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RADIO TEST REPORT – 444710-5TRFWL

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

Yong Huang, Wireless/EMC Specialist
Tested by


Signature

Andrey Adelberg, Senior EMC/RF Specialist
Reviewed by


Signature

Lab locations

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Test site identifier	**Organization**	**Ottawa/Almonte**	**Montreal**	**Cambridge**
	FCC:	CA2040	CA2041	CA0101
	ISED:	2040A-4	2040G-5	24676
Website	www.nemko.com			

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.

Copyright notification

Table of Contents

Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 15, Subpart E, Clause 15.407	Unlicensed National Information Infrastructure Devises 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. 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 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

None.

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

2.1 Modifications incorporated in the EUT for compliance

2.1 Modifications incorporated in the EUT for compliance

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

2.2 Technical judgment

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

No deviations were made from laboratory procedures.

Section 3 Test conditions

3.1 Atmospheric conditions

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

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 4 Measurement uncertainty

4.1 Uncertainty of measurement

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, ±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

5.1 Disclaimer

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

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	☐	Outdoor access point
	☐	Indoor access point
	☐	Fixed point-to-point access point
	☒	Client device
	☐	Device installed in vehicles
Frequency band	5150–5250 MHz (U-NII-1)	
Frequency Min (MHz)	20 MHz bandwidth: 5180 40 MHz bandwidth: 5190 80 MHz bandwidth: 5210	
Frequency Max (MHz)	20 MHz bandwidth: 5240 40 MHz bandwidth: 5230 80 MHz bandwidth:5210	
Channel numbers	20 MHz bandwidth: 36 to 48 40 MHz bandwidth: 38 to 46 80 MHz bandwidth:42	
RF power Max (W), Conducted	20 MHz bandwidth:0.0135 (11.3 dBm) 40 MHz bandwidth: 0.0132 (11.2 dBm) 80 MHz bandwidth: 0.0135 (11.3 dBm)	
Field strength, dBµV/m @ 3 m	N/A	
Measured BW (kHz), 99% OBW	20 MHz bandwidth: 17780 40 MHz bandwidth: 36360 80 MHz bandwidth: 75600	
Type of modulation	802.11a/n/ac: OFDM (QPSK, BPSK, 16-QAM, 64-QAM)	
Emission classification	W7D	
Transmitter spurious, dBµV/m @ 3 m	50.85 average @ 5.15 GHz	
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-continous-2021-06-29”.	

5.5 EUT setup details

5.5.1 Radio exercise details

Operating conditions	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. 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 "8821cs-txpowerlimits-addition to wifi-bt-continous-2021-06-29"
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

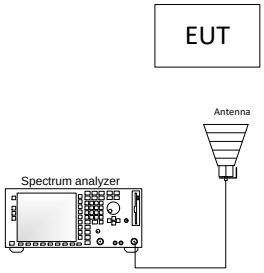


Figure 5.5-1: *Radiated testing block diagram*

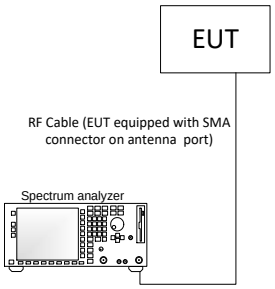


Figure 5.5-2: *Antenna port testing block diagram*

Section 6 Summary of test results

6.1 Testing location

Test location (s)	Montreal

6.2 Testing period

Test start date	June 10, 2021	Test end date	July 31, 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
§15.31I	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)(1)	Power and density limits within 5.15–5.25 GHz band	Pass
§15.407(b)(1)	Undesirable emission limits for 5.15–5.25 GHz band	Pass
§15.407(b)(8)	AC power line conducted limits	Pass
§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
§15.407(k)	Automated frequency coordination (AFC) system	Not applicable

Notes [1]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: [1]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[1]	Types of Modulation	Pass
6.2.1.1	Power limits for 5150–5250 MHz band	Pass
6.2.1.2	Unwanted emission limits for 5150–5250 MHz band	Pass

Notes: [1] 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
Temperature chamber	Thermotron	S-4	FA002534	1 year	July 13, 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	July 24, 2021

8.1.3 Observations, settings and special notes

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

a) 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.
b) For devices, where operating at a supply voltage deviating ±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.
c) 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.
d) 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:	☒ AC	☐ DC	☐ Battery
If EUT is an AC or a DC powered, was the noticeable output power variation observed?	☐ YES	☒ NO	☐ N/A
If EUT is battery operated, was the testing performed using fresh batteries?	☐ YES	☐ NO	☒ N/A
If EUT is rechargeable battery operated, was the testing performed using fully charged batteries?	☐ YES	☐ NO	☒ 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	July 24, 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:

a) 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.

b) 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.

c) 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:

a) 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).

b) 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).

c) 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	5150	5250	100	5180	5200	5240
802.11n HT20/ 802.11ac VHT20	5150	5250	100	5180	5200	5240
802.11n HT40/ 802.11ac VHT40	5150	5250	100	5190	--	5230
802.11ac VHT80	5150	5250	100		5210	

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	July 24, 2021

8.3.3 Observations, settings and special notes

None

8.3.4 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 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 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.

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*

	Conducted emissions limit, dBµV	
Frequency of emission, MHz	**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_{AC}, 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:	– The EUT was set up as tabletop configuration per ANSI C63.10-2013 measurement procedure. – 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) – 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.

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

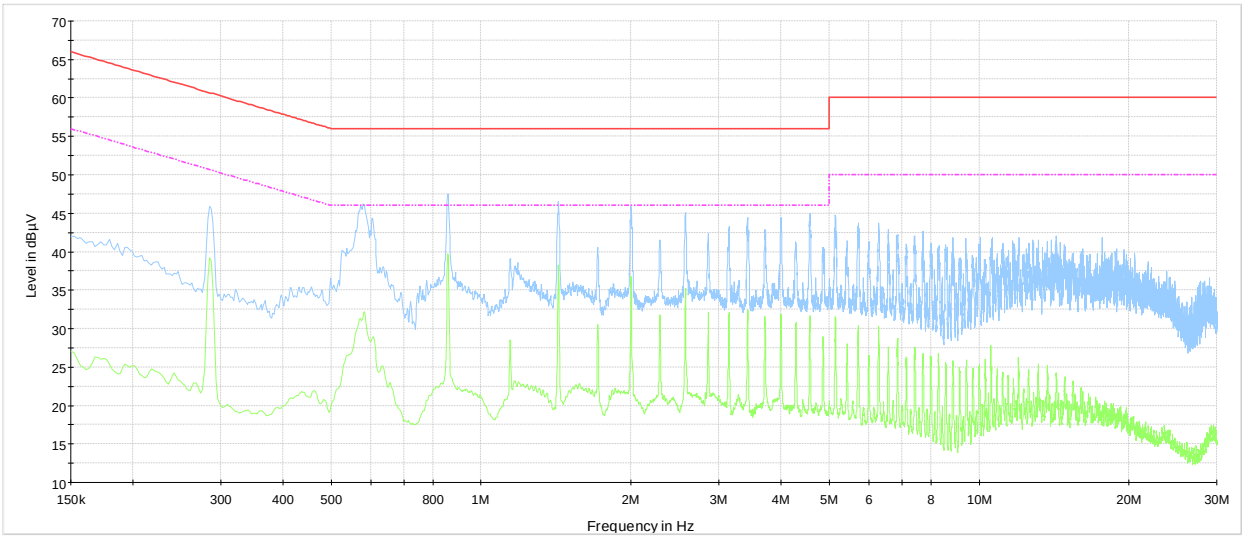
Table 8.4-2: *Conducted emissions results on phase line*

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

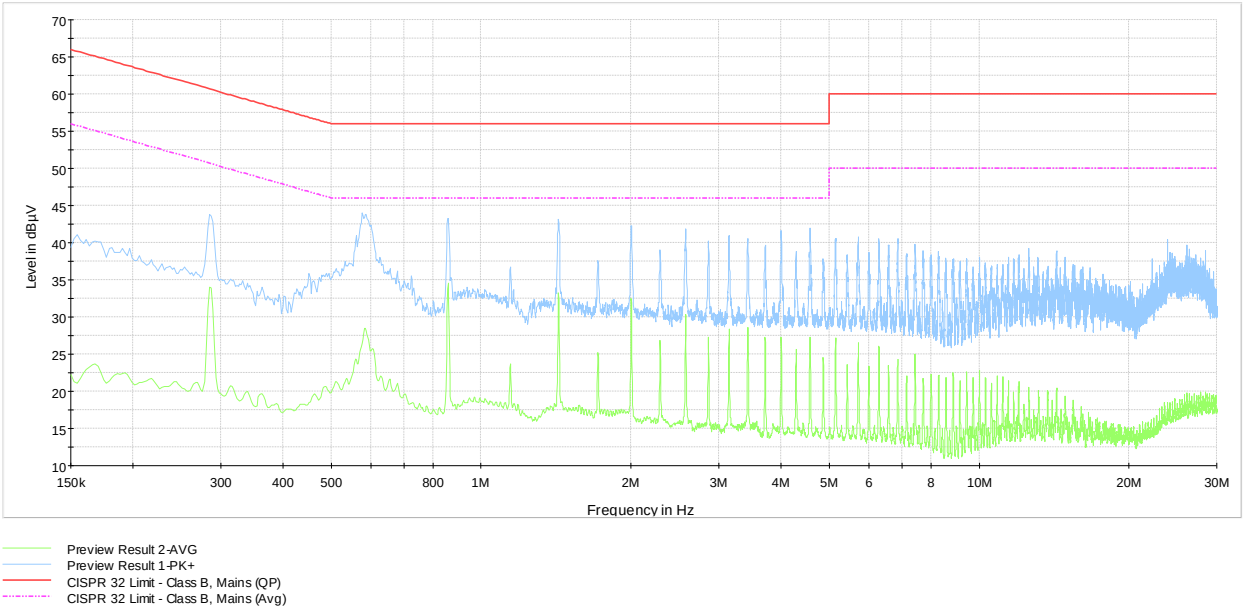
Table 8.4-3: *Conducted emissions results on neutral line*

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

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.

8.5.2 Test summary

Verdict	Pass		
Tested by	Yong Huang	Test date	July 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

8.5.4 Test data

Table 8.5-1: *26 dB bandwidth results*

Modulation	Frequency, MHz	26 dB bandwidth, MHz
802.11a	5180	22.25
	5200	22.03
	5240	21.85
802.11n HT20/802.11ac VHT20	5180	22.28
	5200	22.23
	5240	22.10
802.11n HT40/802.11ac VHT40	5190	43.75
	5230	43.60
802.11ac VHT80	5210	82.73

Test data, continued

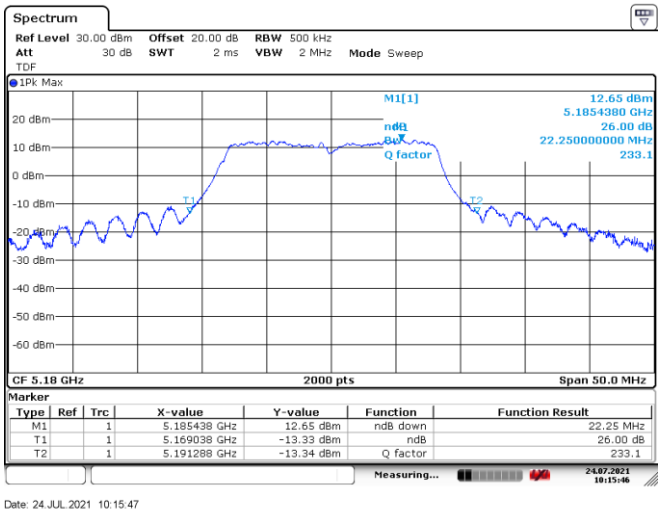


Figure 8.5-1: *26 dB bandwidth on 802.11a, sample plot*

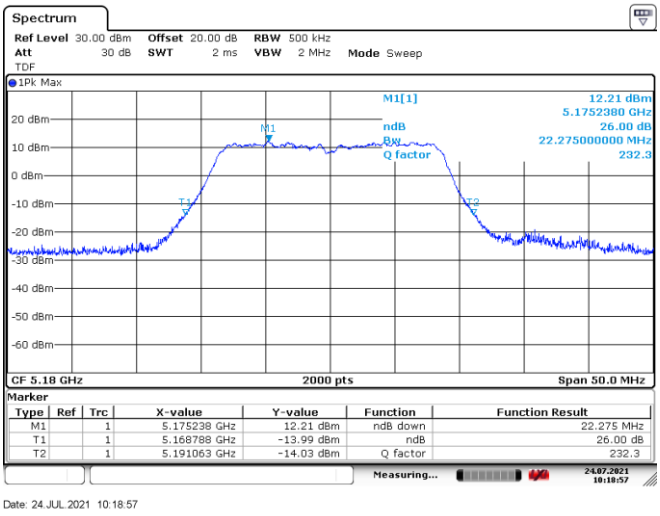


Figure 8.5-2: *26 dB bandwidth on 802.11n HT20/802.11ac VHT20, sample plot*

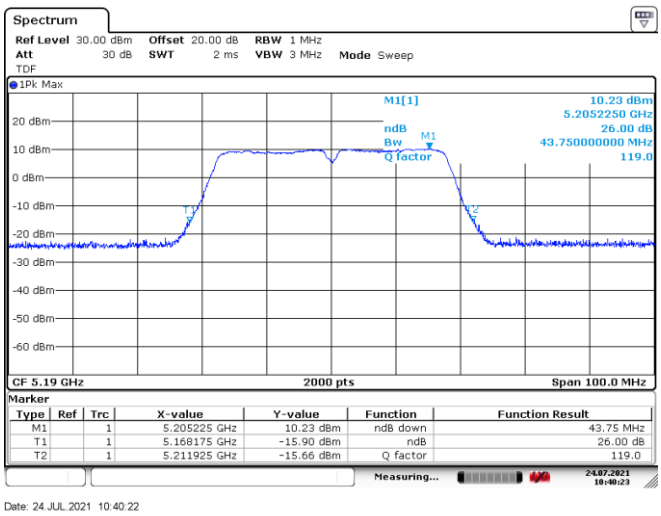


Figure 8.5-3: *26 dB bandwidth on 802.11n HT40/802.11ac VHT40, sample plot*

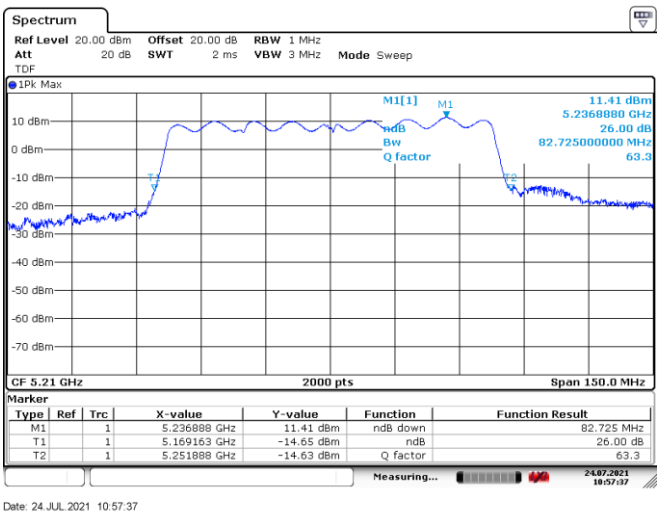


Figure 8.5-4: *26 dB bandwidth on 802.11ac VHT80*

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	July 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:	≥ 1 % of span
Video bandwidth:	≥3 × 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	5180	16.80
	5200	16.84
	5240	16.80
802.11n HT20/802.11ac VHT20	5180	17.78
	5200	17.78
	5240	17.78
802.11n HT40/802.11ac VHT40	5190	36.32
	5230	36.36
802.11ac VHT80	5210	75.60

Test data, continued

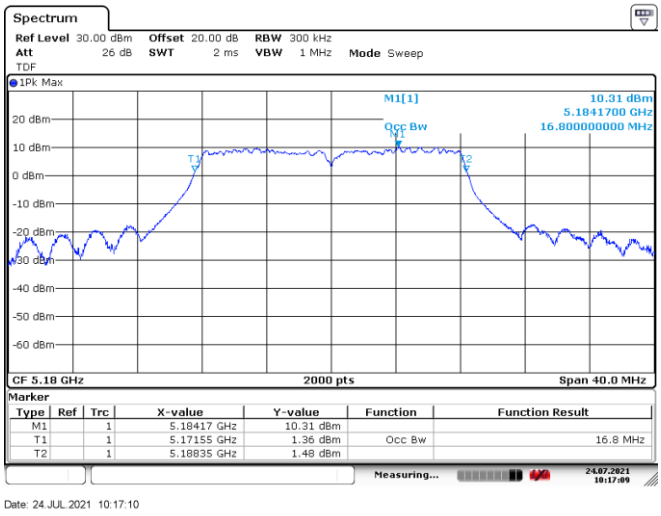


Figure 8.6-1: *99% bandwidth on 802.11a, sample plot*

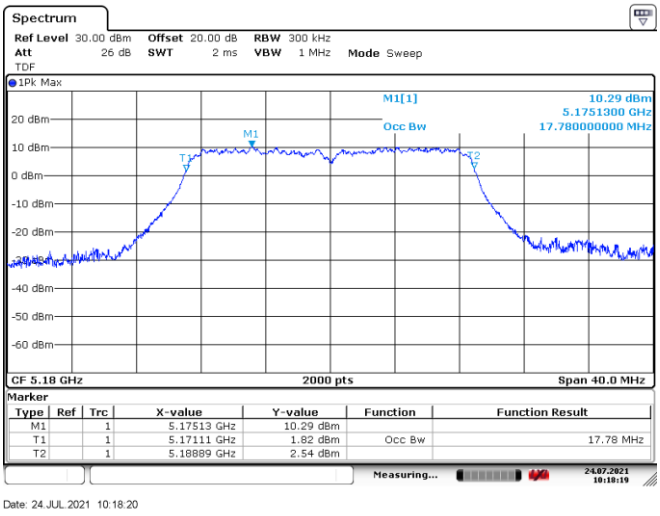


Figure 8.6-2: *99% bandwidth on 802.11n HT20/802.11ac VHT20, sample plot*

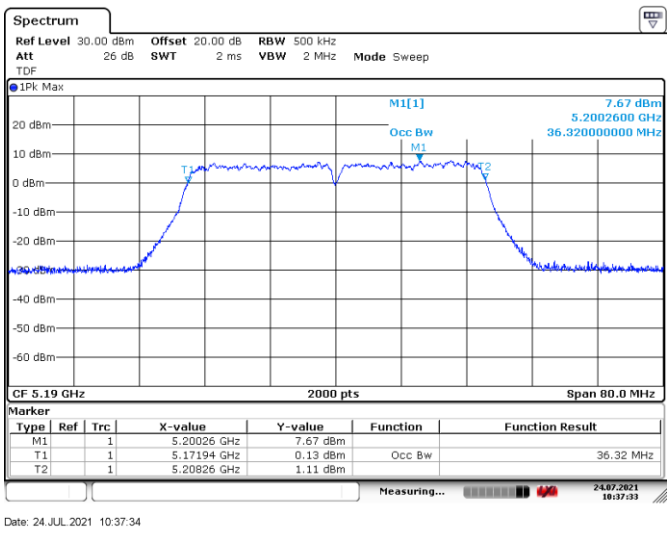


Figure 8.6-3: *99% bandwidth on 802.11n HT40/802.11ac VHT40, sample plot*

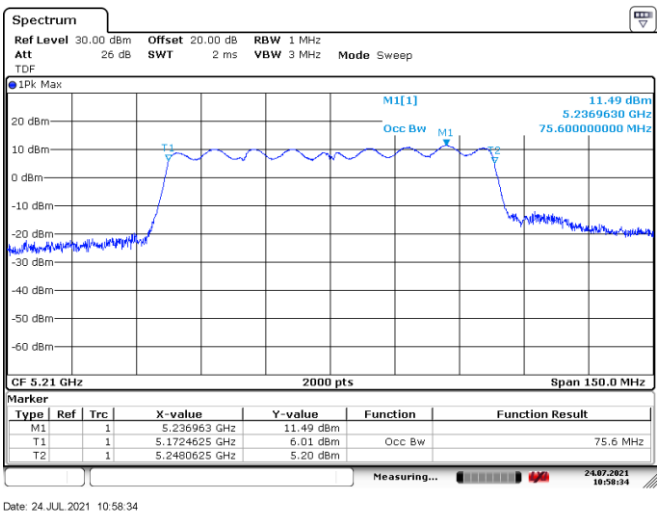


Figure 8.6-4: *99% bandwidth on 802.11ac VHT80, sample plot*

8.7 Transmitter output power and e.i.r.p. requirements for 5150–5250 MHz band

8.7.1 References, definitions and limits

FCC §15.407:

(a) Power limits:

(1) For the band 5.15–5.25 GHz.

(iv) For 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 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.

(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.

6.2.1 Frequency band 5150–5250 MHz

LE-LAN devices are restricted to indoor operation only in the band 5150–5250 MHz. However, original equipment manufacturer (OEM) devices, which are installed in vehicles by vehicles manufacturers, are permitted.

6.2.1.1 Power limits

For OEM devices installed in vehicles, the maximum e.i.r.p. shall not exceed 30 mW or $1.76 + 10 \log_{10}B$, dBm, whichever is less. Devices shall implement transmitter power control (TPC) in order to have the capability to operate at least 3 dB below the maximum permitted e.i.r.p. of 30 mW.

For other devices, the maximum e.i.r.p. shall not exceed 200 mW or $10 + 10 \log_{10}B$, 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.

8.7.2 Test summary

Verdict	Pass		
Tested by	Yong Huang	Test date	July 24, 2021

8.7.3 Observations, settings and special notes

The 99 % measured occupied bandwidth for 802.11a was 16.84 MHz, for 802.11n HT20 was 17.78 MHz, for 802.11n HT40 was 36.36 MHz and for 802.11n HT80 was 75.60 MHz..

IC EIRP limit for 802.11a was calculated as follows: $10 + 10 \times \text{Log}_{10}(16.83) = 22.26$ dBm < 23 dBm

IC EIRP limit for 802.11n HT20 was calculated as follows: $10 + 10 \times \text{Log}_{10}(17.88) = 22.50$ dBm < 23 dBm

IC EIRP limit for 802.11n HT40 was calculated as follows: $10 + 10 \times \text{Log}_{10}(36.54) = 25.60$ dBm > 23 dBm, therefore the limit is 23 dBm

IC EIRP limit for 802.11n HT80 was calculated as follows: $10 + 10 \times \text{Log}_{10}(75.60) = 28.98$ dBm > 23 dBm, therefore the limit is 23 dBm

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	1 MHz
Video bandwidth	≥ 3 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 for FCC*

Modulation	Frequency, MHz	Conducted output power, dBm	Power limit, dBm	Margin, dB
802.11a	5180	10.5	24.0	13.5
	5200	10.8	24.0	13.2
	5240	11.1	24.0	12.9
802.11n HT20/802.11ac VHT20	5180	10.8	24.0	13.2
	5200	11.2	24.0	12.8
	5240	11.3	24.0	12.7
802.11n HT40/802.11ac VHT40	5190	8.5	24.0	15.5
	5230	11.2	24.0	12.8
802.11ac VHT80	5210	11.3	24.0	12.7

Table 8.7-2: *PSD measurements results for FCC*

Modulation	Frequency, MHz	PSD, dBm/MHz	PSD limit, dBm/MHz	Margin, dB
802.11a	5180	-0.6	11.0	11.6
	5200	-0.3	11.0	11.3
	5240	-0.4	11.0	11.4
802.11n HT20/802.11ac VHT20	5180	-0.3	11.0	11.3
	5200	-0.4	11.0	11.4
	5240	-0.7	11.0	11.7
802.11n HT40/802.11ac VHT40	5190	-6.5	11.0	17.5
	5230	-3.8	11.0	14.8
802.11ac VHT80	5210	-5.4	11.0	16.4

Test data, continued

Table 8.7-3: *Output power measurements and EIRP calculations results for ISED*

Modulation	Frequency, MHz	Conducted output power, dBm	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	Margin, dB
802.11a	5180	10.5	2.2	12.7	22.3	9.6
	5200	10.8	2.2	13.0	22.3	9.3
	5240	11.1	2.2	13.3	22.3	9.0
802.11n HT20/802.11ac VHT20	5180	10.8	2.2	13.0	22.5	9.5
	5200	11.2	2.2	13.4	22.5	9.1
	5240	11.3	2.2	13.5	22.5	9.0
802.11n HT40/802.11ac VHT40	5190	8.5	2.2	10.7	23.0	12.3
	5230	11.2	2.2	13.4	23.0	9.6
802.11ac VHT80	5210	11.3	2.2	13.5	23.0	9.5

Table 8.7-4: *PSD measurements results for ISED*

Modulation	Frequency, MHz	PSD, dBm/MHz	Antenna gain, dBi	EIRP PSD, dBm/MHz	EIRP PSD limit, dBm/MHz	Margin, dB
802.11a	5180	-0.6	2.2	1.6	10.0	8.4
	5200	-0.3	2.2	1.9	10.0	8.1
	5240	-0.4	2.2	1.8	10.0	8.2
802.11n HT20/802.11ac VHT20	5180	-0.3	2.2	1.9	10.0	8.1
	5200	-0.4	2.2	1.8	10.0	8.2
	5240	-0.7	2.2	1.5	10.0	8.5
802.11n HT40/802.11ac VHT40	5190	-6.5	2.2	-4.3	10.0	14.3
	5230	-3.8	2.2	-1.6	10.0	11.6
802.11ac VHT80	5210	-5.4	2.2	-3.2	10.0	13.2

Test data, continued

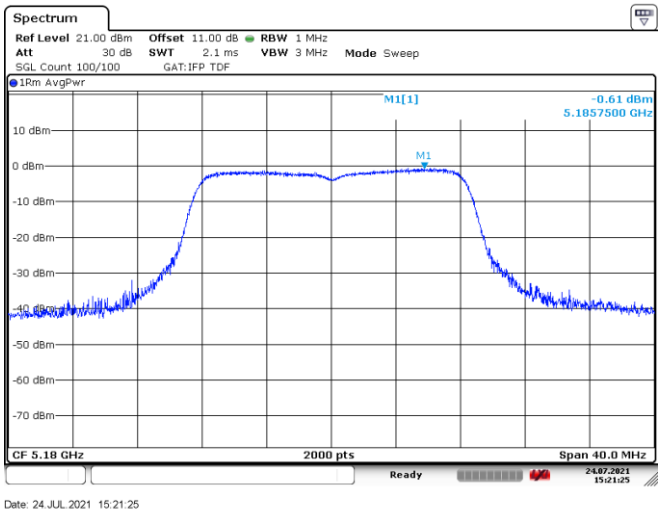


Figure 8.7-1: *Sample plot for power and PPSD on 802.11a*

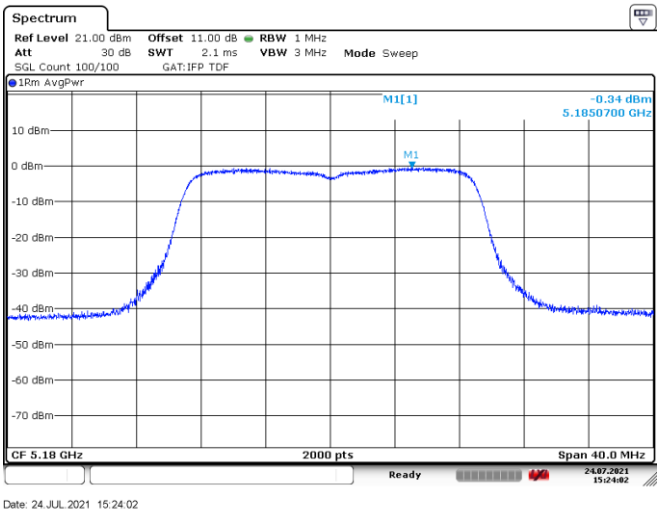


Figure 8.7-2: *Sample plot for power and PPSD on 802.11n HT20/802.11ac VHT20*

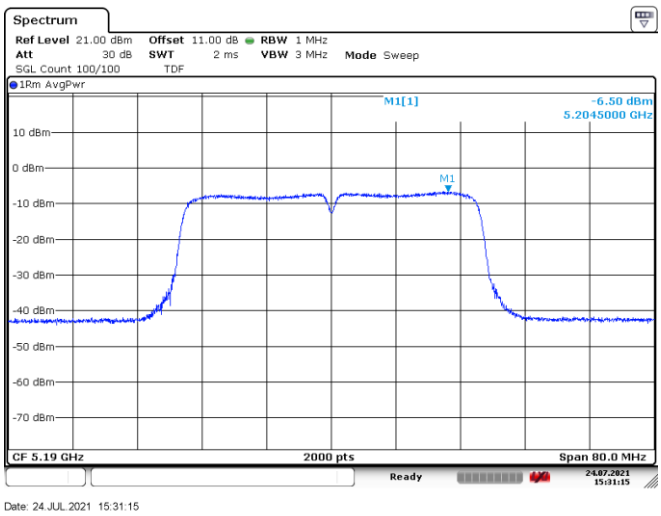


Figure 8.7-3: *Sample plot for power and PPSD on 802.11n HT40/802.11ac VHT40*

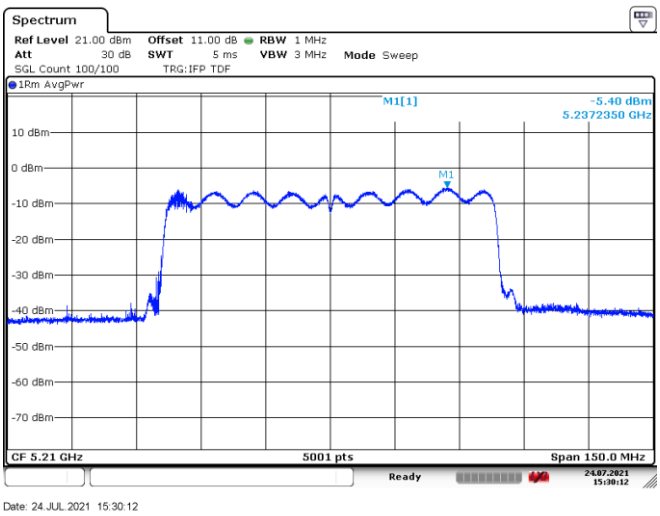


Figure 8.7-4: *Sample plot for power and PPSD on 802.11ac VHT80*

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:

(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 e.i.r.p. of −27 dBm/MHz.

(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.

6.2.1 Frequency band 5150–5250 MHz
LE-LAN devices are restricted to indoor operation only in the band 5150–5250 MHz. However, original equipment manufacturer (OEM) devices, which are installed in vehicles by vehicles manufacturers, are permitted.

6.2.1.2 Unwanted emission limits
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.

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

	Field strength of emissions		
Frequency, MHz	**µV/m**	**dBµV/m**	**Measurement distance, 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	Above 38.6
8.41425–8.41475	167.72–173.2	3500–4400	
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 date	July 28 to 31, 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 Ω 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

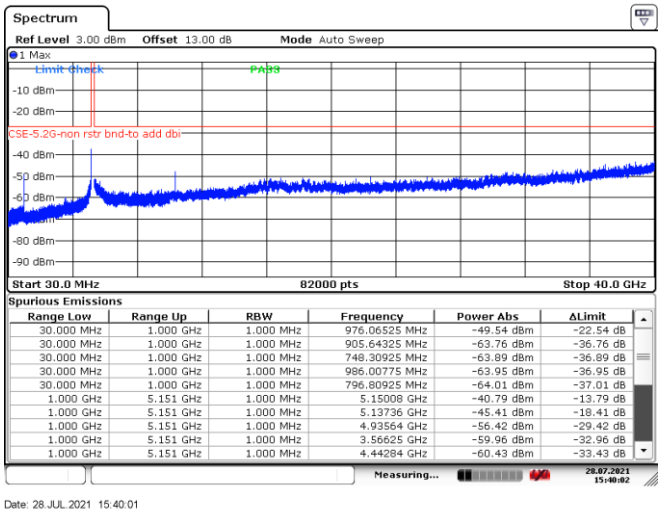


Figure 8.8-1: *Spurious emissions outside restricted bands, Tx on low channel, 802.11a*

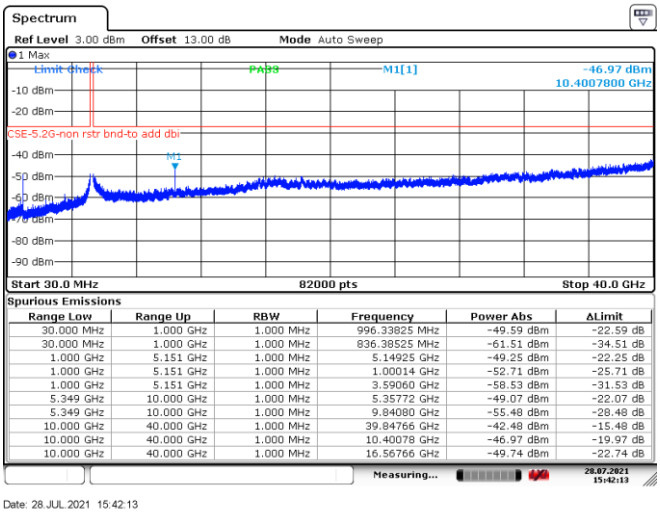


Figure 8.8-2: *Spurious emissions outside restricted bands, Tx on mid channel, 802.11a*

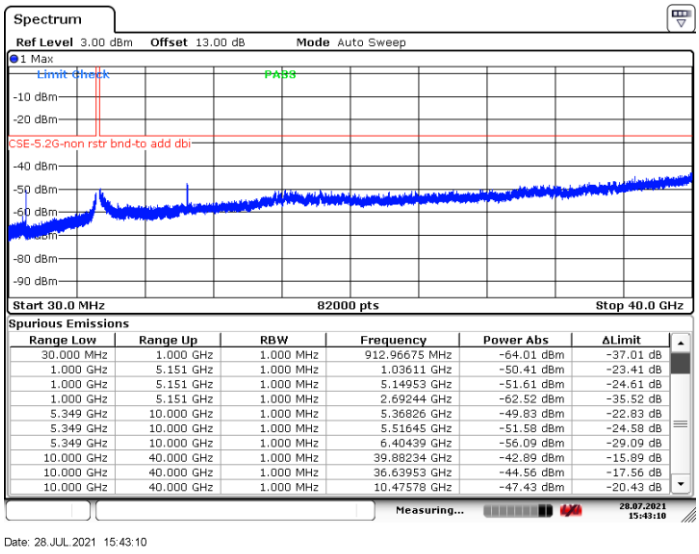


Figure 8.8-3: *Spurious emissions outside restricted bands, Tx on high channel, 802.11a*

Test data, continued

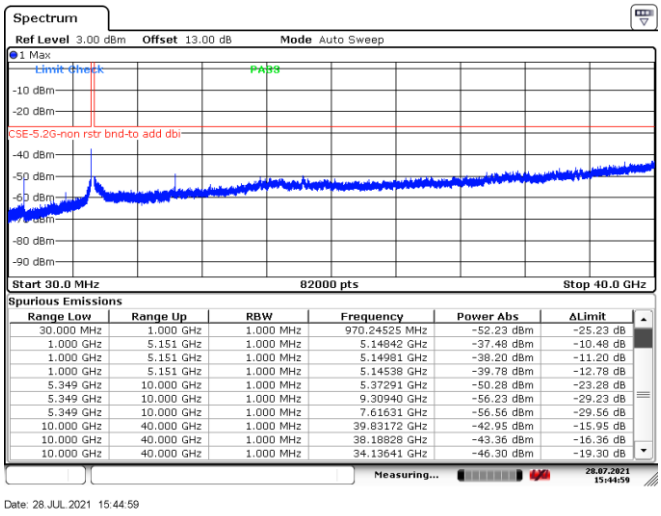


Figure 8.8-4: *Spurious emissions outside restricted bands, Tx on low channel, 802.11n HT20/802.11ac VHT20*

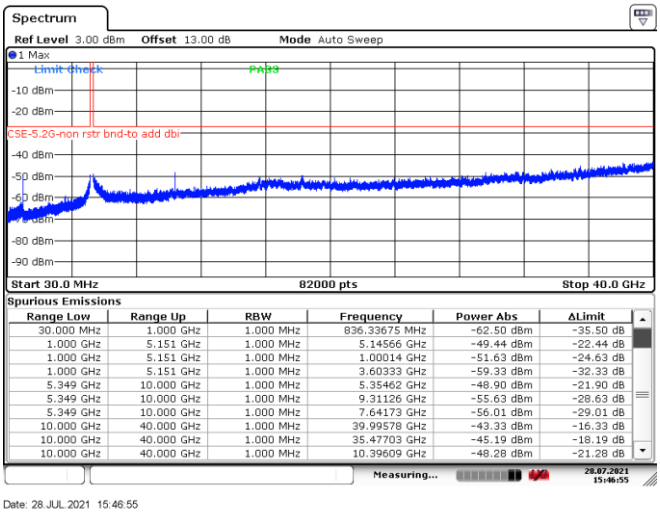


Figure 8.8-5: *Spurious emissions outside restricted bands, Tx on mid channel, 802.11n HT20/802.11ac VHT20*

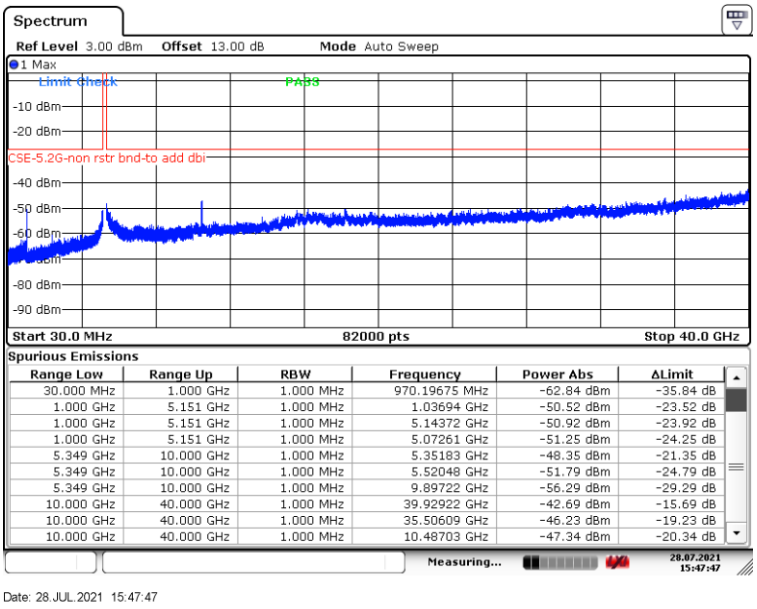


Figure 8.8-6: *Spurious emissions outside restricted bands, Tx on high channel, 802.11n HT20/802.11ac VHT20*

Test data, continued

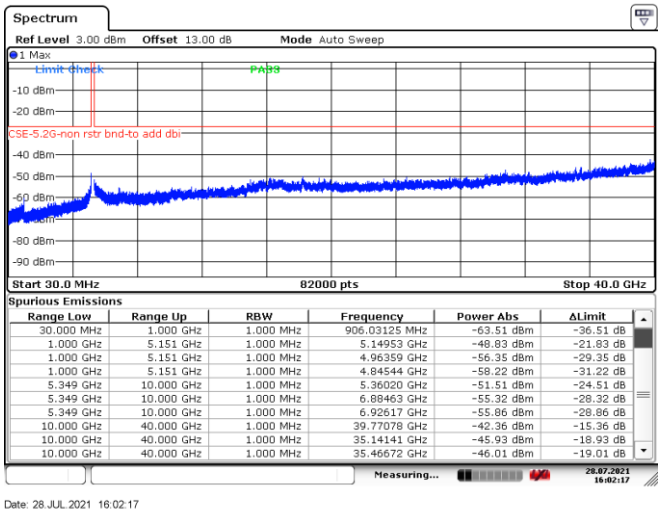


Figure 8.8-7: *Spurious emissions outside restricted bands, Tx on low channel, 802.11n HT40/802.11ac VHT40*

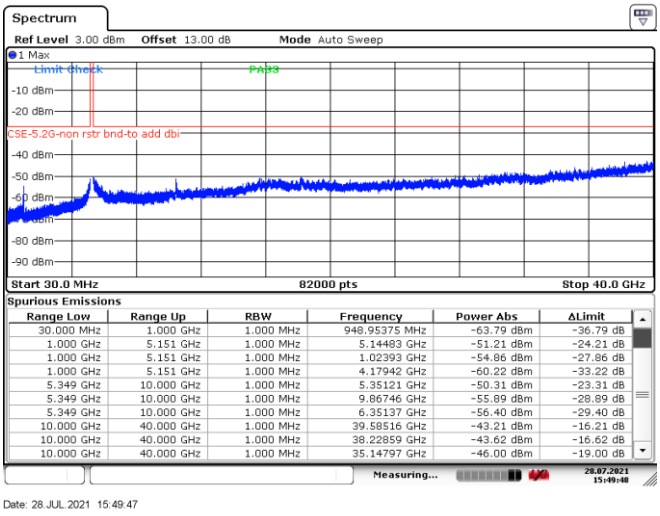


Figure 8.8-8: *Spurious emissions outside restricted bands, Tx on mid channel, 802.11n HT40/802.11ac VHT40*

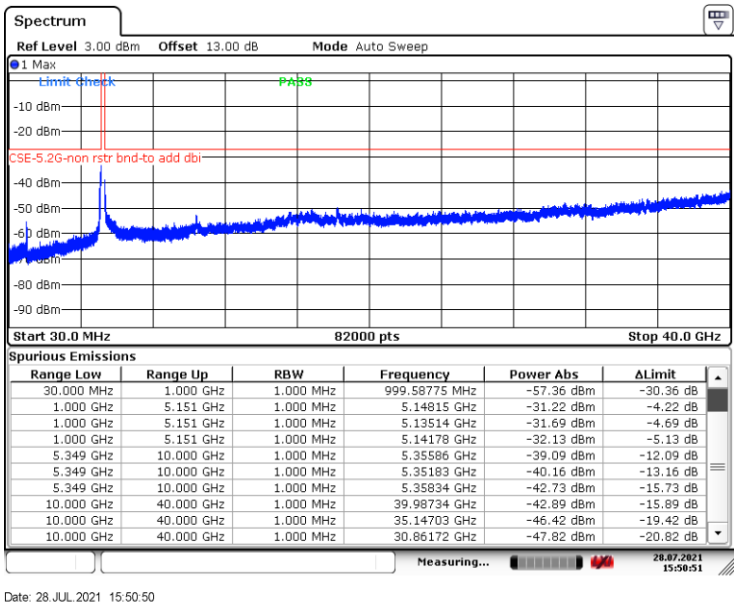


Figure 8.8-9: *Spurious emissions outside restricted bands, 802.11ac VHT80*

Test data, continued

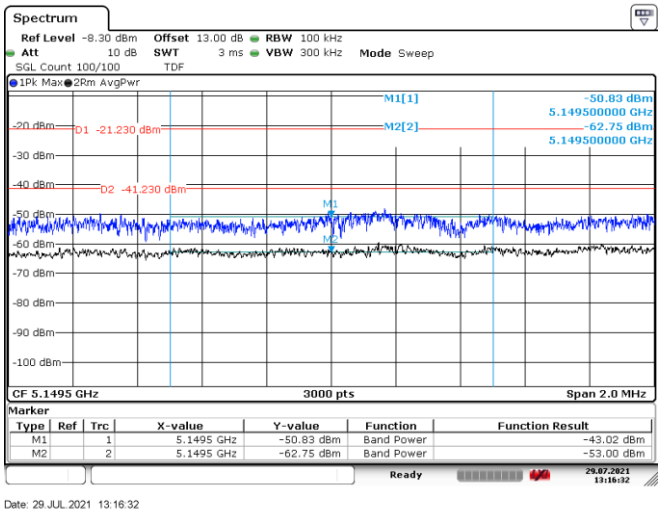


Figure 8.8-10: *Lower band edge, Tx on low channel, 802.11a*

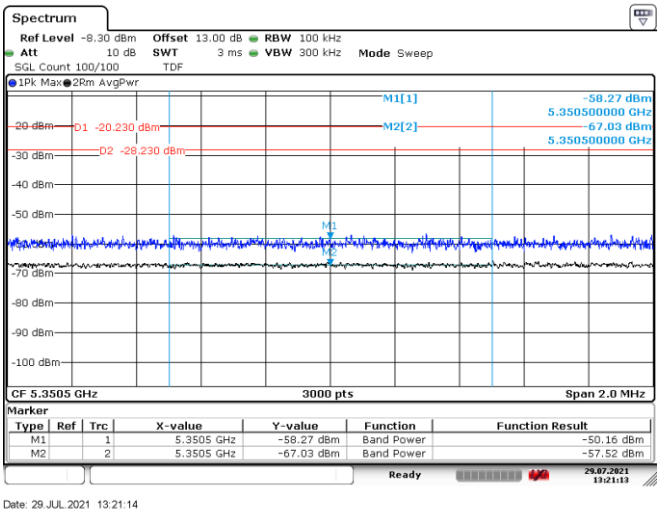


Figure 8.8-11: *Upper band edge, Tx on mid channel, 802.11a*

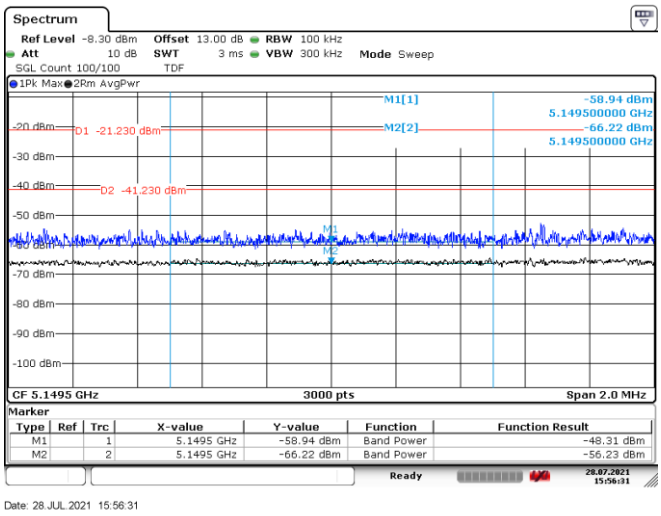


Figure 8.8-12: *Lower band edge, Tx on low channel, 802.11n HT20/802.11ac VHT20*

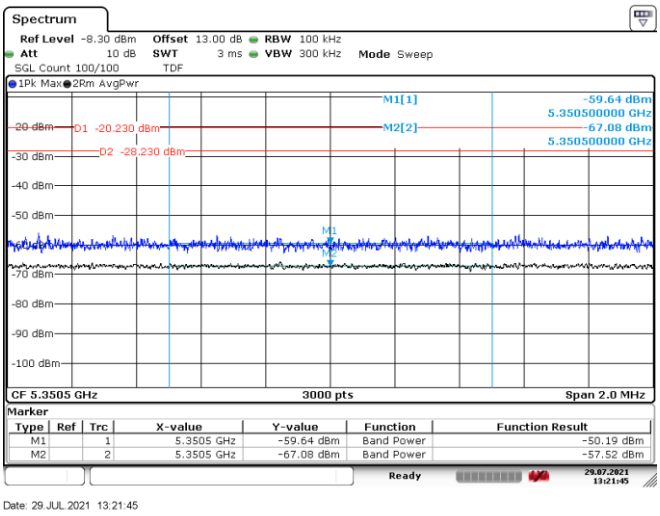


Figure 8.8-13: *Upper band edge, Tx on mid channel, 802.11n HT20/802.11ac VHT20*

Test data, continued

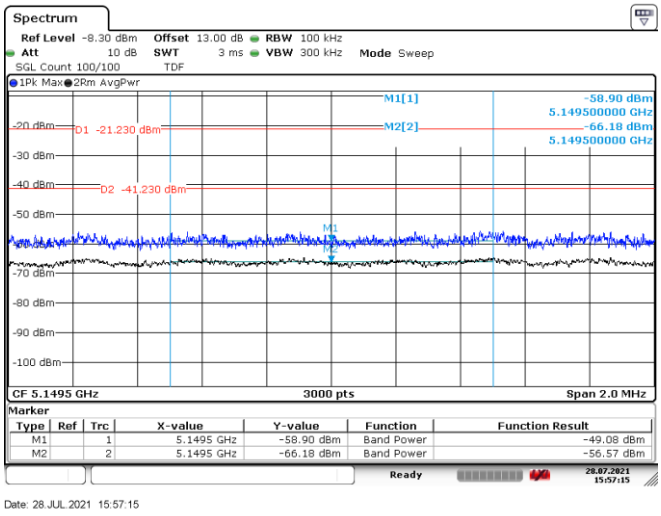


Figure 8.8-14: *Lower band edge, Tx on low channel, 802.11n HT40/802.11ac VHT40*

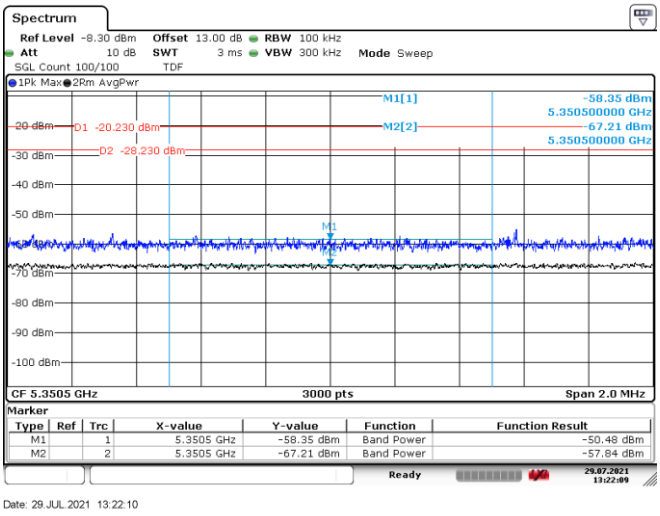


Figure 8.8-15: *Upper band edge, Tx on mid channel, 802.11n HT40/802.11ac VHT40*

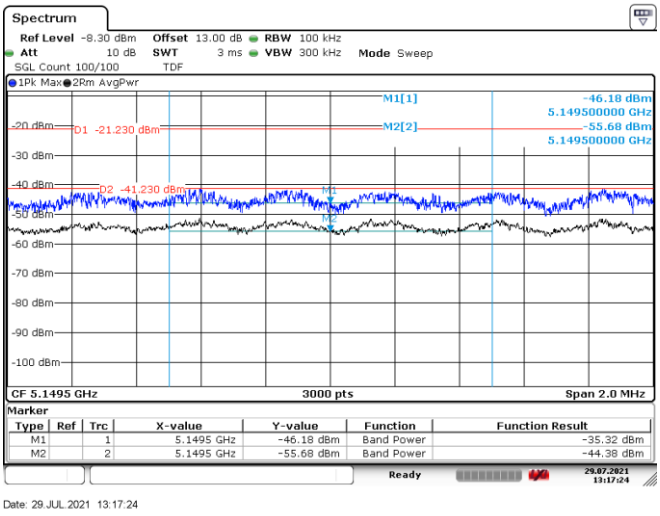


Figure 8.8-16: *Lower band edge, Tx on low channel, 802.11ac VHT80*

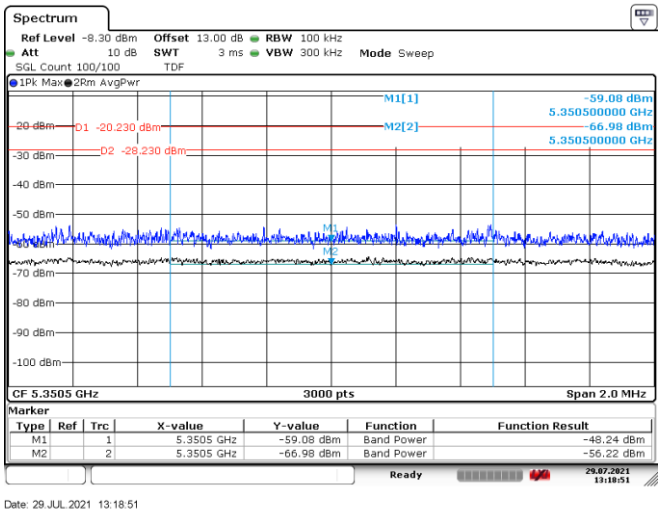


Figure 8.8-17: *Upper band edge, Tx on hi channel, 802.11ac VHT80*

Test data, continued

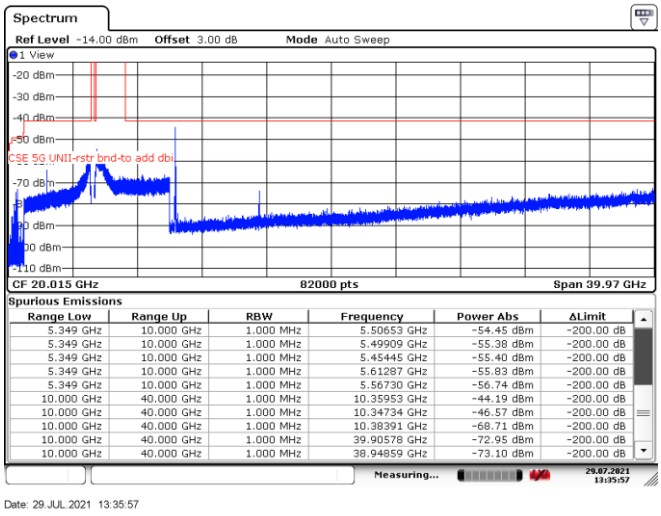


Figure 8.8-18: *Spurious emissions within restricted bands, Tx on low channel, 802.11a*

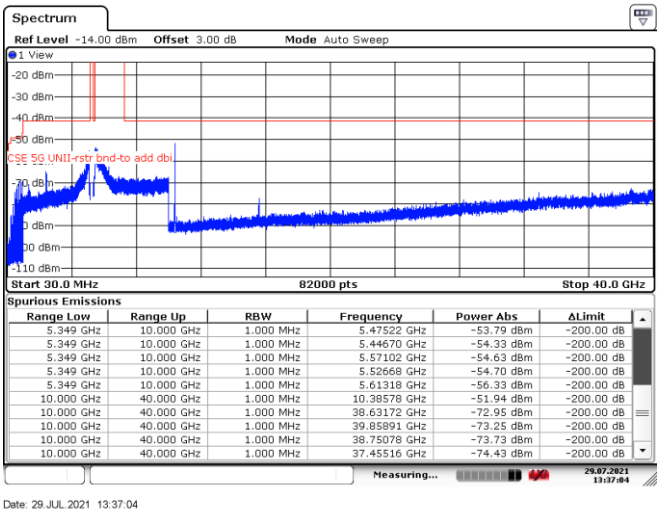


Figure 8.8-19: *Spurious emissions within restricted bands, Tx on mid channel, 802.11a*

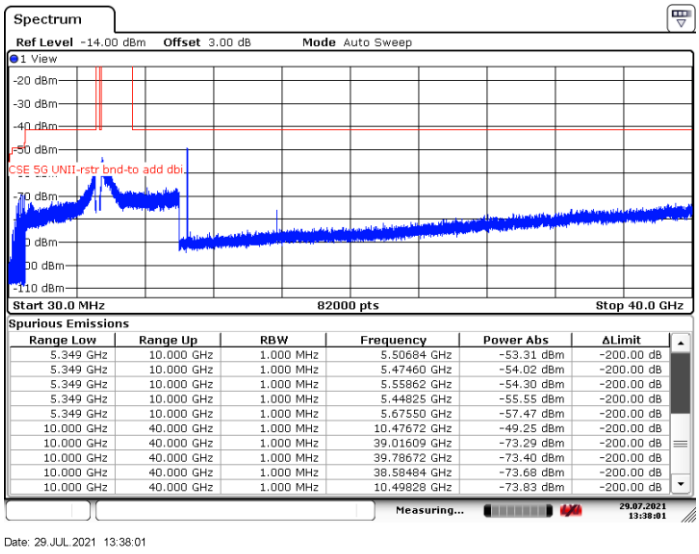


Figure 8.8-20: *Spurious emissions within restricted bands, Tx on high channel, 802.11a*

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

Test data, continued

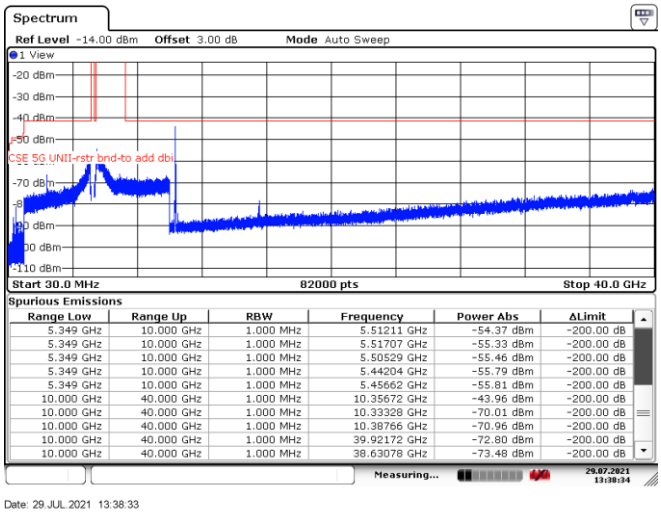


Figure 8.8-21: *Spurious emissions within restricted bands, Tx on low channel, 802.11n HT20/802.11ac VHT20*

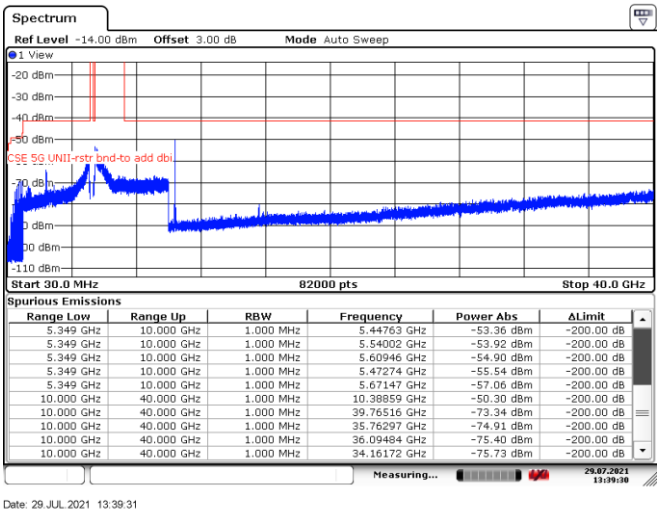


Figure 8.8-22: *Spurious emissions within restricted bands, Tx on mid channel, 802.11n HT20/802.11ac VHT20*

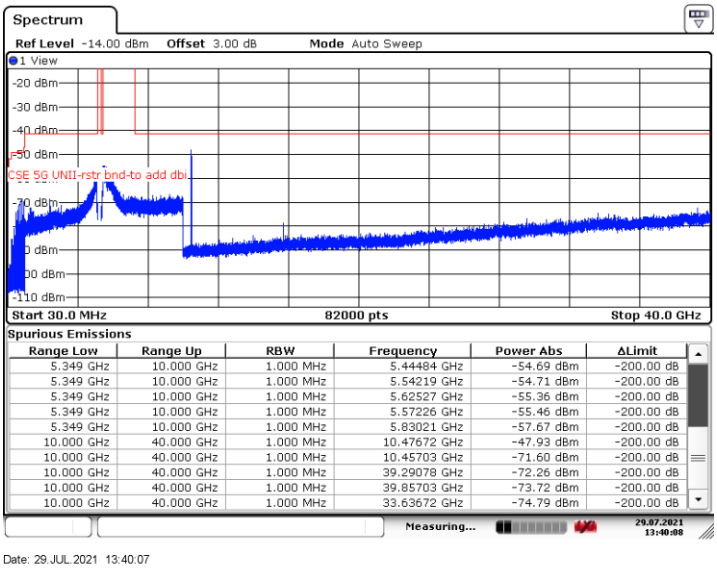


Figure 8.8-23: *Spurious emissions within restricted bands, Tx on high channel, 802.11n HT20/802.11ac VHT20*

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

Test data, continued

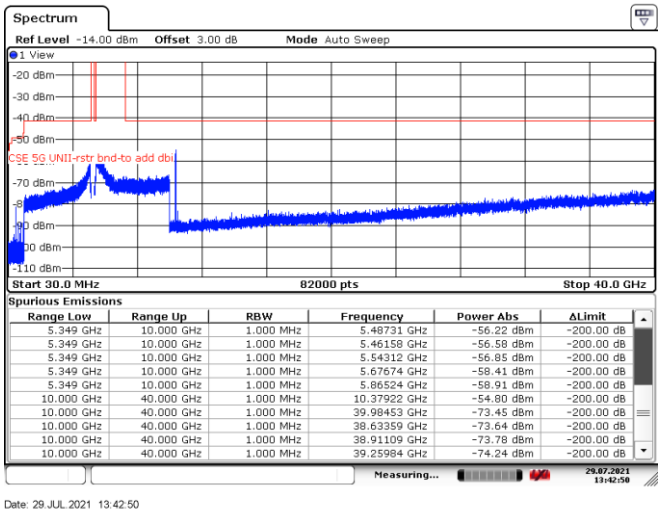


Figure 8.8-24: *Spurious emissions within restricted bands, Tx on low channel, 802.11n HT40/802.11ac VHT40*

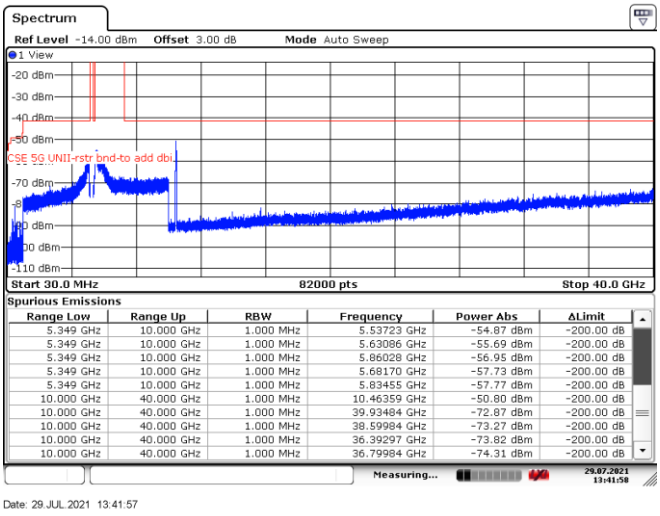


Figure 8.8-25: *Spurious emissions within restricted bands, Tx on high channel, 802.11n HT40/802.11ac VHT40*

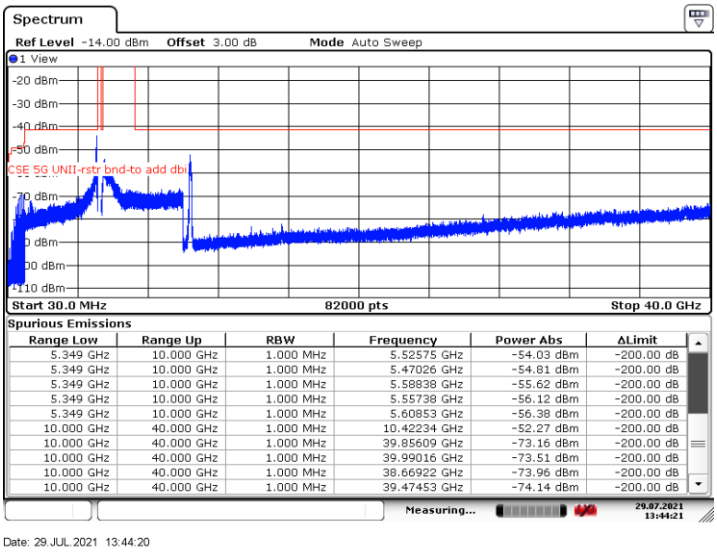


Figure 8.8-26: *Spurious emissions within restricted bands, 802.11ac VHT80*

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

Test data, continued

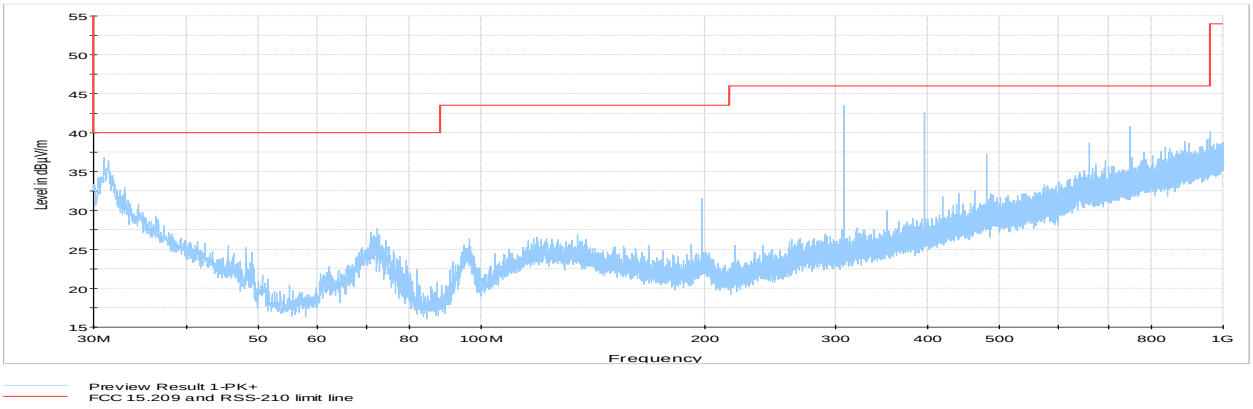


Figure 8.8-27: *Cabinet Radiated spurious emission 30 MHz to 1 GHz , Tx on low channel*

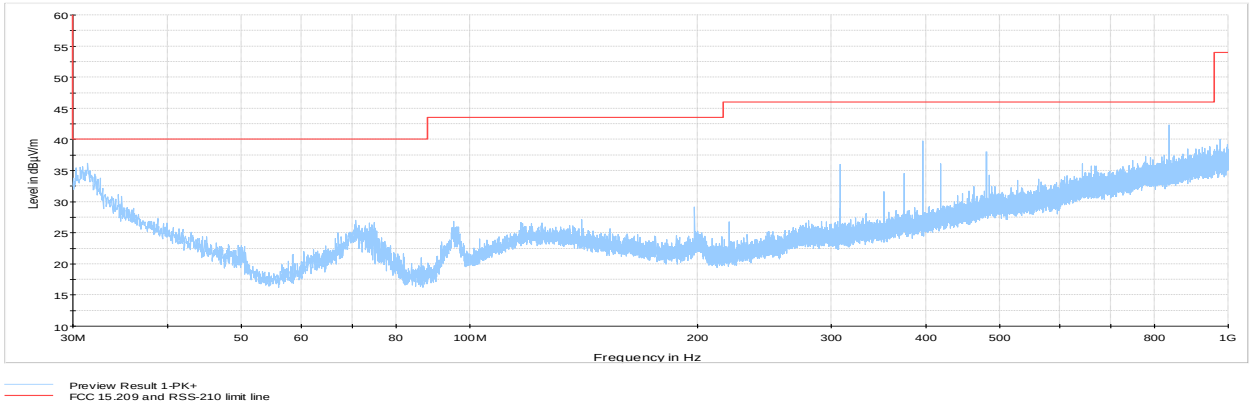


Figure 8.8-28: *Cabinet Radiated spurious emission 30 MHz to 1 GHz , Tx on mid channel*

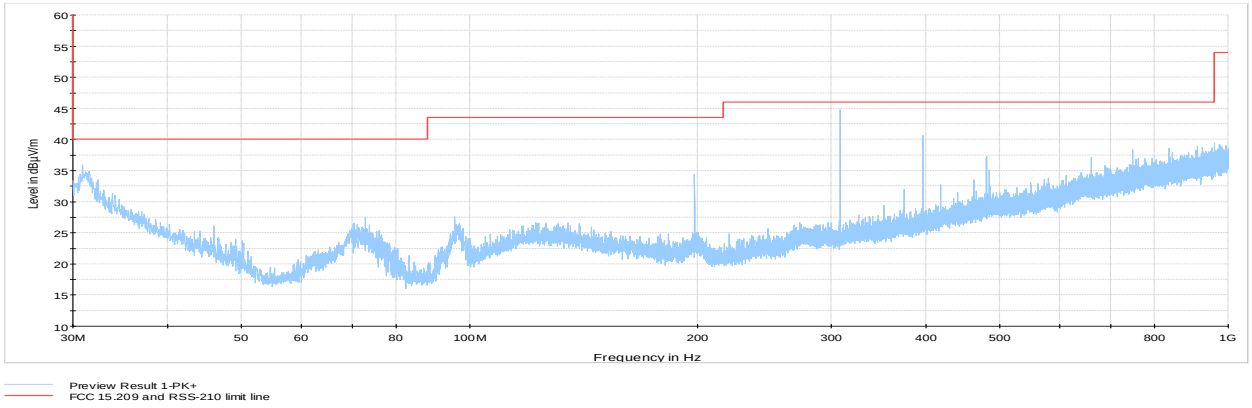


Figure 8.8-29: *Cabinet Radiated spurious emission 30 MHz to 1 GHz , Tx on high channel*

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

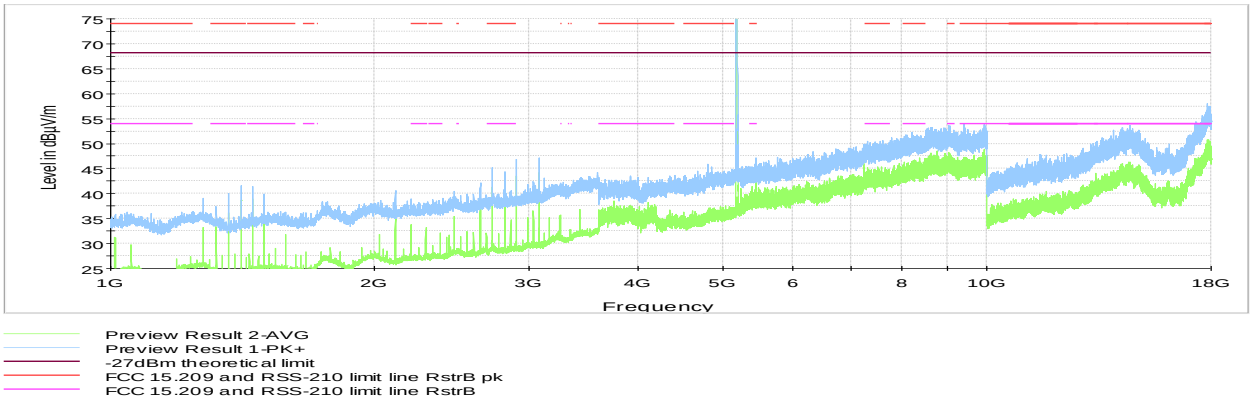


Figure 8.8-30: *Cabinet Radiated spurious emission 1 to 18 GHz, Tx on low channel*

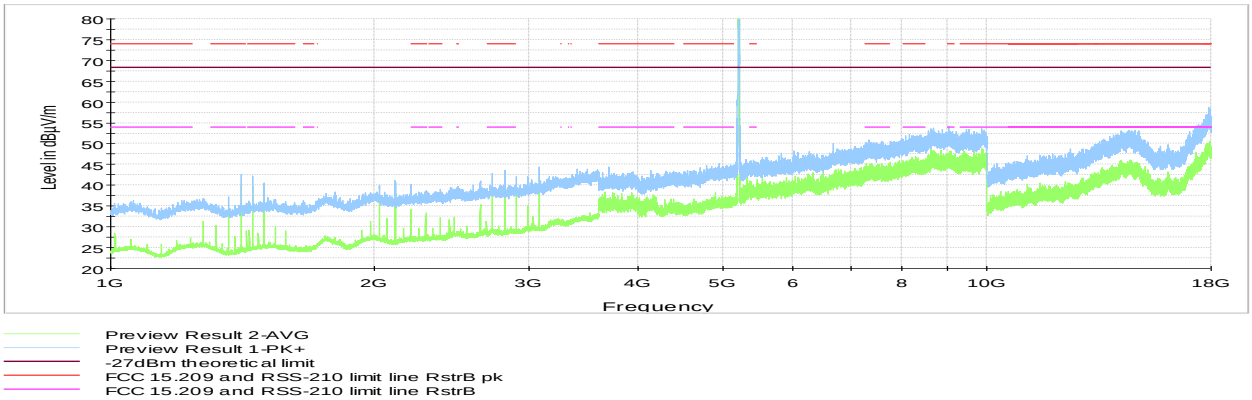


Figure 8.8-31: *Cabinet Radiated spurious emission 1 to 18 GHz , Tx on mid channel*

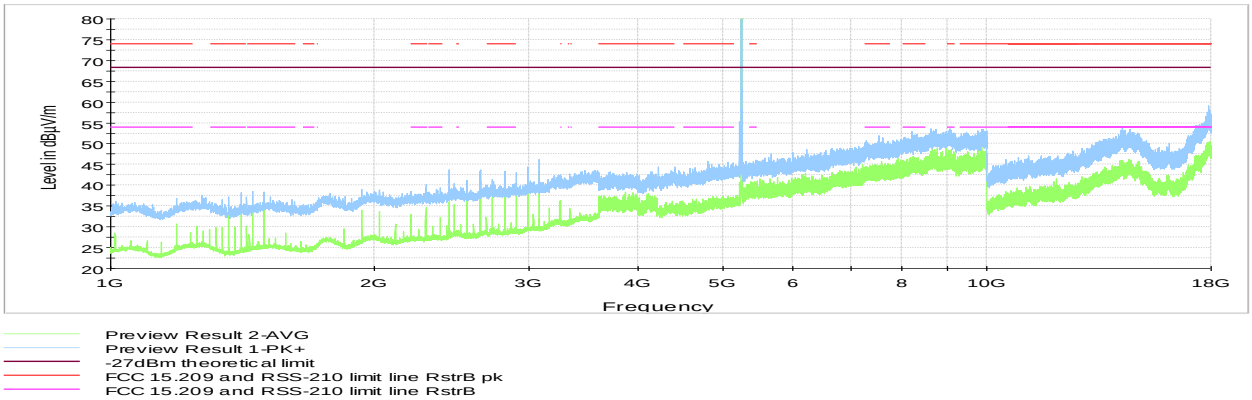


Figure 8.8-32: *Cabinet Radiated spurious emission 1 to 18 GHz , Tx on high channel*

Note: EUT was investigated in high/mid/low channels of 802.11a/802.11n/802.11ac modes, only worst case is presented.
Above 18 GHz, no emissions related to RF portion were found within 10 dB below the limit.

8.9 Frequency stability

8.9.1 References, definitions and limits

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

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

8.9.1 Test data

Table 8.9-1: *Frequency drift measurement*

Test conditions	Nominal frequency, GHz	Frequency, GHz	Drift, Hz
+45 °C, Nominal	5.20000000	5.20001809	18090
+30 °C, Nominal	5.20000000	5.20000217	2170
+20 °C, +15 %	5.20000000	5.20000000	0
+20 °C, Nominal	5.20000000	5.20000000	reference
+20 °C, −15 %	5.20000000	5.20000000	0
+10 °C, Nominal	5.20000000	5.19999522	-4780
0 °C, Nominal	5.20000000	5.19999928	-720

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

Modulation	99% bandwidth lower cross point, GHz	Max negative drift, Hz	Drifted lower cross point, GHz	Band edge, GHz	Margin, MHz
802.11a	5.1715500	4780	5.17154522	5.15000000	21.54522000
802.11n HT20 /802.11ac VHT20	5.1711100	4780	5.17110522	5.15000000	21.10522000
802.11n HT40 /802.11ac VHT40	5.1719400	4780	5.17193522	5.15000000	21.93522000
802.11ac VHT80	5.1724625	4780	5.17245772	5.15000000	22.45772000

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

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

Modulation	99% bandwidth upper cross point, GHz	Max positive drift, Hz	Drifted upper cross point, GHz	Band edge, GHz	Margin, MHz
802.11a	5.2483500	18090	5.2483681	5.2500000	1.6319100
802.11n HT20 /802.11ac VHT20	5.2488900	18090	5.2489081	5.2500000	1.0919100
802.11n HT40 /802.11ac VHT40	5.2482600	18090	5.2482781	5.2500000	1.7219100
802.11ac VHT80	5.2480625	18090	5.2480806	5.2500000	1.9194100

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

Section 9 EUT photos

9.1 External photos

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*

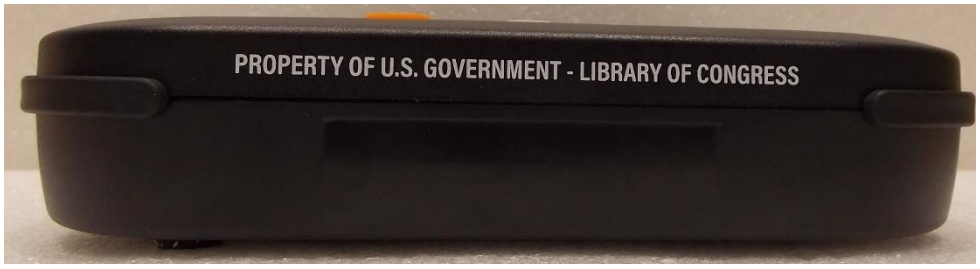


Figure 9.1-5: *Top view photo*

Figure 9.1-6: *Bottom view photo*

End of the test report