

# RADIO TEST REPORT – 444710-4TRFWL

Type of assessment:

**Limited Modular approval**

Applicant:

**Technologies HumanWare Inc.**

Product:

**BT + WIFI module**

Model:

**PCBA-0131-A1.0**

FCC ID:

**XT5-0131**

IC Registration number:

**8670A-0131**

Specifications:

- ◆ FCC 47 CFR Part 15 Subpart E, §15.407
- ◆ RSS-247, Issue 2, Feb 2017, Section 6

Date of issue: December 17, 2021

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Tested by

  
Signature

Andrey Adelberg, Senior EMC/RF Specialist

Reviewed by

  
Signature

Nemko Canada Inc., a testing laboratory, is accredited by the Standards Council of Canada.  
The tests included in this report are within the scope of this accreditation

## Lab locations

|                      |                                                        |                                                                   |                                                                 |                                                                         |
|----------------------|--------------------------------------------------------|-------------------------------------------------------------------|-----------------------------------------------------------------|-------------------------------------------------------------------------|
| Company name         | Nemko Canada Inc.                                      |                                                                   |                                                                 |                                                                         |
| Facilities           | <i>Ottawa site:</i>                                    | <i>Montréal site:</i>                                             | <i>Cambridge site:</i>                                          | <i>Almonte site:</i>                                                    |
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| Test site identifier | <b>Organization</b>                                    | <b>Ottawa/Almonte</b>                                             | <b>Montreal</b>                                                 | <b>Cambridge</b>                                                        |
|                      | FCC:                                                   | CA2040                                                            | CA2041                                                          | CA0101                                                                  |
|                      | ISED:                                                  | 2040A-4                                                           | 2040G-5                                                         | 24676                                                                   |
| Website              | <a href="http://www.nemko.com">www.nemko.com</a>       |                                                                   |                                                                 |                                                                         |

## Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contained in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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## Section 1 Report summary

### 1.1 Test specifications

|                                              |                                                                                                                                                                                                                                                                    |
|----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| FCC 47 CFR Part 15, Subpart E, Clause 15.407 | Unlicensed National Information Infrastructure Devices operating in the 5.15–5.35 GHz, 5.47–5.725 GHz, 5.725–5.85 GHz, and 5.925–7.125 GHz bands.                                                                                                                  |
| RSS-247, Issue 2, Feb 2017, Section 6        | Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices.<br>Technical requirements for licence-exempt local area network devices and digital transmission systems operating in the 5 GHz band |

### 1.2 Test methods

|                                                                                  |                                                                                                                        |
|----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| 789033 D02 General U-NII Test Procedures<br>New Rules v02r01 (December 14, 2017) | Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices Part 15, Subpart E |
| ANSI C63.10 v2013                                                                | American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices                         |

### 1.3 Exclusions

DFS requirements are not included in this report, it will be assessed in separate report.

### 1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.3 above. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See “Summary of test results” for full details.

### 1.5 Test report revision history

**Table 1.5-1: Test report revision history**

| Revision # | Date of issue     | Details of changes made to test report |
|------------|-------------------|----------------------------------------|
| TRF        | December 17, 2021 | Original report issued                 |

## Section 2 Engineering considerations

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### 2.1 Modifications incorporated in the EUT for compliance

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There were no modifications performed to the EUT during this assessment.

### 2.2 Technical judgment

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As provided by client, the RF module under test is applying for limited single- modular approval, compliance is demonstrated with specific host.

### 2.3 Deviations from laboratory tests procedures

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No deviations were made from laboratory procedures.

## Section 3 Test conditions

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### 3.1 Atmospheric conditions

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|                   |                                         |
|-------------------|-----------------------------------------|
| Temperature       | 15 °C – 35 °C                           |
| Relative humidity | 20 % – 75 %                             |
| Air pressure      | 86 kPa (860 mbar) – 106 kPa (1060 mbar) |

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

### 3.2 Power supply range

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The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages  $\pm 5\%$ , for which the equipment was designed.

## Section 4 Measurement uncertainty

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### 4.1 Uncertainty of measurement

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UKAS Lab 34 and TIA-603-B have been used as guidance for measurement uncertainty reasonable estimations with regards to previous experience and validation of data. Nemko Canada, Inc. follows these test methods in order to satisfy ISO/IEC 17025 requirements for estimation of uncertainty of measurement for wireless products.

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of  $K = 2$  with 95% certainty.

**Table 4.1-1:** Measurement uncertainty calculations

| Test name                         | Measurement uncertainty, $\pm$ dB |
|-----------------------------------|-----------------------------------|
| All antenna port measurements     | 0.55                              |
| Occupied bandwidth                | 4.45                              |
| Conducted spurious emissions      | 1.13                              |
| Radiated spurious emissions       | 3.78                              |
| AC power line conducted emissions | 3.55                              |

## Section 5 Information provided by the applicant

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### 5.1 Disclaimer

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This section contains information provided by the applicant and has been utilized to support the test plan. Inaccurate information provided by the applicant can affect the validity of the results contained within this test report. Nemko accepts no responsibility for the information contained within this section and the impact it may have on the test plan and resulting measurements.

### 5.2 Applicant/Manufacture

---

|                     |                                                                             |
|---------------------|-----------------------------------------------------------------------------|
| Applicant name      | Technologies HumanWare Inc.                                                 |
| Applicant address   | 1800, Jean-Berchmans-Michaud street Drummondville, (Quebec), Canada J2C 7G7 |
| Manufacture name    | Same as applicant                                                           |
| Manufacture address | Same as applicant                                                           |

### 5.3 EUT information

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|                                             |                                                                                                                                                                                                            |
|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product                                     | BT + WIFI module                                                                                                                                                                                           |
| Model                                       | PCBA-0131-A1.0                                                                                                                                                                                             |
| Host Model                                  | DA2                                                                                                                                                                                                        |
| Model variant(s)                            | None                                                                                                                                                                                                       |
| Serial number                               | None                                                                                                                                                                                                       |
| Part number                                 | PCBA-0131                                                                                                                                                                                                  |
| Power supply requirements                   | 3.0 to 3.6 Vdc, 300 mA , From host AC: 120 V, 50/60 Hz power cord                                                                                                                                          |
| Product description and theory of operation | The PCBA-0131 RF module integrates a PCB antenna. The module allows the host to connect to Wifi networks via a SDIO interface. It also allows the host to use the Bluetooth protocol via a UART interface. |

## 5.4 Radio technical information

|                                    |                                                                                                                 |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Device type                        | <input type="checkbox"/> Outdoor access point                                                                   |
|                                    | <input type="checkbox"/> Indoor access point                                                                    |
|                                    | <input type="checkbox"/> Fixed point-to-point access point                                                      |
|                                    | <input checked="" type="checkbox"/> Client device                                                               |
|                                    | <input type="checkbox"/> Device installed in vehicles                                                           |
| Frequency band                     | 5725–5850 MHz (U-NII-3)                                                                                         |
| Frequency Min (MHz)                | 20 MHz bandwidth: 5745<br>40 MHz bandwidth: 5755<br>80 MHz bandwidth: 5775                                      |
| Frequency Max (MHz)                | 20 MHz bandwidth: 5825<br>40 MHz bandwidth: 5795<br>80 MHz bandwidth: 5775                                      |
| Channel numbers                    | 20 MHz bandwidth: 149 to 165<br>40 MHz bandwidth: 151 to 159<br>80 MHz bandwidth: 155                           |
| RF power Max (W), Conducted        | 20 MHz bandwidth: 0.0229(13.6 dBm)<br>40 MHz bandwidth: 0.0219(13.4 dBm)<br>80 MHz bandwidth: 0.0209(13.2 dBm)  |
| Field strength, dBμV/m @ 3 m       | N/A                                                                                                             |
| Measured BW (kHz), 99% OBW         | 20 MHz bandwidth: 17800<br>40 MHz bandwidth: 36600<br>80 MHz bandwidth: 75800                                   |
| Type of modulation                 | 802.11a/n/ac: OFDM (QPSK, BPSK, 16-QAM, 64-QAM)                                                                 |
| Emission classification            | W7D                                                                                                             |
| Transmitter spurious, dBμV/m @ 3 m | 51.0, average @ 18GHz                                                                                           |
| Antenna information                | Molex 211964 2.4GHz/5GHz Ceramic SMT antenna, max peak gain: 2.1 dBi at 2.4 GHz band and 2.2 dBi at 5 GHz band. |
| Firmware/Software information      | 8821cs-txpowerlimits-addition to wifi-bt-continuous-2021-06-29                                                  |

## 5.5 EUT setup details

### 5.5.1 Radio exercise details

|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Operating conditions | <p>The EUT is soldered on Humanware Digital Talking Book Machine Main PCB, the DA2. The DA2 provides 3.1Vdc power to the EUT. The DA2 also interfaces to the EUT with a digital interface (SDIO and UART). The DA2 runs on Linux and has the appropriate drivers to control the EUT.</p> <p>In order to control the EUT in the appropriate mode, the DA2 is connected to a laptop with a serial to USB communication adapter. The operator uses a terminal interface on the laptop to communicate with the DA2. The DA2 has a special build for this purpose, the "certification-rtwpriv-wifi-bt-continous-2021-06-10"</p> |
| Transmitter state    | Transmitter set in to continuous mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

Test Channel for 802.11a/n(HT20)/ac(VHT20)

| Band            | Channel | Frequency |
|-----------------|---------|-----------|
| U-NII Band I    |         |           |
| Low             | 36      | 5180MHz   |
| Mid             | 40      | 5200MHz   |
| High            | 48      | 5240MHz   |
| U-NII Band II-A |         |           |
| Low             | 52      | 5260MHz   |
| Mid             | 60      | 5300MHz   |
| High            | 64      | 5320MHz   |
| U-NII Band II-C |         |           |
| Low             | 100     | 5500MHz   |
| Mid             | 116     | 5580MHz   |
| High            | 140     | 5700MHz   |
| U-NII Band III  |         |           |
| Low             | 149     | 5745MHz   |
| Mid             | 157     | 5785MHz   |
| High            | 165     | 5825MHz   |

Test Channel for 802.11n(HT40)/ac(VHT40)

| Band            | Channel | Frequency |
|-----------------|---------|-----------|
| U-NII Band I    |         |           |
| Low             | 38      | 5190MHz   |
| High            | 46      | 5230MHz   |
| U-NII Band II-A |         |           |
| Low             | 54      | 5270MHz   |
| High            | 62      | 5310MHz   |
| U-NII Band II-C |         |           |
| Low             | 102     | 5510MHz   |
| Mid             | 110     | 5550MHz   |
| High            | 134     | 5670MHz   |
| U-NII Band III  |         |           |
| Low             | 151     | 5755MHz   |
| High            | 159     | 5795MHz   |

### 5.5.1 EUT setup configuration

Test Channel for 802.11ac(VHT80)

| Band            | Channel | Frequency |
|-----------------|---------|-----------|
| U-NII Band I    |         |           |
| Only            | 42      | 5210MHz   |
| U-NII Band II-A |         |           |
| Only            | 58      | 5290MHz   |
| U-NII Band II-C |         |           |
| Low             | 106     | 5530MHz   |
| High            | 122     | 5610MHz   |
| U-NII Band III  |         |           |
| Only            | 155     | 5775MHz   |

Test Mode:

| Mode                           | Data rate |
|--------------------------------|-----------|
| 802.11a                        | 6 Mbps    |
| 802.11n(HT20)/ 802.11ac(VHT20) | 6.5 Mbps  |
| 802.11n(HT40) /802.11ac(VHT40) | 13.5 Mbps |
| 802.11ac(VHT80)                | 29.3 Mbps |

## 5.5.1 EUT setup configuration

Table 5.5-1: EUT sub assemblies

| Description                  | Brand name | Model, Part number, Serial number, Revision level |
|------------------------------|------------|---------------------------------------------------|
| Digital Talking Book Machine | Humanware  | MN: DA2 SN: ALPHA-COND-1 PN: ASSY-1100            |
| BT + WIFI module             | Humanware  | MN: PCBA-0131-A1.0, PN: PCBA-0131 Rev: A1.0       |

Table 5.5-2: Support equipment

| Description                | Brand name | Model, Part number, Serial number, Revision level |
|----------------------------|------------|---------------------------------------------------|
| Serial communication board | Humanware  | PN: PCBA-0097B Rev: P2                            |
| AC power adapter           | InnoVision | MN: GW18W-050300UV                                |

## EUT setup configuration, continued

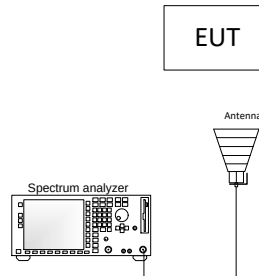


Figure 5.5-1: Radiated testing block diagram

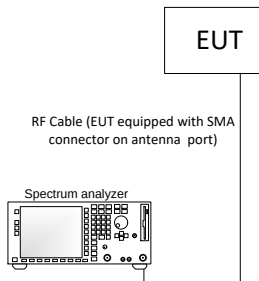


Figure 5.5-2: Antenna port testing block diagram

## Section 6 Summary of test results

### 6.1 Testing location

Test location (s) Montreal

### 6.2 Testing period

Test start date June 22, 2021 Test end date June 26, 2021

### 6.3 Sample information

Receipt date June 10, 2021 Nemko sample ID number(s) 2

### 6.4 FCC Part 15 Subpart A and C, general requirements test results

**Table 6.4-1: FCC general requirements results**

| Part                                | Test description             | Verdict |
|-------------------------------------|------------------------------|---------|
| §15.207(a)                          | Conducted limits             | Pass    |
| §15.31l                             | Variation of power source    | Pass    |
| §15.31(m)                           | Number of tested frequencies | Pass    |
| §15.203                             | Antenna requirement          | Pass    |
| Notes: EUT is an AC powered device. |                              |         |

### 6.5 FCC Part §15.407 test results

**Table 6.5-1: FCC §15.407 requirements results**

| Part                                                                                                      | Test description                                                       | Verdict        |
|-----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|----------------|
| §15.403                                                                                                   | Emission bandwidth                                                     | Pass           |
| §15.407(a)(3)                                                                                             | Power and density limits within 5.725–5.85 GHz band                    | Pass           |
| §15.407(b)(4)                                                                                             | Undesirable emission limits for 5.725–5.85 GHz band                    | Pass           |
| §15.407(b)(8)                                                                                             | AC power line conducted limits                                         | Pass           |
| §15.407(e)                                                                                                | Minimum 6 dB bandwidth of U-NII devices within the 5.725–5.85 GHz band | Pass           |
| §15.407(g)                                                                                                | Frequency stability                                                    | Pass           |
| §15.407(h)(1) <sup>1</sup>                                                                                | Transmit power control (TPC)                                           | Not applicable |
| §15.407(h)(2) <sup>1</sup>                                                                                | Dynamic Frequency Selection (DFS)                                      | Not applicable |
| §15.407(k)                                                                                                | Automated frequency coordination (AFC) system                          | Not applicable |
| Notes <sup>1</sup> DFS and TPC requirements are only applicable to 5.25–5.35 GHz and 5.47–5.725 GHz bands |                                                                        |                |

## 6.6 ISED RSS-Gen, Issue 5, test results

**Table 6.6-1: RSS-Gen requirements results**

| Clause | Test description                                  | Verdict        |
|--------|---------------------------------------------------|----------------|
| 7.3    | Receiver radiated emission limits                 | Not applicable |
| 7.4    | Receiver conducted emission limits                | Not applicable |
| 6.9    | Operating bands and selection of test frequencies | Pass           |
| 8.8    | AC power-line conducted emissions limits          | Pass           |

Notes: <sup>1</sup>According to sections 5.2 and 5.3 of RSS-Gen, Issue 5 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.  
EUT is an AC powered device.

## 6.7 ISED RSS-247, Issue 2, test results

**Table 6.7-1: ISED RSS-247 requirements results**

| Section          | Test description                                                                                                    | Verdict        |
|------------------|---------------------------------------------------------------------------------------------------------------------|----------------|
| 6.1 <sup>1</sup> | Types of Modulation                                                                                                 | Pass           |
| 6.2.4.1          | Power limits for 5725–5850 MHz band                                                                                 | Pass           |
| 6.2.4.1          | Minimum 6 dB bandwidth for 5725–5850 MHz band                                                                       | Pass           |
| 6.2.4.2          | Unwanted emission limits for 5725–5850 MHz band                                                                     | Pass           |
| 6.3              | Dynamic Frequency Selection (DFS) for devices operating in the bands 5250–5350 MHz, 5470–5600 MHz and 5650–5725 MHz | Not applicable |

Notes: <sup>1</sup> The EUT employs digital modulations, such as: 802.11a/n/ac (20–80 MHz)

## Section 7 Test equipment

### 7.1 Test equipment list

**Table 7.1-1: Equipment list**

| Equipment                        | Manufacturer       | Model no.  | Asset no. | Cal cycle | Next cal.          |
|----------------------------------|--------------------|------------|-----------|-----------|--------------------|
| 3 m EMI test chamber (Emissions) | TDK                | SAC-3      | FA002532e | 2 year    | February 25, 2022  |
| Flush mount turntable            | Sunol              | FM2022     | FA002550  | —         | NCR                |
| Controller                       | Sunol              | SC104V     | FA002551  | —         | NCR                |
| Antenna mast                     | Sunol              | TLT2       | FA002552  | —         | NCR                |
| 3 Phase AC Power Supply          | apc AC Power       | AFC-33045T | FA002677  | —         | VOU                |
| Power Meter                      | HIOKI              | PW3337     | FA002727  | 1 year    | March 15, 2022     |
| Receiver/spectrum analyzer       | Rohde & Schwarz    | ESU 40     | FA002071  | 1 year    | March 16, 2022     |
| Bilog antenna (20–2000 MHz)      | Sunol              | JB1        | FA002517  | 1 year    | March 3, 2022      |
| Horn antenna (1–18 GHz)          | EMCO               | 3115       | FA001451  | 1 year    | February 16, 2022  |
| Horn antenna (18–40 GHz)         | EMCO               | 3116       | FA002487  | 2 year    | March 4, 2023      |
| Pre-amplifier (0.5–18 GHz)       | Com-Power          | PAM-118A   | FA002561  | 1 year    | September 22, 2021 |
| Pre-amplifier (18–40 GHz)        | Com-Power          | PAM-840    | FA002508  | 1 year    | September 24, 2021 |
| 2.4 GHz band Notch Filter        | Microwave Circuits | N0324413   | FA002693  | —         | VOU                |
| Spectrum analyzer                | Rohde & Schwarz    | FSV 40     | FA002731  | 1 year    | March 23, 2022     |
| LISN                             | Rohde & Schwarz    | ENV216     | FA002514  | 1 year    | January 29, 2022   |
| 50 Ω coax cable                  | C.C.A.             | None       | FA002605  | —         | VOU                |
| 50 Ω coax cable                  | C.C.A.             | None       | FA002831  | —         | VOU                |

Notes: NCR - no calibration required, VOU - verify on use

## Section 8 Testing data

### 8.1 Variation of power source

#### 8.1.1 References, definitions and limits

##### FCC §15.31 (e):

For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

#### 8.1.2 Test summary

|           |            |           |               |
|-----------|------------|-----------|---------------|
| Verdict   | Pass       |           |               |
| Tested by | Yong Huang | Test date | June 17, 2021 |

#### 8.1.3 Observations, settings and special notes

The testing was performed as per ANSI C63.10 Section 5.13.

- Where the device is intended to be powered from an external power adapter, the voltage variations shall be applied to the input of the adapter provided with the device at the time of sale. If the device is not marketed or sold with a specific adapter, then a typical power adapter shall be used.
- For devices, where operating at a supply voltage deviating  $\pm 15\%$  from the nominal rated value may cause damages or loss of intended function, test to minimum and maximum allowable voltage per manufacturer's specification and document in the report.
- For devices with wide range of rated supply voltage, test at 15% below the lowest and 15% above the highest declared nominal rated supply voltage.
- For devices obtaining power from an input/output (I/O) port (USB, firewire, etc.), a test jig is necessary to apply voltage variation to the device from a support power supply, while maintaining the functionalities of the device.

For battery-operated equipment, the equipment tests shall be performed using a variable power supply.

#### 8.1.4 Test data

|                                                                                                   |                                        |                                        |                                         |
|---------------------------------------------------------------------------------------------------|----------------------------------------|----------------------------------------|-----------------------------------------|
| EUT Power requirements:                                                                           | <input checked="" type="checkbox"/> AC | <input type="checkbox"/> DC            | <input type="checkbox"/> Battery        |
| If EUT is an AC or a DC powered, was the noticeable output power variation observed?              | <input type="checkbox"/> YES           | <input checked="" type="checkbox"/> NO | <input type="checkbox"/> N/A            |
| If EUT is battery operated, was the testing performed using fresh batteries?                      | <input type="checkbox"/> YES           | <input type="checkbox"/> NO            | <input checked="" type="checkbox"/> N/A |
| If EUT is rechargeable battery operated, was the testing performed using fully charged batteries? | <input type="checkbox"/> YES           | <input type="checkbox"/> NO            | <input checked="" type="checkbox"/> N/A |

## 8.2 Number of frequencies

### 8.2.1 References, definitions and limits

#### FCC §15.31:

- (m) Measurements on intentional radiators or receivers shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table.

#### RSS-Gen, Clause 6.9:

Except where otherwise specified, measurements shall be performed for each frequency band of operation for which the radio apparatus is to be certified, with the device operating at the frequencies in each band of operation shown in table below. The frequencies selected for measurements shall be reported in the test report.

**Table 8.2-1: Frequency Range of Operation**

| Frequency range over which the device operates (in each band) | Number of test frequencies required | Location of measurement frequency inside the operating frequency range |
|---------------------------------------------------------------|-------------------------------------|------------------------------------------------------------------------|
| 1 MHz or less                                                 | 1                                   | Center (middle of the band)                                            |
| 1–10 MHz                                                      | 2                                   | 1 near high end, 1 near low end                                        |
| Greater than 10 MHz                                           | 3                                   | 1 near high end, 1 near center and 1 near low end                      |

Notes: “near” means as close as possible to or at the centre / low end / high end of the frequency range over which the device operates.

### 8.2.2 Test summary

|           |            |           |               |
|-----------|------------|-----------|---------------|
| Verdict   | Pass       |           |               |
| Tested by | Yong Huang | Test date | June 21, 2021 |

### 8.2.3 Observations, settings and special notes

#### ANSI C63.10, Clause 5.6.2.1:

The number of channels tested can be reduced by measuring the center channel bandwidth first and then applying the following relaxations as appropriate:

- For each operating mode, if the measured channel bandwidth on the middle channel is at least 150% of the minimum permitted bandwidth, then it is not necessary to measure the bandwidth on the high and low channels.
- For multiple-input multiple-output (MIMO) systems, if the measured channel bandwidth on testing the middle channel exceeds the minimum permitted bandwidth by more than 50% on one transmit chain, then it is not necessary to repeat testing on the other chains.
- If the measured channel bandwidth on the middle channel is less than 50% of the maximum permitted bandwidth, then it is not necessary to measure the bandwidth on the high and low channels.

#### ANSI C63.10, Clause 5.6.2.2:

For devices with multiple operating modes, measurements on the middle channel can be used to determine the worst-case mode(s). The worst-case modes are as follows:

- Band edge requirements—Measurements on the mode with the widest bandwidth can be used to cover the same channel (center frequency) on modes with narrower bandwidth that have the same or lower output power for each modulation family (e.g., OFDM and direct sequence spread spectrum).
- Spurious emissions—Measure the mode with the highest output power and the mode with the highest output power spectral density for each modulation family (e.g., OFDM and direct sequence spread spectrum).
- In-band PSD—Measurements on the mode with the narrowest bandwidth can be used to cover all modes within the same modulation family of an equal or lower output power provided the result is less than 50% of the limit.

#### 8.2.4 Test data

**Table 8.2-2:** Test channels selection

| Modulation                      | Start of Frequency range, MHz | End of Frequency range, MHz | Frequency range bandwidth, MHz | Low channel, MHz | Mid channel, MHz | High channel, MHz |
|---------------------------------|-------------------------------|-----------------------------|--------------------------------|------------------|------------------|-------------------|
| 802.11a                         | 5725                          | 5850                        | 125                            | 5745             | 5785             | 5825              |
| 802.11n HT20/<br>802.11ac VHT20 | 5725                          | 5850                        | 125                            | 5745             | 5785             | 5825              |
| 802.11n HT40/<br>802.11ac VHT40 | 5725                          | 5850                        | 125                            | 5755             | --               | 5795              |
| 802.11ac VHT80                  | 5725                          | 5850                        | 125                            |                  | 5775             |                   |

## 8.3 Antenna requirement

### 8.3.1 References, definitions and limits

#### FCC §15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

#### RSS-Gen, Clause 6.8:

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report.

### 8.3.2 Test summary

|           |            |           |               |
|-----------|------------|-----------|---------------|
| Verdict   | Pass       |           |               |
| Tested by | Yong Huang | Test date | June 18, 2021 |

### 8.3.1 Observations, settings and special notes

None

### 8.3.2 Test data

Must the EUT be professionally installed?      ☐ YES      ☒ NO  
 Does the EUT have detachable antenna(s)?      ☐ YES      ☒ NO  
     If detachable, is the antenna connector(s) non-standard?      ☐ YES      ☐ NO      ☒ N/A

**Table 8.3-1: Antenna information**

| Antenna type            | Manufacturer | Model number | Maximum gain                                       | Connector type |
|-------------------------|--------------|--------------|----------------------------------------------------|----------------|
| PCB Ceramic SMT antenna | Molex        | 211964       | 2.1 dBi for 2.4 GHz band<br>2.2 dBi for 5 GHz band | Surface mount  |

## 8.4 AC power line conducted emissions limits

### 8.4.1 References, definitions and limits

#### FCC §15.407(b):

- (8) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in § 15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in § 15.207.

#### FCC §15.207:

- (a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50  $\mu$ H/50  $\Omega$  line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

#### ANSI C63.10, Clause 6.2:

If the EUT normally receives power from another device that in turn connects to the public utility ac power lines, measurements shall be made on that device with the EUT in operation to demonstrate that the device continues to comply with the appropriate limits while providing the EUT with power. If the EUT is operated only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines (600 VAC or less) to operate the EUT (such as an adapter), then ac power-line conducted measurements are not required.

For direct current (dc) powered devices where the ac power adapter is not supplied with the device, an “off-the-shelf” unmodified ac power adapter shall be used. If the device is supposed to be installed in a host (e.g., the device is a module or PC card), then it is tested in a typical compliant host.

#### RSS-Gen, Clause 8.8:

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in table below.

Unless the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in table below. The more stringent limit applies at the frequency range boundaries.

**Table 8.4-1: Conducted emissions limit**

| Frequency of emission, MHz | Conducted emissions limit, dB $\mu$ V |           |
|----------------------------|---------------------------------------|-----------|
|                            | Quasi-peak                            | Average** |
| 0.15–0.5                   | 66 to 56*                             | 56 to 46* |
| 0.5–5                      | 56                                    | 46        |
| 5–30                       | 60                                    | 50        |

Notes: \* - The level decreases linearly with the logarithm of the frequency.

\*\* - A linear average detector is required.

### 8.4.2 Test summary

|           |            |           |               |
|-----------|------------|-----------|---------------|
| Verdict   | Pass       |           |               |
| Tested by | Yong Huang | Test date | June 10, 2021 |

#### 8.4.3 Observations, settings and special notes

|                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Port under test – Coupling device | AC input of host – Artificial Mains Network (AMN)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| EUT power input during test       | 120 V <sub>AC</sub> , 60 Hz;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| EUT setup configuration           | Table top                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Measurement details               | A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 10 dB or above the limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.                                                                                                                                                                                                                                                                                                                                                                              |
| Additional notes:                 | <ul style="list-style-type: none"> <li>– The EUT was set up as tabletop configuration per ANSI C63.10-2013 measurement procedure.</li> <li>– The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance. Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)</li> <li>– Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded.</li> </ul> |

#### Receiver settings:

|                      |                                                             |
|----------------------|-------------------------------------------------------------|
| Resolution bandwidth | 9 kHz                                                       |
| Video bandwidth      | 30 kHz                                                      |
| Detector mode        | Peak and Average (Preview), Quasi-peak and CAverage (Final) |
| Trace mode           | Max Hold                                                    |
| Measurement time     | 100 ms (Preview), 160 ms (Final)                            |

#### 8.4.4 Test data

**Table 8.4-2: Conducted emissions results on phase line**

| Frequency, MHz | Quasi-Peak result, dBμV | Quasi-Peak limit, dBμV | Quasi-Peak margin, dB | Correction factor, dB |
|----------------|-------------------------|------------------------|-----------------------|-----------------------|
| 0.580          | 43.2                    | 56.0                   | 12.8                  | 10.0                  |
| 0.859          | 44.0                    | 56.0                   | 12.0                  | 9.9                   |
| 1.430          | 43.6                    | 56.0                   | 12.4                  | 9.9                   |

| Frequency, MHz | CAverage result, dBμV | CAverage limit, dBμV | CAverage margin, dB | Correction factor, dB |
|----------------|-----------------------|----------------------|---------------------|-----------------------|
| 0.857          | 38.0                  | 46.0                 | 8.0                 | 9.9                   |
| 1.428          | 36.9                  | 46.0                 | 9.1                 | 9.9                   |
| 2.573          | 34.6                  | 46.0                 | 11.4                | 9.9                   |

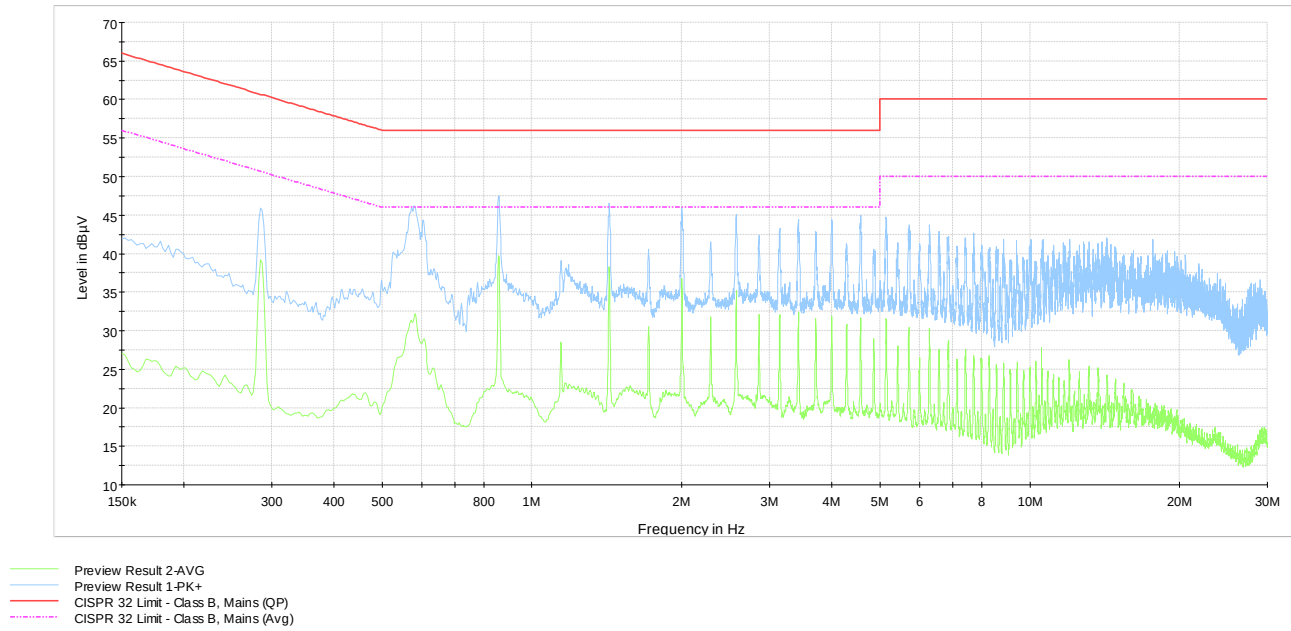
**Table 8.4-3: Conducted emissions results on neutral line**

| Frequency, MHz | Quasi-Peak result, dBμV | Quasi-Peak limit, dBμV | Quasi-Peak margin, dB | Correction factor, dB |
|----------------|-------------------------|------------------------|-----------------------|-----------------------|
| 0.578          | 38.7                    | 56.0                   | 17.3                  | 10.0                  |
| 0.857          | 40.5                    | 56.0                   | 15.5                  | 9.9                   |
| 1.430          | 40.0                    | 56.0                   | 16.0                  | 9.9                   |

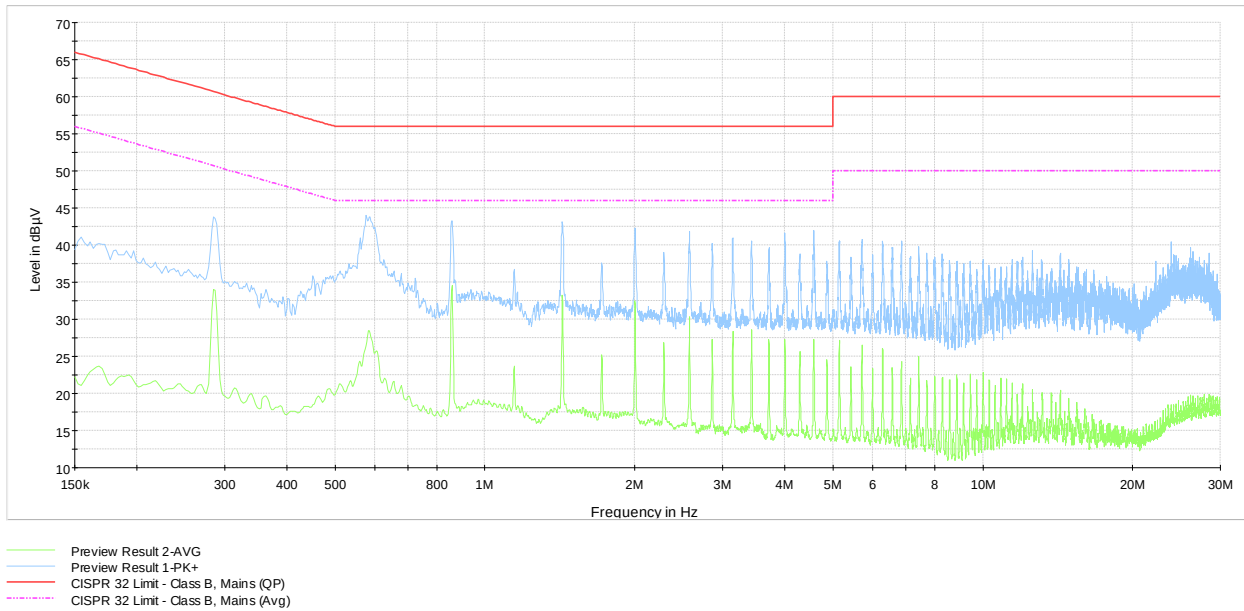
  

| Frequency, MHz | CAverage result, dBμV | CAverage limit, dBμV | CAverage margin, dB | Correction factor, dB |
|----------------|-----------------------|----------------------|---------------------|-----------------------|
| 0.859          | 34.4                  | 46.0                 | 11.6                | 9.9                   |
| 1.430          | 31.5                  | 46.0                 | 14.5                | 9.9                   |
| 2.002          | 30.3                  | 46.0                 | 15.7                | 9.9                   |

Test data, continued



**Plot 8.4-1:** *Conducted emissions on phase line*



**Plot 8.4-2:** *Conducted emissions on neutral line*

## 8.5 Emission bandwidth and 6 dB BW

### 8.5.1 References, definitions and limits

**FCC §15.403:**

For purposes of this subpart the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 26 dB down relative to the maximum level of the modulated carrier. Determination of the emissions bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolution bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement.

**FCC §15.407:**

- (e) Within the 5.725–5.85 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

**RSS-247, Clause 2.6.4:**

Frequency band 5725–5850 MHz:

6.2.4.1 Power limits

For equipment operating in the band 5725–5850 MHz, the minimum 6 dB bandwidth shall be at least 500 kHz.

### 8.5.2 Test summary

|           |            |           |               |
|-----------|------------|-----------|---------------|
| Verdict   | Pass       |           |               |
| Tested by | Yong Huang | Test date | June 24, 2021 |

### 8.5.3 Observations, settings and special notes

The emission bandwidth was tested per ANSI C63.10, Clause 12.4 and KDB 789033 D02, Clause II(C)(1). Spectrum analyser settings:

|                      |                                            |
|----------------------|--------------------------------------------|
| Resolution bandwidth | approximately 1% of the emission bandwidth |
| Video bandwidth      | > RBW                                      |
| Detector mode        | Peak                                       |
| Trace mode           | Max Hold                                   |

The 6 dB bandwidth was tested per ANSI C63.10, Clause 11.8 and KDB 789033 D02, Clause II(C)(2). Spectrum analyser settings:

|                      |                            |
|----------------------|----------------------------|
| Resolution bandwidth | 100 kHz                    |
| Video bandwidth      | $\geq 3 \times \text{RBW}$ |
| Detector mode        | Peak                       |
| Trace mode           | Max Hold                   |

#### 8.5.4 Test data

**Table 8.5-1: 26 dB bandwidth results**

| Modulation                  | Frequency, MHz | 26 dB bandwidth, MHz |
|-----------------------------|----------------|----------------------|
| 802.11a                     | 5745           | 21.4                 |
|                             | 5785           | 21.4                 |
|                             | 5825           | 21.5                 |
| 802.11n HT20/802.11ac VHT20 | 5745           | 22.0                 |
|                             | 5785           | 21.8                 |
|                             | 5825           | 21.7                 |
| 802.11n HT40/802.11ac VHT40 | 5755           | 43.2                 |
|                             | 5795           | 43.6                 |
| 802.11ac VHT80              | 5775           | 82.6                 |

**Table 8.5-2: 6 dB bandwidth results**

| Modulation                  | Frequency, MHz | 6 dB bandwidth, MHz | Minimum limit, MHz | Minimum margin, MHz |
|-----------------------------|----------------|---------------------|--------------------|---------------------|
| 802.11a                     | 5745           | 16.560              | 0.500              | 16.060              |
|                             | 5785           | 16.560              | 0.500              | 16.060              |
|                             | 5825           | 16.500              | 0.500              | 16.000              |
| 802.11n HT20/802.11ac VHT20 | 5745           | 17.720              | 0.500              | 17.220              |
|                             | 5785           | 17.640              | 0.500              | 17.140              |
|                             | 5825           | 17.640              | 0.500              | 17.140              |
| 802.11n HT40/802.11ac VHT40 | 5755           | 36.390              | 0.500              | 35.890              |
|                             | 5795           | 36.400              | 0.500              | 35.900              |
| 802.11ac VHT80              | 5775           | 76.168              | 0.500              | 75.668              |

Test data, continued

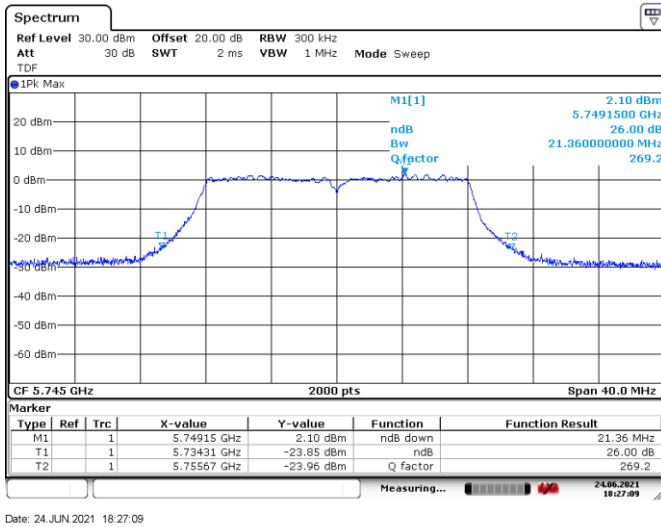


Figure 8.5-1: 26 dB bandwidth on 802.11a, sample plot

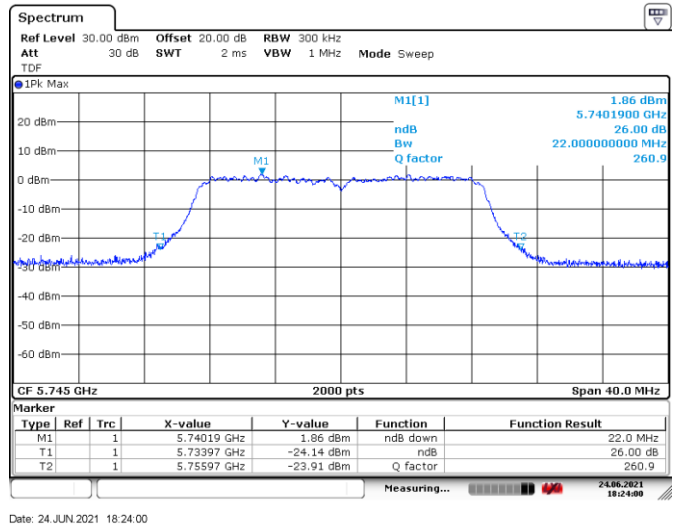


Figure 8.5-2: 26 dB bandwidth on 802.11n HT20/802.11ac VHT20, sample plot

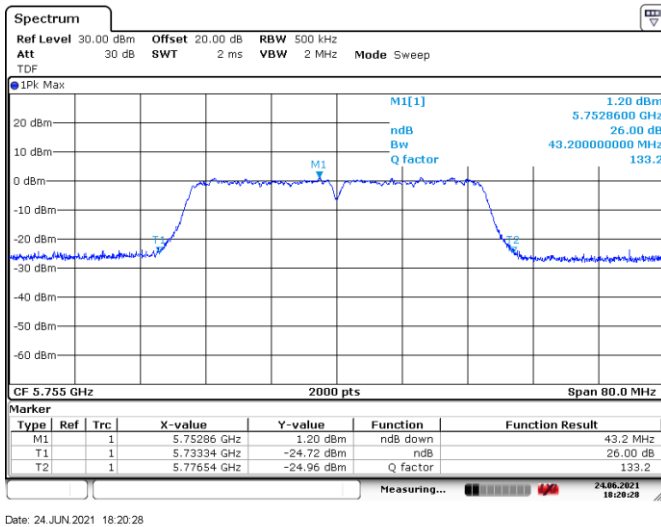


Figure 8.5-3: 26 dB bandwidth on 802.11n HT40/802.11ac VHT40, sample plot

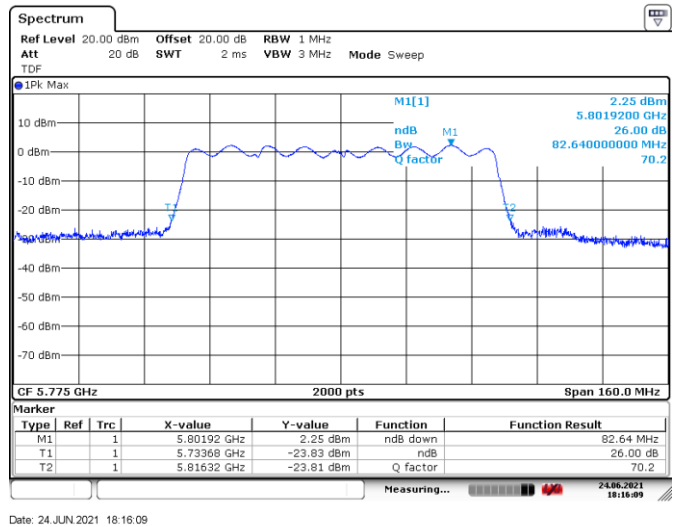
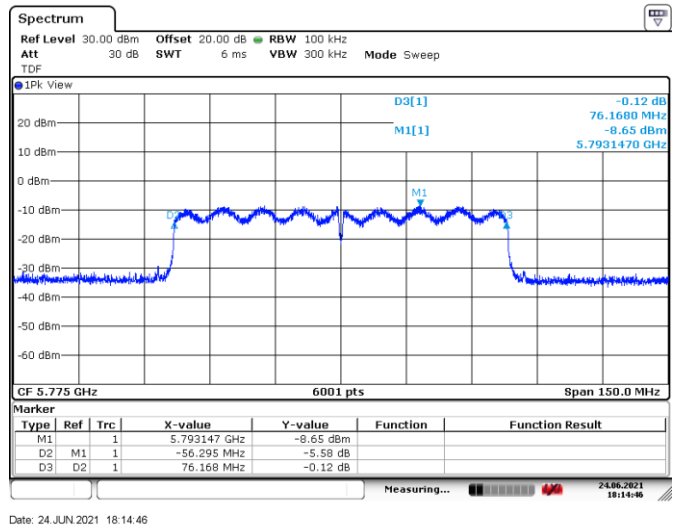
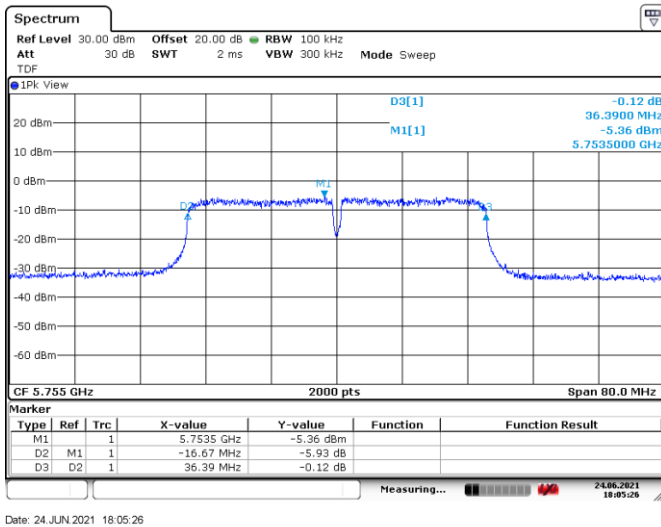
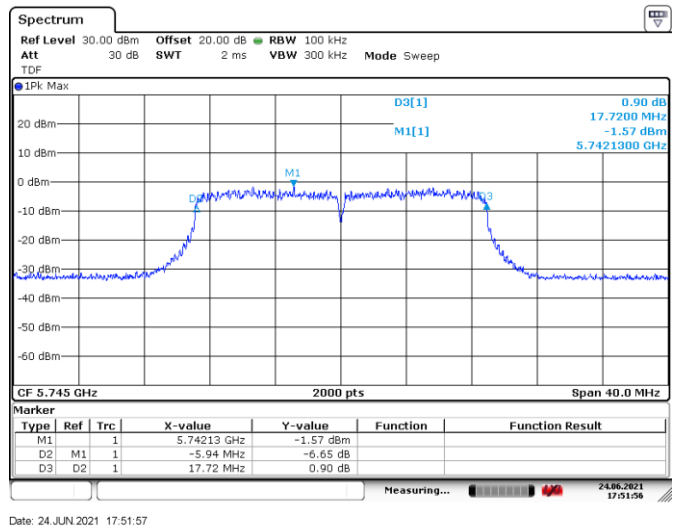
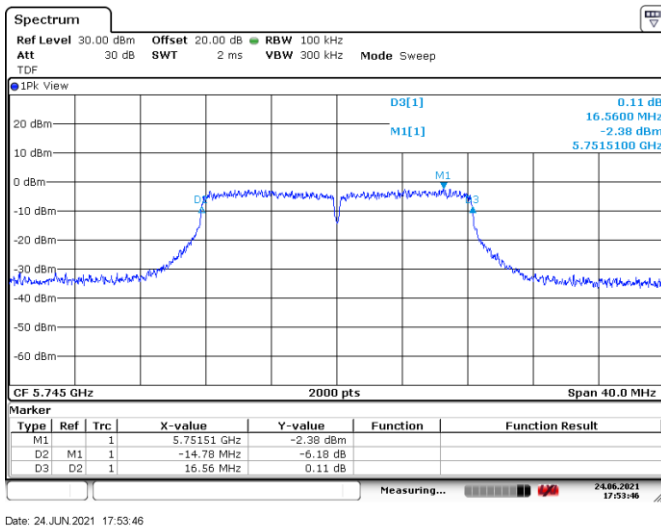


Figure 8.5-4: 26 dB bandwidth on 802.11ac VHT80, sample plot

Test data, continued



## 8.6 Occupied bandwidth

### 8.6.1 References, definitions and limits

#### ANSI C63.10-2013, Clause 6.9.3:

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.

#### RSS-Gen, Clause 6.7:

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

### 8.6.2 Test summary

|           |            |           |               |
|-----------|------------|-----------|---------------|
| Verdict   | Pass       |           |               |
| Tested by | Yong Huang | Test date | June 24, 2021 |

### 8.6.3 Observations, settings and special notes

The emission bandwidth was tested per ANSI C63.10, Clause 6.9.3 and KDB 789033 D02, Clause II(D). Spectrum analyser settings:

|                       |                            |
|-----------------------|----------------------------|
| Resolution bandwidth: | 300/500/1000 kHz           |
| Video bandwidth:      | $\geq 3 \times \text{RBW}$ |
| Detector mode:        | Peak                       |
| Trace mode:           | Max Hold                   |

### 8.6.4 Test data

**Table 8.6-1: 99% bandwidth results**

| Modulation                  | Frequency, MHz | 99% bandwidth, MHz |
|-----------------------------|----------------|--------------------|
| 802.11a                     | 5745           | 16.8               |
|                             | 5785           | 16.8               |
|                             | 5825           | 16.8               |
| 802.11n HT20/802.11ac VHT20 | 5745           | 17.8               |
|                             | 5785           | 17.8               |
|                             | 5825           | 17.8               |
| 802.11n HT40/802.11ac VHT40 | 5755           | 36.5               |
|                             | 5795           | 36.6               |
| 802.11ac VHT80              | 5775           | 75.8               |

## Test data, continued

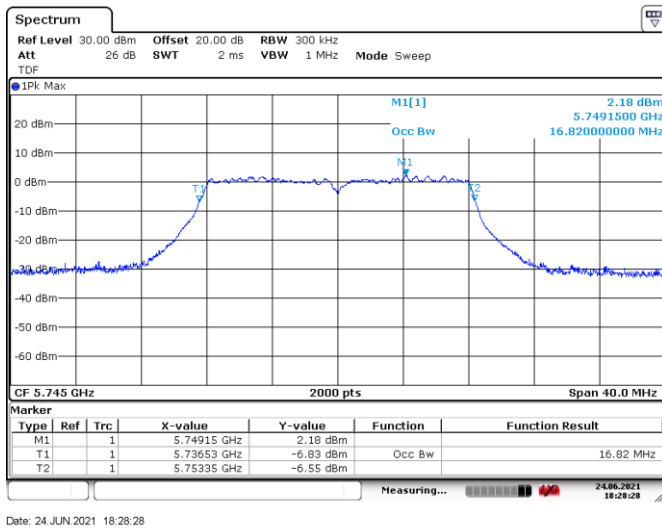


Figure 8.6-1: 99% bandwidth on 802.11a, sample plot

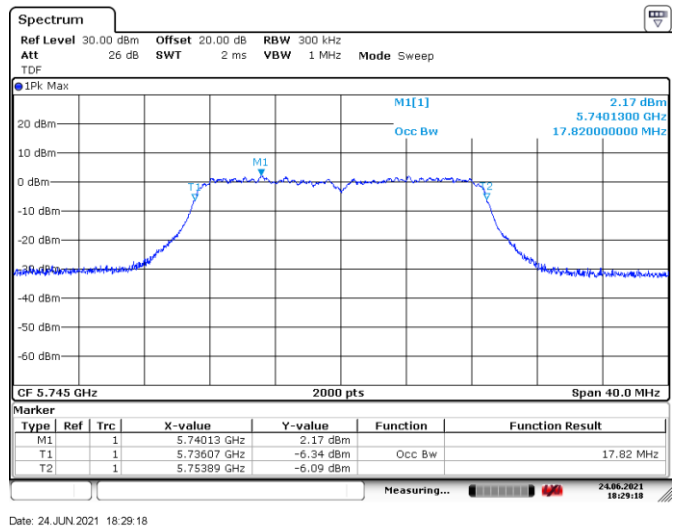


Figure 8.6-2: 99% bandwidth on 802.11n HT20/802.11ac VHT20, sample plot

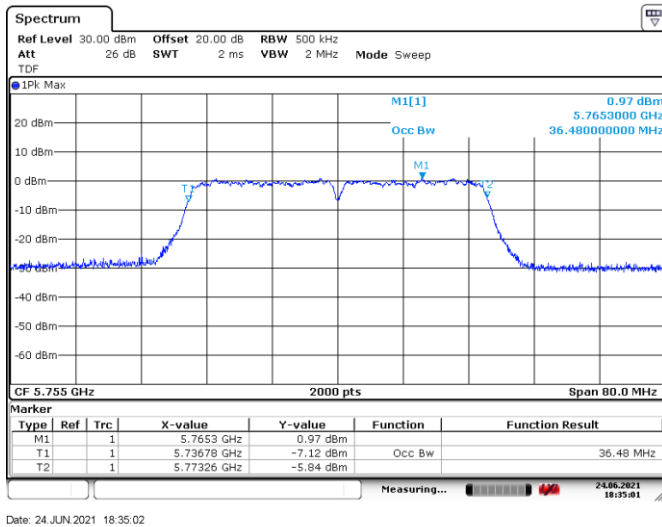


Figure 8.6-3: 99% bandwidth on 802.11n HT40/802.11ac VHT40, sample plot

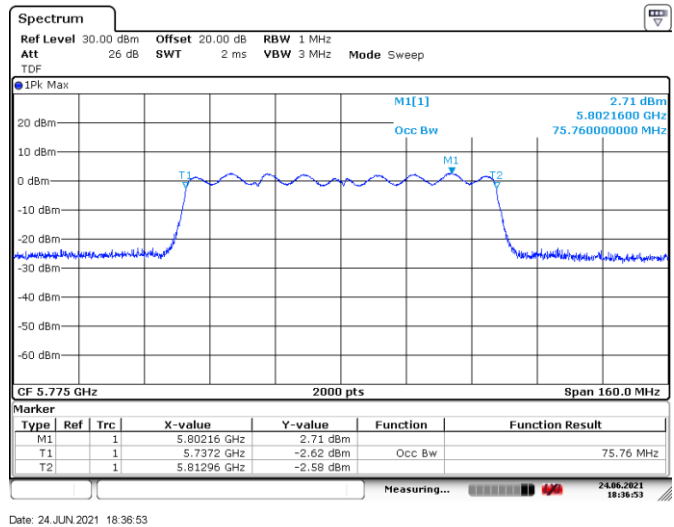


Figure 8.6-4: 99% bandwidth on 802.11ac VHT80, sample plot

## 8.7 Transmitter output power and e.i.r.p. requirements for 5725–5850 MHz band

### 8.7.1 References, definitions and limits

#### FCC §15.407:

- (a) Power limits:
- (3) For the band 5.725–5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.
- (11) The maximum conducted output power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage.
- (12) Power spectral density measurement. The maximum power spectral density is measured as either a conducted emission by direct connection of a calibrated test instrument to the equipment under test or a radiated measurement. Measurements in the 5.725–5.85 GHz band are made over a reference bandwidth of 500 kHz or the 26 dB emission bandwidth of the device, whichever is less. Measurements in all other bands are made over a bandwidth of 1 MHz or the 26 dB emission bandwidth of the device, whichever is less. A narrower resolution bandwidth can be used, provided that the measured power is integrated over the full reference bandwidth.

#### RSS-247, Clause 6.2:

Power and unwanted emissions limits

The output power and e.i.r.p. of the equipment wanted emission shall be measured in terms of average value.

##### 6.2.4 Frequency band 5725–5850 MHz

##### 6.2.4.1 Power limits

The maximum conducted output power shall not exceed 1 W. The output power spectral density shall not exceed 30 dBm in any 500 kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the output power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications and multiple collocated transmitters transmitting the same information.

### 8.7.2 Test summary

|           |            |           |               |
|-----------|------------|-----------|---------------|
| Verdict   | Pass       |           |               |
| Tested by | Yong Huang | Test date | June 24, 2021 |

### 8.7.3 Observations, settings and special notes

EUT is client device. EUT was configured to continuous transmit mode during tests.

Power spectral density was tested per ANSI C63.10, Clause 12.5 and 789033 D02, Clause II(F).

Conducted output power was tested per ANSI C63.10, Clause 12.3 and 789033 D02, Clause II(E) using method PM (Measurement using an RF average power meter).

Spectrum analyser settings:

|                      |                                                                   |
|----------------------|-------------------------------------------------------------------|
| Resolution bandwidth | 500 kHz                                                           |
| Video bandwidth      | 2 MHz                                                             |
| Frequency span       | Enough to encompass the entire 26 dB EBW or 99% OBW of the signal |
| Detector mode        | RMS                                                               |
| Trace mode           | Power Averaging over 100 sweeps                                   |

#### 8.7.4 Test data

**Table 8.7-1: Output power measurements results**

| Modulation                  | Frequency, MHz | Conducted output power, dBm | Power limit, dBm | Margin, dB |
|-----------------------------|----------------|-----------------------------|------------------|------------|
| 802.11a                     | 5745           | 13.2                        | 30.0             | 16.8       |
|                             | 5785           | 12.9                        | 30.0             | 17.1       |
|                             | 5825           | 13.6                        | 30.0             | 16.4       |
| 802.11n HT20/802.11ac VHT20 | 5745           | 13.0                        | 30.0             | 17.0       |
|                             | 5785           | 12.5                        | 30.0             | 17.5       |
|                             | 5825           | 13.3                        | 30.0             | 16.7       |
| 802.11n HT40/802.11ac VHT40 | 5755           | 13.4                        | 30.0             | 16.6       |
|                             | 5795           | 13.3                        | 30.0             | 16.7       |
| 802.11ac VHT80              | 5775           | 13.2                        | 30.0             | 16.8       |

**Table 8.7-2: PPSP measurements results**

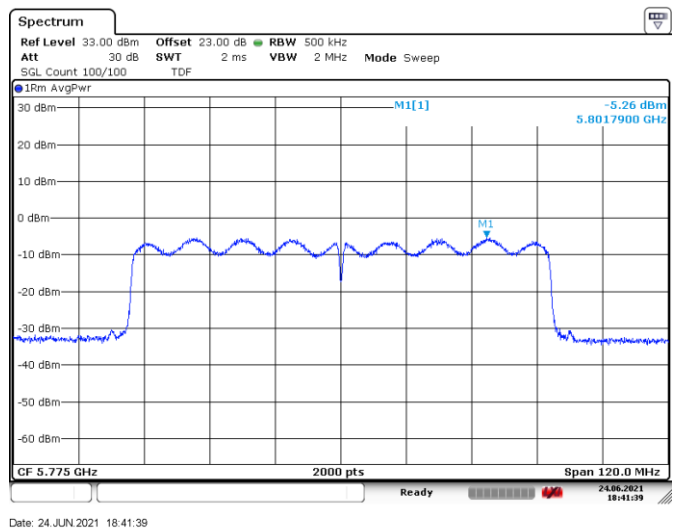
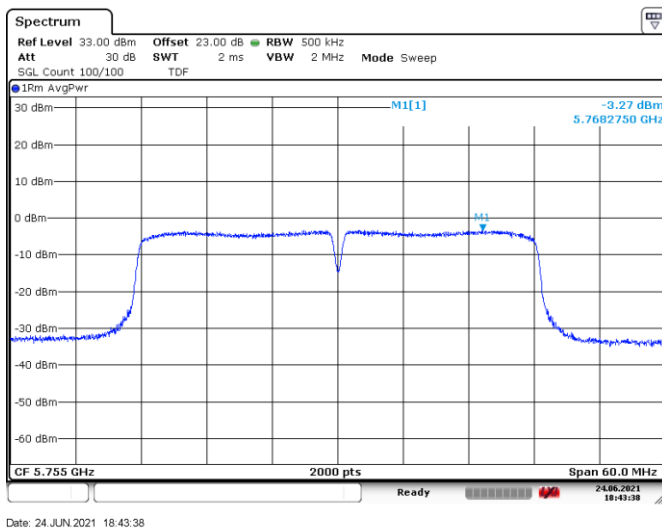
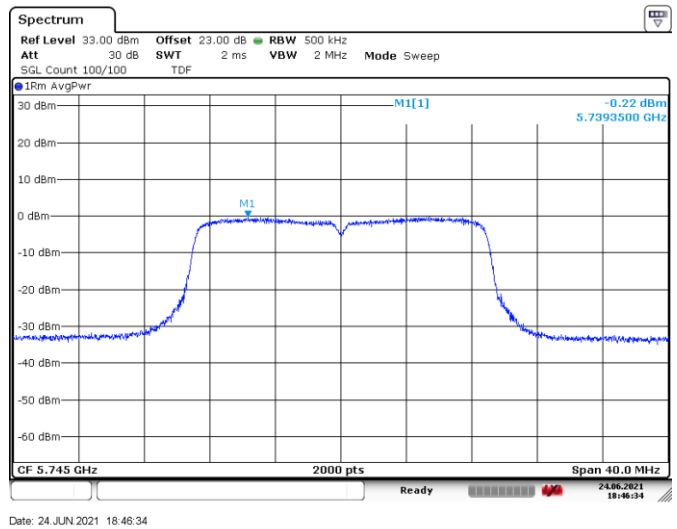
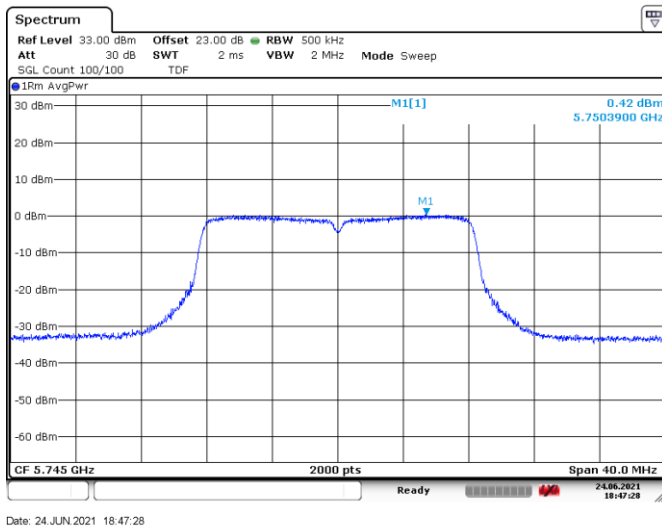
| Modulation                  | Frequency, MHz | PPSP, dBm/500kHz | PPSP limit, dBm/500 kHz | Margin, dB |
|-----------------------------|----------------|------------------|-------------------------|------------|
| 802.11a                     | 5745           | 0.4              | 30.0                    | 29.6       |
|                             | 5785           | 0.4              | 30.0                    | 29.6       |
|                             | 5825           | 1.0              | 30.0                    | 29.0       |
| 802.11n HT20/802.11ac VHT20 | 5745           | -0.2             | 30.0                    | 30.2       |
|                             | 5785           | 0.7              | 30.0                    | 29.3       |
|                             | 5825           | 0.5              | 30.0                    | 29.5       |
| 802.11n HT40/802.11ac VHT40 | 5755           | -3.3             | 30.0                    | 33.3       |
|                             | 5795           | -3.5             | 30.0                    | 33.5       |
| 802.11ac VHT80              | 5775           | -5.3             | 30.0                    | 35.3       |



**Section 8**  
**Test name**  
**Specification**

Testing data  
Transmitter output power and e.i.r.p. requirements for 5725–5850 MHz band  
FCC Part 15 Subpart E and RSS-247, Issue 2

Test data, continued



## 8.8 Spurious unwanted (undesirable) emissions

### 8.8.1 References, definitions and limits

#### FCC §15.407:

- (b) Undesirable emission limits.  
 Except as shown in paragraph (b)(7) of this section, the maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:
- (4) For transmitters operating in the 5.725–5.85 GHz band:
- (i) All emissions shall be limited to a level of –27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.
- (7) The emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.
- (8) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in § 15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in § 15.207.
- (9) The provisions of § 15.205 apply to intentional radiators operating under this section.
- (10) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency band edges as the design of the equipment permits.

#### RSS-247, Clause 6.2:

##### Power and unwanted emissions limits

The power and e.i.r.p. of the equipment unwanted emission shall be measured in peak value. However, the equipment is required to comply with the provisions in RSS-Gen with respect to emissions falling within restricted frequency bands which are listed in the same standard.

If the transmission is in bursts, the provisions of RSS-Gen for pulsed operation shall apply.

The outermost carrier frequencies or channels shall be used when measuring unwanted emissions. Such carrier or channel centre frequencies are to be indicated in the test report.

##### 6.2.4 Frequency band 5725–5850 MHz

##### 6.2.4.2 Unwanted emission limits

Devices operating in the band 5725–5850 MHz shall have e.i.r.p. of unwanted emissions comply with the following:

- 27 dBm/MHz at frequencies from the band edges decreasing linearly to 15.6 dBm/MHz at 5 MHz above or below the band edges;
- 15.6 dBm/MHz at 5 MHz above or below the band edges decreasing linearly to 10 dBm/MHz at 25 MHz above or below the band edges;
- 10 dBm/MHz at 25 MHz above or below the band edges decreasing linearly to –27 dBm/MHz at 75 MHz above or below the band edges; and
- 27 dBm/MHz at frequencies more than 75 MHz above or below the band edges.

**Table 8.8-1: FCC §15.209 and RSS-Gen – Radiated emission limits**

| Frequency, MHz | Field strength of emissions |                                 | Measurement distance, m |
|----------------|-----------------------------|---------------------------------|-------------------------|
|                | µV/m                        | dBµV/m                          |                         |
| 0.009–0.490    | 2400/F                      | $67.6 - 20 \times \log_{10}(F)$ | 300                     |
| 0.490–1.705    | 24000/F                     | $87.6 - 20 \times \log_{10}(F)$ | 30                      |
| 1.705–30.0     | 30                          | 29.5                            | 30                      |
| 30–88          | 100                         | 40.0                            | 3                       |
| 88–216         | 150                         | 43.5                            | 3                       |
| 216–960        | 200                         | 46.0                            | 3                       |
| above 960      | 500                         | 54.0                            | 3                       |

Notes: In the emission table above, the tighter limit applies at the band edges.

For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.

References, definitions and limits, continued

**Table 8.8-2: ISED restricted frequency bands**

| MHz               | MHz                 | MHz           | GHz         |
|-------------------|---------------------|---------------|-------------|
| 0.090–0.110       | 12.57675–12.57725   | 399.9–410     | 7.25–7.75   |
| 0.495–0.505       | 13.36–13.41         | 608–614       | 8.025–8.5   |
| 2.1735–2.1905     | 16.42–16.423        | 960–1427      | 9.0–9.2     |
| 3.020–3.026       | 16.69475–16.69525   | 1435–1626.5   | 9.3–9.5     |
| 4.125–4.128       | 16.80425–16.80475   | 1645.5–1646.5 | 10.6–12.7   |
| 4.17725–4.17775   | 25.5–25.67          | 1660–1710     | 13.25–13.4  |
| 4.20725–4.20775   | 37.5–38.25          | 1718.8–1722.2 | 14.47–14.5  |
| 5.677–5.683       | 73–74.6             | 2200–2300     | 15.35–16.2  |
| 6.215–6.218       | 74.8–75.2           | 2310–2390     | 17.7–21.4   |
| 6.26775–6.26825   | 108–138             | 2483.5–2500   | 22.01–23.12 |
| 6.31175–6.31225   | 149.9–150.05        | 2655–2900     | 23.6–24.0   |
| 8.291–8.294       | 156.52475–156.52525 | 3260–3267     | 31.2–31.8   |
| 8.362–8.366       | 156.7–156.9         | 3332–3339     | 36.43–36.5  |
| 8.37625–8.38675   | 162.0125–167.17     | 3345.8–3358   |             |
| 8.41425–8.41475   | 167.72–173.2        | 3500–4400     | Above 38.6  |
| 12.29–12.293      | 240–285             | 4500–5150     |             |
| 12.51975–12.52025 | 322–335.4           | 5350–5460     |             |

Note: Certain frequency bands listed in Table 8.8-2 and above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

**Table 8.8-3: FCC restricted frequency bands**

| MHz               | MHz                 | MHz           | GHz         |
|-------------------|---------------------|---------------|-------------|
| 0.090–0.110       | 16.42–16.423        | 399.9–410     | 4.5–5.15    |
| 0.495–0.505       | 16.69475–16.69525   | 608–614       | 5.35–5.46   |
| 2.1735–2.1905     | 16.80425–16.80475   | 960–1240      | 7.25–7.75   |
| 4.125–4.128       | 25.5–25.67          | 1300–1427     | 8.025–8.5   |
| 4.17725–4.17775   | 37.5–38.25          | 1435–1626.5   | 9.0–9.2     |
| 4.20725–4.20775   | 73–74.6             | 1645.5–1646.5 | 9.3–9.5     |
| 6.215–6.218       | 74.8–75.2           | 1660–1710     | 10.6–12.7   |
| 6.26775–6.26825   | 108–121.94          | 1718.8–1722.2 | 13.25–13.4  |
| 6.31175–6.31225   | 123–138             | 2200–2300     | 14.47–14.5  |
| 8.291–8.294       | 149.9–150.05        | 2310–2390     | 15.35–16.2  |
| 8.362–8.366       | 156.52475–156.52525 | 2483.5–2500   | 17.7–21.4   |
| 8.37625–8.38675   | 156.7–156.9         | 2690–2900     | 22.01–23.12 |
| 8.41425–8.41475   | 162.0125–167.17     | 3260–3267     | 23.6–24.0   |
| 12.29–12.293      | 167.72–173.2        | 3332–3339     | 31.2–31.8   |
| 12.51975–12.52025 | 240–285             | 3345.8–3358   | 36.43–36.5  |
| 12.57675–12.57725 | 322–335.4           | 3600–4400     | Above 38.6  |
| 13.36–13.41       |                     |               |             |

8.8.2 Test summary

|           |            |                 |               |
|-----------|------------|-----------------|---------------|
| Verdict   | Pass       |                 |               |
| Tested by | Yong Huang | Test start date | June 23, 2021 |

### 8.8.3 Observations, settings and special notes

- As part of the current assessment, the test range of 9 kHz to 40 GHz has been fully considered and compared to the actual frequencies utilized within the EUT. Since the EUT contains a transmitter in the GHz range, the EUT has been deemed compliant without formal testing in the 9 kHz to 30 MHz test range, therefore formal test results (tabular data and/or plots) are not provided within this test report.
- EUT was set to transmit continuously.
- Conducted measurements were performed on antenna port, the reference level offset was adjusted to include antenna gains. Cabinet radiation were performed while the antenna connectors was terminated with 50  $\Omega$  load.
- Radiated measurements were performed at a distance of 3 m below 18 GHz and 1 m above 18 GHz.
- The spurious emission was tested per ANSI C63.10, Clause 12.7 and 789033 D02, Clause II(G).

Spectrum analyser for peak conducted measurements within restricted bands below 1 GHz:

|                       |          |
|-----------------------|----------|
| Resolution bandwidth: | 100 kHz  |
| Video bandwidth:      | 300 kHz  |
| Detector mode:        | Peak     |
| Trace mode:           | Max Hold |

Spectrum analyser for peak conducted measurements within restricted bands above 1 GHz:

|                       |          |
|-----------------------|----------|
| Resolution bandwidth: | 1 MHz    |
| Video bandwidth:      | 3 MHz    |
| Detector mode:        | Peak     |
| Trace mode:           | Max Hold |

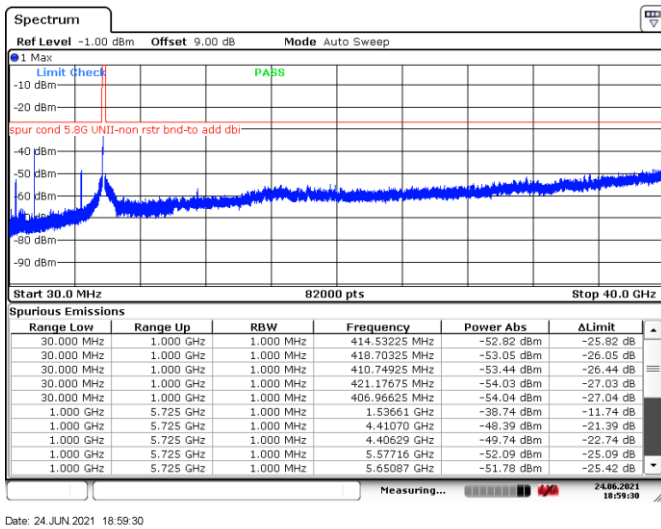
Spectrum analyser for average conducted measurements within restricted bands above 1 GHz for frequencies where peak results were above the average limit:

|                             |               |
|-----------------------------|---------------|
| Resolution bandwidth:       | 1 MHz         |
| Video bandwidth:            | 3 MHz         |
| Detector mode:              | RMS           |
| Trace mode:                 | Power average |
| Number of averaging traces: | 100           |

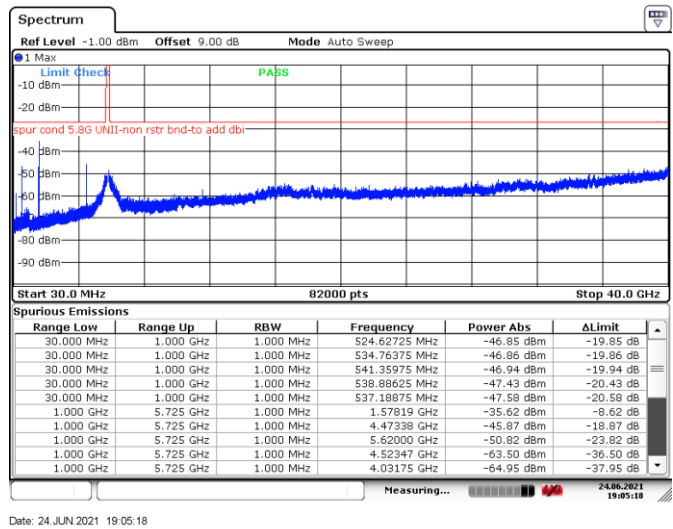
Spectrum analyser for peak conducted measurements outside restricted bands:

|                       |          |
|-----------------------|----------|
| Resolution bandwidth: | 1 MHz    |
| Video bandwidth:      | 3 MHz    |
| Detector mode:        | Peak     |
| Trace mode:           | Max Hold |

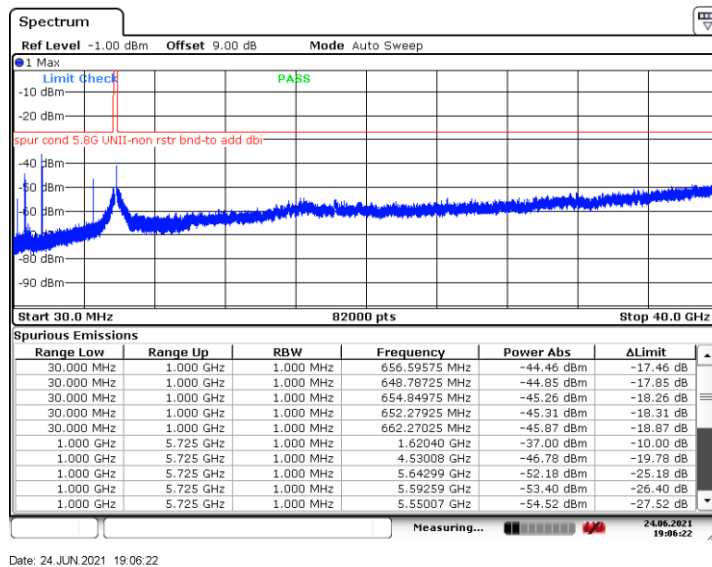
## 8.8.4 Test data



**Figure 8.8-1:** Spurious emissions outside restricted bands, Tx on low channel, 802.11a

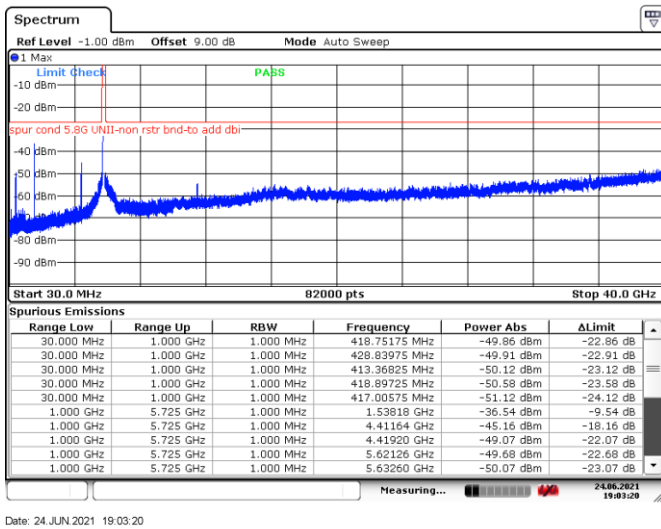


**Figure 8.8-2:** Spurious emissions outside restricted bands, Tx on mid channel, 802.11a

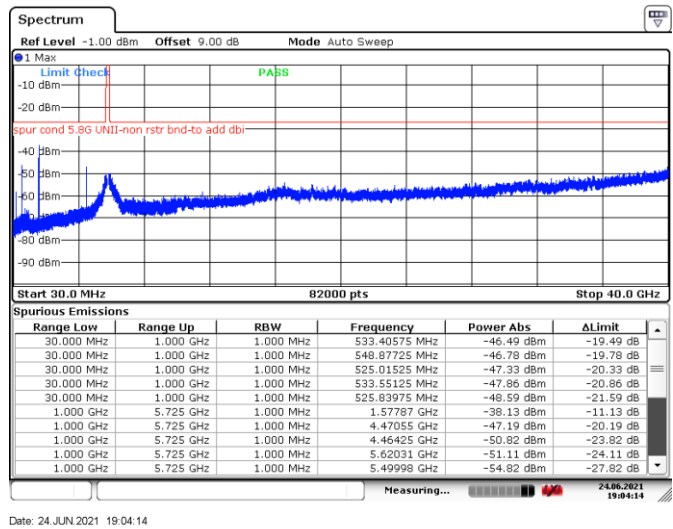


**Figure 8.8-3:** Spurious emissions outside restricted bands, Tx on high channel, 802.11a

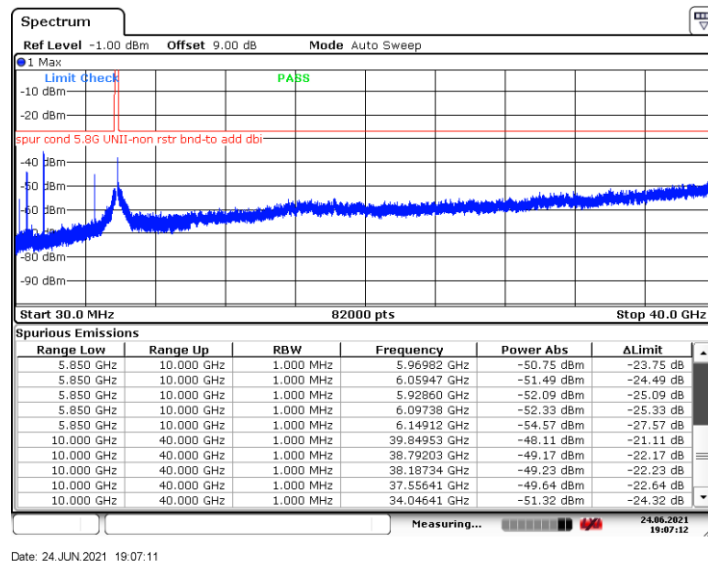
Test data, continued



**Figure 8.8-4:** Spurious emissions outside restricted bands, Tx on low channel, 802.11n HT20/802.11ac VHT20

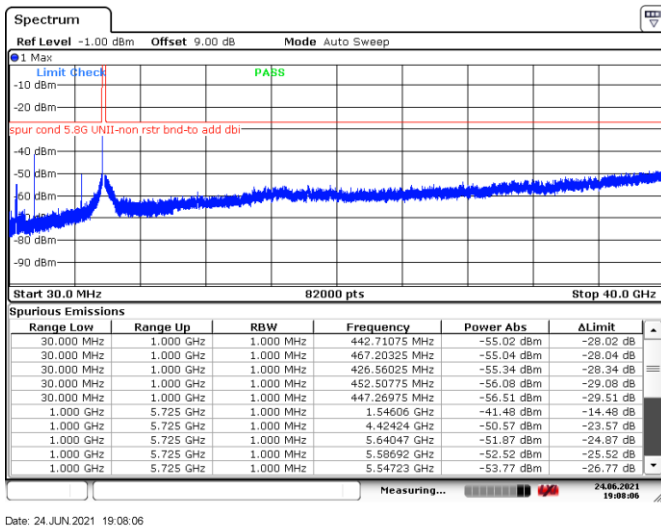


**Figure 8.8-5:** Spurious emissions outside restricted bands, Tx on mid channel, 802.11n HT20/802.11ac VHT20

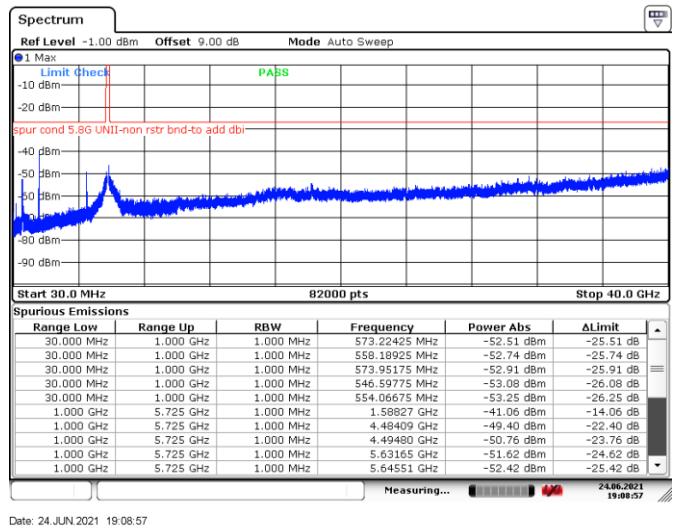


**Figure 8.8-6:** Spurious emissions outside restricted bands, Tx on high channel, 802.11n HT20/802.11ac VHT20

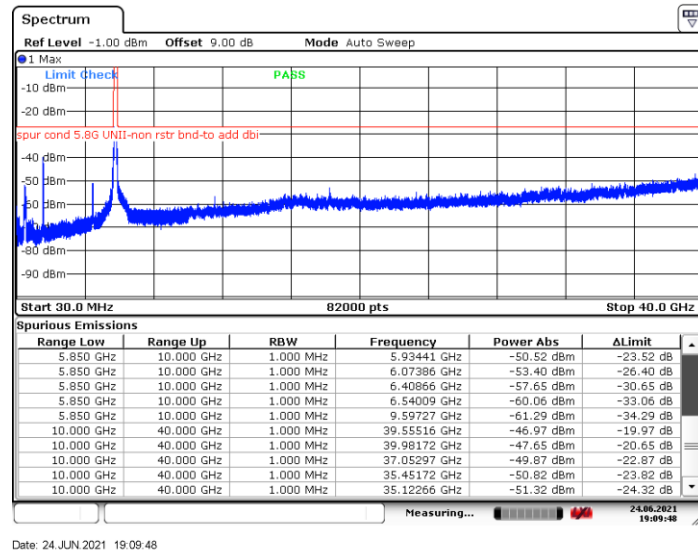
Test data, continued



**Figure 8.8-7:** Spurious emissions outside restricted bands, Tx on low channel, 802.11n HT40/802.11ac VHT40

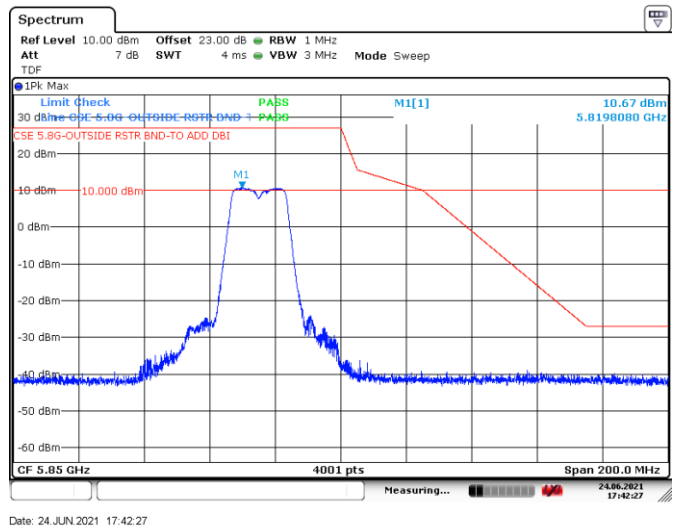
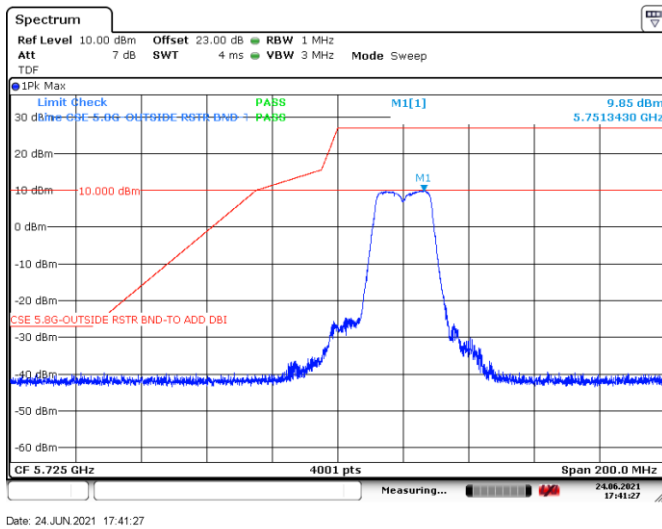
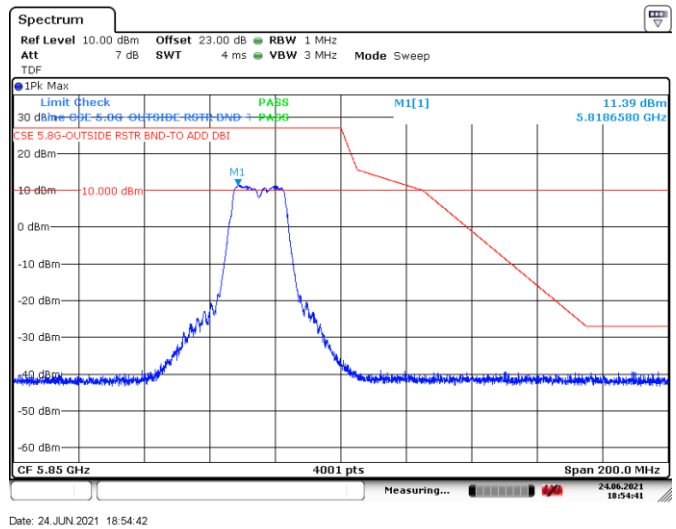
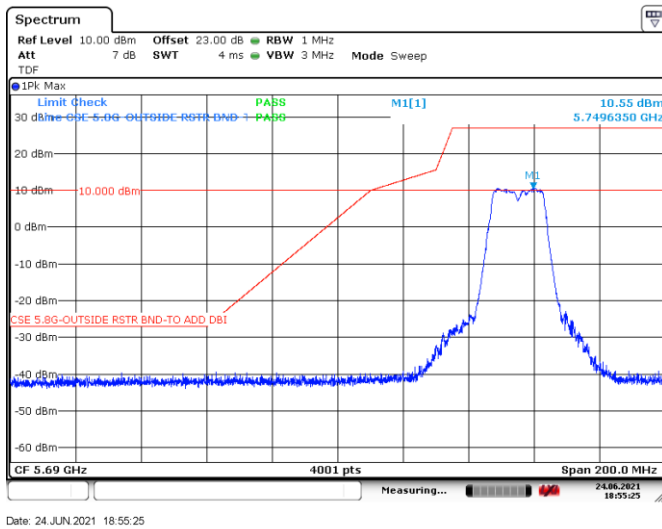


**Figure 8.8-8:** Spurious emissions outside restricted bands, Tx on mid channel, 802.11n HT40/802.11ac VHT40

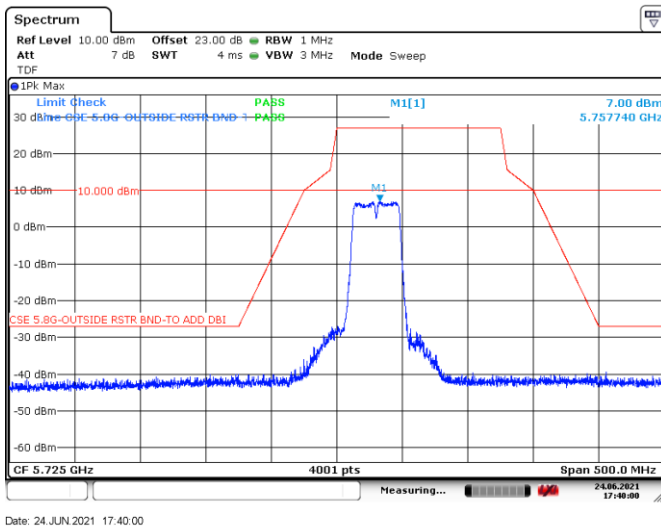


**Figure 8.8-9:** Spurious emissions outside restricted bands, 802.11ac VHT80

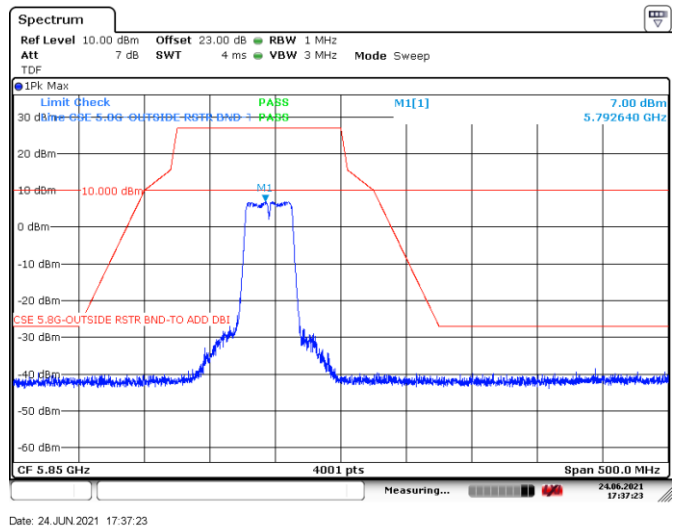
Test data, continued



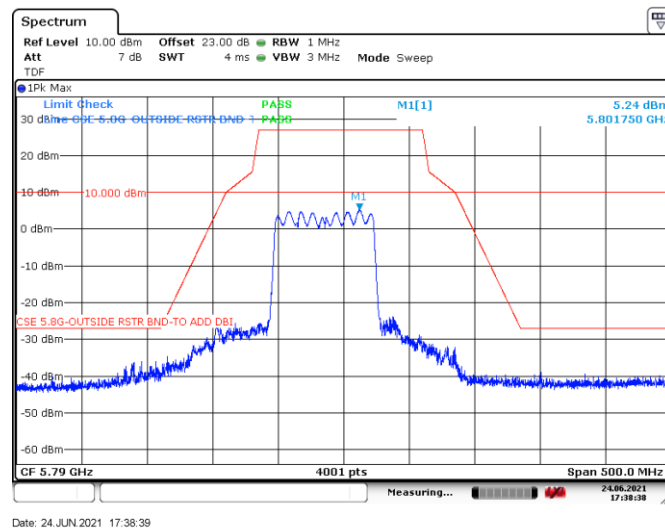
Test data, continued



**Figure 8.8-14:** Lower band edge, Tx on low channel, 802.11n HT40/802.11ac VHT40

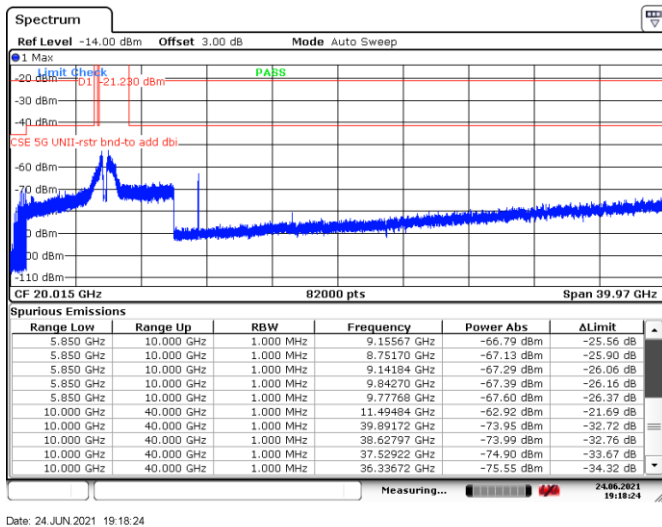


**Figure 8.8-15:** Upper band edge, Tx on mid channel, 802.11n HT40/802.11ac VHT40

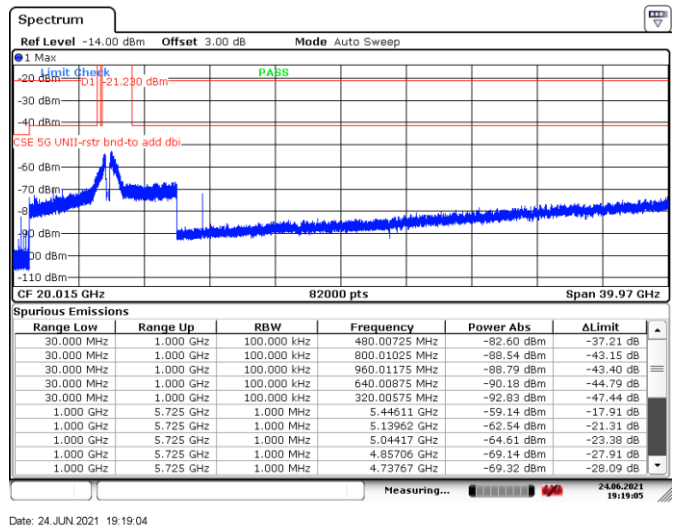


**Figure 8.8-16:** Lower and upper band edge, Tx on low channel, 802.11ac VHT80

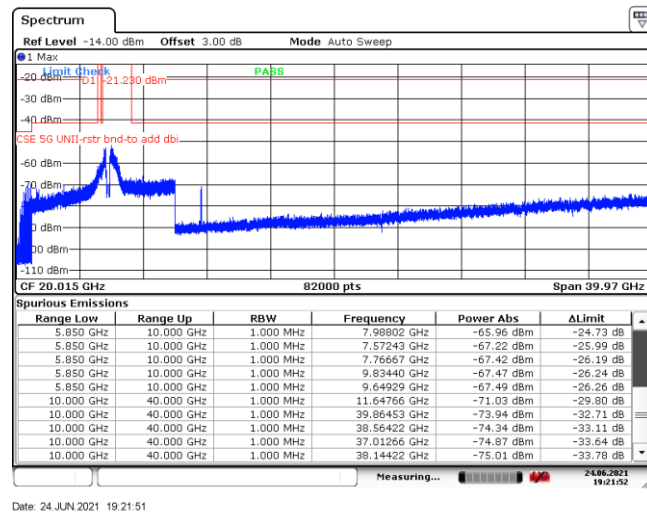
Test data, continued



**Figure 8.8-17:** Spurious emissions within restricted bands, Tx on low channel, 802.11a



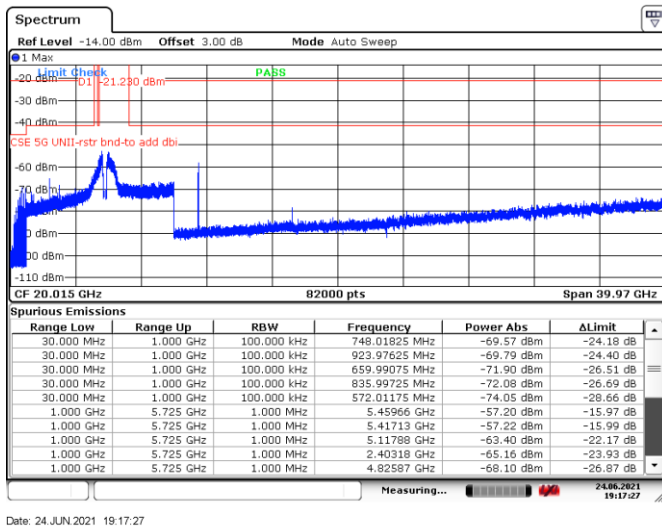
**Figure 8.8-18:** Spurious emissions within restricted bands, Tx on mid channel, 802.11a



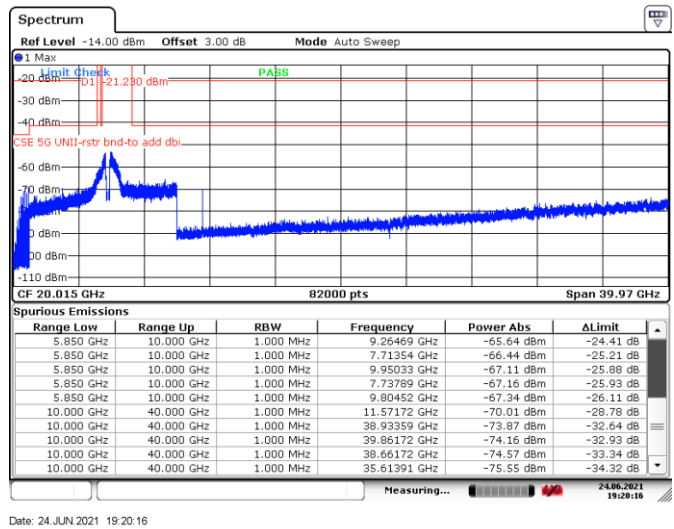
**Figure 8.8-19:** Spurious emissions within restricted bands, Tx on high channel, 802.11a

Note: Peak limit EIRP equivalent:  $74 \text{ dB}\mu\text{V/m} - 95.23 \text{ dB} = -21.23 \text{ dBm}$   
Average limit EIRP equivalent:  $54 \text{ dB}\mu\text{V/m} - 95.23 \text{ dB} = -41.23 \text{ dBm}$

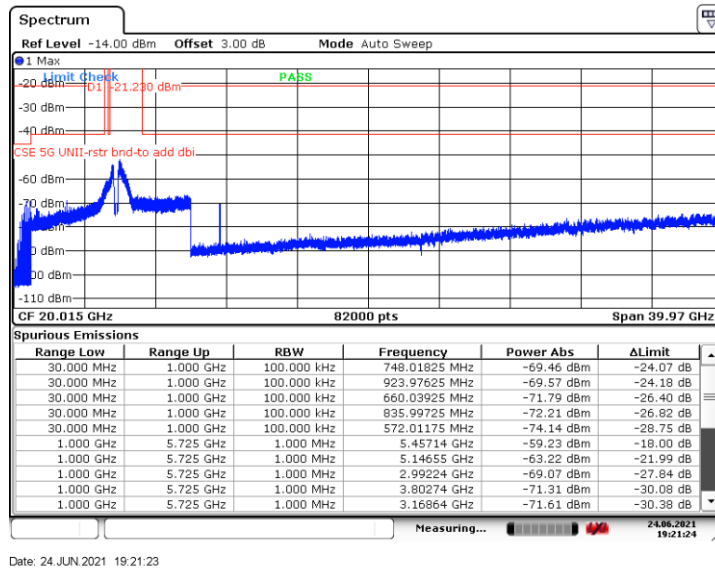
Test data, continued



**Figure 8.8-20:** Spurious emissions within restricted bands, Tx on low channel, 802.11n HT20/802.11ac VHT20



**Figure 8.8-21:** Spurious emissions within restricted bands, Tx on mid channel, 802.11n HT20/802.11ac VHT20



**Figure 8.8-22:** Spurious emissions within restricted bands, Tx on high channel, 802.11n HT20/802.11ac VHT20

Note: Peak limit EIRP equivalent:  $74 \text{ dB}\mu\text{V/m} - 95.23 \text{ dB} = -21.23 \text{ dBm}$   
Average limit EIRP equivalent:  $54 \text{ dB}\mu\text{V/m} - 95.23 \text{ dB} = -41.23 \text{ dBm}$

Test data, continued

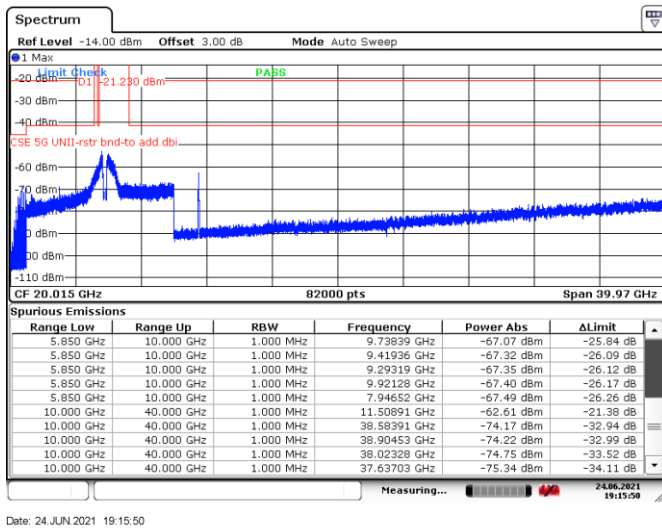


Figure 8.8-23: Spurious emissions within restricted bands, Tx on low channel, 802.11n HT40/802.11ac VHT40

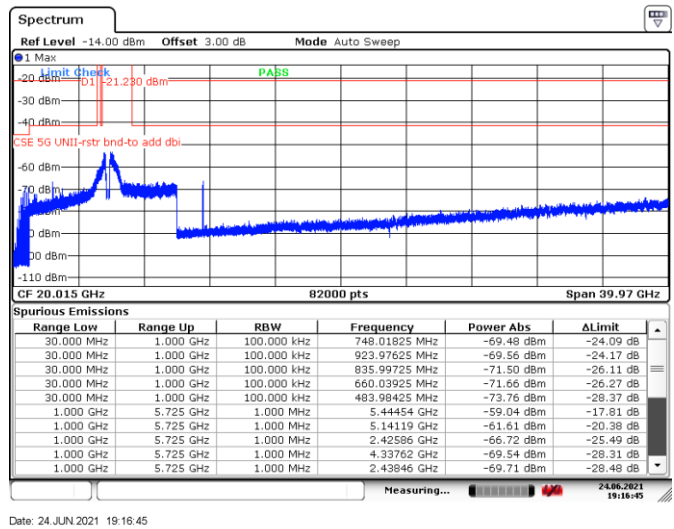


Figure 8.8-24: Spurious emissions within restricted bands, Tx on high channel, 802.11n HT40/802.11ac VHT40

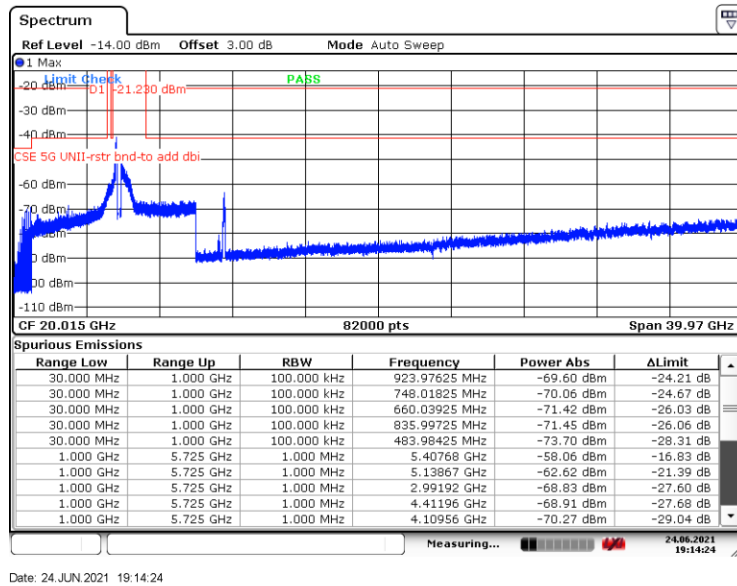
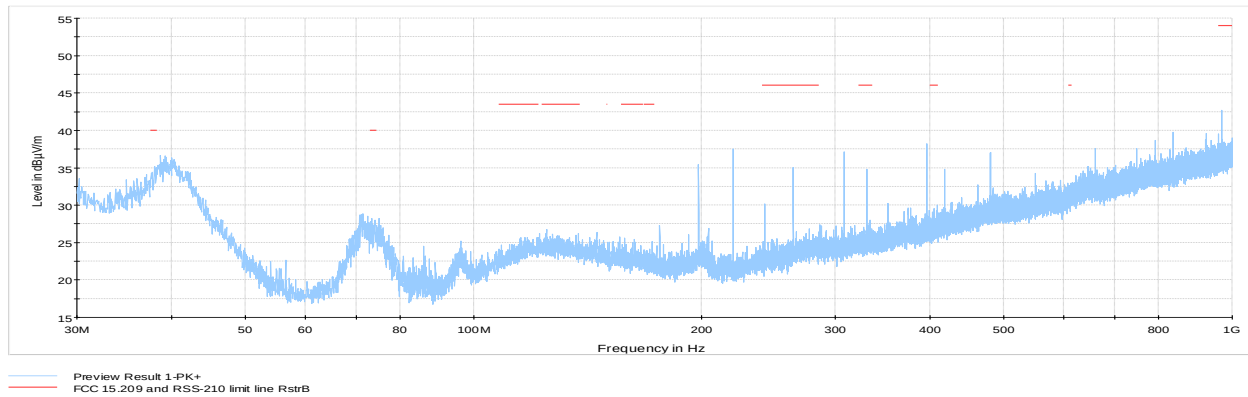


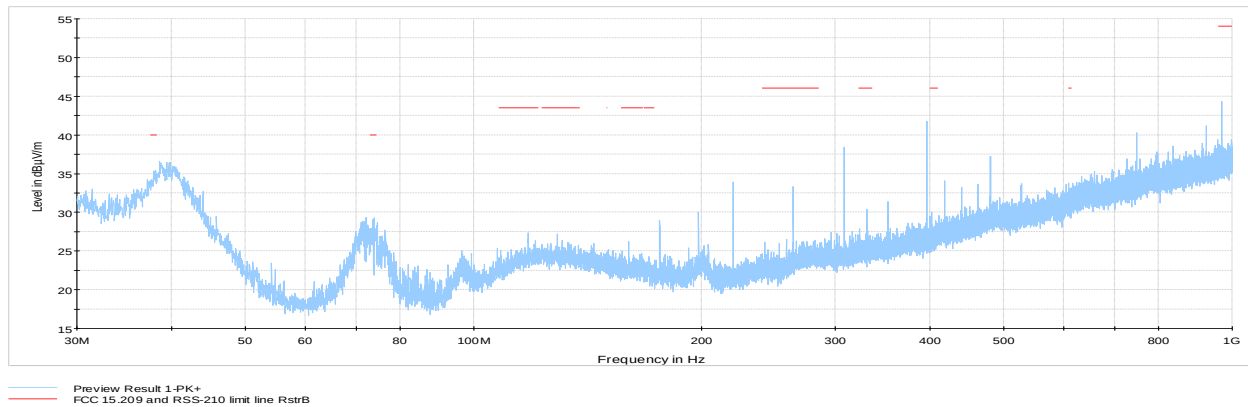
Figure 8.8-25: Spurious emissions within restricted bands, 802.11ac VHT80

Note: Peak limit EIRP equivalent:  $74 \text{ dB}\mu\text{V/m} - 95.23 \text{ dB} = -21.23 \text{ dBm}$   
 Average limit EIRP equivalent:  $54 \text{ dB}\mu\text{V/m} - 95.23 \text{ dB} = -41.23 \text{ dBm}$

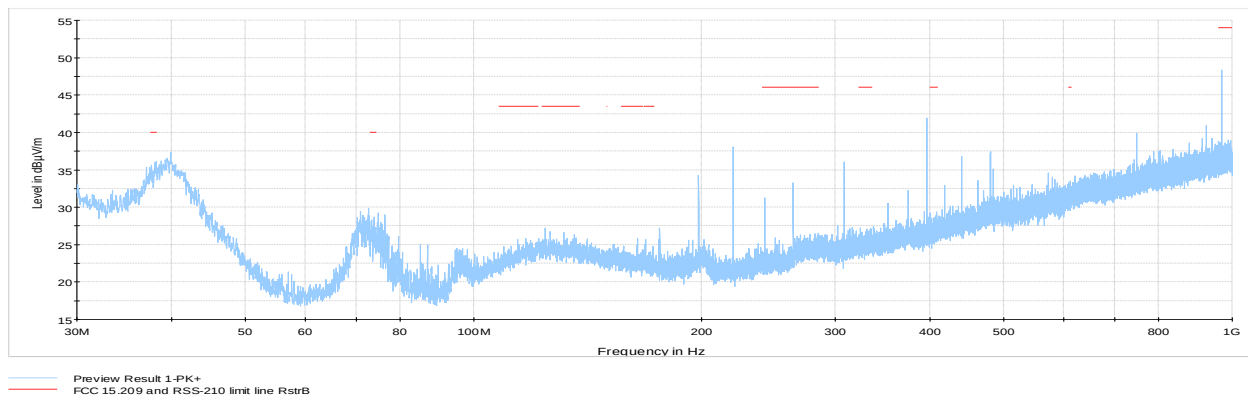
## Test data, continued



**Figure 8.8-26:** Cabinet Radiated spurious emission 30 MHz to 1 GHz , Tx on low channel



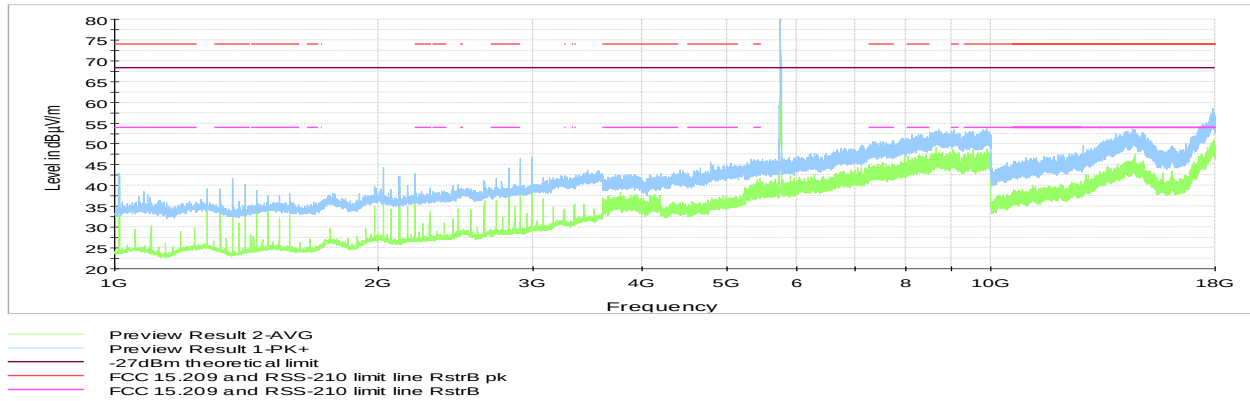
**Figure 8.8-27:** Cabinet Radiated spurious emission 30 MHz to 1 GHz , Tx on mid channel



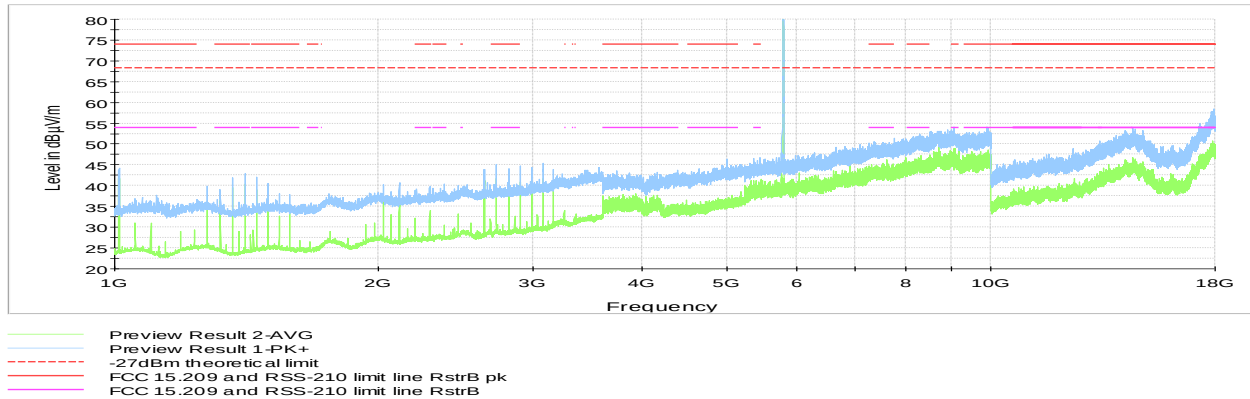
**Figure 8.8-28:** Cabinet Radiated spurious emission 30 MHz to 1 GHz , Tx on high channel

Note: EUT was investigated in all modulation modes, only worst case is presented.  
Emissions were verified to be below the  $-27$  dBm/MHz limit.

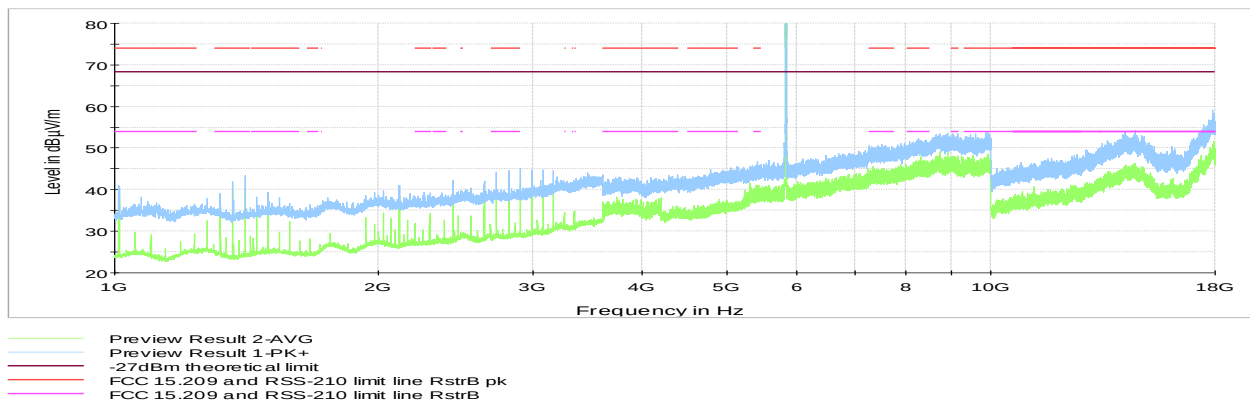
Test data, continued



**Figure 8.8-29:** Cabinet Radiated spurious emission 1 to 18 GHz, Tx on low channel



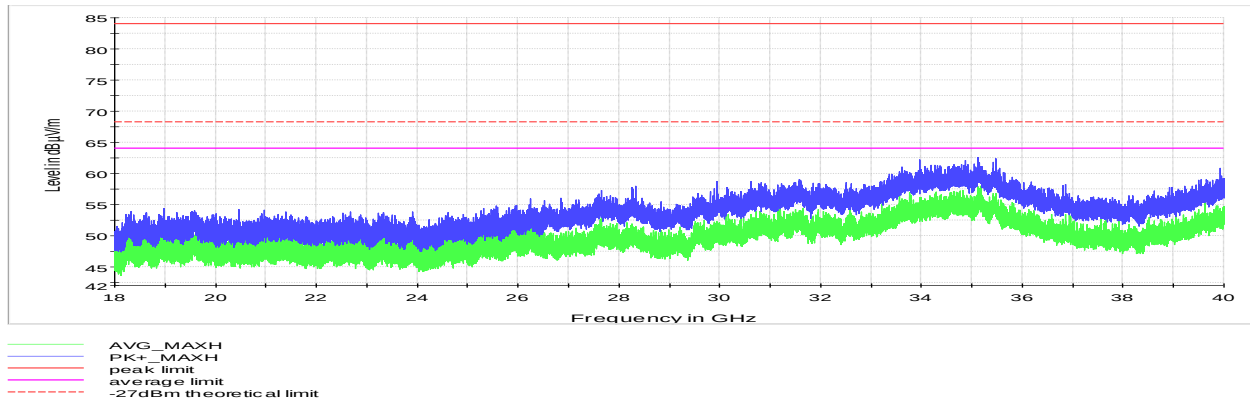
**Figure 8.8-30:** Cabinet Radiated spurious emission 1 to 18 GHz, Tx on mid channel



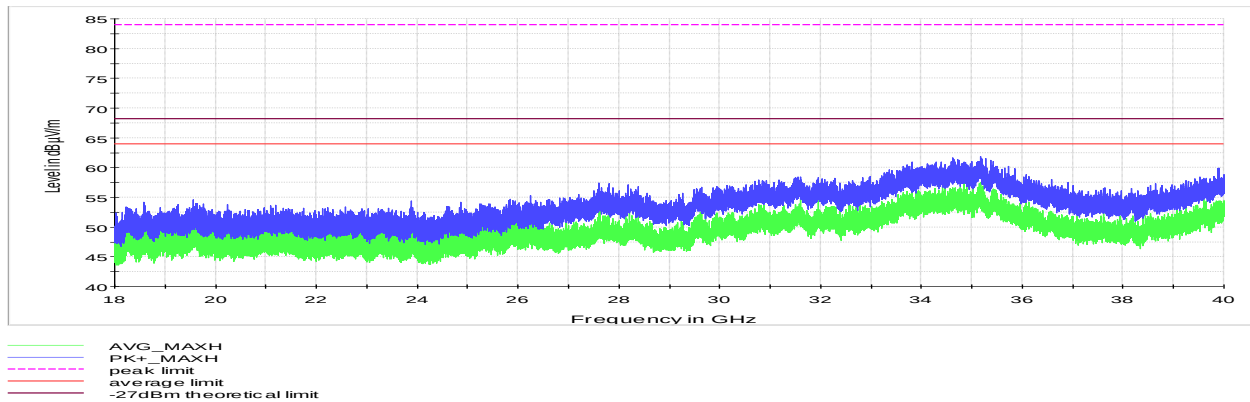
**Figure 8.8-31:** Cabinet Radiated spurious emission 1 to 18 GHz, Tx on high channel

Note: EUT was investigated in high/mid/low channels of 802.11a/802.11n/802.11ac modes, only worst case is presented.

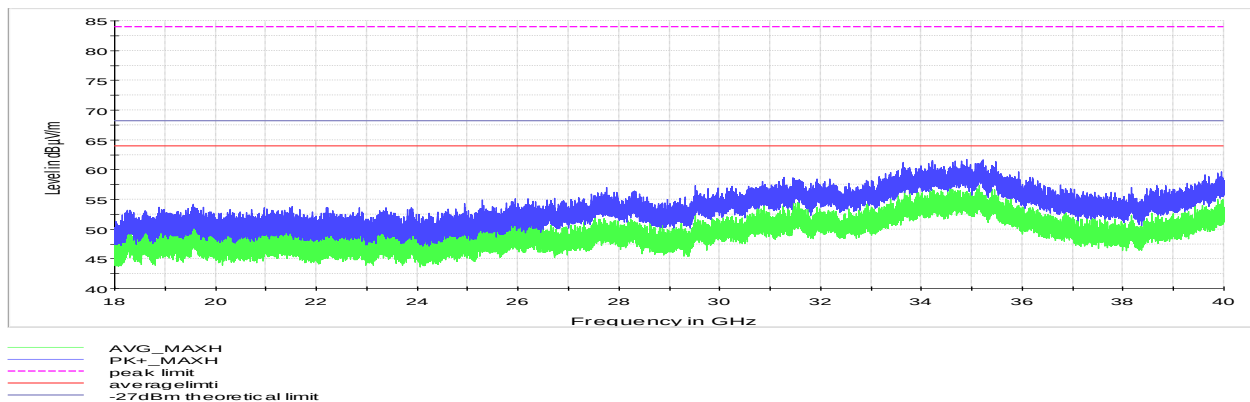
Test data, continued



**Figure 8.8-32:** Cabinet Radiated spurious emission 18 to 40 GHz, Tx on low channel



**Figure 8.8-33:** Cabinet Radiated spurious emission 18 to 40 GHz, Tx on low channel



**Figure 8.8-34:** Cabinet Radiated spurious emission 18 to 40 GHz, Tx on low channel

Note: EUT was investigated in high/mid/low channels of 802.11a/802.11n/802.11ac modes, only worst case is presented.

## 8.9 Frequency stability

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### 8.9.1 References, definitions and limits

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**FCC §15.407:**

- (g) Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the users manual.

**RSS-Gen, Clause 8.11:**

If the frequency stability of the licence-exempt radio apparatus is not specified in the applicable RSS, the fundamental emissions of the radio apparatus should be kept within at least the central 80% of its permitted operating frequency band in order to minimize the possibility of out-of-band operation.

### 8.9.2 Test summary

---

|           |            |           |               |
|-----------|------------|-----------|---------------|
| Verdict   | Pass       |           |               |
| Tested by | Yong Huang | Test date | June 26, 2021 |

### 8.9.3 Observations, settings and special notes

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Frequency stability test was performed as per ANSI C63.10, Clause 6.8 and 789033 D02, Clause II(A)(3). Spectrum analyser settings:

|                       |          |
|-----------------------|----------|
| Resolution bandwidth: | 10 Hz    |
| Video bandwidth:      | 10 Hz    |
| Detector mode:        | Peak     |
| Trace mode:           | Max Hold |

#### 8.9.4 Test data

**Table 8.9-1: Frequency drift measurement**

| Test conditions | Nominal frequency, GHz | Frequency, GHz | Drift, Hz |
|-----------------|------------------------|----------------|-----------|
| +45 °C, Nominal | 5.745000000            | 5.745019970    | 18090     |
| +30 °C, Nominal | 5.745000000            | 5.745004050    | 2170      |
| +20 °C, +15 %   | 5.745000000            | 5.745001880    | 0         |
| +20 °C, Nominal | 5.745000000            | 5.745001880    | reference |
| +20 °C, -15 %   | 5.745000000            | 5.745001880    | 0         |
| +10 °C, Nominal | 5.745000000            | 5.744997100    | -4780     |
| 0 °C, Nominal   | 5.745000000            | 5.745001160    | -720      |

**Table 8.9-2: Lower band edge drift calculation**

| Modulation                      | -26 dBc lower cross point, GHz | Max negative drift, Hz | Drifted lower cross point, GHz | Band edge, GHz | Margin, MHz |
|---------------------------------|--------------------------------|------------------------|--------------------------------|----------------|-------------|
| 802.11a                         | 5.73431                        | 4780                   | 5.734305220                    | 5.725          | 9.30522     |
| 802.11n HT20<br>/802.11ac VHT20 | 5.75597                        | 4780                   | 5.755965220                    | 5.725          | 30.96522    |
| 802.11n HT40<br>/802.11ac VHT40 | 5.77654                        | 4780                   | 5.776535220                    | 5.725          | 51.53522    |
| 802.11ac VHT80                  | 5.73368                        | 4780                   | 5.733675220                    | 5.725          | 8.67522     |

Notes: Drifted lower cross point = -26 dBc lower cross point – max negative drift.

**Table 8.9-3: Upper band edge drift calculation**

| Modulation                      | -26 dBc upper cross point, GHz | Max positive drift, Hz | Drifted upper cross point, GHz | Band edge, GHz | Margin, MHz  |
|---------------------------------|--------------------------------|------------------------|--------------------------------|----------------|--------------|
| 802.11a                         | 5.83567                        | 18090                  | 5.835688090                    | 5.85           | 14.311910000 |
| 802.11n HT20<br>/802.11ac VHT20 | 5.83573                        | 18090                  | 5.835748090                    | 5.85           | 14.251910000 |
| 802.11n HT40<br>/802.11ac VHT40 | 5.81674                        | 18090                  | 5.816758090                    | 5.85           | 33.241910000 |
| 802.11ac VHT80                  | 5.81632                        | 18090                  | 5.816338090                    | 5.85           | 33.661910000 |

Notes: Drifted upper cross point = -26 dBc upper cross point + max positive drift.

## Section 9 EUT photos

### 9.1 External photos

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**Figure 9.1-1:** Front view photo



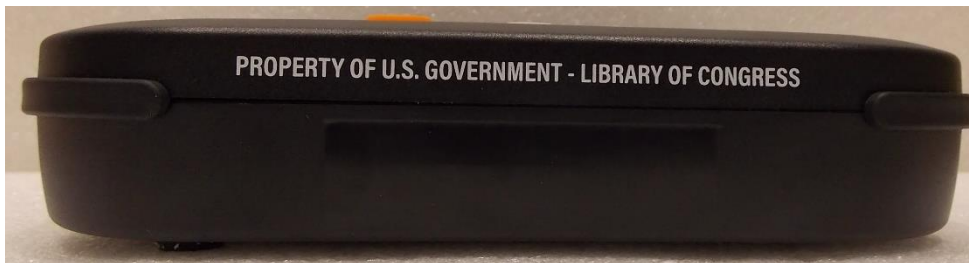
**Figure 9.1-2:** Rear view photo



**Figure 9.1-3:** Side view photo



**Figure 9.1-4:** Side view photo



**Figure 9.1-5:** Top view photo



**Figure 9.1-6:** Bottom view photo

**End of the test report**