



*Testing Tomorrow's Technology*

**Application  
For**

**Title 47 USC, Part 2, Subpart J, Paragraph 2.902, Equipment Authorization of Verification for an Unintentional Radiator per Part 15, Subpart B, Paragraphs 15.107 and 15.109**

**And**

**Part 2, Subpart J, Paragraph 2.907 Equipment Authorization of Certification for an Intentional Radiator per Part 15, Subpart C, paragraphs 15.207, 15.209 and 15.247**

**For the**

**Okyanus Teknoloji Bilgisayar ve Yazilim San. Tic.**

**Model Number: MT-02BDC-IP  
(Wireless Mobile Tag)**

**FCC ID: 2AUF1-MT-02BDC-IP**

**UST Project: 19-0289**

**Issue Date: November 1, 2019**

**Total Pages: 41**

**3505 Francis Circle Alpharetta, GA 30004  
PH: 770-740-0717 Fax: 770-740-1508  
[www.ustech-lab.com](http://www.ustech-lab.com)**



I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: Alan Ghasiani

Name: 

Title: Compliance Engineer – President

Date: November 1, 2019



TESTING

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OKYANUS TEKNOLOJI BILGISAYAR VE YAZILIM SAN. TIC.LTD.STI.

## MEASUREMENT TECHNICAL REPORT

**COMPANY NAME:** OKYANUS TEKNOLOJI BILGISAYAR VE YAZILIM SAN. TIC.LTD.STI.  
**MODEL:** MT-02BDC-IP  
**FCC ID:** 2AUF1-MT-02BDC-IP  
**DATE:** November 1, 2019

This report concerns (check one): Original grant   
Class II change

Equipment type: 2.4 GHz Transmitter (IEEE 802.15.4)

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? yes \_\_\_\_\_ No X

If yes, defer until: \_\_\_\_\_ N/A \_\_\_\_\_  
date

agrees to notify the Commission by \_\_\_\_\_ N/A \_\_\_\_\_  
date

of the intended date of announcement of the product so that the grant can be issued on that date.

Transmitter Details:  
2.4 GHz, IEEE 802.15.4 Radio Device  
Modulation: O-QPSK  
Data rate: 250 kbps  
Frequency band of operation: 2405 – 2480 MHz  
Measured maximum field strength: 96.93 dBuV/m @ 3 m

### Summary of Test Results

FCC Rule	Description of Test	Result
15.247(b)(3)	Peak Output Power	PASS
15.247(a)(2)	6 dB Bandwidth	PASS
15.247(d)	Conducted & Radiated Spurious Emissions	PASS
15.247(e)	Power Spectral Density	PASS
15.209	Spurious Radiated Emissions	PASS
15.207	Power line Conducted Emissions	PASS

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FCC Agency Agreement	External Photographs
FCC Application Forms	Internal Photographs
Letter of Confidentiality	Theory of Operation
Equipment Label(s)	RF Exposure
Block Diagram(s)	User's Manual
Schematic(s)	PAG Letter
Test Configuration Photographs	

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## **1 General Information**

### **1.1 Purpose of this Report**

This report is prepared as a means of conveying test results and information concerning the suitability of this exact product for public distribution according to FCC Rules and Regulations Part 15, Section 247.

### **1.2 Characterization of Test Sample**

The sample used for testing was received by US Tech on July 25, 2019 in good operating condition.

### **1.3 Product Description**

The Equipment under Test (EUT) is the Okyanus Teknoloji Bilgisayar ve Yazilim San. Tic. Model MT-02BDC-IP mobile tag. The EUT is a part of the Wipelot solution family. The EUT sends signals to the high precision readers within the system to find distance between mobile tags and readers. The EUT sends signals to all fix readers to transmit emergency situations. The EUT is powered by an internal 4.2V Lithium Poly battery. The EUT incorporates two types of radio technology. The EUT operates in the 2.4 GHz band using IEEE 802.15.4(Zigbee) and 4.4 GHz (Ultra Wide Band).

This test report covers the 2.4 GHz (Zigbee) compliance testing. The evaluation of the UWB radio feature has been reported separately.

## 1.4 Configuration of Tested System

The Test Sample was tested per *ANSI C63.10:2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices* for the intentional radiator aspect of the device and *ANSI C63.4:2014, Methods of Measurement of Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2014)* for the unintentional radiator aspect of the device as well as FCC subpart B and C of Part 15 and per FCC KDB Publication number 558074 v05r02 for Digital Transmission Systems Operating Under section 15.247.

Digital RF conducted and radiated emissions data below 1 GHz were taken with the measuring receiver (or spectrum analyzer's) resolution bandwidth adjusted to 9 kHz and 120 kHz, respectively. All measurements performed above 1.0 GHz were made with a RBW of 1 MHz. All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was set to 3 times the RBW or as required per the standard throughout the evaluation process.

A list of EUT and Peripherals is found in Table 1 below. A block diagram of the tested system is shown in Figure 1. Test configuration photographs for spurious and fundamental emissions are provided in separate Appendices.

## 1.5 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA 30004. This site has been fully described and registered with the FCC. Its designation number is US5301. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1.

## 1.6 Related Submittal(s)/Grant(s)

The EUT is subject to the following FCC Equipment Authorizations:

- a) Certification of the transmitter incorporated within the EUT; see test data presented herein.
- b) Verification as a class B digital device.



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**Table 1. EUT and Peripherals**

MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/IC ID	CABLES P/D
EUT Wipelot	MT-02BDC-IP	Engineering Sample	2AUF1-MT-02BDC-IP	--
Antenna See antenna details	--	--	--	--

S= Shielded, U= Unshielded, P= Power, D= Data

## 2 Tests and Measurements

### 2.1 Test Equipment

The table below lists test equipment used to evaluate this product. Model numbers, serial numbers and their calibration status are included herein.

**Table 2. Test Instruments**

TEST INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	CALIBRATION DUE DATE
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	8/17/2020 2 yr.
RF PREAMP 100 kHz to 1.3 GHz	8447E	HEWLETT-PACKARD	1937A01828	5/7/2020
PREAMP 1.0 GHz to 26.0 GHz	8449B	HEWLETT-PACKARD	3008A00480	4/8/2020
LOOP ANTENNA	SAS-200/562	A. H. Systems	142	1/22/2020 2 yr.
BICONICAL ANTENNA	3110B	EMCO	9307-1431	10/23/2019 2 yr
LOG PERIODIC ANTENNA	3146	EMCO	9305-3600	2/1/2021 2 yr
HORN ANTENNA	3115	EMCO	9107-3723	11/28/2020 2 yr
HIGH PASS FILTER	H3R020G2	MICROWAVE CIRCUITS	001DC9528	4/2/2020

Note: The calibration interval of the above test instruments are 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

(\*)= used for power line conducted emissions testing

## 2.2 Modifications to EUT Hardware

No modifications were made by US Tech to bring the EUT into compliance with FCC Part 15.247 requirements.

## 2.3 Number of Measurements for Intentional Radiators (15.31(m))

Measurements of intentional radiators or receivers shall be performed and reported for each band in which the device can be operated, with the device operating at the number of frequencies in each band specified in the Table below.

**Table 3. Number of Test Frequencies for Intentional Radiators**

Frequency Range over which the device operates	Number of Frequencies	Location in the Range of operation
1 MHz or less	1	Middle
1 to 10 MHz	2	1 near the top 1 near the bottom
Greater than 10 MHz	3	1 near top 1 near middle 1 near bottom

Because the EUT operates over 2.4 GHz to 2.4835 GHz, 3 test frequencies were used.

## **2.4 Frequency Range of Radiated Measurements (Part 15.33)**

### **2.4.1 Intentional Radiator**

The spectrum shall be investigated for the intentional radiator from the lowest RF signal generated in the EUT, without going below 9 kHz to the 10<sup>th</sup> harmonic of the highest fundamental frequency generated or 40 GHz, whichever is the lowest.

### **2.4.2 Unintentional Radiator**

For the digital device, an unintentional radiator, the frequency range shall be 30 MHz to 1000 MHz, or to the range specified in 2.4.1 above, whichever is the higher range of investigation.

## **2.5 Measurement Detector Function and Bandwidth (CFR 15.35)**

The radiated and conducted emissions limits shown herein are based on the following:

### **2.5.1 Detector Function and Associated Bandwidth**

On frequencies below 1000 MHz, the limits herein are based upon measurement equipment employing a CISPR Quasi-peak detector function and related measurement bandwidths (i.e. 9 kHz from 150 kHz to 30 MHz and 120 kHz from 30 MHz to 1000 MHz). Alternatively, measurements may be made with equipment employing a peak detector function as long as the same bandwidths specified for the Quasi-peak device are used.

### **2.5.2 Corresponding Peak and Average Requirements**

Above 1000 MHz, radiated limits are based on measuring instrumentation employing an average detector function. When average radiated emissions are specified there is also a corresponding Peak requirement, as measured using a peak detector, of 20 dB greater than the average limit. For all measurements above 1000 MHz the Resolution Bandwidth shall be at least 1 MHz.

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## 2.6 EUT Antenna Requirements (CFR 15.203)

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. Only the antenna(s) listed in Table 4 will be used with this module.

**Table 4. Allowed Antenna(s)**

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dB <sub>i</sub>	TYPE OF CONNECTOR
Antenna	Antenova	Chip	A5839	2.1	SMD



**Figure 1. Block Diagram of Test Configuration**

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## **2.7 Restricted Bands of Operation (Part 15.205)**

Only spurious emissions can fall in the frequency bands of CFR 15.205. The field strength of these spurious cannot exceed the limits of 15.209. Radiated harmonics and other Spurious are examined for this requirement see paragraph 2.10.

## **2.8 Transmitter Duty Cycle (Part15.35 (c))**

The EUT employs pulse transmission however for testing purpose the EUT was programmed to transmit at a rate >98%. The pulse transmission requirements of this subpart were acknowledge and considered during testing.

When the radiated emissions limit is expressed as an average value, and the transmitter is pulsed, the measured field strength shall be determined by applying a Duty Cycle Correction Factor based upon dividing the total ON time during the first 100 ms period by 100 ms (or by the period if less than 100 ms). The duty cycle may also be expressed logarithmically in dB.

## **2.9 Antenna Conducted Intentional and Spurious Emissions (CFR 15.209, 15.247(d))**

The EUT did not have a conducted antenna port. Therefore, this test was not performed.

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## **2.10 Intentional Radiator, Radiated Emissions (CFR 15.209, 15.247(d))**

On the test site, the EUT was placed on top of a non-conductive table, 80 cm above the floor for measurements below 1 GHz and 150 cm above the floor for measurements > 1 GHz. The EUT was also evaluated in three orthogonal positions to determine the worst case position. The front of the EUT faced the measurement antenna located 3 meters away. Each signal measured was maximized by raising and lowering the receive antenna between 1 and 4 meters in height while monitoring the ever changing spectrum analyzer display (with channel A in the Clear-Write Mode and channel B in the Max-Hold Mode) for the largest signal visible. That exact antenna height where the signal was maximized was recorded for reproducibility purposes. Also, the EUT was rotated about its Y-axis while monitoring the Spectrum Analyzer display for maximum. The EUT azimuth was recorded for reproducibility purposes. The EUT was measured when both maxima were simultaneously satisfied.

For radiated measurements, the EUT was set into a continuous transmission Mode. Below 1 GHz, the RBW of the measuring instrument was set equal to 120 kHz. Peak measurements above 1 GHz were measured using a RBW = 1 MHz, with a VBW  $\geq$  RBW. The results of peak radiated spurious emissions falling within restricted bands are given in Table 5.

For Average measurements above 1 GHz, the emissions were measured using RBW = 1 MHz and VBW = 10 Hz or the duty cycle correction factor was applied to the Peak recorded value.



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**Table 5. Peak Radiated Fundamental & Harmonic Emissions**

Tested By: AF		Test: FCC Part 15,247(d)						
Frequency (MHz)	Test Data (dBuV)	Additional Factor	AF+CL-PA (dB/m)	Corrected Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detector
<b>Low Channel– PEAK</b>								
2405.00	98.82	0.00	-1.90	96.92	--	3.0m./HORZ	--	<b>PK</b>
*4810.00	49.33	0.00	6.08	55.41	74.0	3.0m./HORZ	18.6	<b>PK</b>
*7215.00	49.60	-9.50	11.07	51.17	74.0	1.0m./HORZ	22.8	<b>PK</b>
<b>Mid Channel – PEAK</b>								
2440.00	97.60	0.00	-0.67	96.93	--	3.0m./HORZ	--	<b>PK</b>
*4880.00	51.76	0.00	7.30	59.06	74.0	3.0m./HORZ	14.9	<b>PK</b>
*7320.00	49.60	-9.50	16.09	56.19	74.0	1.0m./HORZ	17.8	<b>PK</b>
<b>High Channel– PEAK</b>								
2480.00	95.62	0.00	-0.55	95.07	--	3.0m./HORZ	--	<b>PK</b>
*4960.00	49.25	0.00	8.75	58.00	74.0	3.0m./HORZ	16.0	<b>PK</b>
*7440.00	49.68	-9.50	16.24	56.42	74.0	3.0m./HORZ	17.6	<b>PK</b>

- (\*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209& 15.247.
- No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10<sup>th</sup> harmonic

Sample Calculation at 2405.00 MHz:

Magnitude of Measured Frequency	98.82	dBuV
+Additional Factor	0.00	dB
+Antenna Factor + Cable Loss+ Amplifier Gain	-1.90	dB/m
Corrected Result	96.92	dBuV/m

Test Date: September 23, 2019

Tested By  
 Signature: Afzal Fazal

Name: Afzal Fazal

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**Table 6. Average Radiated Fundamental & Harmonic Emissions**

Tested By: AF		Test: FCC Part 15,247(d)						
Frequency (MHz)	Test Data (dBuV)	Additional Factor	AF+CL-PA (dB/m)	Corrected Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detector
<b>Low Channel- AVERAGE</b>								
2405.00	32.86	0.00	-1.90	30.96	--	3.0m./HORZ	--	<b>AVG</b>
*4810.00	27.05	0.00	6.08	33.13	54.0	3.0m./HORZ	20.9	<b>AVG</b>
*7215.00	26.48	-9.50	11.07	28.05	54.0	1.0m./HORZ	26.0	<b>AVG</b>
<b>Mid Channel - AVERAGE</b>								
2440.00	32.31	0.00	-0.67	31.64	--	3.0m./HORZ	--	<b>AVG</b>
*4880.00	33.24	0.00	7.30	40.54	54.0	3.0m./HORZ	13.5	<b>AVG</b>
*7320.00	25.99	-9.50	16.09	32.58	54.0	1.0m./HORZ	21.4	<b>AVG</b>
<b>High Channel- AVERAGE</b>								
2480.00	32/25	0.00	-0.55	31.70	--	3.0m./HORZ	--	<b>AVG</b>
*4960.00	27.11	0.00	8.75	35.86	54.0	3.0m./HORZ	18.1	<b>AVG</b>
*7440.00	25.55	-9.50	16.24	32.29	54.0	3.0m./HORZ	21.7	<b>AVG</b>

- (\*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209& 15.247.
- No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10<sup>th</sup> harmonic

Sample Calculation at 2405.00 MHz:

Magnitude of Measured Frequency	32.86	dBuV
+Additional Factor	0.00	dB
+Antenna Factor + Cable Loss+ Amplifier Gain	-1.90	dB/m
Corrected Result	30.96	dBuV/m

Test Date: September 23, 2019

Tested By  
 Signature: Afzal Fazal

Name: Afzal Fazal

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## 2.11 Maximum Peak Conducted Output Power (CFR 15.247 (b) (3))


Peak power within the band 2400 MHz to 2483.5 MHz was measured per KDB 558074 D01 15.247 Meas guidance v05r02. The device is a handheld device with integral antenna therefore antenna-port conducted test cannot be performed. Radiated test configuration is used. The measured field strength levels were converted to equivalent conducted power levels for comparison to the output power limit. See the calculations below. The field strength levels are the levels measured in Table 5 & 6 above. In this case the peak values are used to determine peak output power.

**Table 7. Peak Antenna Conducted Output Power per Part 15.247 (b)(3)**

Frequency of Fundamental (MHz)	Raw Test Data dBuV/m from Table 5	Converted Data (dBm)	Power in Watts (W)	FCC Limit Watts (W)
2405	96.92	1.7	0.001	1.0
2440	96.93	1.7	0.001	1.0
2480	95.07	-0.1	0.001	1.0

$EIRP (dBm) = E(dBuV/m) + 20 \log (D) - 104.8$ ; where D = 3 meter test distance

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Tested By  
Signature: 

Name: Afzal Fazal

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## 2.12 Band Edge Measurements – (CFR 15.247 (d))

Band Edge measurements are made following the guidelines in ANSI C63.10-2013 with the EUT initially operating on the Lowest Channel and then operating on the Highest Channel within its band of operation. Radiated measurements are performed to demonstrate compliance with the requirement of 15.247(d) that all emissions outside of the band edges be attenuated by at least 20 dB when compared to its highest in-band value (contained in a 100 kHz band). Because these frequencies occur above 1000 MHz they have both a peak and average requirement.

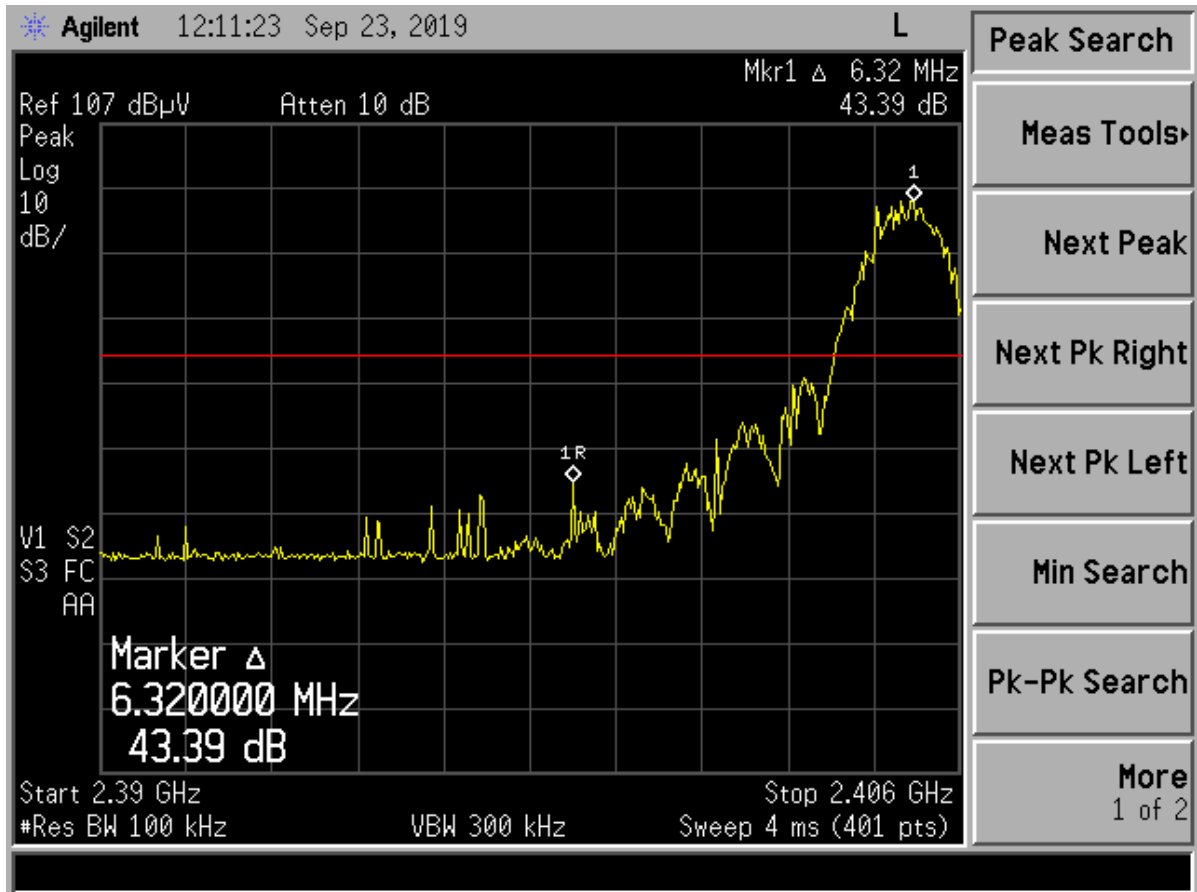
To capture the band edge set the Spectrum Analyzer frequency span large enough (usually around 10 MHz) to capture the peak level of the emission operating on the channel closest to the band edge as well as any modulation products falling outside of the authorized band of operation.

The screen shots are presented following.

Test Date: September 23, 2019

Tested By  
Signature: 

Name: Afzal Fazal



**Figure 2. Band Edge Compliance – Low Channel Delta**

Lower band edge must be 20 dB below the fundamental. This requirement is met.

Measured Result	43.39	dB
Band Edge Limit	20.00	dB
Band Edge Margin	23.39	dB

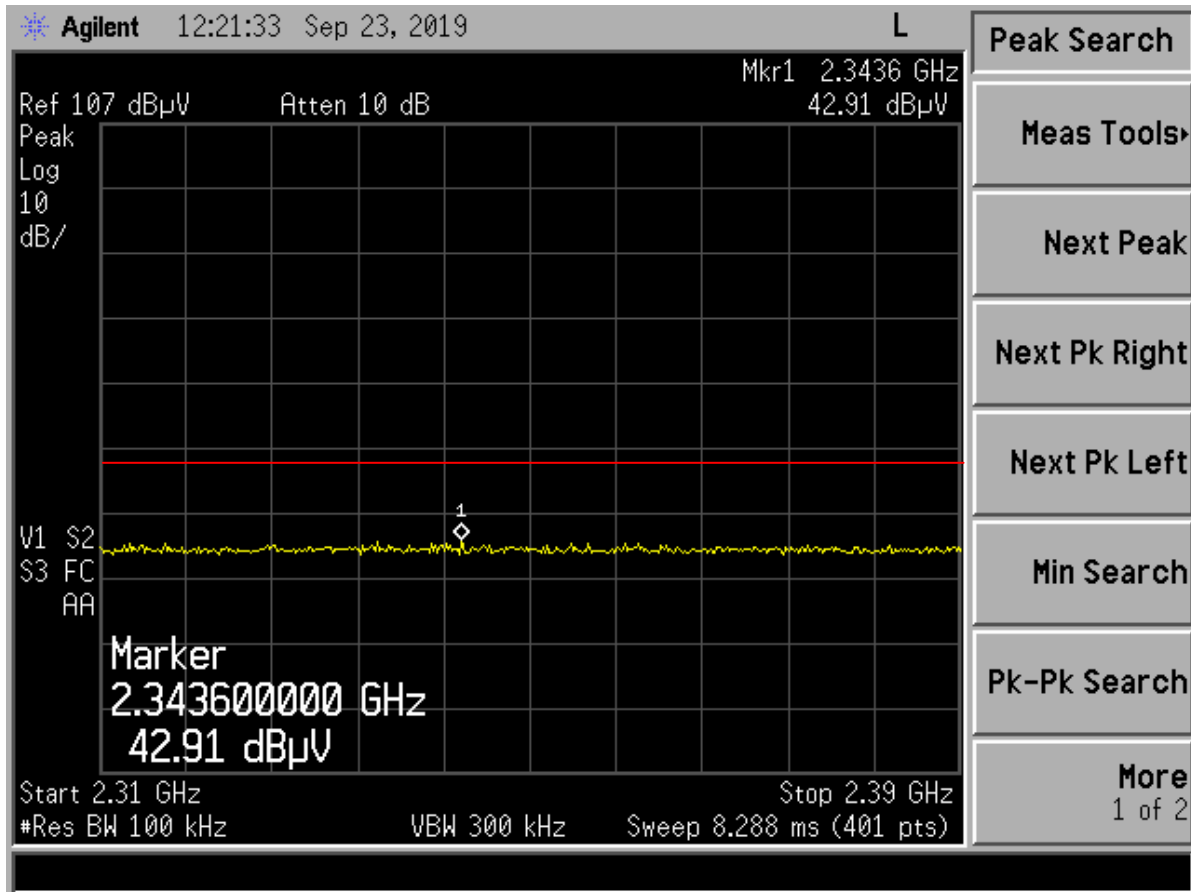


Figure 3. Low Channel Restricted Band – Peak

Frequency (MHz)	Test Data (dBUV)	AF+CA-AMP+DC (dB/m)	Results (dBUV/m)	Limits (dBUV/m)	Distance / Polarization	Margin (dB)	Detector PK/QP/AVG
2343.60	42.91	-2.67	40.24	54.0	3.0m./HORZ	13.8	PK



**Figure 4. Band Edge Compliance – High Channel Delta**

Lower band edge must be 20 dB below the fundamental. This requirement is met.

Measured Result	46.54	dB
Band Edge Limit	20.00	dB
Band Edge Margin	26.54	dB

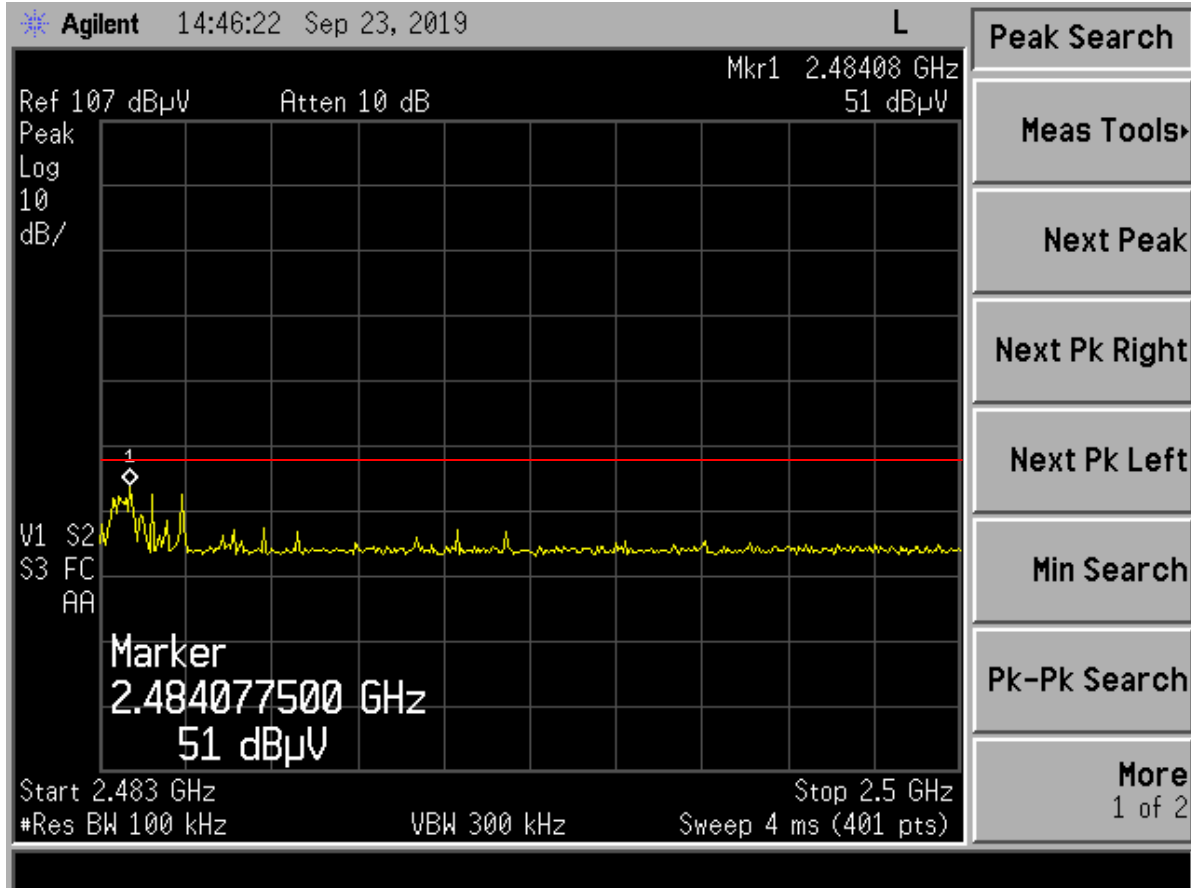


Figure 5. High Channel Restricted Band – Peak

Frequency (MHz)	Test Data (dBuV)	AF+CA-AMP+DC (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detector PK/QP/AVG
2483.75	51.00	-1.66	49.34	54.0	3.0m./HORZ	4.7	PK



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### 2.13 Six (6) dB Bandwidth per CFR 15.247(a)(2)


The EUT antenna port was connected to a spectrum analyzer having a 50  $\Omega$  input impedance. Measurements were performed per ANSI C63.10-2013, clause 11.8. The RBW was set to 100 kHz and the VBW  $\geq$  RBW. The results of this test are given in the table below and figures below.

**Table 8. Six (6) dB Bandwidth**

Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum FCC Bandwidth (MHz)
2405	1.033	0.5
2440	1.255	0.5
2480	1.323	0.5

Test Date: September 24, 2019

Tested By

Signature: 

Name: Afzal Fazal

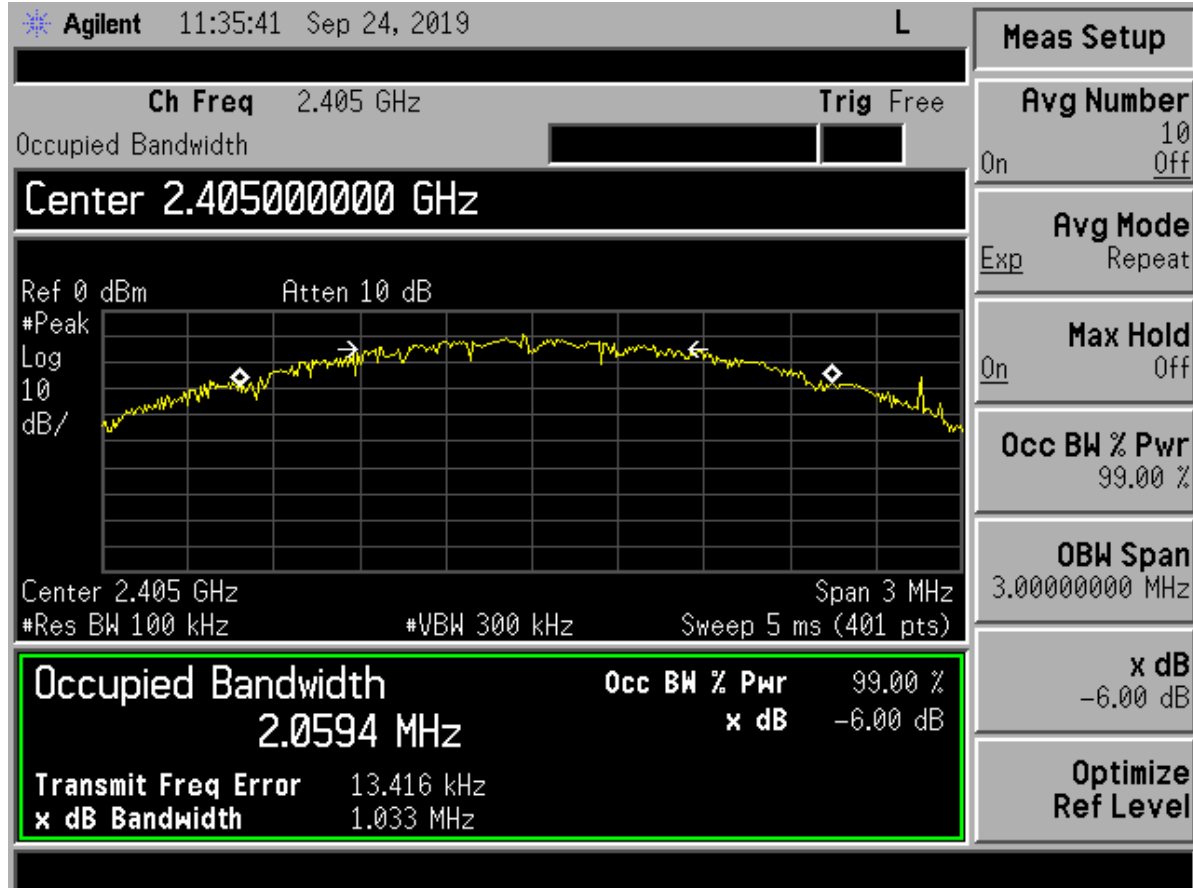


Figure 6. 6 dB Bandwidth Low Channel

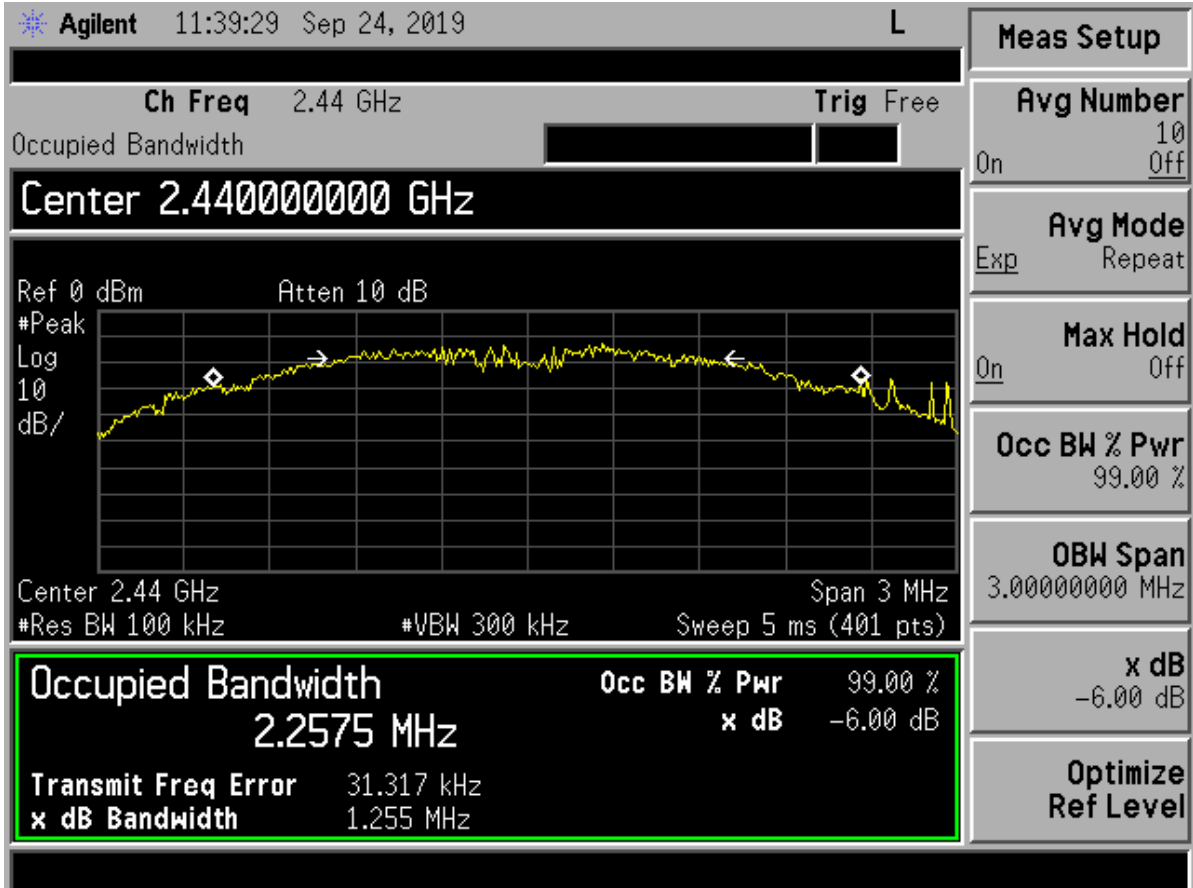


Figure 7. 6 dB Bandwidth Mid Channel

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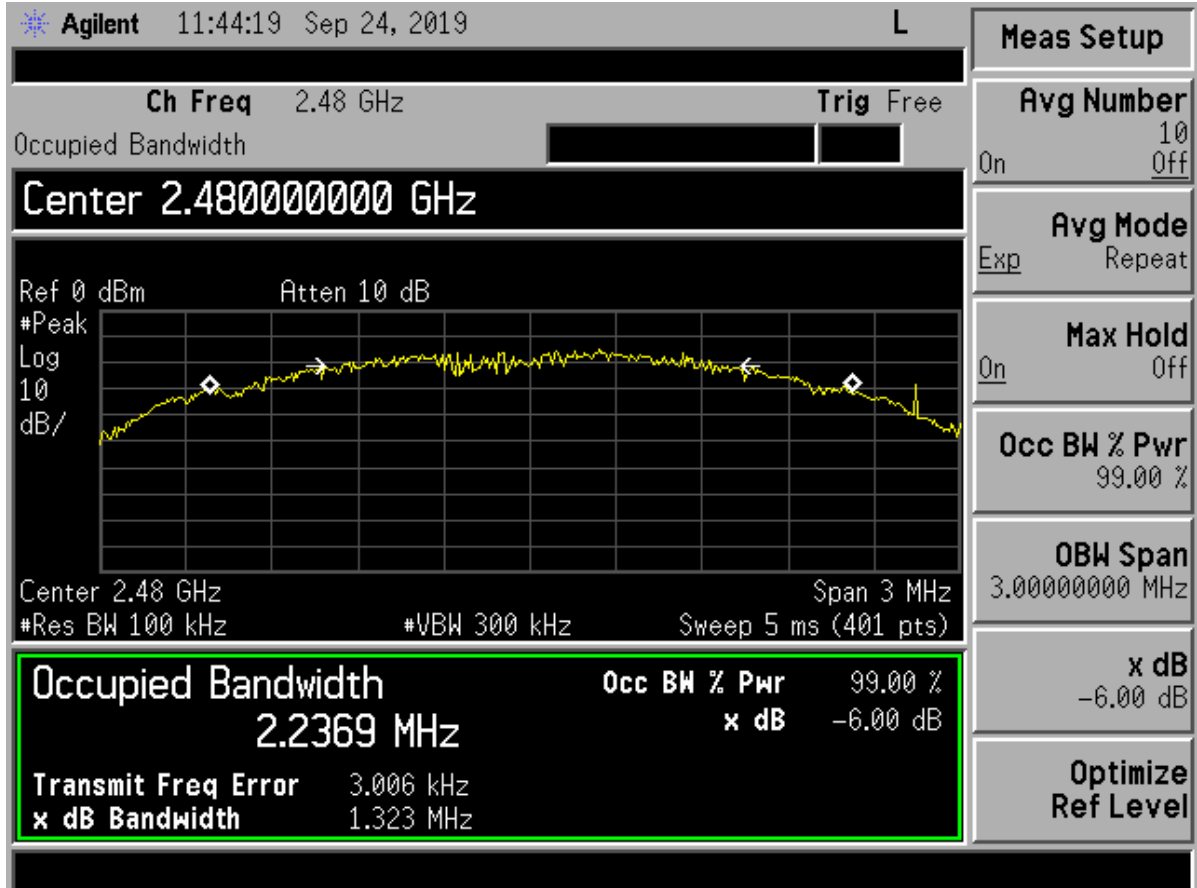


Figure 8. 6 dB Bandwidth High Channel

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## 2.14 Power Spectral Density (CFR 15.247(e))

The transmitter was placed into a continuous Mode of operation at all applicable frequencies. The measurements were performed per the procedures of ANSI C63.10-2013. The RBW was set to 3 kHz and the Video Bandwidth was set to  $\geq$  RBW. The trace capture time was set to (Span/3 kHz).

In accordance with 15.247 (e), the power spectral density shall be no greater than +8 dBm per any 3 kHz band.

Results are shown in the table below and figures below. All are less than +8 dBm per 3 kHz band. SEE figures above.

Note: dBm/Hz correct to dBm/kHz using the following formula,  $10 \log \text{RBW}_{\text{ref}}/\text{RBW}$  measured.

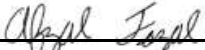
**Table 9. Power Spectral Density for Low, Mid and High Bands**

Frequency (MHz)	Measured Value (dBm/Hz)	Corrected Results (dBm/kHz)	FCC Limit (dBm/3 kHz)
2405	-93.98	-58.61	+8.0
2440	-93.14	-58.37	+8.0
2480	-94.58	-59.81	+8.0

Sample Calculation:  $-93.38 \text{ dBm/Hz} + (10 \cdot \log (3000/1)) = -58.61 \text{ dB/3kHz}$

Test Date: September 24, 2019

Tested By

Signature: 

Name: Afzal Fazal

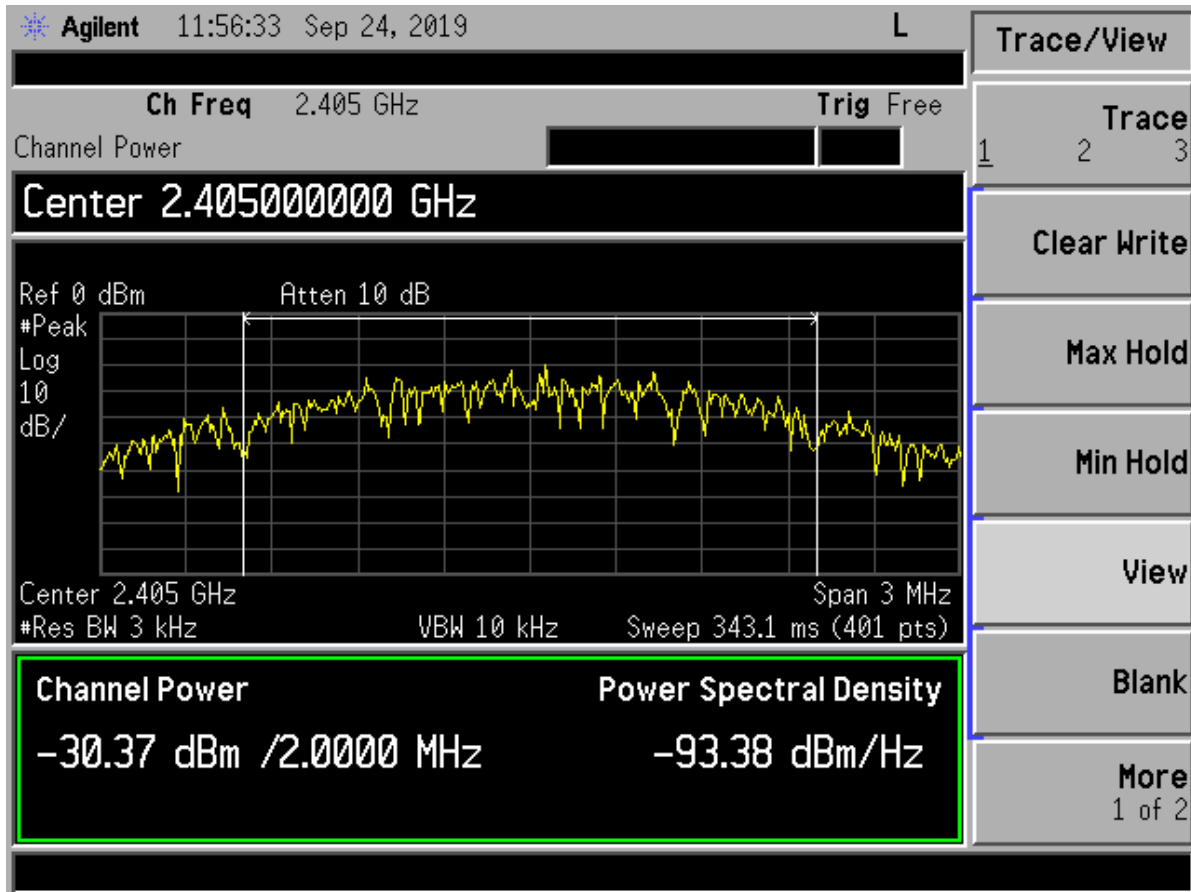


Figure 9. Peak Antenna Conducted Output Power, Low Channel

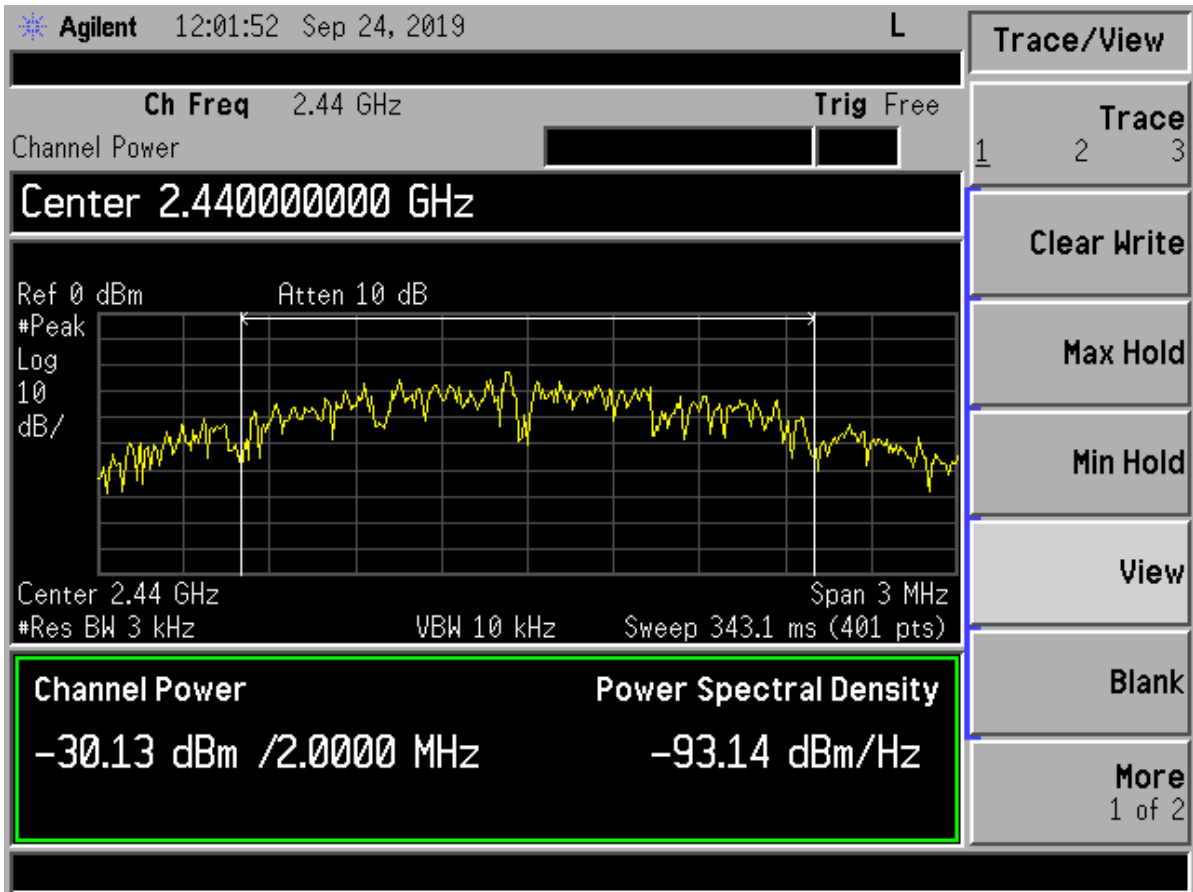


Figure 10. Peak Antenna Conducted Output Power, Mid Channel

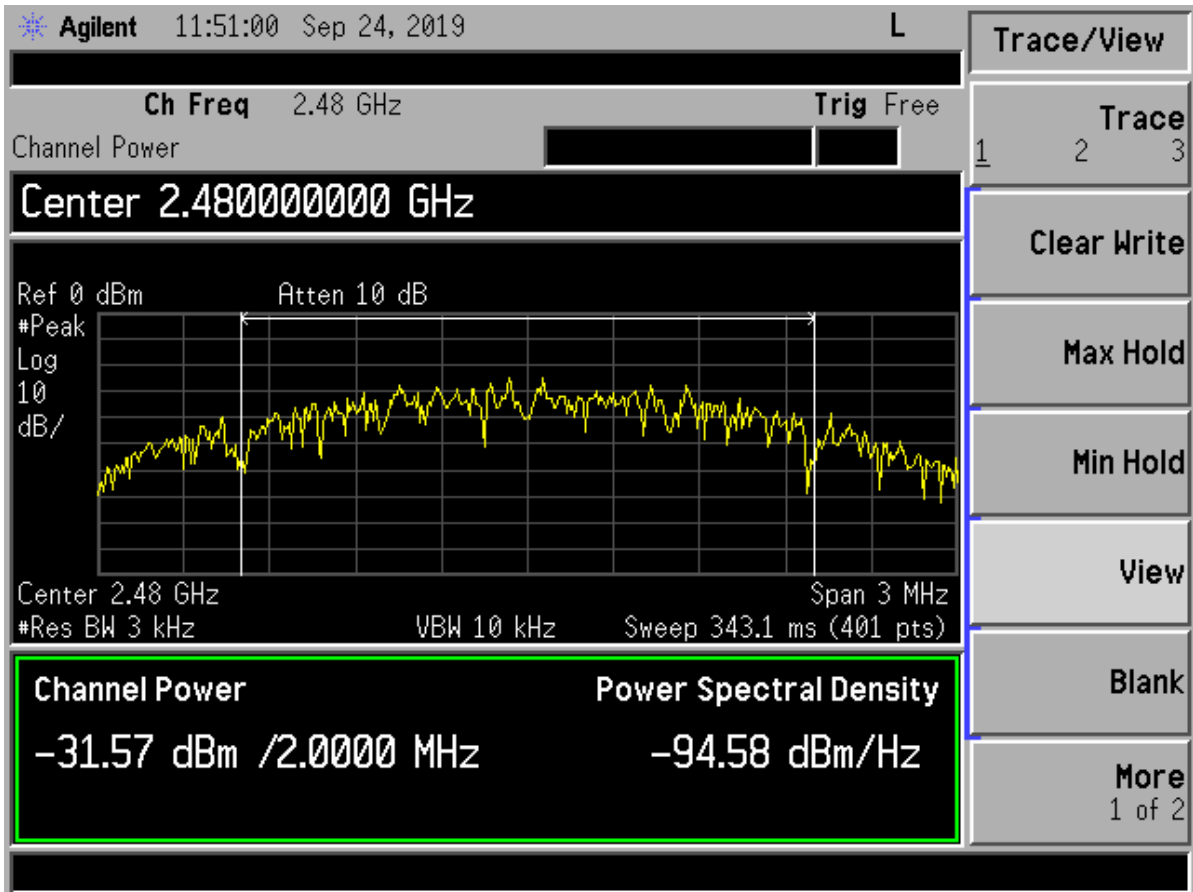


Figure 11. Peak Antenna Conducted Output Power, High Channel



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## **2.15 Intentional Radiator Power Lines Conducted Emissions (CFR 15.207)**

The power line conducted voltage emission measurements have been carried out in accordance with CFR 15.207, per ANSI C63.10:2013, Clause 6.2, with a spectrum analyzer connected to an LISN and the EUT placed into a continuous Mode of transmission.

Since the unit did not have this type of port, the test was deemed non-applicable.

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**Table 10. Power Line Conducted Emissions**

<b>CONDUCTED EMISSIONS 150 kHz to 30 MHz</b>						
Tested By: AF	Specification Requirement: FCC Part 15.207	Project No.: 19-0289	Model: MT-02BDC-IP			
Frequency (MHz)	Test Data (dBuV)	LISN+CL (dB)	Corrected Results (dBuV)	Limits (dBuV)	Margin (dB)	Detector
<b>This test was inapplicable. The EUT does not connect to the AC mains.</b>						

Test Date: September 24, 2019

Tested By  
Signature: 

Name: Afzal Fazal

US Tech Test Report:  
FCC ID:  
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Model:

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## 2.16 Intentional Radiator, Radiated Emissions (CFR 15.209)

The test data provided herein is to support the verification requirement for radiated emissions coming for the EUT in a transmitting state per 15.209 and were investigated from 9kHz or the lowest operating clock frequency to 25 GHz and tested as detailed in ANSI C63.10:2013, Clause 6.4-6.6. Data is presented in the table below.

Radiated emissions within the band of 9 kHz to 30 MHz were investigated using a calibrated Loop Antenna and per the requirements of ANSI C63.10:2013.

Measurements were made with the analyzer's resolution bandwidth set to 120 kHz for measurements made below 1 GHz and 1 MHz for measurements made above 1 GHz. The video bandwidth was set to three times the resolution bandwidth; 1 MHz RBW and 3 MHz VBW. The test data were maximized for magnitude by rotating the turn-table through 360 degrees and raising and lowering the receiving antenna between 1 to 4 meters in height as a part of the measurement procedure.

The measurements were taken at the transmitter set to the mid channel.

The worst-case radiated emission was 6.9 dB below the specification limit at 702.70 MHz. All other measured signals were at least 7.3 dB below the specification limit. The results are shown in the table below. These results are meant to show that this EUT has met the intentional transmitter requirements of CFR Part 15.209.

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**Table 11. Spurious Radiated Emissions – (150 KHz-30MHz)**

Test By: AF	Test: FCC Part 15.209						
Frequency (MHz)	Test Data (dBuV)	AF+CL-PA (dB)	Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	DETECTOR PK / QP/AVG
All emissions were at least 20 dB below the applicable limit.							

No other emissions detected other than those presented in this table and the tables in section 2.10 above.

AF is antenna factor. CL is cable loss. PA is preamplifier gain.

SAMPLE CALCULATION: N/A

Test Date: September 24, 2019

Tested By  
Signature: 

Name: Afzal Fazal

US Tech Test Report:  
 FCC ID:  
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**Table 12. Spurious Radiated Emissions Below 1 GHz**


Test By: AF	Test: FCC Part 15.109/15.209							
Frequency (MHz)	Test Data (dBuV)	Additional Factors	AF+CL-PA (dB)	Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	DETECTOR PK / QP/AVG
<b>Tested from 30 MHz to 1 GHz</b>								
44.18	47.77	-	-15.92	31.85	40.0	3m./VERT	8.1	<b>PK</b>
85.91	44.58	-	-17.77	26.81	40.0	3m./HORZ	13.2	<b>PK</b>
85.91	47.73	-	-17.87	29.86	40.0	3m./VERT	10.1	<b>PK</b>
101.56	48.21	-	-16.26	31.95	43.5	3m./VERT	11.5	<b>PK</b>
702.70	42.28	-	-3.14	39.14	46.0	3m./VERT	6.9	<b>PK</b>
856.09	18.65	-	-0.65	18.00	46.0	3m./HORZ	28.0	<b>QP</b>

AF is antenna factor. CL is cable loss. PA is preamplifier gain.

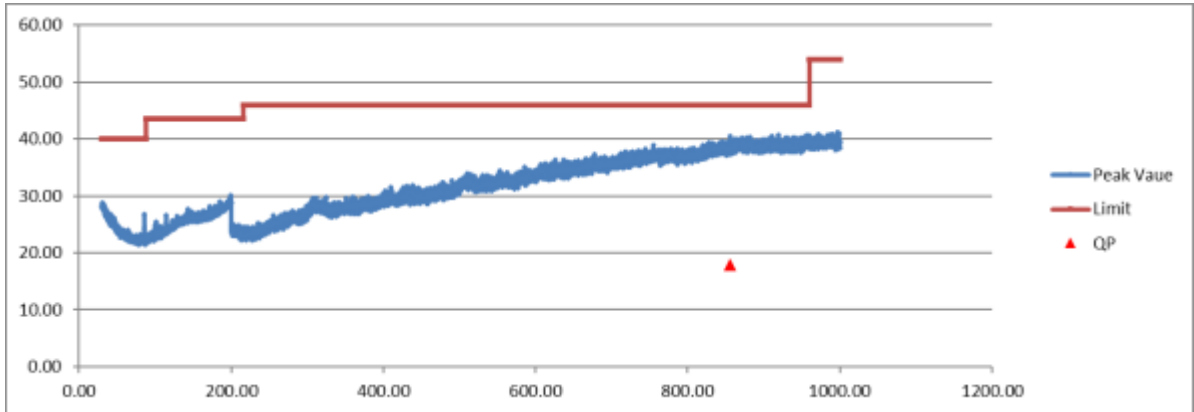
SAMPLE CALCULATION AT: 44.18 MHz

Magnitude of Measured Frequency	47.77	dBuV
Additional Factor	0.00	dB
+Antenna Factor + Cable Loss+ Amplifier Gain	-15.92	dB
Corrected Result	31.85	dBuV/m

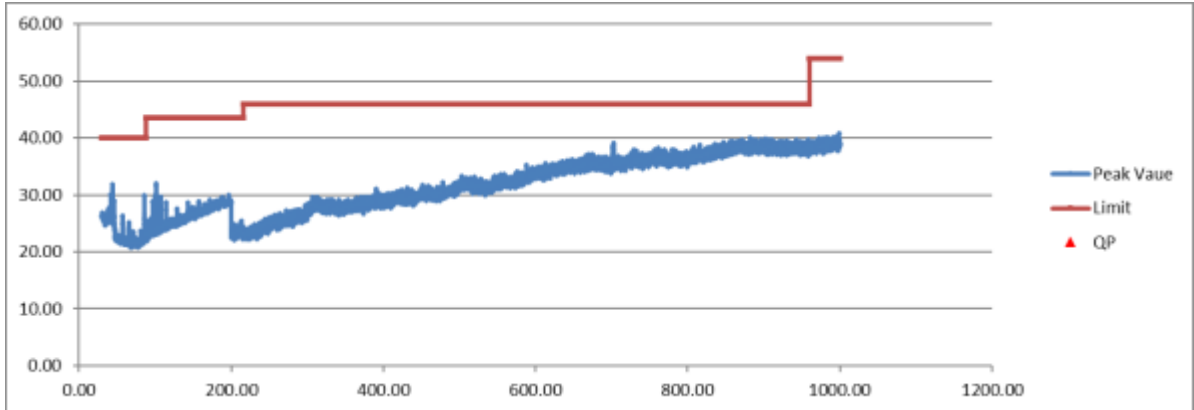
Test Date: September 24, 2019

Tested By  
 Signature: 

Name: Afzal Fazal



**Figure 12. Radiated Emissions Graphical Data, TX, 30-1000 MHz - Horizontal**



**Figure 13. Radiated Emissions Graphical Data, TX, 30-1000 MHz – Vertical**

US Tech Test Report:  
 FCC ID:  
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 Issue Date:  
 Customer:  
 Model:

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**Table 13. Spurious Radiated Emissions Above 1 GHz**

Test By: AF	Test: FCC Part 15.109/15.209							
Frequency (MHz)	Test Data (dBuV)	Additional Factors	AF+CL-PA (dB)	Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	DETECTOR PK / QP/AVG
<b>Tested from 1 GHz to 25 GHz</b>								
1010.00	48.11	-	-10.45	37.66	54.0	3.0m./VERT	16.3	<b>PK</b>
1012.00	48.09	-	-10.63	37.46	54.0	3.0m./HORZ	16.5	<b>PK</b>
2979.00	45.89	-	-2.68	43.21	54.0	3.0m./HORZ	10.8	<b>PK</b>
2980.00	46.54	-	-2.56	43.98	54.0	3.0m./VERT	10.0	<b>PK</b>
5100.00	40.65	-	6.08	46.73	54.0	3.0m./VERT	7.3	<b>PK</b>
8420.22	42.44	-9.50	7.96	40.90	54.0	1.0m./VERT	13.1	<b>PK</b>
9993.65	41.85	-9.50	10.24	42.59	54.0	1.0m./HORZ	11.4	<b>PK</b>
17900.00	19.37	-9.50	26.66	36.53	54.0	1.0m./HORZ	17.5	<b>AVG</b>
17900.00	19.41	-9.50	26.32	36.23	54.0	1.0m./VERT	17.8	<b>AVG</b>
<b>All other emissions were more than 20 dB below the applicable limit.</b>								

AF is antenna factor. CL is cable loss. PA is preamplifier gain.

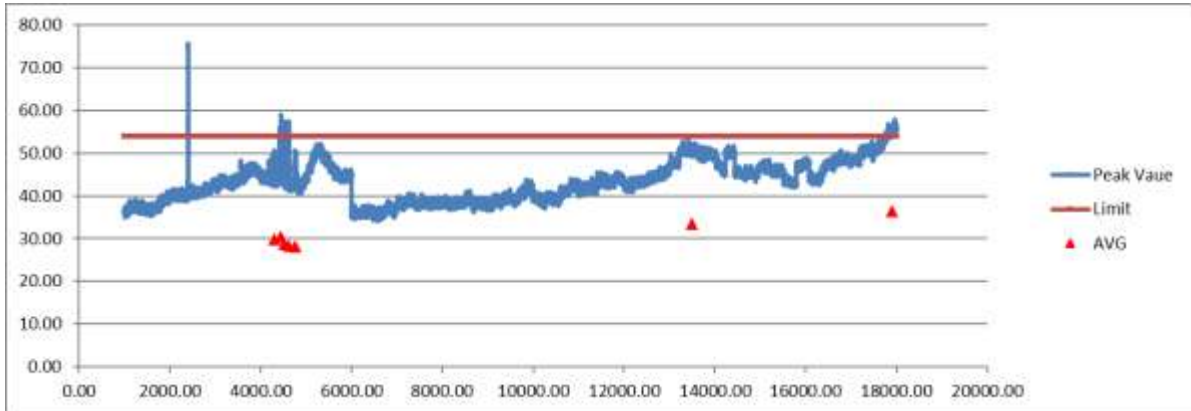
SAMPLE CALCULATION AT: 1010.00 MHz

Magnitude of Measured Frequency	48.11	dBuV
Additional Factor	-0.00	dB
+Antenna Factor + Cable Loss+ Amplifier Gain	-10.45	dB
Corrected Result	37.66	dBuV/m

Test Date: September 23, 2019

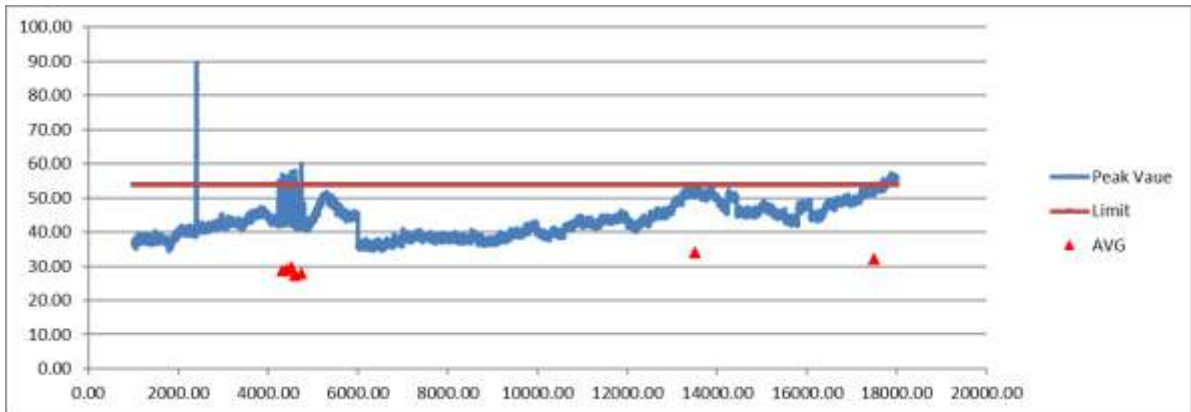
Tested By  
 Signature: Afzal Fazal

Name: Afzal Fazal



**Figure 14. Radiated Emissions Graphical Data, TX, 1 -18GHz - Horizontal**

Note: Intentional emission around 2.4 GHz is for ZigBee transmitter.



**Figure 15. Radiated Emissions Graphical Data, TX, 1 -18GHz – Vertical**

Note: Intentional emission around 2.4 GHz is for ZigBee transmitter.



## **2.17 Measurement Uncertainty**

The measurement uncertainties given were calculated using the method detailed in CISPR 16-4-2:2011. A coverage factor of  $k=2$  was used to give a level of confidence of approximately 95%.

### **2.17.1 Conducted Emissions Measurement Uncertainty**

Measurement Uncertainty (within a 95% confidence level) for this test is  $\pm 2.78$  dB.

### **2.17.2 Radiated Emissions Measurement Uncertainty**

For a measurement distance of 3 m the measurement uncertainty (with a 95% confidence level) for this test using a Biconical Antenna (30 MHz to 200 MHz) is  $\pm 5.3$  dB. This value includes all elements of measurement.

The measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna (200 MHz to 1000 MHz) is  $\pm 5.1$  dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna is  $\pm 5.1$  dB.

## **3 Conclusions**

The EUT is deemed to have met the requirements of the standards cited within the test report when tested as detailed herein.