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# Wireless test report – 350995-3TRFWL

Applicant:

Eurotech SpA

Product name:

ReliaGATE 10-12

DynaGATE 10-12

| Model: | Model variant: |
|---|---|
| REGATE-10-12-GS02 | DYGATE-10-12-GS02 |

| FCC ID: | IC Registration number: |
|---|---|
| UKMMRG1012 | 21442-MRG1012 |

Specifications:

- FCC 47 CFR Part 15 Subpart E, §15.407

  Unlicensed National Information Infrastructure Devises

- RSS-247, Issue 2, Section 6, Feb 2017

  Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices



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

## Test location

| | |
|---|---|
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| Website | www.nemko.com |
| Site number | FCC: CA2041; IC: 2040G-5 (3 m semi anechoic chamber) |

| | |
|---|---|
| Tested by | Yong Huang Wireless/EMC Specialist |
| Reviewed by | Kevin Rose, Wireless/EMC Specialist |
| Review date | September 14, 2018 |
| Reviewer signature | |

## 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 contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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# Section 1. Report summary

## 1.1 Applicant and manufacturer

| | |
|---|---|
| Company name | Eurotech SpA |
| Address | Via Fratelli Solari 3/a 33020 Amaro, UD, Italy |

## 1.2 Test specifications

| | |
|---|---|
| FCC 47 CFR Part 15, Subpart E, Clause 15.407<br>RSS-247, Issue 2, February 2017 | Unlicensed National Information Infrastructure Devises<br>Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices |

## 1.3 Test methods

| | |
|---|---|
| 789033 D02 General UNII Test Procedures New Rules v02r01 (Dec 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 |

## 1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. 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 Exclusions

None

## 1.6 Test report revision history

| Revision # | Details of changes made to test report |
|---|---|
| TRF | Original report issued |

# Section 2. Summary of test results

## 2.1 FCC Part 15 Subpart C, general requirements test results

| Part | Test description | Verdict |
|---|---|---|
| §15.31(e) | Variation of power source | Pass[1] |
| §15.203 | Antenna requirement | Pass[2] |

Notes: [1]Measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, was performed with the supply voltage varied between 85 % and 115 % of the nominal rated supply voltage. No noticeable output power variation was observed

[2]The Antennas uses a unique coupling to the intentional radiator.

## 2.2 FCC Part 15 Subpart E, test results

| Part | Test description | Verdict |
|---|---|---|
| §15.403(i) | Emission bandwidth | Pass |
| §15.407(a)(1) | Power and density limits within 5.15–5.25 GHz band | Pass |
| §15.407(a)(2) | Power and density limits within 5.25–5.35 GHz and 5.47–5.725 GHz bands | Not applicable |
| §15.407(a)(3) | Power and density limits within 5.725–5.85 GHz band | Not applicable |
| §15.407(b)(1) | Undesirable emission limits for 5.15–5.25 GHz band | Pass |
| §15.407(b)(2) | Undesirable emission limits for 5.25–5.35 GHz band | Not applicable |
| §15.407(b)(3) | Undesirable emission limits for 5.47–5.725 GHz bands | Not applicable |
| §15.407(b)(4) | Undesirable emission limits for 5.725–5.85 GHz band | Not applicable |
| §15.407(b)(6) | Conducted limits for U-NII devices using an AC power line | Pass |
| §15.407(e) | Minimum 6 dB bandwidth of U-NII devices within the 5.725-5.85 GHz band | Not applicable |
| §15.407(g) | Frequency stability | Pass |
| §15.407(h)(1)[1] | Transmit power control (TPC) | Not applicable |
| §15.407(h)(2)[1] | Dynamic Frequency Selection (DFS) | Not applicable |

Note: [1]DFS and TPC requirements are only applicable to 5.25–5.35 GHz and 5.47–5.725 GHz bands

## 2.3 IC RSS-GEN, Issue 4, test results

| Part | Test description | Verdict |
|---|---|---|
| 6.6 | Occupied Bandwidth | Pass |
| 7.1.2[1] | Receiver radiated emission limits | Not applicable |
| 7.1.3[1] | Receiver conducted emission limits | Not applicable |
| 8.8 | Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus | Pass |
| 8.11[2] | Frequency stability | Pass |

Notes: [1]According to sections 5.2 and 5.3 of RSS-Gen, Issue 4: if EUT does not have a stand-alone receiver neither scanner receiver, then it exempt from receiver requirements.

[2]According to section 8.11 of RSS-Gen, Issue 4: if the frequency stability of the licence-exempt radio apparatus is not specified in the applicable standard (RSS), measurement of the frequency stability is not required

## 2.4 IC RSS-247, Issue 1, test results

| Section | Test description | Verdict |
|---|---|---|
| 6.1[1] | Types of Modulation | Pass |
| 6.2.1.1 | Power limits for 5150–5250 MHz band | Pass |
| 6.2.2.1 | Power limits for 5250–5350 MHz band | Not applicable |
| 6.2.3.1 | Power limits for 5470–5600 MHz and 5650–5725 MHz bands | Not applicable |
| 6.2.4.1 | Power limits for 5725–5850 MHz band | Not applicable |
| 6.2.4.1 | Minimum 6 dB bandwidth | Not applicable |
| 6.2.1.2 | Unwanted emission limits for 5150–5250 MHz band | Pass |
| 6.2.2.2 | Unwanted emission limits for 5250–5350 MHz band | Not applicable |
| 6.2.2.2 | TPC requirements for devices with a maximum e.i.r.p. greater than 500 mW | Not applicable |
| 6.2.2.3 | e.i.r.p. at different elevations restrictions for 5250–5350 MHz band | Not applicable |
| 6.2.3.2 | Unwanted emission limits for 5470–5600 MHz and 5650–5725 MHz bands | Not applicable |
| 6.2.4.2 | Unwanted emission limits for 5725–5850 MHz band | Not applicable |
| 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: [1] The EUT employs digital modulation: 802.11a/n

# Section 3. Equipment under test (EUT) details

## 3.1 Sample information

| | |
|---|---|
| Receipt date | July 17, 2018 |
| Nemko sample ID number | Item #2 |

## 3.2 EUT information

| | |
|---|---|
| Product name | ReliaGATE 10-12<br>DynaGATE 10-12 |
| Model | REGATE-10-12-GS02 |
| Model variant | DYGATE-10-12-GS02 |
| Serial number | Y117LQA0010 |

## 3.3 Technical information

| | |
|---|---|
| Applicant IC company number | 21442 |
| IC UPN number | MRG1012 |
| All used IC test site(s) Reg. number | 2040G-5 |
| RSS number and Issue number | RSS-247 Issue 2, Section 6, February 2017 |
| Frequency band | 5150–5250 MHz |
| Frequency Min (MHz) | 5180(20 MHz channel); 5190 (40 MHz channel) |
| Frequency Max (MHz) | 5240(20 MHz channel); 5230 (40 MHz channel) |
| Measured BW (MHz) (26 dB) | 22.82 (20 MHz channel); 42.20 (40 MHz channel) |
| Measured BW (MHz) (99%) | 17.78 (20 MHz channel); 36.08 (40 MHz channel) |
| Type of modulation | 802.11a/n |
| Emission classification (F1D, G1D, D1D) | W7D |
| Transmitter spurious, Units @ distance | 51.03dBµV/m @3m, average at 5.15GHz |
| Power requirements | 24 $V_{DC,}$ via 120 $V_{AC}$ adapter or battery |
| Antenna information | The EUT uses a unique antenna coupling.<br>EUT has 2 antenna configurations. The max antenna peak gain is 5.47 dBi at 2.4 GHz band and 7.07 dBi at 5 GHz WIFI bands.<br>Linx Technologies ANT-DB1-RAF-RPS (2.5 dBi for 2.4 GHz, 4.6 dBi antenna for 5 GHz)<br>Taoglas MA.950.W.A.LBICG.005 (5.47 dBi for 2.4GHz, 7.07 for 5GHz) |

## 3.4 Product description and theory of operation

The ReliaGATE and DynaGATE 10-12 are IoT Edge Gateways that have been designed to deliver LTE connectivity (with 3G fallback) to industrial and lightly rugged applications. Based on the TI AM335x Cortex-A8 (Sitara) processor family, with 1 GB of RAM, 4 GB of eMMC and user-accessible MicroSD and dual Micro-SIM slots, the ReliaGATE and DynaGATE 10-12 are low power gateways suitable for demanding use cases. They support a 6 to 36 V power supply with transient protection and ignition sense, two protected RS-232/RS-485 serial ports, two CAN bus interfaces, three noise and surge protected USB ports, and four isolated digital interfaces

## 3.5 EUT exercise details

EUT was set to continuously transmit mode during tests, by test software provided by client.
The EUT runs a Linux operating system which allows for the testing to be performed using engineering test tools and scripts. Communication with the EUT is via a serial console or Ethernet connection which provides a Linux command line interface for execution of the test tools/scripts. These tools/scripts configure the radio modules to enable continuous transmission with the ability to adjust modulation, frequency and output power as required.

WiFi/BT – using a engineering test tool provided by the silicon vendor allowing for full radio control.
Cellular – using Linux scripts running AT command sequences provided by the cellular radio module vendor allowing for full radio control.

## 3.6 EUT setup diagram

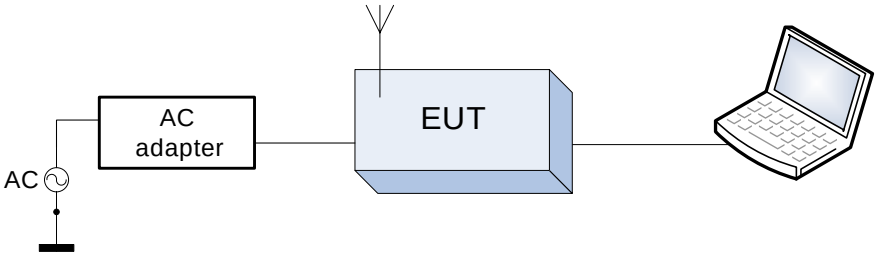



***Figure 3.6-1:*** *Setup diagram*

## 3.7 EUT sub assemblies

***Table 3.7-1:*** *EUT sub assemblies*

| Description | Brand name | Model/Part number | Serial number |
|---|---|---|---|
| REGATE-10-12 | Eurotech | REGATE-10-12-GS02 | Y117LQA0010 |
| AC adapter | Sunny | SYS15412424 | None |

# **Section 4.** Engineering considerations

## 4.1 Modifications incorporated in the EUT

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

## 4.2 Technical judgment

Differences between the variants are as below. REGATE-10-12 was chosen as representative worst-case.

| **Model** | **ReliaGATE 10-12** | | | | | **DynaGATE 10-12** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Variant (Base Hardware) REGATE-10-12-xx** | **REGATE-10-12-GS02 (EMC Sample Unit)** | **REGATE-10-12-01** | **REGATE-10-12-02** | **REGATE-10-12-03** | **REGATE-10-12-05** | **DYGATE-10-12-GS02 (EMC Sample Unit)** | **DYGATE-10-12-01** | **DYGATE-10-12-02** | **DYGATE-10-12-03** | **DYGATE-10-12-05** |
| **OS SW Versions Refer Note 1.** | **-** | **REGATE-10-12-21 REGATE-10-12-31** | **REGATE-10-12-22 REGATE-10-12-32** | **REGATE-10-12-23 REGATE-10-12-33** | **REGATE-10-12-25 REGATE-10-12-35** | **-** | **DYGATE-10-12-21 DYGATE-10-12-31** | **DYGATE-10-12-22 DYGATE-10-12-32** | **DYGATE-10-12-23 DYGATE-10-12-33** | **DYGATE-10-12-25 DYGATE-10-12-35** |
| GENERAL | | | | | | | | | | |
| Processor | TI Sitara AM3352 1GHz | | | | | | | | | |
| DRAM | 1GB DDR3 | | | | | | | | | |
| STORAGE | 4GB eMMC, micro SD slot accessible under service panel opening, 256kbit EEPROM | | | | | | | | | |
| PCB Design | Both models share the same PCB design with population differences as described below (8-layers PCB) | | | | | | | | | |
| Ethernet | 2x 10-100Mbps on shielded RJ45 | | | | | | | | | |
| Serial | Two identical 2-lines channels(RX/TX, RA+/RB-) available on 3.5mm terminal | | | | | | | | | |
| Debug | RS232 3.3V TTL debug port available under service panel opening | | | | | | | | | |
| CAN | Two identical Can bus ports available on 3.5mm terminal header with external power delivery 5V@100mA | | | | | | | | | |
| Digital I/O | 2x Digital Input 36V, 1kV Opto-isolated, 2x Digital Output (40VDC), 500mA fuse protected, 1KHz Max Switching(optorelay) | | | | | | | | | |
| USB | 3x Host 2.0 (Noise and Surge Protected) - Type A – Electrically identical to DynaGATE 10-12 Variants | | | | | 3x Host 2.0 (Noise and Surge Protected) - High Retention Type A - Electrically identical to ReliaGATE 10-12 Variants | | | | |
| Expansion | Yes, for Side Expansion Modules (24way 2mm/2row female header) | | | | | | | | | |
| WIRELESS | | | | | | | | | | |
| LTE | TELIT LE910-NA1 LTE | None | None | TELIT LE910-NA1 LTE | | TELIT LE910-NA1 LTE | None | None | TELIT LE910-NA1 LTE | |
| WiFi | Jorjin WG7833-B0 | None | Jorjin WG7833-B0 | None | Jorjin WG7833-B0 | Jorjin WG7833-B0 | None | Jorjin WG7833-B0 | None | Jorjin WG7833-B0 |
| GPS | U-Blox NEO M8 GPS | Optional U-Blox NEO-M8x GPS Receiver | | | | Integrated U-Blox NEO-M8x GPS Receiver | | | | |
| OTHER | | | | | | | | | | |
| RTC | Yes (Lithium BR1225 battery backup) | | | | | Yes (Supercap backup) | | | | |
| Sensors | Temperature, Accelerometer | | | | | | | | | |
| Buttons | 1x RESET, 1x user programmable available under the service panel | | | | | | | | | |
| LEDs | 1x Power, 1x Cellular, 4x Programmable | | | | | | | | | |
| TPM | Factory Option | | | | | | | | | |
| SIM slot | 2x microSIM (User Accessible under the service panel) | | | | | | | | | |
| Power | 6-36VDC, with Transient Protection, Vehicle Ignition Sense (2W typ.) | | | | | | | | | |
| ENVIRONMENT | | | | | | | | | | |
| Operating temp. range | - 20 to +70°C | | | | | - 40 to +85°C | | | | |
| Storage temp. range | - 40 to +85°C | | | | | | | | | |
| MECHANICAL | | | | | | | | | | |
| Enclosure | ABS Plastic | | | | | Aluminium Sheetmetal | | | | |
| Ingress | IP40 | | | | | | | | | |
| Dimensions | 138.9x115.0x46.2mm (LxWxH) - with mounting bracket and SMA connectors | | | | | 138.9x118.2x51.6mm (LxWxH) - with mounting bracket and SMA connectors | | | | |

**Note 1:** Radio module firmware and operating system based radio firmware loaded during OS boot are identical across all REGATE-10-12-xx and DYGATE-10-12-xx variants.

## 4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

# Section 5. Test conditions

## 5.1 Atmospheric conditions

| | |
|---|---|
| Temperature | 15–30 °C |
| Relative humidity | 20–75 % |
| Air pressure | 860–1060 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.

## 5.2 Power supply range

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 ±5 %, for which the equipment was designed.

# Section 6. Measurement uncertainty

## 6.1 Uncertainty of measurement

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

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

# 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. |
|---|---|---|---|---|---|
| Flush mount turntable | Sunol | FM2022 | FA002550 | — | NCR |
| Controller | Sunol | SC104V | FA002551 | — | NCR |
| Antenna mast | Sunol | TLT2 | FA002552 | — | NCR |
| Spectrum analyzer | Rohde & Schwarz | FSV 40 | FA002731 | 1 year | Oct 10/18 |
| 50 Ω coax cable | C.C.A. | None | FA002603 | — | VOU |
| 50 Ω coax cable | C.C.A. | None | FA002605 | — | VOU |
| 50 Ω coax cable | C.C.A. | None | FA002607 | — | VOU |
| Bilog antenna (20–2000 MHz) | Sunol | JB1 | FA002517 | 1 year | Dec. 6/18 |
| Horn antenna (1–18 GHz) | EMCO | 3115 | FA001452 | 1 year | Nov. 20/18 |
| Horn antenna (18–40 GHz) | EMCO | 3116 | FA002487 | 2 year | Aug. 16/18 |
| Pre-amplifier (0.5–18 GHz) | COM-POWER | PAM-118A | FA002561 | 1 year | Sept. 21/18 |
| Pre-amplifier (18–40 GHz) | COM-POWER | PAM-840 | FA002508 | 1 year | May 8/19 |
| 5150-5350 MHz Notch Filter | Microwave Circuits | N0452501 | FA002690 | — | VOU |
| 50 Ω coax cable | HUBER+SUHNER | SUCOFLEX 100 | FA002564 | — | VOU |
| Three phase power system | TESEQ | ProfLine 2115-400 | FA002516 | 1 year | Aug. 21/18 |
| Power sensor | Rohde & Schwarz | NRP18S | FA002730 | 1 year | Oct 21/18 |
| Receiver/spectrum analyzer | Rohde & Schwarz | ESU 40 | FA002071 | 1 year | Sept. 18/18 |
| Environmental Chamber | ESPEC | EPX-4H | FA002736 | 1 year | June 6/19 |
| True RMS Multimeter | Fluke | 175 | FA002642 | 1 year | Nov. 2/18 |
| LISN | Rohde & Schwarz | ENV216 | FA002514 | 1 year | Dec. 15/18 |

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

# Section 8. Testing data

## 8.1 FCC 15.403(i) Emission bandwidth

### 8.1.1 Definitions and limits

15.403(i) 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.

### 8.1.2 Test summary

| | |
|---|---|
| Test start date | July 16, 2018 |
| Test engineer | Yong Huang |

### 8.1.3 Observations, settings and special notes

Spectrum analyzer settings:

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

### 8.1.4 Test data

***Table 8.1-1:*** *26 dB bandwidth results*

| Modulation | Frequency, MHz | 26 dB bandwidth, MHz |
|---|---|---|
| 802.11a | 5180 | 22.56 |
| | 5200 | 21.66 |
| | 5240 | 21.18 |
| 802.11n HT20 | 5180 | 22.08 |
| | 5200 | 22.58 |
| | 5240 | 22.82 |
| 802.11n HT40 | 5190 | 42.20 |
| | 5230 | 41.64 |

## 8.1.4 Test data, continued

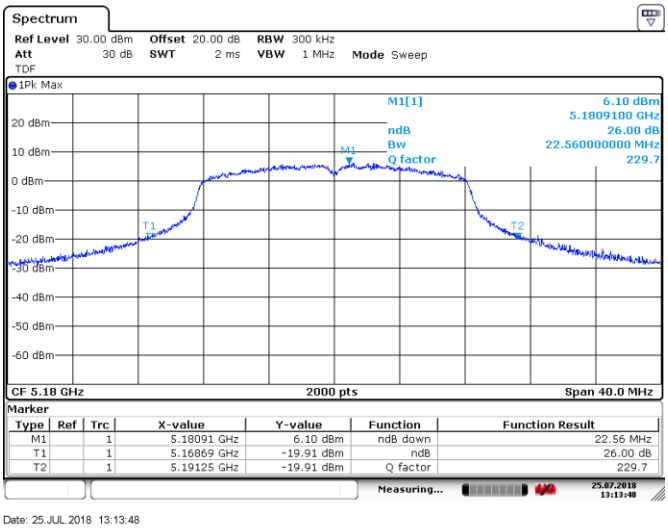



***Figure 8.1-1:*** *26 dB bandwidth on 802.11a, sample plot*

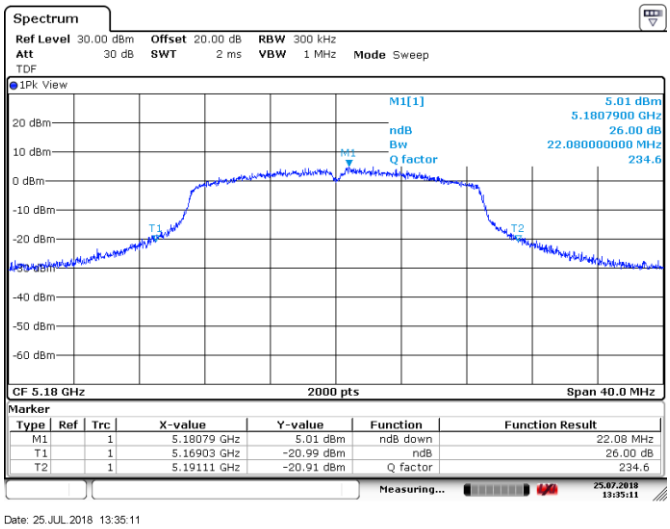



***Figure 8.1-2:*** *26 dB bandwidth on 802.11n HT20, sample plot*

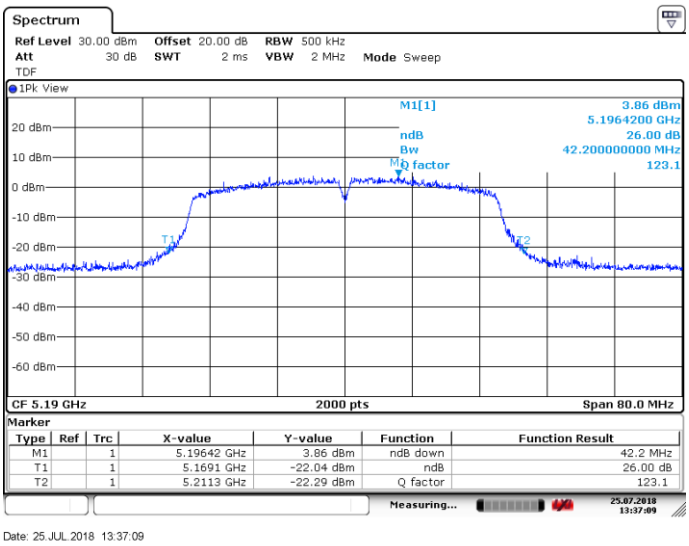



***Figure 8.1-3:*** *26 dB bandwidth on 802.11n HT40, sample plot*

## 8.2 RSS-Gen 6.6 Occupied bandwidth

### 8.2.1 Definitions and limits

The emission bandwidth (×dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated × dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3× the resolution bandwidth.

When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

### 8.2.2 Test summary

| | |
|---|---|
| Test start date | July 25, 2018 |
| Test engineer | Yong Huang |

### 8.2.3 Observations, settings and special notes

Spectrum analyser settings:

| | |
|---|---|
| Resolution bandwidth: | 1 % to 5 % of OBW |
| Video bandwidth: | ≥3 × RBW |
| Detector mode: | Peak |
| Trace mode: | Max Hold |

### 8.2.4 Test data

***Table 8.2-1:*** *99 % bandwidth results*

| Modulation | Frequency, MHz | 99 % bandwidth, MHz |
|---|---|---|
| 802.11a | 5180 | 16.64 |
| | 5200 | 16.66 |
| | 5240 | 16.64 |
| 802.11n HT20 | 5180 | 17.76 |
| | 5200 | 17.72 |
| | 5240 | 17.78 |
| 802.11n HT40 | 5190 | 36.08 |
| | 5230 | 36.08 |

## 8.2.4 Test data, continued

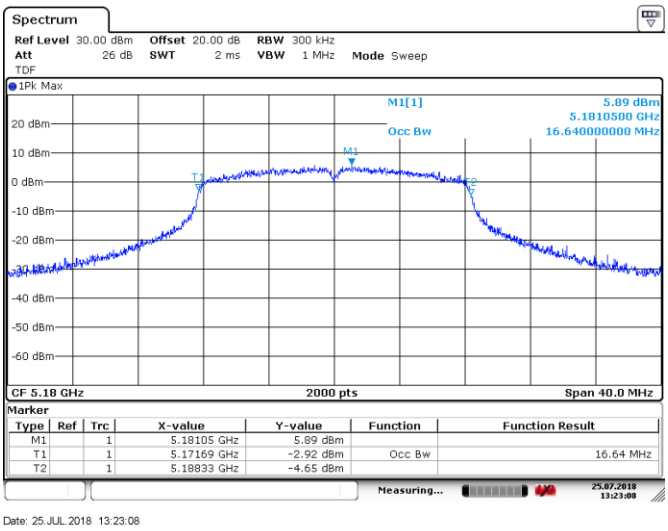



***Figure 8.2-1:*** *99 % bandwidth on 802.11a, sample plot*

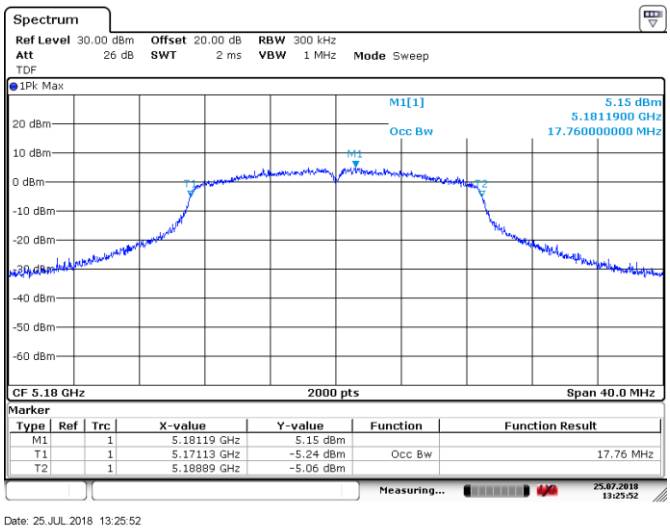



***Figure 8.2-2:*** *99 % bandwidth on 802.11n HT20, sample plot*

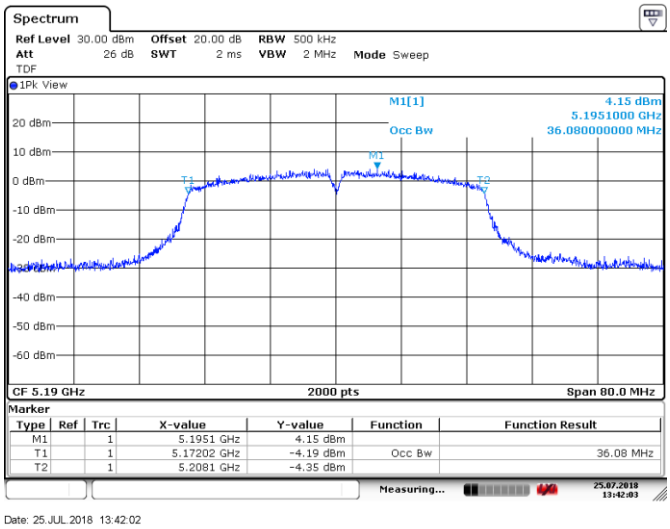



***Figure 8.2-3:*** *99 % bandwidth 802.11n HT40, sample plot*

Note: 99% bandwidth is verified for ISED requirement that it does not fall within the 5250-5350 MHz band.

## 8.3 FCC 15.407(a)(1) 5.15–5.25 GHz band output power and spectral density limits

### 8.3.1 Definitions and limits

FCC:

(i) For an outdoor access point operating in the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W (30 dBm) provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz 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.

The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W (30 dBm) provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz 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.

(iii) For fixed point-to-point access points operating in the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W (30 dBm). In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. 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.

(iv) For mobile and portable client devices in the 5.15–5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW (24 dBm) provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz 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.

**ISED:**
**LE-LAN devices are restricted to indoor operation only in the band 5150–5250 MHz.**
The maximum e.i.r.p. shall not exceed 200 mW (23 dBm) or $10 + 10 \times \log_{10}(B)$, dBm, whichever power is less. B is the 99% emission bandwidth in megahertz. The e.i.r.p. spectral density shall not exceed 10 dBm in any 1.0 MHz band.

### 8.3.2 Test summary

| | |
|---|---|
| Test start date: | July 25, 2018 |
| Test engineer: | Yong Huang |

### 8.3.3 Observations, settings and special notes

As per manufacturer declaration, EUT is for indoor fix operation only. EUT was configured to continuous transmit mode during tests.
Output power was tested using RMS power meter.
The highest and lowest data rate setting have been investigated, only the worst-cases were presented.

Spectrum analyzer settings for PSD measurement:

| | |
|---|---|
| Resolution bandwidth | 1 MHz |
| Video bandwidth | 3 MHz |
| Frequency span | > EBW |
| Detector mode | RMS |
| Trace mode | Power Averaging over 100 sweeps |

EIRP was calculated as follows: $EIRP = P_{combined} + antenna\ directional\ gain$

Output power/EIRP/PSD limit adjustment: Output power/EIRP/PSD limit – (Total antenna gain – 6 dBi).

FCC Output power limit is30 dBm
FCC PSD limit is17 dBm/MHz
ISED e.i.r.p limit is 200 mW (23 dBm) or 10 + 10 × $\log_{10}$ (B), dBm, whichever power is less.
ISED PSD limit is10 dBm/MHz e.i.r.p

### 8.3.4 Test data

***Table 8.3-1:*** *FCC Output power measurements results , Taoglas Antenna configuration*

| Modulation | Frequency, MHz | Output power, dBm | Power limit, dBm | Margin, dB |
|---|---|---|---|---|
| 802.11a | 5180 | 12.3 | 28.9 | 16.6 |
| | 5200 | 13.3 | 28.9 | 15.6 |
| | 5240 | 12.7 | 28.9 | 16.2 |
| 802.11n HT20 | 5180 | 12.3 | 28.9 | 16.6 |
| | 5200 | 12.6 | 28.9 | 16.3 |
| | 5240 | 12.6 | 28.9 | 16.3 |
| 802.11n HT40 | 5190 | 12.1 | 28.9 | 16.8 |
| | 5230 | 12.0 | 28.9 | 16.9 |

***Table 8.3-2:*** *ISED e.i.r.p measurements results , Taoglas Antenna configuration*

| Modulation | Frequency, MHz | Output power, dBm | Antenna Gain, dBi | EIRP, dBm | EIRP limit, dBm | Margin, dB |
|---|---|---|---|---|---|---|
| 802.11a | 5180 | 12.3 | 7.07 | 19.4 | 22.2 | 2.8 |
| | 5200 | 13.3 | 7.07 | 20.4 | 22.2 | 1.8 |
| | 5240 | 12.7 | 7.07 | 19.8 | 22.2 | 2.4 |
| 802.11n HT20 | 5180 | 12.3 | 7.07 | 19.4 | 22.5 | 3.1 |
| | 5200 | 12.6 | 7.07 | 19.7 | 22.5 | 2.8 |
| | 5240 | 12.6 | 7.07 | 19.7 | 22.5 | 2.8 |
| 802.11n HT40 | 5190 | 12.1 | 7.07 | 19.2 | 23.0 | 3.8 |
| | 5230 | 12.0 | 7.07 | 19.1 | 23.0 | 3.9 |

***Table 8.3-3:*** *FCC Output power measurements results , Linx Technology Antenna configuration*

| Modulation | Frequency, MHz | Output power, dBm | Power limit, dBm | Margin, dB |
|---|---|---|---|---|
| 802.11a | 5180 | 12.3 | 30.0 | 17.7 |
| | 5200 | 13.3 | 30.0 | 16.7 |
| | 5240 | 12.7 | 30.0 | 17.3 |
| 802.11n HT20 | 5180 | 12.3 | 30.0 | 17.7 |
| | 5200 | 12.6 | 30.0 | 17.4 |
| | 5240 | 12.6 | 30.0 | 17.4 |
| 802.11n HT40 | 5190 | 12.1 | 30.0 | 17.9 |
| | 5230 | 12.0 | 30.0 | 18.0 |

***Table 8.3-4:*** *ISED e.i.r.p measurements results , Linx Technology Antenna configuration*

| Modulation | Frequency, MHz | Output power, dBm | Antenna Gain, dBi | EIRP, dBm | EIRP limit, dBm | Margin, dB |
|---|---|---|---|---|---|---|
| 802.11a | 5180 | 12.3 | 4.6 | 16.9 | 22.2 | 5.3 |
| | 5200 | 13.3 | 4.6 | 17.9 | 22.2 | 4.3 |
| | 5240 | 12.7 | 4.6 | 17.3 | 22.2 | 4.9 |
| 802.11n HT20 | 5180 | 12.3 | 4.6 | 16.9 | 22.5 | 5.6 |
| | 5200 | 12.6 | 4.6 | 17.2 | 22.5 | 5.3 |
| | 5240 | 12.6 | 4.6 | 17.2 | 22.5 | 5.3 |
| 802.11n HT40 | 5190 | 12.1 | 4.6 | 16.7 | 23.0 | 6.3 |
| | 5230 | 12.0 | 4.6 | 16.6 | 23.0 | 6.4 |

***Table 8.3-5:*** *FCC PSD measurements results , Taoglas Antenna configuration*

| Modulation | Frequency, MHz | PSD on ch0, dBm/MHz | Limit, dBm/MHz | Margin, dB |
|---|---|---|---|---|
| 802.11a | 5180 | 2.26 | 15.93 | 13.67 |
| | 5200 | 2.30 | 15.93 | 13.63 |
| | 5240 | 2.55 | 15.93 | 13.38 |
| 802.11n HT20 | 5180 | 1.13 | 15.93 | 14.80 |
| | 5200 | 1.34 | 15.93 | 14.59 |
| | 5240 | 1.78 | 15.93 | 14.15 |
| 802.11n HT40 | 5190 | -2.72 | 15.93 | 18.65 |
| | 5230 | -2.41 | 15.93 | 18.34 |

***Table 8.3-6:*** *ISED PSD measurements results , Taoglas Antenna configuration*

| Modulation | Frequency, MHz | Conducted PSD, dBm/MHz | Antenna Gain, dBi | PSD, dBm/MHz e.i.r.p | Limit, dBm/MHz | Margin, dB |
|---|---|---|---|---|---|---|
| 802.11a | 5180 | 2.26 | 7.07 | 9.33 | 10 | 0.67 |
| | 5200 | 2.30 | 7.07 | 9.37 | 10 | 0.63 |
| | 5240 | 2.55 | 7.07 | 9.62 | 10 | 0.38 |
| 802.11n HT20 | 5180 | 1.13 | 7.07 | 8.20 | 10 | 1.80 |
| | 5200 | 1.34 | 7.07 | 8.41 | 10 | 1.59 |
| | 5240 | 1.78 | 7.07 | 8.85 | 10 | 1.15 |
| 802.11n HT40 | 5190 | -2.72 | 7.07 | 4.35 | 10 | 5.65 |
| | 5230 | -2.41 | 7.07 | 4.66 | 10 | 5.34 |

***Table 8.3-7:*** *FCC PSD measurements results , Linx Technology Antenna configuration*

| Modulation | Frequency, MHz | PSD on ch0, dBm/MHz | Limit, dBm/MHz | Margin, dB |
|---|---|---|---|---|
| 802.11a | 5180 | 2.26 | 17 | 14.74 |
| | 5200 | 2.30 | 17 | 14.70 |
| | 5240 | 2.55 | 17 | 14.45 |
| 802.11n HT20 | 5180 | 1.13 | 17 | 15.87 |
| | 5200 | 1.34 | 17 | 15.66 |
| | 5240 | 1.78 | 17 | 15.22 |
| 802.11n HT40 | 5190 | -2.72 | 17 | 19.72 |
| | 5230 | -2.41 | 17 | 19.41 |

***Table 8.3-8:*** *ISED PSD measurements results , Linx Technology Antenna configuration*

| Modulation | Frequency, MHz | Conducted PSD, dBm/MHz | Antenna Gain, dBi | PSD, dBm/MHz e.i.r.p | Limit, dBm/MHz | Margin, dB |
|---|---|---|---|---|---|---|
| 802.11a | 5180 | 2.26 | 4.6 | 6.86 | 10 | 3.14 |
| | 5200 | 2.30 | 4.6 | 6.90 | 10 | 3.10 |
| | 5240 | 2.55 | 4.6 | 7.15 | 10 | 2.85 |
| 802.11n HT20 | 5180 | 1.13 | 4.6 | 5.73 | 10 | 4.27 |
| | 5200 | 1.34 | 4.6 | 5.94 | 10 | 4.06 |
| | 5240 | 1.78 | 4.6 | 6.38 | 10 | 3.62 |
| 802.11n HT40 | 5190 | -2.72 | 4.6 | 1.88 | 10 | 8.12 |
| | 5230 | -2.41 | 4.6 | 2.19 | 10 | 7.81 |

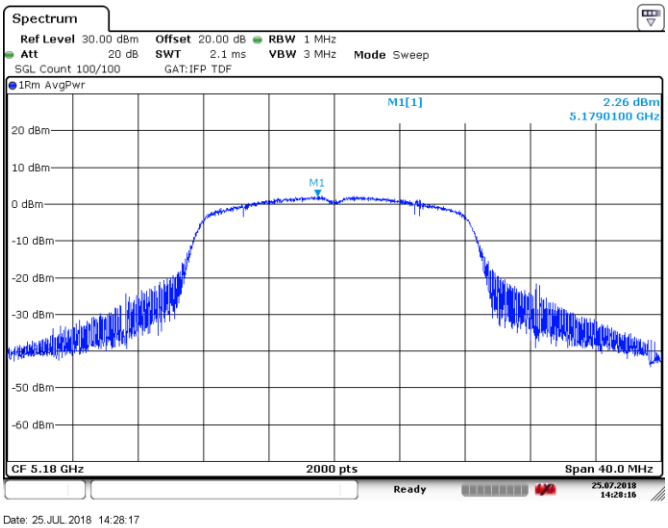



***Figure 8.3-1:*** *PSD on 802.11a Sample plot*

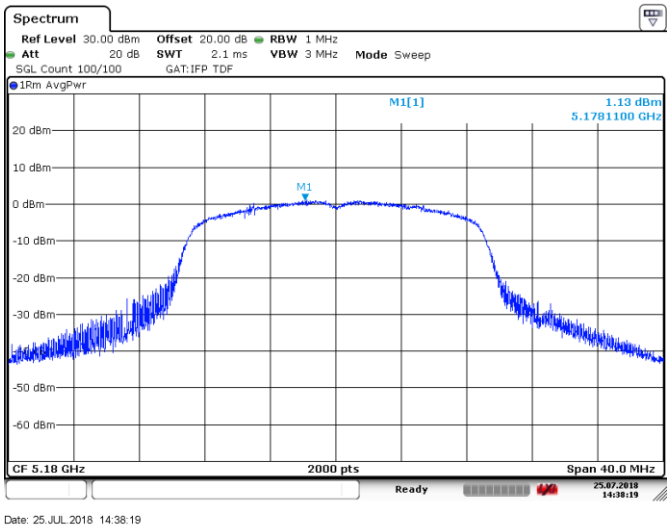



***Figure 8.3-2:*** *PSD on 802.11n HT20, Sample plot*

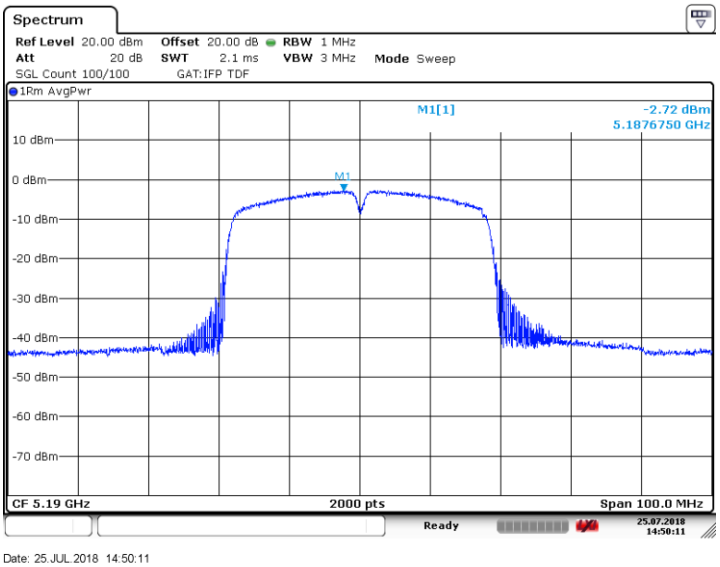



***Figure 8.3-3:*** *PSD on 802.11n HT40, Sample plot*

## 8.4 FCC 15.407(b) Undesirable (unwanted) emissions

### 8.4.1 Definitions and limits

**FCC:**
(1) For transmitters operating in the 5.15–5.25 GHz band: all emissions outside of the 5.15–5.35 GHz band shall not exceed an EIRP of −27 dBm/MHz.
(5) 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.
(6) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in § 15.209.
(7) The provisions of § 15.205 apply to intentional radiators operating under this section.
(8) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency block edges as the design of the equipment permits.

**ISED:**
For transmitters with operating frequencies in the band 5150-5250 MHz, all emissions outside the band 5150-5350 MHz shall not exceed -27 dBm/MHz e.i.r.p. Any unwanted emissions that fall into the band 5250-5350 MHz shall be attenuated below the channel power by at least 26 dB, when measured using a resolution bandwidth between 1 and 5% of the occupied bandwidth (i.e. 99% bandwidth), above 5250 MHz. The 26 dB bandwidth may fall into the 5250-5350 MHz band; however, if the occupied bandwidth also falls within the 5250-5350 MHz band, the transmission is considered as intentional and the devices shall comply with all requirements in the band 5250-5350 MHz including implementing dynamic frequency selection (DFS) and TPC, on the portion of the emission that resides in the 5250-5350 MHz band.

RSS-Gen 8.10 Emissions falling within restricted frequency bands
Restricted bands, identified in Table 8.4-2, are designated primarily for safety-of-life services (distress calling and certain aeronautical bands), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following restrictions apply:
(a) fundamental components of modulation of licence-exempt radio apparatus shall not fall within the restricted bands of below;
(b) unwanted emissions falling into restricted bands of below shall comply with the limits specified in RSS-Gen;
(c) unwanted emissions not falling within restricted frequency bands shall either comply with the limits specified in the applicable RSS, or with those specified in RSS-Gen.

***Table 8.4-1:*** *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 *(F in kHz)* | 67.6 – 20 × $\log_{10}$(F) *(F in kHz)* | 300 |
| 0.490–1.705 | 24000/F *(F in kHz)* | 87.6 – 20 × $\log_{10}$(F) *(F in kHz)* | 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

## 8.4.1 Definitions and limits, continued

***Table 8.4-2:*** *ISED restricted frequency bands*

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.090–0.110 | 12.51975–12.52025 | 399.9–410 | 5.35–5.46 |
| 2.1735–2.1905 | 12.57675–12.57725 | 608–614 | 7.25–7.75 |
| 3.020–3.026 | 13.36–13.41 | 960–1427 | 8.025–8.5 |
| 4.125–4.128 | 16.42–16.423 | 1435–1626.5 | 9.0–9.2 |
| 4.17725–4.17775 | 16.69475–16.69525 | 1645.5–1646.5 | 9.3–9.5 |
| 4.20725–4.20775 | 16.80425–16.80475 | 1660–1710 | 10.6–12.7 |
| 5.677-5.683 | 25.5–25.67 | 1718.8–1722.2 | 13.25–13.4 |
| 6.215–6.218 | 37.5–38.25 | 2200–2300 | 14.47–14.5 |
| 6.26775–6.26825 | 73–74.6 | 2310–2390 | 15.35–16.2 |
| 6.31175–6.31225 | 74.8–75.2 | 2655–2900 | 17.7–21.4 |
| 8.291–8.294 | 108–138 | 3260–3267 | 22.01–23.12 |
| 8.362–8.366 | 156.52475–156.52525 | 3332–3339 | 23.6–24.0 |
| 8.37625–8.38675 | 156.7–156.9 | 3345.8–3358 | 31.2–31.8 |
| 8.41425–8.41475 | 240–285 | 3500–4400 | 36.43–36.5 |
| 12.29–12.293 | 322–335.4 | 4500–5150 | Above 38.6 |

Note: Certain frequency bands listed in Table 8.4-2 and above 38.6 GHz are designated for low-power license-exempt applications. These frequency bands and the requirements that apply to the devices are set out in this Standard

***Table 8.4-3:*** *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 | | | |

## 8.4.2 Test summary

| | |
|---|---|
| Test start date: | July 26, 2018 |
| Test engineer: | Yong Huang |

### 8.4.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to 40 GHz while the EUT was continuously transmitting.
Conducted measurements were performed on the antenna ports, with the highest and the lowest data rate, the worst case is presented.
In the conducted plots below, the reference level offset was adjusted to include antenna directional gains, the max peak gain of two antenna configurations has been applied to show as representative worst case.
Radiated measurements below 18 GHz were performed at a distance of 3 m. Radiated measurements above 18 GHz were performed at a distance of 1 m.
Cabinet radiation were performed while the antenna connector was terminated with 50 Ω load. Below 1 GHz and above 18 GHz, no emissions related to RF transmitter were detected within 6 dB below the limit.

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 |

Spectrum analyzer settings for radiated measurements within restricted bands below 1 GHz:

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

Spectrum analyzer settings for peak radiated measurements within restricted bands above 1 GHz:

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

## 8.4.4 Test data

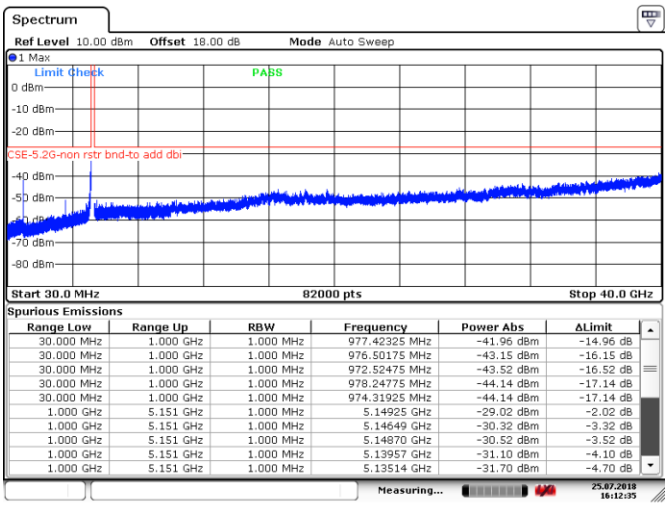



***Figure 8.4-1:*** *Spurious emissions outside restricted bands, Tx on ch 36, 802.11a*

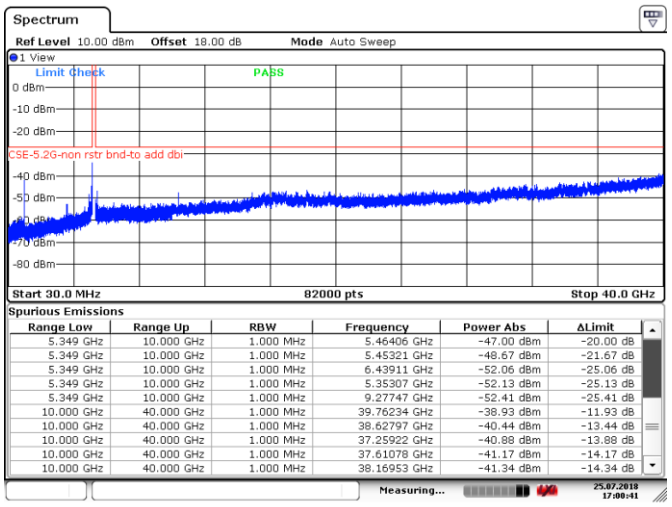



***Figure 8.4-2:*** *Spurious emissions outside restricted bands, Tx on ch 40, 802.11a*

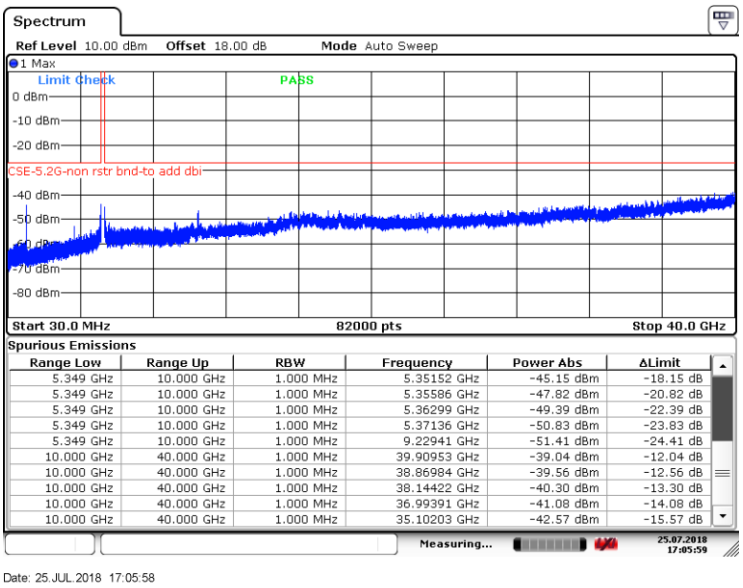



***Figure 8.4-3:*** *Spurious emissions outside restricted bands, Tx on ch 48, 802.11a*

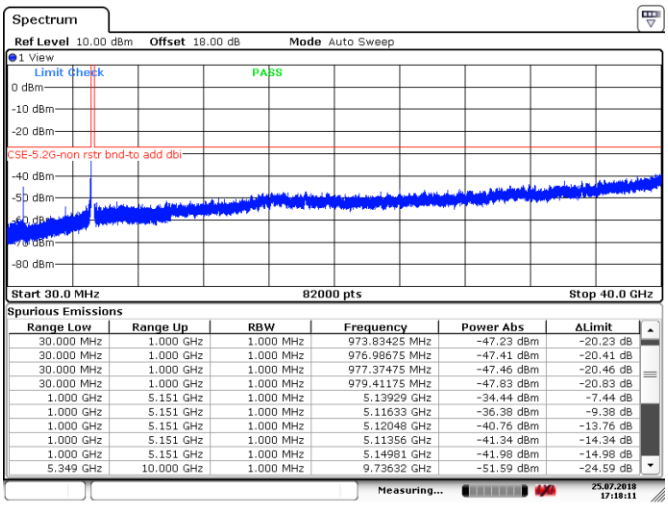



***Figure 8.4-4:*** *Spurious emissions outside restricted bands, Tx on ch 36, 802.11n HT20*

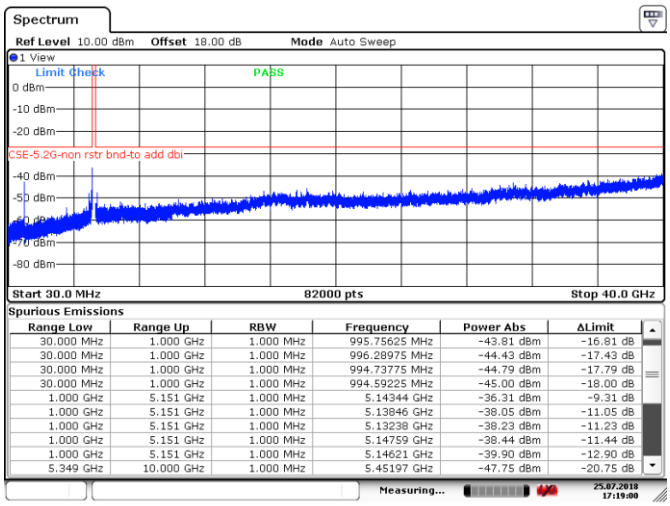



***Figure 8.4-5:*** *Spurious emissions outside restricted bands, Tx on ch 40, 802.11n HT20*

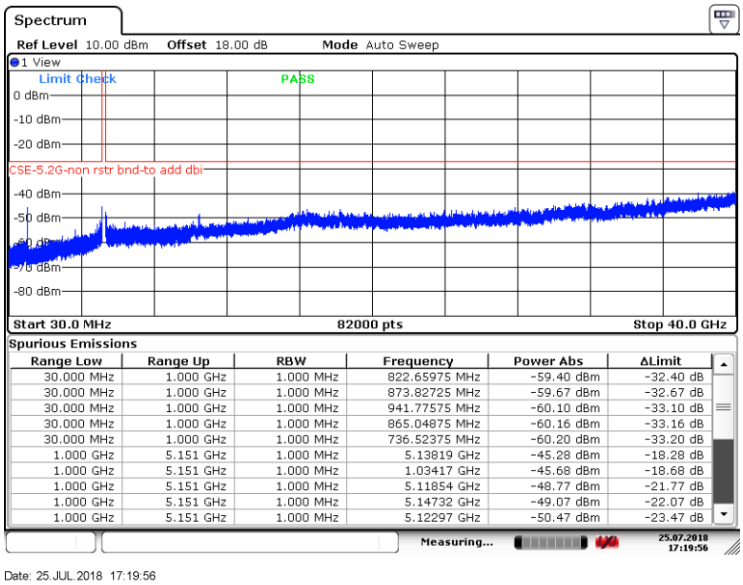
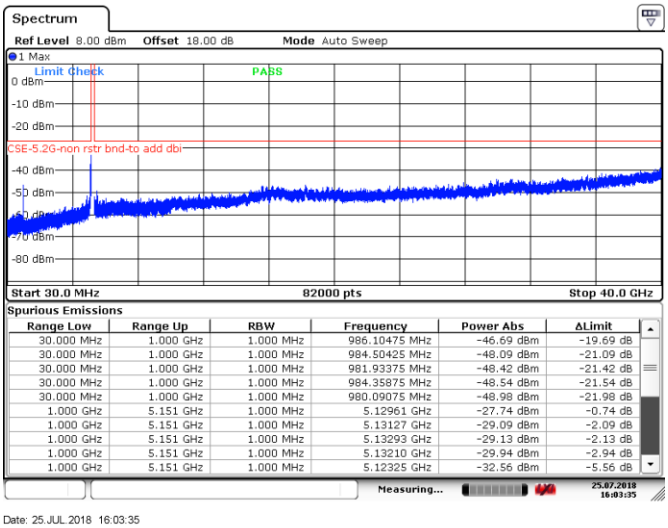



***Figure 8.4-6:*** *Spurious emissions outside restricted bands, Tx on ch 48, 802.11n HT20*




Spurious Emissions

| Range Low | Range Up | RBW | Frequency | Power Abs | ΔLimit |
|---|---|---|---|---|---|
| 30.000 MHz | 1.000 GHz | 1.000 MHz | 986.10475 MHz | -46.69 dBm | -19.69 dB |
| 30.000 MHz | 1.000 GHz | 1.000 MHz | 984.50425 MHz | -48.09 dBm | -21.09 dB |
| 30.000 MHz | 1.000 GHz | 1.000 MHz | 981.93375 MHz | -48.42 dBm | -21.42 dB |
| 30.000 MHz | 1.000 GHz | 1.000 MHz | 984.35875 MHz | -48.54 dBm | -21.54 dB |
| 30.000 MHz | 1.000 GHz | 1.000 MHz | 980.09075 MHz | -48.98 dBm | -21.98 dB |
| 1.000 GHz | 5.151 GHz | 1.000 MHz | 5.12961 GHz | -27.74 dBm | -0.74 dB |
| 1.000 GHz | 5.151 GHz | 1.000 MHz | 5.13127 GHz | -29.09 dBm | -2.09 dB |
| 1.000 GHz | 5.151 GHz | 1.000 MHz | 5.13293 GHz | -29.13 dBm | -2.13 dB |
| 1.000 GHz | 5.151 GHz | 1.000 MHz | 5.13210 GHz | -29.94 dBm | -2.94 dB |
| 1.000 GHz | 5.151 GHz | 1.000 MHz | 5.12325 GHz | -32.56 dBm | -5.56 dB |

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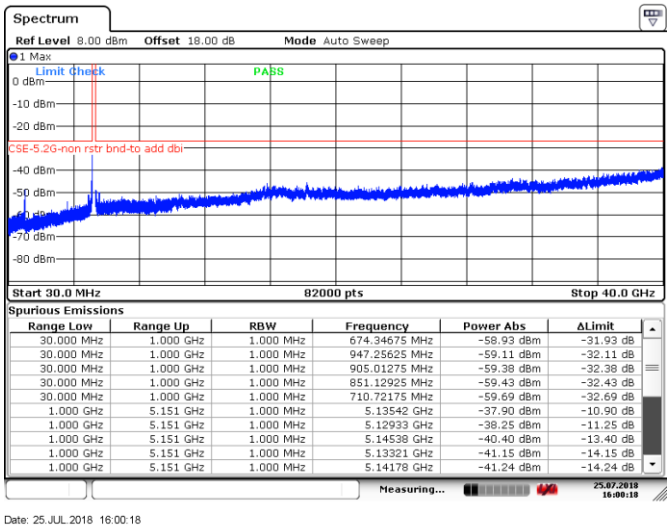
***Figure 8.4-7:*** *Spurious emissions outside restricted bands, Tx on ch 38, 802.11n HT40*




Spurious Emissions

| Range Low | Range Up | RBW | Frequency | Power Abs | ΔLimit |
|---|---|---|---|---|---|
| 30.000 MHz | 1.000 GHz | 1.000 MHz | 674.34675 MHz | -58.93 dBm | -31.93 dB |
| 30.000 MHz | 1.000 GHz | 1.000 MHz | 947.25625 MHz | -59.11 dBm | -32.11 dB |
| 30.000 MHz | 1.000 GHz | 1.000 MHz | 905.01275 MHz | -59.38 dBm | -32.38 dB |
| 30.000 MHz | 1.000 GHz | 1.000 MHz | 851.12925 MHz | -59.43 dBm | -32.43 dB |
| 30.000 MHz | 1.000 GHz | 1.000 MHz | 710.72175 MHz | -59.69 dBm | -32.69 dB |
| 1.000 GHz | 5.151 GHz | 1.000 MHz | 5.13542 GHz | -37.90 dBm | -10.90 dB |
| 1.000 GHz | 5.151 GHz | 1.000 MHz | 5.12933 GHz | -38.25 dBm | -11.25 dB |
| 1.000 GHz | 5.151 GHz | 1.000 MHz | 5.14538 GHz | -40.40 dBm | -13.40 dB |
| 1.000 GHz | 5.151 GHz | 1.000 MHz | 5.13321 GHz | -41.15 dBm | -14.15 dB |
| 1.000 GHz | 5.151 GHz | 1.000 MHz | 5.14178 GHz | -41.24 dBm | -14.24 dB |

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***Figure 8.4-8:*** *Spurious emissions outside restricted bands, Tx on ch 46, 802.11n HT40*

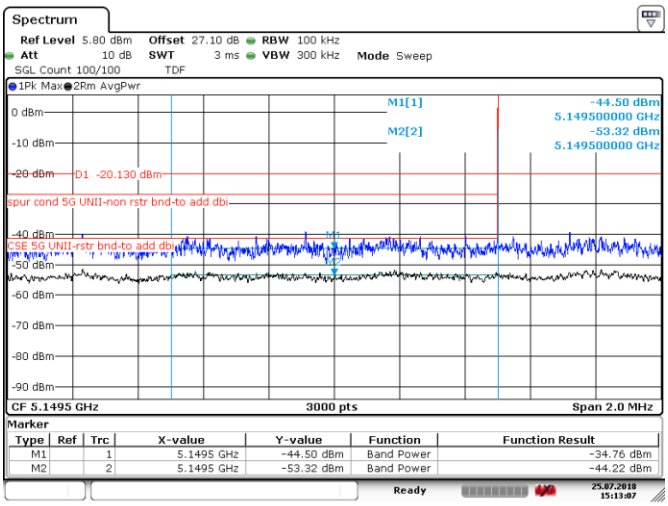


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***Figure 8.4-9:*** *Lower band edge, Tx on ch 36 802.11a*

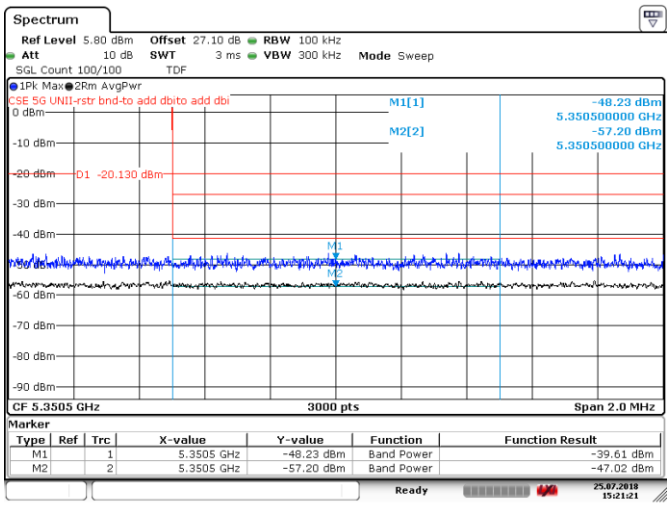


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***Figure 8.4-10:*** *Upper band edge, Tx on ch 48, 802.11a*

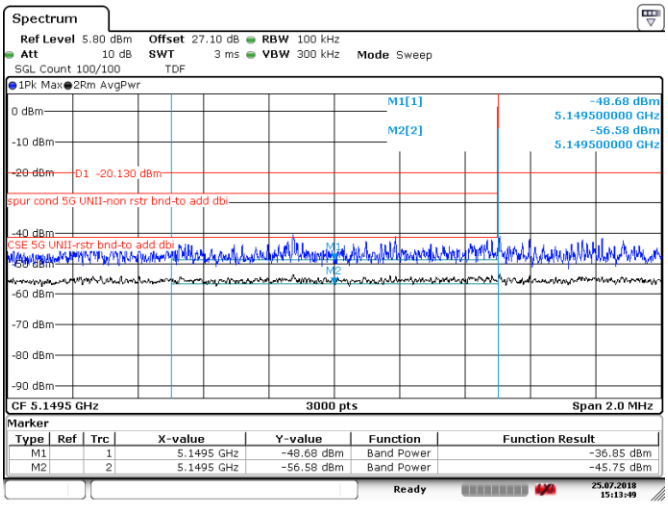


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***Figure 8.4-11:*** *Lower band edge, Tx on ch 36 802.11n HT20*

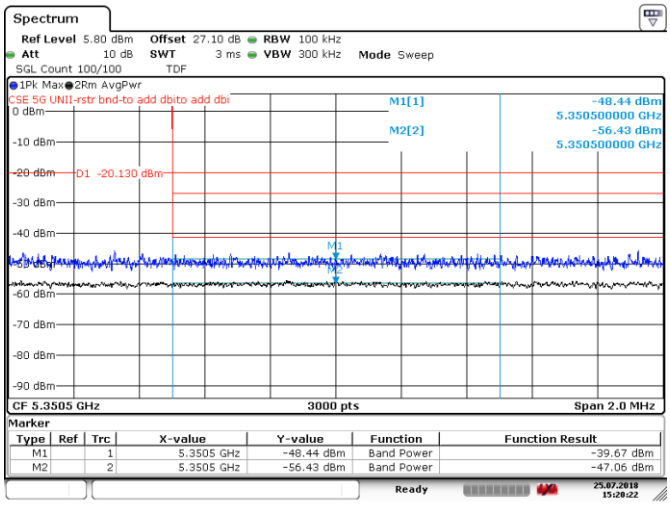


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***Figure 8.4-12:*** *Upper band edge, Tx on ch 48, 802.11n HT20*

Note: Transmitter spurious emission calculation as below:
E = EIRP – 20log D + 104.8 =-44.22 – 20Log 3 + 104.8 = 51.03 dBµV/m at 3m
margin of compliance = 54 – 51.03 = 3.97 dB
where:
E = electric field strength in dBµV/m,
EIRP = equivalent isotropic radiated power in dBm = -44.22 dBm
D = specified measurement distance in meters = 3 m
Average field strength limit = 54 dBµV/m at 3m

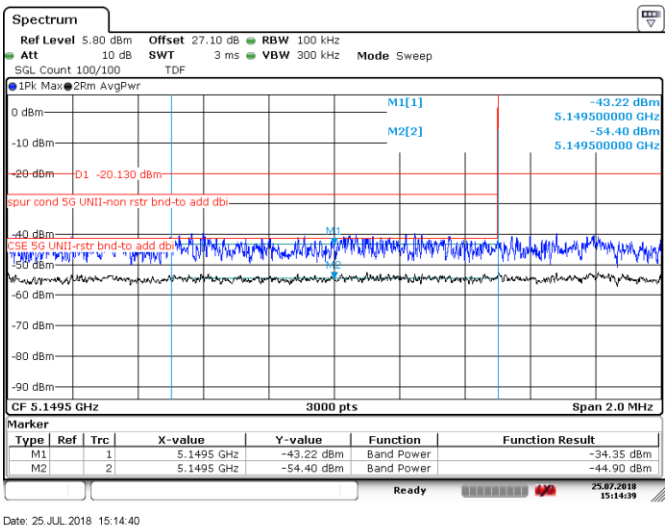


***Figure 8.4-13:*** *Lower band edge, Tx on ch 38 802.11n HT40*

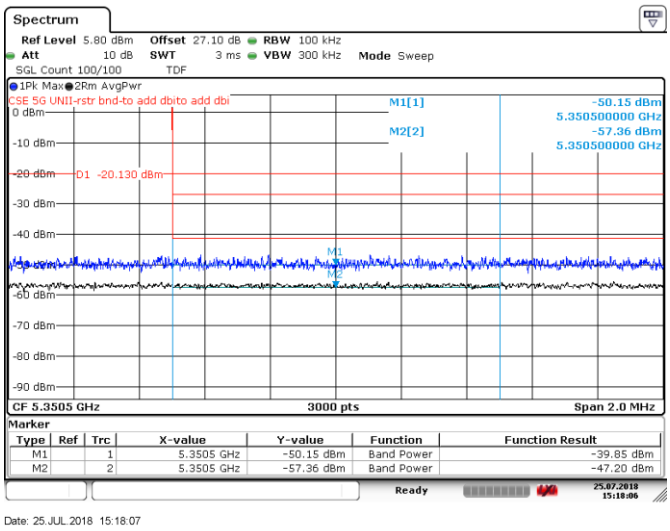


***Figure 8.4-14:*** *Upper band edge, Tx on ch 46, 802.11n HT40*

In order to comply with the ISED band edge emissions requirements at 5.25 GHz, occupied bandwidth is verified to be within 5150 to 5250 MHz.

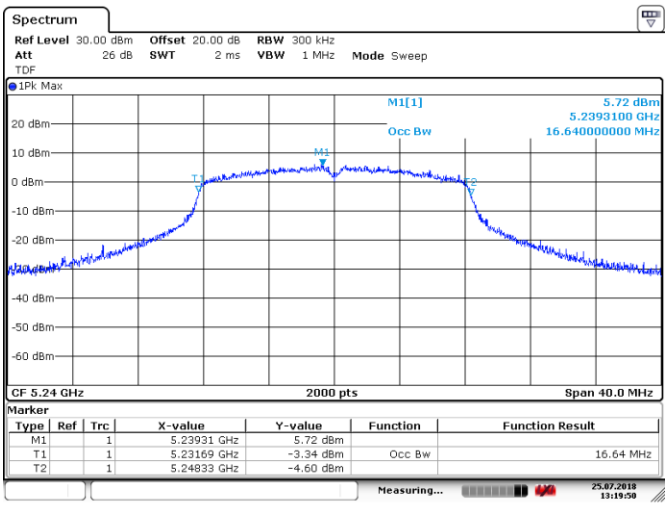


***Figure 8.4-15:*** *Band edge emission for ISED at 5.25 GHz, Tx on ch 48 802.11a*

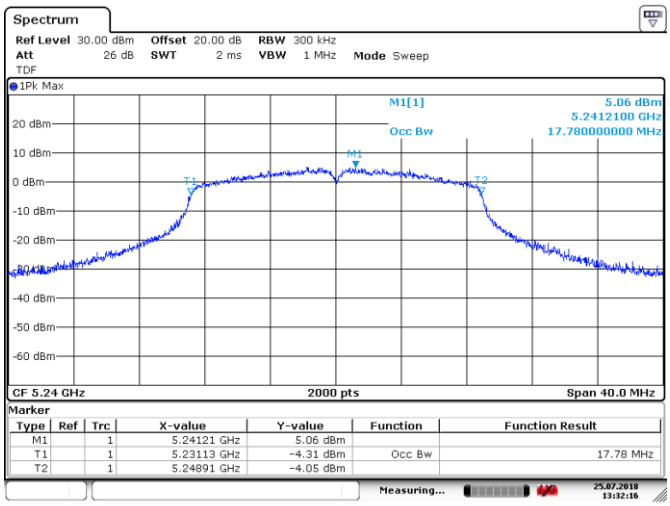


***Figure 8.4-16:*** *Band edge emission for ISED at 5.25 GHz Tx on ch 48 802.11n HT20*

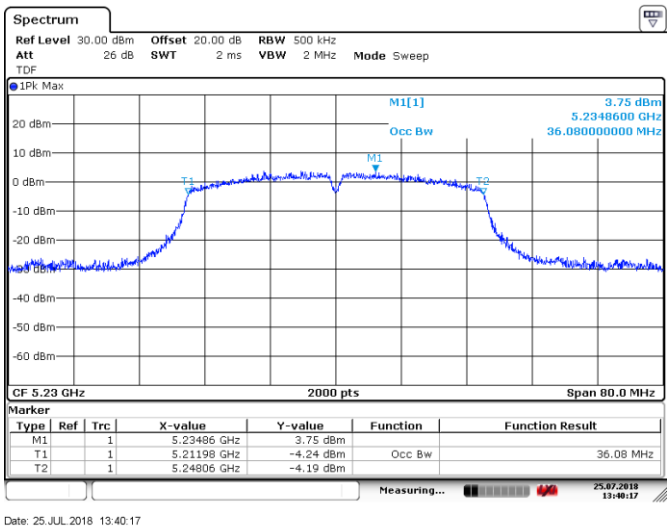


***Figure 8.4-17:*** *Band edge emission for ISED at 5.25 GHz, Tx on ch 46 802.11n HT40*

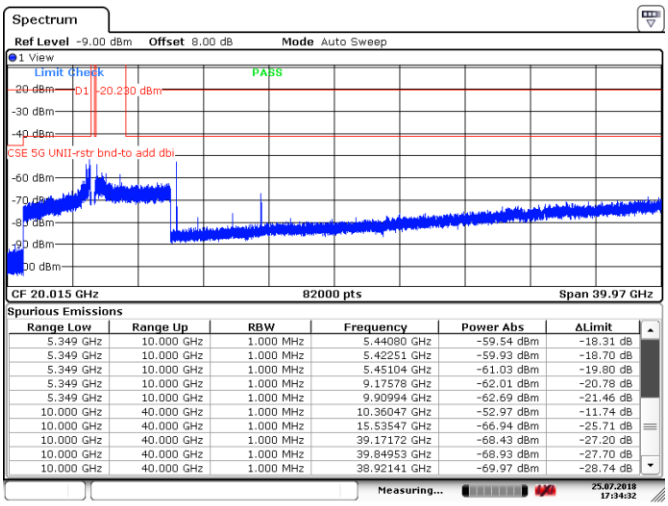


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***Figure 8.4-18:*** *Spurious emissions within restricted bands, Tx on ch 36, 802.11a*

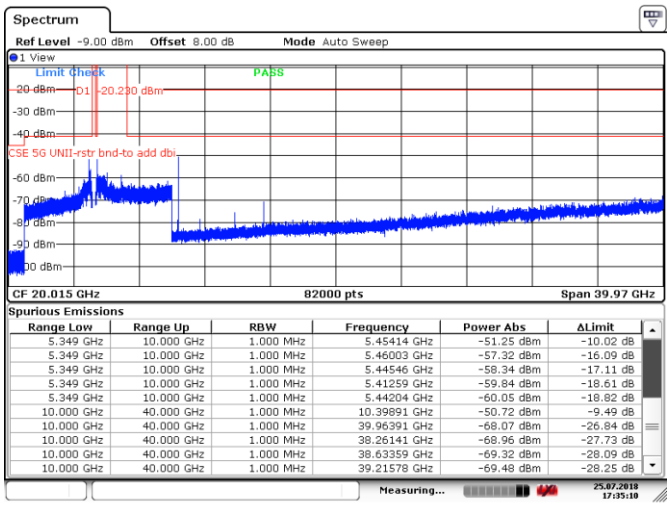


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***Figure 8.4-19:*** *Spurious emissions within restricted bands, Tx on ch 40, 802.11a*

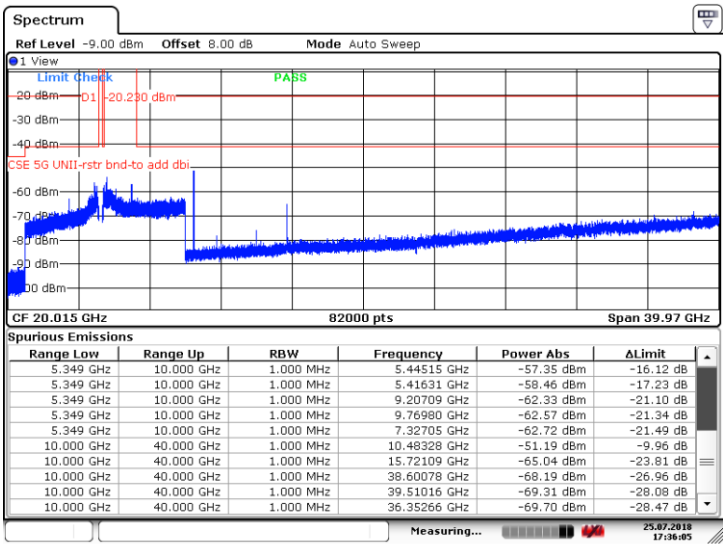


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***Figure 8.4-20:*** *Spurious emissions within restricted bands, Tx on ch 48, 802.11a*

Note: Peak limit EIRP equivalent: 74 dBµV/m – 95.23 dB = −21.23 dBm
Average limit EIRP equivalent: 54 dBµV/m – 95.23 dB = −41.23 dBm
EUT's antenna max gain and ground reflection factors below 1 GHz have been included in the factors of the plots above.

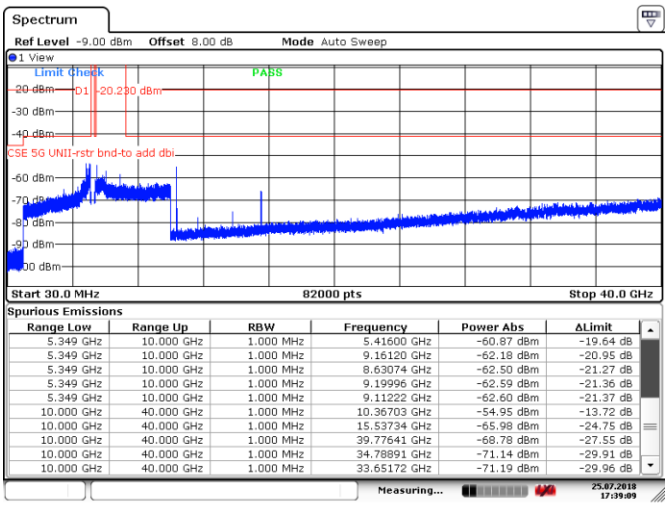



***Figure 8.4-21:*** *Spurious emissions within restricted bands, Tx on ch 36, 802.11n HT20*

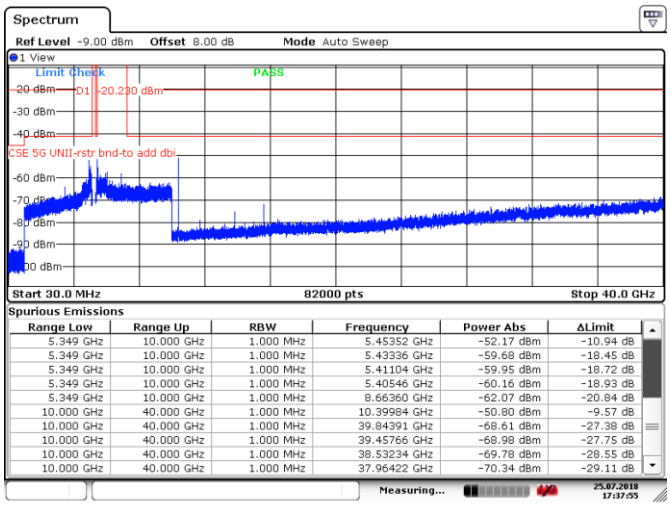



***Figure 8.4-22:*** *Spurious emissions within restricted bands, Tx on ch 40, 802.11n HT20*

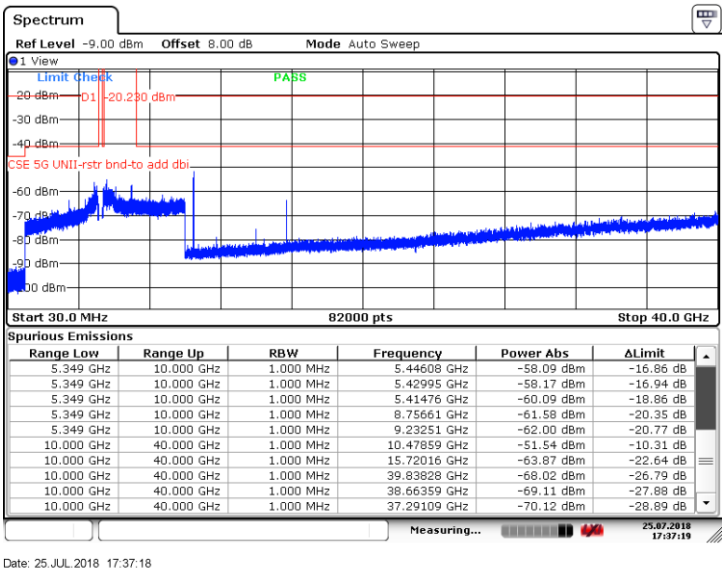



***Figure 8.4-23:*** *Spurious emissions within restricted bands, Tx on ch 48, 802.11n HT20*

Note: Peak limit EIRP equivalent: 74 dBµV/m – 95.23 dB = −21.23 dBm
Average limit EIRP equivalent: 54 dBµV/m – 95.23 dB = −41.23 dBm
EUT's antenna max gain and ground reflection factors below 1 GHz have been included in the factors of the plots above.

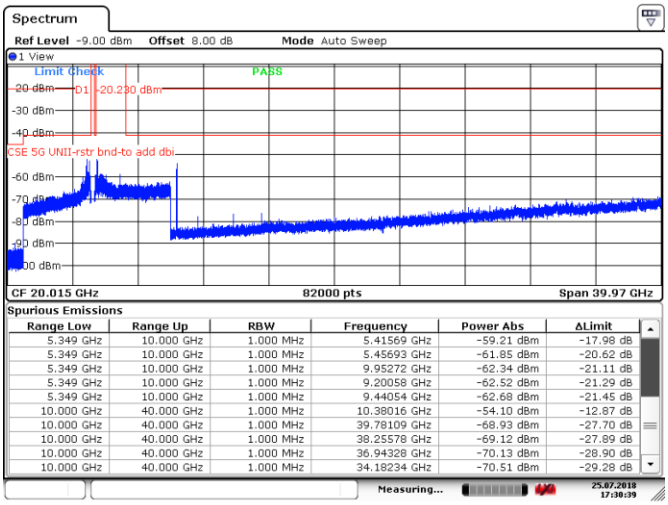



***Figure 8.4-24:*** *Spurious emissions within restricted bands, Tx on ch 38, 802.11n HT40, Peak detector*

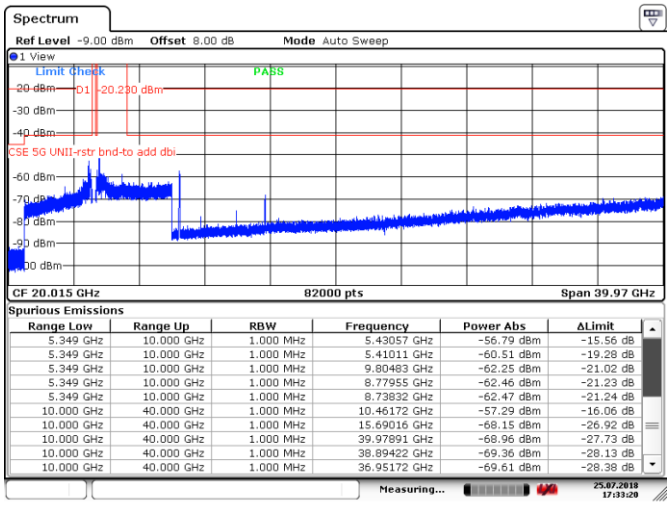



***Figure 8.4-25:*** *Peak Spurious emissions within restricted bands, Tx on ch 46, 802.11n HT40, Peak detector*

Note: Peak limit EIRP equivalent: 74 dBµV/m – 95.23 dB = −21.23 dBm
Average limit EIRP equivalent: 54 dBµV/m – 95.23 dB = −41.23 dBm
Where peak level of any emission had exceeded average limit line, those emissions were then re-measured with RMS detector.

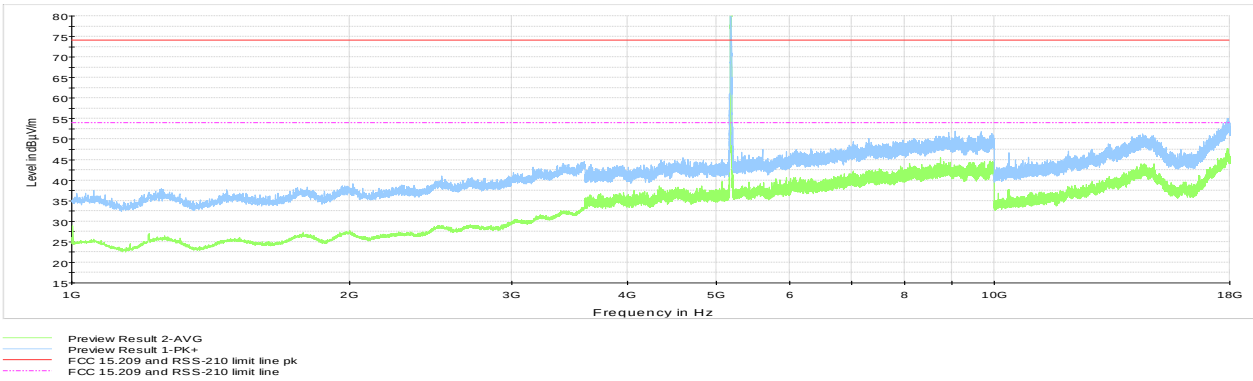



***Figure 8.4-26:*** *Cabinet Radiated spurious emission 1 to 18 GHz Tx on low channel*

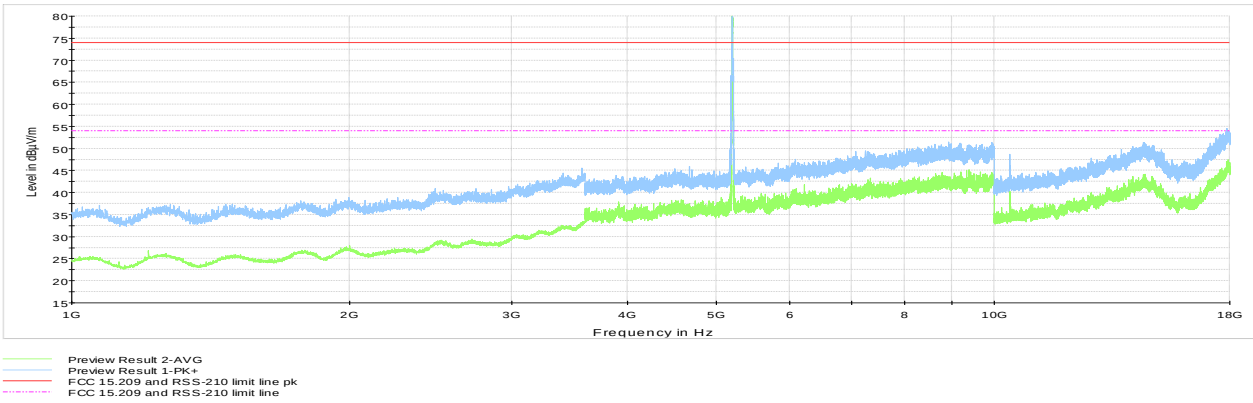



***Figure 8.4-27:*** *Cabinet Radiated spurious emission 1 to 18 GHz, Tx on mid channel*

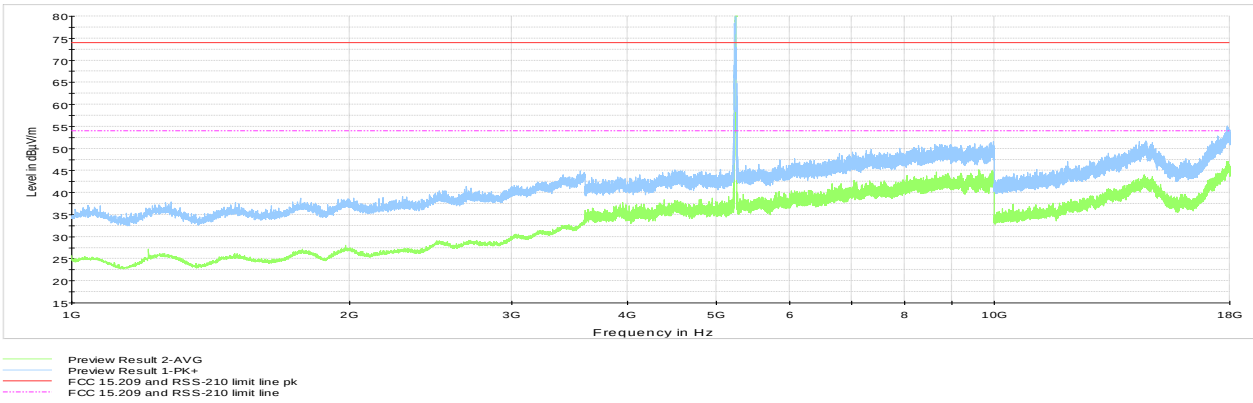



***Figure 8.4-28:*** *Cabinet Radiated spurious emission 1 to 18 GHz, Tx on high channle*

Note: Spectrum was searched from 30 MHz to 25 GHz. Below 1 GHz and above 18 GHz, no emissions related to RF transmitter were detected within 6 dB below the limit. The emissions above limit on plots above are from intentional transmission.

## 8.5 FCC 15.207(a) and RSS-Gen 8.8 AC power line conducted emissions limits

### 8.5.1 Definitions and limits

**FCC §15.407(6)(b):**

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 µH/50 Ω 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.

**ISED:**
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 8.5-1:*** *Conducted emissions limit*

| Frequency of emission (MHz) | Conducted limit (dBµV) | |
|---|---|---|
| | Quasi-peak | Average** |
| 0.15–0.5 | 66 to 56* | 56 to 46* |
| 0.5–5 | 56 | 46 |
| 5–30 | 60 | 50 |

Note: * - The level decreases linearly with the logarithm of the frequency.
** - A linear average detector is required.

### 8.5.2 Test summary

| | |
|---|---|
| Test start date: | August 17, 2018 |
| Test engineer: | Yong Huang |

### 8.5.3 Observations, settings and special notes

The EUT was set up as tabletop configuration.

The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

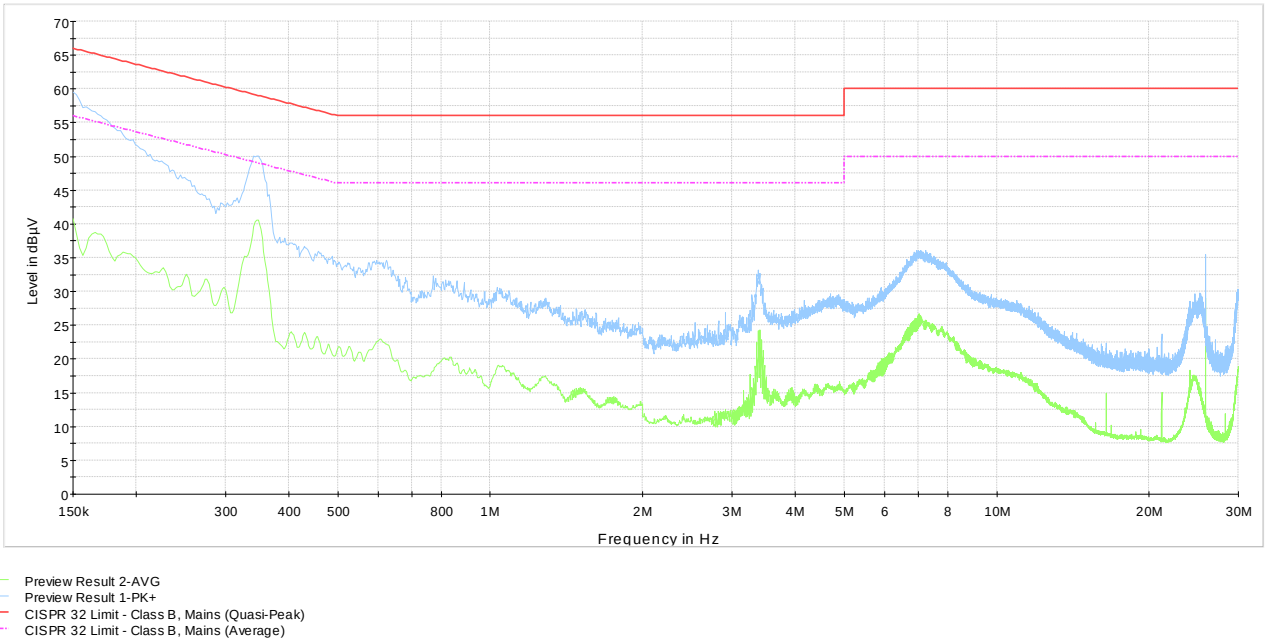
Receiver settings for preview measurements:

| | |
|---|---|
| Resolution bandwidth | 9 kHz |
| Video bandwidth | 30 kHz |
| Detector mode | Peak and Average |
| Trace mode | Max Hold |
| Measurement time | 100 ms |

Receiver settings for final measurements:

| | |
|---|---|
| Resolution bandwidth | 9 kHz |
| Video bandwidth | 30 kHz |
| Detector mode | Quasi-Peak and Average |
| Trace mode | Max Hold |
| Measurement time | 100 ms |

## 8.5.4 Test data




***Plot 8.5-1:*** *Conducted emissions on phase line*

***Table 8.5-2:*** *Quasi-Peak conducted emissions results on phase line*

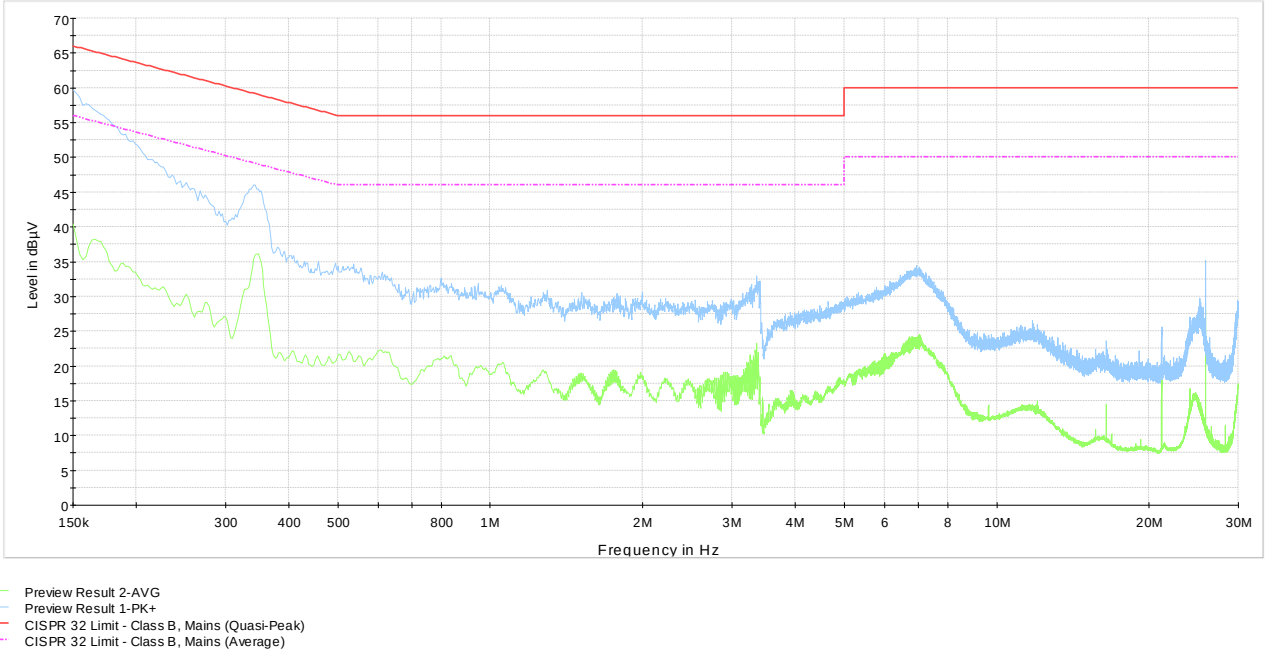
| Frequency, MHz | Q-Peak result, dBµV | Correction, dB | Margin, dB | Limit, dBµV |
|---|---|---|---|---|
| 0.150 | 57.5 | 9.4 | 8.5 | 66.0 |
| 0.348 | 47.0 | 9.4 | 12.0 | 59.0 |

***Table 8.5-3:*** *Average conducted emissions results on phase line*

| Frequency, MHz | Average result, dBµV | Correction, dB | Margin, dB | Limit, dBµV |
|---|---|---|---|---|
| 0.346 | 40.5 | 9.4 | 8.6 | 49.1 |

Notes: [1] Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)
[3] 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 have been recorded.

Sample calculation: 37.1 dBµV (result) = 26.6 dBµV (receiver reading) + 9.5 dB (Correction factor)




***Plot 8.5-2:*** *Conducted emissions on neutral line*

***Table 8.5-4:*** *Quasi-Peak conducted emissions results on neutral line*

| Frequency, MHz | Q-Peak result, dBµV | Correction, dB | Margin, dB | Limit, dBµV |
|---|---|---|---|---|
| 0.150 | 57.5 | 9.4 | 8.5 | 66.0 |

Notes: [1] Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)
[3] 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 have been recorded.

Sample calculation: 37.1 dBµV (result) = 26.6 dBµV (receiver reading) + 9.5 dB (Correction factor)

## 8.6 FCC 15.407(g) Frequency stability

### 8.6.1 Definitions and limits

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 user's manual.

### 8.6.2 Test summary

| | |
|---|---|
| Test start date: | August 20, 2018 |
| Test engineer: | Yong Huang |

### 8.6.3 Observations, settings and special notes

As per EUT's document provided by client, EUT's Operating Temperature is -40 °C to +70 °C(REGATE-10-12) and -40 °C to +85 °C (DYGATE-10-12), Nominal AC input voltage is 120 V.

Spectrum analyzer settings:

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

### 8.6.4 Test data

***Table 8.6-1:*** *Frequency drift measurement*

| Test conditions Temperature, Voltage | Nominal frequency, GHz | Frequency, GHz | Drift, Hz |
|---|---|---|---|
| +85 °C, Nominal | 5.2 | 5.2000889280 | 91105.1 |
| +70 °C, Nominal | 5.2 | 5.2000091900 | 11367.1 |
| +23 °C, +15 % | 5.2 | 5.1999978229 | 0 |
| +23 °C, Nominal | 5.2 | 5.1999978229 | reference |
| +23 °C, −15 % | 5.2 | 5.1999978229 | 0 |
| -40 °C, Nominal | 5.2 | 5.1999969610 | -861.9 |

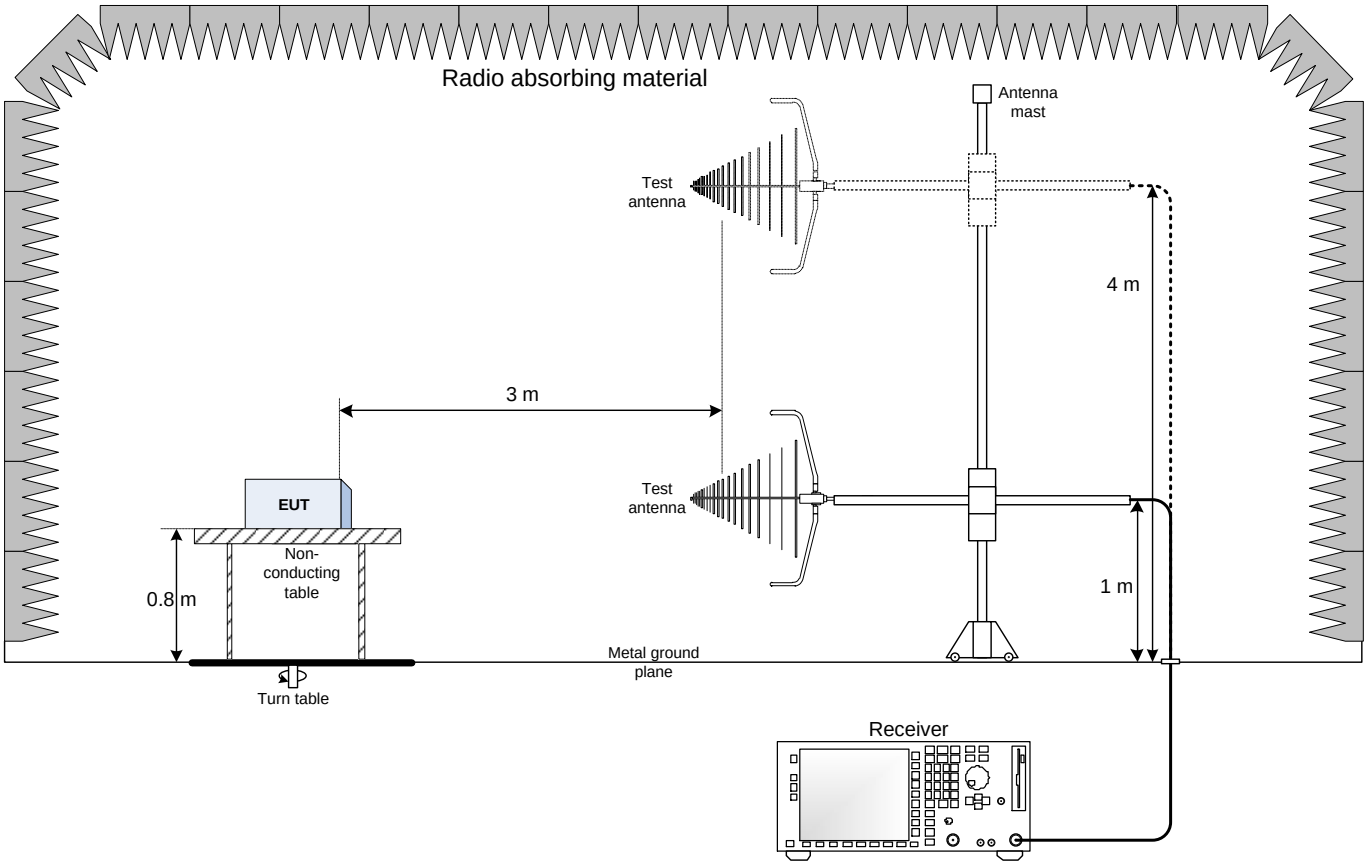
Minimum lower band edge margin is more than 1 kHz

Minimum upper band edge margin is more than 100 kHz

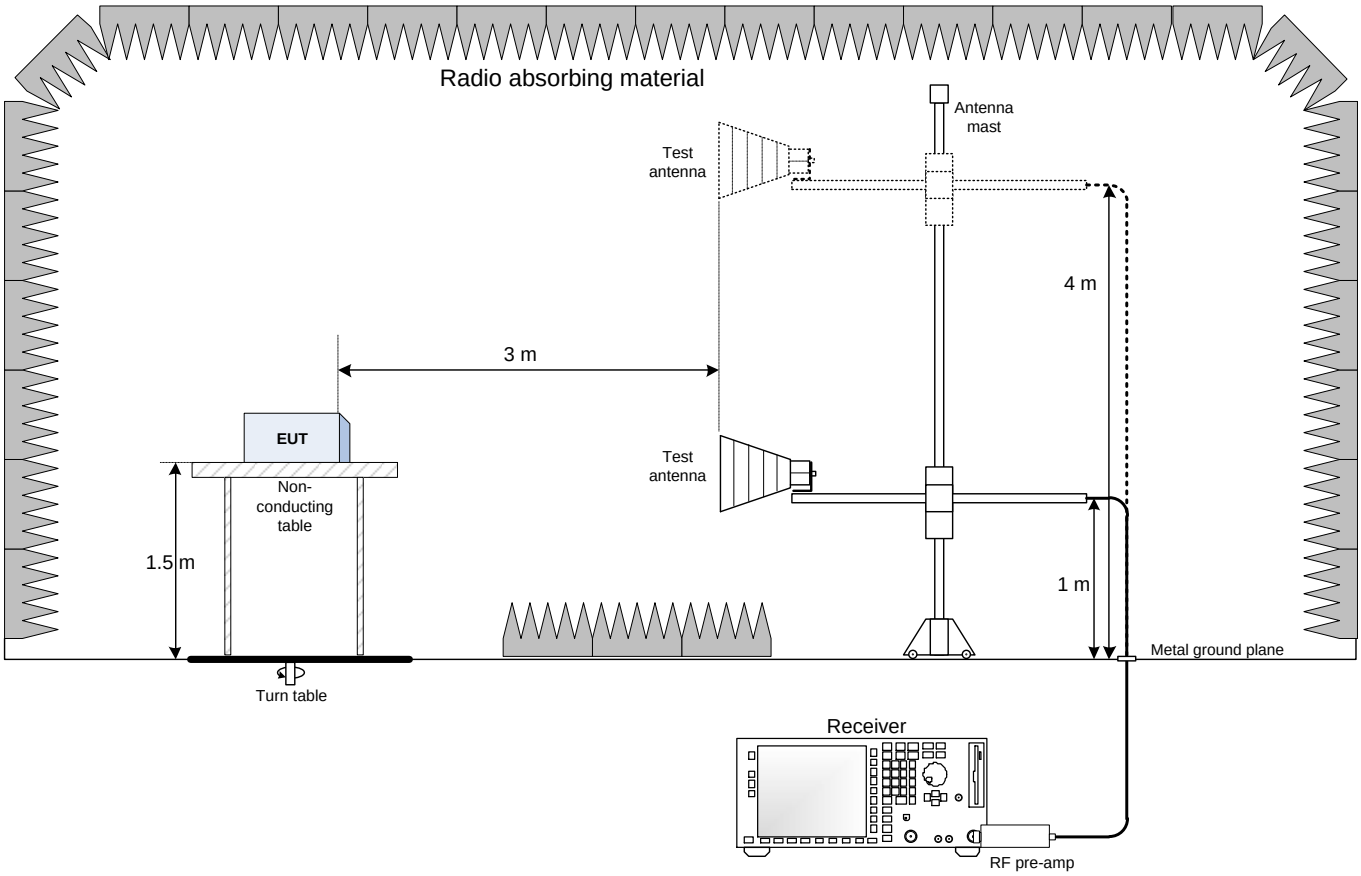
The frequency drifts in above table are within these minimum margins, the emissions are deemed to maintain within the band of operation.

# Section 9. Block diagrams of test set-ups

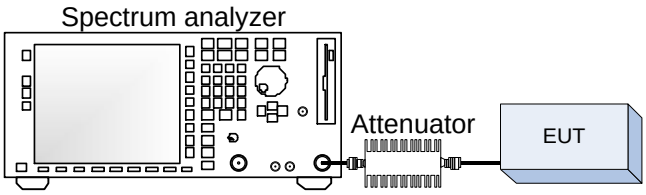
## 9.1 Radiated emissions set-up for frequencies below 1 GHz



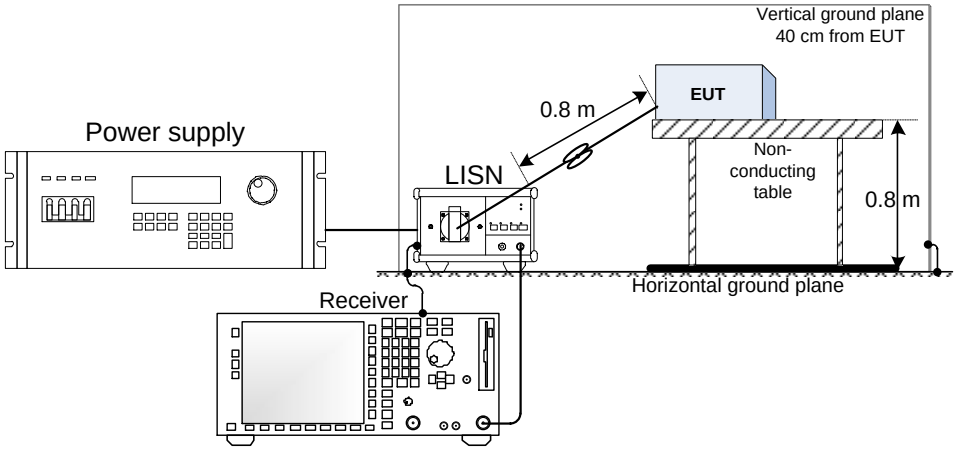
## 9.2 Radiated emissions set-up for frequencies above 1 GHz



## 9.3 Antenna port conducted measurements set-up




## 9.4 Power line Conducted emissions set-up




(End of report)