# RADIO TEST REPORT

| | | |
|---|---|---|
| **Product** | : | Essential Spotlight Camera |
| **Model Name** | : | VMC2030 |
| **FCC ID** | : | 2APLE18300409 |
| **Test Regulation** | : | FCC 47 CFR Part 15 Subpart C (Section 15.247) |
| **Received Date** | : | Apr. 8, 2020 |
| **Test Date** | : | Apr. 6, 2020 ~ May 14, 2020 |
| **Issued Date** | : | May. 14, 2020 |
| **Applicant** | : | Arlo Technologies Inc<br>2200 Faraday Avenue, Suite 150, Carlsbad, CA 92008, USA |
| **Issued By** | : | Underwriters Laboratories Taiwan Co., Ltd.<br>Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd.,<br>Zhudong Township, Hsinchu County, Taiwan |

Testing Laboratory
3398

**The results reported herein have been performed in accordance with the laboratory's terms of accreditation. This report shall not be reproduced except in full without the written approval of the Laboratory. The results in this report are responsible of the test sample(s) provided by the client only and are not to be used to indicate applicability to other similar products.**

# REVISION HISTORY

## Original Test Report No.: 4789445245-US-R0-V0

| Rev. | Test report No. | Date | Page revised | Contents |
|---|---|---|---|---|
| Original | 4789445245-US-R0-V0 | May. 11, 2020 | - | Initial issue |
| - | 4789445245-US-R0-V0 | May. 14, 2020 | P.8<br>P.9<br>P.11<br>P.17, P.20,<br>P.21, P.23,<br>P.26 ~ P.34,<br>P.42, P.44,<br>P.47, P.49,<br>P.52, P.54,<br>P.65~P.82 | Modify Note 1.<br>Modify accessory devices.<br>Modify section 6.5.<br>Add test data of channel 2 & channel 10. |
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# Table Of Contents

# 1. Attestation of Test Results

| | |
|---|---|
| **APPLICANT:** | Arlo Technologies Inc<br>2200 Faraday Avenue, Suite 150, Carlsbad, CA 92008, USA |
| **MANUFACTURER** | Funing Precision Component Co., Ltd.<br>Lot B, Que Vo Industrial Zone, Van Duong Ward, Bac Ninh City, Bac Ninh Province, VIETNAM |
| **EUT DESCRIPTION:** | Essential Spotlight Camera |
| **BRAND:** | Arlo |
| **MODEL:** | VMC2030 |
| **SAMPLE STAGE:** | Identical Prototype |
| **DATE of TESTED:** | Apr. 6, 2020 ~ May 14, 2020 |

**APPLICABLE STANDARDS**

| STANDARD | Test Results |
|---|---|
| FCC 47 CFR PART 15 Subpart C (Section 15.247) | PASS |

Underwriters Laboratories Taiwan Co., Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by Underwriters Laboratories Taiwan Co., Ltd. based on interpretations and/or observations of test results. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

**Note:** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by Underwriters Laboratories Taiwan Co., Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Underwriters Laboratories Taiwan Co., Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Prepared By:

Cindy Hsin Date : May. 14, 2020
Project Handler

Approved and Authorized By:

Howard Kao Date : May. 14, 2020
Project Engineer

## 2. Summary of Test Results

| Summary of Test Results | | |
|---|---|---|
| **FCC Clause** | **Test Items** | **Result** |
| 15.247(a)(2) | 6dB Bandwidth | PASS |
| 15.247(b) | Conducted Output Power | PASS |
| 15.247(e) | Power Spectral Density | PASS |
| 15.247(d) | Antenna Port Emission | PASS |
| 15.205 / 15.209 / 15.247(d) | Radiated Emissions and Band Edge Measurement | PASS |
| 15.207 | AC Power Conducted Emission | PASS |
| 15.203 | Antenna Requirement | PASS |

Note:
1. For the Radiated Band Edge test plots were recorded in Appendix I, the Radiated Emissions test plots were recorded in Appendix II.

## 3. Test Methodology and Reference Procedures

The tests documented in this report were performed in accordance with 47 CFR FCC Part 2, KDB558074 D01 Meas Guidance v05r02, KDB414788 D01 Radiated Test Site v01r01, ANSI C63.10-2013.

## 4. Facilities and Accreditation

| | |
|---|---|
| **Test Location** | Underwriters Laboratories Taiwan Co., Ltd. |
| **Address** | Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan |
| **Accreditation Certificate** | Underwriters Laboratories Taiwan Co., Ltd. is accredited by TAF, Laboratory Code 3398. The full scope of accreditation can be viewed at http://accreditation.taftw.org.tw/taf/public/basic/viewApplyItems.action?unitNo=3398 |

## 5. Measurement Uncertainty

For statement of conformity, accuracy method (Section 8.2.4 and 8.2.5 of ISO Guide 98-4) was applied as decision rule for measurement in this test report.

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor k=2.

| Test Item | Measurement Frequency Range | K | U(dB) |
|---|---|---|---|
| Conducted disturbance at mains terminals ports | 0.15MHz ~ 30MHz | 2 | 1.7 |
| RF Conducted | 9 kHz - 40GHz | 2 | 1.0 |
| Radiated disturbance below 30MHz | 9 kHz - 30 MHz | 2 | 2.2 |
| Radiated disturbance below 1 GHz | 30MHz ~ 1GHz | 2 | 5.3 |
| Radiated disturbance above 1GHz | 1GHz ~ 40GHz | 2 | 4.8 |

# 6. Equipment under Test

## 6.1. Description of EUT

| | |
|---|---|
| **Product** | Essential Spotlight Camera |
| **Brand Name** | Arlo |
| **Model Name** | VMC2030 |
| **Operating Frequency** | 2412MHz ~ 2462MHz |
| **Modulation** | CCK, DQPSK, DBPSK for DSSS<br>64QAM, 16QAM, QPSK, BPSK for OFDM |
| **Transfer Rate** | 802.11b: up to 11 Mbps<br>802.11g: up to 54 Mbps<br>802.11n: up to MCS7 |
| **Number of Channel** | 11 for 802.11b, 802.11g, 802.11n (HT20) |
| **Maximum Output Power** | 802.11b: 25.38 dBm<br>802.11g: 25.77 dBm<br>802.11n (HT20): 26.03 dBm |
| **Normal Voltage** | 5Vdc (adapter or host equipment)<br>3.63Vdc for battery |
| **S/N** | A471037MA0308 |
| **Hardware Version** | DV2 |
| **SW/FW version** | 20200324-2_mfg |

Note:

1. The EUT incorporates a SISO diversity function. Physically, the EUT provides one completed transmitter and one receiver.

| Modulation Mode | Tx,Rx Function |
|---|---|
| 802.11b | 1TX,1RX |
| 802.11g | 1TX,1RX |
| 802.11n (HT20) | 1TX,1RX |

2. The EUT contains following accessory devices

| Product | Brand | Model | Description |
|---|---|---|---|
| USB Cable | Arlo | 310-50001-01 | Length: 0.3meter, non-shielded cable |
| Security Mount | Arlo | 300-11092-01 | - |
| Mount Screw kit | Arlo | 422-50002-01 | - |

3. The above EUT information is declared by manufacturer and for more detailed features description, please refer the manufacturer's or user's manual.

## 6.2. Channel List

11 channels are provided for 802.11b, 802.11g and 802.11n (HT20):

| Channel | Frequency | Channel | Frequency |
|---|---|---|---|
| 1 | 2412MHz | 7 | 2442MHz |
| 2 | 2417MHz | 8 | 2447MHz |
| 3 | 2422MHz | 9 | 2452MHz |
| 4 | 2427MHz | 10 | 2457MHz |
| 5 | 2432MHz | 11 | 2462MHz |
| 6 | 2437MHz | - | - |

## 6.3. Test Condition

| Test Item | Test Site No. | Environmental Condition | Input Power | Test Date | Tested by |
|---|---|---|---|---|---|
| Antenna Port Conducted Measurement | SR4 | 23~26°C / 62~66%RH | 120Vac / 60 Hz | Apr. 10, 2020 ~ May. 14, 2020 | Wayne Chen |
| Radiated Spurious Emission | 966-1 | 23~27°C / 63~69%RH | 120Vac / 60 Hz | Apr. 6, 2020 ~ May. 14, 2020 | Wayne Chen |
| AC power Line Conducted Emission | SR1 | 23~25°C / 60~64%RH | 120Vac / 60 Hz | Apr. 15, 2020 ~ Apr. 16, 2020 | Wayne Chen |

FCC Test Firm Registration Number: 498077

## 6.4. Description Of Available Antennas

| Antenna | Brand Name | Model Name | Antenna Type | Antenna Gain(dBi) |
|---|---|---|---|---|
| Ant 0 | Masterwave | 902P00239S0 | Monopole | 1.8 |
| Ant 1 | Masterwave | 902P00239S0 | Monopole | 1.4 |

Note: The above antenna information was provided from customer and for more detailed features description, please refer the manufacturer's specification or user's manual.

## 6.5. Test Mode Applicability and Tested Channel Detail

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- For below 1 GHz radiated emission and AC power line conducted emission have performed all modes of operation were investigated and the worst-case emissions are reported.
- For Antenna Port Conducted Measurement, this item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- The fundamental of the EUT was investigated in three orthogonal axes X/Y/Z, it was determined that X axis was worst-case. Therefore, all final radiated testing was performed with the EUT in X axis.
- For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel), parallel and perpendicular are the worst orientations, therefore testing was performed on these two orientations only.
- The EUT has two antenna that supports diversity function. Pre-scan radiation has been determined by Antenna 0 with adapter mode (worst case).
- For AC power line conducted emissions, the pre-scan has been determined by AC power 120Vac/60Hz (worst case).

| Test item | Mode | Modulation Technology | Modulation Type | Available Channel | Test Channel | Data Rate |
|---|---|---|---|---|---|---|
| Radiated Emissions (Above 1GHz) | 802.11b | DSSS | DBPSK | 1 to 11 | 1,2,6,10, 11 | 1.0 |
| | 802.11g | OFDM | BPSK | 1 to 11 | 1,2,6,10, 11 | 6.0 |
| | 802.11n(HT20) | OFDM | BPSK | 1 to 11 | 1,2,6,10, 11 | MCS0 |
| Radiated Emissions (Below 1GHz) | 802.11n(HT20) | OFDM | BPSK | 1 to 11 | 11 | MCS0 |
| AC Power Line Conducted Emission | 802.11n(HT20) | OFDM | BPSK | 1 to 11 | 11 | MCS0 |
| Antenna Port Conducted Measurement | 802.11b | DSSS | DBPSK | 1 to 11 | 1,2,6,10, 11 | 1.0 |
| | 802.11g | OFDM | BPSK | 1 to 11 | 1,2,6,10, 11 | 6.0 |
| | 802.11n(HT20) | OFDM | BPSK | 1 to 11 | 1,2,6,10, 11 | MCS0 |

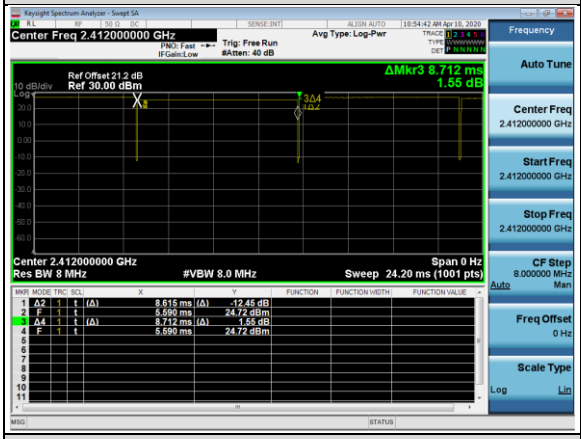
## 6.6. Duty cycle

802.11b: Duty cycle = 8.615/8.712 = 0.989, Duty cycle of test signal is ≥ 98 %, duty factor is not required.

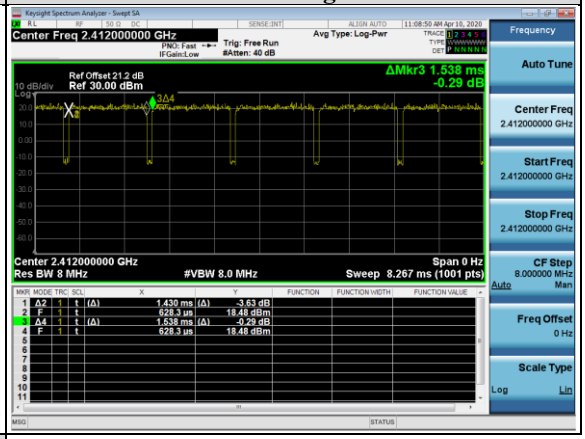
802.11g: Duty cycle = 1.43/1.538 = 0.93, Duty factor = 10 * log( 1/0.93) = 0.32

802.11n (HT20): Duty cycle = 1.339/1.447 = 0.925, Duty factor = 10 * log( 1/0.925) = 0.34

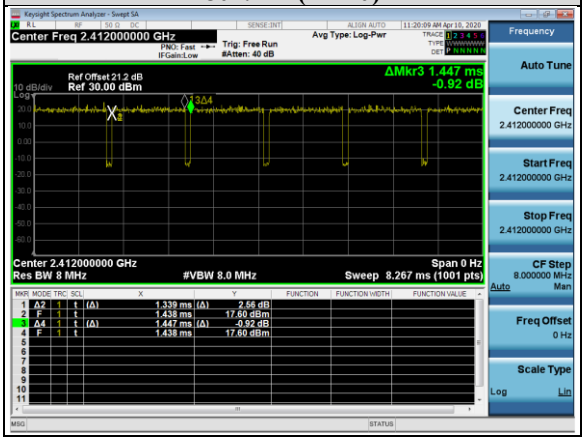
**802.11b**




**802.11g**




**802.11n (HT20)**



# 7. Test Equipment

| Test Equipment List | | | | | |
|---|---|---|---|---|---|
| **Equipment** | **Manufacturer** | **Model No.** | **Serial No.** | **Cal. Date** | **Cal. Interval** |
| **Radiated Spurious Emission** | | | | | |
| Spectrum Analyzer | Keysight | N9010A | MY56070827 | Nov. 13, 2019 | 1 year |
| EMI Test Receiver | Rohde & Schwarz | ESR7 | 101754 | Dec. 4, 2019 | 1 year |
| Loop Antenna | ETS lindgren | 6502 | 00213440 | Dec. 19, 2019 | 1 year |
| Trilog-Broadband Antenna with 5dB Attenuator | Schwarzbeck & EMCI | VULB 9168 & N-6-05 | 774 & AT-N0538 | Jan. 3, 2020 | 1 year |
| Horn Antenna (1-18 GHz) | Schwarzbeck | BBHA 9120 D | 01690 | Jan. 3, 2020 | 1 year |
| Horn Antenna(18-40 GHz) | Schwarzbeck | BBHA 9170 | 781 | Dec. 27, 2019 | 1 year |
| Preamplifier (30-1000 MHz) | EMCI | EMC330E | 980405 | Feb. 4, 2020 | 1 year |
| Preamplifier (1-18 GHz) | EMCI | EMC051835BE | 980406 | Feb. 4, 2020 | 1 year |
| Preamplifier (18-40GHz) | EMCI | EMC184040SE E | 980426 | May. 8, 2019<br>May. 7, 2020 | 1 year |
| Cables | Hanyitek | K1K50-UP0264-K1K50-2500 | 170214-4 & 170425-2 | Jan. 8, 2020 | 1 year |
| Cables | Hanyitek | K1K50-UP0264-K1K50-2500 | 170214-1 & 170214-2 | Jan. 8, 2020 | 1 year |

| Test Equipment List | | | | | |
|---|---|---|---|---|---|
| **Equipment** | **Manufacturer** | **Model No.** | **Serial No.** | **Cal. Date** | **Cal. Interval** |
| **Antenna Port Conducted Measurement** | | | | | |
| Spectrum Analyzer | Keysight | N9010A | MY56070834 | Nov. 6, 2019 | 1 year |
| Pulse Power Sensor | Anrisu | MA2411B | 1531202 | Dec. 23, 2019 | 1 year |
| Power Meter | Anrisu | ML2495A | 1645002 | Dec. 23, 2019 | 1 year |
| **AC power Line Conducted Emission** | | | | | |
| EMI Test Receiver | Rohde & Schwarz | ESR7 | 101753 | Nov. 19, 2019 | 1 year |
| Two-Line V-Network | Rohde & Schwarz | ENV216 | 102136 | Aug. 8, 2019 | 1 year |
| Impuls-Begrenzer Pulse Limiter | Rohde & Schwarz | ESH3-Z2 | 102219-Qt | Aug. 6, 2019 | 1 year |
| Cables | HARBOUR INDUSTRIES | LL142 | 170205-5000-1 | Feb. 5, 2020 | 1 year |

| UL Software | | |
|---|---|---|
| **Description** | **Name** | **Version** |
| Radiated measurement | EZ_EMC | 1.1.4.2 |
| Conducted measurement | Keysight.TestSystem | 1.0.0.0 |
| AC power Line Conducted Emission | EZ_EMC | 1.1.4.2 |

# 8. Description of Test Setup

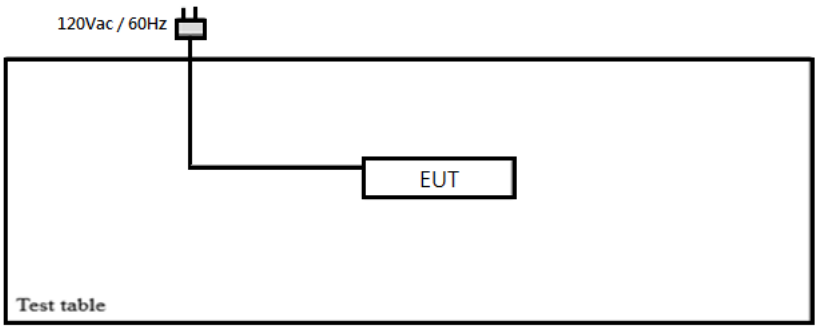
## Support Equipment

| Equipment | Brand Name | Model Name | S/N | Remark |
|---|---|---|---|---|
| Notebook | DELL | Latitude E5470 | 3JFKWF2 | N/A |
| Adapter | Arlo | AD2037320 | 332-50032-02 | Provided by customer |

## Test Setup

Controlled using a bespoke application (Teraterm469) on a test Notebook. The application was used to enable a continuous transmission mode and to select the test channels, data rates, modulation schemes and power setting as required.

## Setup Diagram for Test



# 9. Test Results

## 9.1. 6dB Bandwidth

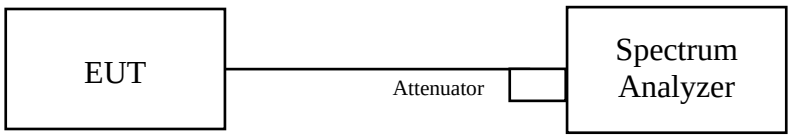
**Requirements**

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

**Test procedure**

a. Set resolution bandwidth (RBW) = 100kHz
b. Set the video bandwidth (VBW) ≥ 3 x RBW, Detector = Peak.
c. Trace mode = max hold.
d. Sweep = auto couple.
e. Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission

**Test Setup**




The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

## Test Data

### 802.11b

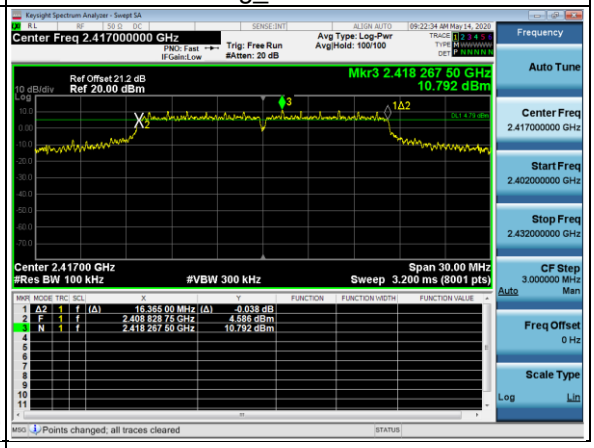
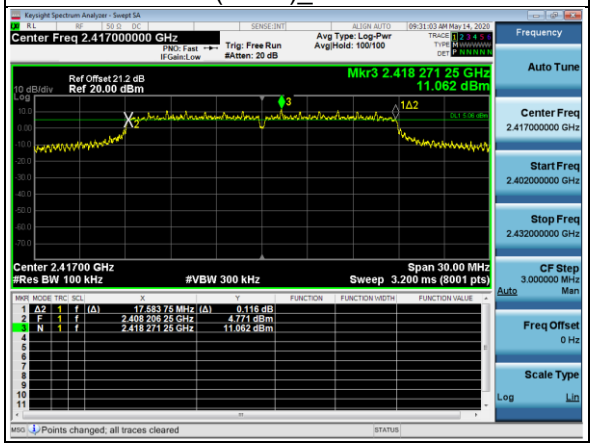
| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) | Pass / Fail |
|---|---|---|---|---|
| 1 | 2412 | 9.07875 | 0.5 | Pass |
| 2 | 2417 | 9.07125 | 0.5 | Pass |
| 6 | 2437 | 9.56625 | 0.5 | Pass |
| 10 | 2457 | 10.02378 | 0.5 | Pass |
| 11 | 2462 | 10.035 | 0.5 | Pass |

### 802.11g

| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) | Pass / Fail |
|---|---|---|---|---|
| 1 | 2412 | 16.43625 | 0.5 | Pass |
| 2 | 2417 | 16.36500 | 0.5 | Pass |
| 6 | 2437 | 16.38375 | 0.5 | Pass |
| 10 | 2457 | 16.39500 | 0.5 | Pass |
| 11 | 2462 | 16.455 | 0.5 | Pass |

### 802.11n (HT20)

| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) | Pass / Fail |
|---|---|---|---|---|
| 1 | 2412 | 17.6775 | 0.5 | Pass |
| 2 | 2417 | 17.58375 | 0.5 | Pass |
| 6 | 2437 | 17.6025 | 0.5 | Pass |
| 10 | 2457 | 17.61375 | 0.5 | Pass |
| 11 | 2462 | 17.65875 | 0.5 | Pass |

| Spectrum Plot of Worst Value | |
|---|---|
| 802.11b_Chain 0 / CH2 | 802.11g_Chain 0 / CH2 |
|  |  |
| 802.11n (HT20)_Chain 0 / CH2 | |
|  | |

## 9.2. Conducted output power

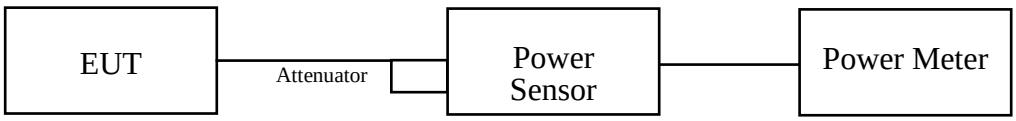
### Requirements

For systems using digital modulation in the 2400-2483.5 MHz bands: 1 Watt.

### Test Procedure

A peak power sensor was used on the output port of the EUT. A power meter was used to read the response of the peak power sensor. Record the power level.

### Test Setup




The loss between RF output port of the EUT and the input port of the Power Meter has been taken into consideration.

# Test Data

## Peak Power

### 802.11b

| Channel | Frequency (MHz) | Peak Power (mW) | Peak Power (dBm) | Limit (dBm) | Pass / Fail |
|---|---|---|---|---|---|
| 1 | 2412 | 298.538 | 24.75 | 30 | Pass |
| 2 | 2417 | 332.66 | 25.22 | 30 | Pass |
| 6 | 2437 | 345.144 | 25.38 | 30 | Pass |
| 10 | 2457 | 329.61 | 25.18 | 30 | Pass |
| 11 | 2462 | 324.34 | 25.11 | 30 | Pass |

### 802.11g

| Channel | Frequency (MHz) | Peak Power (mW) | Peak Power (dBm) | Limit (dBm) | Pass / Fail |
|---|---|---|---|---|---|
| 1 | 2412 | 236.592 | 23.74 | 30 | Pass |
| 2 | 2417 | 369.828 | 25.68 | 30 | Pass |
| 6 | 2437 | 377.572 | 25.77 | 30 | Pass |
| 10 | 2457 | 373.25 | 25.72 | 30 | Pass |
| 11 | 2462 | 243.781 | 23.87 | 30 | Pass |

### 802.11n (HT20)

| Channel | Frequency (MHz) | Peak Power (mW) | Peak Power (dBm) | Limit (dBm) | Pass / Fail |
|---|---|---|---|---|---|
| 1 | 2412 | 244.906 | 23.89 | 30 | Pass |
| 2 | 2417 | 396.278 | 25.98 | 30 | Pass |
| 6 | 2437 | 400.867 | 26.03 | 30 | Pass |
| 10 | 2457 | 392.645 | 25.94 | 30 | Pass |
| 11 | 2462 | 238.232 | 23.77 | 30 | Pass |

## Average Power (Reference Only)

### 802.11b

| Channel | Frequency (MHz) | Average Power (mW) | Average Power (dBm) |
|---|---|---|---|
| 1 | 2412 | 163.305 | 22.13 |
| 2 | 2417 | 200.909 | 23.03 |
| 6 | 2437 | 206.063 | 23.14 |
| 10 | 2457 | 201.372 | 23.04 |
| 11 | 2462 | 193.197 | 22.86 |

### 802.11g

| Channel | Frequency (MHz) | Average Power (mW) | Average Power (dBm) |
|---|---|---|---|
| 1 | 2412 | 119.399 | 20.77 |
| 2 | 2417 | 251.768 | 24.01 |
| 6 | 2437 | 257.632 | 24.11 |
| 10 | 2457 | 252.93 | 24.03 |
| 11 | 2462 | 123.88 | 20.93 |

### 802.11n (HT20)

| Channel | Frequency (MHz) | Average Power (mW) | Average Power (dBm) |
|---|---|---|---|
| 1 | 2412 | 77.446 | 18.89 |
| 2 | 2417 | 181.552 | 22.59 |
| 6 | 2437 | 185.353 | 22.68 |
| 10 | 2457 | 182.39 | 22.61 |
| 11 | 2462 | 75.509 | 18.78 |

## 9.3. Power Spectral Density

### Requirements

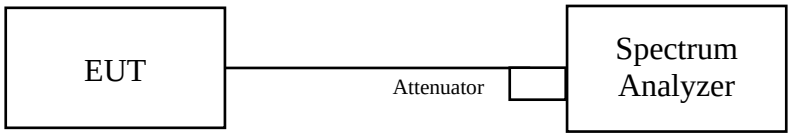
The Maximum of Power Spectral Density Measurement is 8dBm in any 3 kHz (If $G_{TX}$ > 6 dBi, then PSD = 8 – ($G_{TX}$ – 6)).

Note:
1. PSD = power spectral density that he same method as used to determine the conducted output power shall be used to determine the power spectral density. And power spectral density in dBm/MHz.
2. $G_{TX}$ = the maximum transmitting antenna directional gain in dBi.

### Test procedure

a. Set analyzer center frequency to DTS channel center frequency.
b. Set the span to 1.5 times the DTS bandwidth.
c. Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
d. Set the VBW ≥ 3 × RBW.
e. Detector = peak.
f. Sweep time = auto couple.
g. Trace mode = max hold.
h. Allow trace to fully stabilize.
i. Use the peak marker function to determine the maximum amplitude level within the RBW.

### Test Setup




The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

## Test Data

### 802.11b

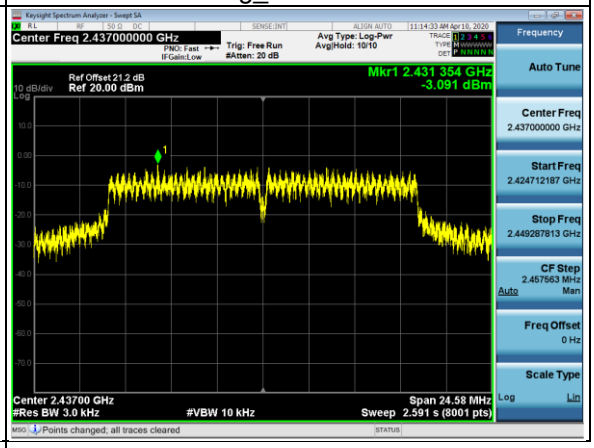
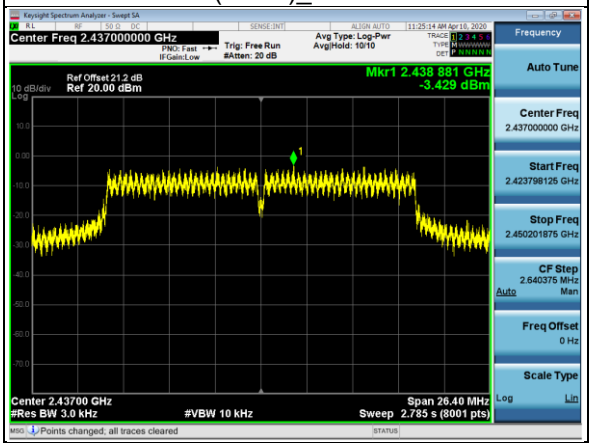
| Channel | Frequency (MHz) | PSD (dBm/3 kHz) | Limit (dBm/3 kHz) | Pass / Fail |
|---|---|---|---|---|
| 1 | 2412 | -1.470 | 8 | Pass |
| 2 | 2417 | -1.021 | 8 | Pass |
| 6 | 2437 | -0.936 | 8 | Pass |
| 10 | 2457 | -1.080 | 8 | Pass |
| 11 | 2462 | -0.805 | 8 | Pass |

### 802.11g

| Channel | Frequency (MHz) | PSD (dBm/3 kHz) | Limit (dBm/3 kHz) | Pass / Fail |
|---|---|---|---|---|
| 1 | 2412 | -7.439 | 8 | Pass |
| 2 | 2417 | -3.166 | 8 | Pass |
| 6 | 2437 | -3.091 | 8 | Pass |
| 10 | 2457 | -3.223 | 8 | Pass |
| 11 | 2462 | -7.408 | 8 | Pass |

### 802.11n (HT20)

| Channel | Frequency (MHz) | PSD (dBm/3 kHz) | Limit (dBm/3 kHz) | Pass / Fail |
|---|---|---|---|---|
| 1 | 2412 | -8.866 | 8 | Pass |
| 2 | 2417 | -3.814 | 8 | Pass |
| 6 | 2437 | -3.429 | 8 | Pass |
| 10 | 2457 | -3.511 | 8 | Pass |
| 11 | 2462 | -9.254 | 8 | Pass |

| Spectrum Plot of Worst Value | |
|---|---|
| 802.11b_Chain 0 / CH11 | 802.11g_Chain 0 / CH6 |
|  |  |
| 802.11n (HT20)_Chain 0 / CH6 | |
|  | |

## 9.4. Conducted Out of Band Emission

### Requirements

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, 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, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b) (3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209 (a) is not required.

### Test procedure

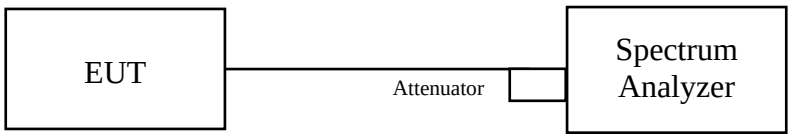
Measurement Procedure REF

1. Set the RBW = 100 kHz.
2. Set the VBW ≥ 300 kHz.
3. Set the span to 1.5 times the DTS bandwidth.
4. Detector = peak.
5. Sweep time = auto couple.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

Measurement Procedure OOBE

1. Set RBW = 100 kHz.
2. Set VBW ≥ 300 kHz.
3. Detector = peak.
4. Sweep = auto couple.
5. Trace Mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

### Test Setup

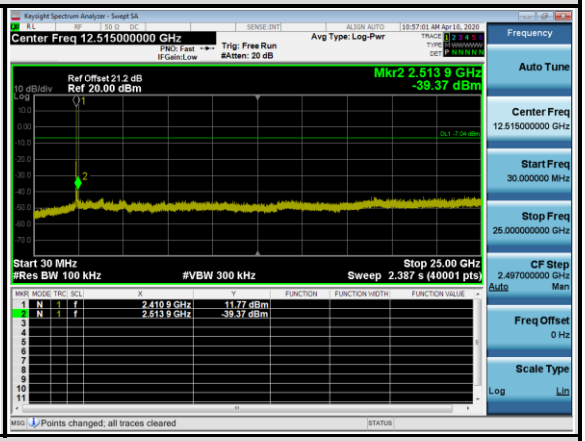



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

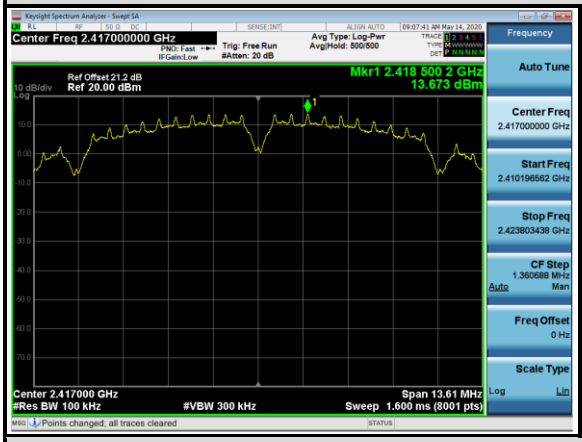
## Test Data

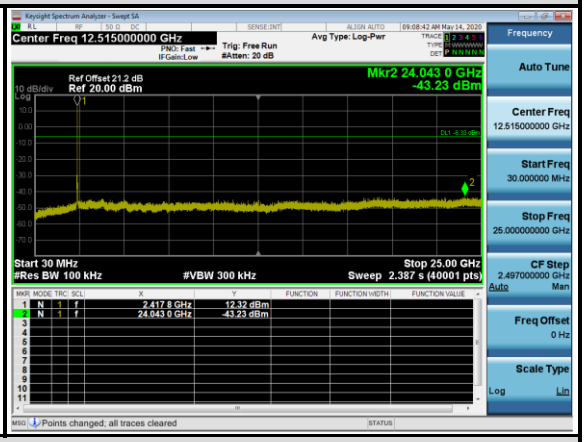
### 802.11b

**Ch 1**

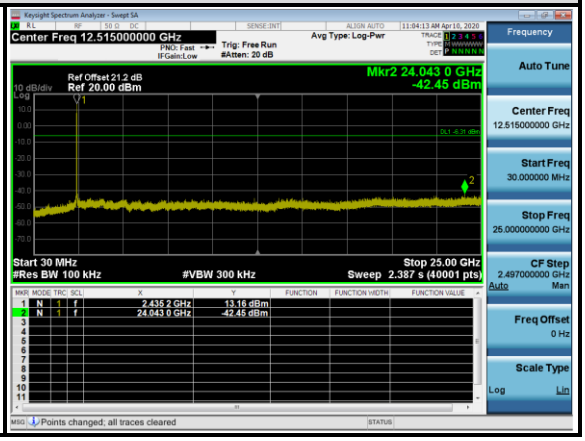




**Ch 2**



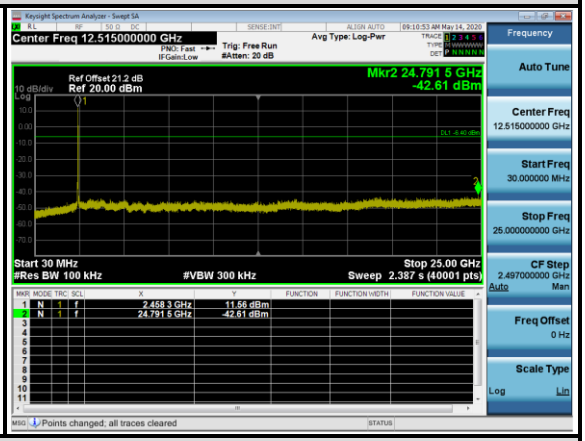




**Ch 6**

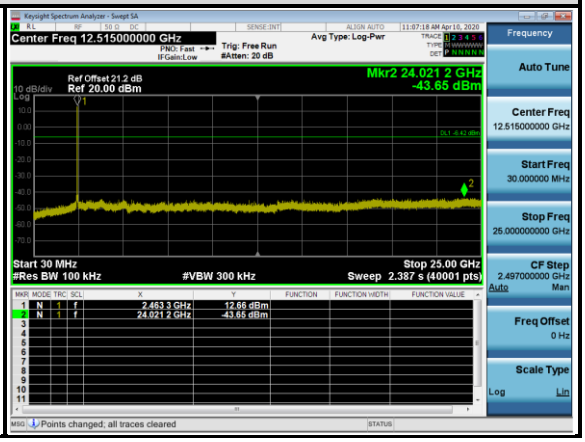
**Ch 10**

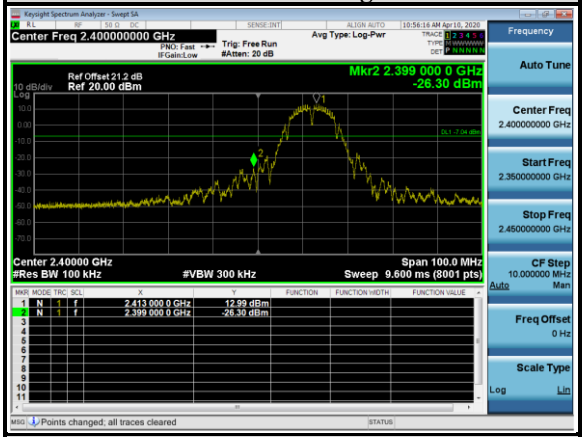
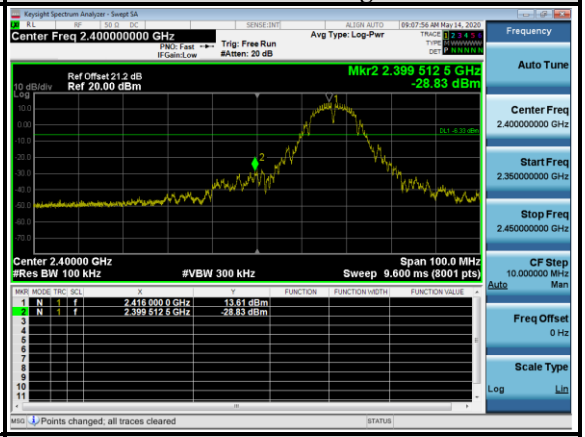
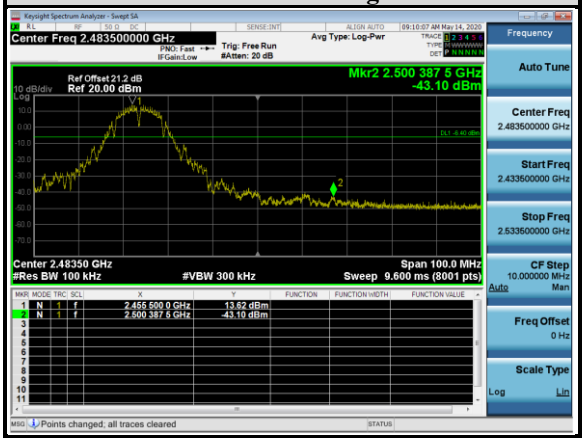
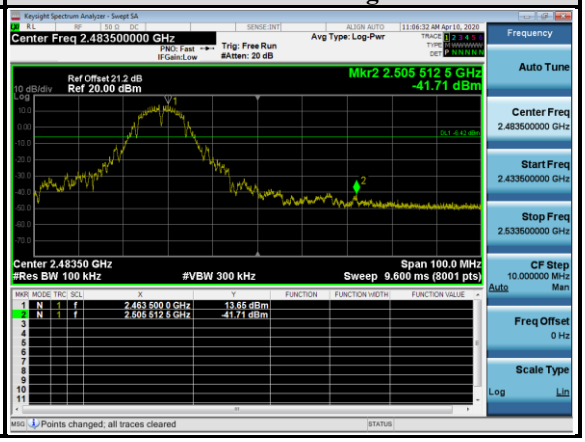

Center Freq 2.457000000 GHz
Mkr1 2.455 505 8 GHz
13.601 dBm
Ref Offset 21.2 dB
10 dB/div Ref 20.00 dBm
Center 2.457000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Span 15.04 MHz
Sweep 1.600 ms (8001 pts)
Points changed; all traces cleared


Center Freq 12.515000000 GHz
Mkr2 24.791 5 GHz
-42.61 dBm
Ref Offset 21.2 dB
10 dB/div Ref 20.00 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.387 s (40001 pts)
Points changed; all traces cleared

**Ch 11**

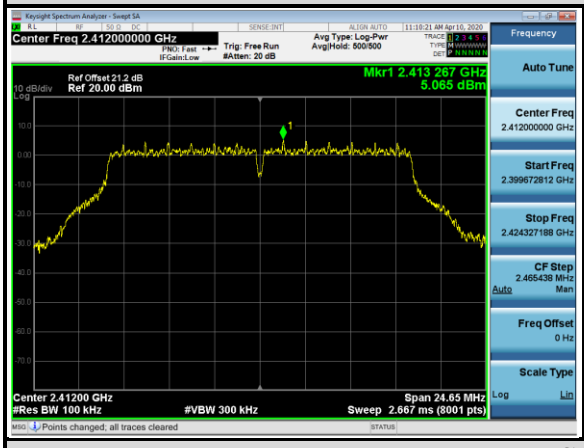

Center Freq 2.462000000 GHz
Mkr1 2.460 502 3 GHz
13.582 dBm
Ref Offset 21.2 dB
10 dB/div Ref 20.00 dBm
Center 2.462000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Span 15.05 MHz
Sweep 1.600 ms (8001 pts)
Points changed; all traces cleared

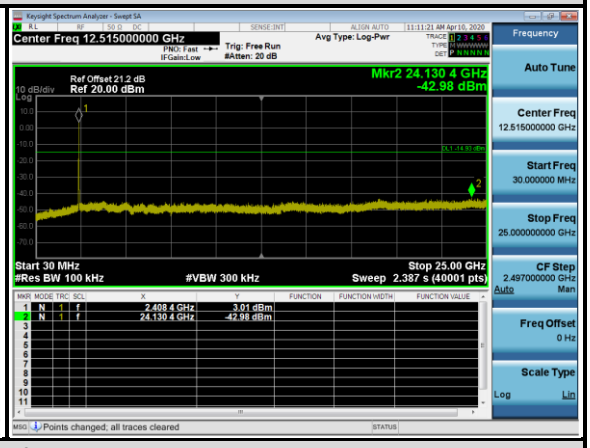

Center Freq 12.515000000 GHz
Mkr2 24.021 2 GHz
-43.65 dBm
Ref Offset 21.2 dB
10 dB/div Ref 20.00 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.387 s (40001 pts)
Points changed; all traces cleared

| Ch 1 Band Edge | Ch 2 Band Edge |
|---|---|
|  |  |
| **Ch 10 Band Edge** | **Ch 11 Band Edge** |
|  |  |

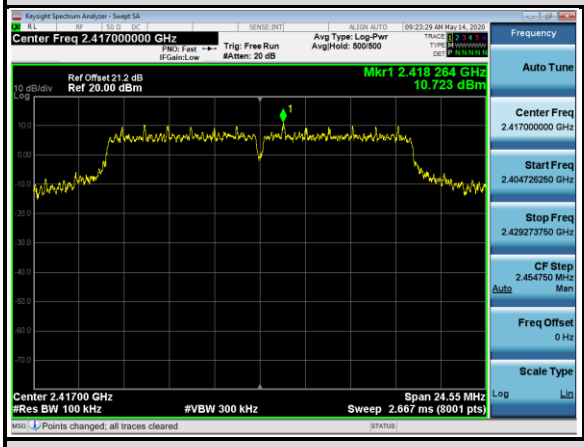
## 802.11g

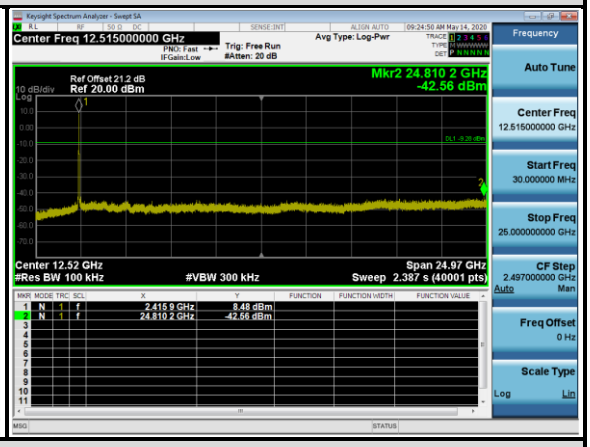
**Ch 1**



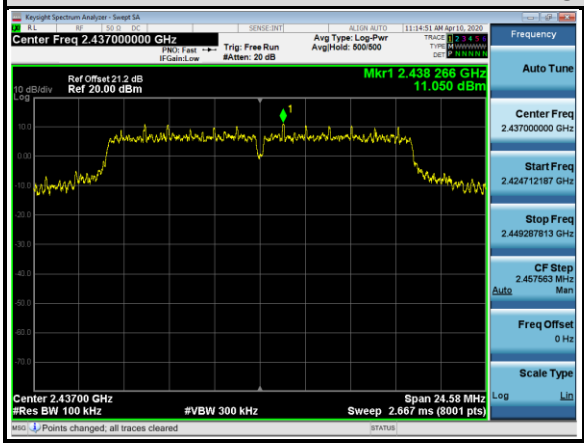



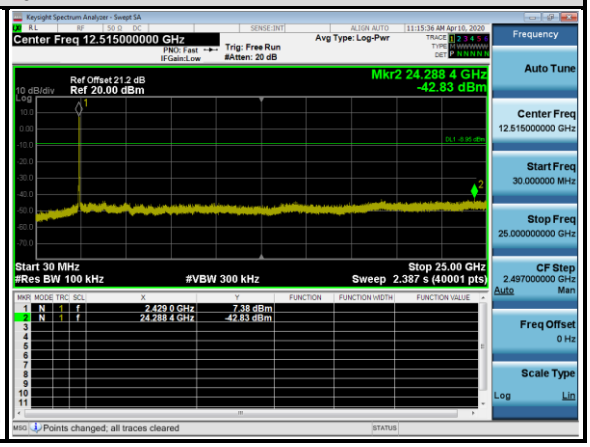

**Ch 2**



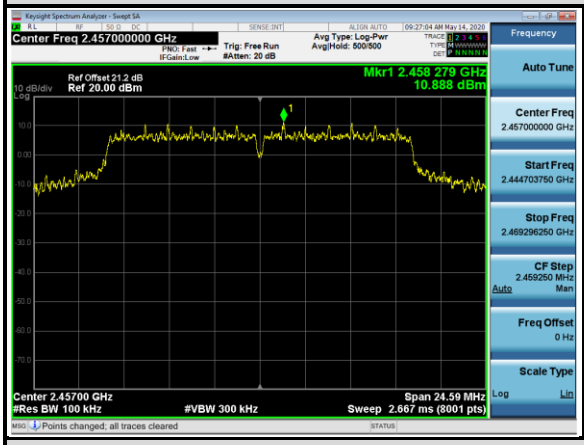



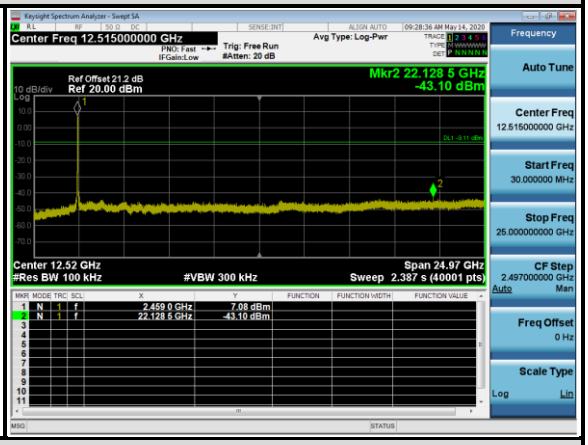

**Ch 6**



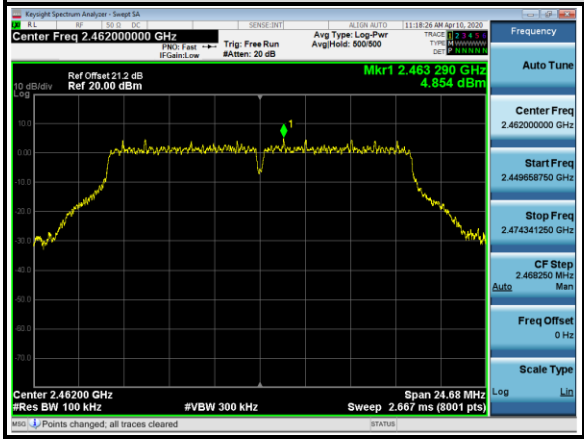



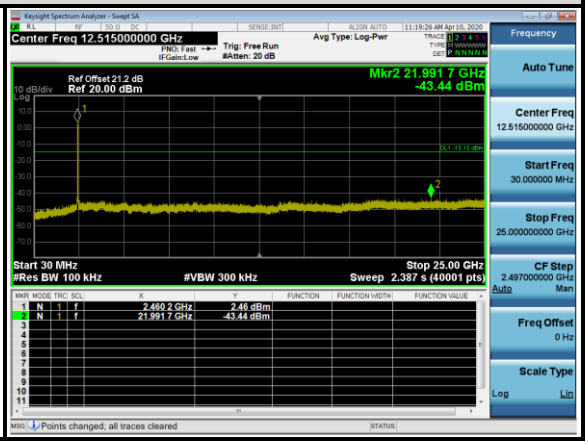
**Ch 10**

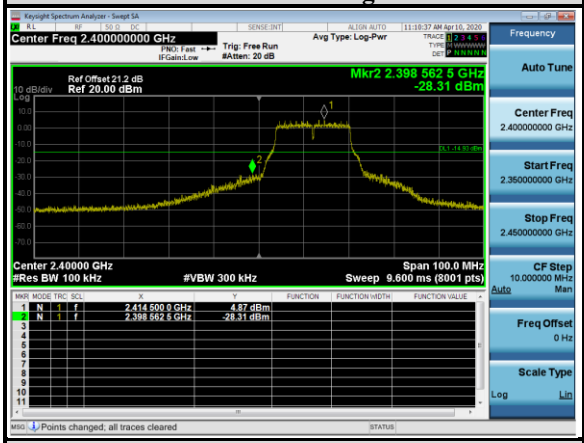
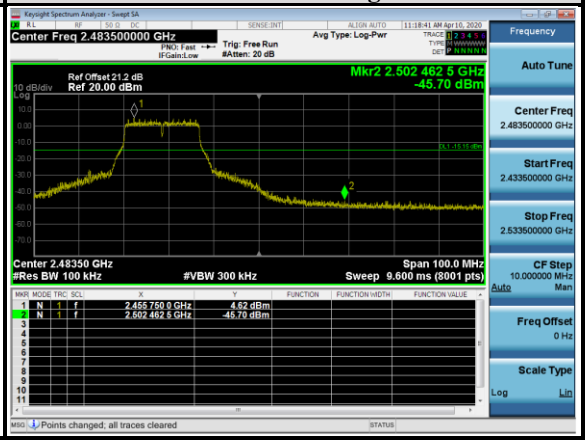

Center Freq 2.457000000 GHz
Mkr1 2.458 279 GHz
10.888 dBm
Ref Offset 21.2 dB
Ref 20.00 dBm
Center 2.45700 GHz
#Res BW 100 kHz
#VBW 300 kHz
Span 24.59 MHz
Sweep 2.667 ms (8001 pts)
Points changed; all traces cleared


Center Freq 12.515000000 GHz
Mkr2 22.128 5 GHz
-43.10 dBm
Ref Offset 21.2 dB
Ref 20.00 dBm
Center 12.52 GHz
#Res BW 100 kHz
#VBW 300 kHz
Span 24.97 GHz
Sweep 2.387 s (40001 pts)

**Ch 11**

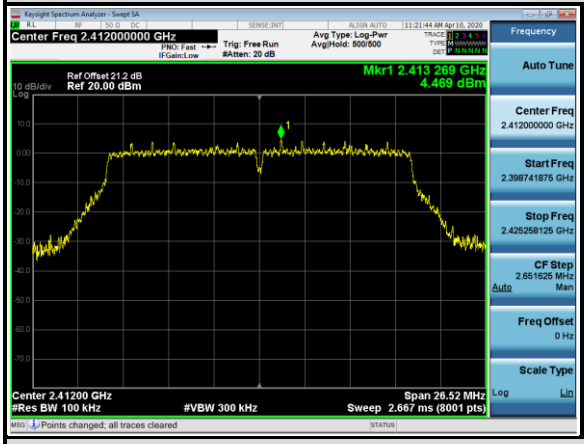

Center Freq 2.462000000 GHz
Mkr1 2.463 290 GHz
4.854 dBm
Ref Offset 21.2 dB
Ref 20.00 dBm
Center 2.46200 GHz
#Res BW 100 kHz
#VBW 300 kHz
Span 24.68 MHz
Sweep 2.667 ms (8001 pts)
Points changed; all traces cleared

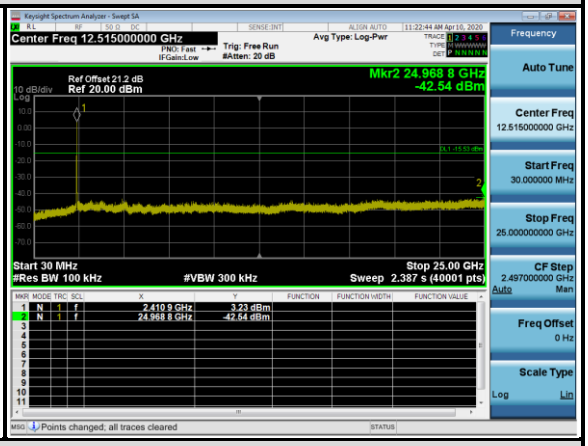

Center Freq 12.515000000 GHz
Mkr2 21.991 7 GHz
-43.44 dBm
Ref Offset 21.2 dB
Ref 20.00 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.387 s (40001 pts)
Points changed; all traces cleared

| Ch 1 Band Edge | Ch 2 Band Edge |
|---|---|
|  |  |
| **Ch 10 Band Edge** | **Ch 11 Band Edge** |
|  |  |

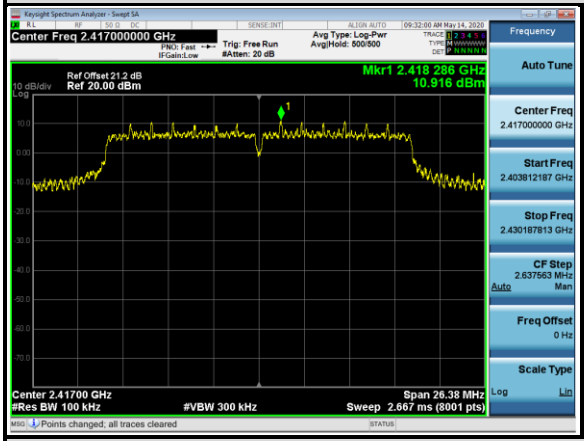
## 802.11n (HT20)

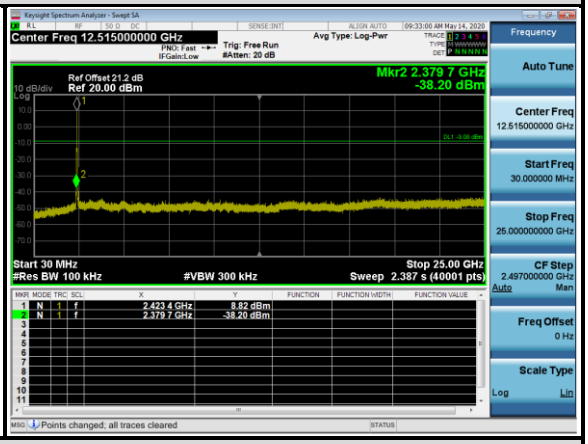
**Ch 1**



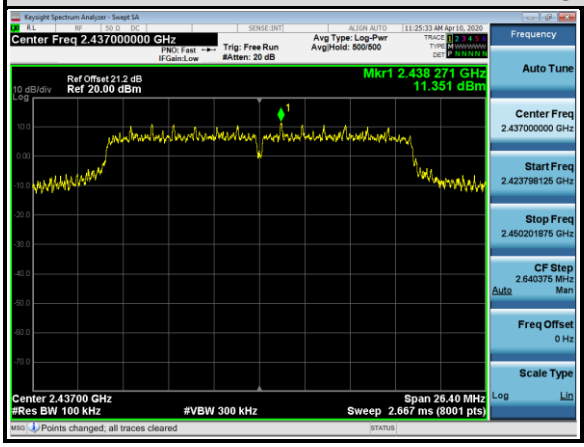



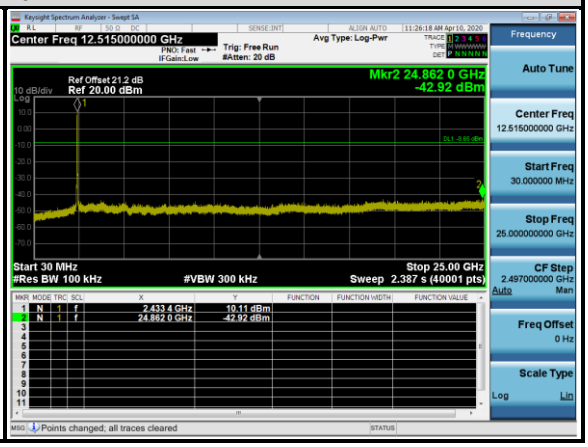

**Ch 2**



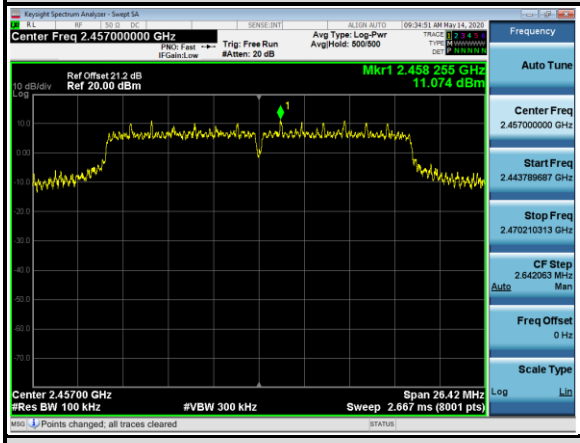



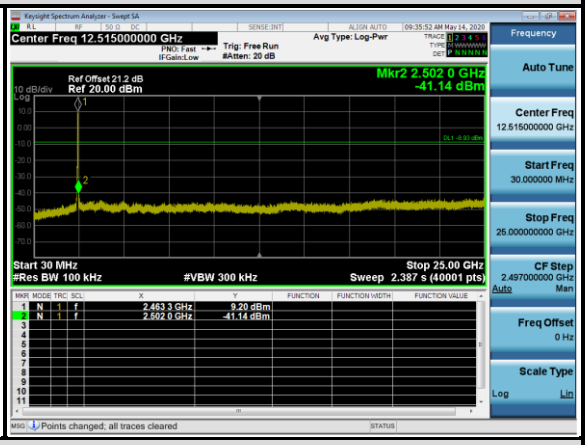

**Ch 6**



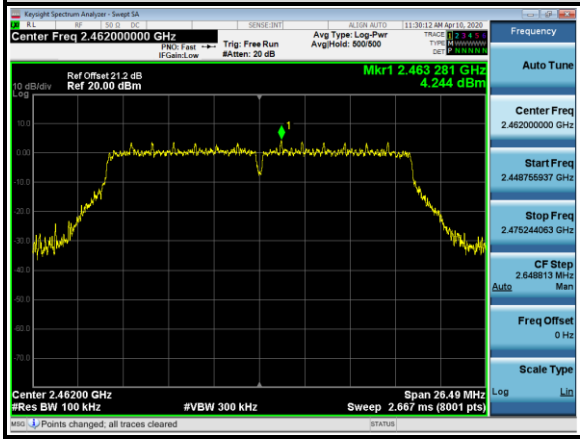



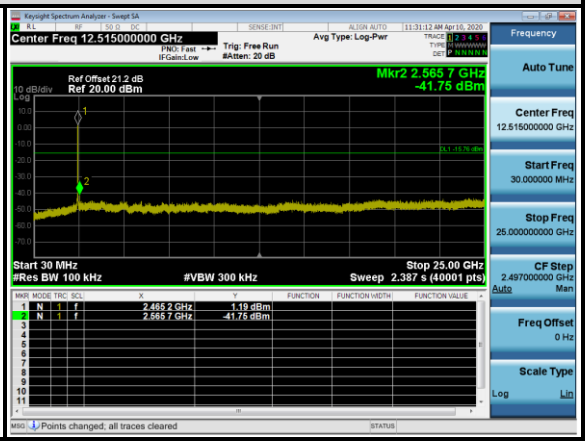
**Ch 10**

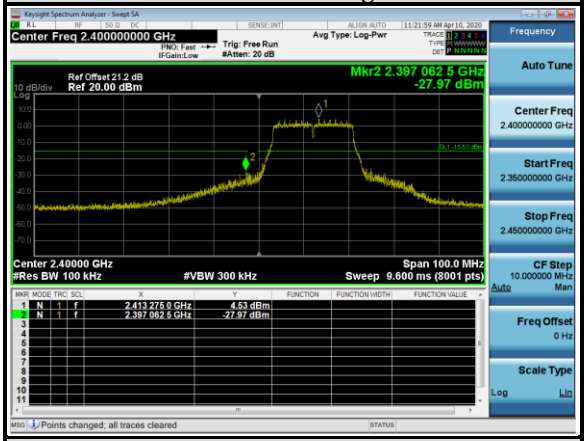
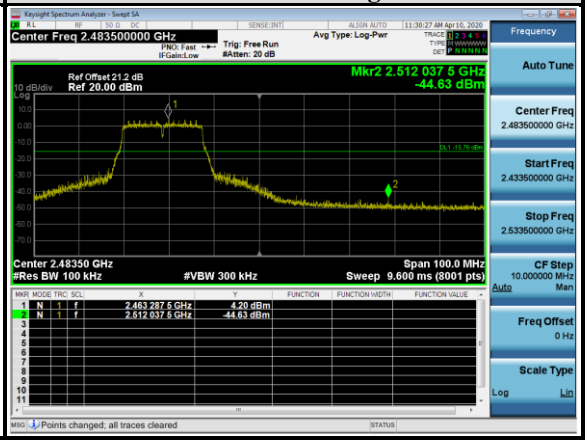

Center Freq 2.457000000 GHz
Mkr1 2.458 255 GHz
11.074 dBm
Ref Offset 21.2 dB
10 dB/div Ref 20.00 dBm
Center 2.45700 GHz
#Res BW 100 kHz
#VBW 300 kHz
Span 26.42 MHz
Sweep 2.667 ms (8001 pts)
Points changed; all traces cleared


Center Freq 12.515000000 GHz
Mkr2 2.502 0 GHz
-41.14 dBm
Ref Offset 21.2 dB
10 dB/div Ref 20.00 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.387 s (40001 pts)
2.463 3 GHz 9.20 dBm
2.502 0 GHz -41.14 dBm
Points changed; all traces cleared

**Ch 11**


Center Freq 2.462000000 GHz
Mkr1 2.463 281 GHz
4.244 dBm
Ref Offset 21.2 dB
10 dB/div Ref 20.00 dBm
Center 2.46200 GHz
#Res BW 100 kHz
#VBW 300 kHz
Span 26.49 MHz
Sweep 2.667 ms (8001 pts)
Points changed; all traces cleared


Center Freq 12.515000000 GHz
Mkr2 2.565 7 GHz
-41.75 dBm
Ref Offset 21.2 dB
10 dB/div Ref 20.00 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.387 s (40001 pts)
2.465 2 GHz 1.19 dBm
2.565 7 GHz -41.75 dBm
Points changed; all traces cleared

| Ch 1 Band Edge | Ch 2 Band Edge |
|---|---|
|  |  |
| **Ch 10 Band Edge** | **Ch 11 Band Edge** |
|  |  |

## 9.5. Radiated Spurious Emission

### Requirements

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20dB below the highest level of the desired power:

| 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 |

NOTE:
1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

## Test Procedures

[For 9 kHz ~ 30 MHz]

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
c. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
e. For measurement below 30MHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. If the emission level of the EUT measured by the peak detector is lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

NOTE:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

[For above 30 MHz]

a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
e. For measurement below 1GHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. If the emission level of the EUT measured by the peak detector is lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
f. The test-receiver system was set to peak and average detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

a. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.

b. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.

c. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is ≥ 1/T (Duty cycle < 98%) or 10Hz (Duty cycle ≥ 98%) for Average detection (AV) at frequency above 1GHz.

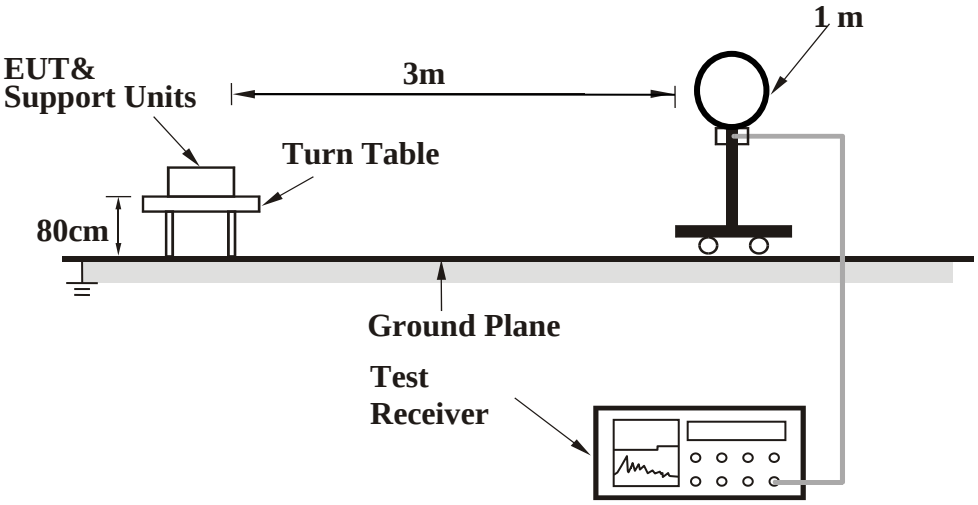
| Configuration | Average | |
|---|---|---|
| | RBW | VBW |
| 802.11b | 1MHz | 10 Hz |
| 802.11g | | 1 kHz |
| 802.11n (HT20) | | 1 kHz |

Note: Refer to section 6.6 for duty cycle.

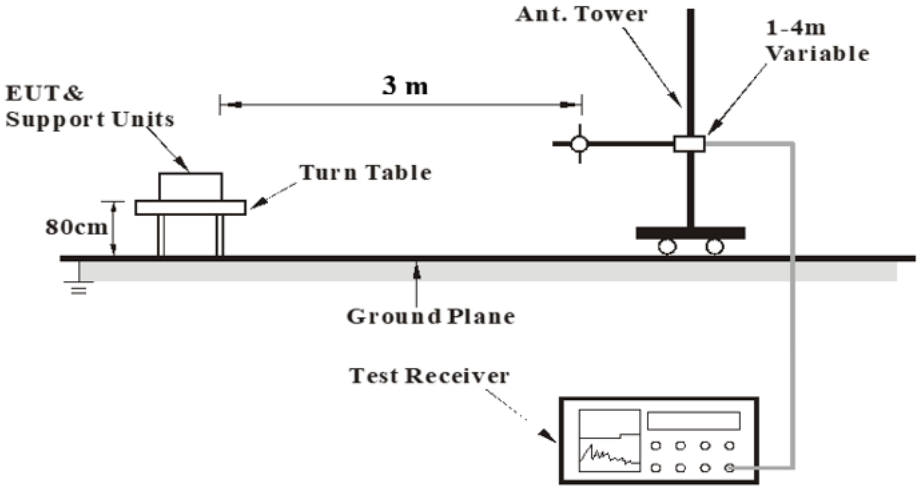
d. All modes of operation were investigated (includes all external accessories) and the worst-case emissions are reported.

## Test Setup

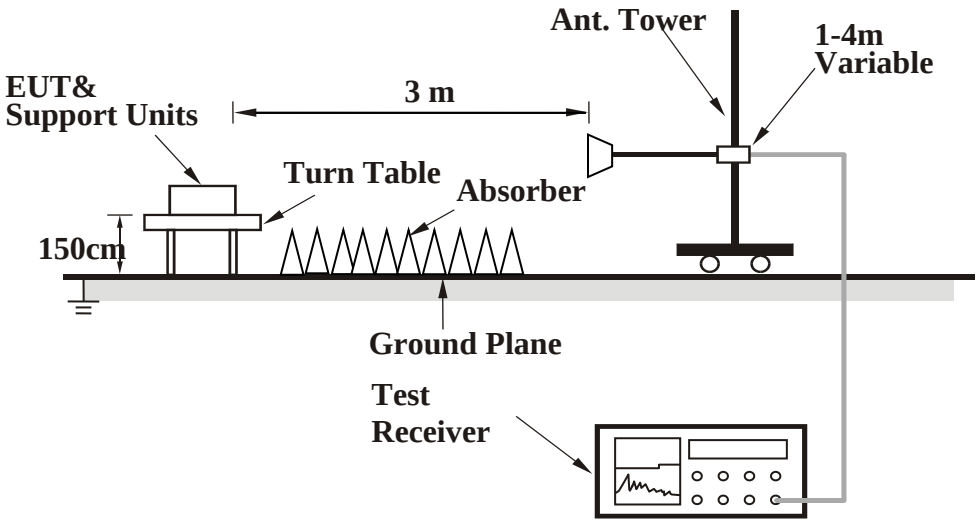
<Frequency Range 9 kHz ~ 30 MHz>




<Frequency Range 30 MHz ~ 1 GHz >



<Frequency Range above 1 GHz>




For the actual test configuration, please refer to the Setup Configurations.

# Test Data

## Above 1GHz Data

## 802.11b

| EUT Test Condition | | Measurement Detail | |
|---|---|---|---|
| **Channel** | Channel 1 | **Frequency Range** | 1 GHz ~ 26.5 GHz |

| Antenna Polarity & Test Distance: Horizontal at 3 m | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Notation** | **Frequency** | **Reading** | **Correct** | **Result** | **Limit** | **Margin** | **Remark** |
| | **(MHz)** | **(dBuV/m)** | **dB/m** | **(dBuV/m)** | **(dBuV/m)** | **(dB)** | |
| - | 2390.000 | 58.70 | 1.43 | 60.13 | 74.00 | -13.87 | peak |
| @ | 2412.000 | 104.91 | 1.88 | 106.79 | - | - | peak |
| - | 2390.000 | 50.74 | 1.43 | 52.17 | 54.00 | -1.83 | AVG |
| @ | 2412.000 | 101.45 | 1.88 | 103.33 | - | - | AVG |
| * | 4824.000 | 53.09 | -0.66 | 52.43 | 74.00 | -21.57 | peak |
| # | 7236.000 | 43.94 | 6.32 | 50.26 | 86.79 | -36.53 | peak |
| **Antenna Polarity & Test Distance: Vertical at 3 m** | | | | | | | |
| **Notation** | **Frequency** | **Reading** | **Correct** | **Result** | **Limit** | **Margin** | **Remark** |
| | **(MHz)** | **(dBuV/m)** | **dB/m** | **(dBuV/m)** | **(dBuV/m)** | **(dB)** | |
| - | 2390.000 | 59.52 | 1.43 | 60.95 | 74.00 | -13.05 | peak |
| @ | 2412.000 | 106.14 | 1.88 | 108.02 | - | - | peak |
| - | 2390.000 | 51.94 | 1.43 | 53.37 | 54.00 | -0.63 | AVG |
| @ | 2412.000 | 102.62 | 1.88 | 104.50 | - | - | AVG |
| * | 4824.000 | 44.68 | -0.66 | 44.02 | 74.00 | -29.98 | peak |
| # | 7236.000 | 43.88 | 6.32 | 50.20 | 88.02 | -37.82 | peak |

Remarks:

1. Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
2. Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
3. Correction Factor (dB/m) = Antenna Factor (dBuV/m) + Cable Loss (dB) - Preamp Factor (dB).
4. "@": Fundamental Frequency.
5. " # ": The radiated frequency is out of the restricted band.
6. " * ": The peak result complies with AVG limit, AVG result is deemed to comply with AVG limit.
7. The other emission levels were very low against the limit.