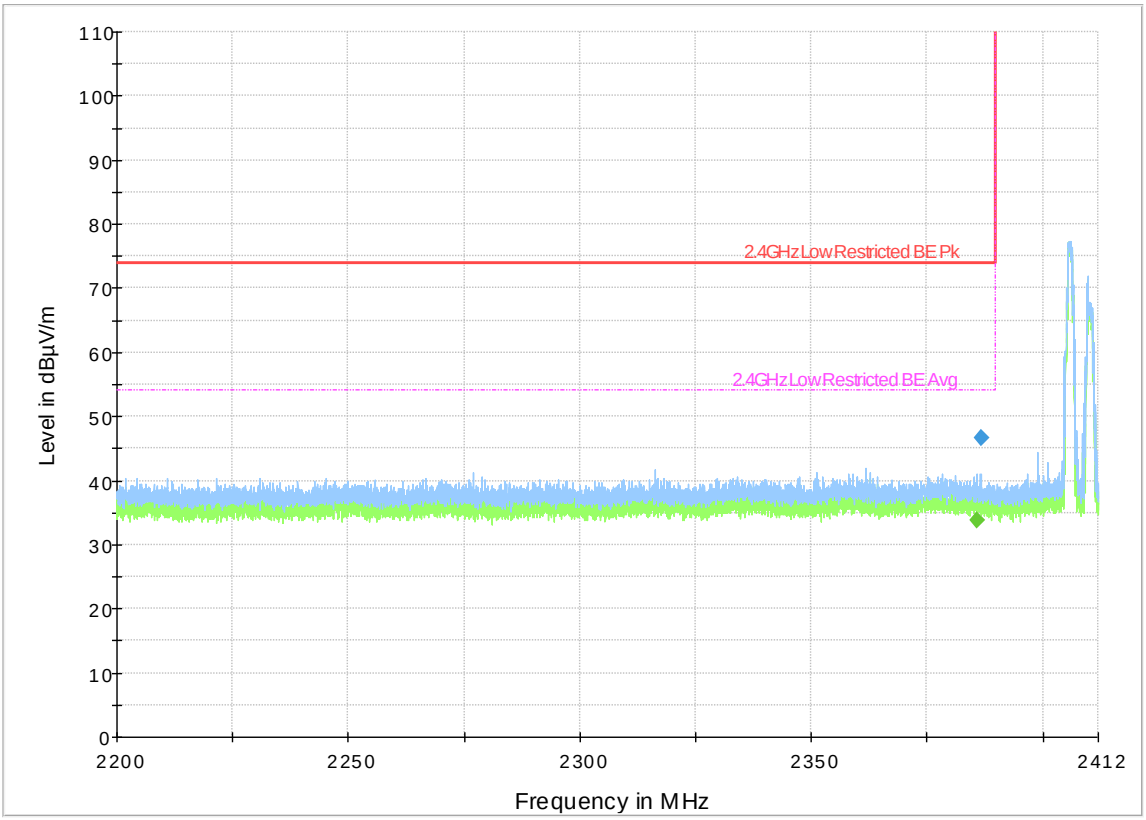
Test Conditions: Radiated Measurement, Normal Temperature and Voltage							
Lower Restricted Band Edge							
Freq. (MHz)	**Mode**	**Center Freq (MHz)**	**Detector (Average/ Peak)**	**Measured (dBuV/m)**	**Limit (dBuV/m)**	**Margin**	**Results**
2376.1720	Continuous Tx	2405.8	Average	33.81	54	20.19	Pass
2386.8780	Continuous Tx	2405.8	Peak	46.99	74	27.01	Pass
2385.9240	Hopping	2405.8	Average	33.71	54	20.29	Pass
2386.6024	Hopping	2405.8	Peak	46.66	74	27.34	Pass
Upper Restricted Band Edge							
Freq. (MHz)	**Mode**	**Center Freq (MHz)**	**Detector (Average/ Peak)**	**Measured (dBuV/m)**	**Limit (dBuV/m)**	**Margin**	**Results**
2488.2656	Continuous Tx	2479.1	Average	34.04	54	19.96	Pass
2488.2656	Continuous Tx	2479.1	Peak	47.25	74	26.75	Pass
2487.0848	Hopping	2479.1	Average	33.97	54	20.03	Pass
2487.0848	Hopping	2479.1	Peak	47.39	74	26.61	Pass
Note: All restricted band edge tests were performed at full power.							

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2376.172000	---	33.81	54.00	20.19	1000.0	1000.000	104.0	V	46.0
2376.172000	46.91	---	74.00	27.09	1000.0	1000.000	104.0	V	46.0
2386.878000	---	33.68	54.00	20.32	1000.0	1000.000	197.0	V	157.0
2386.878000	46.99	---	74.00	27.01	1000.0	1000.000	197.0	V	157.0



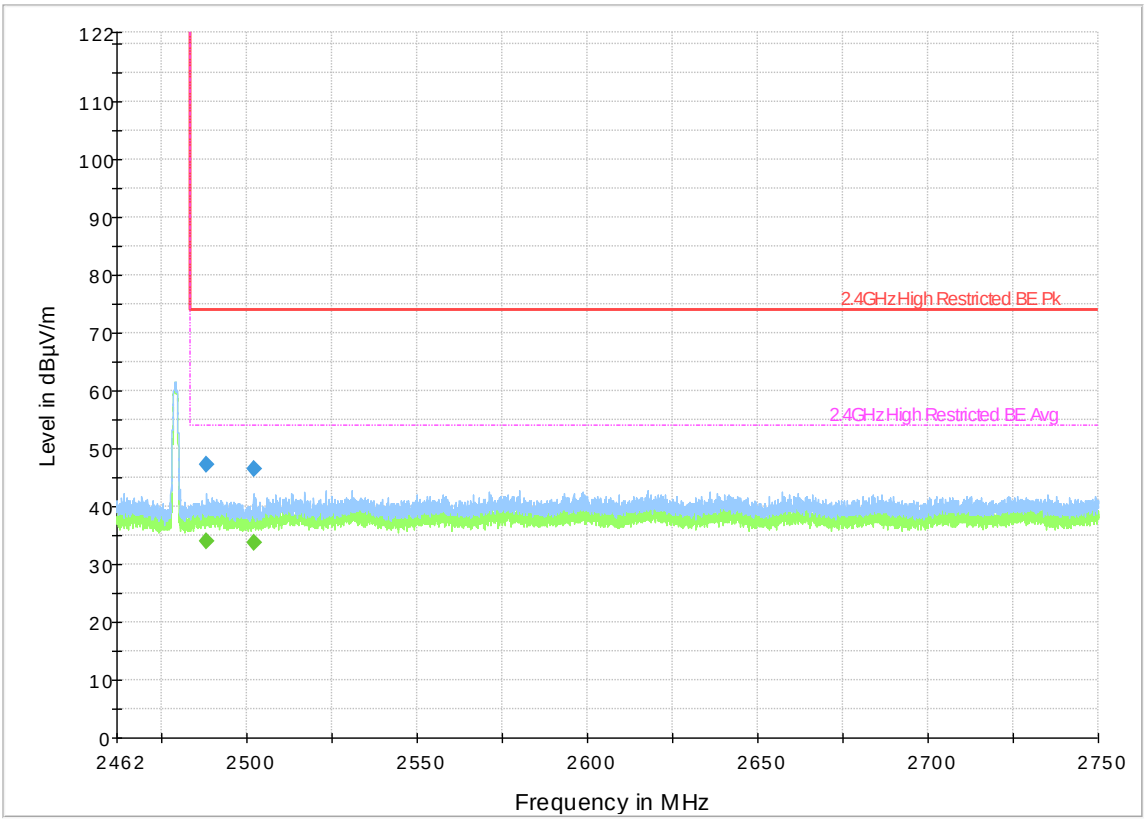
Plot 27. Lower Restricted Band Edge, 2405.8MHz

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2385.924000	---	33.71	54.00	20.29	1000.0	1000.000	103.0	V	23.0
2386.602400	46.66	---	74.00	27.34	1000.0	1000.000	153.0	V	145.0



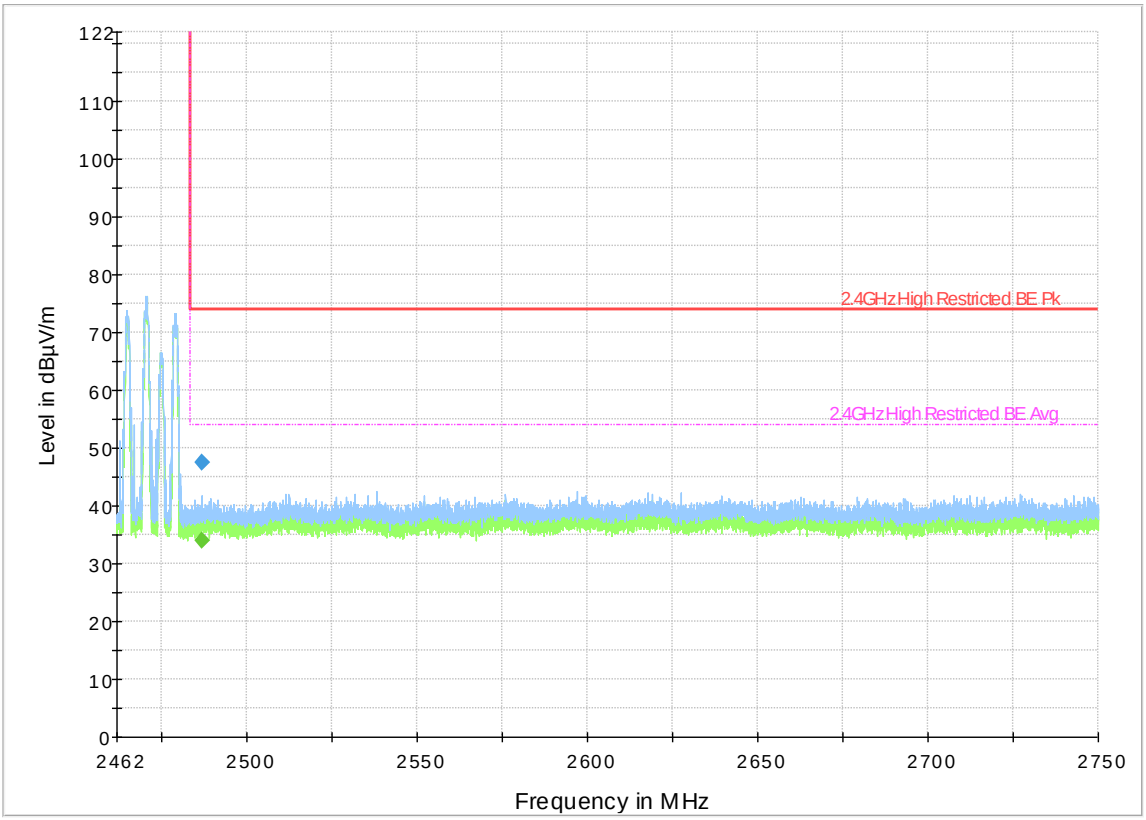
Plot 28. Lower Restricted Band Edge, 2405.8MHz - Hopping

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2488.265600	---	34.04	54.00	19.96	1000.0	1000.000	197.0	H	16.0
2488.265600	47.25	---	74.00	26.75	1000.0	1000.000	197.0	H	16.0
2502.032000	---	33.79	54.00	20.21	1000.0	1000.000	104.0	V	-99.0
2502.032000	46.39	---	74.00	27.61	1000.0	1000.000	103.0	V	-99.0



Plot 29. Upper Restricted Band Edge, 2479.1MHz

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2487.084800	---	33.97	54.00	20.03	1000.0	1000.000	106.0	V	157.0
2487.084800	47.39	---	74.00	26.61	1000.0	1000.000	104.0	V	157.0



Plot 30. Upper Restricted Band Edge, 2479.1MHz - Hopping

4.6 Transmitter Spurious Emissions

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

4.6.1 Test Methodology

4.6.1.1 *Preliminary Test*

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

Preliminary emission profile testing was performed inside the anechoic chamber. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm (<1 GHz) and 150cm (>1 GHz) above the floor. The EUT was positioned as shown in the setup photographs. The receiving antenna was placed at a distance of 3m at a height of 1 – 4m. Measurement equipment was located outside of the chamber < 1GHz frequency range. RBW was set at 120kHz for measurements form 30MHz – 1000MHz and 1MHz for measurements above 1GHz. VBW was set to ~3x the RBW.

4.6.1.2 *Final Test*

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

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

The final scans were performed on the worst EUT axis for three operating channels in the operating mode with the highest power.

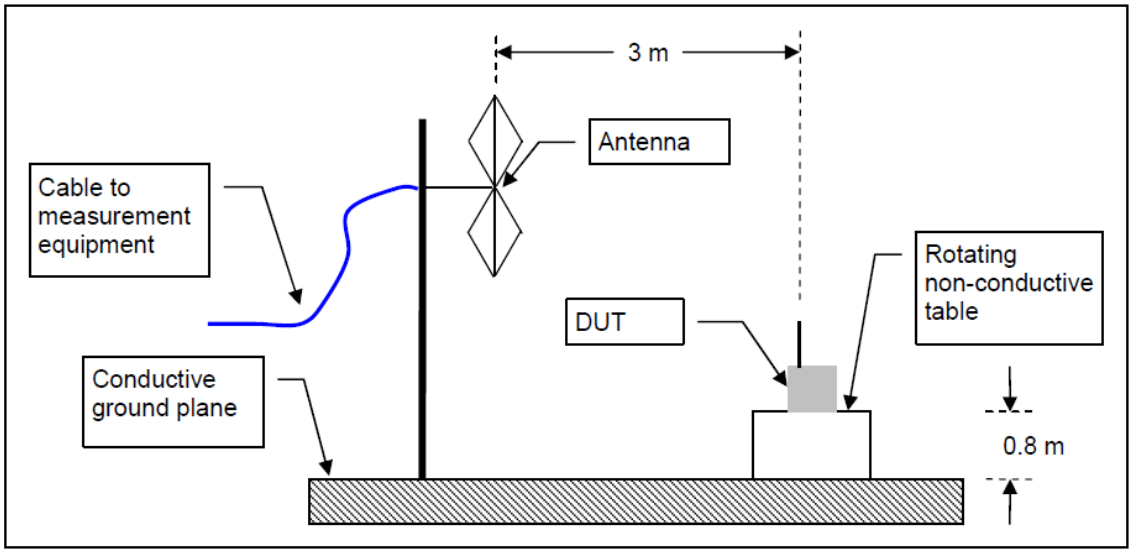
Resolution bandwidth (RBW) = 120 KHz and Video bandwidth (VBW) = 300 KHz for Spurious emission below 1GHz.

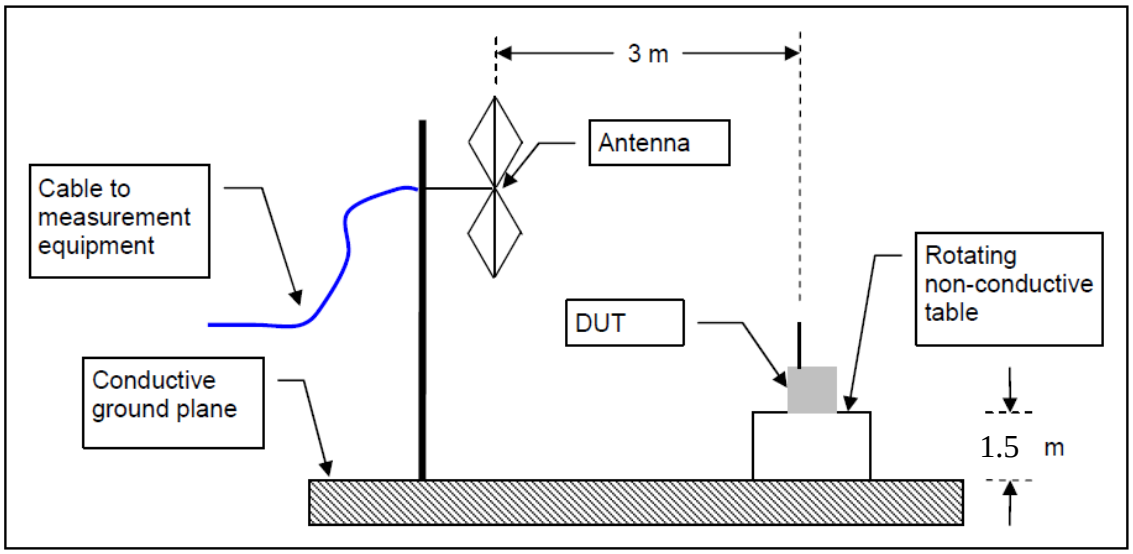
Resolution bandwidth (RBW) = 1 MHz and Video bandwidth (VBW) = 3 MHz for Spurious emission above 1GHz.

4.6.1.3 *Deviations*

None.

Test Setup:


3 m
Antenna
Cable to measurement equipment
Rotating non-conductive table
DUT
Conductive ground plane
0.8 m


3 m
Antenna
Cable to measurement equipment
Rotating non-conductive table
DUT
Conductive ground plane
1.5 m

4.6.2 Transmitter Spurious Emission Limit

The spurious emissions of the transmitter shall not exceed the values in CFR47 Part 15.205, 15.209: 2018 and RSS Gen Sect. 8.9, 8.10: 2018.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F (kHz)	30
1.705-30.0	30	30
30-88	100 **	3
88-216	150 **	3
216-960	200 **	3
Above 960	500	3

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

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

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

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

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

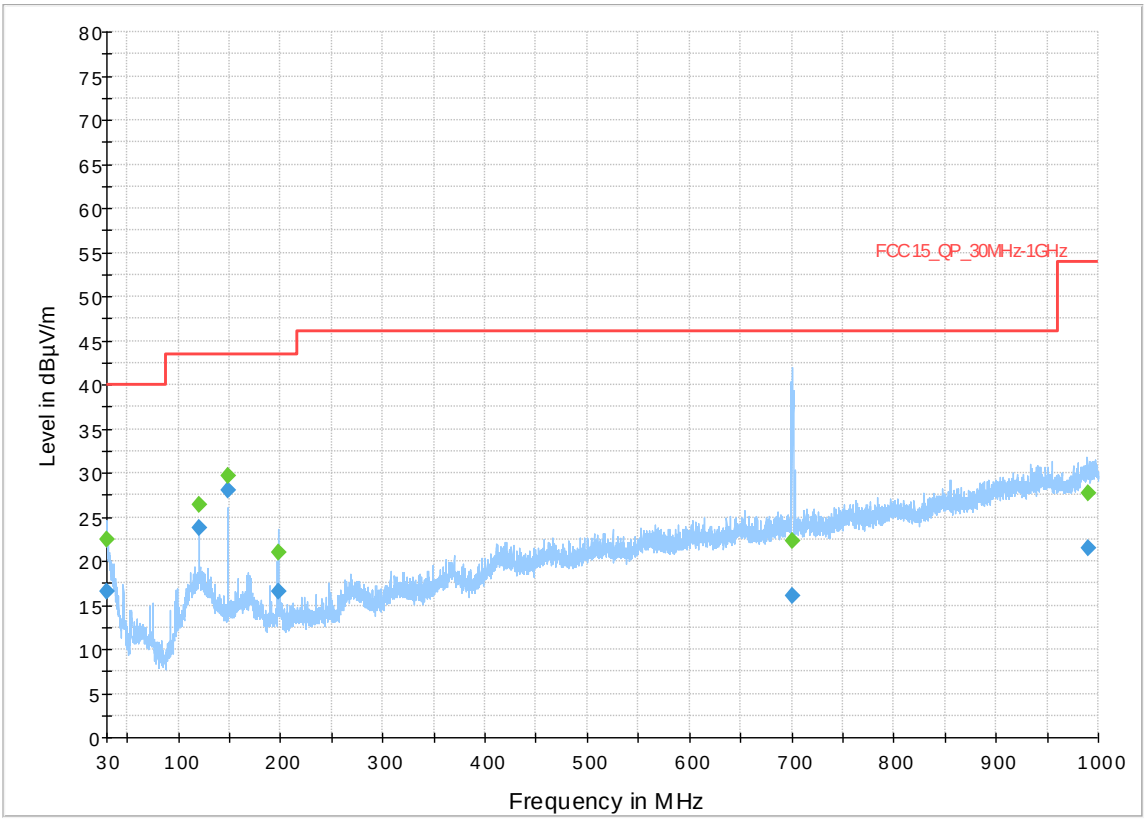
4.6.3 Test Results

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). Worse case modes are provided below

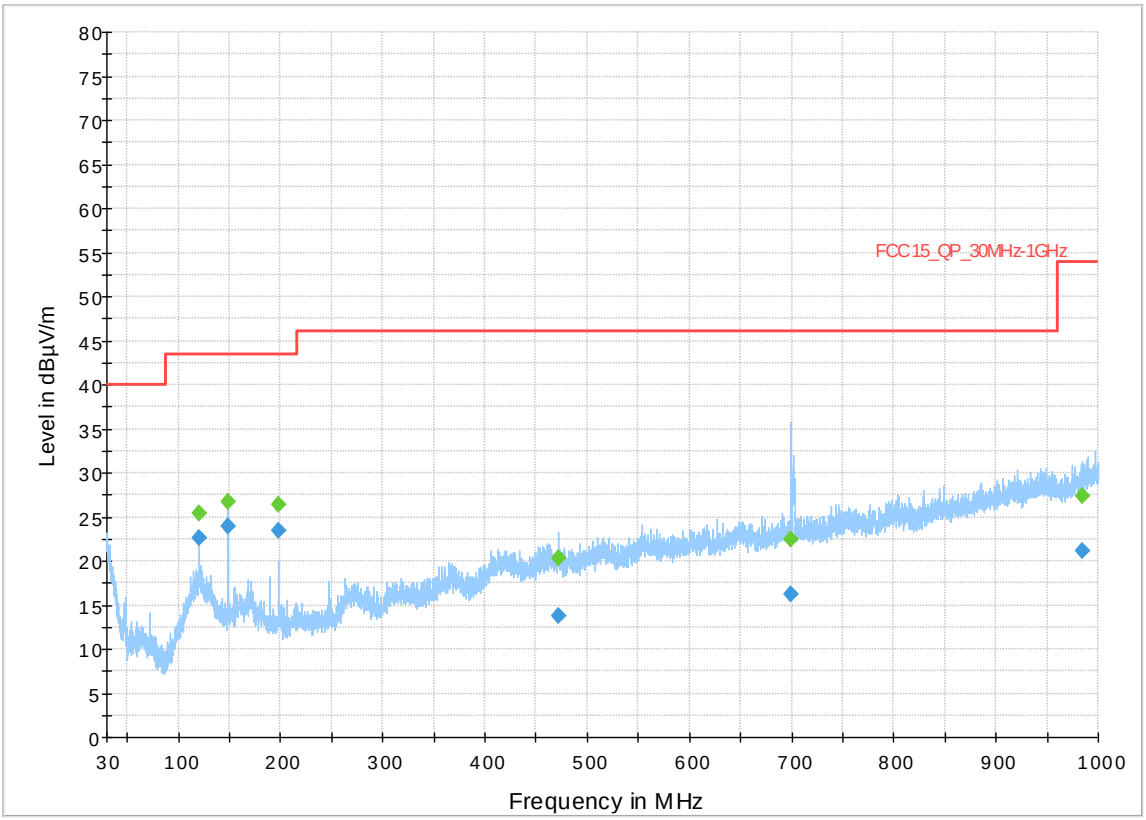
Note: Below 30 MHz was investigated and no emissions was found above noise floor. No Emissions within 6dB of the limit were found above 18 GHz. The 2.4 GHz notch filter was used to protect the front end of the pre-amp.

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.118699	16.51	40.00	23.49	1000.0	120.000	152.0	H	-180.0	-6.8
119.996320	23.73	43.52	19.79	1000.0	120.000	253.0	H	112.0	-10.7
148.341560	27.97	43.52	15.55	1000.0	120.000	103.0	V	23.0	-14.4
197.816720	16.53	43.52	26.99	1000.0	120.000	253.0	V	-138.0	-14.6
700.561160	16.13	46.00	29.87	1000.0	120.000	152.0	V	-68.0	-4.8
989.520080	21.54	54.00	32.46	1000.0	120.000	154.0	V	180.0	1.0



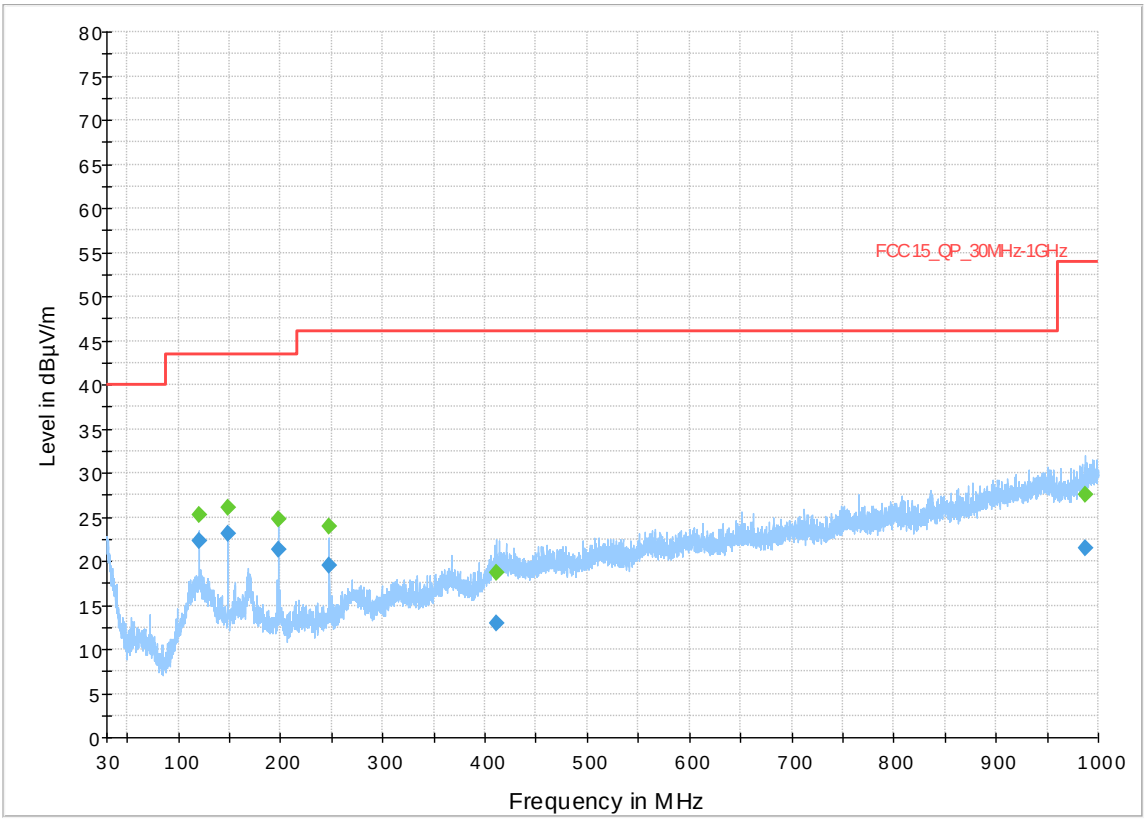
Plot 31. 30-1000MHz, 2405.8 MHz

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
120.006000	22.61	43.52	20.91	1000.0	120.000	154.0	H	-180.0	-10.7
148.346240	23.95	43.52	19.57	1000.0	120.000	103.0	V	38.0	-14.4
197.801120	23.51	43.52	20.01	1000.0	120.000	103.0	V	29.0	-14.6
471.654640	13.70	46.00	32.30	1000.0	120.000	152.0	H	180.0	-8.2
698.936320	16.21	46.00	29.79	1000.0	120.000	154.0	H	180.0	-4.9
984.815200	21.16	54.00	32.84	1000.0	120.000	103.0	V	122.0	0.7



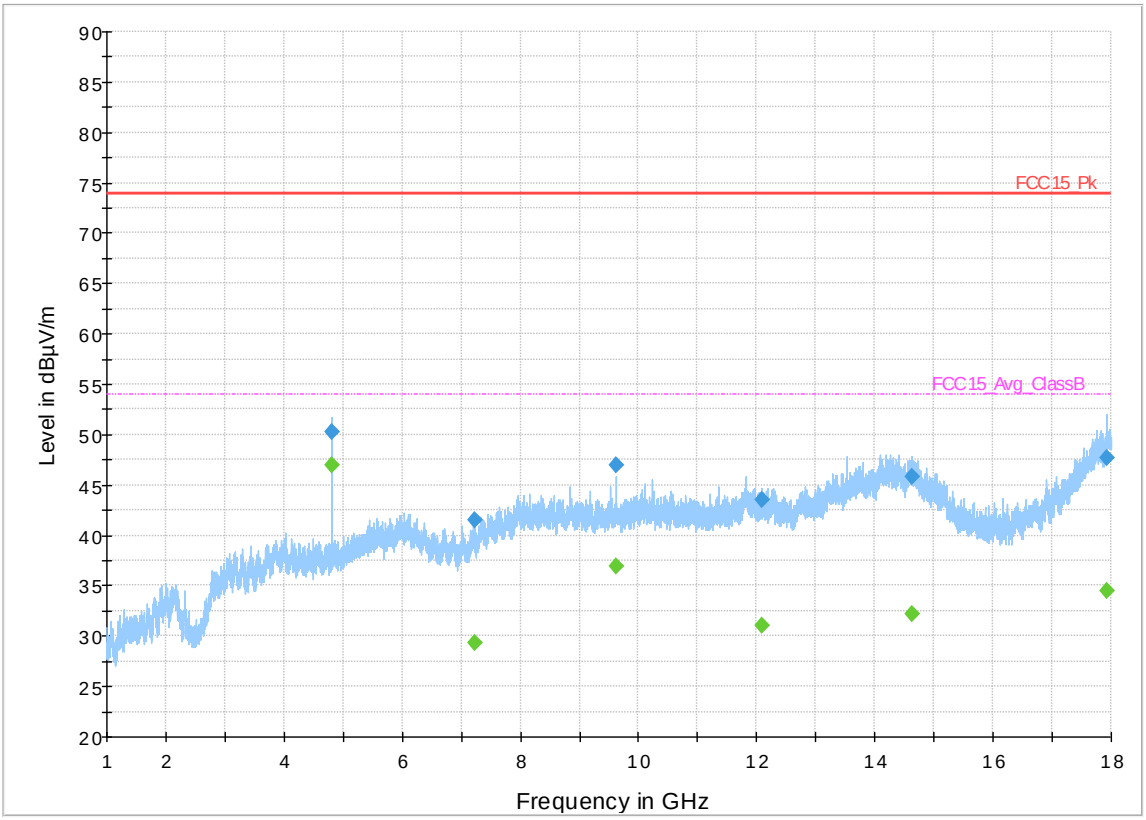
Plot 32. 30-1000MHz, 2440 MHz

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
119.997400	22.29	43.52	21.23	1000.0	120.000	154.0	H	180.0	-10.7
148.328720	23.16	43.52	20.36	1000.0	120.000	103.0	V	-22.0	-14.4
197.787200	21.28	43.52	22.24	1000.0	120.000	154.0	V	41.0	-14.6
247.243520	19.46	46.00	26.54	1000.0	120.000	154.0	V	-67.0	-14.6
411.223440	12.90	46.00	33.10	1000.0	120.000	152.0	V	-180.0	-9.1
987.201480	21.41	54.00	32.59	1000.0	120.000	103.0	V	8.0	0.8



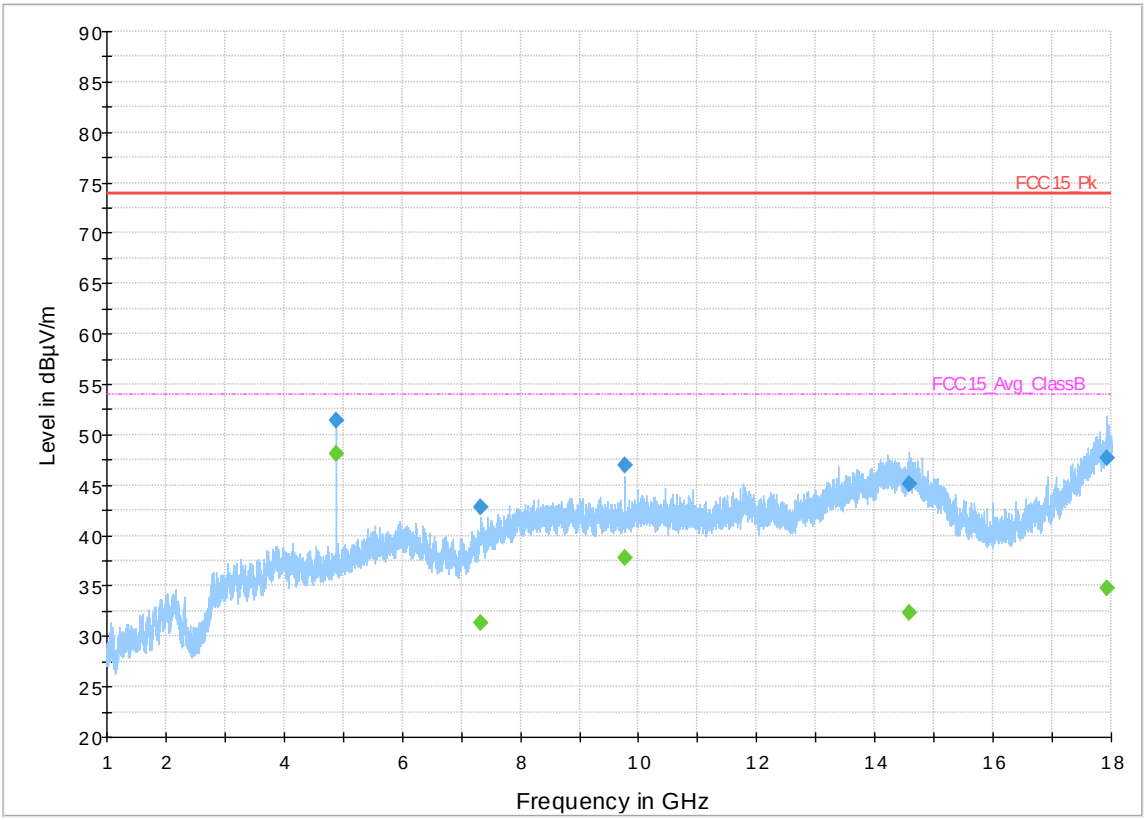
Plot 33. 30-1000MHz, 2479.1 MHz

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
4811.677000	50.23	---	74.00	23.77	1000.0	1000.000	152.0	V	-164.0
4811.677000	---	46.99	54.00	7.01	1000.0	1000.000	152.0	V	-164.0
7217.218500	---	29.35	54.00	24.65	1000.0	1000.000	152.0	V	-180.0
7217.218500	41.46	---	74.00	32.54	1000.0	1000.000	152.0	V	-180.0
9623.250000	---	36.91	54.00	17.09	1000.0	1000.000	152.0	V	-180.0
9623.250000	47.03	---	74.00	26.97	1000.0	1000.000	152.0	V	-180.0
12094.642500	---	31.04	54.00	22.96	1000.0	1000.000	152.0	H	180.0
12094.642500	43.58	---	74.00	30.42	1000.0	1000.000	152.0	H	180.0
14622.145000	45.76	---	74.00	28.24	1000.0	1000.000	152.0	V	-127.0
14622.145000	---	32.13	54.00	21.87	1000.0	1000.000	152.0	V	-127.0
17922.805500	---	34.47	54.00	19.53	1000.0	1000.000	152.0	V	-180.0
17922.805500	47.65	---	74.00	26.35	1000.0	1000.000	152.0	V	-180.0



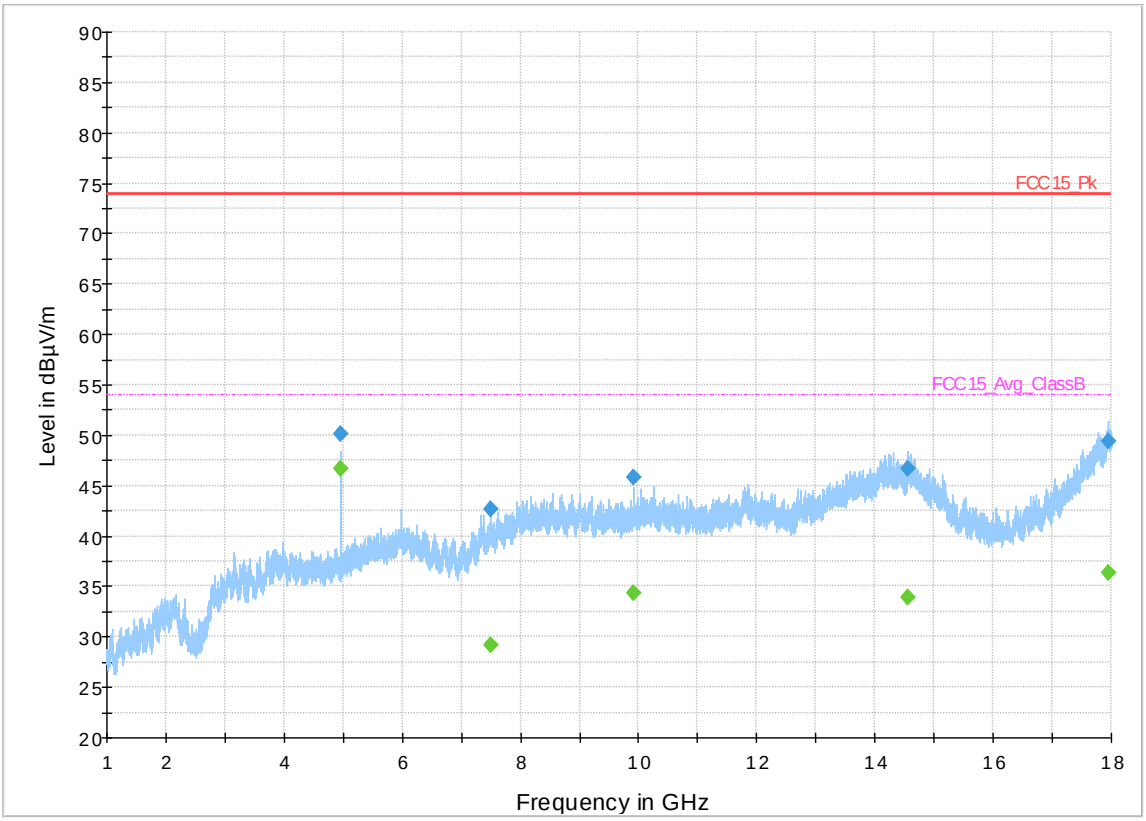
Plot 34. 1-18GHz, 2405.8MHz

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
4880.080500	51.41	---	74.00	22.59	1000.0	1000.000	202.0	V	-150.0
4880.080500	---	48.08	54.00	5.92	1000.0	1000.000	202.0	V	-150.0
7320.005000	42.86	---	74.00	31.14	1000.0	1000.000	202.0	V	180.0
7320.005000	---	31.30	54.00	22.70	1000.0	1000.000	202.0	V	180.0
9759.970500	46.91	---	74.00	27.09	1000.0	1000.000	200.0	V	180.0
9759.970500	---	37.75	54.00	16.25	1000.0	1000.000	200.0	V	180.0
14575.539500	45.12	---	74.00	28.88	1000.0	1000.000	202.0	V	-180.0
14575.539500	---	32.40	54.00	21.60	1000.0	1000.000	202.0	V	-180.0
17919.672500	---	34.75	54.00	19.25	1000.0	1000.000	201.0	H	14.0
17919.672500	47.63	---	74.00	26.37	1000.0	1000.000	201.0	H	14.0



Plot 35. 1-18GHz, 2440MHz

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
4958.357000	50.13	---	74.00	23.87	1000.0	1000.000	202.0	V	-154.0
4958.357000	---	46.70	54.00	7.30	1000.0	1000.000	202.0	V	-154.0
7489.875000	---	29.24	54.00	24.76	1000.0	1000.000	103.0	H	-180.0
7489.875000	42.66	---	74.00	31.34	1000.0	1000.000	103.0	H	-180.0
9916.982500	45.76	---	74.00	28.24	1000.0	1000.000	202.0	V	180.0
9916.982500	---	34.35	54.00	19.65	1000.0	1000.000	202.0	V	180.0
14561.094000	46.74	---	74.00	27.26	1000.0	1000.000	202.0	V	180.0
14561.094000	---	33.96	54.00	20.04	1000.0	1000.000	202.0	V	180.0
17943.665000	49.35	---	74.00	24.65	1000.0	1000.000	202.0	H	-180.0
17943.665000	---	36.31	54.00	17.69	1000.0	1000.000	202.0	H	-180.0



Plot 36. 1-18GHz, 2479.1MHz

5 Test Equipment Use List

5.1 Equipment List

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal mm/dd/yyyy	Next Cal mm/dd/yyyy
Spectrum Analyzer	Rohde & Schwarz	FSU26.5	1166.1660.26	02/23/2020	02/23/2021
EMI Receiver	Rohde & Schwarz	ESW44	101663-dv	07/18/2019	07/18/2021
Preamplifier, 9 kHz – 1 GHz	Sonoma	310N	213221	01/16/2019	01/16/2021
Bilog Antenna	Sunol Sciences	JB3	A061907	12/19/2018	12/19/2020
Amplifier	Miteq	TTA1800-30-HG	1842452	01/16/2019	01/16/2021
Horn Antenna	Sunol Sciences	DRH-118	A040806	03/05/2019	03/05/2021
Amplifier	HP	8449B	3008A01013	01/16/2019	01/16/2021
1.6 GHz Low Pass Filter	K&L Microwave	8L120-X1600-0/09135-0249	UA691-35	N/A (See Note)	
2.4GHZ Band Pass Filter	Microtronics	BRM50702	009	N/A (See Note)	

Note: Equipment is characterized before use.

6 EMC Test Plan

6.1 Introduction

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

6.2 Customer

Table 7: Customer Information

Company Name	Actall Corporation
Address	2017 Curtis St.
City, State, Zip	Denver, CO 80205
Country	U.S.A.

Table 8: Technical Contact Information

Name	Isaac Davenport
E-mail	isaac@isaacdavenport.com

6.3 Equipment Under Test (EUT)

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

Table 9: EUT Designation

Product Name	PMT (HDT)
Model Name	PMT (HDT)
System Name	NA
Product Description	Personal Tracking Monitor

6.4 Product Specification

Table 10: EUT Specifications

EUT Specifications	
Input Power	3.0 VDC (Battery)
Environment	Indoor/Outdoor
Operating Temperature Range:	0 to 50 degrees C
Multiple Feeds:	☐ Yes and how many ☒ No
Product Marketing Name (PMN)	PMT (HDT)
Hardware Version Identification Number (HVIN)	60001
Firmware Version Identification Number (FVIN)	4.52
2.4GHz Radio	
Operating Mode	FHSS
Transmitter Frequency Band	2405.8 MHz to 2479.1 MHz
Power Setting at operating Channel	+1
Radio Antenna Information	☒ Internal ☐ External
Antenna Type	Chip
Antenna Gain	-1.2 dBi
Modulation Type	MSK
Data Rate	1 Mbps
Type of Equipment	☐ Table Top ☐ Wall-mount ☐ Floor standing cabinet ☒ Other: Body worn
Note: 1. This report only documents the radio characteristics for 2405.8 – 2479.1 MHz bands.	

Table 11: 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?
N/A	N/A	N/A	N/A	N/A
Note:				

Table 12: Supported Equipment

Equipment	Manufacturer	Model	Serial	Used for
Note:				

Table 13: Description of Sample used for Testing

Device	Serial Numnber	Configuration	Used For
PMT (HDT)	N/A	Radiated Sample	TX Spurious Emissions, Band edge
		Conducted Sample	All other conducted Measurements

Table 14: Description of Test Configuration used for Radiated Measurement.

Device	Antenna	Mode	Setup Description
PMT	Internal Chip	Transmit	EUT positioned vertical, worst case.
Note:			

6.5 Test Specifications

Testing requirements

Table 15: Test Specifications

Emissions and Immunity	
Standard	Requirement
CFR 47 Part 15.247: 2020 and RSS 247 :2017	All

END OF REPORT