



## Electromagnetic Compatibility Test Report

Tests Performed on a Latchable, Inc.

Entry Security System, Model R2

Radiometrics Document RP-9194A



*Product Detail:*

FCC ID: 2AK5B-R2

IC: 22134-R2

Equipment type: Low power transmitter

*Test Standards:*

US CFR Title 47, Chapter I, FCC Part 15 Subpart C

FCC Part 15 CFR Title 47: 2017

Canada ISED; RSS-210, Issue 10: 2019 as required for Category I Equipment

Canada ISED; RSS-247, Issue 2

IC RSS-GEN Issue 5: 2018

This report concerns: Original Grant for Certification

FCC Part 15.247, 15.209 & 15.249

*Tests Performed For:*

**Latchable, Inc.**

450 West 33rd Street

New York, NY 10001

*Test Facility:*

**Radiometrics Midwest Corporation**

12 Devonwood Avenue

Romeoville, IL 60446-1349

(815) 293-0772

*Test Date(s):*

November 21, 2019 to January 10, 2020

Document RP-9194A Revisions:

| Rev. | Issue Date        | Revised By        |
|------|-------------------|-------------------|
| 0    | February 5, 2020  |                   |
| 1    | February 18, 2020 | Joseph Strzelecki |
|      |                   |                   |

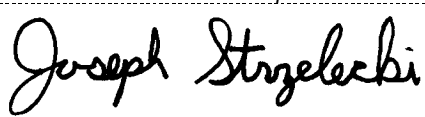


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**1.0 ADMINISTRATIVE DATA**

|                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| <i>Equipment Under Test:</i><br>A Latchable, Inc., Entry Security System<br>Model: R2<br>This will be referred to as the EUT in this Report                                                                                                                                                                                                                             |                                                                                                      |
| <i>Date EUT Received at Radiometrics:</i><br>November 21, 2019                                                                                                                                                                                                                                                                                                          | <i>Test Date(s):</i><br>November 21, 2019 to January 10, 2020                                        |
| <i>Test Report Written and Authorized By:</i><br>Joseph Strzelecki<br>Senior EMC Engineer                                                                                                                                                                                                                                                                               | <i>Test Witnessed By:</i><br>The tests were not witnessed by personnel from Latchable, Inc..         |
| <i>Radiometrics' Personnel Responsible for Test:</i><br><br><br>02/05/2020<br>Date<br><br>Joseph Strzelecki<br>Senior EMC Engineer<br>NARTE EMC-000877-NE<br><br>Chris D'Alessio<br>EMC Technician<br><br>Dave Jarvis<br>EMC Technician<br><br>Richard L. Tichgelaar<br>EMC Technician | <i>EUT Checked By:</i><br><br>Joseph Strzelecki<br>Richard Tichgelaar<br>Dave Jarvis<br>Radiometrics |

**2.0 TEST SUMMARY AND RESULTS**

The EUT (Equipment Under Test) is an Entry Security System, Model R2, manufactured by Latchable, Inc.. The detailed test results are presented in a separate section. The following is a summary of the test results.

**Wi-Fi Test Results**

| Environmental Phenomena                        | Frequency Range  | FCC Section | RSS- Section           | Test Result |
|------------------------------------------------|------------------|-------------|------------------------|-------------|
| RF AC Mains Conducted Emissions                | 0.15 - 30 MHz    | 15.207      | RSS-GEN; 8.8           | Pass        |
| 6 dB Bandwidth Test                            | 2400 to 2483 MHz | 15.247 a    | RSS-247; 5.2a          | Pass        |
| Peak Output Power                              | 2400 to 2483 MHz | 15.247 b    | RSS-247; 5.4           | Pass        |
| Band-edge Compliance of RF Conducted Emissions | 2400 to 2483 MHz | 15.247 d    | RSS-247; 5.5           | Pass        |
| Spurious Radiated Emissions                    | 30 MHz to 25 GHz | 15.247 d    | RSS-247; 5.5 & RSS-GEN | Pass        |
| Power Spectral Density                         | 2400 to 2483 MHz | 15.247 e    | RSS-247; 5.2           | Pass        |

**Bluetooth Results**

| Environmental Phenomena                               | Frequency Range   | RSS Spec | RSS section | FCC Section | Test Result |
|-------------------------------------------------------|-------------------|----------|-------------|-------------|-------------|
| All RF Radiated Emissions<br>Fundamental and Spurious | 30-25,000 MHz     | RSS-210  | B.10        | 15.249      | Pass        |
| Conducted Emissions, AC Mains                         | 0.15 - 30 MHz     | RSS-Gen  | 8.8         | 15.249      | Pass        |
| Occupied Bandwidth Test                               | Fundamental Freq. | RSS-Gen  | 6.6         | 15.249      | Pass        |

**Unintentional Emissions Tests Results**

| Environmental Phenomena       | Frequency Range | Basic Standard           | Test Result |
|-------------------------------|-----------------|--------------------------|-------------|
| RF Radiated Emissions         | 30-12,500 MHz   | RSS-Gen &<br>FCC Part 15 | Pass        |
| Conducted Emissions, AC Mains | 0.15 - 30 MHz   | RSS-Gen &<br>FCC Part 15 | Pass        |

**13.56 MHz RFID results**

| Environmental Phenomena       | Frequency Range | Test Result |
|-------------------------------|-----------------|-------------|
| RF Radiated Emissions         | 30-1000 MHz     | Pass        |
| RF Radiated Emissions H-Field | 0.009 – 30 MHz  | Pass        |
| Occupied Bandwidth            | 13.56 MHz       | Pass        |

The 13.56 MHz met the general limits of 15.209, so temperature stability tests were not performed. Both Bluetooth transmitters met the FCC 15.249 results.

**IEC 17025 Decision Rule:**

The declaration of pass or fail is based on the specifications listed above. The declaration of pass or fail did not consider measurement uncertainty.

**3.0 EQUIPMENT UNDER TEST (EUT) DETAILS****3.1 EUT Description**

The EUT is an Entry Security System, Model R2, manufactured by Latchable, Inc. The EUT was in good working condition during the tests, with no known defects.

**3.1.1 FCC Section 15.203 & RSS-GEN Antenna Requirements**

The antennas are permanently attached to the printed circuit board. The antenna is internal to the EUT and it is not readily available to be modified by the end user. Therefore, it meets the 15.203 Requirements.

Since the measurements at the antenna port are used to determine the RF output power, RSS-GEN section 6.8 requires that the effective gain of the products antenna be stated, based on a measurement or on data from the antenna's manufacturer.



## 4.0 TESTED SYSTEM DETAILS

### 4.1 Tested System Configuration

The system was configured for testing in a typical fashion. The EUT was placed on an 80-cm or 150 cm high, nonconductive test stand. The testing was performed in conditions as close as possible to installed conditions. Wiring was consistent with manufacturer's recommendations. Since the EUT is wall or door mounted, it was placed in an upright configuration during the tests. The EUT was tested as a stand-alone device. Power was supplied at 120 VAC, 60 Hz single-phase to its external power supply.

The identification for all equipment, plus descriptions of all cables used in the tested system, are:

#### Tested System Configuration List

| Item | Description           | Type* | Manufacturer         | Model Number | Serial Number |
|------|-----------------------|-------|----------------------|--------------|---------------|
| 1    | Entry Security System | E     | Latchable, Inc.      | R2           | None          |
| 2    | AC-DC Power Supply    |       | SL Power Electronics | TE30A1203B01 | None          |
| 3    | Router                | P     | Dynex                | DX-GB8PRT    | 10K22B16124   |

\* Type: E = EUT, P = Peripheral, S = Support Equipment; H = Host Computer

#### List of System Cables

| QTY | Length (m) | Cable Description                     | Shielded? |
|-----|------------|---------------------------------------|-----------|
| 1   | 1.8        | DC Cord from power supply to EUT (R2) | No        |
| 1   | 1.3        | Ethernet cable to router              | No        |
| 1   | 1.0        | Output cable                          | No        |

### 4.2 EUT Operating Modes

#### WiFi Tests:

| Environmental Phenomena       | Channels Tested | Mode    | Data Mbps | Notes  |
|-------------------------------|-----------------|---------|-----------|--------|
| Bandwidth Test                | 1, 6, 11        | 802.11b | 1.0       |        |
| Bandwidth Test                | 1, 6, 11        | 802.11g | 6.0       |        |
| Bandwidth Test                | 1, 6, 11        | 802.11n | 6.5       |        |
| Peak Output Power             | 1, 6, 11        | 802.11b | 1.0       |        |
| Peak Output Power             | 1, 6, 11        | 802.11g | 6.0       |        |
| Peak Output Power             | 1, 6, 11        | 802.11n | 6.5       |        |
| Band-edge Conducted Emissions | 1, 6, 11        | 802.11b | 1.0       |        |
| Band-edge                     | 1, 6, 11        | 802.11g | 6.0       |        |
| Band-edge                     | 1, 6, 11        | 802.11n | 6.5       |        |
| RF Conducted Emissions        | 1, 6, 11        | 802.11b | 1.0       |        |
| RF Conducted Emissions        | 1, 6, 11        | 802.11g | 6.0       |        |
| RF Conducted Emissions        | 1, 6, 11        | 802.11n | 6.5       |        |
| Radiated Emissions            | 1, 6, 11        | 802.11b | 1.0       |        |
| Radiated Emissions            | 1, 6, 11        | 802.11g | 6.0       |        |
| Radiated Emissions            | 1, 6, 11        | 802.11n | 6.5       |        |
| Power Spectral Density        | 1, 6, 11        | 802.11b | 1.0       |        |
| Power Spectral Density        | 1, 6, 11        | 802.11g | 6.0       |        |
| Power Spectral Density        | 1, 6, 11        | 802.11n | 6.5       |        |
| Conducted Emissions, AC Mains | 6               | 802.11b | 1.0       | Note 1 |

Note 1: During preliminary testing, 802.11b mode, Channel 6 was found to be worst cast for this test.



The transmit mode for all transmitter tests was continuous. The continuous mode produces a Duty cycle of at least 98%.

**Bluetooth testing:**

The EUT was transmitting continuously with its maximum duty cycle.

**13.56 MHz testing:**

The EUT was transmitting continuously with its maximum duty cycle.

### 4.3 Special Accessories

No special accessories were used during the tests in order to achieve compliance.

### 4.4 Equipment Modifications

No modifications were made to the EUT at Radiometrics' test facility in order to comply with the standards listed in this report.

## 5.0 TEST SPECIFICATIONS

| Document               | Date | Title                                                                                                                        |
|------------------------|------|------------------------------------------------------------------------------------------------------------------------------|
| FCC<br>CFR Title 47    | 2018 | Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15 - Radio Frequency Devices        |
| IC RSS-210<br>Issue 10 | 2019 | Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands) Category I Equipment                               |
| IC RSS-247<br>Issue 2  | 2017 | Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices |
| IC RSS-Gen<br>Issue 5  | 2019 | General Requirements and Information for the Certification of Radiocommunication Equipment (RSS-Gen)                         |

## 6.0 TEST PROCEDURE DOCUMENTS

The tests were performed using the procedures from the following specifications:

| Document                           | Date | Title                                                                                                                                |
|------------------------------------|------|--------------------------------------------------------------------------------------------------------------------------------------|
| ANSI<br>C63.4-2014                 | 2014 | Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |
| ANSI<br>C63.10-2013                | 2013 | American National Standard for Testing Unlicensed Wireless Devices                                                                   |
| 558074 D01<br>DTS Meas<br>Guidance | 2019 | Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247; v05r02                |



## 7.0 RADIOMETRICS' TEST FACILITIES

The results of these tests were obtained at Radiometrics Midwest Corp. in Romeoville, Illinois, USA. Radiometrics is accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025: 2005 "General Requirements for the Competence of Calibration and Testing Laboratories". Radiometrics' Lab Code is 121191 and Certification Number is 1495.01. Radiometrics' scope of accreditation includes all of the test methods listed herein. A copy of the accreditation can be accessed on our web site ([www.radiomet.com](http://www.radiomet.com)). Radiometrics accreditation status can be verified at A2LA's web site ([www.a2la2.org](http://www.a2la2.org)).

The following is a list of shielded enclosures located in Romeoville, Illinois used during the tests:

Chamber E: Is a custom-made anechoic chamber that measures 52' L X 30' W X 18' H. The walls and ceiling are fully lined with RF absorber. Pro-shield of Collinsville, Oklahoma manufactured the chamber. The floor has a 9' x 9' section of microwave absorber for testing above 1 GHz.

Test Station F: Is an area that measures 10' D X 12' W X 10' H. The floor and back wall are metal shielded. This area is used for conducted emissions measurements.

A separate ten-foot long, brass plated, steel ground rod attached via a 6-inch copper braid grounds each of the above chambers. Each enclosure is also equipped with low-pass power line filters.

The FCC has accepted these sites as test site number US1065. The FCC test site Registration Number is 732175. Details of the site characteristics are on file with the Industry Canada as site number IC 3124A-1.

A complete list of the test equipment is provided herein. The calibration due dates are indicated on the equipment list. The equipment is calibrated in accordance to ANSI/NCSL Z540-1 with traceability to the National Institute of Standards and Technology (NIST).

## 8.0 DEVIATIONS AND EXCLUSIONS FROM THE TEST SPECIFICATIONS

There were no deviations or exclusions from the test specifications.

## 9.0 CERTIFICATION

Radiometrics Midwest Corporation certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specification and the data contained herein was taken with calibrated test equipment. The results relate only to the EUT listed herein.

## 10.0 TEST EQUIPMENT TABLE

| RMC ID | Manufacturer    | Description       | Model No. | Serial No. | Frequency Range | Cal Period | Cal Date             |
|--------|-----------------|-------------------|-----------|------------|-----------------|------------|----------------------|
| AMP-05 | RMC/Celeritek   | Pre-amplifier     | MW110G    | 1001       | 1.0-12GHz       | 12 Mo.     | 01/10/19<br>01/14/20 |
| AMP-20 | Avantek         | Pre-amplifier     | SF8-0652  | 15221      | 8-18GHz         | 12 Mo      | 04/22/19             |
| AMP-59 | Amplitech       | Pre-amplifier     | APTMP44   | AMP-59     | 18-26 GHz       | 12 Mo.     | 01/10/19<br>01/06/20 |
| ANT-08 | RMC             | Log-Periodic Ant. | LP1000    | 1002       | 200-1000MHz     | 24 Mo.     | 11/19/18             |
| ANT-13 | EMCO            | Horn Antenna      | 3115      | 2502       | 1.0-18GHz       | 24 Mo.     | 01/16/19             |
| ANT-36 | Ailtech (Eaton) | Horn Antenna      | 96001     | 2013       | 1.0-18GHz       | 24 Mo.     | 11/19/18             |
| ANT-48 | RMC             | Std Gain Horn     | HW2020    | 1001       | 18-26 GHz       | 36 Mo.     | 08/09/19             |
| ANT-53 | EMCO            | Loop Antenna      | 6507      | 1453       | 1 kHz-30 MHz    | 24 Mo      | 12/28/17             |
| ANT-66 | ETS-Lindgren    | Horn Antenna      | 3115      | 62580      | 1.0-18GHz       | 24 Mo.     | 03/05/19             |



| RMC ID   | Manufacturer  | Description       | Model No.     | Serial No.                | Frequency Range | Cal Period | Cal Date             |
|----------|---------------|-------------------|---------------|---------------------------|-----------------|------------|----------------------|
| ANT-80   | AH Systems    | Bicon Antenna     | SAS-540       | 294                       | 20-330MHz       | 24 Mo.     | 12/14/18             |
| CAB-106A | Teledyne      | Coaxial Cable     | N/A           | 106A                      | DC-2 GHz        | 24 Mo.     | 05/07/18             |
| CAB-1090 | Teledyne      | Coaxial Cable     | N/A           | 1090                      | DC-18 GHz       | 24 Mo.     | 02/12/19             |
| CAB-160B | Teledyne      | Coaxial Cable     | N/A           | 160B                      | DC-18 GHz       | 24 Mo.     | 05/09/18             |
| CAB-090A | Teledyne      | Coaxial Cable     | N/A           | 090A                      | DC-26 GHz       | 24 Mo.     | 05/15/18             |
| CAB-295A | Teledyne      | Coaxial Cable     | N/A           | 295A                      | DC-26 GHz       | 24 Mo.     | 05/09/18             |
| HPF-01   | Solar         | High Pass Filter  | 7930-100      | HPF-1                     | 0.15-30MHz      | 24 Mo.     | 03/04/18             |
| HPF-06   | Mini-Circuits | High Pass Filter  | VHF-3800+     | 31035                     | 3-11 GHz        | 24 Mo.     | 04/04/18             |
| LSN-17   | EMCO          | 50 uH LISN        | 3810/2NM      | 9602-1356                 | 0.15 - 30MHz    | 24 Mo.     | 03/04/19             |
| LSN-03   | Farnell       | 50 uH LISN        | 1EXLSN30B     | 000314                    | 0.01-30MHz      | 24 Mo.     | 03/27/18             |
| REC-11   | HP / Agilent  | Spectrum Analyzer | E7405A        | US39110103                | 9Hz-26.5GHz     | 24 Mo      | 04/02/18             |
| REC-20   | HP / Agilent  | Spectrum Analyzer | 85460A/84562A | 33330A00135<br>3410A00178 | 30Hz-6GHz       | 24 Mo.     | 08/14/19             |
| REC-21   | Agilent       | Spectrum Analyzer | E7405A        | MY45118341                | 9Hz-26.5 GHz    | 24 Mo.     | 01/06/18<br>01/14/20 |
| REC-43   | Adventest     | Spectrum Analyzer | U3772         | 150800305                 | 9Hz-43GHz       | 24 Mo.     | 06/24/19             |
| RNT-17   | Agilent       | Spectrum Analyzer | E4440A        | MY42510244                | E4440A          | 36 Mo.     | 07/19/17             |
| THM-03   | Fluke         | Temp/Humid Meter  | 971           | 95850465                  | N/A             | 12 Mo.     | 05/03/19             |

Note: All calibrated equipment is subject to periodic checks.

The test equipment was in calibration during the tests.

| Software Company | Test Software Name | Version  | Applicable Tests                                |
|------------------|--------------------|----------|-------------------------------------------------|
| Radiometrics     | EN550XX0           | 07.16.19 | RF Conducted Emissions (FCC Part 15 & EN 55032) |
| Radiometrics     | REREC11D           | 07.16.19 | RF Radiated Emissions (FCC Part 15 & EN 55032)  |
| Agilent          | PSA/ESA-E/L/EMC    | 2.4.0.42 | Bandwidth and screen shots                      |

## 11.0 TEST SECTIONS

### 12.0 AC CONDUCTED EMISSIONS

The tests and limits are in accordance with FCC section 15.207 and RSS Gen section 8.8.

A computer-controlled analyzer was used to perform the conducted emissions measurements. The frequency range was divided into 500 subranges equally spaced on a logarithmic scale. The computer recorded the peak of each subrange. This data was then plotted on a semi-log graph generated by the computer. Adjusting the positions of the cables and orientation of the test system then maximizes the highest emissions.

Mains Conducted emission measurements were performed using a 50 Ohm/50 uH Line Impedance Stabilization Network (LISN) as the pick-up device. Measurements were repeated on both leads within the power cord. If the EUT power cord exceeded 80 cm in length, the excess length of the power cord was made into a 30 to 40 cm bundle near the center of the cord. The LISN was placed on the floor at the base of the test platform and electrically bonded to the ground plane.

**FCC Limits of Conducted Emissions at the AC Mains Ports**

| Frequency Range<br>(MHz)                                                          | Class B Limits (dBuV) |         |
|-----------------------------------------------------------------------------------|-----------------------|---------|
|                                                                                   | Quasi-Peak            | Average |
| 0.150 - 0.50*                                                                     | 66 - 56               | 56 - 46 |
| 0.5 – 5.0                                                                         | 56                    | 46      |
| 5.0 - 30                                                                          | 60                    | 50      |
| * The limit decreases linearly with the logarithm of the frequency in this range. |                       |         |

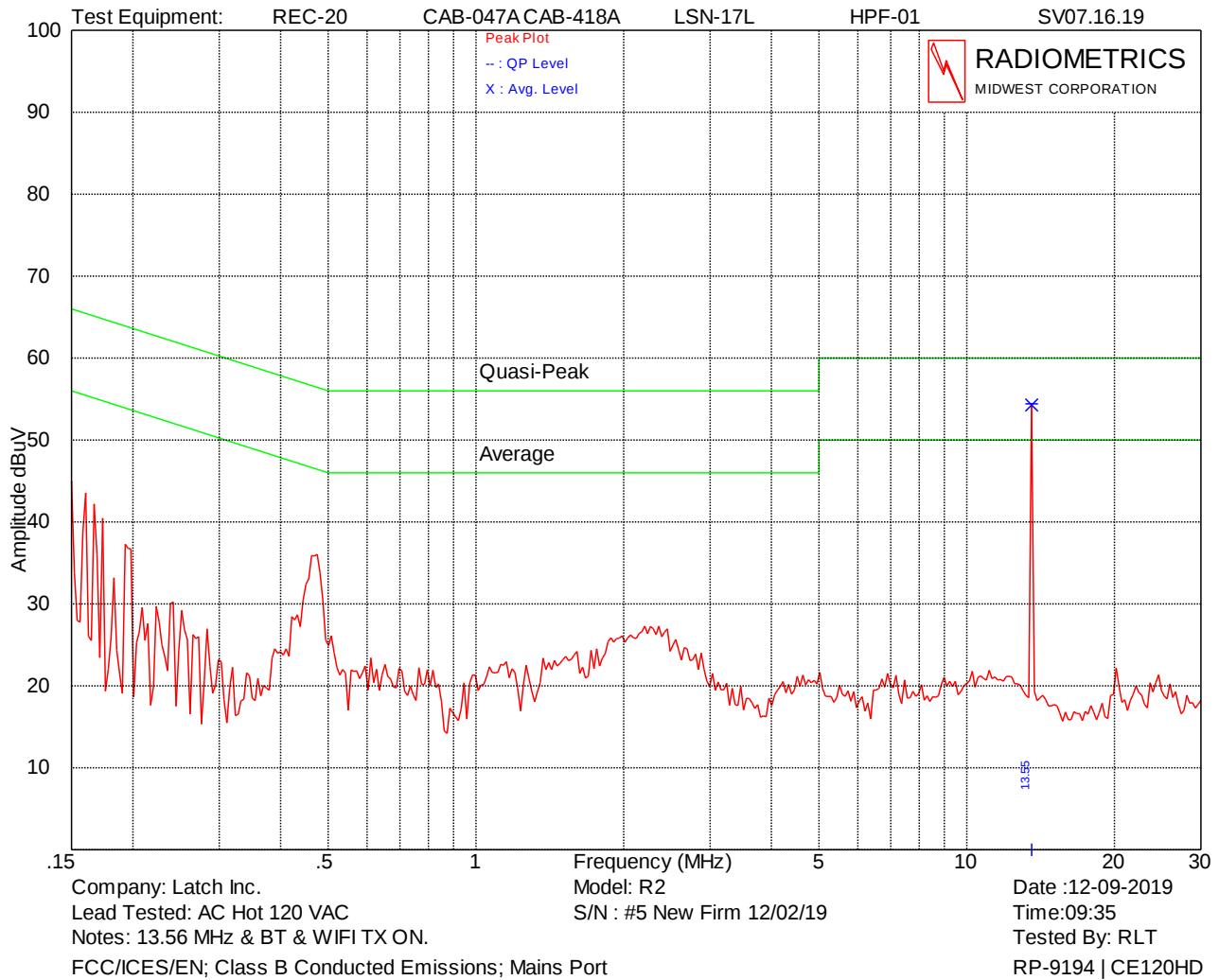
The initial step in collecting conducted data is a peak detector scan and the plotting of the measurement range. Significant peaks are then marked as shown on the following table, and these signals are then measured with the quasi-peak detector. The following represents the worst case emissions from the EUT power supply, after testing all modes of operation.

The transmitter was tested with a dummy load under the following conditions:

- 1) First, perform the AC line conducted tests with the antenna attached were performed to determine if the EUT complies with the 15.207 limits outside the transmitter's fundamental emission band.
- 2) The AC line conducted emissions were retested with a dummy load of to make sure the device complies with the 15.207 limits inside the transmitter's fundamental emission band. Only the fundamental TX emission band needs to be retested. The load was 100 Ohm. This is the characteristic impedance of the antenna.

Test Date : December 9, 2019

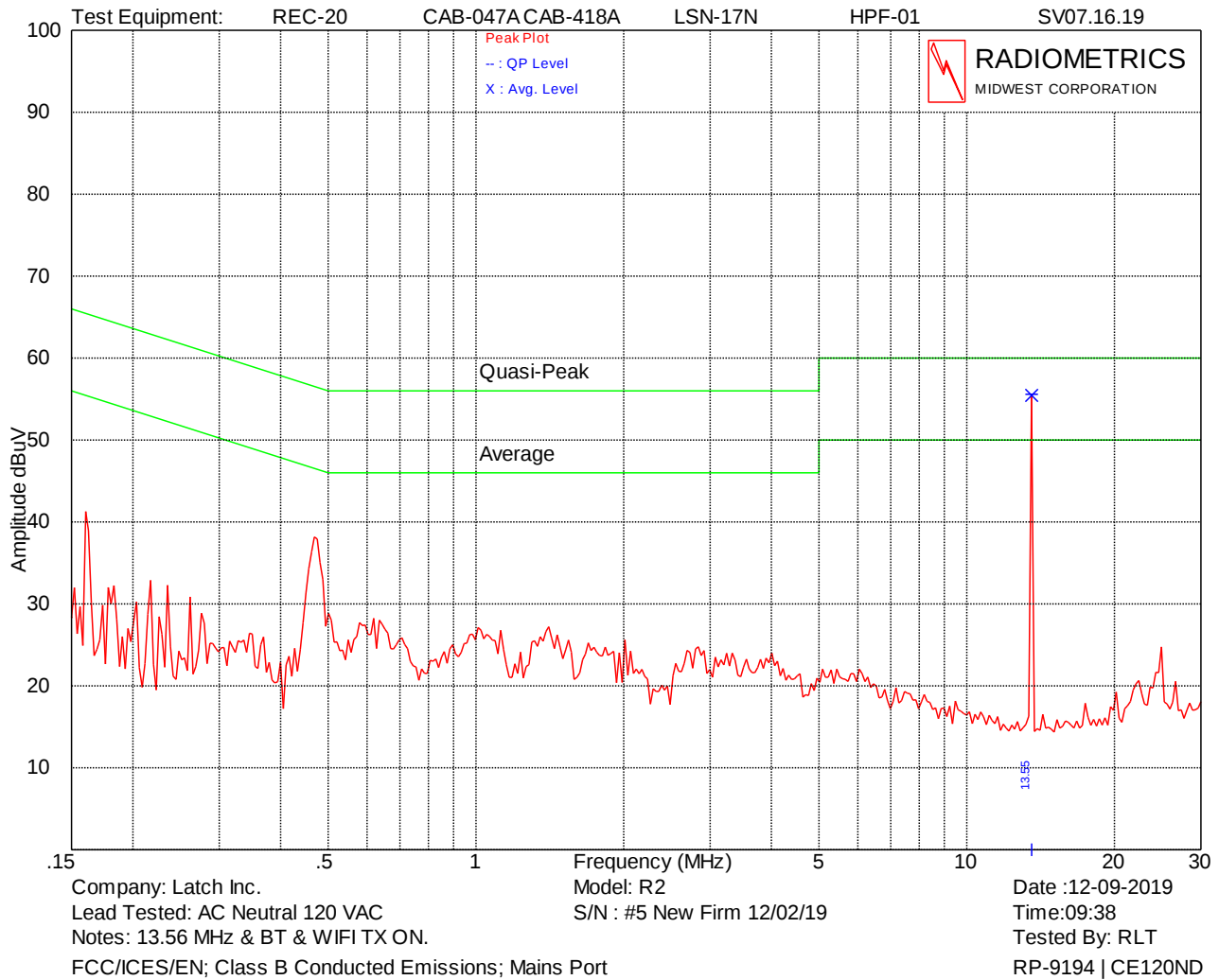
The Amplitude is the final corrected value with cable and LISN Loss.



With Antenna installed

The emission at 13.56 MHz was re-measured with a resistive load in place of the antenna and was fully compliant.

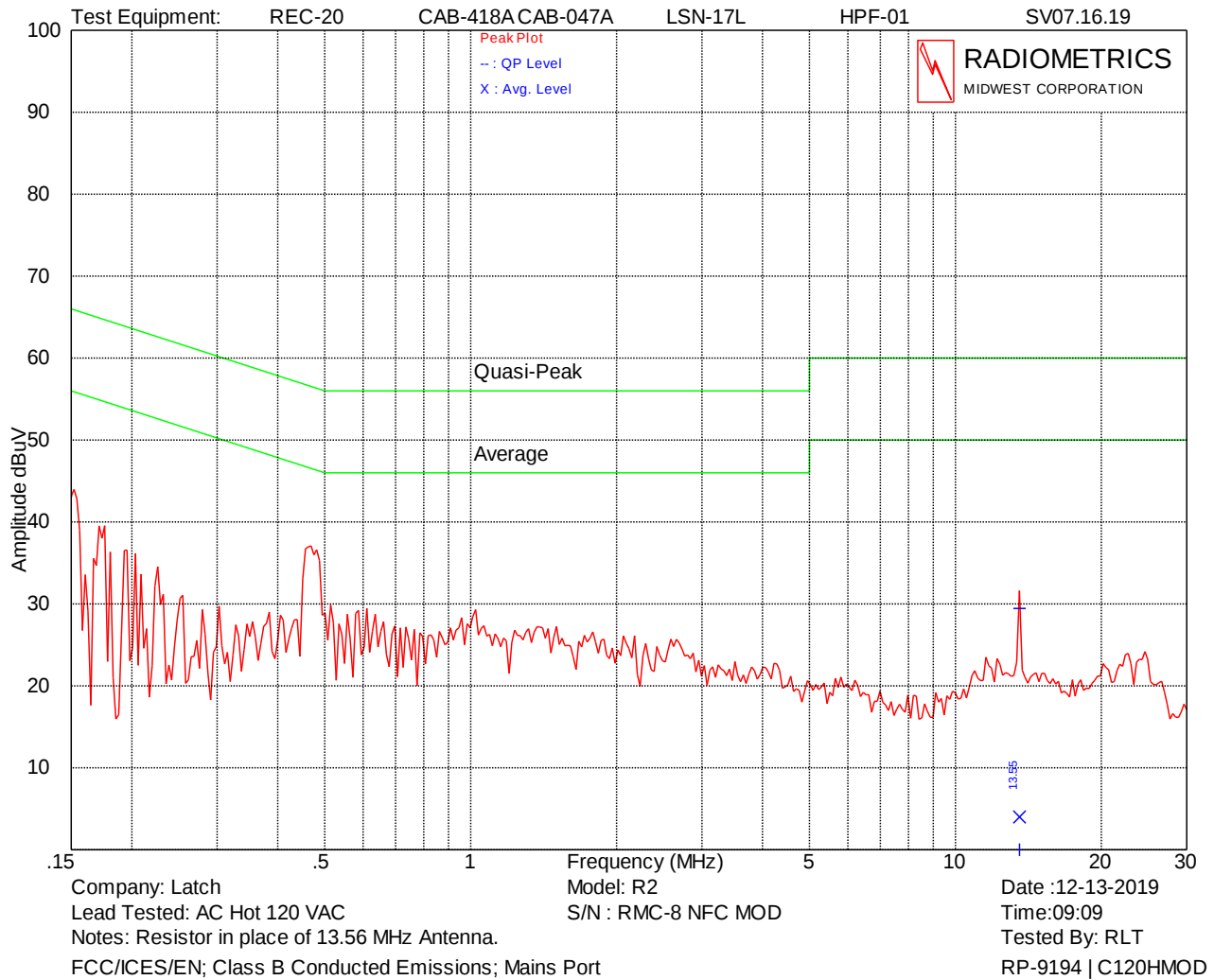
| Frequency (MHz) | QP Amplitude (dBuV) | QP Limit (dBuV) | Average Amplitude (dBuV) | Average Limit (dBuV) | Margin (dB) |
|-----------------|---------------------|-----------------|--------------------------|----------------------|-------------|
| 13.560          | 54.4                | 60.0            | 54.3                     | 50.0                 | -4.3        |



With Antenna installed

The emission at 13.56 MHz was re-measured with a resistive load in place of the antenna and was fully compliant.

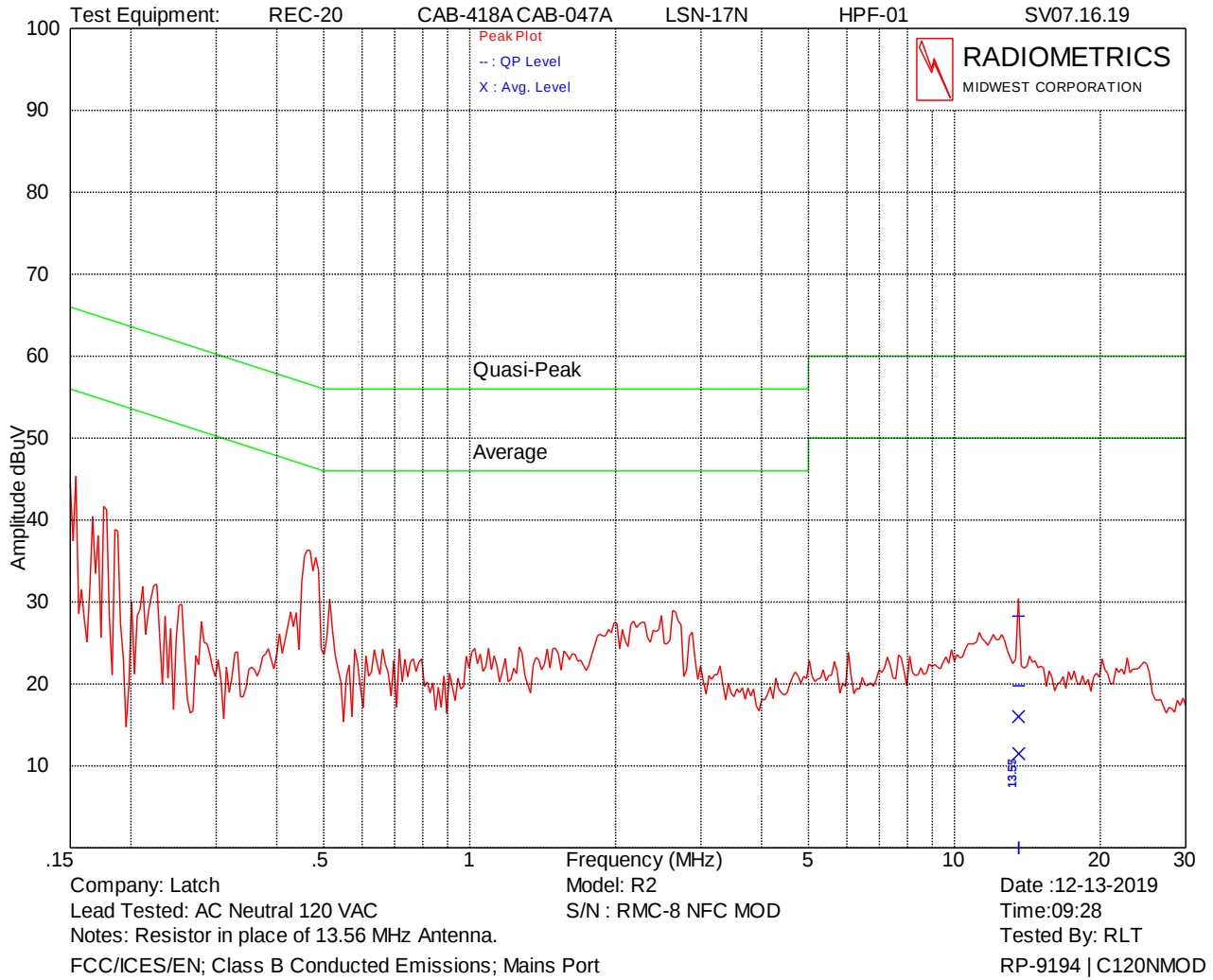
| Frequency (MHz) | QP Amplitude (dBuV) | QP Limit (dBuV) | Average Amplitude (dBuV) | Average Limit (dBuV) | Margin (dB) |
|-----------------|---------------------|-----------------|--------------------------|----------------------|-------------|
| 13.560          | 55.6                | 60.0            | 55.5                     | 50.0                 | -5.5        |



With Load in place of Antenna

| Frequency (MHz) | QP Amplitude (dBuV) | QP Limit (dBuV) | Average Amplitude (dBuV) | Average Limit (dBuV) | Margin (dB) |
|-----------------|---------------------|-----------------|--------------------------|----------------------|-------------|
| 13.560          | 29.4                | 60.0            | 4.0                      | 50.0                 | 30.6        |

Pass by at least 10 dB at 13.56 MHz with Load in place of antenna



With Load in place of Antenna

| Frequency (MHz) | QP Amplitude (dBuV) | QP Limit (dBuV) | Average Amplitude (dBuV) | Average Limit (dBuV) | Margin (dB) |
|-----------------|---------------------|-----------------|--------------------------|----------------------|-------------|
| 13.559          | 28.3                | 60.0            | 16.0                     | 50.0                 | 31.7        |

Pass by at least 10 dB at 13.56 MHz with Load in place of antenna

Judgment: Passed by 9 dB



## 13.0 WIFI TEST RESULTS

### 13.1 Occupied Bandwidth Data

The test procedures were in accordance to FCC DTS Measurement Guideline 558074 D01, Section 8.1.

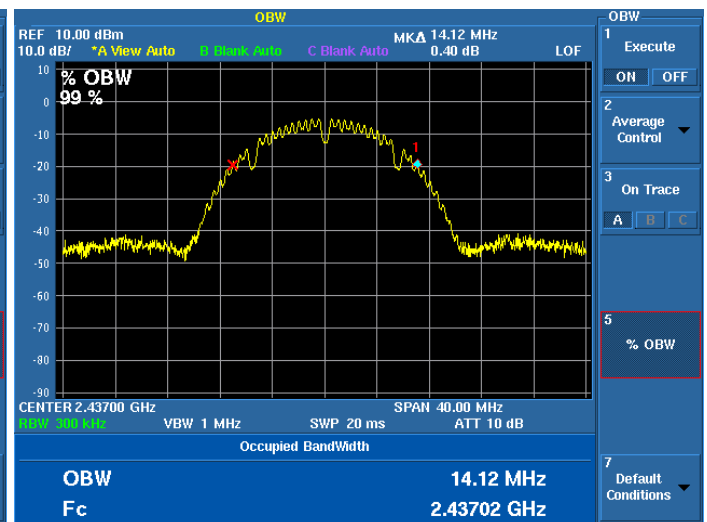
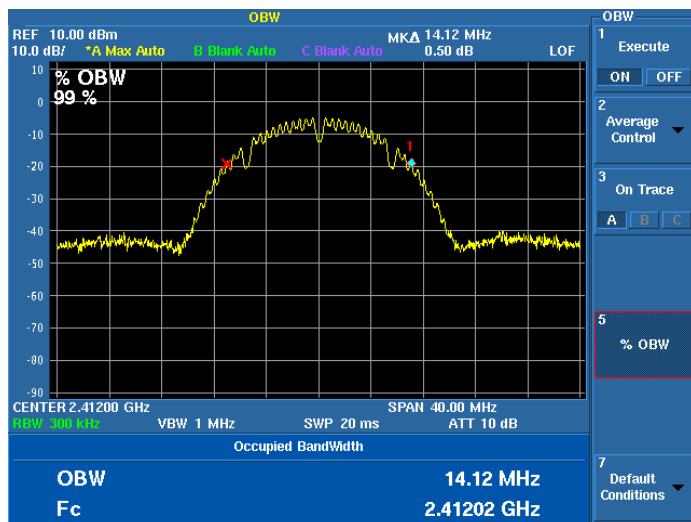
The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation. The EUT was transmitting at its maximum data rate. The trace was allowed to stabilize. The marker-to-peak function was set to the peak of the emission. Then the marker-delta function was used to measure 6 dB down one side of the emission. The marker-delta function was reset and then moved to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the bandwidth of the emission.

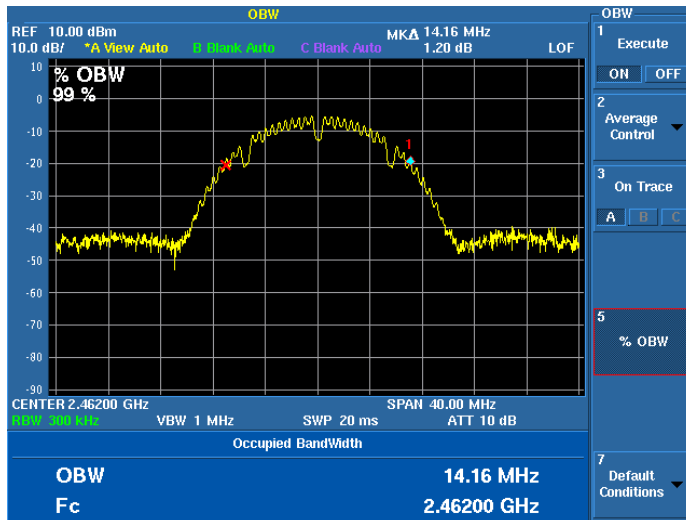
| Mode    | Freq. (MHz) | 99% Bandwidth MHz | 6 dB DTS EBW MHz |
|---------|-------------|-------------------|------------------|
| 802.11b | 2412        | 14.12             | 9.284            |
| 802.11b | 2437        | 14.12             | 9.359            |
| 802.11b | 2462        | 14.16             | 9.29             |
| 802.11g | 2412        | 16.56             | 15.14            |
| 802.11g | 2437        | 16.56             | 15.115           |
| 802.11g | 2462        | 16.52             | 15.065           |
| 802.11N | 2412        | 17.60             | 15.14            |
| 802.11N | 2437        | 17.60             | 15.065           |
| 802.11N | 2462        | 17.64             | 15.14            |

The 6 dB bandwidth is greater than 500 kHz

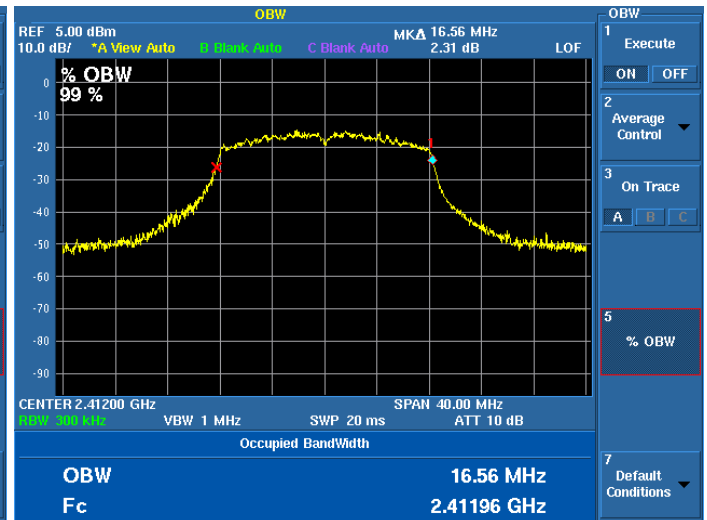
Judgement: Pass

#### 99%

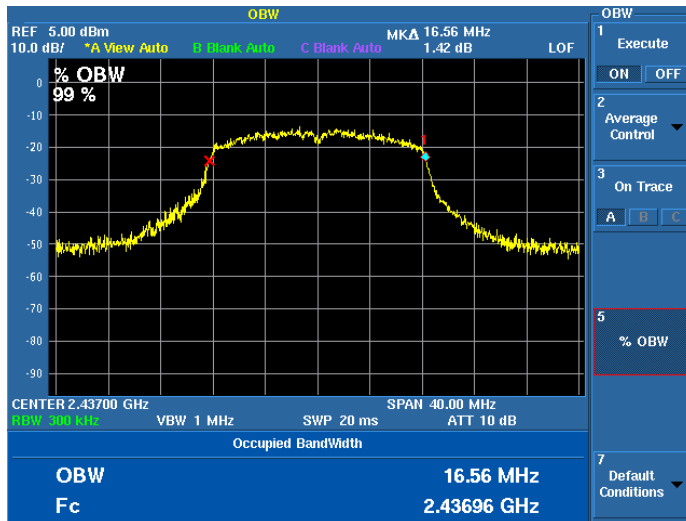




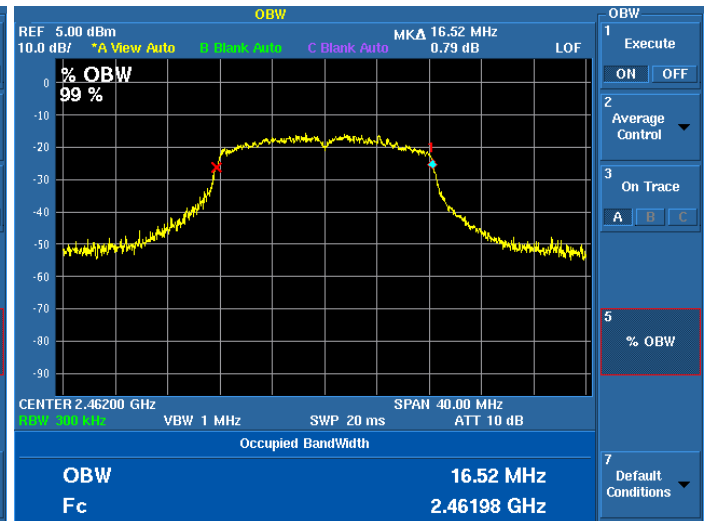
802.11b, Channel 6



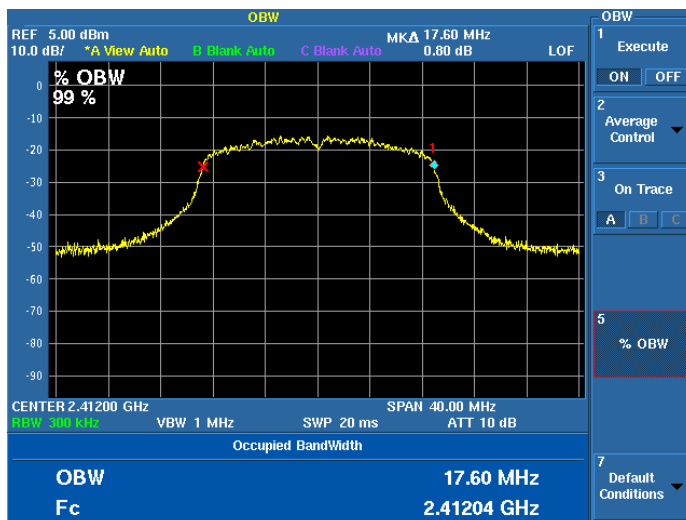
802.11g, Channel 1



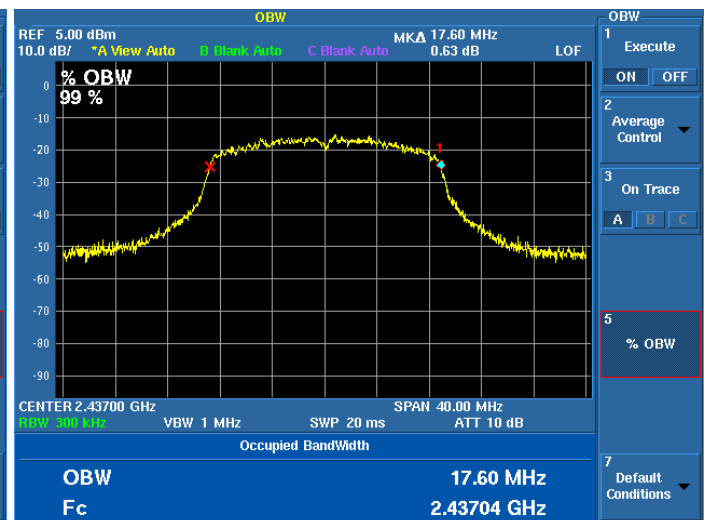
802.11g, Channel 6



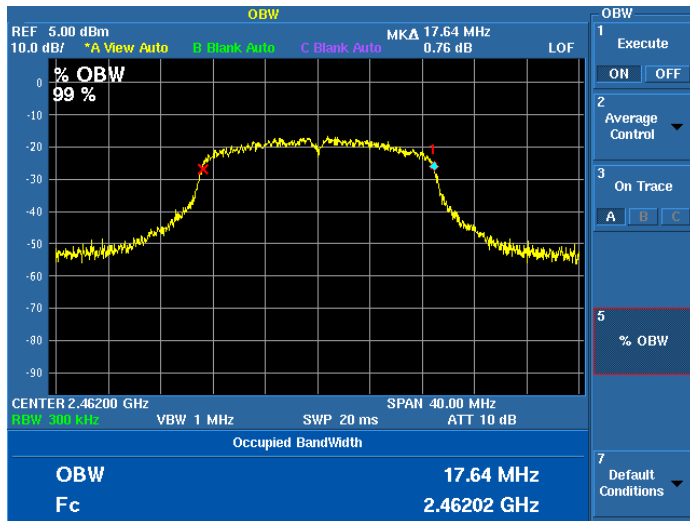
802.11g, Channel 11



802.11n, Channel 1

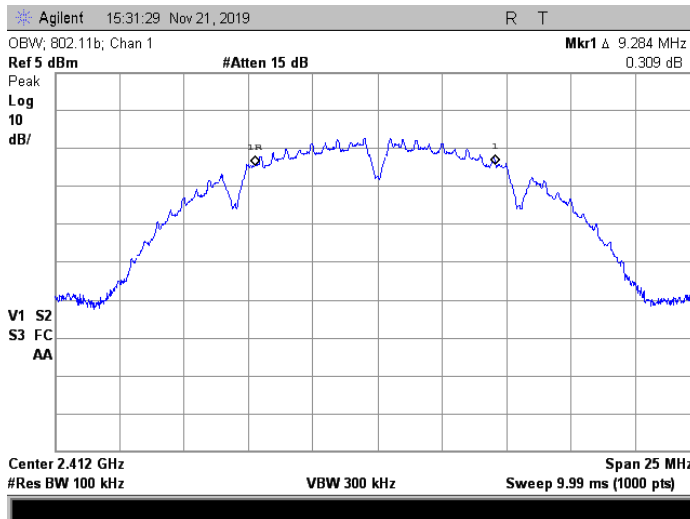


802.11n, Channel 6

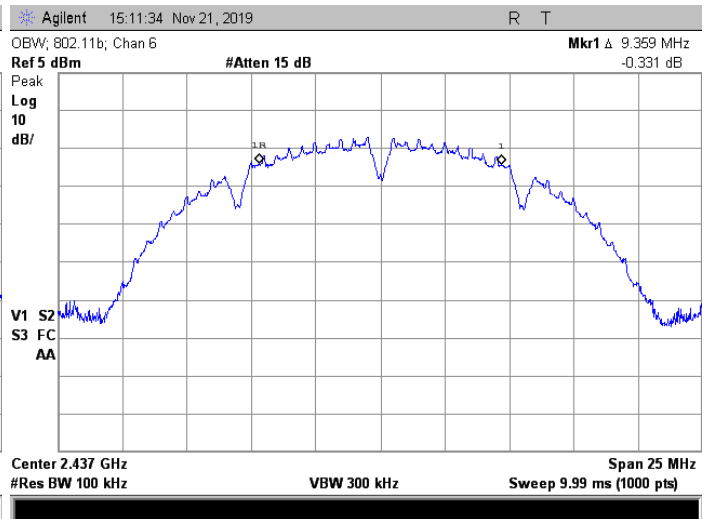


802.11n, Channel 11

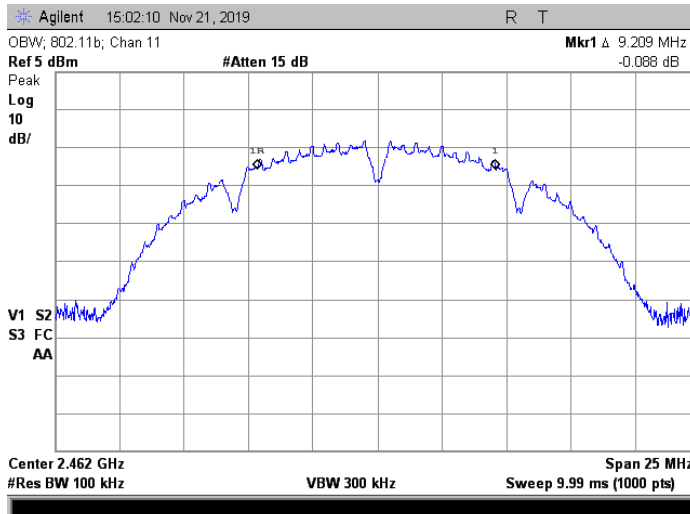
6 dB



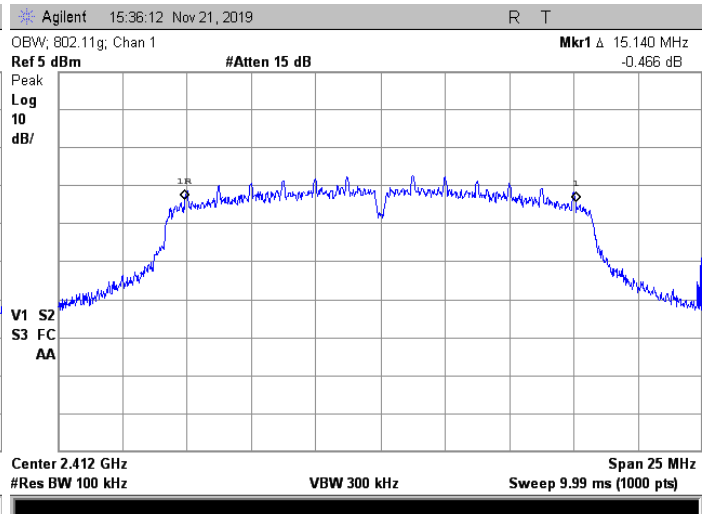
802.11b, Channel 1



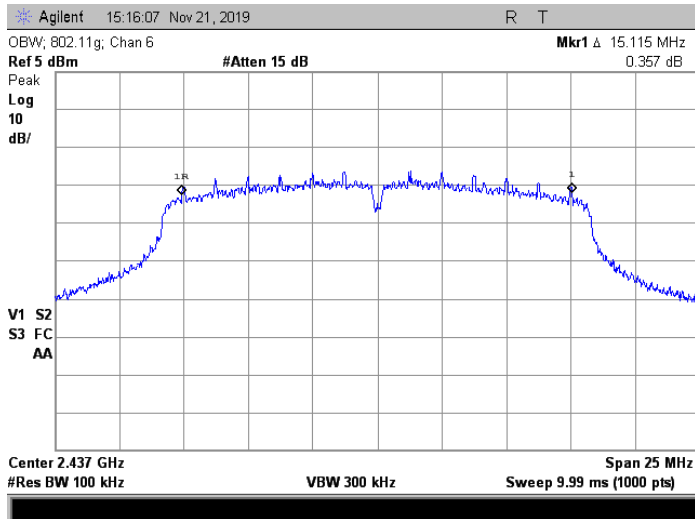
802.11b, Channel 6



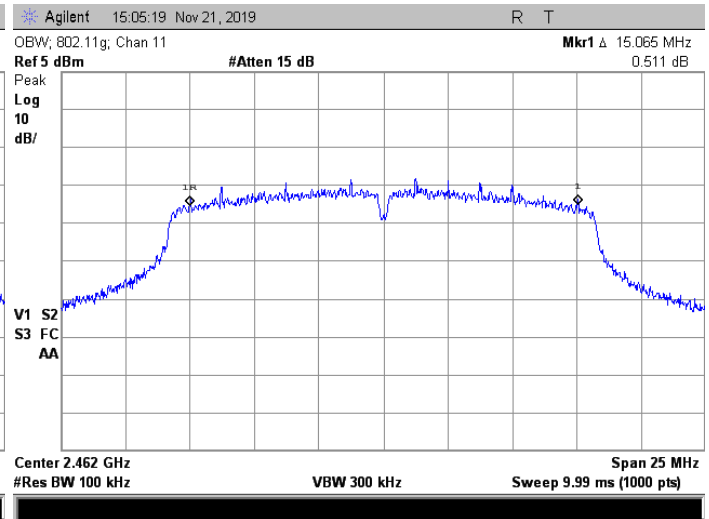
802.11b, Channel 11



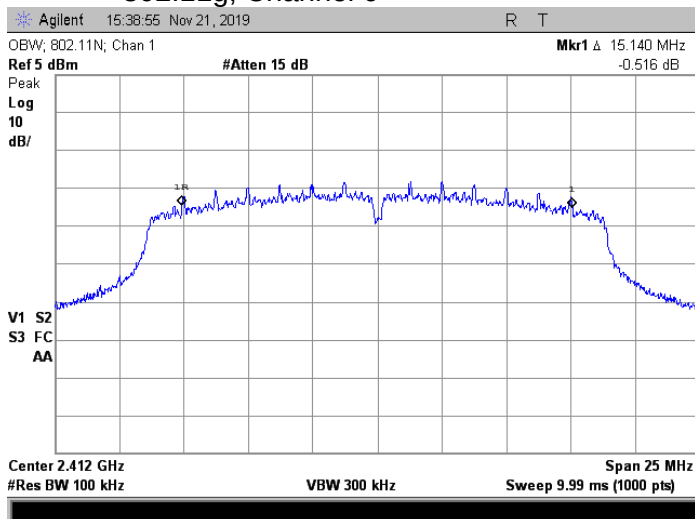
802.11g, Channel 1



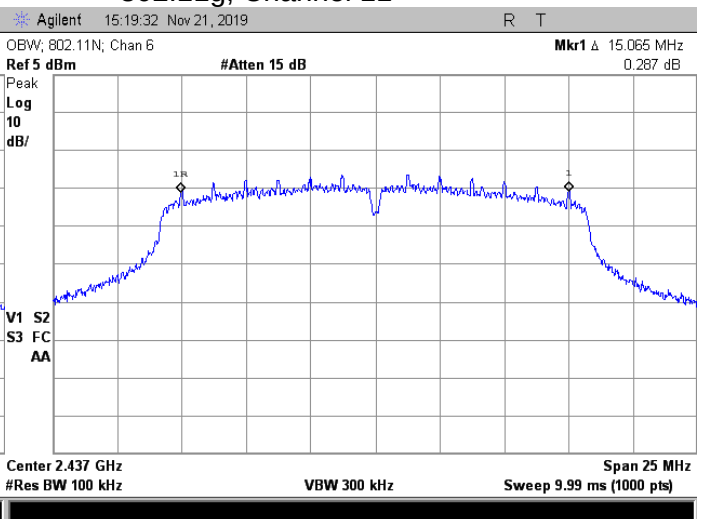
802.11g, Channel 6



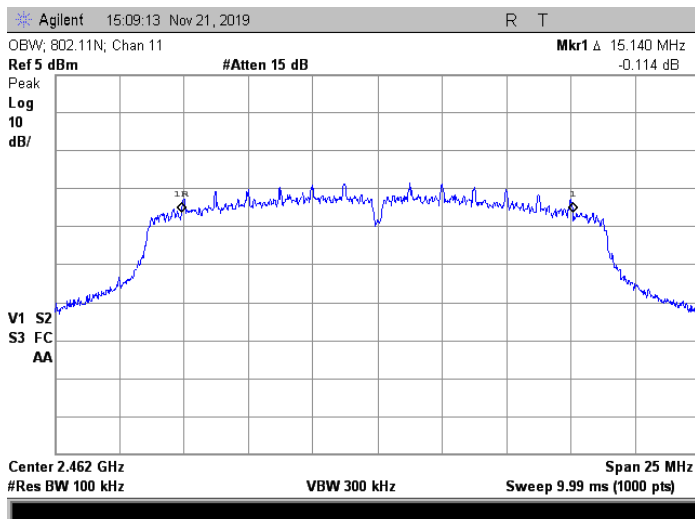
802.11g, Channel 11



802.11n, Channel 1



802.11n, Channel 6



802.11n, Channel 11



## 13.2 Peak Output Power

The test procedures were in accordance to FCC DTS Measurement Guideline 558074 D01 & ANSI C63.10-2013 section 11.9.1.2. The EUT antenna port was connected to the Spectrum analyzer Via a low loss coaxial cable. The trace was allowed to stabilize. The indicated level is the peak output power. Since the gain of the antenna is always less than 6 dB, the limit is not reduced.

The spectrum analyzer was set to peak channel power. The EUT antenna port was connected to the Spectrum analyzer Via a low loss coaxial cable.  
Span = 30 MHz; RBW = 1 MHz; VBW = 3 MHz

Tested by: Joseph Strzelecki/ Richard Tichgelaar

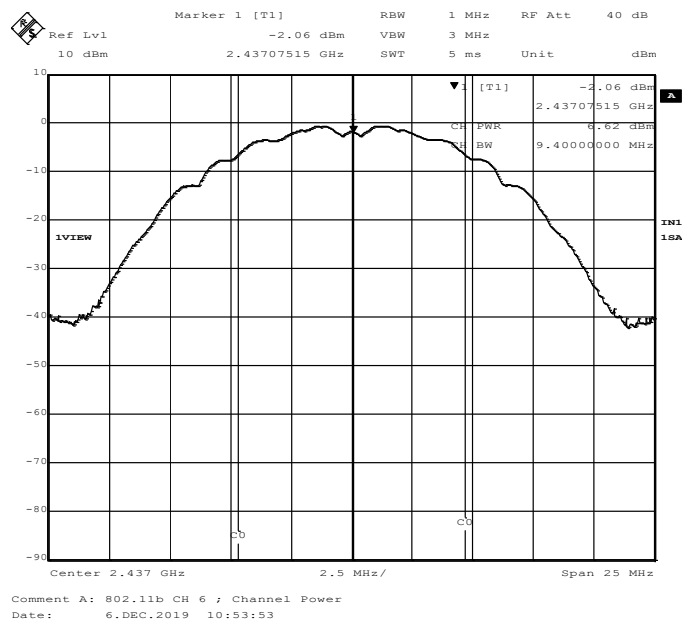
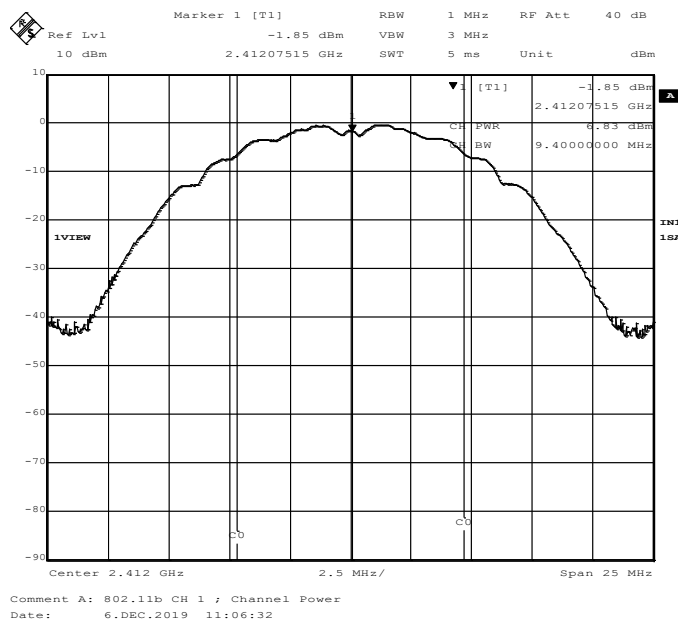
Test Date: 12/06/2019

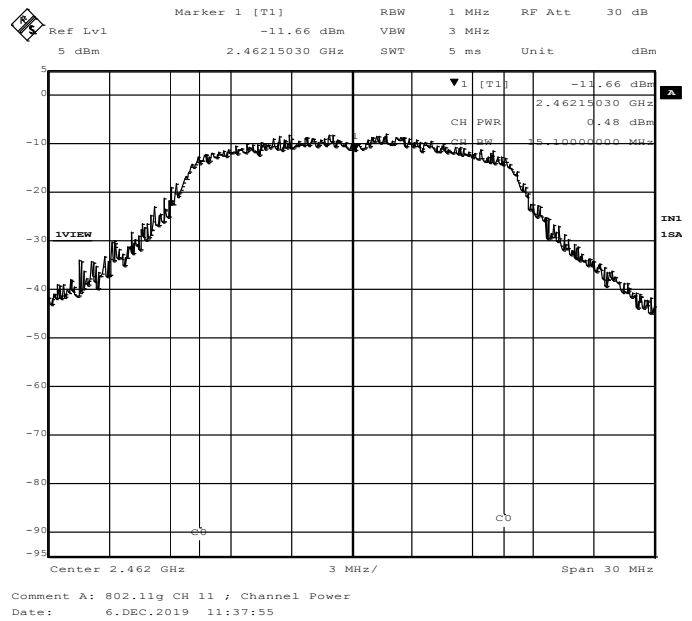
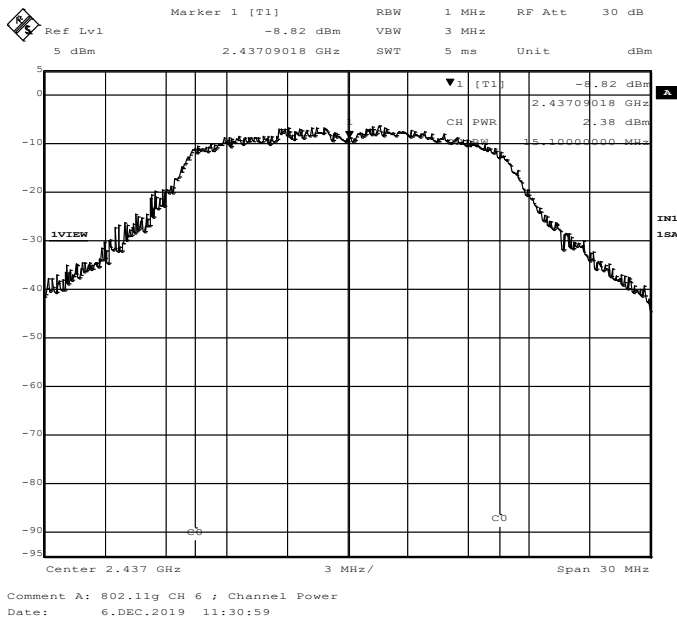
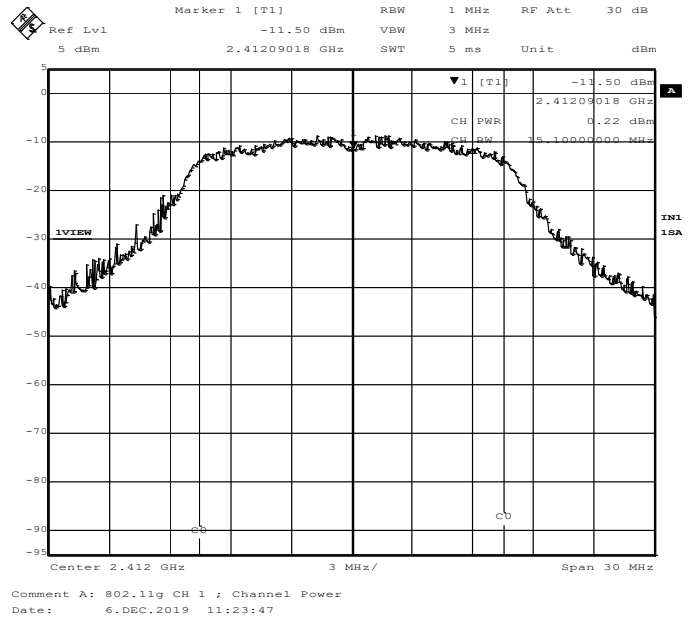
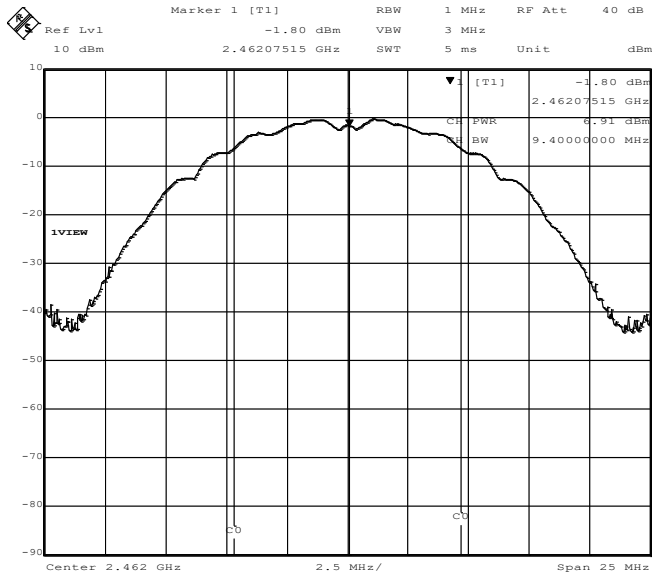
Since the gain of the antenna is always less than 6 dB, the limit is not reduced. The antenna gain is 5 dBi.

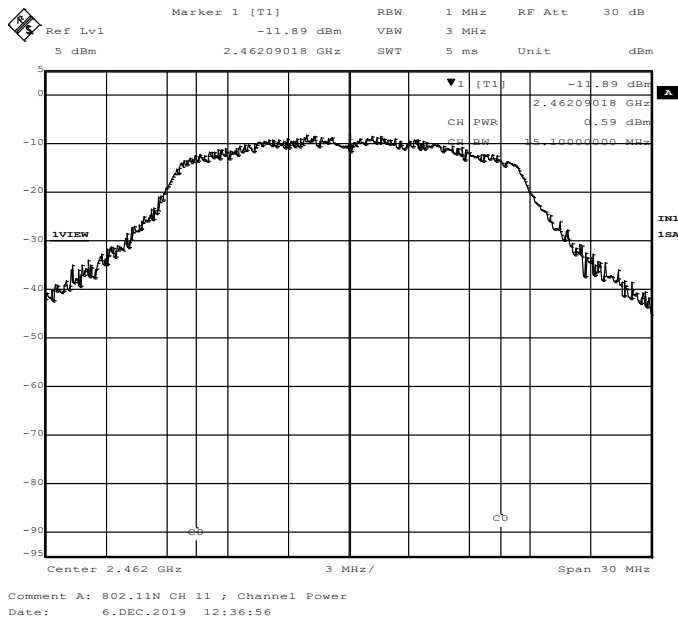
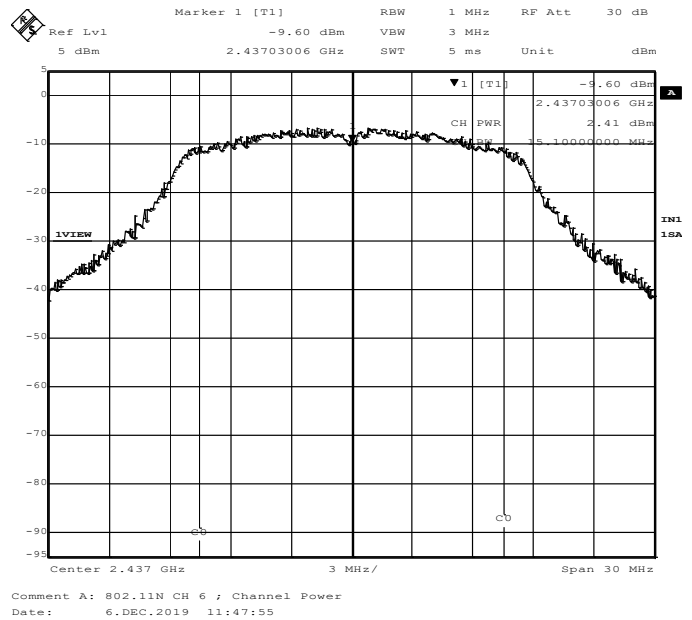
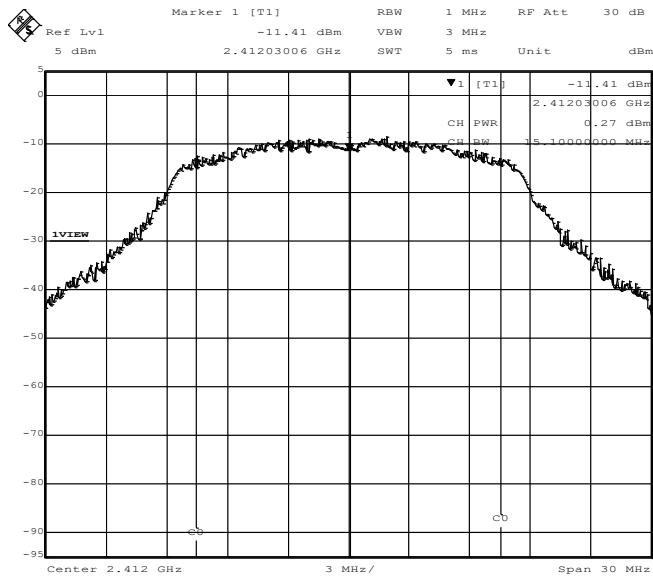
| Mode    | Freq. (MHz) | Reading (dBm) | Cable + Atten Loss (dB) | Total Power (dBm) |        | Limit (dBm) |
|---------|-------------|---------------|-------------------------|-------------------|--------|-------------|
|         |             |               |                         | dBm               | Watts  |             |
| 802.11b | 2412        | 6.8           | 10.0                    | 16.8              | 0.0479 | 30          |
| 802.11b | 2437        | 6.6           | 10.0                    | 16.6              | 0.0457 | 30          |
| 802.11b | 2462        | 6.9           | 10.0                    | 16.9              | 0.0490 | 30          |
| 802.11g | 2412        | 0.2           | 10.0                    | 10.2              | 0.0105 | 30          |
| 802.11g | 2437        | 2.4           | 10.0                    | 12.4              | 0.0174 | 30          |
| 802.11g | 2462        | 0.5           | 10.0                    | 10.5              | 0.0112 | 30          |
| 802.11N | 2412        | 0.3           | 10.0                    | 10.3              | 0.0107 | 30          |
| 802.11N | 2437        | 2.4           | 10.0                    | 12.4              | 0.0174 | 30          |
| 802.11N | 2462        | 0.6           | 10.0                    | 10.6              | 0.0115 | 30          |

Overall Test result: Pass by 13.1 dB

### Peak Power Plots







### 13.3 Power Spectral Density

The PSD test method from ANSI C63.10 section 11.10.2 and FCC DTS Measurement Guideline 558074 D01, Section 10.2. The spectrum analyzer was set to the following settings:

Span = 1.5x DTS Bandwidth; RBW = 10 kHz; VBW = 30 kHz  
Tested by: Joseph Strzelecki/Richard Tichelaar

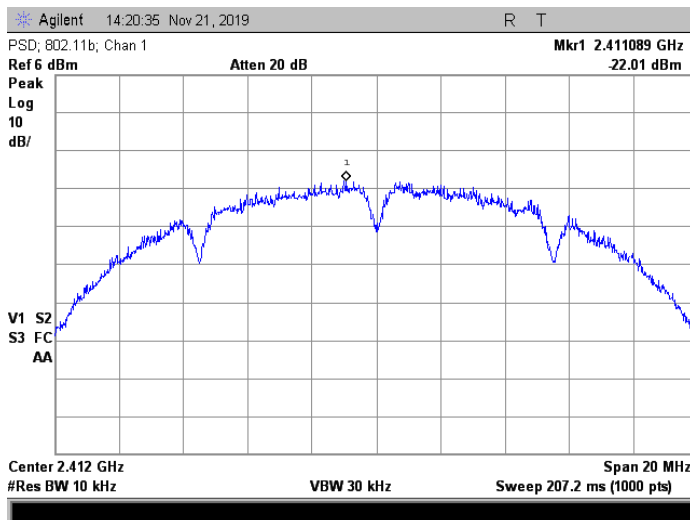
Test Date: 11/21/2019



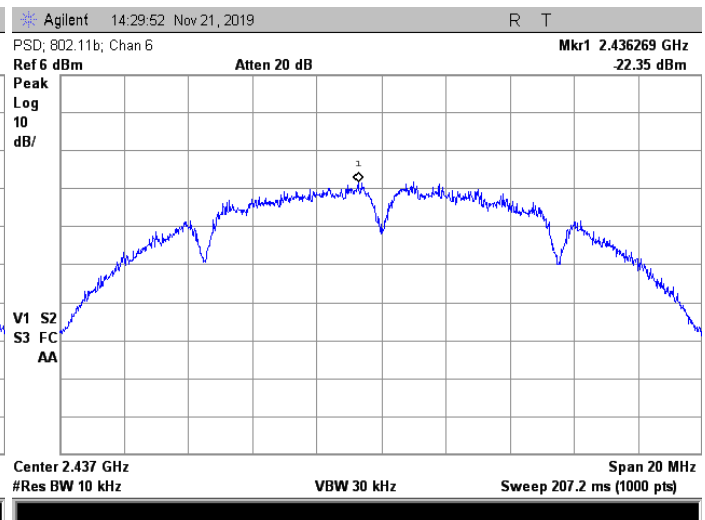
| Mode    | Frequency (MHz) | Reading dBm | Cable Loss (dB) | 3 kHz Spectral Density (dBm) | Limit (dBm) | Margin (dB) |
|---------|-----------------|-------------|-----------------|------------------------------|-------------|-------------|
| 802.11b | 2412            | -22.01      | 12.0            | -10.0                        | 8.0         | 18.0        |
| 802.11b | 2437            | -22.35      | 12.0            | -10.4                        | 8.0         | 18.4        |
| 802.11b | 2462            | -23.12      | 12.0            | -11.1                        | 8.0         | 19.1        |
| 802.11g | 2412            | -31.76      | 12.0            | -19.8                        | 8.0         | 27.8        |
| 802.11g | 2437            | -31.19      | 12.0            | -19.2                        | 8.0         | 27.2        |
| 802.11g | 2462            | -34.65      | 12.0            | -22.7                        | 8.0         | 30.7        |
| 802.11N | 2412            | -30.35      | 12.0            | -18.4                        | 8.0         | 26.4        |
| 802.11N | 2437            | -31.41      | 12.0            | -19.4                        | 8.0         | 27.4        |
| 802.11N | 2462            | -32.85      | 12.0            | -20.9                        | 8.0         | 28.9        |

Judgment: Passed by 18.0 dB

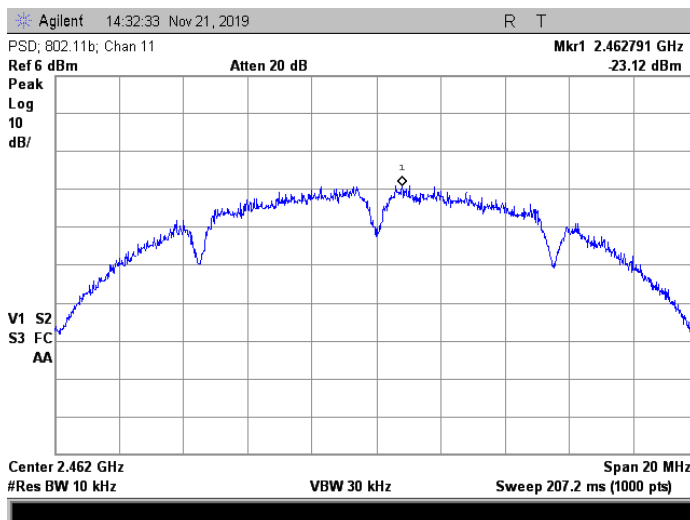
## PSD Plots



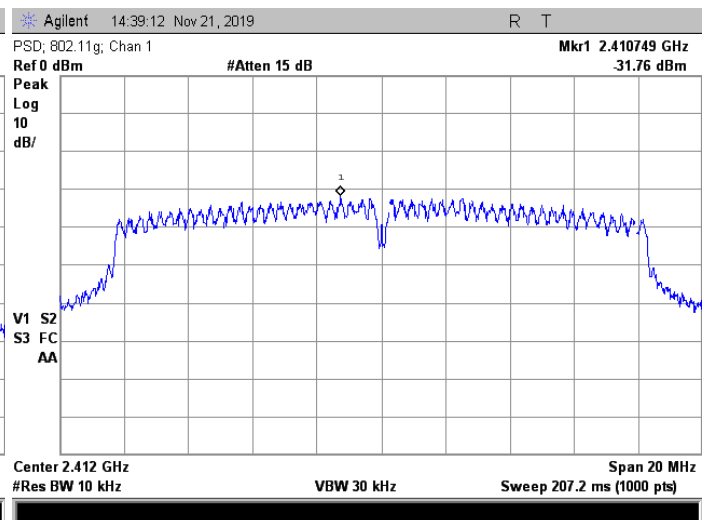
802.11b, Channel 1



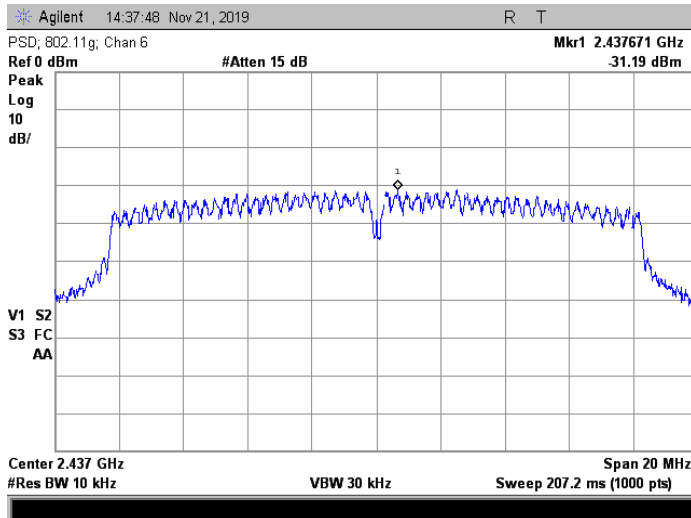
802.11b, Channel 6



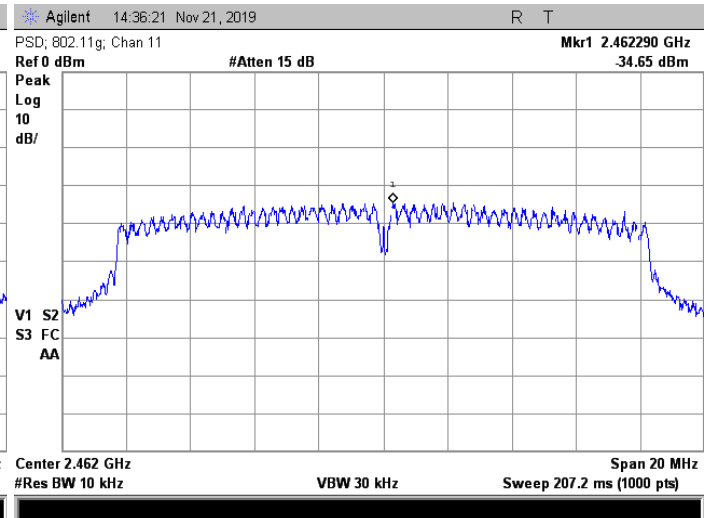
802.11b, Channel 11



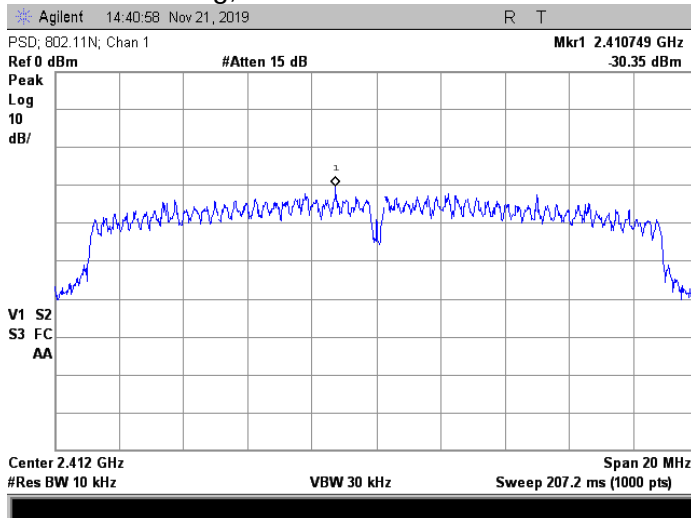
802.11g, Channel 1



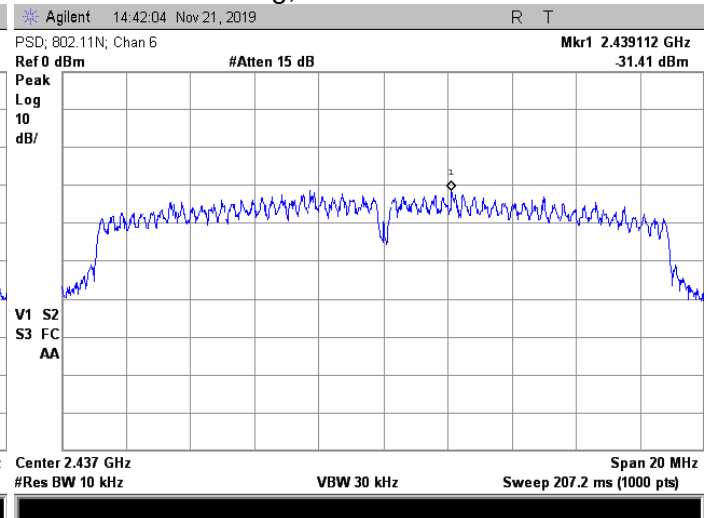
802.11g, Channel 6



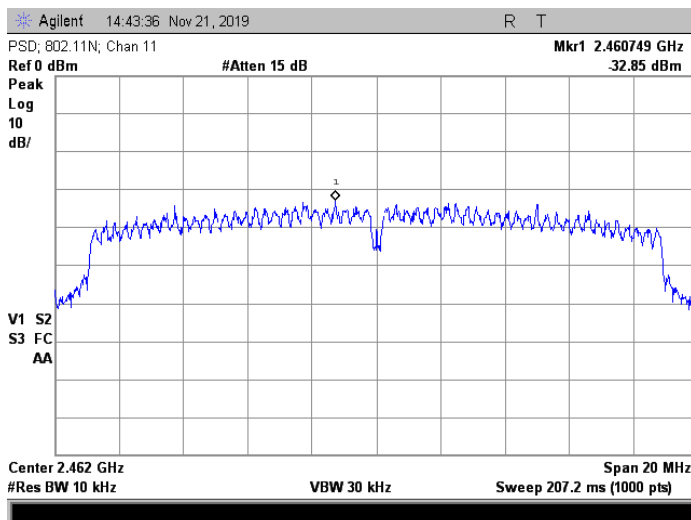
802.11g, Channel 11



802.11N, Channel 1



802.11N, Channel 6



802.11N, Channel 11



### 13.4 Band-edge Compliance of RF Conducted Emissions

The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation at the band-edge, with the EUT set to the lowest frequency. The trace was allowed to stabilize.

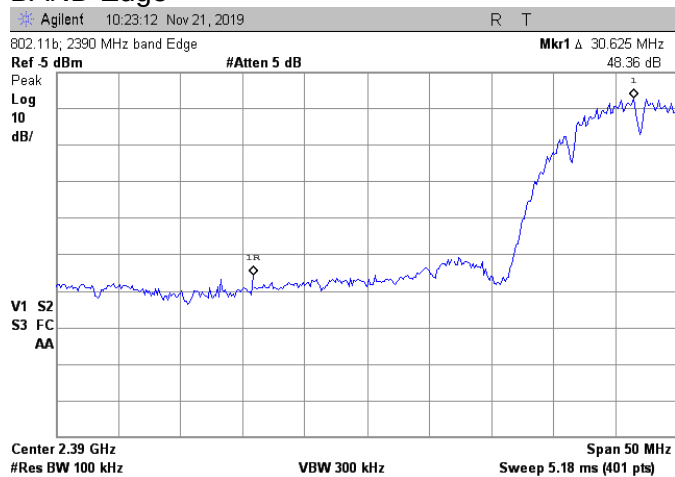
Tested by: Joseph Strzelecki/ Richard Tichelaar

Test Date: November 21, 2019

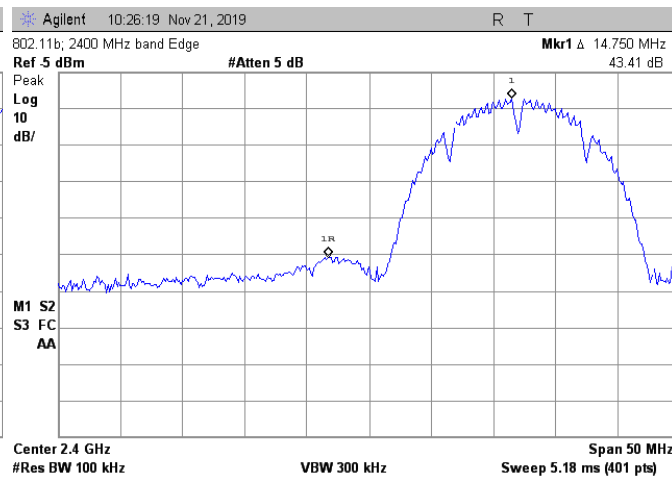
| Channel              | Band Edge Delta Readings in dB |              |              |              | Limit (dB) |
|----------------------|--------------------------------|--------------|--------------|--------------|------------|
|                      | Freq (MHz)                     | 802.11b (dB) | 802.11g (dB) | 802.11N (dB) |            |
| 2412 Lower Band edge | 2400.0                         | 43.41        | 33.37        | 32.8         | 20         |
| 2412 Lower Band edge | 2390.0                         | 48.36        | 44.2         | 42.3         | 20         |
| 2462 Upper Band edge | 2483.5                         | 47.2         | 40.0         | 40.0         | 20         |

Judgment: Passed by 12.8 dB

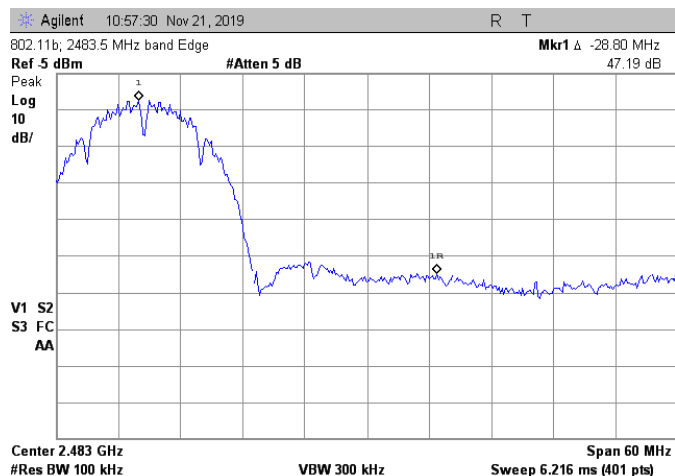
#### BAND Edge



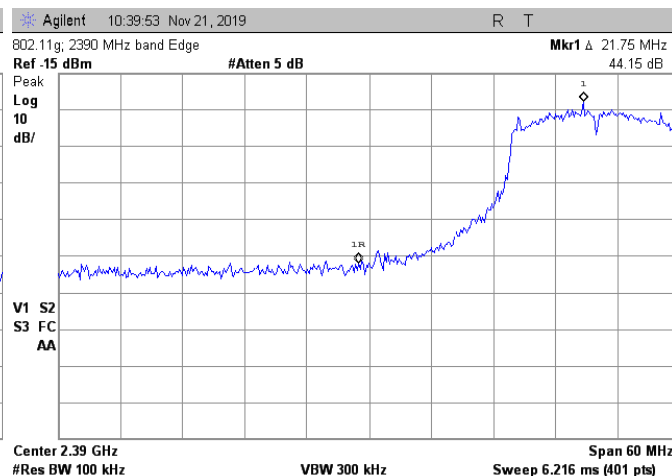
802.11b, Channel 1



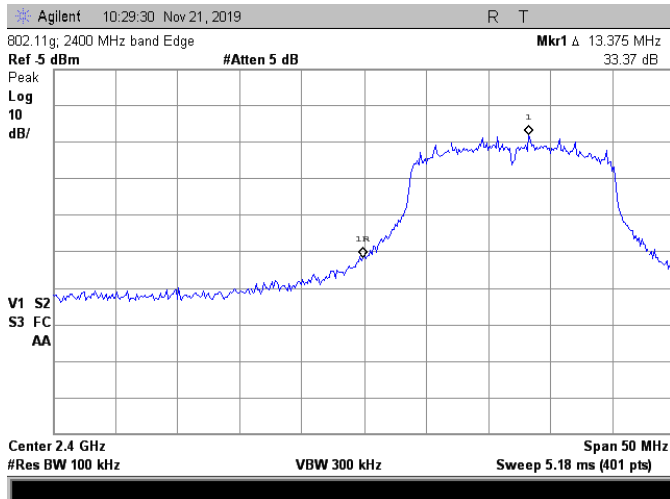
802.11b, Cannel 1



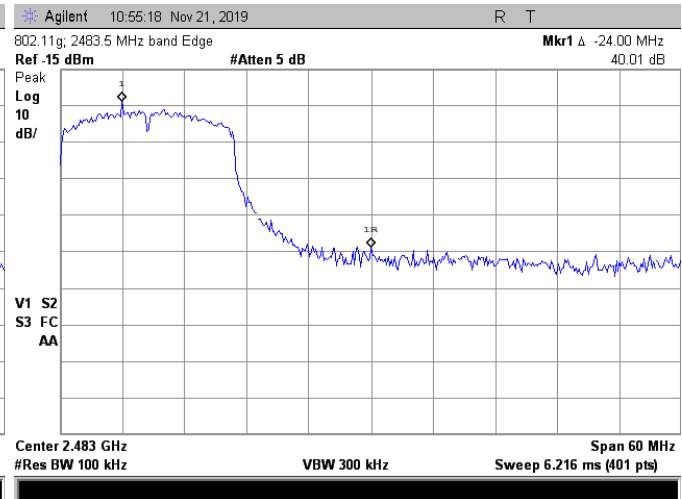
802.11b, Channel 11



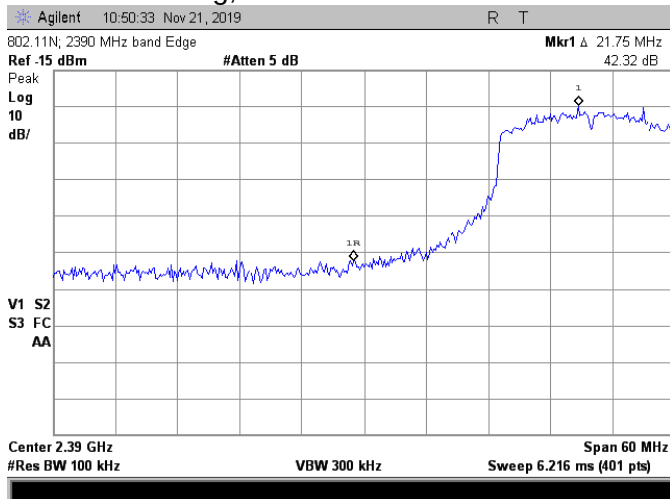
802.11g, Channel 1



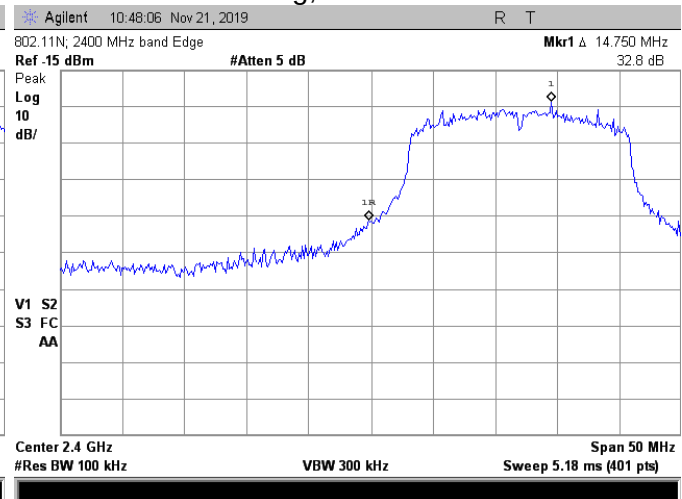
802.11g, Channel 1



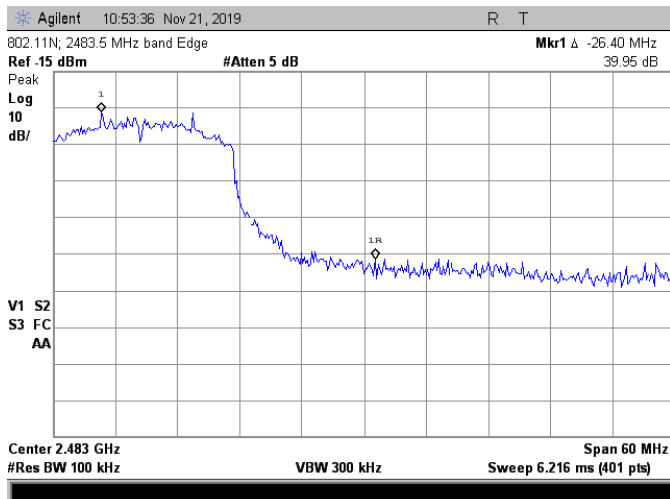
802.11g, Channel 11



802.11N, Channel 1



802.11N, Channel 1



802.11N, Channel 11



### 13.5 Spurious RF Conducted Emissions at Antenna Port

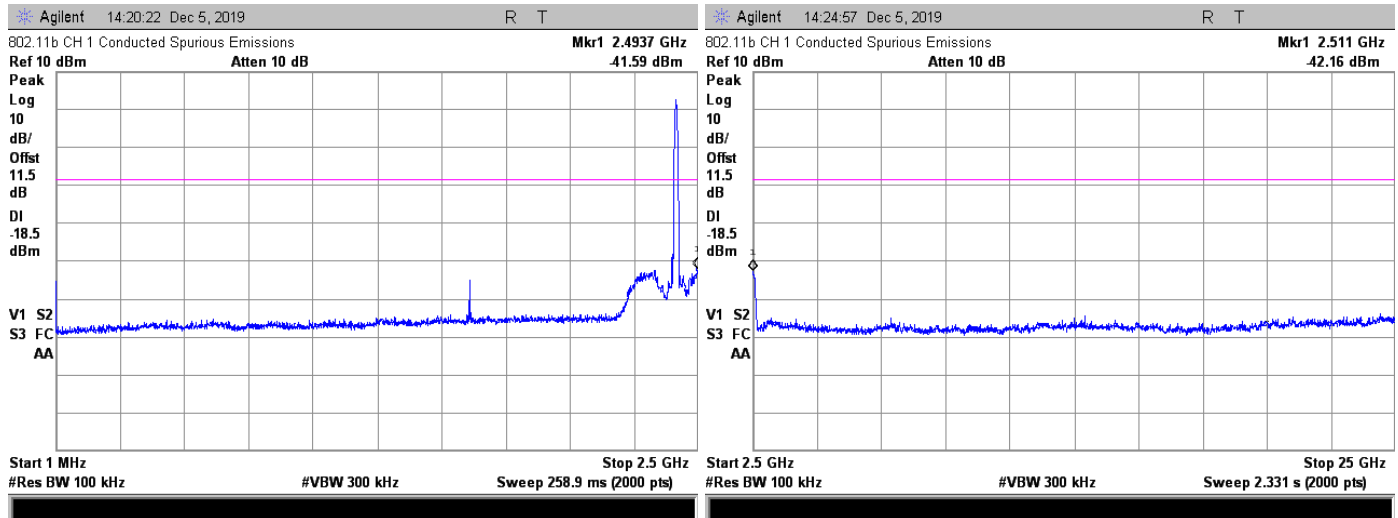
The spectrum analyzer was set to the MAX HOLD mode to record all spurious emissions from the lowest frequency generated in the EUT up through the 10<sup>th</sup> harmonic. The trace was allowed to stabilize. The first two plots were made while stepping through three frequencies (Low middle and high). Each frequency was on for at least 30 seconds.

Tested by: Joseph Strzelecki/ Richard Tichgelaar

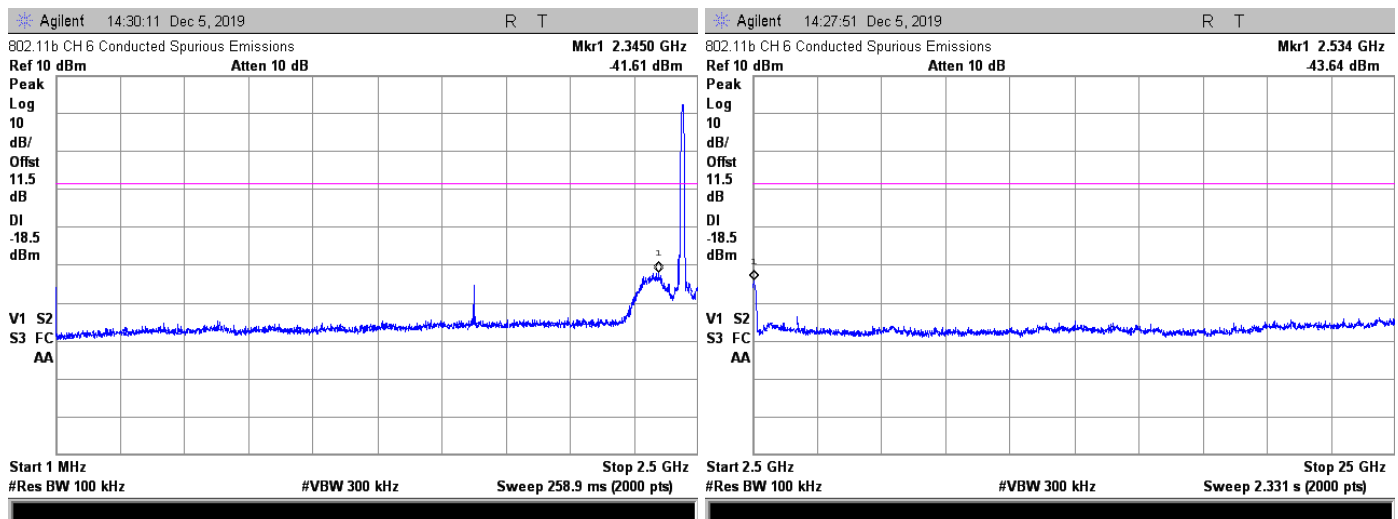
Test Date: December 6, 2019

Judgement: Pass by at least 15 dB

#### 802.11b

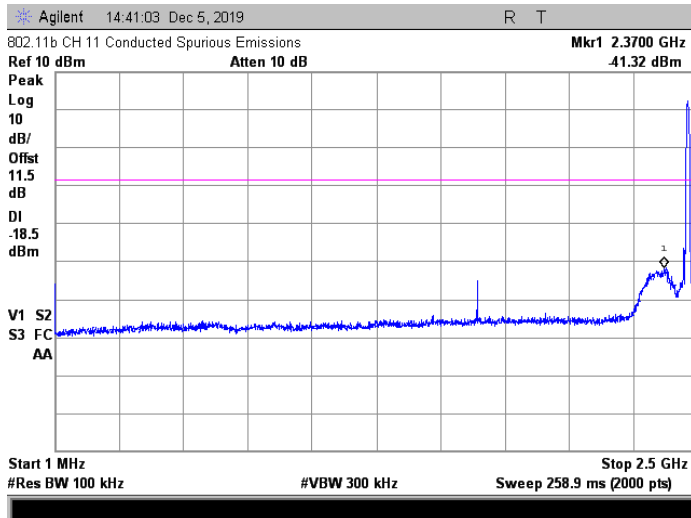


#### Channel 1

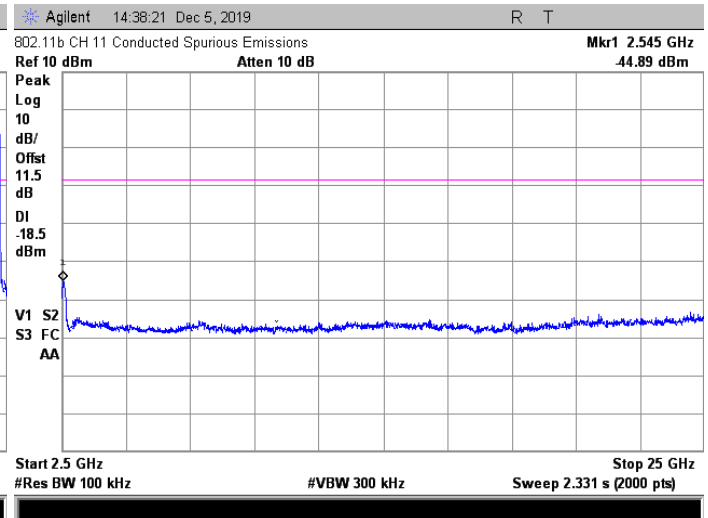


#### Channel 6

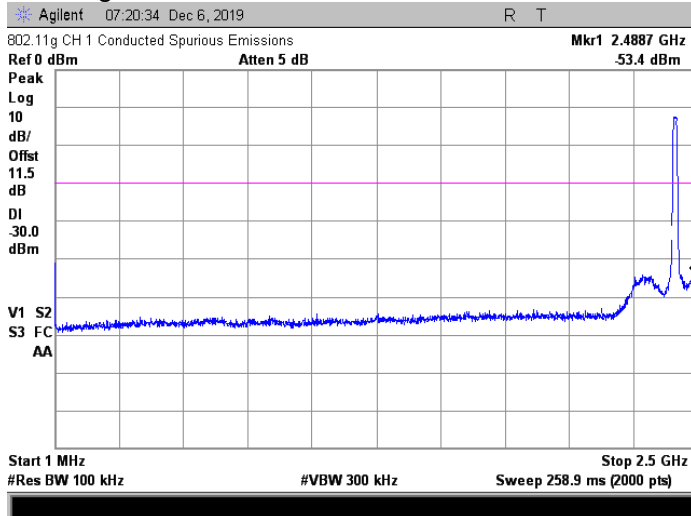
The Pink line is 20 dB below the fundamental.



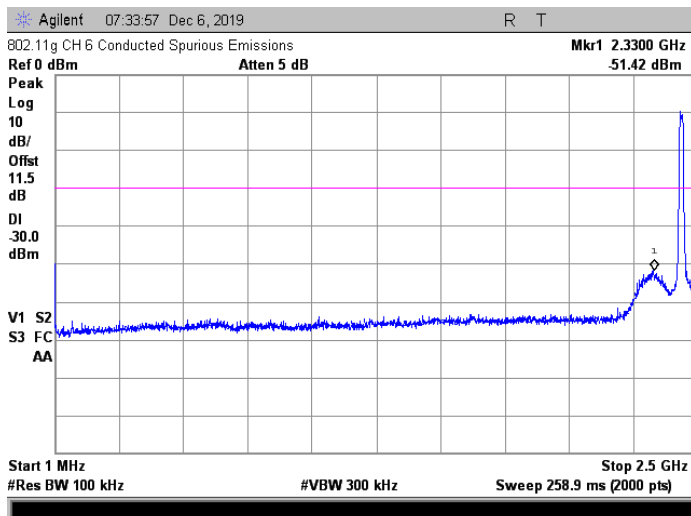
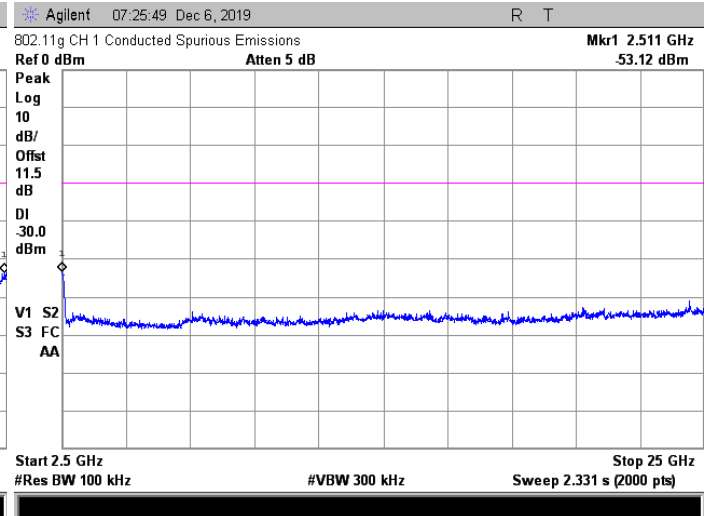
Channel 11



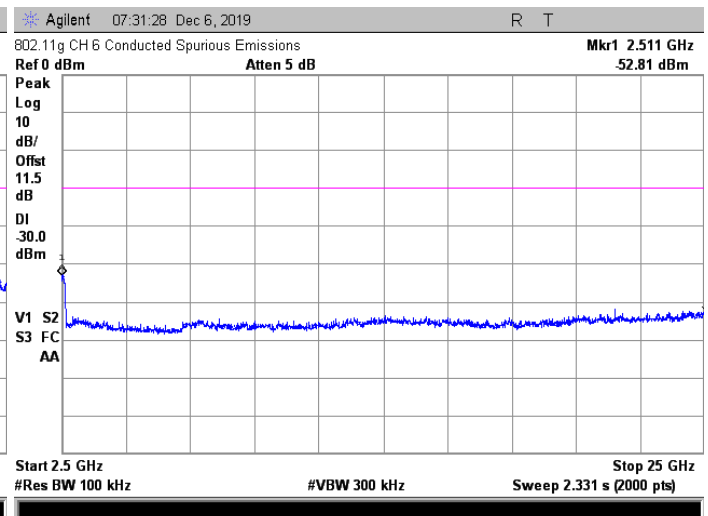
802.11g

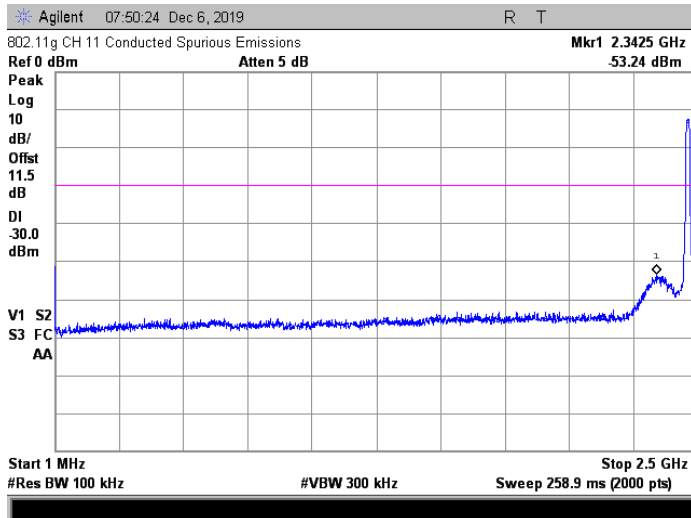


Channel 1



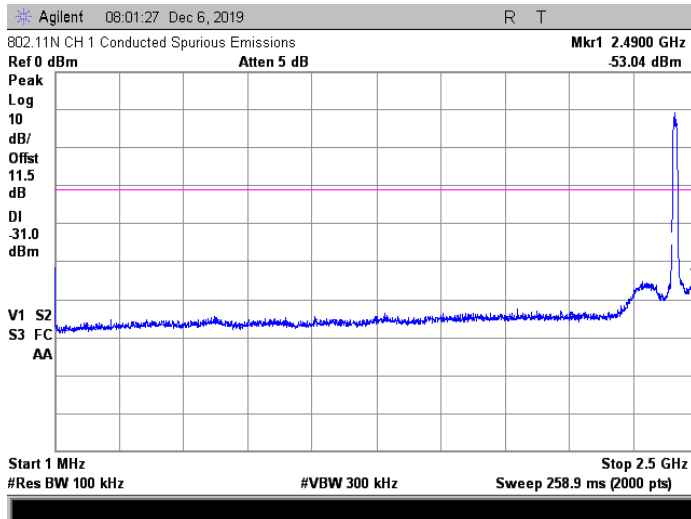
Channel 6



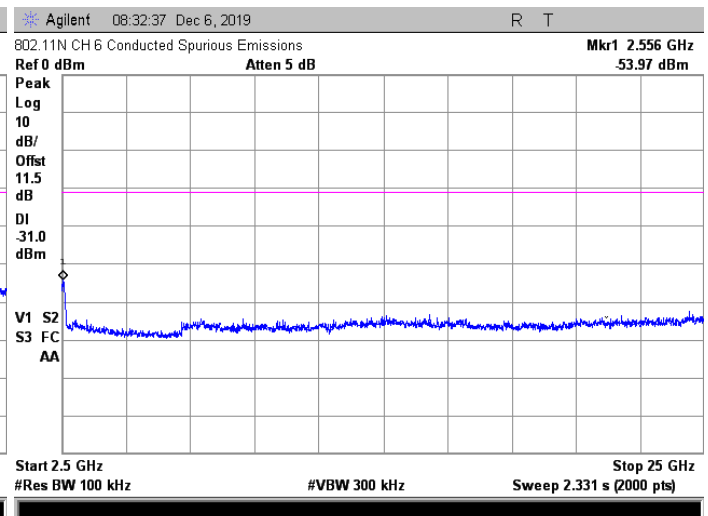
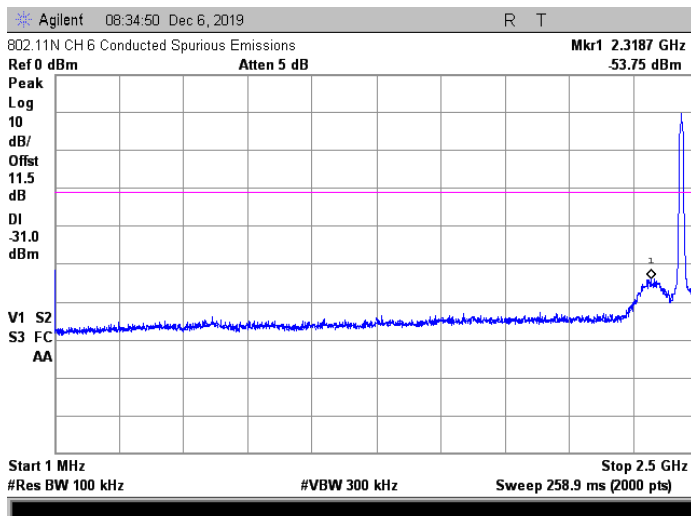
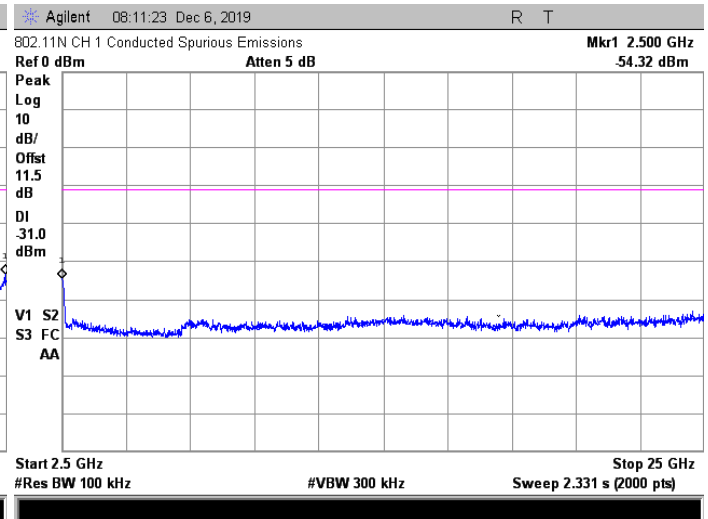
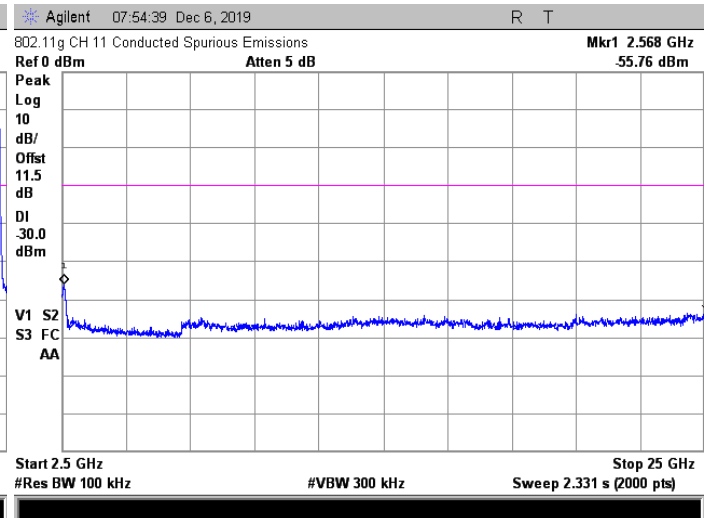


Channel 11

802.11n

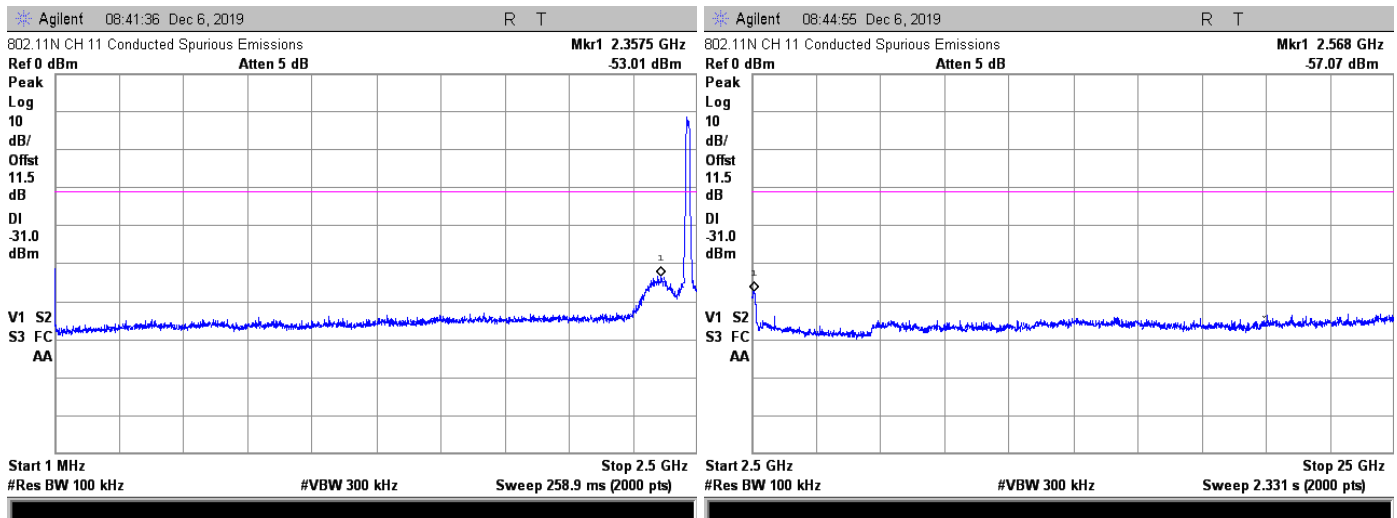


Channel 1



Channel 6

The Pink line is 20 dB below the fundamental.



Channel 11

The Pink line is 20 dB below the fundamental.

### 13.6 Spurious Radiated Emissions

The procedures were in accordance to FCC DTS Measurement Guideline 558074 D01, Section 12.1 and ANSI C63.10.

Radiated emission measurements were performed with linearly polarized broadband antennas. The results obtained with these antennas can be correlated with results obtained with a tuned dipole antenna. The radiated emission measurements were performed with a spectrum analyzer. The bandwidth used from 30 MHz to 1000 MHz is 120 kHz. Above 1 GHz, a 1 MHz bandwidth is used. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists. Figure 4 herein lists the details of the test equipment used during radiated emissions tests.

For tests from 1 to 10 GHz, a high pass filter was used to reduce the fundamental emission. High pass filters were not needed above 10 GHz, since the preamplifiers attenuated the fundamental emission. Figure 4 herein lists the details of the test equipment used during radiated emissions tests.

Radiated emissions measurements were performed inside of an anechoic chamber at a test distance of 3 meters. The anechoic chamber is designated as Chamber E. This Chamber meets the Site Attenuation requirements of ANSI C63.4. Chamber E is located at 12 Devonwood Ave. Romeoville, Illinois EMI test lab.

The entire frequency range from 30 to 25,000 MHz was slowly scanned with particular attention paid to those frequency ranges which appeared high. Measurements were performed using two antenna polarizations, (vertical and horizontal). The worst-case emissions were recorded. All measurements may be performed using either the peak, average or quasi-peak detector functions. If the peak detector data exceeds or is marginally close to the limits, the measurements are repeated using a quasi-peak detector or average function as required by the specification for final determination of compliance.

The detected emission levels were maximized by rotating the EUT, adjusting the positions of all cables, and by scanning the measurement antenna from 1 to 4 meters above the ground.

#### 13.6.1 Radiated Emissions Field Strength Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and by subtracting the Amplifier Gain from the measured reading. The antenna factor converts the voltage reading in dBuV to field strength in dBuV/meter. The basic equation is as follows:



$$FS = RA + AF + CF - AG$$

Where: FS = Field Strength in dBuV/m

RA = Receiver Amplitude dBuV

AF = Antenna Factor dB/m

CF = Cable Attenuation Factor dB

AG = Amplifier Gain dB

HPF = High pass Filter Loss dB

### 13.7 Radiated Emissions Test Results

|               |                                                                            |
|---------------|----------------------------------------------------------------------------|
| Test Date     | 11/21/2019 & 12/03/2019                                                    |
| Test Distance | 3 Meters                                                                   |
| Specification | FCC Part 15 Subpart C & RSS-GEN                                            |
| Abbreviations | Pol = Antenna Polarization; V = Vertical; H = Horizontal; P = peak; Q = QP |
| Configuration | The EUT is in the transmit mode with the receiver on                       |

This table includes all emissions except Fundamental, Band Edge, and Harmonics emissions.

| Freq. MHz | Meter Reading dBuV | Dect. | Ant. Pol. | Ant Factor dB/m | Cbl/amp Factors | Dist Fact dB | EUT dBuV/m | Limit dBuV/m | Margin Under Limit dB | Note |
|-----------|--------------------|-------|-----------|-----------------|-----------------|--------------|------------|--------------|-----------------------|------|
| 34.4      | 19.4               | P     | H         | 12.4            | 0.6             | 0.0          | 32.3       | 40.0         | 7.7                   |      |
| 52.7      | 21.0               | P     | H         | 9.4             | 0.7             | 0.0          | 31.1       | 40.0         | 8.9                   |      |
| 80.3      | 16.8               | P     | H         | 9.4             | 0.9             | 0.0          | 27.1       | 40.0         | 12.9                  |      |
| 120.1     | 14.7               | P     | H         | 11.6            | 1.1             | 0.0          | 27.4       | 43.5         | 16.1                  |      |
| 189.7     | 16.6               | P     | H         | 13.8            | 1.4             | 0.0          | 31.9       | 43.5         | 11.6                  |      |
| 204.0     | 12.5               | P     | H         | 14.5            | 1.5             | 0.0          | 28.4       | 43.5         | 15.1                  |      |
| 218.4     | 16.2               | P     | H         | 14.9            | 1.5             | 0.0          | 32.7       | 46.0         | 13.3                  |      |
| 230.0     | 13.3               | P     | H         | 15.1            | 1.6             | 0.0          | 30.0       | 46.0         | 16.0                  |      |
| 253.9     | 18.1               | P     | H         | 12.1            | 1.6             | 0.0          | 31.8       | 46.0         | 14.2                  |      |
| 284.8     | 16.6               | P     | H         | 13.5            | 1.8             | 0.0          | 31.8       | 46.0         | 14.2                  |      |
| 306.8     | 15.1               | P     | H         | 15.1            | 1.8             | 0.0          | 32.1       | 46.0         | 13.9                  |      |
| 339.0     | 12.9               | P     | H         | 13.9            | 1.9             | 0.0          | 28.7       | 46.0         | 17.3                  |      |
| 350.3     | 21.1               | P     | H         | 14.6            | 1.9             | 0.0          | 37.6       | 46.0         | 8.4                   |      |
| 409.5     | 16.3               | P     | H         | 15.3            | 2.1             | 0.0          | 33.7       | 46.0         | 12.3                  |      |
| 480.7     | 10.6               | P     | H         | 16.9            | 2.3             | 0.0          | 29.8       | 46.0         | 16.2                  |      |
| 575.0     | 10.0               | P     | H         | 18.3            | 2.5             | 0.0          | 30.8       | 46.0         | 15.2                  |      |
| 752.5     | 11.0               | P     | H         | 21.6            | 2.9             | 0.0          | 35.5       | 46.0         | 10.5                  |      |
| 937.5     | 8.9                | P     | H         | 22.7            | 3.3             | 0.0          | 35.0       | 46.0         | 11.0                  |      |
| 1300.0    | 50.6               | P     | H         | 25.5            | -33.2           | 0.0          | 42.9       | 74.0         | 31.1                  | 1    |
| 1350.0    | 51.6               | P     | H         | 25.6            | -33.2           | 0.0          | 44.0       | 74.0         | 30.0                  | 1    |
| 1400.0    | 50.5               | P     | H         | 25.5            | -33.2           | 0.0          | 42.8       | 74.0         | 31.2                  | 1    |
| 1625.0    | 49.5               | P     | H         | 25.8            | -33.1           | 0.0          | 42.2       | 74.0         | 31.8                  | 1    |
| 2333.8    | 44.4               | A     | H         | 28.1            | -32.4           | 0.0          | 40.1       | 54.0         | 13.9                  |      |
| 2333.8    | 56.4               | P     | H         | 28.1            | -32.3           | 0.0          | 52.1       | 74.0         | 21.9                  | 1    |
| 2516.6    | 46.2               | A     | H         | 28.7            | -32.0           | 0.0          | 42.9       | 54.0         | 11.1                  |      |
| 2516.6    | 55.9               | P     | H         | 28.7            | -32.0           | 0.0          | 52.7       | 74.0         | 21.3                  | 1    |
| 2580.0    | 50.5               | P     | H         | 28.9            | -32.1           | 0.0          | 47.3       | 74.0         | 26.7                  | 1    |
| 3427.5    | 39.8               | P     | H         | 31.2            | -30.9           | 0.0          | 40.1       | 74.0         | 33.9                  | 1    |
| 3662.5    | 39.0               | P     | H         | 31.7            | -30.6           | 0.0          | 40.2       | 74.0         | 33.8                  | 1    |
| 3915.0    | 38.2               | P     | H         | 32.9            | -30.4           | 0.0          | 40.7       | 74.0         | 33.3                  | 1    |
| 3980.0    | 39.2               | P     | H         | 32.9            | -30.2           | 0.0          | 41.9       | 74.0         | 32.1                  | 1    |
| 4017.5    | 37.3               | P     | H         | 32.9            | -30.1           | 0.0          | 40.1       | 74.0         | 33.9                  | 1    |
| 4062.5    | 44.8               | P     | H         | 32.9            | -30.0           | 0.0          | 47.7       | 74.0         | 26.3                  | 1    |
| 4807.5    | 35.8               | P     | H         | 33.5            | -28.8           | 0.0          | 40.4       | 74.0         | 33.6                  | 1    |
| 5195.0    | 37.0               | P     | H         | 34.0            | -28.1           | 0.0          | 42.9       | 74.0         | 31.1                  | 1    |



| Freq.<br>MHz | Meter<br>Reading<br>dBuV | Dect. | Ant.<br>Pol. | Ant<br>Factor<br>dB/m | Cbl/amp<br>Factors | Dist<br>Fact<br>dB | EUT<br>dBuV/m | Limit<br>dBuV/m | Margin<br>Under<br>Limit dB | Note |
|--------------|--------------------------|-------|--------------|-----------------------|--------------------|--------------------|---------------|-----------------|-----------------------------|------|
| 5705.0       | 36.8                     | P     | H            | 34.2                  | -27.3              | 0.0                | 43.7          | 74.0            | 30.3                        | 1    |
| 5892.5       | 36.9                     | P     | H            | 34.4                  | -27.3              | 0.0                | 44.0          | 74.0            | 30.0                        | 1    |
| 6102.5       | 36.2                     | P     | H            | 34.8                  | -26.9              | 0.0                | 44.1          | 74.0            | 29.9                        | 1    |
| 6500.0       | 39.4                     | P     | H            | 34.5                  | -26.4              | 0.0                | 47.5          | 74.0            | 26.5                        | 1    |
| 40.5         | 21.9                     | P     | V            | 11.1                  | 0.6                | 0.0                | 33.7          | 40.0            | 6.3                         |      |
| 65.9         | 18.3                     | P     | V            | 9.2                   | 0.8                | 0.0                | 28.3          | 40.0            | 11.7                        |      |
| 89.1         | 15.9                     | P     | V            | 9.7                   | 1.0                | 0.0                | 26.6          | 43.5            | 16.9                        |      |
| 122.8        | 17.2                     | P     | V            | 11.8                  | 1.1                | 0.0                | 30.1          | 43.5            | 13.4                        |      |
| 149.3        | 16.3                     | P     | V            | 12.8                  | 1.2                | 0.0                | 30.4          | 43.5            | 13.1                        |      |
| 176.4        | 21.0                     | P     | V            | 13.2                  | 1.4                | 0.0                | 35.5          | 43.5            | 8.0                         |      |
| 194.6        | 6.2                      | Q     | V            | 14.1                  | 1.4                | 0.0                | 21.8          | 43.5            | 21.7                        |      |
| 207.4        | 16.2                     | P     | V            | 14.6                  | 1.5                | 0.0                | 32.2          | 43.5            | 11.3                        |      |
| 228.9        | 14.3                     | P     | V            | 15.1                  | 1.5                | 0.0                | 31.0          | 46.0            | 15.0                        |      |
| 243.3        | 13.8                     | P     | V            | 15.2                  | 1.6                | 0.0                | 30.6          | 46.0            | 15.4                        |      |
| 275.3        | 18.0                     | P     | V            | 12.9                  | 1.7                | 0.0                | 32.6          | 46.0            | 13.4                        |      |
| 284.8        | 20.3                     | P     | V            | 13.5                  | 1.8                | 0.0                | 35.5          | 46.0            | 10.5                        |      |
| 303.0        | 19.7                     | P     | V            | 14.8                  | 1.8                | 0.0                | 36.3          | 46.0            | 9.7                         |      |
| 432.2        | 16.5                     | P     | V            | 16.3                  | 2.2                | 0.0                | 35.0          | 46.0            | 11.0                        |      |
| 467.5        | 15.7                     | P     | V            | 16.9                  | 2.3                | 0.0                | 34.8          | 46.0            | 11.2                        |      |
| 608.8        | 14.5                     | P     | V            | 18.7                  | 2.6                | 0.0                | 35.8          | 46.0            | 10.2                        |      |
| 785.0        | 16.8                     | P     | V            | 21.5                  | 3.0                | 0.0                | 41.3          | 46.0            | 4.7                         |      |
| 805.0        | 12.9                     | P     | V            | 20.1                  | 3.1                | 0.0                | 36.1          | 46.0            | 9.9                         |      |
| 878.8        | 12.5                     | P     | V            | 22.3                  | 3.2                | 0.0                | 38.1          | 46.0            | 7.9                         |      |
| 987.5        | 9.1                      | P     | V            | 22.9                  | 3.4                | 0.0                | 35.4          | 54.0            | 18.6                        |      |
| 1000.0       | 39.9                     | P     | V            | 24.3                  | -33.0              | 0.0                | 31.2          | 54.0            | 22.8                        | 1    |
| 1067.5       | 42.8                     | P     | V            | 24.9                  | -33.3              | 0.0                | 34.5          | 74.0            | 39.5                        | 1    |
| 1215.0       | 47.7                     | P     | V            | 25.5                  | -33.2              | 0.0                | 40.0          | 74.0            | 34.0                        | 1    |
| 1400.0       | 48.6                     | P     | V            | 25.5                  | -33.2              | 0.0                | 40.9          | 74.0            | 33.1                        | 1    |
| 1930.0       | 47.8                     | P     | V            | 27.8                  | -32.7              | 0.0                | 42.9          | 74.0            | 31.1                        | 1    |
| 2247.5       | 48.1                     | P     | V            | 27.7                  | -32.5              | 0.0                | 43.3          | 74.0            | 30.7                        | 1    |
| 2326.0       | 53.6                     | A     | V            | 28.0                  | -32.4              | 0.0                | 49.2          | 54.0            | 4.8                         |      |
| 2326.0       | 61.2                     | P     | V            | 28.0                  | -32.4              | 0.0                | 56.9          | 74.0            | 17.1                        |      |
| 2522.1       | 56.9                     | P     | V            | 28.7                  | -32.0              | 0.0                | 53.6          | 74.0            | 20.4                        |      |
| 2522.1       | 45.8                     | A     | V            | 28.7                  | -32.0              | 0.0                | 42.5          | 54.0            | 11.5                        |      |
| 2590.0       | 52.4                     | P     | V            | 28.9                  | -32.1              | 0.0                | 49.2          | 74.0            | 24.8                        | 1    |
| 3377.5       | 39.7                     | P     | V            | 31.2                  | -30.9              | 0.0                | 40.0          | 74.0            | 34.0                        | 1    |
| 3740.0       | 38.6                     | P     | V            | 32.2                  | -30.3              | 0.0                | 40.5          | 74.0            | 33.5                        | 1    |
| 4060.7       | 48.0                     | P     | V            | 32.9                  | -30.0              | 0.0                | 50.9          | 74.0            | 23.1                        |      |
| 4060.7       | 43.2                     | A     | V            | 32.9                  | -30.0              | 0.0                | 46.1          | 54.0            | 7.9                         |      |
| 4290.0       | 37.2                     | P     | V            | 32.7                  | -29.8              | 0.0                | 40.1          | 74.0            | 33.9                        | 1    |
| 4517.5       | 36.6                     | P     | V            | 33.4                  | -29.3              | 0.0                | 40.7          | 74.0            | 33.3                        | 1    |
| 4875.0       | 45.9                     | P     | V            | 33.5                  | -28.7              | 0.0                | 50.7          | 74.0            | 23.3                        | 1    |
| 5087.5       | 35.4                     | P     | V            | 33.8                  | -28.3              | 0.0                | 40.8          | 74.0            | 33.2                        | 1    |
| 5460.0       | 35.9                     | P     | V            | 34.3                  | -27.8              | 0.0                | 42.4          | 74.0            | 31.6                        | 1    |
| 5830.0       | 37.3                     | P     | V            | 34.2                  | -27.4              | 0.0                | 44.2          | 74.0            | 29.8                        | 1    |
| 6255.0       | 36.7                     | P     | V            | 34.8                  | -27.0              | 0.0                | 44.6          | 74.0            | 29.4                        | 1    |
| 6460.0       | 36.4                     | P     | V            | 34.5                  | -26.5              | 0.0                | 44.4          | 74.0            | 29.6                        | 1    |
| 6635.0       | 36.6                     | P     | V            | 34.9                  | -26.4              | 0.0                | 45.1          | 74.0            | 28.9                        | 1    |
| 6872.5       | 36.3                     | P     | V            | 35.3                  | -26.4              | 0.0                | 45.2          | 74.0            | 28.8                        | 1    |

Note1 : Peak reading below Average limits, so average readings not performed for that frequency.

Judgment: Passed by 4.7 dB

No other emissions were detected in within 10 db of the limits.



Harmonic Emissions above 1 GHz; There is no radiated limit on the fundamental

|                                             |      |                            |      |            |      |               | EUT         | Peak    | Ave  | Peak   | Ave | Margin |                |
|---------------------------------------------|------|----------------------------|------|------------|------|---------------|-------------|---------|------|--------|-----|--------|----------------|
| hrm                                         | Tx   | Spectrum Analyzer Readings |      |            |      | Corr.         | Emission    | Tot. FS |      | Limit  |     | Under  |                |
| #                                           | Freq | Vertical                   |      | Horizontal |      | Fact.<br>dB/m | Freq<br>MHz | dBuV/m  |      | dBuV/m |     | Limit  | 802.11<br>Mode |
|                                             |      | Peak                       | Ave  | Peak       | Ave  |               |             |         |      |        |     |        |                |
| BE                                          | 2412 | 46.9                       | 44.5 | 51.3       | 49.7 | -3.0          | 2390.0      | 48.3    | 46.7 | 74     | 54  | 7.3    | b              |
| 2                                           | 2412 | 43.4                       | 41.8 | 45.9       | 43.8 | 3.2           | 4824.0      | 49.1    | 47.0 | 74     | 54  | 7.0    | b              |
| 3                                           | 2412 | 40.7                       | 38.7 | 40.9       | 39.0 | 8.1           | 7236.0      | 49.0    | 47.1 | 74     | 54  | 6.9    | b              |
| 2                                           | 2437 | 45.2                       | 43.6 | 44.9       | 43.0 | 3.4           | 4874.0      | 48.6    | 47.0 | 74     | 54  | 7.0    | b              |
| 3                                           | 2437 | 43.1                       | 41.0 | 43.8       | 41.3 | 8.6           | 7311.0      | 52.4    | 49.9 | 74     | 54  | 4.1    | b              |
| BE                                          | 2462 | 47.0                       | 44.7 | 46.6       | 44.3 | -2.6          | 2483.5      | 44.4    | 42.1 | 74     | 54  | 11.9   | b              |
| 2                                           | 2462 | 41.0                       | 38.8 | 39.5       | 37.3 | 3.4           | 4924.0      | 44.4    | 42.2 | 74     | 54  | 11.8   | b              |
| 3                                           | 2462 | 38.1                       | 36.3 | 39.7       | 38.0 | 8.9           | 7386.0      | 48.6    | 46.9 | 74     | 54  | 7.1    | b              |
|                                             |      |                            |      |            |      |               |             |         |      |        |     |        |                |
| BE                                          | 2412 | 45.6                       | 40.1 | 50.5       | 45.9 | -3.0          | 2390.0      | 47.5    | 42.9 | 74     | 54  | 11.1   | g              |
| 2                                           | 2412 | 39.1                       | 33.6 | 45.1       | 40.2 | 3.2           | 4824.0      | 48.3    | 43.4 | 74     | 54  | 10.6   | g              |
| 3                                           | 2412 | 37.4                       | 31.9 | 38.2       | 33.6 | 8.1           | 7236.0      | 46.3    | 41.7 | 74     | 54  | 12.3   | g              |
| 2                                           | 2437 | 38.4                       | 32.9 | 44.7       | 40.0 | 3.4           | 4874.0      | 48.1    | 43.4 | 74     | 54  | 10.6   | g              |
| 3                                           | 2437 | 39.2                       | 33.7 | 38.6       | 33.5 | 8.6           | 7311.0      | 47.8    | 42.3 | 74     | 54  | 11.7   | g              |
| BE                                          | 2462 | 45.2                       | 39.7 | 53.4       | 48.1 | -2.6          | 2483.5      | 50.8    | 45.5 | 74     | 54  | 8.5    | g              |
| 2                                           | 2462 | 38.3                       | 32.8 | 45.0       | 40.2 | 3.4           | 4924.0      | 48.4    | 43.6 | 74     | 54  | 10.4   | g              |
| 3                                           | 2462 | 38.5                       | 33.0 | 38.3       | 33.2 | 8.9           | 7386.0      | 47.4    | 42.1 | 74     | 54  | 11.9   | g              |
|                                             |      |                            |      |            |      |               |             |         |      |        |     |        |                |
| BE                                          | 2412 | 47.5                       | 42.4 | 49.8       | 44.1 | -3.0          | 2390.0      | 46.8    | 41.1 | 74     | 54  | 12.9   | N              |
| 2                                           | 2412 | 38.9                       | 33.4 | 38.1       | 32.7 | 3.2           | 4824.0      | 42.1    | 36.6 | 74     | 54  | 17.4   | N              |
| 3                                           | 2412 | 38.9                       | 33.5 | 37.3       | 32.2 | 8.1           | 7236.0      | 47.0    | 41.6 | 74     | 54  | 12.4   | N              |
| 2                                           | 2437 | 40.3                       | 34.5 | 41.1       | 35.6 | 3.4           | 4874.0      | 44.5    | 39.0 | 74     | 54  | 15.0   | N              |
| 3                                           | 2437 | 38.7                       | 32.8 | 37.7       | 32.0 | 8.6           | 7311.0      | 47.3    | 41.4 | 74     | 54  | 12.6   | N              |
| BE                                          | 2462 | 48.7                       | 43.5 | 52.9       | 47.5 | -2.6          | 2483.5      | 50.3    | 44.9 | 74     | 54  | 9.1    | N              |
| 2                                           | 2462 | 38.1                       | 32.5 | 38.3       | 32.3 | 3.4           | 4924.0      | 41.7    | 35.9 | 74     | 54  | 18.1   | N              |
| 3                                           | 2462 | 37.6                       | 31.9 | 37.7       | 32.1 | 8.9           | 7386.0      | 46.6    | 41.0 | 74     | 54  | 13.0   | N              |
| Column numbers (see below for explanations) |      |                            |      |            |      |               |             |         |      |        |     |        |                |
| 1                                           | 2    | 3                          | 4    | 5          | 6    | 7             | 8           | 9       | 10   | 11     | 12  | 13     | 14             |

Notes on Columns:

Column #1. hrm = Harmonic; BE = Band Edge emissions

Column #2. Frequency of Transmitter.

Column #3. Peak reading readings from the spectrum analyzer (Vertical Pol)

Column #4. Average reading readings from the spectrum analyzer (Vertical Pol)

Column #5. Peak reading readings from the spectrum analyzer (Horizontal Pol)

Column #6. Average reading readings from the spectrum analyzer (Horizontal Pol)

Column #7. Corr. Factors = Cable Loss – Preamp Gain + Antenna Factor

Column #8. Frequency of Tested Emission

Column #9. Highest peak field strength at listed frequency.

Column #10. Highest Average field strength at listed frequency.

Column #11. Peak Limit using FCC 15.209

Column #12. Average Limit using FCC 15.209.

Column #13. The margin (last column) is the worst case margin under the peak or average limits for that row.

Column #14. 802.11b, g or N mode tested

Judgment: Passed by 4.1 dB

All emissions outside of the band from 2390 to 2483.5 were below the limits of 15.209.

No other Emissions were detected from 30 to 25,000 MHz within 10 dB of the limits.

All emissions were measured including outside restricted bands.



## 14.0 BLUETOOTH RESULTS

### 14.1 Radiated Emissions Procedures

The procedures were in accordance to ANSI C63.10.

Radiated emission measurements were performed with linearly polarized broadband antennas. The results obtained with these antennas can be correlated with results obtained with a tuned dipole antenna. The radiated emission measurements were performed with a spectrum analyzer. The bandwidth used from 30 MHz to 1000 MHz is 120 kHz. Above 1 GHz, a 1 MHz bandwidth is used. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists. Figure 4 herein lists the details of the test equipment used during radiated emissions tests.

For tests from 1 to 10 GHz, a high pass filter was used to reduce the fundamental emission. High pass filters were not needed above 10 GHz, since the preamplifiers attenuated the fundamental emission. Figure 4 herein lists the details of the test equipment used during radiated emissions tests.

Radiated emissions measurements were performed inside of an anechoic chamber at a test distance of 3 meters. The anechoic chamber is designated as Chamber E. This Chamber meets the Site Attenuation requirements of ANSI C63.4. Chamber E is located at 12 Devonwood Ave. Romeoville, Illinois EMI test lab.

The entire frequency range from 30 to 25,000 MHz was slowly scanned with particular attention paid to those frequency ranges which appeared high. Measurements were performed using two antenna polarizations, (vertical and horizontal). The worst-case emissions were recorded. All measurements may be performed using either the peak, average or quasi-peak detector functions. If the peak detector data exceeds or is marginally close to the limits, the measurements are repeated using a quasi-peak detector or average function as required by the specification for final determination of compliance.

The detected emission levels were maximized by rotating the EUT, adjusting the positions of all cables, and by scanning the measurement antenna from 1 to 4 meters above the ground.

### 14.2 Radiated Emissions Results

|               |                                                                            |
|---------------|----------------------------------------------------------------------------|
| Test Date     | 12-06-2019                                                                 |
| Test Distance | 3 Meters                                                                   |
| Specification | FCC Part 15 Subpart C & RSS-210 Section B.10                               |
| Abbreviations | Pol = Antenna Polarization; V = Vertical; H = Horizontal; P = peak; Q = QP |
| Configuration | Both bluetooth transmitters were on during the tests.                      |

The EUT is in the transmit mode with the receiver on

This table includes all emissions except Fundamental, Band edge and harmonics emissions.

| Freq. MHz | Meter Reading dBuV | Dect. | Ant. Pol. | Ant Factor dB/m | Cbl/amp Factors | Dist Fact dB | EUT dBuV/m | Limit dBuV/m | Margin Under Limit dB | Note |
|-----------|--------------------|-------|-----------|-----------------|-----------------|--------------|------------|--------------|-----------------------|------|
| 40.5      | 11.3               | P     | H         | 11.1            | 0.6             | 0.0          | 23.0       | 40.0         | 17.0                  |      |
| 67.6      | 12.7               | P     | H         | 9.3             | 0.8             | 0.0          | 22.8       | 40.0         | 17.2                  |      |
| 172.0     | 14.7               | P     | H         | 13.1            | 1.3             | 0.0          | 29.1       | 43.5         | 14.4                  |      |
| 183.0     | 15.3               | P     | H         | 13.6            | 1.4             | 0.0          | 30.3       | 43.5         | 13.2                  |      |
| 200.2     | 15.1               | P     | H         | 14.3            | 1.4             | 0.0          | 30.8       | 43.5         | 12.7                  |      |
| 249.9     | 15.3               | P     | H         | 15.4            | 1.6             | 0.0          | 32.3       | 46.0         | 13.7                  |      |
| 580.0     | 12.9               | P     | H         | 18.2            | 2.5             | 0.0          | 33.7       | 46.0         | 12.3                  |      |
| 601.3     | 10.0               | P     | H         | 18.6            | 2.6             | 0.0          | 31.2       | 46.0         | 14.8                  |      |



| Freq.<br>MHz | Meter<br>Reading<br>dBuV | Dect. | Ant.<br>Pol. | Ant<br>Factor<br>dB/m | Cbl/amp<br>Factors | Dist<br>Fact<br>dB | EUT<br>dBuV/m | Limit<br>dBuV/m | Margin<br>Under<br>Limit dB | Note |
|--------------|--------------------------|-------|--------------|-----------------------|--------------------|--------------------|---------------|-----------------|-----------------------------|------|
| 751.3        | 14.6                     | P     | H            | 21.6                  | 2.9                | 0.0                | 39.1          | 46.0            | 6.9                         |      |
| 876.3        | 11.9                     | P     | H            | 22.2                  | 3.2                | 0.0                | 37.3          | 46.0            | 8.7                         |      |
| 941.3        | 9.5                      | P     | H            | 22.6                  | 3.4                | 0.0                | 35.4          | 46.0            | 10.6                        |      |
| 1300.0       | 50.1                     | P     | H            | 25.5                  | -33.2              | 0.0                | 42.4          | 74.0            | 31.6                        | 1    |
| 1350.0       | 52.4                     | P     | H            | 25.6                  | -33.2              | 0.0                | 44.7          | 74.0            | 29.3                        | 1    |
| 1400.0       | 52.3                     | P     | H            | 25.5                  | -33.2              | 0.0                | 44.6          | 74.0            | 29.4                        | 1    |
| 1425.0       | 51.0                     | P     | H            | 25.5                  | -33.2              | 0.0                | 43.3          | 74.0            | 30.7                        | 1    |
| 1930.0       | 47.8                     | P     | H            | 27.8                  | -32.7              | 0.0                | 42.9          | 74.0            | 31.1                        | 1    |
| 2312.5       | 50.3                     | P     | H            | 27.9                  | -32.4              | 0.0                | 45.7          | 74.0            | 28.3                        | 1    |
| 2327.5       | 47.2                     | P     | H            | 28.0                  | -32.4              | 0.0                | 42.9          | 74.0            | 31.1                        | 1    |
| 2360.0       | 49.2                     | P     | H            | 28.3                  | -32.3              | 0.0                | 45.2          | 74.0            | 28.8                        | 1    |
| 2392.5       | 54.4                     | P     | H            | 28.5                  | -32.3              | 0.0                | 50.6          | 74.0            | 23.4                        | 1    |
| 2552.5       | 45.9                     | P     | H            | 28.8                  | -31.9              | 0.0                | 42.8          | 74.0            | 31.2                        | 1    |
| 4575.0       | 38.2                     | P     | H            | 33.5                  | -29.2              | 0.0                | 42.5          | 74.0            | 31.5                        | 1    |
| 4755.0       | 38.3                     | P     | H            | 33.4                  | -28.9              | 0.0                | 42.8          | 74.0            | 31.2                        | 1    |
| 5075.0       | 37.2                     | P     | H            | 33.7                  | -28.4              | 0.0                | 42.5          | 74.0            | 31.5                        | 1    |
| 5472.5       | 37.3                     | P     | H            | 34.3                  | -27.8              | 0.0                | 43.8          | 74.0            | 30.2                        | 1    |
| 42.2         | 9.8                      | Q     | V            | 10.6                  | 0.6                | 0.0                | 21.1          | 40.0            | 18.9                        | 1    |
| 50.4         | 5.8                      | Q     | V            | 9.4                   | 0.7                | 0.0                | 15.9          | 40.0            | 24.1                        | 1    |
| 74.8         | 19.2                     | P     | V            | 9.3                   | 0.9                | 0.0                | 29.4          | 40.0            | 10.6                        |      |
| 122.3        | 19.9                     | P     | V            | 11.8                  | 1.1                | 0.0                | 32.8          | 43.5            | 10.7                        |      |
| 130.6        | 18.9                     | P     | V            | 12.2                  | 1.2                | 0.0                | 32.3          | 43.5            | 11.2                        |      |
| 176.4        | 16.9                     | P     | V            | 13.2                  | 1.4                | 0.0                | 31.4          | 43.5            | 12.1                        |      |
| 200.2        | 17.0                     | P     | V            | 14.3                  | 1.4                | 0.0                | 32.8          | 43.5            | 10.7                        |      |
| 249.9        | 19.8                     | P     | V            | 15.4                  | 1.6                | 0.0                | 36.9          | 46.0            | 9.1                         |      |
| 250.1        | 22.6                     | P     | V            | 11.9                  | 1.6                | 0.0                | 36.2          | 46.0            | 9.8                         |      |
| 284.8        | 22.3                     | P     | V            | 13.5                  | 1.8                | 0.0                | 37.6          | 46.0            | 8.4                         |      |
| 325.1        | 13.0                     | P     | V            | 14.0                  | 1.9                | 0.0                | 28.9          | 46.0            | 17.1                        |      |
| 345.9        | 13.6                     | P     | V            | 14.1                  | 1.9                | 0.0                | 29.6          | 46.0            | 16.4                        |      |
| 423.4        | 11.1                     | P     | V            | 16.2                  | 2.2                | 0.0                | 29.5          | 46.0            | 16.5                        |      |
| 485.1        | 13.1                     | P     | V            | 17.1                  | 2.3                | 0.0                | 32.5          | 46.0            | 13.5                        |      |
| 571.3        | 18.7                     | P     | V            | 18.4                  | 2.5                | 0.0                | 39.7          | 46.0            | 6.3                         |      |
| 605.0        | 17.4                     | P     | V            | 18.6                  | 2.6                | 0.0                | 38.7          | 46.0            | 7.3                         |      |
| 612.5        | 13.5                     | P     | V            | 18.7                  | 2.6                | 0.0                | 34.8          | 46.0            | 11.2                        |      |
| 751.3        | 12.4                     | P     | V            | 21.6                  | 2.9                | 0.0                | 36.9          | 46.0            | 9.1                         |      |
| 902.5        | 11.7                     | P     | V            | 21.5                  | 3.3                | 0.0                | 36.5          | 46.0            | 9.5                         |      |
| 968.8        | 10.8                     | P     | V            | 23.2                  | 3.4                | 0.0                | 37.4          | 54.0            | 16.6                        |      |
| 1300.0       | 48.2                     | P     | V            | 25.5                  | -33.2              | 0.0                | 40.5          | 74.0            | 33.5                        | 1    |
| 1350.0       | 48.9                     | P     | V            | 25.6                  | -33.2              | 0.0                | 41.2          | 74.0            | 32.8                        | 1    |
| 1400.0       | 50.4                     | P     | V            | 25.5                  | -33.2              | 0.0                | 42.7          | 74.0            | 31.3                        | 1    |
| 1450.0       | 46.8                     | P     | V            | 25.5                  | -33.2              | 0.0                | 39.2          | 74.0            | 34.8                        | 1    |
| 2265.0       | 46.2                     | P     | V            | 27.7                  | -32.5              | 0.0                | 41.4          | 74.0            | 32.6                        | 1    |
| 2552.5       | 48.3                     | P     | V            | 28.8                  | -31.9              | 0.0                | 45.2          | 74.0            | 28.8                        | 1    |
| 2585.0       | 50.3                     | P     | V            | 28.9                  | -32.1              | 0.0                | 47.1          | 74.0            | 26.9                        | 1    |
| 2600.0       | 46.8                     | P     | V            | 28.9                  | -32.0              | 0.0                | 43.8          | 74.0            | 30.2                        | 1    |
| 3710.0       | 41.1                     | P     | V            | 32.0                  | -30.4              | 0.0                | 42.6          | 74.0            | 31.4                        | 1    |
| 3980.0       | 41.3                     | P     | V            | 32.9                  | -30.2              | 0.0                | 44.0          | 74.0            | 30.0                        | 1    |
| 4075.0       | 38.3                     | P     | V            | 32.9                  | -29.9              | 0.0                | 41.3          | 74.0            | 32.7                        | 1    |
| 4532.5       | 37.2                     | P     | V            | 33.4                  | -29.3              | 0.0                | 41.3          | 74.0            | 32.7                        | 1    |
| 5077.5       | 36.0                     | P     | V            | 33.7                  | -28.4              | 0.0                | 41.3          | 74.0            | 32.7                        | 1    |
| 5442.5       | 37.5                     | P     | V            | 34.3                  | -27.9              | 0.0                | 43.9          | 74.0            | 30.1                        | 1    |

Note1 : Peak reading below Average limits, so average readings not performed for that frequency.

Judgment: Passed by 6.3 dB



## HS Bluetooth Fundamental, Band edge, and harmonics

|                                             |      |                            |      |            |      |               | EUT         | Peak    | Ave  | Peak   | Ave | Margin |
|---------------------------------------------|------|----------------------------|------|------------|------|---------------|-------------|---------|------|--------|-----|--------|
| hrm                                         | Tx   | Spectrum Analyzer Readings |      |            |      | Corr.         | Emission    | Tot. FS |      | Limit  |     | Under  |
| #                                           | Freq | Vertical                   |      | Horizontal |      | Fact.<br>dB/m | Freq<br>MHz | dBuV/m  |      | dBuV/m |     | Limit  |
|                                             |      | Peak                       | Ave  | Peak       | Ave  |               |             |         |      |        |     |        |
| 1                                           | 2402 | 103.8                      | 85.9 | 100.9      | 83.8 | -3.0          | 2402.0      | 100.8   | 82.9 | 114    | 94  | 11.1   |
| BE                                          | 2402 | 63.8                       | 46.0 | 60.9       | 42.8 | -3.0          | 2400.0      | 60.8    | 43.0 | 74     | 54  | 11.0   |
| 2                                           | 2402 | 39.5                       | 21.8 | 46.9       | 29.1 | 3.2           | 4804.0      | 50.1    | 32.3 | 74     | 54  | 21.7   |
| 3                                           | 2402 | 44.2                       | 27.2 | 40.2       | 22.7 | 8.1           | 7206.0      | 52.3    | 35.3 | 74     | 54  | 18.7   |
| 1                                           | 2440 | 105.5                      | 87.8 | 99.4       | 81.6 | -2.8          | 2440.0      | 102.7   | 85.0 | 114    | 94  | 9.0    |
| 2                                           | 2440 | 39.4                       | 21.6 | 47.6       | 29.7 | 3.4           | 4880.0      | 51.0    | 33.1 | 74     | 54  | 20.9   |
| 3                                           | 2440 | 44.4                       | 26.2 | 40.3       | 22.9 | 8.6           | 7320.0      | 53.0    | 34.8 | 74     | 54  | 19.2   |
| 1                                           | 2480 | 103.6                      | 86.6 | 94.0       | 76.4 | -2.6          | 2480.0      | 101.0   | 84.0 | 114    | 94  | 10.0   |
| BE                                          | 2480 | 63.0                       | 45.2 | 53.4       | 35.1 | -2.6          | 2483.5      | 60.4    | 42.6 | 74     | 54  | 11.4   |
| 2                                           | 2480 | 40.5                       | 22.7 | 47.1       | 29.0 | 3.4           | 4960.0      | 50.5    | 32.4 | 74     | 54  | 21.6   |
| 3                                           | 2480 | 45.3                       | 27.0 | 41.2       | 23.1 | 8.9           | 7440.0      | 54.2    | 35.9 | 74     | 54  | 18.1   |
| Column numbers (see below for explanations) |      |                            |      |            |      |               |             |         |      |        |     |        |
| 1                                           | 2    | 3                          | 4    | 5          | 6    | 7             | 8           | 9       | 10   | 11     | 12  | 13     |

## Notes on Columns:

- Column #1. hrm = Harmonic; BE = Band Edge emissions  
 Column #2. Frequency of Transmitter.  
 Column #3. Peak reading readings from the spectrum analyzer (Vertical Pol)  
 Column #4. Average reading readings from the spectrum analyzer (Vertical Pol)  
 Column #5. Peak reading readings from the spectrum analyzer (Horizontal Pol)  
 Column #6. Average reading readings from the spectrum analyzer (Horizontal Pol)  
 Column #7. Corr. Factors = Cable Loss – Preamp Gain + Antenna Factor  
 Column #8. Frequency of Tested Emission  
 Column #9. Highest peak field strength at listed frequency.  
 Column #10. Highest Average field strength at listed frequency.  
 Column #11. Peak Limit using FCC 15.209  
 Column #12. Average Limit using FCC 15.209.  
 Column #13. The margin (last column) is the worst case margin under the peak or average limits for that row.

Judgment: Passed by 9.0 dB

All emissions outside of the band from 2340 to 2483.5 were below the limits of 15.209.  
 No other Emissions were detected from 30 to 25,000 MHz within 10 dB of the limits.



## LENS Bluetooth Fundamental, Band edge and harmonics

|                                             |      | Spectrum Analyzer Readings |      |            |      |               | EUT         | Peak    | Ave  | Peak   | Ave | Margin |
|---------------------------------------------|------|----------------------------|------|------------|------|---------------|-------------|---------|------|--------|-----|--------|
| hrm                                         | Tx   |                            |      |            |      | Corr.         | Emission    | Tot. FS |      | Limit  |     | Under  |
| #                                           | Freq | Vertical                   |      | Horizontal |      | Fact.<br>dB/m | Freq<br>MHz | dBuV/m  |      | dBuV/m |     | Limit  |
|                                             |      | Peak                       | Ave  | Peak       | Ave  |               |             |         |      |        |     |        |
| 1                                           | 2402 | 96.4                       | 77.8 | 88.1       | 68.3 | -3.0          | 2402.0      | 93.4    | 74.8 | 114    | 94  | 19.2   |
| BE                                          | 2402 | 62.6                       | 43.4 | 54.3       | 35.9 | -3.0          | 2400.0      | 59.6    | 40.4 | 74     | 54  | 13.6   |
| 2                                           | 2402 | 52.1                       | 32.8 | 51.2       | 31.6 | 3.2           | 4804.0      | 55.3    | 36.0 | 74     | 54  | 18.0   |
| 3                                           | 2402 | 47.8                       | 28.5 | 52.4       | 33.8 | 8.1           | 7206.0      | 60.5    | 41.9 | 74     | 54  | 12.1   |
| 4                                           | 2402 | 42.1                       | 23.0 | 38.6       | 19.1 | 0.0           | 9608.0      | 42.1    | 23.0 | 74     | 54  | 31.0   |
| 1                                           | 2440 | 100.4                      | 81.6 | 90.1       | 71.3 | -2.8          | 2440.0      | 97.6    | 78.8 | 114    | 94  | 15.2   |
| 2                                           | 2440 | 51.4                       | 32.9 | 50.0       | 30.6 | 3.4           | 4880.0      | 54.8    | 36.3 | 74     | 54  | 17.7   |
| 3                                           | 2440 | 46.0                       | 27.4 | 51.6       | 33.3 | 8.6           | 7320.0      | 60.2    | 41.9 | 74     | 54  | 12.1   |
| 4                                           | 2440 | 42.1                       | 23.0 | 41.8       | 22.3 | 0.0           | 9760.0      | 42.1    | 23.0 | 74     | 54  | 31.0   |
| 1                                           | 2480 | 97.3                       | 78.4 | 91.6       | 73.2 | -2.6          | 2480.0      | 94.7    | 75.8 | 114    | 94  | 18.2   |
| BE                                          | 2480 | 60.8                       | 41.4 | 55.1       | 36.1 | -2.6          | 2483.5      | 58.2    | 38.8 | 74     | 54  | 15.2   |
| 2                                           | 2480 | 52.3                       | 32.9 | 48.4       | 29.0 | 3.4           | 4960.0      | 55.7    | 36.3 | 74     | 54  | 17.7   |
| 3                                           | 2480 | 47.3                       | 28.2 | 52.3       | 32.7 | 8.9           | 7440.0      | 61.2    | 41.6 | 74     | 54  | 12.4   |
| 4                                           | 2480 | 37.7                       | 18.0 | 37.7       | 19.1 | 10.3          | 9920.0      | 48.0    | 29.4 | 74     | 54  | 24.6   |
| Column numbers (see below for explanations) |      |                            |      |            |      |               |             |         |      |        |     |        |
| 1                                           | 2    | 3                          | 4    | 5          | 6    | 7             | 8           | 9       | 10   | 11     | 12  | 13     |

## Notes on Columns:

- Column #1. hrm = Harmonic; BE = Band Edge emissions  
 Column #2. Frequency of Transmitter.  
 Column #3. Peak reading readings from the spectrum analyzer (Vertical Pol)  
 Column #4. Average reading readings from the spectrum analyzer (Vertical Pol)  
 Column #5. Peak reading readings from the spectrum analyzer (Horizontal Pol)  
 Column #6. Average reading readings from the spectrum analyzer (Horizontal Pol)  
 Column #7. Corr. Factors = Cable Loss – Preamp Gain + Antenna Factor  
 Column #8. Frequency of Tested Emission  
 Column #9. Highest peak field strength at listed frequency.  
 Column #10. Highest Average field strength at listed frequency.  
 Column #11. Peak Limit using FCC 15.209  
 Column #12. Average Limit using FCC 15.209.  
 Column #13. The margin (last column) is the worst case margin under the peak or average limits for that row.

Judgment: Passed by at least 10 dB

All emissions outside of the band from 2340 to 2483.5 were below the limits of 15.209.

No other Emissions were detected from 30 to 25,000 MHz within 10 dB of the limits.

### 14.3 Occupied Bandwidth Data

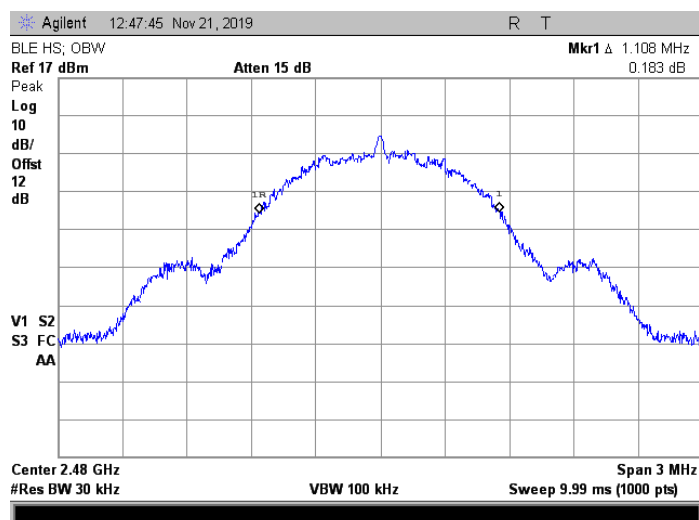
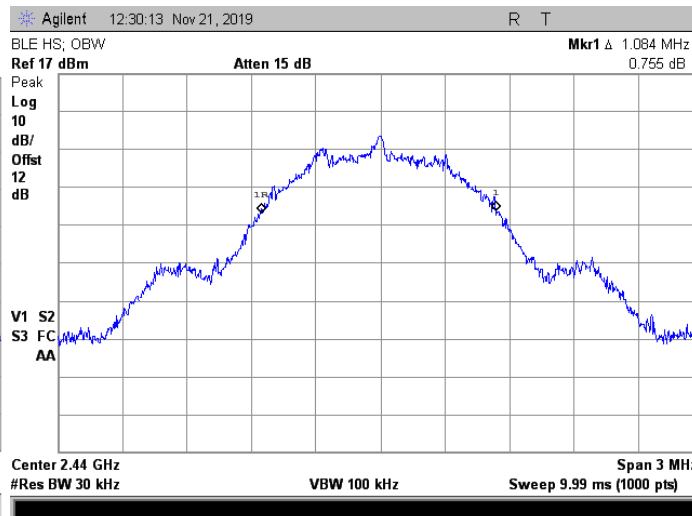
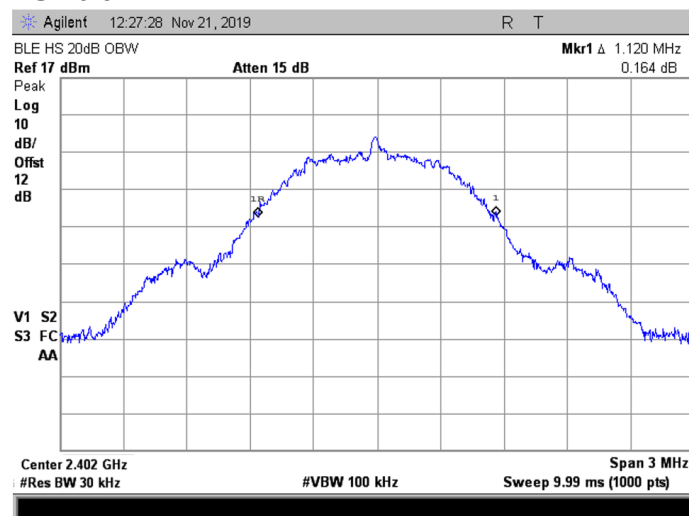
The occupied bandwidth of the RF output was measured using a spectrum analyzer. The bandwidth was measured using the peak detector function. The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation. The marker-to-peak function was set to the peak of the emission. Then the marker-delta function was used to measure 20 dB down one side of the emission. The marker-delta function was reset and then moved to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the bandwidth of the emission. The plots of the occupied bandwidth for the EUT are supplied on the following pages.



The 20 dB OBW is within the allowed 2400 to 2483.5 MHz authorourized band.

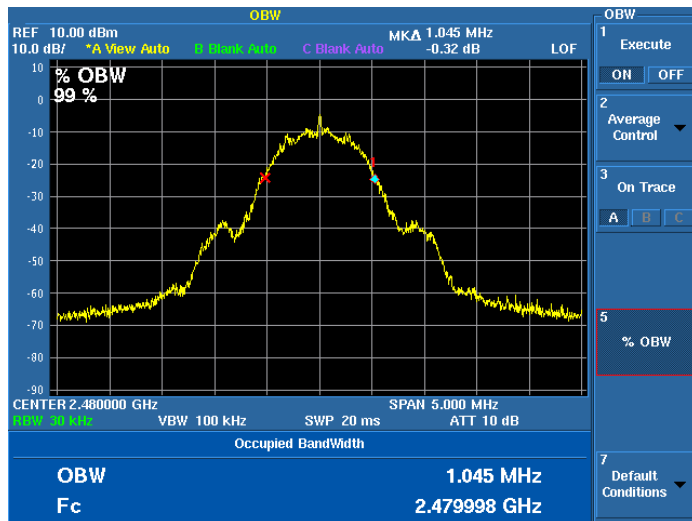
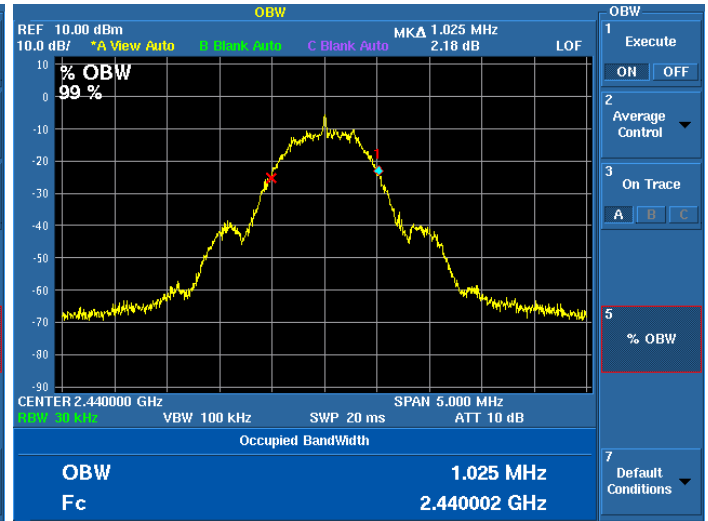
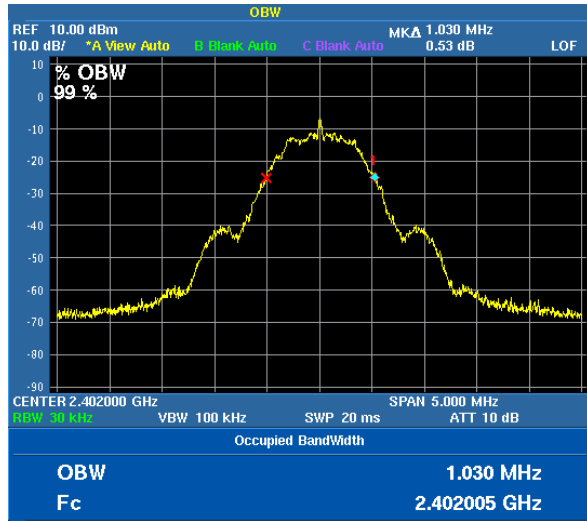
| BLE EUT | Channel | 20 dB OBW MHz | 99% EBW MHz |
|---------|---------|---------------|-------------|
| HS      | 2402    | 1.120         | 1.030       |
| HS      | 2440    | 1.084         | 1.025       |
| HS      | 2480    | 1.108         | 1.045       |
| LENS    | 2402    | 1.1806        | 1.090       |
| LENS    | 2440    | 1.1946        | 1.085       |
| LENS    | 2480    | 1.1926        | 1.080       |

### HS 20 dB

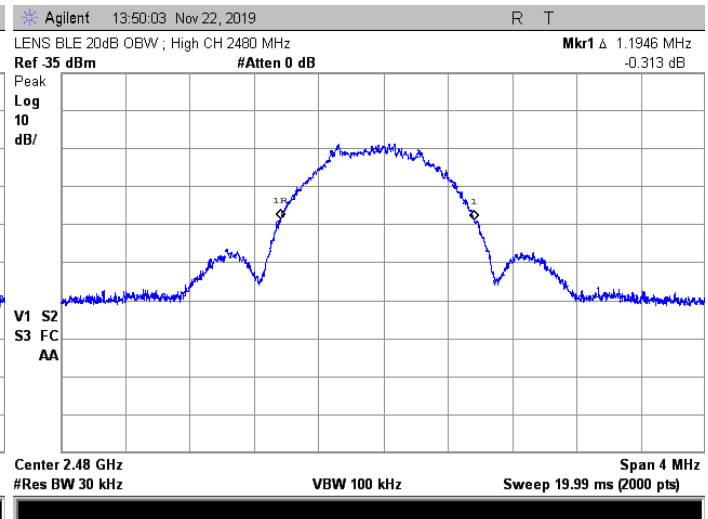
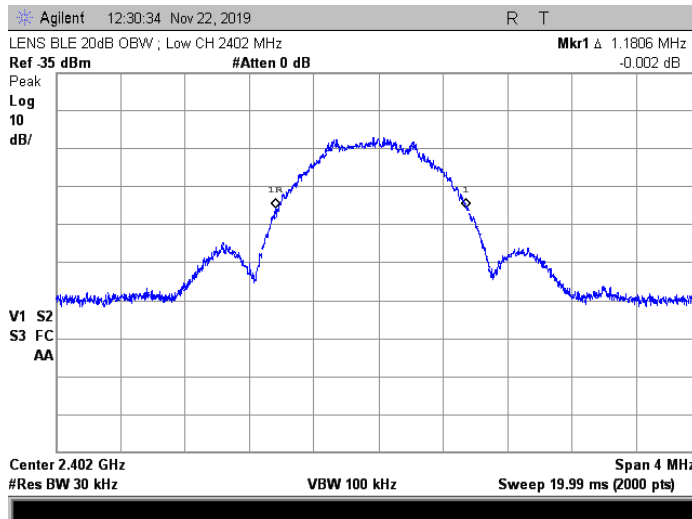


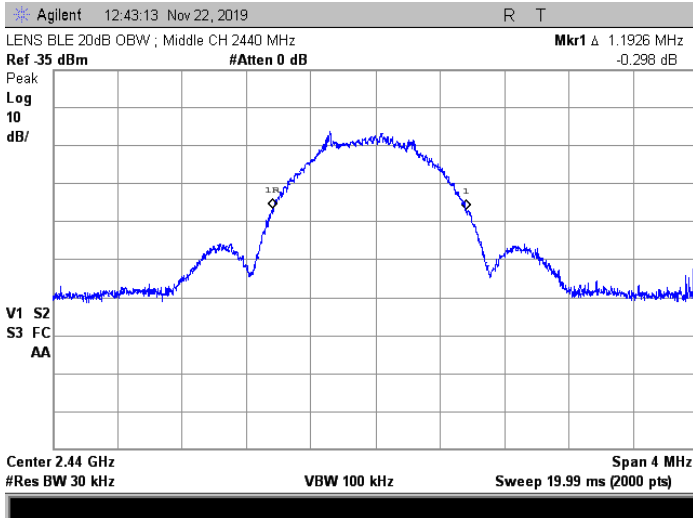


## HS BLE 99%

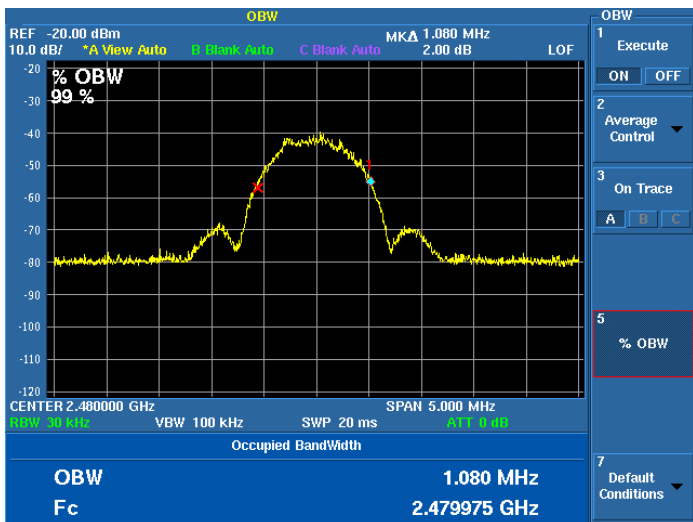
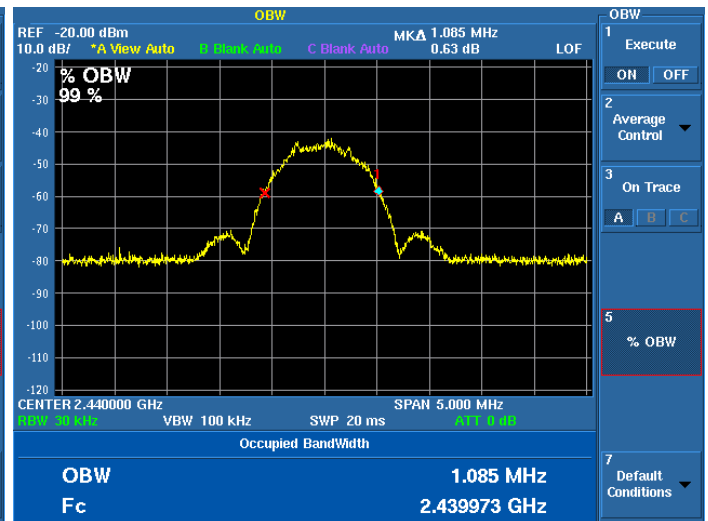
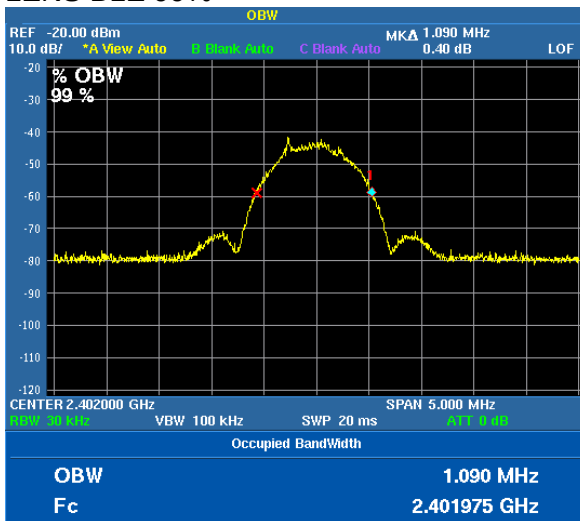


## LENS 20 dB





LENS BLE 99%





## 15.0 FCC 15.209 TESTS RESULTS

### 15.1 Magnetic Field Measurements and Decay Factor Calculations

Radiated emission measurements are performed with an EMCO shielded loop antenna. The antenna was rotated in order to find the maximize readings.

The distance correction factor is calculated as follows:

The distance factor in (dB) =  $DE \cdot 20 \cdot \log(TD/SD)$

Where: DE = Decay Exponent (2.0 is used for this)

TD = Test distance in meters. This is 3 meters

SD = Specification Distance in meters

From 9 kHz to 490 kHz, the Specification Distance is 300m therefore the distance factor is  $2 \cdot 20 \cdot \log(300/3) = 80$  dB.

From 490 kHz to 30 MHz, the Specification Distance is 30m therefore the distance factor is  $2 \cdot 20 \cdot \log(30/3) = 40$  dB.

#### 15.1.1 Magnetic Field Radiated Emissions Results (0.009 to 30 MHz)

|               |                                                        |
|---------------|--------------------------------------------------------|
| Test Date     | 12/20/2019                                             |
| EUT           | R2                                                     |
| Test Distance | 3 Meters                                               |
| Specification | FCC 15.209 & RSS-GEN table 5 limit for all frequencies |
| Tested by     | Chris Dalessio; Joseph Strzelecki                      |

| Freq (kHz) | Peak reading dBuV | Loop Ant Factor dB/m | Test Dist. (m) | Decay exp | Cable Loss dB | FCC Distance factor dB | Field Strength dBuV/m | RSS & FCC Limit dBuV/m | Margin under limit | Notes |
|------------|-------------------|----------------------|----------------|-----------|---------------|------------------------|-----------------------|------------------------|--------------------|-------|
| 13560      | 46.7              | 16.8                 | 3.0            | 2.0       | 0.4           | -40.0                  | 23.9                  | 29.5                   | 5.6                |       |
| 27120      | 15.6              | 16.0                 | 3.0            | 2.0       | 0.5           | -40.0                  | -7.9                  | 29.5                   | 37.4               |       |

All limits are general limits of FCC 15.209 or the RSS-Gen.

No other emissions were detected from 10 kHz to 30 MHz within 10 dB of the 15.209 or the RSS-GEN limits.

Judgement: Passed by 5.6 dB.

### 15.2 Occupied Bandwidth Data

The occupied bandwidth of the RF output was measured using a spectrum analyzer using a peak detector function and a narrow resolution bandwidth. A broadband antenna was used to receive the modulated signal. The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation. The spectrum analyzer display was digitized and plotted. The plots of the occupied bandwidth for the EUT are supplied on the following page.

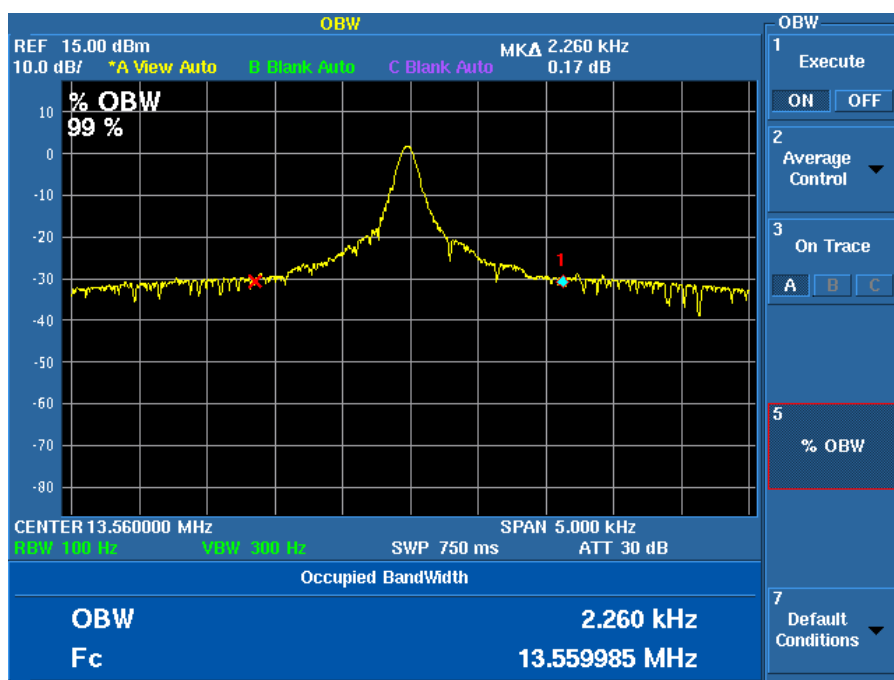
|                |                    |               |                            |
|----------------|--------------------|---------------|----------------------------|
| Model          | R2                 | Specification | FCC Part 15.209<br>RSS-GEN |
| Test Personnel | Richard Tichgelaar | Test Date     | 12/20/2019                 |

99% OBW = 2.26 kHz

Judgement: Pass



Figure 1. Occupied Bandwidth Plot



Worst case OBW

## 16.0 UNINTENTIONAL EMISSIONS (RECEIVE MODE)

|               |                                                                            |               |                           |
|---------------|----------------------------------------------------------------------------|---------------|---------------------------|
| Manufacturer  | Latchable, Inc.                                                            | Specification | FCC Part 15.209 & RSS-GEN |
| Model         | R2                                                                         | Test Date     | 12/19/2019                |
| Serial Number | RMC1                                                                       | Test Distance | 3 Meters                  |
| Abbreviations | Pol = Antenna Polarization; V = Vertical; H = Horizontal; P = peak; Q = QP |               |                           |
| Notes         | Corr. Factors = Cable Loss – Preamp Gain                                   |               |                           |
| Configuration | Receive mode                                                               |               |                           |

| Freq. MHz | Meter Reading dBuV | Dect. | Ant. Pol. | Ant Factor dB/m | Cbl/amp Factors dB | Dist Fact dB | EUT dBuV/m | Limit dBuV/m | Margin Under Limit dB | Note |
|-----------|--------------------|-------|-----------|-----------------|--------------------|--------------|------------|--------------|-----------------------|------|
| 40.5      | 13.7               | P     | H         | 11.1            | 0.6                | 0.0          | 25.5       | 40.0         | 14.5                  |      |
| 67.6      | 14.0               | P     | H         | 9.3             | 0.8                | 0.0          | 24.2       | 40.0         | 15.8                  |      |
| 112.9     | 17.9               | P     | H         | 11.1            | 1.1                | 0.0          | 30.1       | 43.5         | 13.4                  |      |
| 176.4     | 15.6               | P     | H         | 13.2            | 1.4                | 0.0          | 30.1       | 43.5         | 13.4                  |      |
| 187.5     | 14.3               | P     | H         | 13.7            | 1.4                | 0.0          | 29.4       | 43.5         | 14.1                  |      |
| 200.2     | 14.8               | P     | H         | 14.3            | 1.4                | 0.0          | 30.5       | 43.5         | 13.0                  |      |
| 249.9     | 22.8               | P     | H         | 15.4            | 1.6                | 0.0          | 39.9       | 46.0         | 6.1                   |      |
| 275.3     | 15.6               | P     | H         | 12.9            | 1.7                | 0.0          | 30.3       | 46.0         | 15.7                  |      |
| 284.8     | 20.6               | P     | H         | 13.5            | 1.8                | 0.0          | 35.9       | 46.0         | 10.1                  |      |
| 311.9     | 16.3               | P     | H         | 14.9            | 1.8                | 0.0          | 33.0       | 46.0         | 13.0                  |      |
| 325.1     | 14.3               | P     | H         | 14.0            | 1.9                | 0.0          | 30.1       | 46.0         | 15.9                  |      |
| 366.7     | 15.1               | P     | H         | 14.4            | 2.0                | 0.0          | 31.5       | 46.0         | 14.5                  |      |
| 374.9     | 15.2               | P     | H         | 14.7            | 2.0                | 0.0          | 31.9       | 46.0         | 14.1                  |      |
| 390.0     | 14.2               | P     | H         | 14.8            | 2.0                | 0.0          | 31.0       | 46.0         | 15.0                  |      |
| 425.3     | 12.3               | P     | H         | 16.3            | 2.2                | 0.0          | 30.8       | 46.0         | 15.2                  |      |
| 500.2     | 14.7               | P     | H         | 17.5            | 2.4                | 0.0          | 34.6       | 46.0         | 11.4                  |      |
| 592.5     | 10.2               | P     | H         | 18.6            | 2.6                | 0.0          | 31.4       | 46.0         | 14.6                  |      |



| Freq.<br>MHz | Meter<br>Reading<br>dBuV | Dect. | Ant.<br>Pol. | Ant<br>Factor<br>dB/m | Cbl/amp<br>Factors<br>dB | Dist<br>Fact<br>dB | EUT<br>dBuV/m | Limit<br>dBuV/m | Margin<br>Under<br>Limit dB | Note |
|--------------|--------------------------|-------|--------------|-----------------------|--------------------------|--------------------|---------------|-----------------|-----------------------------|------|
| 726.3        | 13.1                     | P     | H            | 20.1                  | 2.9                      | 0.0                | 36.0          | 46.0            | 10.0                        |      |
| 917.5        | 12.4                     | P     | H            | 22.7                  | 3.3                      | 0.0                | 38.4          | 46.0            | 7.6                         |      |
| 1400.0       | 52.5                     | P     | H            | 25.5                  | -33.2                    | 0.0                | 44.8          | 74.0            | 29.2                        | 1    |
| 1450.0       | 47.0                     | P     | H            | 25.5                  | -33.2                    | 0.0                | 39.3          | 74.0            | 34.7                        | 1    |
| 1927.5       | 42.7                     | P     | H            | 27.8                  | -32.7                    | 0.0                | 37.8          | 74.0            | 36.2                        | 1    |
| 2315.0       | 48.6                     | P     | H            | 28.0                  | -32.4                    | 0.0                | 44.2          | 74.0            | 29.8                        | 1    |
| 2530.0       | 49.3                     | P     | H            | 28.7                  | -31.9                    | 0.0                | 46.1          | 74.0            | 27.9                        | 1    |
| 2570.0       | 45.9                     | P     | H            | 28.9                  | -32.0                    | 0.0                | 42.8          | 74.0            | 31.2                        | 1    |
| 3712.5       | 37.3                     | P     | H            | 32.0                  | -30.4                    | 0.0                | 38.9          | 74.0            | 35.1                        | 1    |
| 4115.0       | 36.2                     | P     | H            | 32.8                  | -29.9                    | 0.0                | 39.2          | 74.0            | 34.8                        | 1    |
| 4550.0       | 34.2                     | P     | H            | 33.5                  | -29.2                    | 0.0                | 38.4          | 74.0            | 35.6                        | 1    |
| 4727.5       | 35.6                     | P     | H            | 33.5                  | -29.0                    | 0.0                | 40.1          | 74.0            | 33.9                        | 1    |
| 4877.5       | 37.7                     | P     | H            | 33.5                  | -28.7                    | 0.0                | 42.5          | 74.0            | 31.5                        | 1    |
| 5232.5       | 34.0                     | P     | H            | 34.0                  | -28.1                    | 0.0                | 39.9          | 74.0            | 34.1                        | 1    |
| 5852.5       | 33.9                     | P     | H            | 34.3                  | -27.3                    | 0.0                | 40.9          | 74.0            | 33.1                        | 1    |
| 32.2         | 17.7                     | P     | V            | 13.1                  | 0.6                      | 0.0                | 31.3          | 40.0            | 8.7                         |      |
| 41.0         | 21.3                     | P     | V            | 10.9                  | 0.6                      | 0.0                | 32.8          | 40.0            | 7.2                         |      |
| 70.3         | 20.5                     | Q     | V            | 9.3                   | 0.8                      | 0.0                | 30.7          | 40.0            | 9.3                         |      |
| 133.9        | 16.7                     | P     | V            | 12.3                  | 1.2                      | 0.0                | 30.2          | 43.5            | 13.3                        |      |
| 149.3        | 16.7                     | P     | V            | 12.8                  | 1.2                      | 0.0                | 30.7          | 43.5            | 12.8                        |      |
| 176.4        | 19.7                     | P     | V            | 13.2                  | 1.4                      | 0.0                | 34.2          | 43.5            | 9.3                         |      |
| 188.0        | 15.6                     | P     | V            | 13.7                  | 1.4                      | 0.0                | 30.7          | 43.5            | 12.8                        |      |
| 200.2        | 15.9                     | P     | V            | 14.3                  | 1.4                      | 0.0                | 31.6          | 43.5            | 11.9                        |      |
| 215.1        | 17.9                     | P     | V            | 14.8                  | 1.5                      | 0.0                | 34.2          | 43.5            | 9.3                         |      |
| 225.0        | 15.3                     | P     | V            | 15.1                  | 1.5                      | 0.0                | 31.9          | 46.0            | 14.1                        |      |
| 250.1        | 24.7                     | P     | V            | 11.9                  | 1.6                      | 0.0                | 38.3          | 46.0            | 7.7                         |      |
| 267.1        | 18.0                     | P     | V            | 12.3                  | 1.7                      | 0.0                | 32.0          | 46.0            | 14.0                        |      |
| 284.8        | 20.4                     | P     | V            | 13.5                  | 1.8                      | 0.0                | 35.6          | 46.0            | 10.4                        |      |
| 315.6        | 16.7                     | P     | V            | 14.6                  | 1.8                      | 0.0                | 33.2          | 46.0            | 12.8                        |      |
| 354.7        | 15.3                     | P     | V            | 14.8                  | 2.0                      | 0.0                | 32.0          | 46.0            | 14.0                        |      |
| 374.9        | 14.7                     | P     | V            | 14.7                  | 2.0                      | 0.0                | 31.4          | 46.0            | 14.6                        |      |
| 441.6        | 13.5                     | P     | V            | 16.0                  | 2.2                      | 0.0                | 31.7          | 46.0            | 14.3                        |      |
| 473.8        | 15.0                     | P     | V            | 16.8                  | 2.3                      | 0.0                | 34.1          | 46.0            | 11.9                        |      |
| 513.8        | 12.5                     | P     | V            | 18.0                  | 2.4                      | 0.0                | 32.9          | 46.0            | 13.1                        |      |
| 527.5        | 13.0                     | P     | V            | 17.6                  | 2.4                      | 0.0                | 33.1          | 46.0            | 12.9                        |      |
| 580.0        | 17.1                     | P     | V            | 18.2                  | 2.5                      | 0.0                | 37.9          | 46.0            | 8.1                         |      |
| 750.0        | 10.0                     | P     | V            | 21.6                  | 2.9                      | 0.0                | 34.5          | 46.0            | 11.5                        |      |
| 862.5        | 10.4                     | P     | V            | 21.9                  | 3.2                      | 0.0                | 35.5          | 46.0            | 10.5                        |      |
| 946.3        | 11.6                     | P     | V            | 22.8                  | 3.4                      | 0.0                | 37.7          | 46.0            | 8.3                         |      |
| 1350.0       | 46.1                     | P     | V            | 25.6                  | -33.2                    | 0.0                | 38.5          | 74.0            | 35.5                        | 1    |
| 1400.0       | 47.4                     | P     | V            | 25.5                  | -33.2                    | 0.0                | 39.7          | 74.0            | 34.3                        | 1    |
| 1927.5       | 47.3                     | P     | V            | 27.8                  | -32.7                    | 0.0                | 42.4          | 74.0            | 31.6                        | 1    |
| 2512.5       | 49.5                     | P     | V            | 28.7                  | -32.0                    | 0.0                | 46.2          | 74.0            | 27.8                        | 1    |
| 2552.5       | 46.8                     | P     | V            | 28.8                  | -31.9                    | 0.0                | 43.7          | 74.0            | 30.3                        | 1    |
| 2587.5       | 43.2                     | P     | V            | 28.9                  | -32.1                    | 0.0                | 40.0          | 74.0            | 34.0                        | 1    |
| 3250.0       | 39.3                     | P     | V            | 31.1                  | -31.0                    | 0.0                | 39.4          | 74.0            | 34.6                        | 1    |
| 3945.0       | 37.6                     | P     | V            | 32.9                  | -30.3                    | 0.0                | 40.2          | 74.0            | 33.8                        | 1    |
| 4717.5       | 34.8                     | P     | V            | 33.5                  | -29.0                    | 0.0                | 39.3          | 74.0            | 34.7                        | 1    |
| 4967.5       | 33.0                     | P     | V            | 33.5                  | -28.6                    | 0.0                | 37.9          | 74.0            | 36.1                        | 1    |
| 5030.0       | 35.9                     | P     | V            | 33.6                  | -28.5                    | 0.0                | 41.1          | 74.0            | 32.9                        | 1    |
| 5817.5       | 34.4                     | P     | V            | 34.2                  | -27.4                    | 0.0                | 41.3          | 74.0            | 32.7                        | 1    |

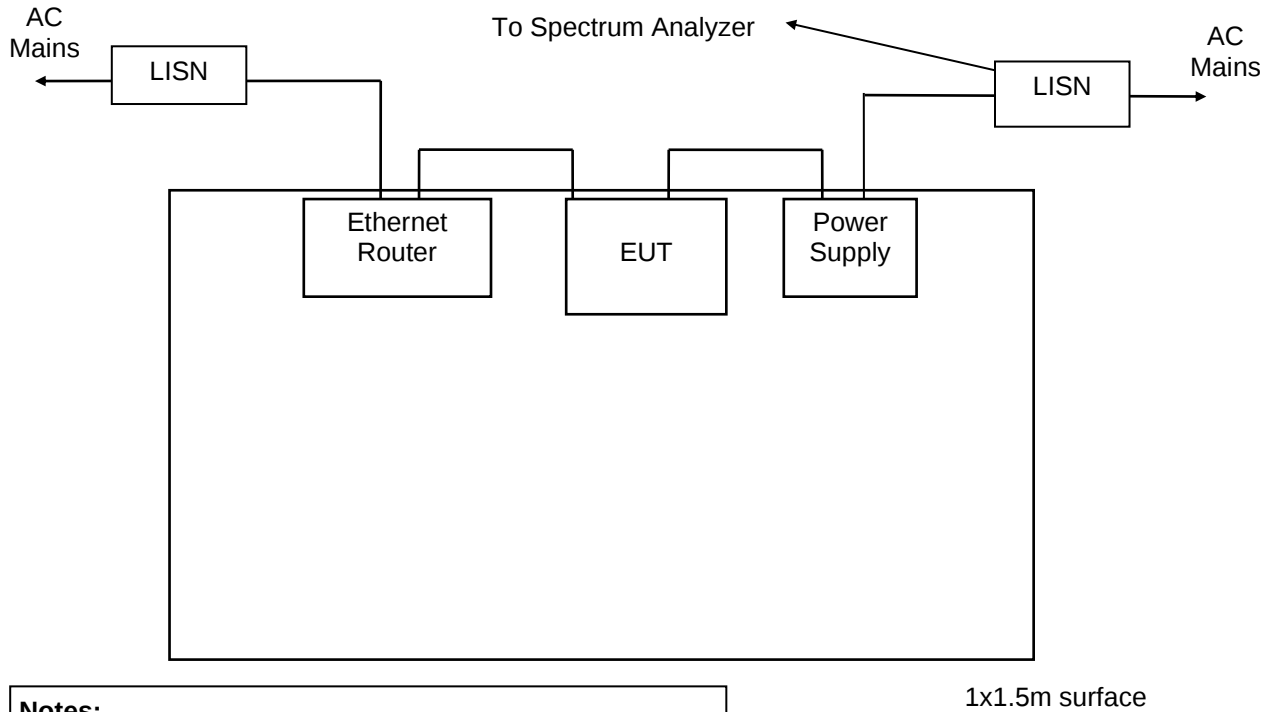
Note1 : Peak reading below Average limits, so average readings not performed for that frequency.

Judgment: Passed by 6.1 dB



## 17.0 GENERAL TEST SETUPS

Figure 2. Conducted Emissions Test Setup

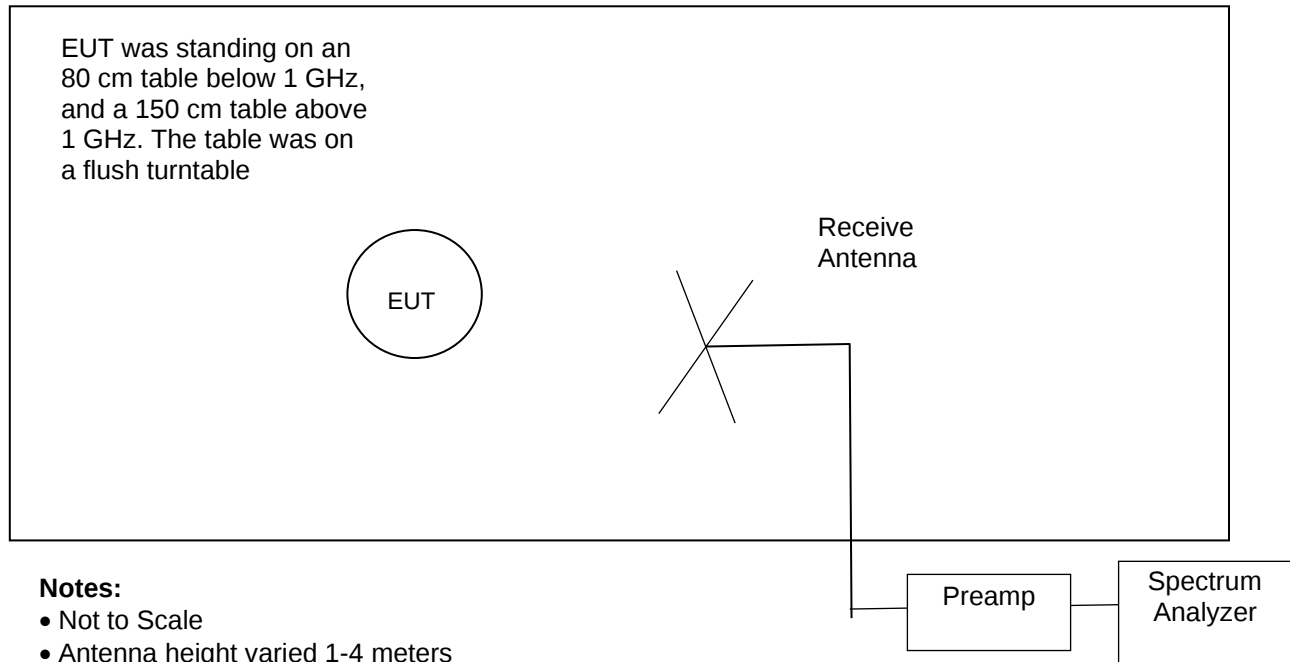


**Notes:**

- LISN's at least 80 cm from EUT chassis
- Vertical conductive plane 40 cm from rear of tabletop
- EUT power cord bundled

**Figure 3. Drawing of Radiated Emissions Setup**

Chamber E, anechoic

**Notes:**

- Not to Scale
- Antenna height varied 1-4 meters
- Distance from antenna to tested system is 3 meters
- AC cords not shown. They are connected to AC outlet with low-pass filter on turntable

| Frequency Range | Receive Antenna | Pre-Amplifier | Spectrum Analyzer | High Pass Filter |
|-----------------|-----------------|---------------|-------------------|------------------|
| 0.01 to 30 MHz  | ANT-53          | None          | REC-11            | None             |
| 30 to 200 MHz   | ANT-80          | None          | REC-11            | None             |
| 200 to 1000 MHz | ANT-08          | None          | REC-11            | None             |
| 1 to 10 GHz     | ANT-66          | AMP-05        | REC-21 or RNT-17  | HPF-06           |
| 10 to 18 GHz    | ANT-66          | AMP-20        | REC-21 or RNT-17  | None*            |
| 18 to 25 GHz    | ANT-48          | AMP-59        | REC-21 or RNT-17  | None*            |

\* A high pass filter was not needed since the fundamental frequency was outside of the amplifiers pass band.

**17.1 Radiated emissions Limits****Unintentional Radiated Emissions Field Strength Limits**

| Frequency Range (MHz) | Test Distance (meters) | Class B Limits |                   |
|-----------------------|------------------------|----------------|-------------------|
|                       |                        | uV/m           | dB(uV/m)          |
| 0.009-0.490           | 300                    | 2400/F(kHz)    | 20*LOG(2400/kHz)  |
| 0.490-1.705           | 30                     | 24000/F(kHz)   | 20*LOG(24000/kHz) |
| 1.705-30.0            | 30                     | 30             | 29.5              |
| 30 - 88               | 3                      | 100            | 40.0              |
| 88 - 216              | 3                      | 150            | 43.5              |
| 216 - 960             | 3                      | 200            | 46.0              |
| Above 960             | 3                      | 500            | 54.0              |

**18.0 MEASUREMENT INSTRUMENTATION UNCERTAINTY**

| Measurement                                             | Uncertainty          |
|---------------------------------------------------------|----------------------|
| Conducted Emissions, LISN method, 150 kHz to 30 MHz     | 2.2 dB               |
| Radiated Emissions, H-field, 3 meters, 9 kHz to 30 MHz  | 2.7 dB               |
| Radiated Emissions, E-field, 3 meters, 30 to 200 MHz    | 4.7 dB               |
| Radiated Emissions, E-field, 3 meters, 200 to 1000 MHz  | 6.2 dB               |
| Radiated Emissions, E-field, 3 meters, 1 to 6 GHz       | 5.0 dB               |
| Radiated Emissions, E-field, 3 meters, 6 to 18 GHz      | 5.5 dB               |
| Radiated Emissions, E-field, 3 meters, 18 to 26 GHz     | 5.9 dB               |
| Bandwidth using marker delta method at a span of 20 MHz | 8 kHz                |
| 99% Occupied Bandwidth using REC-43                     | 1% of frequency span |
| Direct Amplitude measurement 1-26,000 MHz               | 1.5 dB               |
| Temperature THM-02                                      | 0.6 Deg C            |

The uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2 in accordance with CISPR 16-4-2.

**19.0 REVISION HISTORY**

| Document RP-9194 Revisions: |                   |                                              |                                                              |
|-----------------------------|-------------------|----------------------------------------------|--------------------------------------------------------------|
| Rev.                        | Affected Sections | Description                                  | Rationale                                                    |
| 1                           | 6.0               | The version of KDB 558074 was updated        | This was an oversight. The previous version was used.        |
| 1                           | 10.0              | The calibration date for THM-03 was revised. | This was an oversight. An old calibration date was was used. |
|                             |                   |                                              |                                                              |
|                             |                   |                                              |                                                              |
|                             |                   |                                              |                                                              |
|                             |                   |                                              |                                                              |
|                             |                   |                                              |                                                              |