

# TEST REPORT

**Product Name:** WIFI Module  
**Trade Mark:** RF-LINK  
**Model No.:** RL-UM02SPC-8812BU-V1.0  
**Report Number:** 180327015RFC-1  
**Test Standards:** FCC 47 CFR Part 15 Subpart C  
**FCC ID:** QCIIDXMOD1  
**Test Result:** PASS  
**Date of Issue:** April 18, 2018

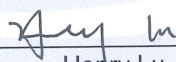
Prepared for:

**SMART Technologies Inc.**  
**3636 Research Road NW Calgary, AB T2L 1Y1, Canada**

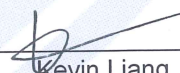
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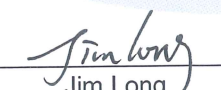
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April 18, 2018



## Version

| Version No. | Date           | Description                                                                                                                                         |
|-------------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| V1.0        | April 18, 2018 | Original                                                                                                                                            |
| V2.0        | April 18, 2018 | <ol style="list-style-type: none"> <li>1. Add 5.9 section on page 45</li> <li>2. Revised Power limit on page 14 and PSD limit on page 19</li> </ol> |



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## 1. GENERAL INFORMATION

### 1.1 CLIENT INFORMATION

|                                 |                                                   |
|---------------------------------|---------------------------------------------------|
| <b>Applicant:</b>               | SMART Technologies Inc.                           |
| <b>Address of Applicant:</b>    | 3636 Research Road NW Calgary, AB T2L 1Y1, Canada |
| <b>Manufacturer:</b>            | SMART Technologies Inc.                           |
| <b>Address of Manufacturer:</b> | 3636 Research Road NW Calgary, AB T2L 1Y1, Canada |

### 1.2 EUT INFORMATION

#### 1.2.1 General Description of EUT

|                               |                                                     |                      |                   |
|-------------------------------|-----------------------------------------------------|----------------------|-------------------|
| <b>Product Name:</b>          | WIFI Module                                         |                      |                   |
| <b>Model No.:</b>             | RL-UM02SPC-8812BU-V1.0                              |                      |                   |
| <b>Add. Model No.:</b>        | N/A                                                 |                      |                   |
| <b>Trade Mark:</b>            | RF-LINK                                             |                      |                   |
| <b>DUT Stage:</b>             | Identical Prototype                                 |                      |                   |
| <b>EUT Supports Function:</b> | 2.4 GHz ISM Band:                                   | IEEE 802.11b/g/n     |                   |
|                               | 5 GHz U-NII Bands:                                  | 5150 MHz to 5250 MHz | IEEE 802.11a/n/ac |
|                               |                                                     | 5250 MHz to 5350 MHz | IEEE 802.11a/n/ac |
|                               |                                                     | 5470 MHz to 5600 MHz | IEEE 802.11a/n/ac |
|                               |                                                     | 5650 MHz to 5725 MHz | IEEE 802.11a/n/ac |
| <b>Software Version:</b>      | RL-UM02SPC-8812BU-V1.0                              |                      |                   |
| <b>Hardware Version:</b>      | rtl88x2bu v5.2.4.5_26498.20180205_COEX20171012-5044 |                      |                   |
| <b>Sample Received Date:</b>  | February 1, 2018                                    |                      |                   |
| <b>Sample Tested Date:</b>    | February 2, 2018 to March 16, 2018                  |                      |                   |

#### 1.2.2 Description of Accessories

None.

### 1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

|                            |                                                                                                                                                                                                       |                |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| <b>Frequency Range:</b>    | 2400 MHz to 2483.5 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 MCS15<br>IEEE 802.11n-HT40: Up to MCS15                                                                        |                |
| <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>       | Chain 0                                                                                                                                                                                               | Dipole Antenna |
|                            | Chain 1                                                                                                                                                                                               | Dipole Antenna |
| <b>Antenna Gain:</b>       | Chain 0                                                                                                                                                                                               | 5.03 dBi       |
|                            | Chain 1                                                                                                                                                                                               | 5.03 dBi       |

|                             |                 |                                                              |
|-----------------------------|-----------------|--------------------------------------------------------------|
| <b>Directional gain:</b>    | 8.04 dBi        |                                                              |
| <b>Maximum Peak Power:</b>  | STBC_ Chain 0+1 | IEEE 802.11b: 13.82dBm                                       |
|                             | CCD_ Chain 0+1  | IEEE 802.11g: 21.20 dBm                                      |
|                             | MIMO_ Chain 0+1 | IEEE 802.11n-HT20: 18.99 dBm<br>IEEE 802.11n-HT40: 20.58 dBm |
| <b>Normal Test Voltage:</b> | 3.3 Vdc         |                                                              |

## 1.4 OTHER INFORMATION

| Operation Frequency Each of Channel           |           |         |           |         |           |         |           |
|-----------------------------------------------|-----------|---------|-----------|---------|-----------|---------|-----------|
| IEEE 802.11b, IEEE 802.11g, IEEE 802.11n-HT20 |           |         |           |         |           |         |           |
| Channel                                       | Frequency | Channel | Frequency | Channel | Frequency | Channel | Frequency |
| 1                                             | 2412 MHz  | 4       | 2427 MHz  | 7       | 2442 MHz  | 10      | 2457 MHz  |
| 2                                             | 2417 MHz  | 5       | 2432 MHz  | 8       | 2447 MHz  | 11      | 2462 MHz  |
| 3                                             | 2422 MHz  | 6       | 2437 MHz  | 9       | 2452 MHz  | --      | --        |
| IEEE 802.11n-HT40                             |           |         |           |         |           |         |           |
| --                                            | --        | 4       | 2427 MHz  | 7       | 2442 MHz  | --      | --        |
| --                                            | --        | 5       | 2432 MHz  | 8       | 2447 MHz  | --      | --        |
| 3                                             | 2422 MHz  | 6       | 2437 MHz  | 9       | 2452 MHz  | --      | --        |

## 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  |
| --          | --           | --        | --            | --          |

### 2) Support Cable

| Cable No. | Description       | Connector | Length     | Supplied by |
|-----------|-------------------|-----------|------------|-------------|
| 1         | Antenna Cable * 2 | 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  
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Fax: +86 (0) 755 2823 0886

### 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

Tel: +86-755-28230888

Fax: +86-755-28230886

E-mail: info@uttlab.com

[Http://www.uttlab.com](http://www.uttlab.com)

## 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.: 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.

**Compliance Certification Services (Shenzhen) Inc.**

FCC Registration Number is 441872.

IC Registration Number is 2324I-2.

## 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  | ±3.2878 dB              |
| 2   | Conducted emission 150KHz-30MHz | ±3.2878 dB              |
| 3   | Radiated emission 30MHz-200Hz   | ±3.8928 dB              |
| 4   | Radiated emission 200MHz-1GHz   | ±3.8753 dB              |
| 5   | Radiated emission 1GHz-8GHz     | ±5.3112 dB              |
| 6   | Radiated emission Above 8GHz    | ±5.3493 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) | ANSI C63.10-2013                 | PASS       |
| AC Power Line Conducted Emission                                                                        | FCC 47 CFR Part 15 Subpart C Section 15.207            | ANSI C63.10-2013                 | N/A NOTE 2 |
| Conducted Peak Output Power                                                                             | FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(3)     | KDB 558074 D01 v04 Section 9.1.3 | PASS       |
| 6dB Bandwidth                                                                                           | FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(2)     | KDB 558074 D01 v04 Section 8.1   | PASS       |
| Occupied Bandwidth                                                                                      | RSS-Gen section 6.6                                    | RSS-Gen section 6.6              | PASS       |
| Power Spectral Density                                                                                  | FCC 47 CFR Part 15 Subpart C Section 15.247 (e)        | KDB 558074 D01 v04 Section 10.2  | PASS       |
| Conducted Out of Band Emission                                                                          | FCC 47 CFR Part 15 Subpart C Section 15.247(d)         | KDB 558074 D01 v04 Section 11    | PASS       |
| Radiated Spurious Emissions                                                                             | FCC 47 CFR Part 15 Subpart C Section 15.205/15.209     | KDB 558074 D01 v04 Section 12.1  | PASS       |
| Band Edge Measurements (Radiated)                                                                       | FCC 47 CFR Part 15 Subpart C Section 15.205/15.209     | KDB 558074 D01 v04 Section 12.1  | PASS       |
| <b>Note:</b><br>1) N/A: In this whole report not application.<br>2) This EUT is powered by DC form PCB. |                                                        |                                  |            |

### 3. EQUIPMENT LIST

| Radiated Emission Test Equipment List (3M Chamber) |                                  |              |           |                            |                         |                             |
|----------------------------------------------------|----------------------------------|--------------|-----------|----------------------------|-------------------------|-----------------------------|
| 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"/>                | EXA Spectrum Analyzer            | KEYSIGHT     | N9010A    | MY51440197                 | Dec.10, 2017            | Dec. 10, 2018               |
| <input checked="" type="checkbox"/>                | Loop Antenna                     | ETS-LINDGREN | 6502      | 00202525                   | Dec. 17, 2017           | Dec. 17, 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                   | Dec. 17, 2017           | Dec. 17, 2018               |
| <input checked="" type="checkbox"/>                | Horn Antenna                     | ETS-LINDGREN | 3116C     | 00200180                   | Jul. 28, 2015           | Jul. 27, 2018               |
| <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"/>                | 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 checked="" 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 (V) | Relative Humidity (%) |
| NT/NV                                                           | +15 to +35                   | 3.3         | 20 to 75              |
| <b>Remark:</b><br>1) NV: Normal Voltage; NT: Normal Temperature |                              |             |                       |

### 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 6 | Channel 11 |
|                   |                      | 2412 MHz              | 2437 MHz  | 2462 MHz   |
| IEEE 802.11g      | 2412 MHz to 2462 MHz | Channel 1             | Channel 6 | Channel 11 |
|                   |                      | 2412 MHz              | 2437 MHz  | 2462 MHz   |
| IEEE 802.11n-HT20 | 2412 MHz to 2462 MHz | Channel 1             | Channel 6 | Channel 11 |
|                   |                      | 2412 MHz              | 2437 MHz  | 2462 MHz   |
| IEEE 802.11n-HT40 | 2422 MHz to 2452 MHz | Channel 3             | Channel 6 | Channel 9  |
|                   |                      | 2422 MHz              | 2437 MHz  | 2452 MHz   |

### 4.3 EUT TEST STATUS

| Mode                                   | Tx/Rx Function | Description                                                                            |
|----------------------------------------|----------------|----------------------------------------------------------------------------------------|
| IEEE 802.11b<br>IEEE 802.11g           | 1Tx/1Rx        | 1. Keep the EUT in continuously transmitting or receiving with modulation test single. |
| IEEE 802.11n-HT20<br>IEEE 802.11n-HT40 | 2Tx/2Rx        |                                                                                        |

## 4.4 PRE-SCAN

### 4.4.1 Pre-scan under all rates

| Mode and Frequency            | Maximum Conducted Average Power (dBm)_Chain 0 |      |       |       |       |       |       |       |
|-------------------------------|-----------------------------------------------|------|-------|-------|-------|-------|-------|-------|
|                               | 1                                             |      | 2     |       | 5.5   |       | 11    |       |
| IEEE 802.11b<br>2437 MHz      | <b>8.45</b>                                   |      | 8.34  |       | 8.27  |       | 8.11  |       |
| IEEE 802.11g<br>2437 MHz      | 6                                             | 9    | 12    | 18    | 24    | 36    | 48    | 54    |
|                               | <b>7.92</b>                                   | 7.84 | 7.78  | 7.56  | 7.09  | 6.98  | 6.89  | 6.82  |
| IEEE 802.11n-HT20<br>2437 MHz | MCS0                                          | MCS1 | MCS2  | MCS3  | MCS4  | MCS5  | MCS6  | MCS7  |
|                               | <b>6.38</b>                                   | 6.11 | 5.97  | 5.82  | 5.78  | 5.48  | 5.41  | 5.36  |
|                               | MCS8                                          | MCS9 | MCS10 | MCS11 | MCS12 | MCS13 | MCS14 | MCS15 |
|                               | <b>5.33</b>                                   | 5.44 | 5.41  | 5.68  | 5.43  | 5.88  | 5.72  | 5.49  |
| IEEE 802.11n-HT40<br>2437 MHz | MCS0                                          | MCS1 | MCS2  | MCS3  | MCS4  | MCS5  | MCS6  | MCS7  |
|                               | <b>8.61</b>                                   | 8.56 | 8.46  | 7.89  | 7.94  | 7.90  | 7.83  | 7.78  |
|                               | MCS8                                          | MCS9 | MCS10 | MCS11 | MCS12 | MCS13 | MCS14 | MCS15 |
|                               | 7.71                                          | 6.67 | 6.42  | 6.33  | 6.12  | 6.10  | 6.05  | 6.01  |

### 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

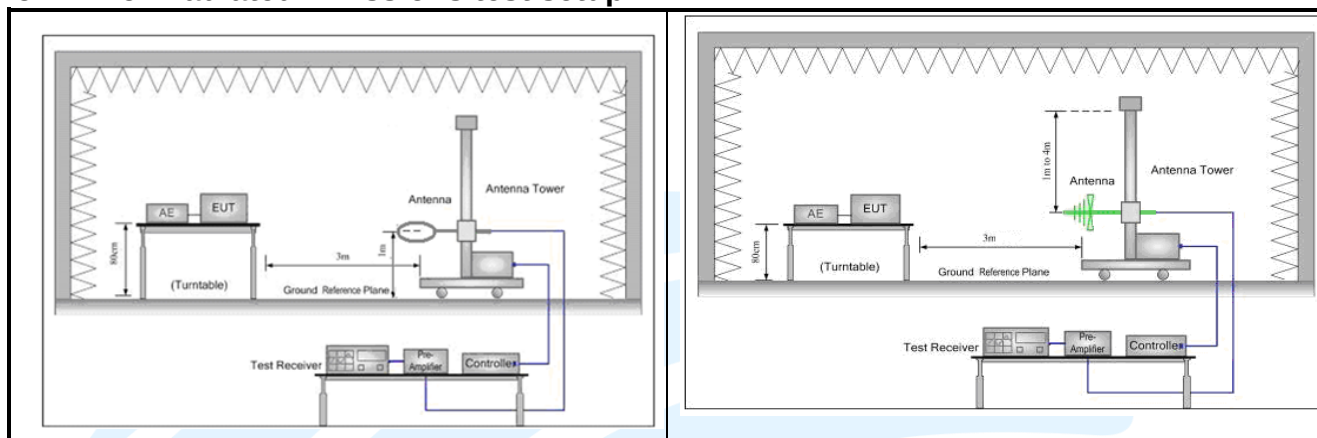


Figure 1. Below 30MHz

Figure 2. 30MHz to 1GHz

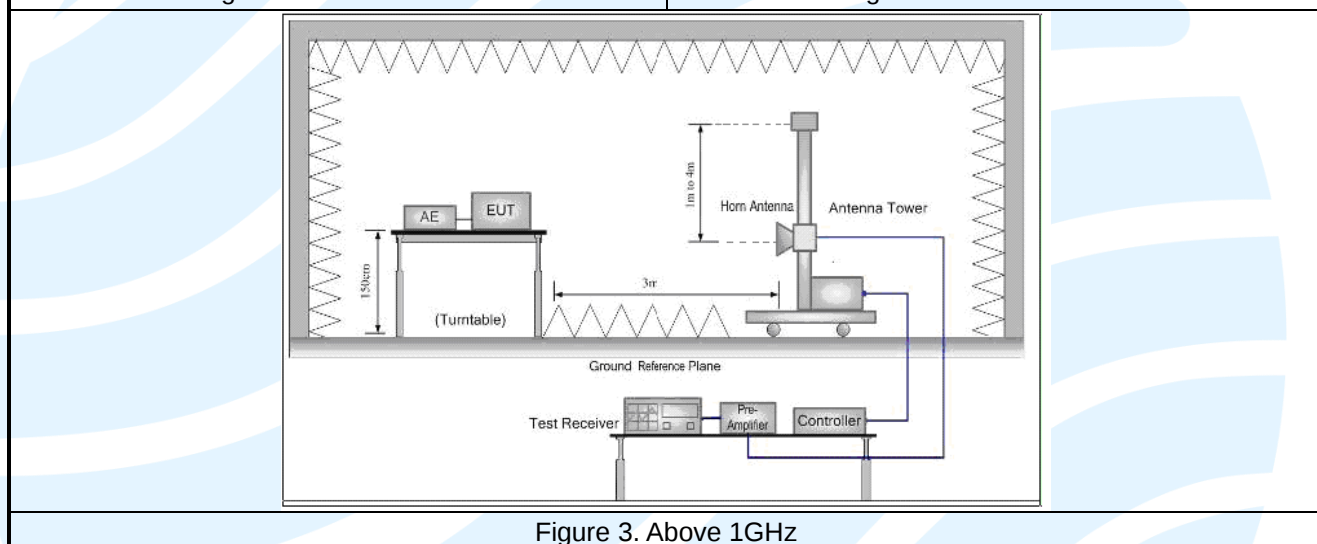


Figure 3. Above 1GHz

### 4.5.2 For Conducted Emissions test setup

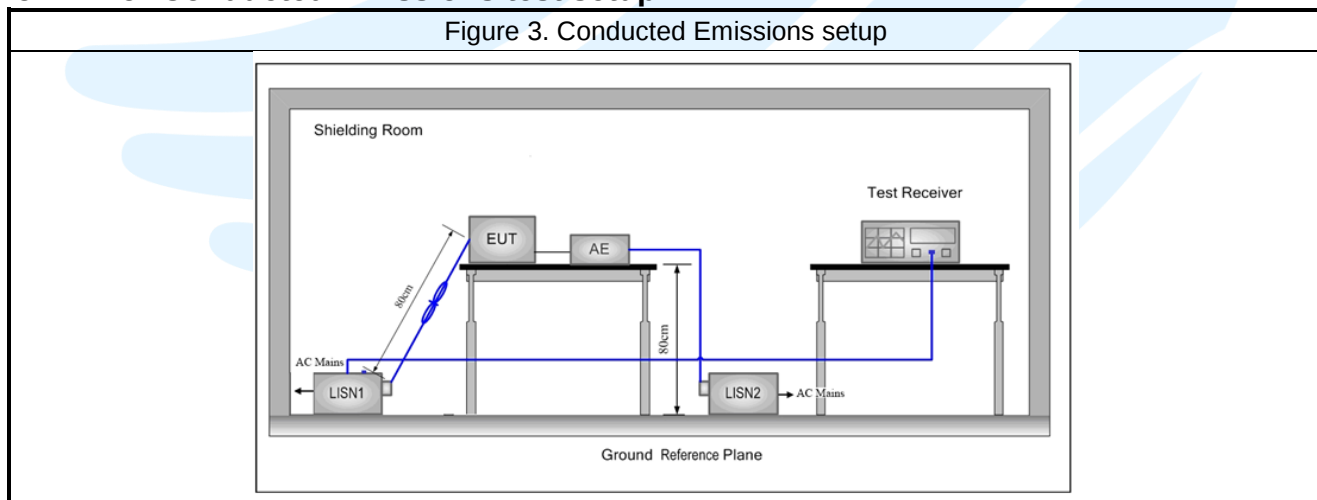
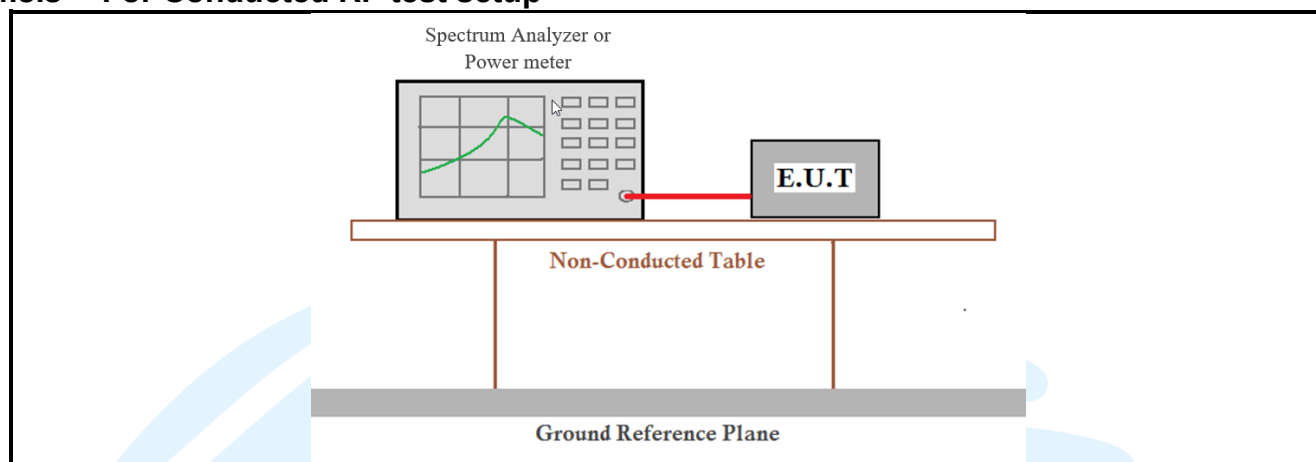


Figure 3. Conducted Emissions setup

#### 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 a 3.3Vdc. 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                      |
|            | 1TX  | Chain 1      | Y axis                      |
|            | 2TX  | Chain 0+1    | 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

The EUT working with 100% duty cycle of continuous transmit for tested

## 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   | ANSI C63.10-2013                                  | American National Standard for Testing Unlicensed Wireless Devices                                            |
| 4   | KDB 558074 D01 DTS Meas Guidance v04              | Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 |
| 5   | KDB 662911 D01 Multiple Transmitter Output v02r01 | Emissions Testing of Transmitters with Multiple Outputs in the Same Band                                      |

### 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>EUT Antenna:</b><br/>Both antenna in the interior of the equipment and no consideration of replacement. The transmit signals are correlated with each other and the antenna gain of both chains is completely consistent, the best case directional gain of the antenna is <b>8.04 dBi</b> (See section 5.3).</p> |

### 5.3 CONDUCTED PEAK OUTPUT POWER

**Test Requirement:** FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(3)

**Test Method:** KDB 558074 D01 v04, Section 9.1.3

**Limit:** For DTSSs employing digital modulation techniques operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. The e.i.r.p. shall not exceed 4 W

**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 4.4.3 for details.

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

**Test Mode:** Transmitter mode

**Test Results:** Pass

**The worst case test data:**

**For maximum peak conducted output power**

| Mode                            | Channel/<br>Frequency<br>(MHz) | Maximum peak conducted power (dBm) |         |                          |                |             |
|---------------------------------|--------------------------------|------------------------------------|---------|--------------------------|----------------|-------------|
|                                 |                                | Chain 0                            | Chain 1 | Total Power<br>Chain 0+1 | Limit<br>(dBm) | Pass / Fail |
| IEEE 802.11b<br>(STBC)          | 1(2412)                        | 9.82                               | 10.91   | 13.41                    | 27.96          | Pass        |
|                                 | 6(2437)                        | 10.34                              | 11.23   | 13.82                    | 27.96          | Pass        |
|                                 | 11(2462)                       | 10.43                              | 10.93   | 13.70                    | 27.96          | Pass        |
| IEEE 802.11g<br>(CCD)           | 1(2412)                        | 17.68                              | 18.23   | 20.97                    | 27.96          | Pass        |
|                                 | 6(2437)                        | 17.21                              | 18.54   | 20.94                    | 27.96          | Pass        |
|                                 | 11(2462)                       | 17.68                              | 18.65   | 21.20                    | 27.96          | Pass        |
| IEEE 802.11n-<br>HT20<br>(MIMO) | 1(2412)                        | 15.22                              | 15.46   | 18.35                    | 27.96          | Pass        |
|                                 | 6(2437)                        | 15.34                              | 16.03   | 18.71                    | 27.96          | Pass        |
|                                 | 11(2462)                       | 16.32                              | 15.61   | 18.99                    | 27.96          | Pass        |
| IEEE 802.11n-<br>HT40<br>(MIMO) | 3(2422)                        | 17.03                              | 17.39   | 20.22                    | 27.96          | Pass        |
|                                 | 6(2437)                        | 17.34                              | 17.79   | 20.58                    | 27.96          | Pass        |
|                                 | 9(2452)                        | 16.34                              | 17.22   | 19.81                    | 27.96          | Pass        |

Remark:

1. Total (Chain 0+1) =  $10 \cdot \log[(10^{\text{Chain 0/10}}) + (10^{\text{Chain 1/10}})]$

2. Directional gain and the maximum peak conducted power limit see table below:

| Frequency Band            | Chain 0 Antenna<br>Gain (dBi) | Chain 1 Antenna<br>Gain (dBi) | Correlated chains<br>directional gain<br>(dBi) | Peak Power Limit<br>(dBm) |
|---------------------------|-------------------------------|-------------------------------|------------------------------------------------|---------------------------|
| 2400 MHz to 2483.5<br>MHz | 5.03                          | 5.03                          | 8.04                                           | 27.96                     |

Basic methodology with  $N_{ANT}$  transmit antennas, each with the same directional gain  $G_{ANT}$  dBi, being driven by  $N_{ANT}$  transmitter outputs of equal power. Directional gain is to be computed as follows:

If any transmit signals are *correlated* with each other,

$$\text{Directional gain} = G_{ANT} + 10 \log(N_{ANT}) \text{ dBi}$$

## 5.46 DB BANDWIDTH & OCCUPIED BANDWIDTH

**Test Requirement:** FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(2)

**Test Method:** KDB 558074 D01 v04, Section 8.1

**Limit:** For direct sequence systems, the minimum 6dB bandwidth shall be at least 500kHz

**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:  
a) Set RBW = 100 kHz.  
b) Set the video bandwidth (VBW)  $\geq 3 \times$  RBW.  
c) Detector = Peak.  
d) Trace mode = max hold.  
e) Sweep = auto couple.  
f) Allow the trace to stabilize.  
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.

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

**Test Setup:** Refer to section 4.4.3 for details.

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

**Test Mode:** Transmitter mode

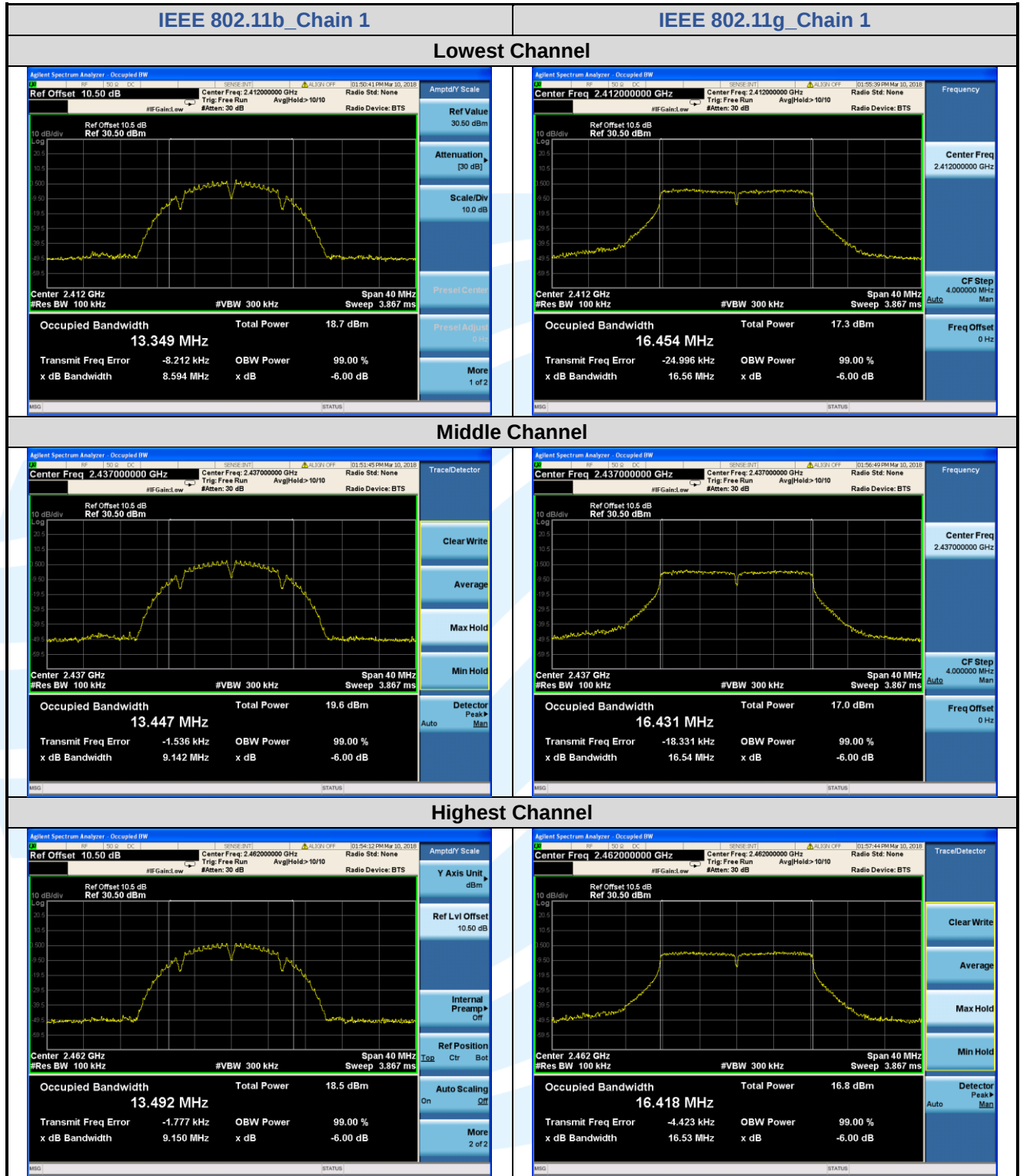
**Test Results:** Pass

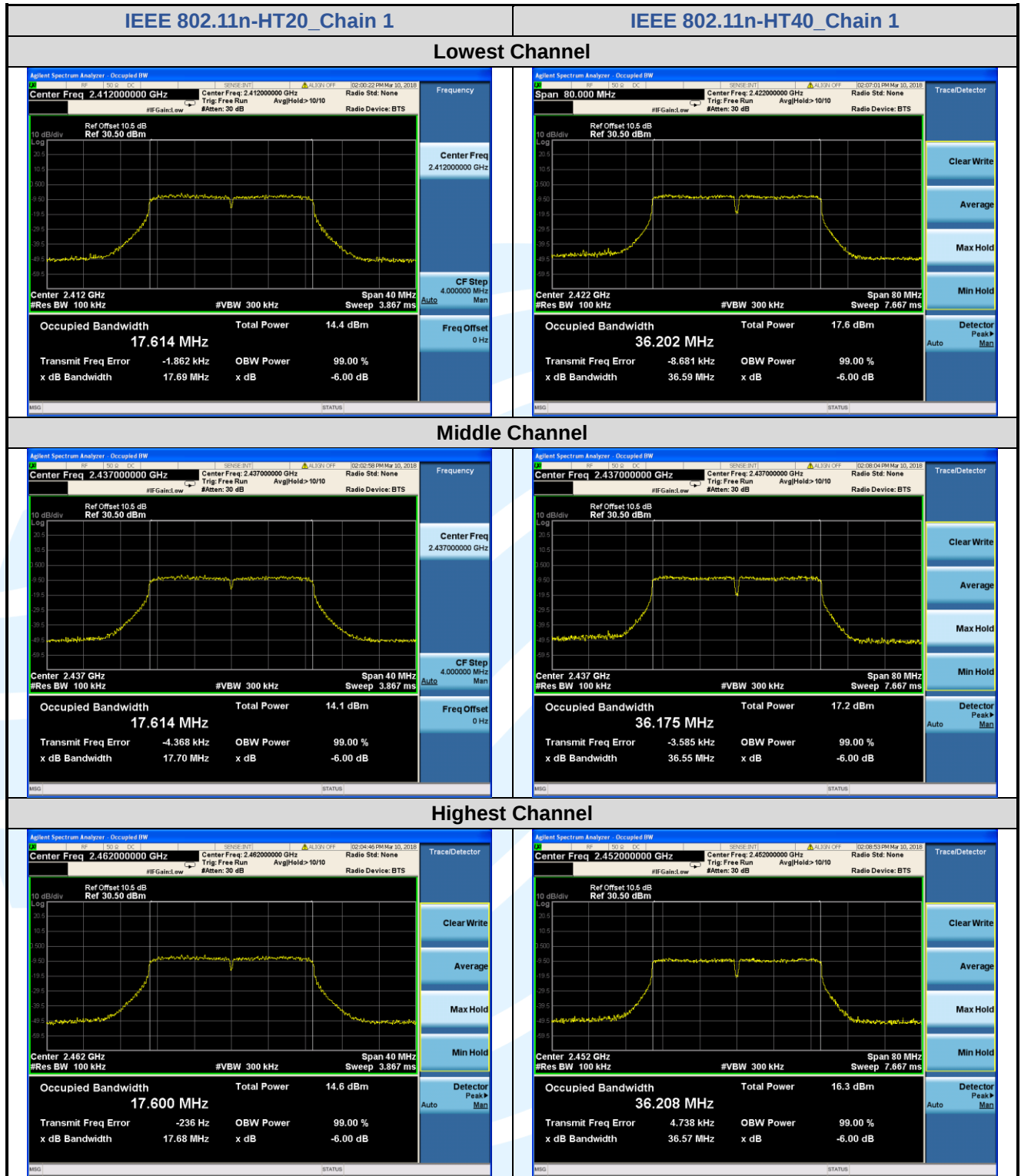
### The worst case test data:

| 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<br>STBC_Chain 1      | 1(2412)                        | 8.594                      | 13.349                    | > 500 kHz                  | Pass        |
|                                   | 6(2437)                        | 9.142                      | 13.447                    | > 500 kHz                  | Pass        |
|                                   | 11(2462)                       | 9.150                      | 13.492                    | > 500 kHz                  | Pass        |
| IEEE 802.11g<br>CDD_Chain 1       | 1(2412)                        | 16.560                     | 16.454                    | > 500 kHz                  | Pass        |
|                                   | 6(2437)                        | 16.540                     | 16.431                    | > 500 kHz                  | Pass        |
|                                   | 11(2462)                       | 16.530                     | 16.418                    | > 500 kHz                  | Pass        |
| IEEE 802.11n-HT20<br>MIMO_Chain 1 | 1(2412)                        | 17.690                     | 17.614                    | > 500 kHz                  | Pass        |
|                                   | 6(2437)                        | 17.700                     | 17.614                    | > 500 kHz                  | Pass        |
|                                   | 11(2462)                       | 17.680                     | 17.600                    | > 500 kHz                  | Pass        |
| IEEE 802.11n-HT40<br>MIMO_Chain 1 | 3(2422)                        | 36.590                     | 36.202                    | > 500 kHz                  | Pass        |
|                                   | 6(2437)                        | 36.550                     | 36.175                    | > 500 kHz                  | Pass        |
|                                   | 9(2452)                        | 36.570                     | 36.208                    | > 500 kHz                  | Pass        |

The test plot as follows:

The worst case test data:





## 5.5 POWER SPECTRAL DENSITY

**Test Requirement:** FCC 47 CFR Part 15 Subpart C Section 15.247 (e)

**Test Method:** KDB 558074 D01 v04, Section 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:

- 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:  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ .
- d) Set the VBW  $\geq 3 \times \text{RBW}$ .
- 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.
- j) 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 4.4.3 for details.

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

**Test Mode:** Transmitter mode

**Test Results:** Pass

#### The worst case test data:

| Mode                            | Channel/<br>Frequency<br>(MHz) | Power spectral density (dBm) |         |                          |                      | Pass / Fail |
|---------------------------------|--------------------------------|------------------------------|---------|--------------------------|----------------------|-------------|
|                                 |                                | Chain 0                      | Chain 1 | Total Power<br>Chain 0+1 | Limit @3kHz<br>(dBm) |             |
| IEEE 802.11b<br>(STBC)          | 1(2412)                        | -22.60                       | -21.52  | -19.02                   | 5.96                 | Pass        |
|                                 | 6(2437)                        | -21.76                       | -18.25  | -16.65                   | 5.96                 | Pass        |
|                                 | 11(2462)                       | -22.77                       | -16.94  | -15.93                   | 5.96                 | Pass        |
| IEEE 802.11g<br>(CDD)           | 1(2412)                        | -22.67                       | -18.59  | -17.16                   | 5.96                 | Pass        |
|                                 | 6(2437)                        | -22.88                       | -18.50  | -17.15                   | 5.96                 | Pass        |
|                                 | 11(2462)                       | -22.63                       | -17.13  | -16.05                   | 5.96                 | Pass        |
| IEEE 802.11n-<br>HT20<br>(MIMO) | 1(2412)                        | -23.65                       | -20.26  | -18.62                   | 5.96                 | Pass        |
|                                 | 6(2437)                        | -24.33                       | -20.10  | -18.71                   | 5.96                 | Pass        |
|                                 | 11(2462)                       | -23.55                       | -19.38  | -17.97                   | 5.96                 | Pass        |
| IEEE 802.11n-<br>HT40<br>(MIMO) | 3(2422)                        | -23.23                       | -17.96  | -16.83                   | 5.96                 | Pass        |
|                                 | 6(2437)                        | -21.87                       | -19.04  | -17.22                   | 5.96                 | Pass        |
|                                 | 9(2452)                        | -23.29                       | -18.72  | -17.42                   | 5.96                 | Pass        |

#### Remark:

1. Power with Duty Factor = Measured Power + Duty Cycle Factor
2. Total (Chain 0+1) =  $10 \cdot \log[(10^{\text{Chain 0/10}}) + (10^{\text{Chain 1/10}})]$
3. Directional gain and the maximum conducted power spectral density limit see table below:

| Frequency Band            | Chain 0 Antenna<br>Gain (dBi) | Chain 1 Antenna<br>Gain (dBi) | Correlated chains<br>directional gain<br>(dBi) | Peak Power Limit<br>(dBm) |
|---------------------------|-------------------------------|-------------------------------|------------------------------------------------|---------------------------|
| 2400 MHz to 2483.5<br>MHz | 5.03                          | 5.03                          | 8.04                                           | 5.96                      |

Basic methodology with  $N_{ANT}$  transmit antennas, each with the same directional gain  $G_{ANT}$  dBi, being driven by  $N_{ANT}$  transmitter outputs of equal power. Directional gain is to be computed as follows:

If any transmit signals are *correlated* with each other,

$$\text{Directional gain} = G_{ANT} + 10 \log(N_{ANT}) \text{ dBi}$$

The test plot as follows:

