

# TEST REPORT

**Product Name:** 2.4 GHz WiFi Module  
**Trade Mark:** NA  
**Model No. / HVIN:** HUB100  
**Add. Model No. / HVIN:** NA  
**Report Number:** 180808010RFC-1  
**Test Standards:** FCC 47 CFR Part 15 Subpart C  
RSS-247 Issue 2  
RSS-Gen Issue 5  
**FCC ID:** X4K-HUB100BSM02  
**IC:** 8880A-HUB100BSM02  
**Test Result:** PASS  
**Date of Issue:** December 4, 2018

Prepared for:

**Automatic Technology (Australia) Pty. Ltd.**  
**6-8 Fiveways Boulevard, Keysborough, Victoria, 3173, Australia**

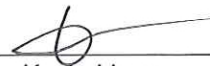
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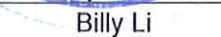
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December 4, 2018

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## Version

| Version No. | Date             | Description |
|-------------|------------------|-------------|
| V1.0        | December 4, 2018 | Original    |



### **Shenzhen UnionTrust Quality and Technology Co., Ltd.**

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## 1. GENERAL INFORMATION

### 1.1 CLIENT INFORMATION

|                                 |                                                                                                                |
|---------------------------------|----------------------------------------------------------------------------------------------------------------|
| <b>Applicant:</b>               | Automatic Technology (Australia) Pty. Ltd.                                                                     |
| <b>Address of Applicant:</b>    | 6-8 Fiveways Boulevard, Keysborough, Victoria, 3173, Australia                                                 |
| <b>Manufacturer:</b>            | SHENZHEN GIEC DIGITAL Co., Ltd                                                                                 |
| <b>Address of Manufacturer:</b> | Building 7 Zhong Qing Industrial Park, Free Trade Zone, Dalian, China, 116000 DALIAN, China, People's Republic |

### 1.2 EUT INFORMATION

#### 1.2.1 General Description of EUT

|                               |                                       |                  |
|-------------------------------|---------------------------------------|------------------|
| <b>Product Name:</b>          | 2.4 GHz WiFi Module                   |                  |
| <b>Model No. / HVIN:</b>      | HUB100                                |                  |
| <b>Add. Model No. / HVIN:</b> | NA                                    |                  |
| <b>Trade Mark:</b>            | NA                                    |                  |
| <b>DUT Stage:</b>             | Production Unit                       |                  |
| <b>EUT Supports Function:</b> | 2.4 GHz ISM Band:                     | IEEE 802.11b/g/n |
| <b>Software Version:</b>      | V1.0.1.20170711                       |                  |
| <b>Hardware Version:</b>      | V1.0                                  |                  |
| <b>Sample Received Date:</b>  | October 8, 2018                       |                  |
| <b>Sample Tested Date:</b>    | October 10, 2018 to November 21, 2018 |                  |

#### 1.2.2 Description of Accessories

| Adapter              |                                        |
|----------------------|----------------------------------------|
| <b>Model No.:</b>    | FJ-SW1260502000DS                      |
| <b>Input:</b>        | 100-240 V~50/60 Hz 0.4 A Max           |
| <b>Output:</b>       | 5.0 V $\pm$ 2000mA                     |
| <b>DC Cable:</b>     | 1.50 Meter, Unshielded without ferrite |
| <b>Manufacturer:</b> | SHENZHEN FUJIA APPLIANCE Co., Ltd.     |

### 1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

|                            |                                                                                                                                                                                                       |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Frequency Band:</b>     | 2400 MHz to 2483.5 MHz                                                                                                                                                                                |
| <b>Frequency Range:</b>    | 2412 MHz to 2462 MHz                                                                                                                                                                                  |
| <b>Support Standards:</b>  | IEEE 802.11b, IEEE 802.11g, IEEE 802.11n-HT20, IEEE 802.11n-HT40                                                                                                                                      |
| <b>Type of Modulation:</b> | IEEE 802.11b: DSSS(CCK, DQPSK, DBPSK)<br>IEEE 802.11g: OFDM(64-QAM, 16-QAM, QPSK, BPSK)<br>IEEE 802.11n-HT20: OFDM(64-QAM, 16-QAM, QPSK, BPSK)<br>IEEE 802.11n-HT40: OFDM(64-QAM, 16-QAM, QPSK, BPSK) |
| <b>Data Rate:</b>          | IEEE 802.11b: Up to 11 Mbps<br>IEEE 802.11g: Up to 54 Mbps<br>IEEE 802.11n-HT20: Up to MCS7<br>IEEE 802.11n-HT40: Up to MCS7                                                                          |
| <b>Number of Channels:</b> | IEEE 802.11b: 11<br>IEEE 802.11g: 11<br>IEEE 802.11n-HT20: 11<br>IEEE 802.11n-HT40: 7                                                                                                                 |
| <b>Channel Separation:</b> | 5 MHz                                                                                                                                                                                                 |
| <b>Antenna Type:</b>       | External Antenna                                                                                                                                                                                      |
| <b>Antenna Gain:</b>       | 0 dBi                                                                                                                                                                                                 |

|                             |                                                                                                                    |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------|
| <b>Maximum Peak Power:</b>  | IEEE 802.11b: 19.34 dBm<br>IEEE 802.11g: 23.35 dBm<br>IEEE 802.11n-HT20: 21.55 dBm<br>IEEE 802.11n-HT40: 21.87 dBm |
| <b>Normal Test Voltage:</b> | 120V~60Hz                                                                                                          |

## 1.4 OTHER INFORMATION

| Operation Frequency Each of Channel                                         |                                               |
|-----------------------------------------------------------------------------|-----------------------------------------------|
| IEEE 802.11b,<br>IEEE 802.11g,<br>IEEE 802.11n-HT20                         | $f = 2407 + 5k \text{ MHz}, k = 1, \dots, 11$ |
| IEEE 802.11n-HT40                                                           | $f = 2407 + 5k \text{ MHz}, k = 3, \dots, 9$  |
| Note:<br>f is the operating frequency (MHz);<br>k is the operating channel. |                                               |

## 1.5 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested with associated equipment below.

### 1) Support Equipment

| Description | Manufacturer | Model No. | Serial Number | Supplied by |
|-------------|--------------|-----------|---------------|-------------|
| Notebook    | Lenovo       | E450      | SL10G10780    | UnionTrust  |
| Monitor     | Panasonic    | 32E2A     | NA            | UnionTrust  |
| U disk      | Kingston     | DTGE9     | NA            | UnionTrust  |

### 2) Support Cable

| Cable No. | Description   | Connector | Length     | Supplied by |
|-----------|---------------|-----------|------------|-------------|
| 1         | Antenna Cable | SMA       | 0.30 Meter | UnionTrust  |

## 1.6 TEST LOCATION

### Shenzhen UnionTrust Quality and Technology Co., Ltd.

Address: 16/F, Block A, Building 6, Baoneng Science and Technology Park, Qingxiang Road No.1, Longhua New District, Shenzhen, China 518109  
Telephone: +86 (0) 755 2823 0888  
Fax: +86 (0) 755 2823 0886

## 1.7 TEST FACILITY

The test facility is recognized, certified, or accredited by the following organizations:

### CNAS-Lab Code: L9069

The measuring equipment utilized to perform the tests documented in this report has been calibrated once a year or in accordance with the manufacturer's recommendations, and is traceable under the ISO/IEC/EN 17025 to international or national standards. Equipment has been calibrated by accredited calibration laboratories.

### IC-Registration No.: 21600-1

The 3m Semi-anechoic chamber of Shenzhen UnionTrust Quality and Technology Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.:

### Shenzhen UnionTrust Quality and Technology Co., Ltd.

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21600-1.

**A2LA-Lab Certificate No.: 4312.01**

Shenzhen UnionTrust Quality and Technology Co., Ltd. has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

**FCC Accredited Lab.**

Designation Number: CN1194

Test Firm Registration Number: 259480

## 1.8 DEVIATION FROM STANDARDS

None.

## 1.9 ABNORMALITIES FROM STANDARD CONDITIONS

None.

## 1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER

None.

## 1.11 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

| No. | Item                            | Measurement Uncertainty |
|-----|---------------------------------|-------------------------|
| 1   | Conducted emission 9KHz-150KHz  | ±3.8 dB                 |
| 2   | Conducted emission 150KHz-30MHz | ±3.4 dB                 |
| 3   | Radiated emission 9KHz-30MHz    | ±4.9 dB                 |
| 4   | Radiated emission 30MHz-1GHz    | ±4.7 dB                 |
| 5   | Radiated emission 1GHz-18GHz    | ±5.1 dB                 |
| 6   | Radiated emission 18GHz-26GHz   | ±5.2 dB                 |
| 7   | Radiated emission 26GHz-40GHz   | ±5.2 dB                 |



## 2. TEST SUMMARY

| FCC 47 CFR Part 15 Subpart C Test Cases |                                                                                              |                                                 |        |
|-----------------------------------------|----------------------------------------------------------------------------------------------|-------------------------------------------------|--------|
| Test Item                               | Test Requirement                                                                             | Test Method                                     | Result |
| Antenna Requirement                     | FCC 47 CFR Part 15 Subpart C Section 15.203/15.247 (c)<br>RSS-Gen Issue 5, Section 6.8       | N/A                                             | PASS   |
| AC Power Line Conducted Emission        | FCC 47 CFR Part 15 Subpart C Section 15.207<br>RSS-Gen Issue 5, Section 8.8                  | ANSI C63.10-2013<br>Clause 6.2                  | PASS   |
| Conducted Peak Output Power             | FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(3)<br>RSS-247 Issue 2, Section 5.4(d)        | ANSI C63.10-2013<br>Clause 11.9.1.3             | PASS   |
| 6dB Bandwidth                           | FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(2)<br>RSS-247 Issue 2, Section 5.2(a)        | ANSI C63.10-2013<br>Clause 11.8.1               | PASS   |
| Occupied Bandwidth                      | RSS-Gen Issue 5, Section 6.7                                                                 | RSS-Gen Issue 5,<br>Section 6.7                 | PASS   |
| Power Spectral Density                  | FCC 47 CFR Part 15 Subpart C Section 15.247 (e)<br>RSS-247 Issue 2, Section 5.2(b)           | ANSI C63.10-2013<br>Clause 11.10.2              | PASS   |
| Conducted Out of Band Emission          | FCC 47 CFR Part 15 Subpart C Section 15.247(d)<br>RSS-247 Issue 2, Section 5.5               | ANSI C63.10-2013<br>Clause 11.11                | PASS   |
| Radiated Spurious Emissions             | FCC 47 CFR Part 15 Subpart C Section 15.205/15.209<br>RSS-Gen Issue 5, Section 6.13/8.9/8.10 | ANSI C63.10-2013<br>Clause 11.11 & Clause 11.12 | PASS   |
| Band Edge Measurements (Radiated)       | FCC 47 CFR Part 15 Subpart C Section 15.205/15.209<br>RSS-247 Issue 2, Section 5.5           | ANSI C63.10-2013<br>Clause 11.13                | PASS   |

### 3. EQUIPMENT LIST

| Radiated Emission Test Equipment List |                                         |               |           |                            |                         |                             |
|---------------------------------------|-----------------------------------------|---------------|-----------|----------------------------|-------------------------|-----------------------------|
| Used                                  | Equipment                               | Manufacturer  | Model No. | Serial Number              | Cal. date (mm dd, yyyy) | Cal. Due date (mm dd, yyyy) |
| <input checked="" type="checkbox"/>   | 3M Chamber & Accessory Equipment        | ETS-LINDGREN  | 3M        | N/A                        | Dec. 20, 2015           | Dec. 19, 2018               |
| <input checked="" type="checkbox"/>   | Receiver                                | R&S           | ESIB26    | 100114                     | Dec. 10, 2017           | Dec. 10, 2018               |
| <input checked="" type="checkbox"/>   | Loop Antenna                            | ETS-LINDGREN  | 6502      | 00202525                   | Dec. 22, 2017           | Dec. 22, 2018               |
| <input checked="" type="checkbox"/>   | Broadband Antenna                       | ETS-LINDGREN  | 3142E     | 00201566                   | Dec. 17, 2017           | Dec. 17, 2018               |
| <input checked="" type="checkbox"/>   | Preamplifier                            | HP            | 8447F     | 2805A02960                 | Dec. 10, 2017           | Dec. 10, 2018               |
| <input checked="" type="checkbox"/>   | Horn Antenna (Pre-amplifier)            | ETS-LINDGREN  | 3117-PA   | 00201874                   | May 22, 2018            | May 22, 2019                |
| <input checked="" type="checkbox"/>   | Horn Antenna (Pre-amplifier)            | ETS-LINDGREN  | 3116C-PA  | 00202652                   | Dec. 17, 2017           | Dec. 17, 2018               |
| <input checked="" type="checkbox"/>   | Multi device Controller                 | ETS-LINDGREN  | 7006-001  | 00160105                   | N/A                     | N/A                         |
| <input checked="" type="checkbox"/>   | Band Rejection Filter (2400MHz~2500MHz) | Micro-Tronics | BRM50702  | G248                       | June 06, 2018           | June 06, 2019               |
| <input checked="" type="checkbox"/>   | Test Software                           | Audix         | e3        | Software Version: 9.160323 |                         |                             |

| Conducted Emission Test Equipment List |               |              |           |                            |                         |                             |
|----------------------------------------|---------------|--------------|-----------|----------------------------|-------------------------|-----------------------------|
| Used                                   | Equipment     | Manufacturer | Model No. | Serial Number              | Cal. date (mm dd, yyyy) | Cal. Due date (mm dd, yyyy) |
| <input checked="" type="checkbox"/>    | Receiver      | R&S          | ESR7      | 1316.3003K07-101181-K3     | Dec. 10, 2017           | Dec. 10, 2018               |
| <input checked="" type="checkbox"/>    | Pulse Limiter | R&S          | ESH3-Z2   | 0357.8810.54               | Dec. 10, 2017           | Dec. 10, 2018               |
| <input checked="" type="checkbox"/>    | LISN          | R&S          | ESH2-Z5   | 860014/024                 | Dec. 10, 2017           | Dec. 10, 2018               |
| <input checked="" type="checkbox"/>    | LISN          | ETS-Lindgren | 3816/2SH  | 00201088                   | Dec. 10, 2017           | Dec. 10, 2018               |
| <input checked="" type="checkbox"/>    | Test Software | Audix        | e3        | Software Version: 9.160323 |                         |                             |

| Conducted RF test Equipment List    |                           |              |           |               |                         |                             |
|-------------------------------------|---------------------------|--------------|-----------|---------------|-------------------------|-----------------------------|
| Used                                | Equipment                 | Manufacturer | Model No. | Serial Number | Cal. date (mm dd, yyyy) | Cal. Due date (mm dd, yyyy) |
| <input checked="" type="checkbox"/> | EXA Spectrum Analyzer     | KEYSIGHT     | N9010A    | MY51440197    | Dec.10, 2017            | Dec. 10, 2018               |
| <input checked="" type="checkbox"/> | USB Wideband Power Sensor | KEYSIGHT     | U2021XA   | MY55430035    | Dec. 10, 2017           | Dec. 10, 2018               |
| <input type="checkbox"/>            | USB Wideband Power Sensor | KEYSIGHT     | U2021XA   | MY55430023    | Dec. 10, 2017           | Dec. 10, 2018               |



## 4. TEST CONFIGURATION

### 4.1 ENVIRONMENTAL CONDITIONS FOR TESTING

#### 4.1.1 Normal or Extreme Test Conditions

| Environment Parameter                                           | Selected Values During Tests |           |                       |
|-----------------------------------------------------------------|------------------------------|-----------|-----------------------|
| Test Condition                                                  | Ambient                      |           |                       |
|                                                                 | Temperature (°C)             | Voltage   | Relative Humidity (%) |
| NT/NV                                                           | +15 to +35                   | 120V~60Hz | 20 to 75              |
| <b>Remark:</b><br>1) NV: Normal Voltage; NT: Normal Temperature |                              |           |                       |

#### 4.1.2 Record of Normal Environment

| Test Item                          | Temperature (°C) | Relative Humidity (%) | Pressure (kPa) | Tested by    |
|------------------------------------|------------------|-----------------------|----------------|--------------|
| AC Power Line Conducted Emission   | 24.6             | 47                    | 100.89         | Gemini Huang |
| Conducted Peak Output Power        | 20.8             | 46                    | 100.93         | Terence Chen |
| 6dB Bandwidth & Occupied Bandwidth |                  |                       |                |              |
| Power Spectral Density             |                  |                       |                |              |
| Conducted Out of Band Emission     | 23.5             | 47                    | 101.01         | Andy Lin     |
| Radiated Spurious Emissions        |                  |                       |                |              |
| Band Edge Measurements (Radiated)  | 23.5             | 47                    | 101.01         | Andy Lin     |

### 4.2 TEST CHANNELS

| Mode              | Tx/Rx Frequency      | Test RF Channel Lists |           |            |
|-------------------|----------------------|-----------------------|-----------|------------|
|                   |                      | Lowest(L)             | Middle(M) | Highest(H) |
| IEEE 802.11b      | 2412 MHz to 2462 MHz | Channel 1             | Channel 7 | Channel 11 |
|                   |                      | 2412 MHz              | 2437 MHz  | 2462 MHz   |
| IEEE 802.11g      | 2412 MHz to 2462 MHz | Channel 1             | Channel 7 | Channel 11 |
|                   |                      | 2412 MHz              | 2437 MHz  | 2462 MHz   |
| IEEE 802.11n-HT20 | 2412 MHz to 2462 MHz | Channel 1             | Channel 7 | Channel 11 |
|                   |                      | 2412 MHz              | 2437 MHz  | 2462 MHz   |
| IEEE 802.11n-HT40 | 2422 MHz to 2452 MHz | Channel 3             | Channel 7 | Channel 9  |
|                   |                      | 2422 MHz              | 2437 MHz  | 2452 MHz   |

### 4.3 EUT TEST STATUS

| Mode                                                                   | Tx Function | Description                                                               |
|------------------------------------------------------------------------|-------------|---------------------------------------------------------------------------|
| IEEE 802.11b<br>IEEE 802.11g<br>IEEE 802.11n-HT20<br>IEEE 802.11n-HT40 | 1Tx         | 1. Keep the EUT in continuously transmitting with modulation test single. |

| Power Setting                                                          |
|------------------------------------------------------------------------|
| Power Setting: not applicable, test used software default power level. |

| Test Software                    |
|----------------------------------|
| Test software name: RtkWiFiTest; |

### 4.4 PRE-SCAN

#### 4.4.1 Pre-scan under all rates

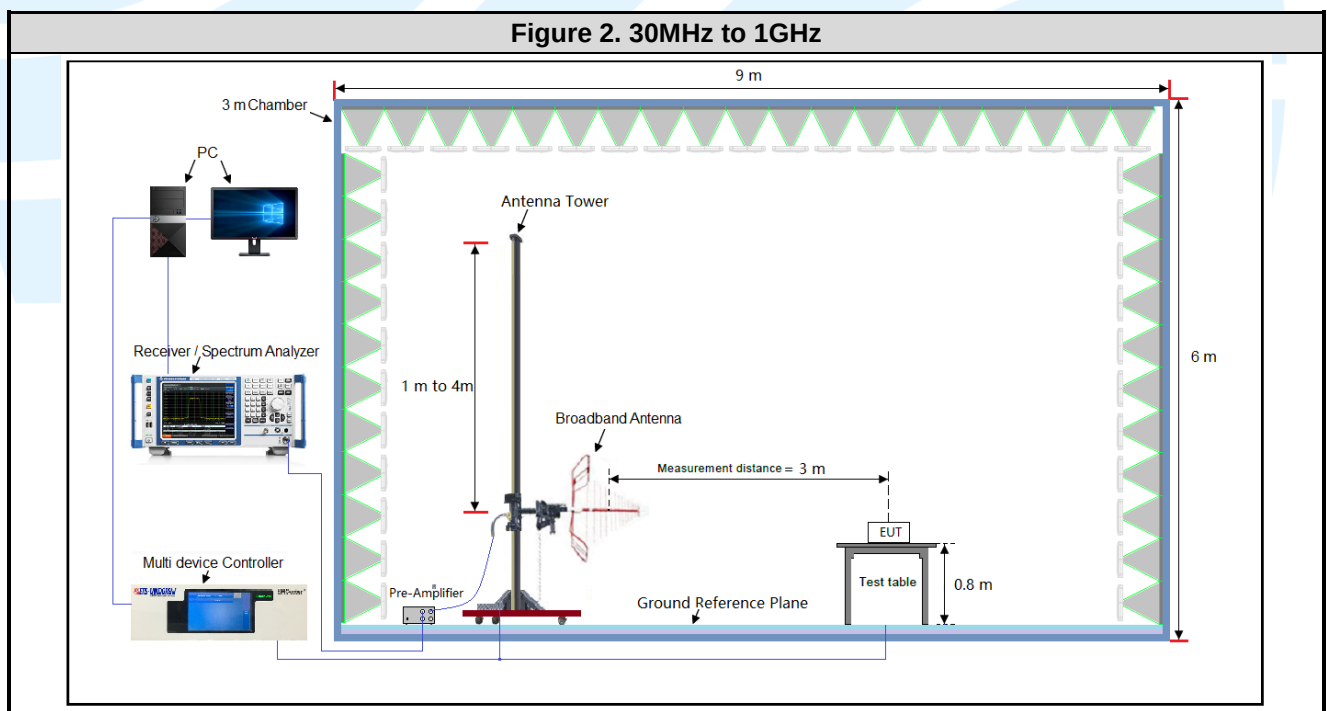
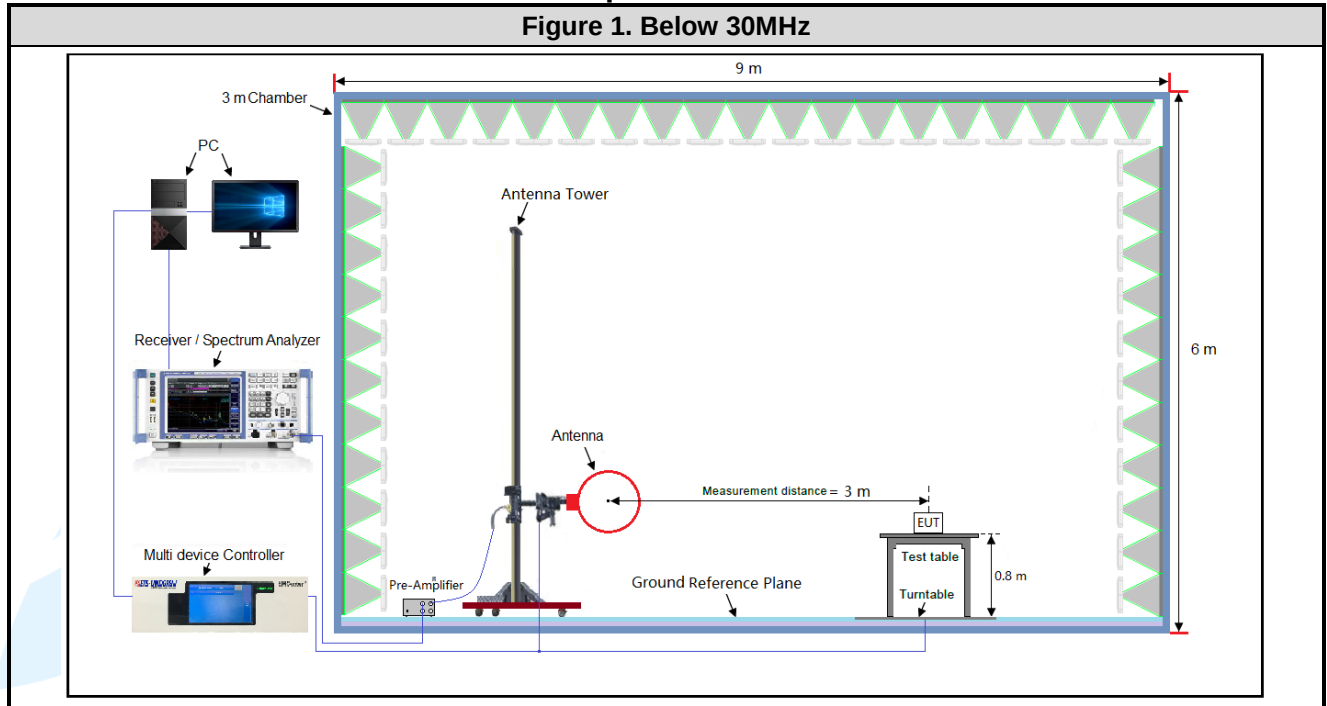
| Mode and Frequency            | Maximum Conducted Average Power (dBm) |       |       |       |       |       |       |       |
|-------------------------------|---------------------------------------|-------|-------|-------|-------|-------|-------|-------|
|                               | 1                                     |       | 2     |       | 5.5   |       | 11    |       |
| IEEE 802.11b<br>2437 MHz      | 16.72                                 |       | 16.71 |       | 16.68 |       | 16.64 |       |
| IEEE 802.11g<br>2437 MHz      | 6                                     | 9     | 12    | 18    | 24    | 36    | 48    | 54    |
|                               | 13.51                                 | 13.34 | 13.26 | 13.01 | 12.90 | 12.78 | 12.66 | 12.58 |
| IEEE 802.11n-HT20<br>2437 MHz | MCS0                                  | MCS1  | MCS2  | MCS3  | MCS4  | MCS5  | MCS6  | MCS7  |
|                               | 12.53                                 | 12.48 | 12.36 | 12.25 | 12.13 | 12.01 | 11.93 | 11.79 |
| IEEE 802.11n-HT40<br>2437 MHz | MCS0                                  | MCS1  | MCS2  | MCS3  | MCS4  | MCS5  | MCS6  | MCS7  |
|                               | 11.99                                 | 11.86 | 11.61 | 11.50 | 11.38 | 11.26 | 11.18 | 11.04 |

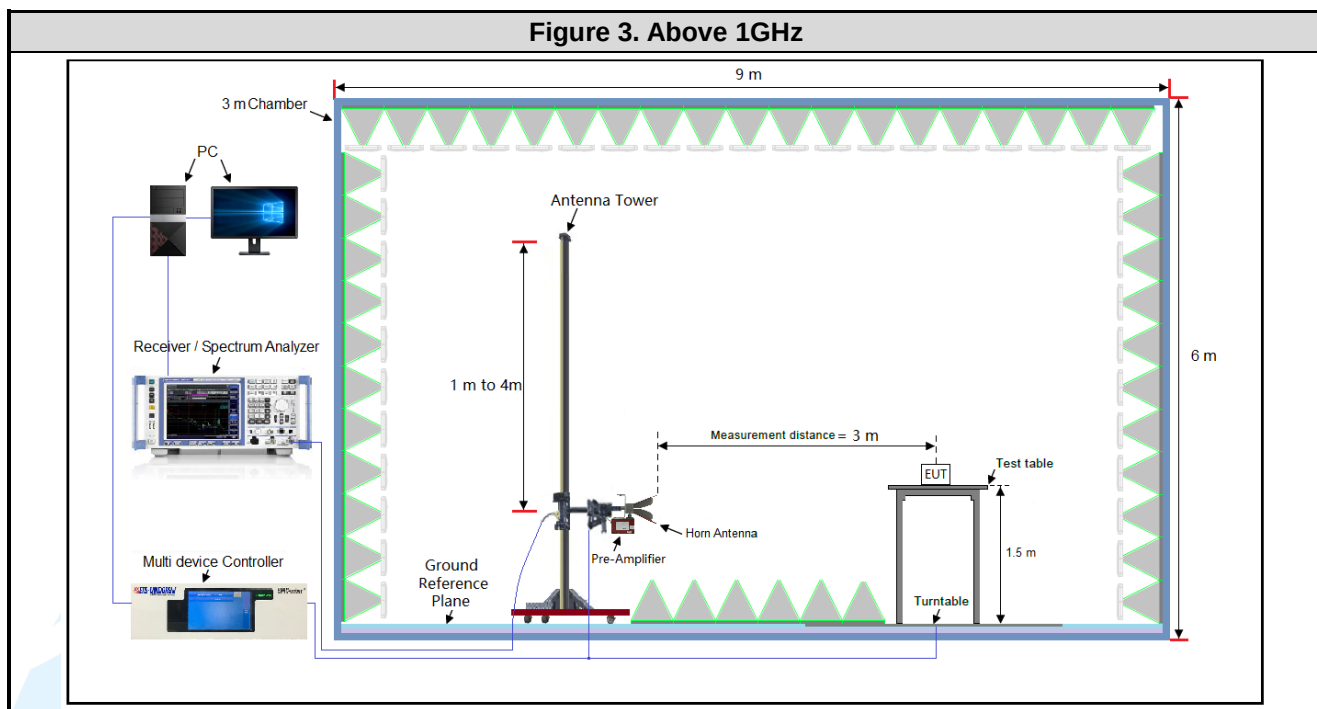
#### 4.4.2 Worst-case data rates

| Mode              | Worst-case data rates |
|-------------------|-----------------------|
| IEEE 802.11b      | 1 Mbps                |
| IEEE 802.11g      | 6 Mbps                |
| IEEE 802.11n-HT20 | MCS0                  |
| IEEE 802.11n-HT40 | MCS0                  |

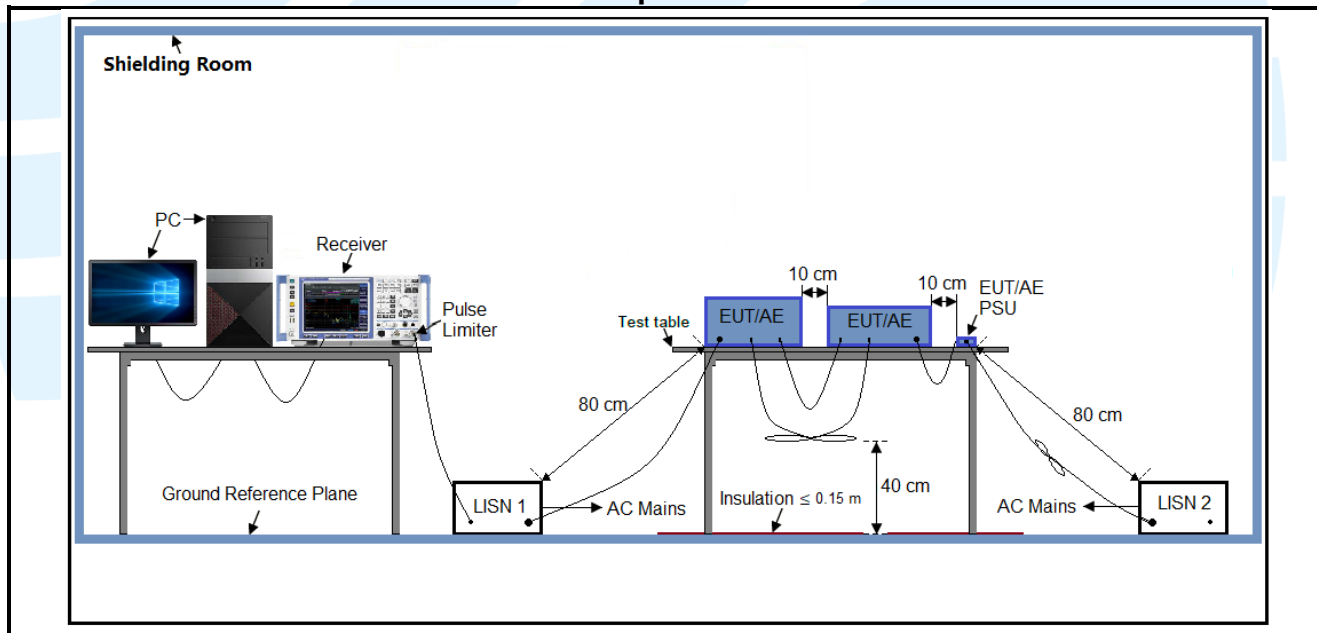
## 4.5 TEST SETUP

### 4.5.1 For Radiated Emissions test setup

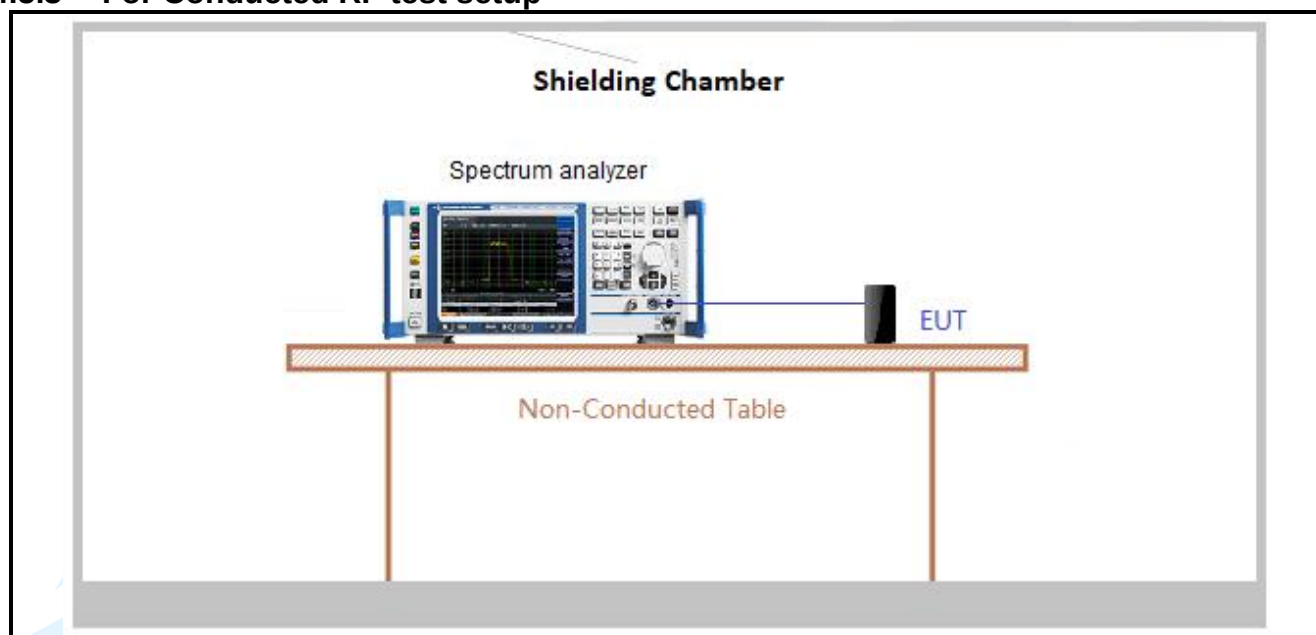




#### 4.5.2 For Conducted Emissions test setup



### 4.5.3 For Conducted RF test setup



## 4.6 SYSTEM TEST CONFIGURATION

For emissions testing, the equipment under test (EUT) setup to transmit continuously to simplify the measurement methodology. Care was taken to ensure proper power supply voltages during testing. During testing, radiated emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario. It was powered by 120V~60Hz. Only the worst case data were recorded in this test report.

The signal is maximized through rotation and placement in the three orthogonal axes. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. Therefore, all final radiated testing was performed with the EUT in (see table below) orientation.

| Frequency  | Mode | Antenna Port | Worst-case axis positioning |
|------------|------|--------------|-----------------------------|
| Above 1GHz | 1TX  | Chain 0      | Y axis                      |

All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance. Analyzer resolution is 100 kHz or greater for frequencies below 1000 MHz. The resolution is 1 MHz or greater for frequencies above 1000 MHz. The spurious emissions more than 20 dB below the permissible value are not reported.

Radiated emission measurement were performed from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

## 4.7 DUTY CYCLE

Test Procedure: ANSI C63.10-2013 Clause 11.6.

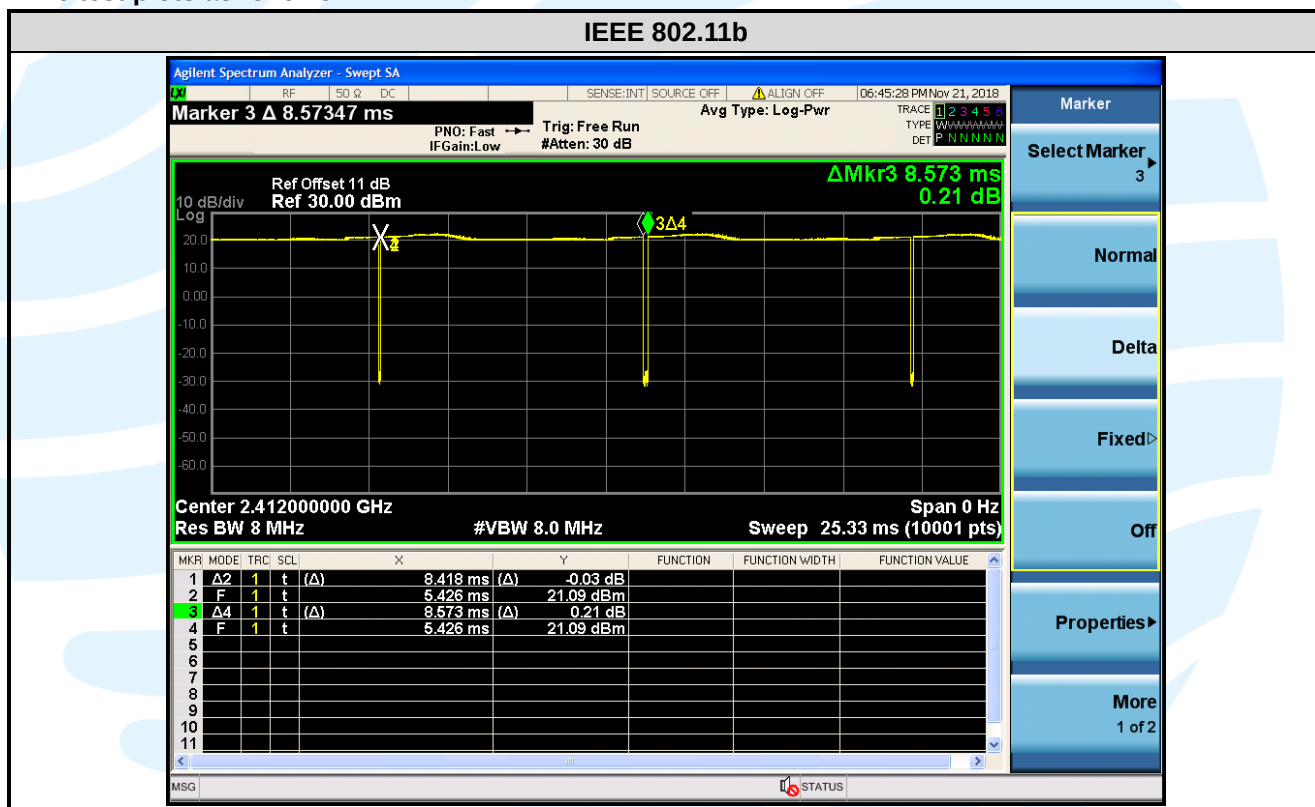
### Test Results

| Mode              | Data rates (Mbps) | On Time (msec) | Period (msec) | Duty Cycle (linear) | Duty Cycle (%) | Duty Cycle Factor (dB) | 1/ T Minimum VBW (kHz) | Average Factor (dB) |
|-------------------|-------------------|----------------|---------------|---------------------|----------------|------------------------|------------------------|---------------------|
| IEEE 802.11b      | 1                 | 8.418          | 8.573         | 0.98                | 98.19          | 0.00                   | 0.01                   | -0.16               |
| IEEE 802.11g      | 6                 | 1.396          | 1.513         | 0.92                | 92.27          | 0.35                   | 0.72                   | -0.70               |
| IEEE 802.11n-HT20 | MCS0              | 1.307          | 1.426         | 0.92                | 91.65          | 0.38                   | 0.77                   | -0.76               |
| IEEE 802.11n-HT40 | MCS0              | 0.647          | 0.809         | 0.80                | 79.98          | 0.97                   | 1.55                   | -1.94               |

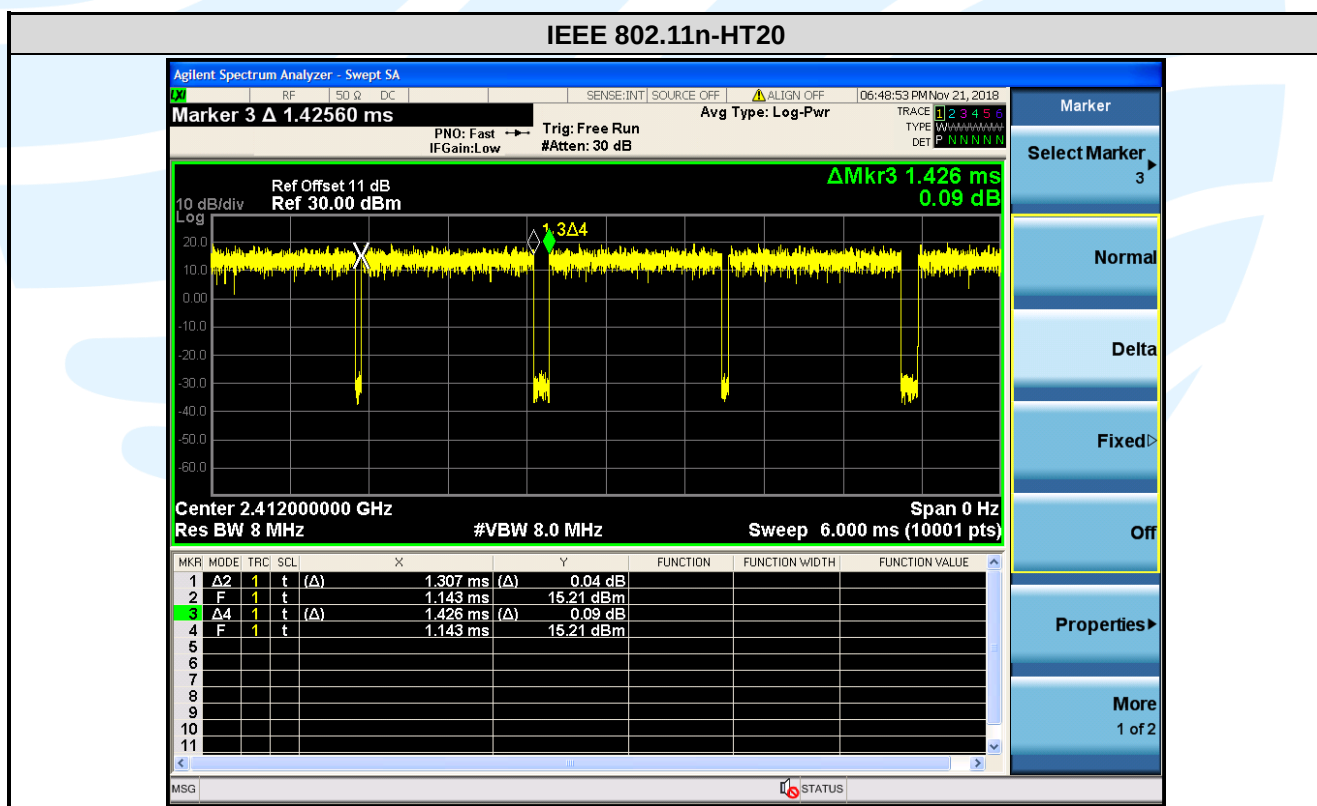
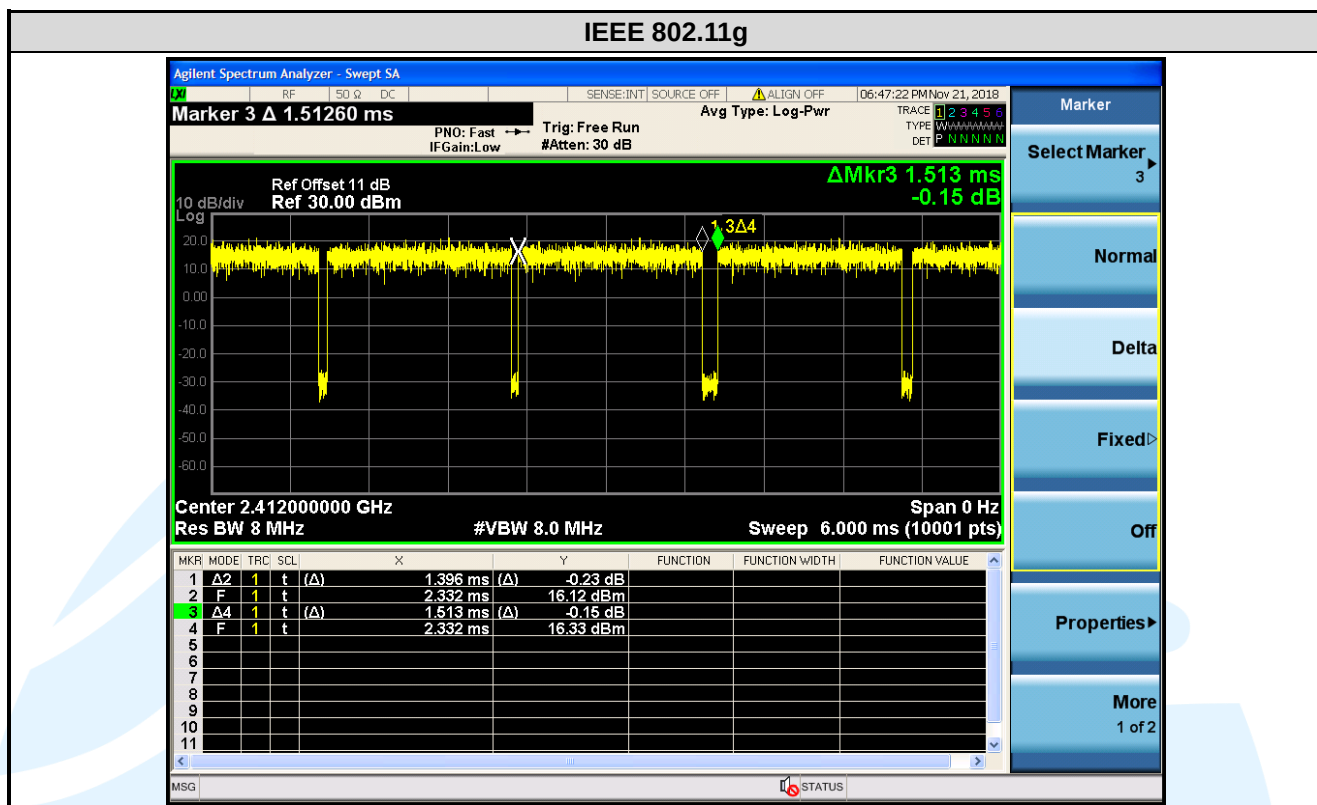
### Remark:

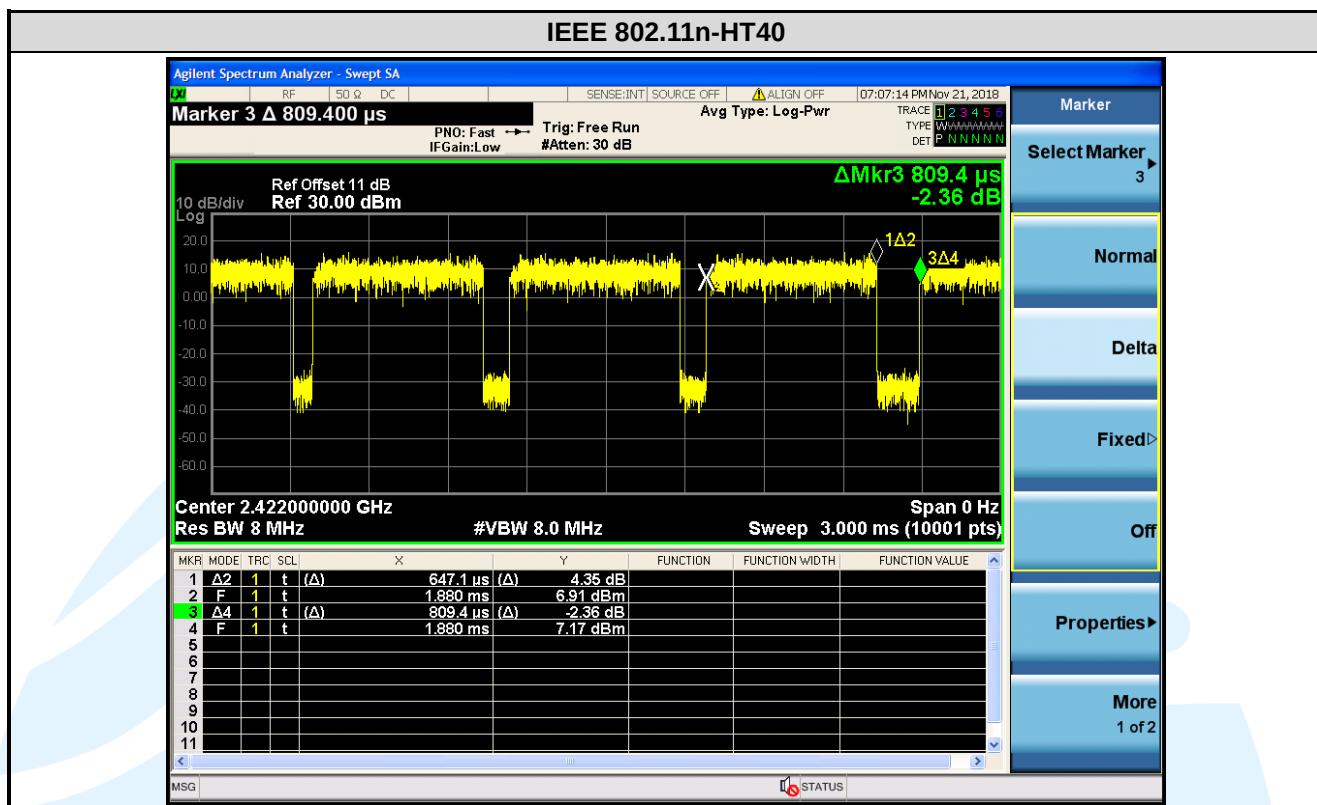
- 1) Duty cycle= On Time/ Period;
- 2) Duty Cycle factor =  $10 * \log(1/ \text{Duty cycle})$ ;
- 3) Average factor =  $20 \log_{10} \text{Duty Cycle}$ .

The test plots as follows









## 5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION

### 5.1 REFERENCE DOCUMENTS FOR TESTING

| No. | Identity                                | Document Title                                                                                                                                                                            |
|-----|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | FCC 47 CFR Part 2                       | Frequency allocations and radio treaty matters; general rules and regulations                                                                                                             |
| 2   | FCC 47 CFR Part 15                      | Radio Frequency Devices                                                                                                                                                                   |
| 3   | RSS-247 Issue 2                         | Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices                                                              |
| 4   | RSS-Gen Issue 5                         | General Requirements for Compliance of Radio Apparatus                                                                                                                                    |
| 5   | ANSI C63.10-2013                        | American National Standard for Testing Unlicensed Wireless Devices                                                                                                                        |
| 6   | KDB 558074 D01 15.247 Meas Guidance v05 | Guidance for compliance measurements on Digital Transmission Systems, Frequency Hopping Spread Spectrum system, and Hybrid system devices operating under Section 15.247 of the FCC rules |

### 5.2 ANTENNA REQUIREMENT

| Standard Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>15.203 requirement:</b><br/>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, 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.</p> <p><b>15.247(b) (4) requirement:</b><br/>The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.</p> <p><b>RSS-Gen Issue 5, Section 6.8 requirement:</b><br/>According to RSS-Gen Issue 5, Section 6.8, a transmitter can only be sold or operated with antennas with which it was certified. A transmitter may be certified with multiple antenna types. An antenna type comprises antennas having similar in-band and out-of-band radiation patterns.</p> <p><b>EUT Antenna:</b><br/>Antenna in the external of the equipment and no consideration of replacement. The gain of the antenna is 0 dBi.</p> |

### 5.3 CONDUCTED PEAK OUTPUT POWER

**Test Requirement:** FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(3)  
RSS-247 Issue 2, Section 5.4(d)

**Test Method:** ANSI C63.10-2013 Clause 11.9.1.3

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

**Test Procedure:**

1. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.
2. Measure out each test modes' peak or average output power, record the power level.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

**Test Setup:** Refer to section 4.5.3 for details.

**Instruments Used:** Refer to section 3 for details

**Test Results:**

| Mode              | Channel/<br>Frequency<br>(MHz) | Maximum<br>Conducted<br>Peak Power<br>(dBm) | Maximum<br>e.i.r.p (dBm) | Limit<br>(dBm) | Psss / Fail |
|-------------------|--------------------------------|---------------------------------------------|--------------------------|----------------|-------------|
| IEEE 802.11b      | 1(2412)                        | 18.80                                       | 18.80                    | 30             | Pass        |
|                   | 6(2437)                        | 19.34                                       | 19.34                    | 30             | Pass        |
|                   | 11(2462)                       | 19.23                                       | 19.23                    | 30             | Pass        |
| IEEE 802.11g      | 1(2412)                        | 22.98                                       | 22.98                    | 30             | Pass        |
|                   | 6(2437)                        | 23.07                                       | 23.07                    | 30             | Pass        |
|                   | 11(2462)                       | 23.35                                       | 23.35                    | 30             | Pass        |
| IEEE 802.11n-HT20 | 1(2412)                        | 21.55                                       | 21.55                    | 30             | Pass        |
|                   | 6(2437)                        | 21.71                                       | 21.71                    | 30             | Pass        |
|                   | 11(2462)                       | 21.46                                       | 21.46                    | 30             | Pass        |
| IEEE 802.11n-HT40 | 3(2422)                        | 21.48                                       | 21.48                    | 30             | Pass        |
|                   | 6(2437)                        | 21.87                                       | 21.87                    | 30             | Pass        |
|                   | 9(2452)                        | 21.28                                       | 21.28                    | 30             | Pass        |

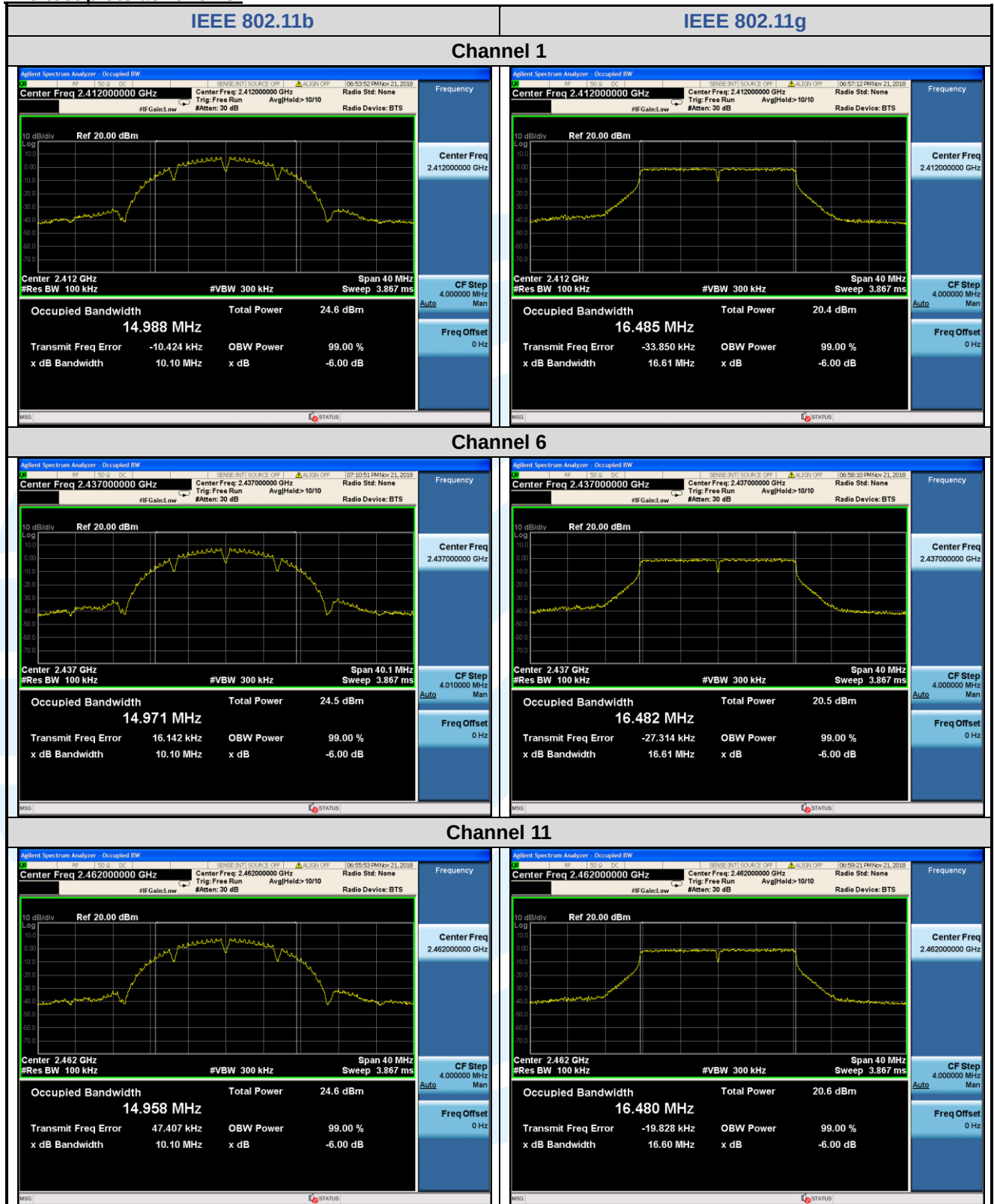
Note: The antenna gain of 0 dBi less than 6dBi maximum permission antenna gain value based on 1 watt (30dBm) peak output power limit.

## 5.46 DB BANDWIDTH & OCCUPIED BANDWIDTH

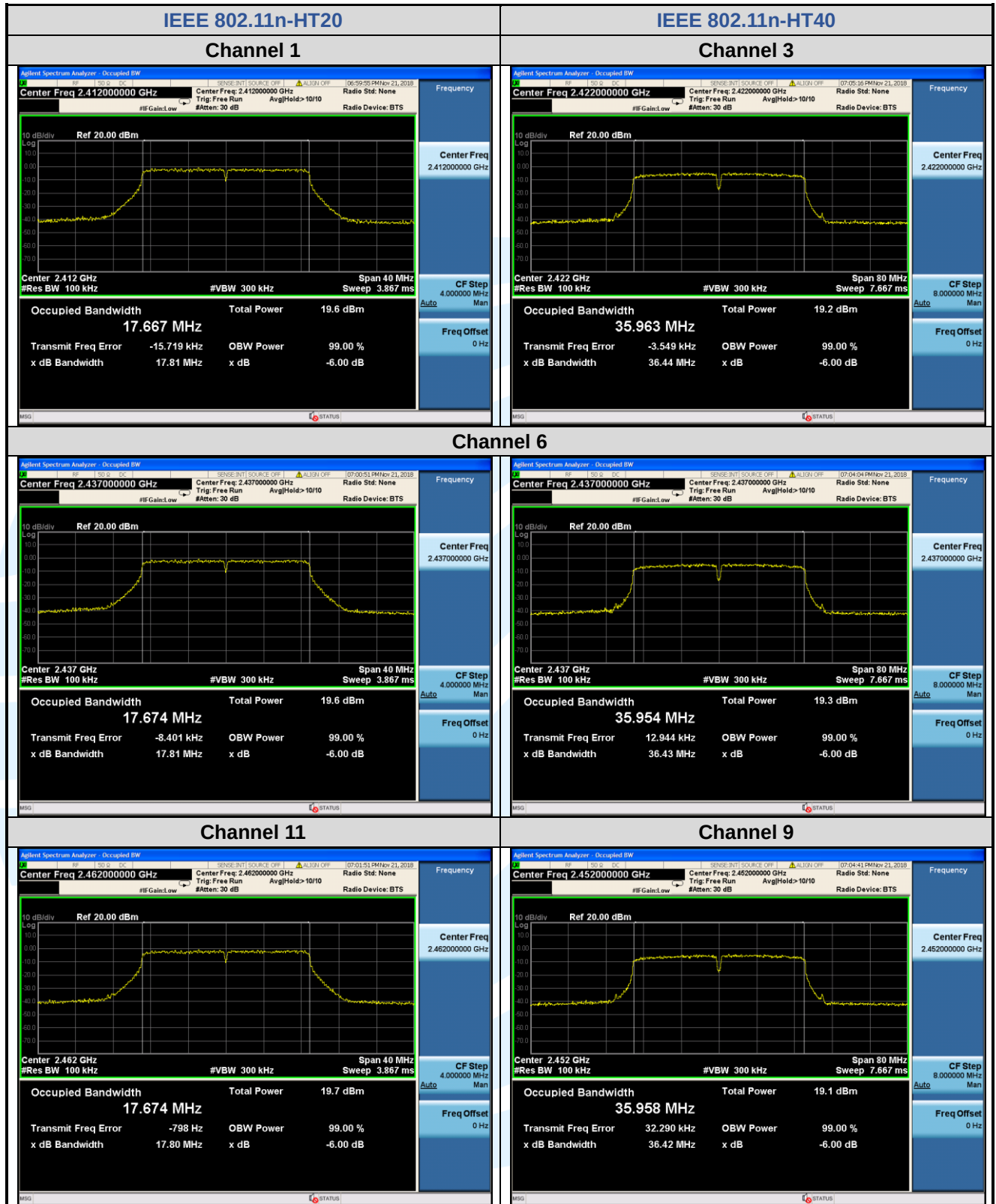
|                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Test Requirement:</b> | FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(2)<br>RSS-247 Issue 2, Section 5.2(a)<br>RSS-Gen Issue 5, Section 6.7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Test Method:</b>      | ANSI C63.10-2013 Clause 11.8.1<br>RSS-Gen Issue 5, Section 6.7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Limit:</b>            | For direct sequence systems, the minimum 6dB bandwidth shall be at least 500kHz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Test Procedure:</b>   | Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.<br>Use the following spectrum analyzer settings:<br>a) Set RBW = 100 kHz.<br>b) Set the video bandwidth (VBW) $\geq 3 \times$ RBW.<br>c) Detector = Peak.<br>d) Trace mode = max hold.<br>e) Sweep = auto couple.<br>f) Allow the trace to stabilize.<br>g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.<br><br>Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset. |
| <b>Test Setup:</b>       | Refer to section 4.5.3 for details.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Instruments Used:</b> | Refer to section 3 for details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Test Results:</b>     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

| Mode              | Channel/<br>Frequency<br>(MHz) | 6 dB<br>Bandwidth<br>(MHz) | 99%<br>Bandwidth<br>(MHz) | 6 dB<br>Bandwidth<br>Limit | Pass / Fail |
|-------------------|--------------------------------|----------------------------|---------------------------|----------------------------|-------------|
| IEEE 802.11b      | 1(2412)                        | 10.10                      | 14.988                    | > 500 kHz                  | Pass        |
|                   | 6(2437)                        | 10.10                      | 14.971                    | > 500 kHz                  | Pass        |
|                   | 11(2462)                       | 10.10                      | 14.958                    | > 500 kHz                  | Pass        |
| IEEE 802.11g      | 1(2412)                        | 16.61                      | 16.485                    | > 500 kHz                  | Pass        |
|                   | 6(2437)                        | 16.61                      | 16.482                    | > 500 kHz                  | Pass        |
|                   | 11(2462)                       | 16.60                      | 16.480                    | > 500 kHz                  | Pass        |
| IEEE 802.11n-HT20 | 1(2412)                        | 17.81                      | 17.667                    | > 500 kHz                  | Pass        |
|                   | 6(2437)                        | 17.81                      | 17.674                    | > 500 kHz                  | Pass        |
|                   | 11(2462)                       | 17.80                      | 17.674                    | > 500 kHz                  | Pass        |
| IEEE 802.11n-HT40 | 3(2422)                        | 36.44                      | 35.963                    | > 500 kHz                  | Pass        |
|                   | 6(2437)                        | 36.43                      | 35.954                    | > 500 kHz                  | Pass        |
|                   | 9(2452)                        | 36.42                      | 35.958                    | > 500 kHz                  | Pass        |

The test plots as follows:







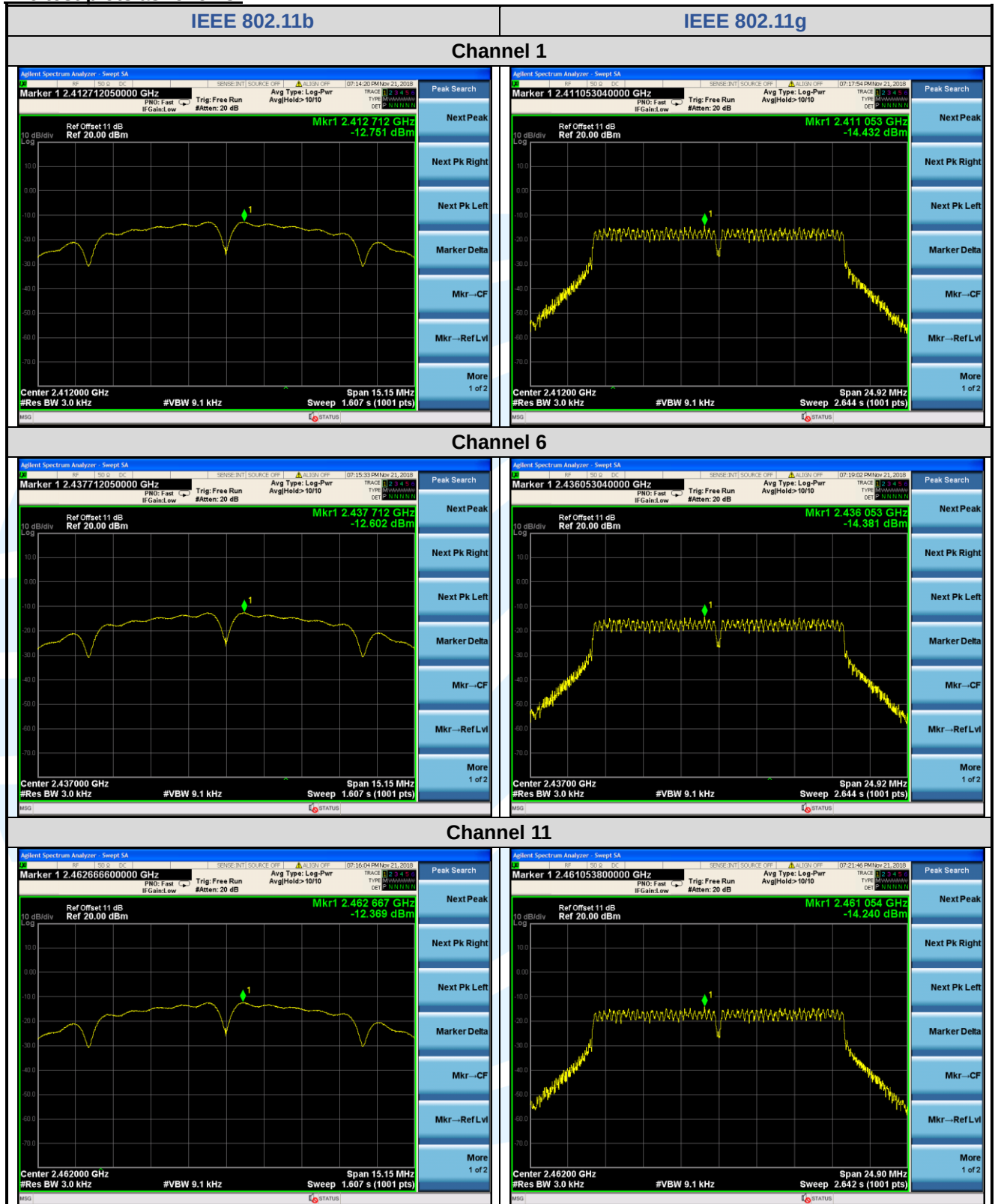


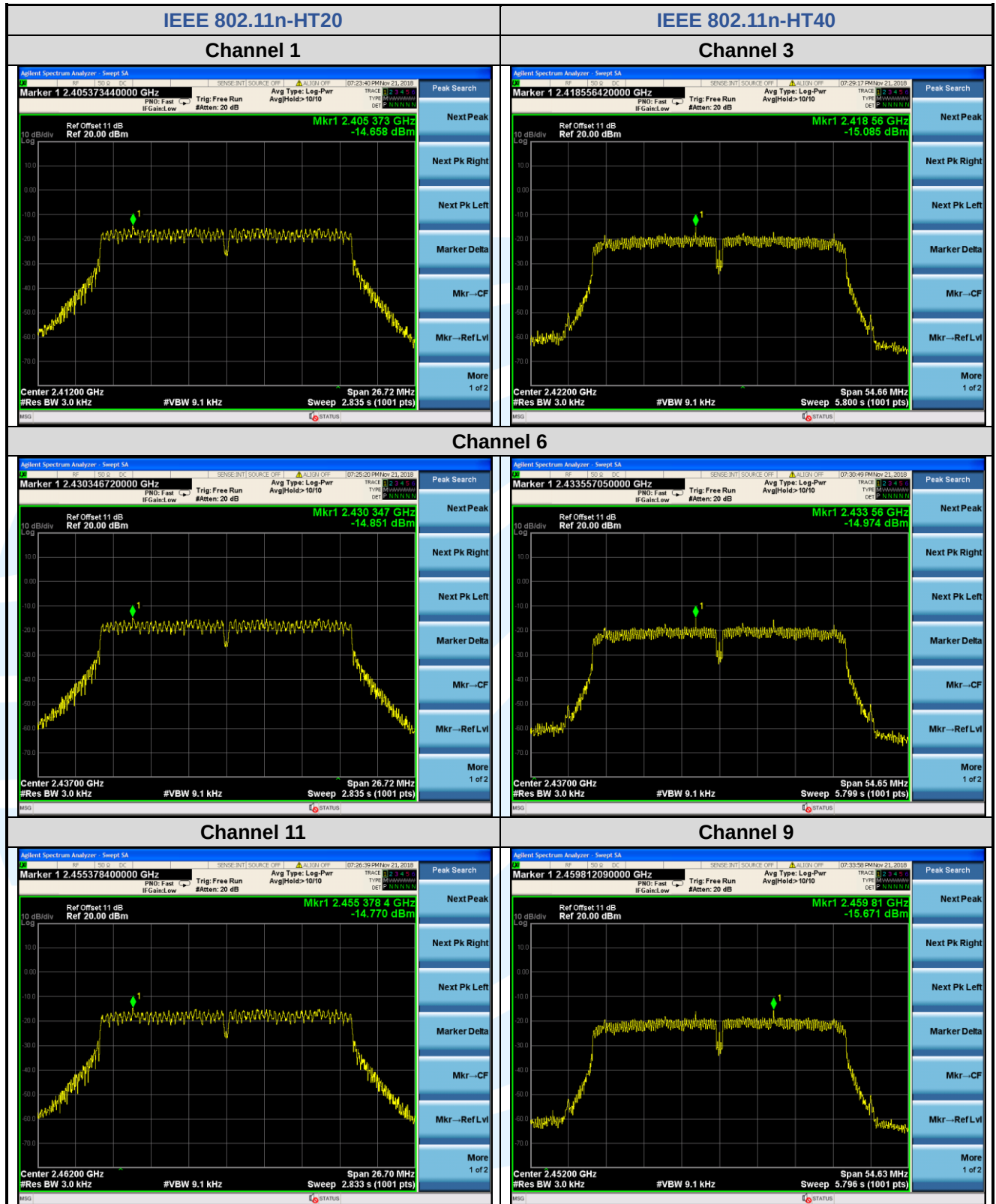
## 5.5 POWER SPECTRAL DENSITY

- Test Requirement:** FCC 47 CFR Part 15 Subpart C Section 15.247 (e)  
RSS-247 Issue 2, Section 5.2(b)
- Test Method:** ANSI C63.10-2013 Clause 11.10.2
- Limit:** For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3kHz band during any time interval of continuous transmission.
- Test Procedure:** Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.  
Use the following spectrum analyzer settings:
- Set analyzer center frequency to DTS channel center frequency.
  - Set the span to 1.5 times the DTS bandwidth.
  - Set the RBW to:  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ .
  - Set the VBW  $\geq 3 \times \text{RBW}$ .
  - Detector = peak.
  - Sweep time = auto couple.
  - Trace mode = max hold.
  - Allow trace to fully stabilize.
  - Use the peak marker function to determine the maximum amplitude level within the RBW.
  - If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.
- Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.
- Test Setup:** Refer to section 4.5.3 for details.
- Instruments Used:** Refer to section 3 for details
- Test Results:**

| Mode              | Channel/<br>Frequency (MHz) | PSD<br>(dBm/3kHz) | PSD Limit<br>(dBm/3kHz) | Pass / Fail |
|-------------------|-----------------------------|-------------------|-------------------------|-------------|
| IEEE 802.11b      | 1(2412)                     | -12.75            | 8                       | Pass        |
|                   | 6(2437)                     | -12.60            | 8                       | Pass        |
|                   | 11(2462)                    | -12.37            | 8                       | Pass        |
| IEEE 802.11g      | 1(2412)                     | -14.43            | 8                       | Pass        |
|                   | 6(2437)                     | -14.38            | 8                       | Pass        |
|                   | 11(2462)                    | -14.24            | 8                       | Pass        |
| IEEE 802.11n-HT20 | 1(2412)                     | -14.66            | 8                       | Pass        |
|                   | 6(2437)                     | -14.85            | 8                       | Pass        |
|                   | 11(2462)                    | -14.77            | 8                       | Pass        |
| IEEE 802.11n-HT40 | 3(2422)                     | -15.08            | 8                       | Pass        |
|                   | 6(2437)                     | -14.97            | 8                       | Pass        |
|                   | 9(2452)                     | -15.67            | 8                       | Pass        |

The test plots as follows:





## 5.6 CONDUCTED OUT OF BAND EMISSION

|                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Test Requirement:</b> | FCC 47 CFR Part 15 Subpart C Section 15.247(d)<br>RSS-247 Issue 2, Section 5.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Test Method:</b>      | ANSI C63.10-2013 Clause 11.11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Limit:</b>            | In any 100kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Test Procedure:</b>   | <p>Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.</p> <p>Use the following spectrum analyzer settings:</p> <p><b>Step 1: Measurement Procedure REF</b></p> <ol style="list-style-type: none"> <li>Set instrument center frequency to DTS channel center frequency.</li> <li>Set the span to <math>\geq 1.5</math> times the DTS bandwidth.</li> <li>Set the RBW = 100 kHz.</li> <li>Set the VBW <math>\geq 3 \times</math> RBW.</li> <li>Detector = peak.</li> <li>Sweep time = auto couple.</li> <li>Trace mode = max hold.</li> <li>Allow trace to fully stabilize.</li> <li>Use the peak marker function to determine the maximum PSD level.</li> <li>Note that the channel found to contain the maximum PSD level can be used to establish the reference level.</li> </ol> <p><b>Step 2: Measurement Procedure OOBE</b></p> <ol style="list-style-type: none"> <li>Set RBW = 100 kHz.</li> <li>Set VBW <math>\geq 300</math> kHz.</li> <li>Detector = peak.</li> <li>Sweep = auto couple.</li> <li>Trace Mode = max hold.</li> <li>Allow trace to fully stabilize.</li> <li>Use the peak marker function to determine the maximum amplitude level.</li> </ol> <p>Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.</p> |
| <b>Test Setup:</b>       | Refer to section 4.5.3 for details.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Instruments Used:</b> | Refer to section 3 for details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Test Results:</b>     | Pass                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

The test plots as follows:

