

RADIO TEST REPORT – 449306-8TRFWL

Type of assessment:

Partial Assessment

Applicant:

Keyence Corporation

Product:

Handheld Terminal

Model:

DX-W600

FCC ID:

RF41539A

IC Registration number:

5798A-1539A

Specifications:

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

Date of issue: May 3, 2022

Tarek Elkholy, Wireless/EMC Specialist

Tested by

David Duchesne, EMC/RF Lab Manager

Reviewed by



Signature



Signature

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SCC File Number: 15064 (Ottawa/Almonte); 151100 (Montreal); 151097 (Cambridge)

FCC 15.407, RSS-247 UNII2c; Date: August 2020

Lab locations

Company name	Nemko Canada Inc.			
Facilities	<i>Ottawa site:</i>	<i>Montréal site:</i>	<i>Cambridge site:</i>	<i>Almonte site:</i>
	303 River Road	292 Labrosse Avenue	1-130 Saltsman Drive	1500 Peter Robinson Road
	Ottawa, Ontario	Pointe-Claire, Québec	Cambridge, Ontario	West Carleton, Ontario
	Canada K1V 1H2	Canada H9R 5L8	Canada N3E 0B2	Canada K0A 1L0
	Tel: +1 613 737 9680	Tel: +1 514 694 2684	Tel: +1 519 650 4811	Tel: +1 613 256-9117
	Fax: +1 613 737 9691	Fax: +1 514 694 3528		
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.

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Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 15, Subpart E, Clause 15.407	Unlicensed National Information Infrastructure Devices operating in the 5.15–5.35 GHz, 5.47–5.725 GHz, 5.725–5.85 GHz, and 5.925–7.125 GHz bands.
RSS-247, Issue 2, Feb 2017, Section 6	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices. 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

Partial testing was performed on the product to proof compliance of the EUT originally certified based on the test reports RF140808E04S-1 and RF140808E04S-3, only power, power spectral density, emission bandwidth and spurious emissions in restricted bands are tested in this assessment.

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	May 3, 2022	Original report issued

Section 2 Engineering considerations

2.1 Modifications incorporated in the EUT for compliance

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

2.2 Technical judgment

None

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 $\pm 5\%$, 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, $\pm$ dB
All antenna port measurements	0.55
Occupied bandwidth	4.45
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 5 Information provided by the applicant

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	Keyence Corporation
Applicant address	1-3-14, Higashinakajima Higashiyodogawa-ku, Osaka 533-8555, Japan.
Manufacture name	Keyence Corporation
Manufacture address	1-3-14, Higashinakajima Higashiyodogawa-ku, Osaka 533-8555, Japan.

5.3 EUT information

Product	Handheld Terminal
Model	DX-W600
Serial number	74AM000344 (radiated sample), 74AM000496 (conducted sample)
Power supply requirements	Battery: 3.8 V(DC)
Product description and theory of operation	Model: DX-W600 is Handheld Terminal. This product is battery powered. It is equipped with an optical scanner and can read labels such as QR codes.

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	(U-NII-2c); FCC: 5470–5725 MHz; ISD: 5470–5600 MHz and 5650 MHz–5725 MHz
Frequency Min (MHz)	5500 MHz for 20 MHz bandwidth, 5510 MHz for 40 MHz bandwidth, 5530 MHz for 80 MHz bandwidth
Frequency Max (MHz)	5720 MHz for 20 MHz bandwidth, 5710 MHz for 40 MHz bandwidth, 5690 MHz for 80 MHz bandwidth
RF power Max (W), Conducted	0.0115 W and (10.6 dBm)
Measured BW (MHz), 99% OBW	17.6 MHz (20 MHz bandwidth), 36.0 MHz (40 MHz bandwidth), 74.6 MHz (80 MHz bandwidth)
Type of modulation	802.11a/n/ac: OFDM (QPSK, BPSK, 16-QAM, 64-QAM)
Emission classification	W7D
Transmitter spurious, dBμV/m @ 3 m	48.7 dBμV/m peak at 7480 MHz
Antenna information	Model: FPA2514-5A Peak gain: -2.1 dBi

5.5 EUT setup details

5.5.1 Radio exercise details

Operating conditions	This WiFi / BT module is a module with 802.11ac / a / b / g / n WiFi and Bluetooth communication function. It is programmed to recognize the country code issued by the AP and communicate with the output according to the wireless specifications allowed in each country. Output power level was set according to the table below • Software: Qualcomm Atheros Radio Control Toolkit • Version: V3.0-00191
Transmitter state	Transmitter set into maximum typical duty cycle mode.

Modulation	Channel number	Frequency (MHz)	Power level (dBm)	Measured Duty Cycle (%)	Calculated DCCF (dB)
802.11a	100	5500	14	91.9	0.4
	120	5600	15		
	140	5700	13		
	144	5720	11		
802.11ac VHT20	100	5500	13	94	0.3
	120	5600	14		
	140	5700	12		
	144	5720	11		
802.11ac VHT40	102	5510	10	86.5	0.6
	118	5590	13		
	134	5670	13		
	142	57110	10		
802.11ac VHT80	106	5530	10	76.6	1.2
	122	5610	13		
	138	5690	10		

Note: $DCCF = 10 \log_{10} (1/\text{duty cycle})$, ex. For DC 91.9 %, $DCCF = 10 \log_{10} (1/0.919) = 0.4 \text{ dB}$.
Frequency range 5600-5650 MHz is not permitted in Canada.

Table 5.5-1: EUT interface ports

Description	Qty.
Charging DC power input / micro-USB	1

EUT setup configuration, continued



Figure 5.5-1: Radiated testing block diagram

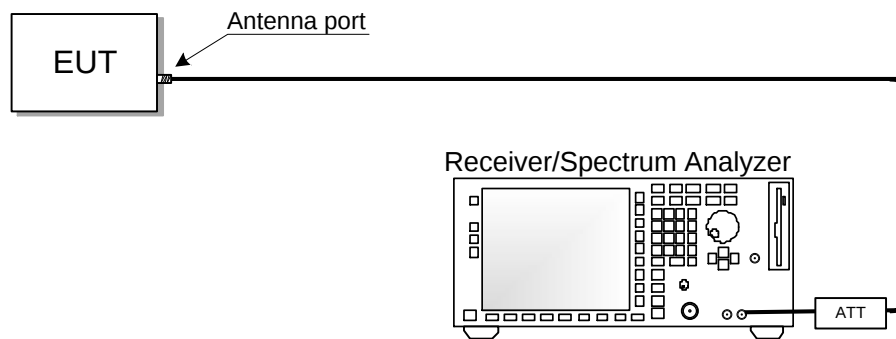


Figure 5.5-2: Antenna port testing block diagram

Section 6 Summary of test results

6.1 Testing location

Test location (s)	Cambridge
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6.2 Testing period

Test start date	March 17, 2022	Test end date	April 5, 2022
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6.3 Sample information

Receipt date	September 9, 2021	Nemko sample ID number(s)	2 and 3
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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	Not tested ¹
§15.31l	Variation of power source	Not tested ¹
§15.31(m)	Number of tested frequencies	Pass
§15.203	Antenna requirement	Pass

Notes: EUT is a battery operated device, the testing was performed using fresh batteries.

¹Partial testing was performed on the product to proof compliance of the EUT originally certified based on the test reports RF140808E04S-1 and RF140808E04S-3, only power, power spectral density and spurious emissions in restricted bands are tested in this assessment.

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)(2)	Power and density limits within 5.25–5.35 GHz and 5.47–5.725 GHz bands	Pass
§15.407(b)(3)	Undesirable emission limits for 5.47–5.725 GHz bands	Pass
§15.407(b)(8)	AC power line conducted limits	Not tested ¹
§15.407(g)	Frequency stability	Not tested ¹
§15.407(h)(1) ¹	Transmit power control (TPC)	Not applicable
§15.407(h)(2) ¹	Dynamic Frequency Selection (DFS)	Not tested ¹
§15.407(k)	Automated frequency coordination (AFC) system	Not applicable

Notes: ¹Partial testing was performed on the product to proof compliance of the EUT originally certified based on the test reports RF140808E04S-1 and RF140808E04S-3, only power, power spectral density, emission bandwidth and spurious emissions in restricted bands are tested in this assessment.

6.6 ISSED 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	Not tested ²

Notes: ¹According 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 a battery operated device, the testing was performed using fresh batteries.
²Partial testing was performed on the product to proof compliance of the EUT originally certified based on the test reports RF140808E04S-1 and RF140808E04S-3, only power, power spectral density and spurious emissions in restricted bands are tested in this assessment.

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
6.2.3.1	Power limits for 5470–5600 MHz and 5650–5725 MHz bands	Pass
6.2.3.1(b)	TPC requirements for 5470–5600 MHz and 5650–5725 MHz bands	Not applicable
6.2.3.	Unwanted emission limits for 5470–5600 MHz and 5650–5725 MHz bands	Pass
6.3	Dynamic Frequency Selection (DFS) for devices operating in the bands 5250–5350 MHz, 5470–5600 MHz and 5650–5725 MHz	Not tested ²

Notes:

¹ The EUT employs digital modulations, such as: 802.11a, 802.11ac VHT20, 802.11ac VHT40 and 802.11ac VHT80.

² Partial testing was performed on the product to proof compliance of the EUT originally certified based on the test reports RF140808E04S-1 and RF140808E04S-3, only power, power spectral density, emission bandwidth and spurious emissions in restricted bands are tested in this assessment.

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	TDK	SAC-3	FA003012	1 year	Feb 7, 2023
Flush mount turntable	SUNAR	FM2022	FA003006	—	NCR
Controller	SUNAR	SC110V	FA002976	—	NCR
Antenna mast	SUNAR	TLT2	FA003007	—	NCR
Vector signal generator	Rohde & Schwarz	SMW200A	FA002970	1 Year	Dec 31, 2022
Spectrum analyzer	Rohde & Schwarz	FSW43	FA002971	1 year	Dec 31, 2022
Receiver/spectrum analyzer	Rohde & Schwarz	ESR26	FA002969	1 year	Nov 30, 2022
Horn antenna (1–18 GHz)	ETS Lindgren	3117	FA002911	1 year	April 21, 2022
Preamp (1–18 GHz)	ETS Lindgren	124334	FA002956	1 year	Mar 30, 2023
Horn antenna (18–40 GHz)	EMCO	3116B	FA002948	1 year	Jan 23, 2023
Preamp 18-40 GHz	None	None	FA003323	1 year	Mar 30, 2023
Bilog antenna (30–2000 MHz)	SUNAR	JB1	FA003009	1 year	Jan 31, 2023
50 Ω coax cable	Huber + Suhner	None	FA003047	1 year	July 13, 2022
50 Ω coax cable	Huber + Suhner	None	FA003043	1 year	July 13, 2022

Notes: NCR - no calibration required

Section 8 Testing data

8.1 Number of frequencies

8.1.1 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 8.1-1: 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.

8.1.2 Test summary

Verdict	Pass		
Tested by	Tarek Elkholy	Test date	March 17, 2022

8.1.3 Observations, settings and special notes

ANSI C63.10, Clause 5.6.2.1:

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

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

ANSI C63.10, Clause 5.6.2.2:

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

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

8.1.4 Test data

Table 8.1-2: Test channels selection - 20 MHz bandwidth

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low channel, MHz	Mid channel, MHz	High channel, MHz	Straddle channel, MHz
5470	5725	255	5500	5600	5700	5720

Table 8.1-3: Test channels selection - 40 MHz bandwidth

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low channel, MHz	Mid channel, MHz	High channel, MHz	Straddle channel, MHz
5470	5725	255	5510	5590	5670	5710

Table 8.1-4: Test channels selection - 80 MHz bandwidth

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low channel, MHz	Mid channel, MHz	High channel, MHz
5470	5725	255	5530	5610	5690

8.2 Antenna requirement

8.2.1 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.

8.2.2 Test summary

Verdict	Pass		
Tested by	Tarek Elkholy	Test date	March 17, 2022

8.2.3 Observations, settings and special notes

None

8.2.4 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 8.2-1: Antenna information

Model number	Maximum gain	Connector type
FPA2514-5A	-2.1 dBi	WFL

8.3 Emission bandwidth

8.3.1 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.

8.3.2 Test summary

Verdict	Pass		
Tested by	Tarek Elkholy	Test date	April 4, 2022

8.3.3 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

8.3.4 Test data

Table 8.3-1: 26 dB bandwidth results

Modulation	Frequency, MHz	26 dB bandwidth, MHz
802.11a	5500	18.7
	5600	19.2
	5700	18.7
	5720	18.6

Table 8.3-2: 26 dB bandwidth results

Modulation	Frequency, MHz	26 dB bandwidth, MHz
802.11ac VHT20	5500	19.7
	5600	19.8
	5700	19.7
	5720	19.7

Table 8.3-3: 26 dB bandwidth results

Modulation	Frequency, MHz	26 dB bandwidth, MHz
802.11ac VHT40	5510	40.6
	5590	40.8
	5670	40.6
	5710	40.4

Test data, continued

Table 8.3-4: 26 dB bandwidth results

Modulation	Frequency, MHz	26 dB bandwidth, MHz
802.11ac VHT80	5530	80.8
	5610	80.4
	5690	81.1

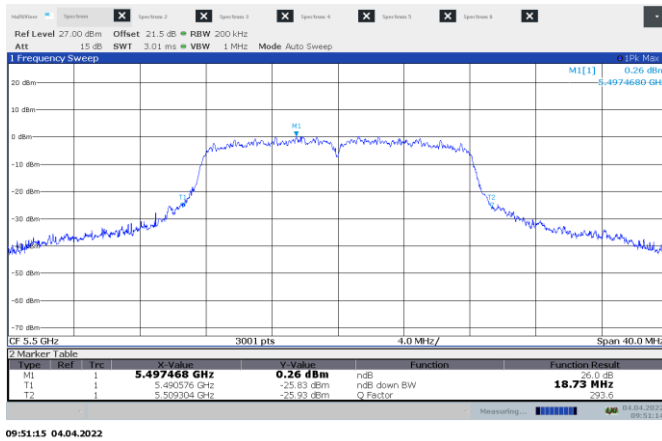


Figure 8.3-1: 26 dB bandwidth on 802.11a, sample plot

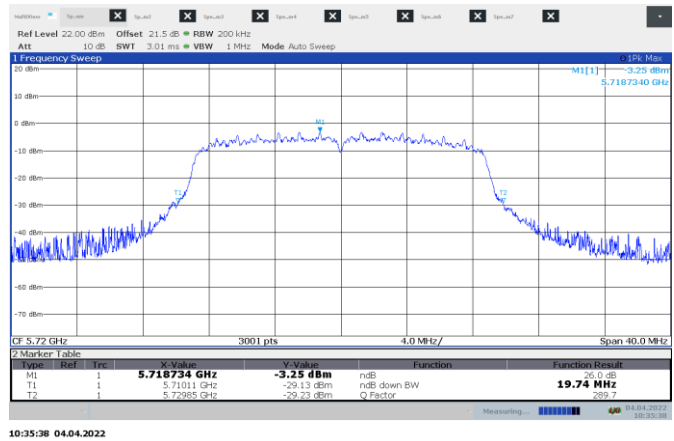


Figure 8.3-2: 26 dB bandwidth on 802.11n VHT20, sample plot

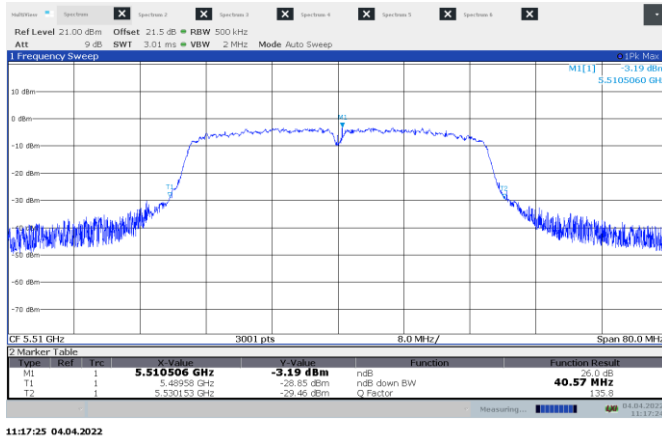


Figure 8.3-3: 26 dB bandwidth on 802.11n VHT40, sample plot

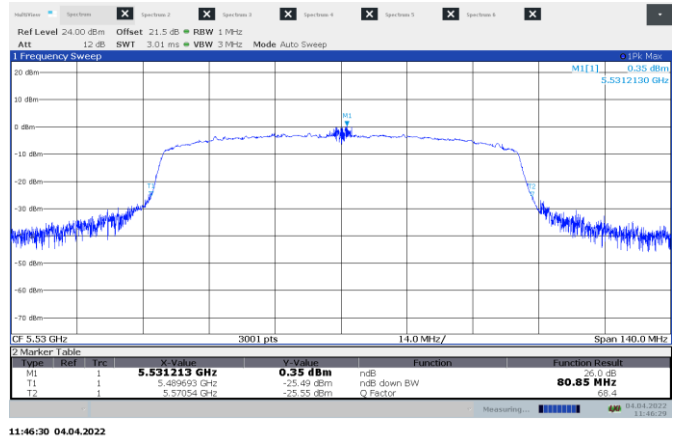


Figure 8.3-4: 26 dB bandwidth on 802.11n VHT80, sample plot

8.4 Occupied bandwidth

8.4.1 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).

8.4.2 Test summary

Verdict	Pass		
Tested by	Tarek Elkholy	Test date	March 17, 2022

8.4.3 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:	$\geq 1\%$ of span
Video bandwidth:	$\geq 3 \times \text{RBW}$
Detector mode:	Peak
Trace mode:	Max Hold

8.4.4 Test data

Table 8.4-1: 99% bandwidth results

Modulation	Frequency, MHz	99% bandwidth, MHz
802.11a	5500	16.5
	5600	16.6
	5700	16.5
	5720	16.5

Table 8.4-2: 99% bandwidth results

Modulation	Frequency, MHz	99% bandwidth, MHz
802.11ac VHT20	5500	17.6
	5600	17.6
	5700	17.5
	5720	17.5

Test data, continued

Table 8.4-3: 99% bandwidth results

Modulation	Frequency, MHz	99% bandwidth, MHz
802.11ac VHT40	5510	35.9
	5590	36.0
	5670	36.0
	5710	36.0

Table 8.4-4: 99% bandwidth results

Modulation	Frequency, MHz	99% bandwidth, MHz
802.11ac VHT80	5530	74.5
	5610	74.6
	5690	74.5

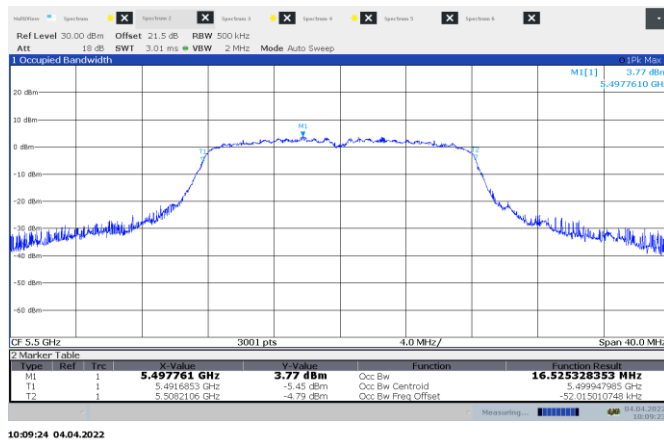


Figure 8.4-1: 99% bandwidth on 802.11a, sample plot

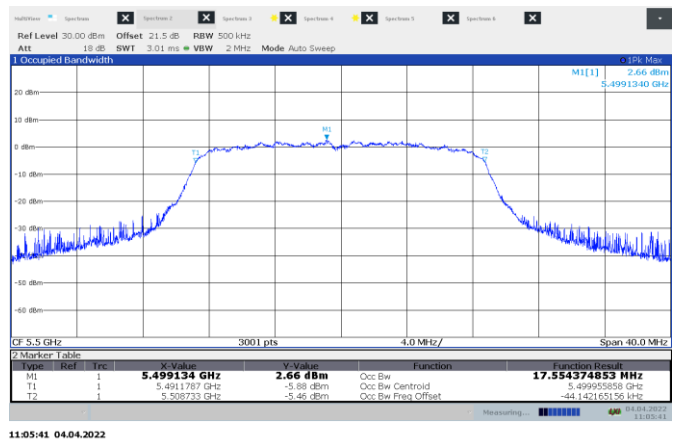


Figure 8.4-2: 99% bandwidth on 802.11ac VHT20, sample plot

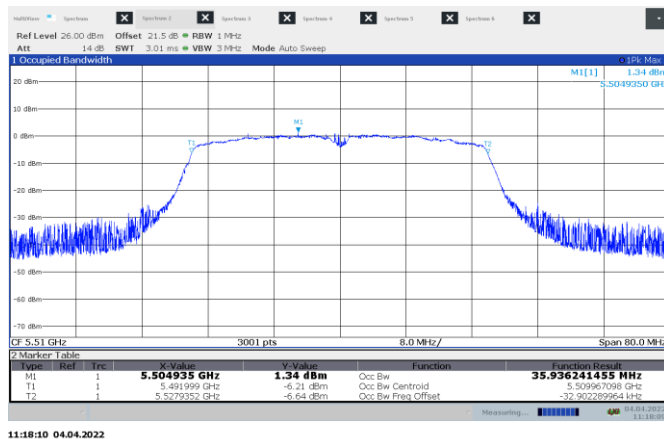


Figure 8.4-3: 99% bandwidth on 802.11ac VHT40, sample plot

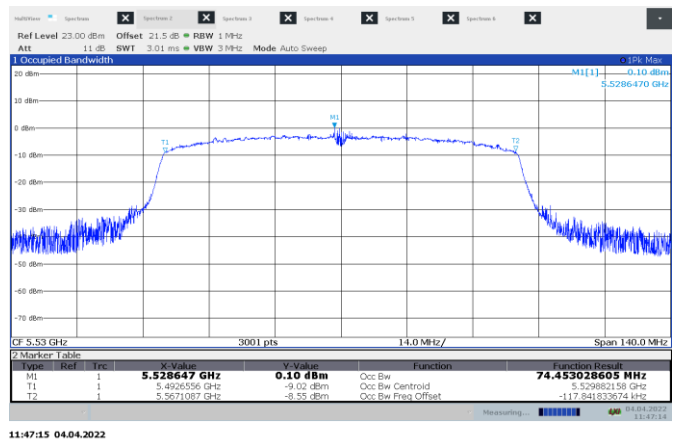


Figure 8.4-4: 99% bandwidth on 802.11ac VHT80, sample plot

8.5 Transmitter output power and e.i.r.p. requirements for 5470–5725 MHz band

8.5.1 References, definitions and limits

FCC §15.407:

- (a) Power limits:
- (2) For the 5.25–5.35 GHz and 5.47–5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. 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.

6.2.3 Frequency bands 5470–5600 MHz and 5650–5725 MHz

Until further notice, devices subject to this section shall not be capable of transmitting in the band 5600–5650 MHz. This restriction is for the protection of Environment Canada's weather radars operating in this band.

6.2.3.1 Power limits

The maximum conducted output power shall not exceed 250 mW or 11 + 10 log₁₀B, dBm, whichever is less. The power spectral density shall not exceed 11 dBm in any 1.0 MHz band.

The maximum e.i.r.p. shall not exceed 1.0 W or 17 + 10 log₁₀B, dBm, whichever is less. B is the 99% emission bandwidth in megahertz. Note that devices with a maximum e.i.r.p. greater than 500 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

8.5.2 Test summary

Verdict	Pass		
Tested by	Tarek Elkholy	Test date	April 4, 2022

8.5.3 Observations, settings and special notes

The maximum measured emission bandwidth for 802.11a was 19.2 MHz, for 802.11ac VHT20 was 19.8 MHz, for 802.11ac VHT40 was 40.8 MHz and for 802.11ac VHT80 was 81.1 MHz

FCC output power limit for 802.11a was calculated as follows: $11 \text{ dBm} + 10 \times \log_{10}(19.2) = 23.8 \text{ dBm} > 23 \text{ dBm}$, therefore the limit is 23 dBm

FCC output power limit for 802.11ac VHT20 was calculated as follows: $11 \text{ dBm} + 10 \times \log_{10}(19.8) = 23.9 \text{ dBm} > 23 \text{ dBm}$, therefore the limit is 23 dBm

FCC output power limit for 802.11ac VHT40 was calculated as follows: $11 \text{ dBm} + 10 \times \log_{10}(40.8) = 27.1 \text{ dBm} > 23 \text{ dBm}$, therefore the limit is 23 dBm

FCC output power limit for 802.11ac VHT80 was calculated as follows: $11 \text{ dBm} + 10 \times \log_{10}(81.1) = 30.1 \text{ dBm} > 23 \text{ dBm}$, therefore the limit is 23 dBm

The maximum measured 99 % occupied bandwidth for 802.11a was 16.6 MHz, for 802.11ac VHT20 was 17.6 MHz, for 802.11ac VHT40 was 36 MHz and for 802.11ac VHT80 was 74.6 MHz

IC output power limit for 802.11a was calculated as follows: $11 + 10 \times \log_{10}(16.6) = 23.2 \text{ dBm} > 23 \text{ dBm}$, therefore the limit is 23 dBm

IC output power limit for 802.11ac VHT20 was calculated as follows: $11 + 10 \times \log_{10}(17.6) = 23.5 \text{ dBm} > 23 \text{ dBm}$, therefore the limit is 23 dBm

IC output power limit for 802.11ac VHT40 was calculated as follows: $11 + 10 \times \log_{10}(36) = 26.6 \text{ dBm} > 23 \text{ dBm}$, therefore the limit is 23 dBm

IC output power limit for 802.11ac VHT80 was calculated as follows: $11 + 10 \times \log_{10}(74.6) = 29.7 \text{ dBm} > 23 \text{ dBm}$, therefore the limit is 23 dBm

IC EIRP limit for 802.11a was calculated as follows: $17 + 10 \times \log_{10}(16.6) = 29.2 \text{ dBm} < 30 \text{ dBm}$

IC EIRP limit for 802.11ac VHT20 was calculated as follows: $17 + 10 \times \log_{10}(17.6) = 29.5 \text{ dBm} < 30 \text{ dBm}$

IC EIRP limit for 802.11ac VHT40 was calculated as follows: $17 + 10 \times \log_{10}(36) = 32.6 \text{ dBm} > 30 \text{ dBm}$, therefore the limit is 30 dBm

IC EIRP limit for 802.11ac VHT80 was calculated as follows: $17 + 10 \times \log_{10}(74.6) = 35.7 \text{ dBm} > 30 \text{ dBm}$, therefore the limit is 30 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 SA-2 or SA-2 Alternative (averaging across on and off times of the EUT transmissions, followed by duty cycle correction).

Spectrum analyser settings:

Resolution bandwidth	1 MHz
Video bandwidth	$\geq 3 \text{ MHz}$
Frequency span	Enough to encompass the entire 26 dB EBW or 99% OBW of the signal
Detector mode	RMS
Trace mode	Max Hold
Power aggregation	Over 26 dB EBW or 99% OBW

8.5.4 Test data

Table 8.5-1: Output power measurements results for FCC

Modulation	Frequency, MHz	Conducted output power, dBm	Power limit, dBm	Margin, dB
802.11a	5500	9.7	23.0	13.3
	5600	10.6	23.0	12.4
	5700	9.4	23.0	13.6
	5720	6.6	23.0	16.4
802.11ac VHT20	5500	8.3	23.0	14.7
	5600	9.7	23.0	13.3
	5700	7.4	23.0	15.6
	5720	6.0	23.0	17.0
802.11ac VHT40	5510	6.2	23.0	16.8
	5590	9.1	23.0	13.9
	5670	9.2	23.0	13.8
	5710	5.8	23.0	17.2
802.11ac VHT80	5530	5.7	23.0	17.3
	5610	8.2	23.0	14.8
	5690	5.6	23.0	17.4

Note: The conducted power levels are corrected to the relevant DCCF.

Table 8.5-2: Output power measurements and EIRP calculations results for ISSED

Modulation	Frequency, MHz	Conducted output power, dBm	Conducted output power limit, dBm	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	Margin, dB
802.11a	5500	9.7	23.0	-2.1	7.6	29.2	21.6
	5600	10.6	23.0	-2.1	8.5	29.2	20.7
	5700	9.4	23.0	-2.1	7.3	29.2	21.9
	5720	6.6	23.0	-2.1	4.5	29.2	24.7
802.11ac VHT20	5500	8.3	23.0	-2.1	6.2	29.5	23.3
	5600	9.7	23.0	-2.1	7.6	29.5	21.9
	5700	7.4	23.0	-2.1	5.3	29.5	24.2
	5720	6.0	23.0	-2.1	3.9	29.5	25.6
802.11ac VHT40	5510	6.2	23.0	-2.1	4.1	30.0	25.9
	5590	9.1	23.0	-2.1	7.0	30.0	23.0
	5670	9.2	23.0	-2.1	7.1	30.0	22.9
	5710	5.8	23.0	-2.1	3.7	30.0	26.3
802.11ac VHT80	5530	5.7	23.0	-2.1	3.6	30.0	26.4
	5610	8.2	23.0	-2.1	6.1	30.0	23.9
	5690	5.6	23.0	-2.1	3.5	30.0	26.5

Note: The conducted power levels are corrected to the relevant DCCF.

Frequency range 5600-5650 MHz is not permitted in Canada.

Test data, continued

Table 8.5-3: PSD measurements results

Modulation	Frequency, MHz	PPSD, dBm/MHz	PPSD limit, dBm/MHz	Margin, dB
802.11a	5500	-1.4	11.0	12.4
	5600	1.2	11.0	9.8
	5700	-1.5	11.0	12.5
	5720	-4.2	11.0	15.2
802.11ac VHT20	5500	-3.3	11.0	14.3
	5600	2.4	11.0	8.6
	5700	-3.9	11.0	14.9
	5720	-5.0	11.0	16.0
802.11ac VHT40	5510	-8.1	11.0	19.1
	5590	-5.1	11.0	16.1
	5670	-5.1	11.0	16.1
	5710	-8.8	11.0	19.8
802.11ac VHT80	5530	-12.1	11.0	23.1
	5610	-9.3	11.0	20.3
	5690	-12.3	11.0	23.3

Note: The PSD levels are corrected to the relevant DCCF.

Test data, continued

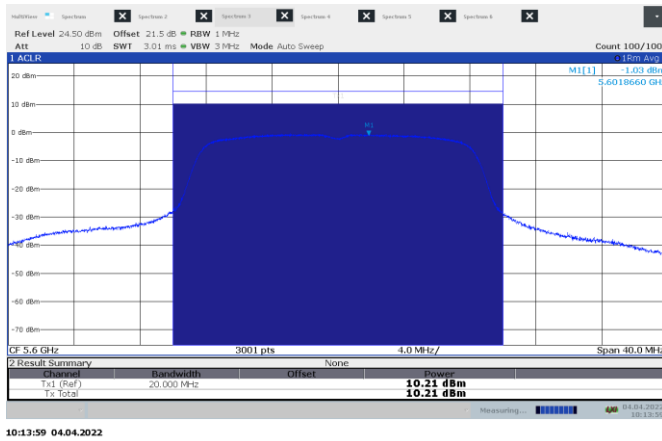


Figure 8.5-1: Sample plot for power on 802.11a

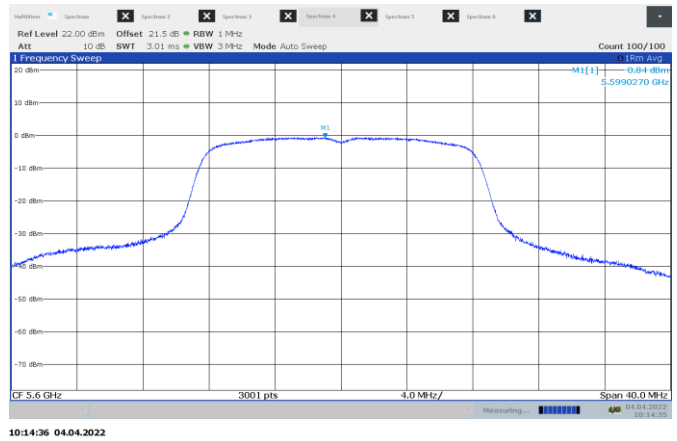


Figure 8.5-2: Sample plot for PSD on 802.11a

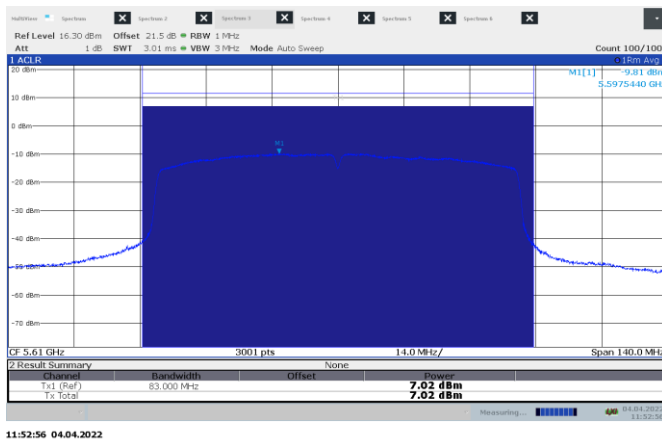


Figure 8.5-3: Sample plot for power on 802.11ac VHT80

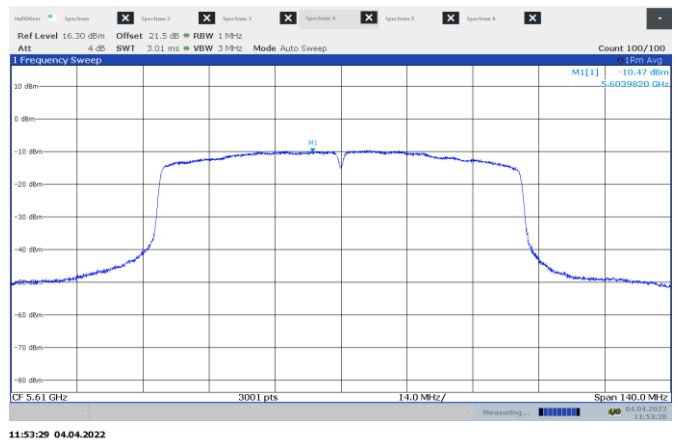


Figure 8.5-4: Sample plot for PSD on 802.11ac VHT80

8.6 Spurious unwanted (undesirable) emissions

8.6.1 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:
- (3) For transmitters operating in the 5.47–5.725 GHz band: All emissions outside of the 5.47–5.725 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.

6.2.3 Frequency bands 5470–5600 MHz and 5650–5725 MHz

Until further notice, devices subject to this section shall not be capable of transmitting in the band 5600–5650 MHz. This restriction is for the protection of Environment Canada's weather radars operating in this band.

6.2.3.2 Unwanted emission limits

Emissions outside the band 5470–5725 MHz shall not exceed –27 dBm/MHz e.i.r.p. However, devices with bandwidth overlapping the band edge of 5725 MHz can meet the emission limit of –27 dBm/MHz e.i.r.p. at 5850 MHz instead of 5725 MHz.

Table 8.6-1: FCC §15.209 and RSS-Gen – Radiated emission limits

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

Notes: In the emission table above, the tighter limit applies at the band edges.
 For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.

References, definitions and limits, continued

Table 8.6-2: ISED restricted frequency bands

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

Note: Certain frequency bands listed in Table 8.6-2 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 8.6-3: 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			

8.6.2 Test summary

Verdict	Pass		
Tested by	Tarek Elkholy	Test date	April 4, 2022

8.6.3 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.
- Radiated measurements were performed at a distance of 3 m, except for the 18-40 GHz scan it was performed at 1 m distance.
- The spurious emission was tested per ANSI C63.10, Clause 12.7 and 789033 D02, Clause II(G).
- All emissions noticed in 740-881 MHz are not related to the EUT.

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

Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	Average
Trace mode:	Max Hold

8.6.4 Test data

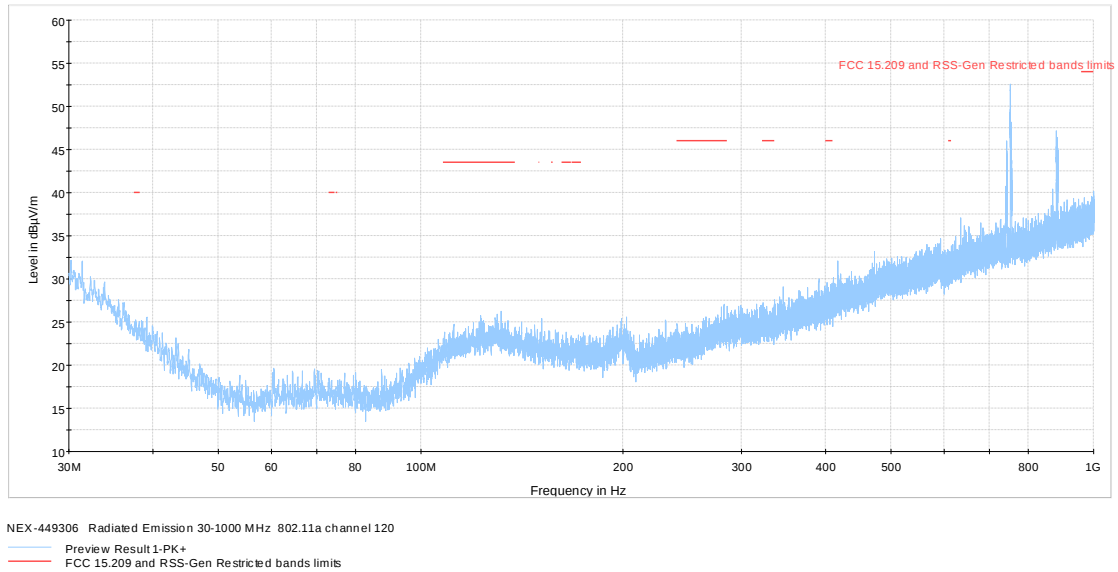


Figure 8.6-1: Sample plot, radiated spurious emissions 30-1000 MHz on 802.11a ch 120

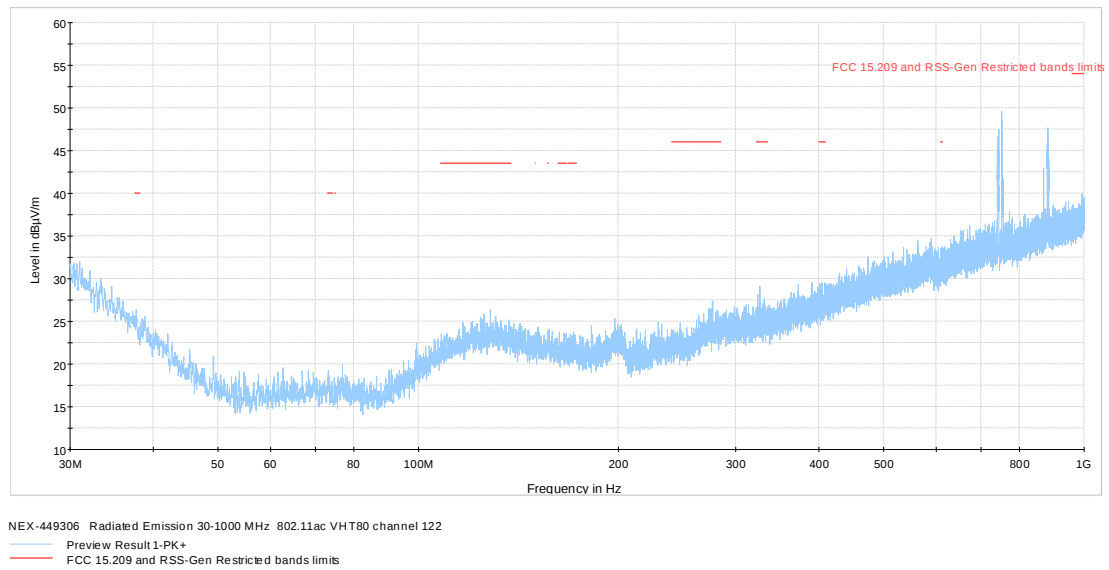
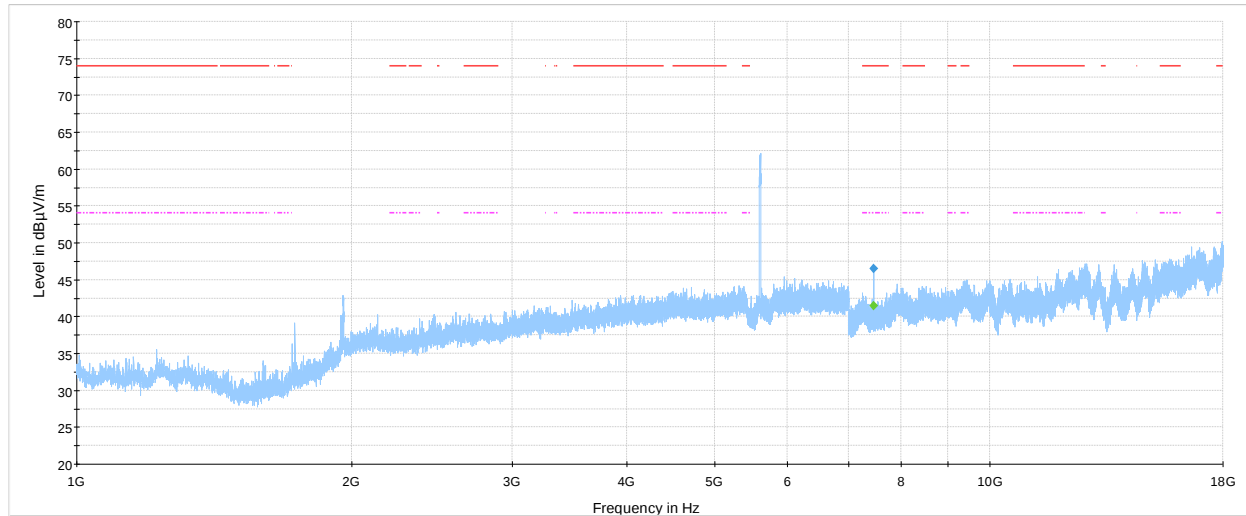


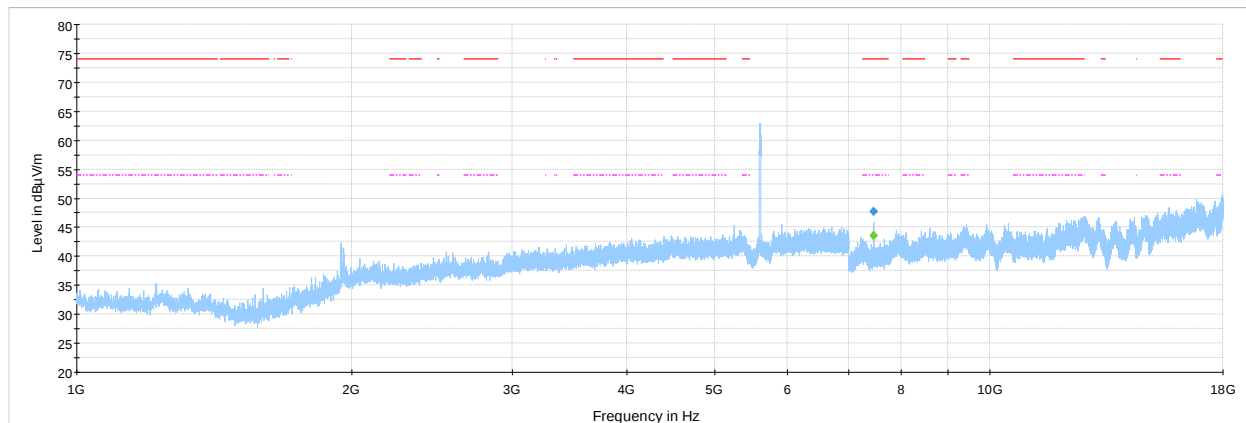
Figure 8.6-2: Sample plot, radiated spurious emissions 30-1000 MHz on 802.11ac VHT80 ch 122

Test data, continued



NEX-449306 Radiated Emission 1-18 GHz, 802.11a channel 120
 Preview Result 1-PK+
 FCC 15.209 and RSS-Gen Restricted bands peak limits
 FCC 15.209 and RSS-Gen Restricted bands average limits
 Final_Result PK+
 Final_Result CAV

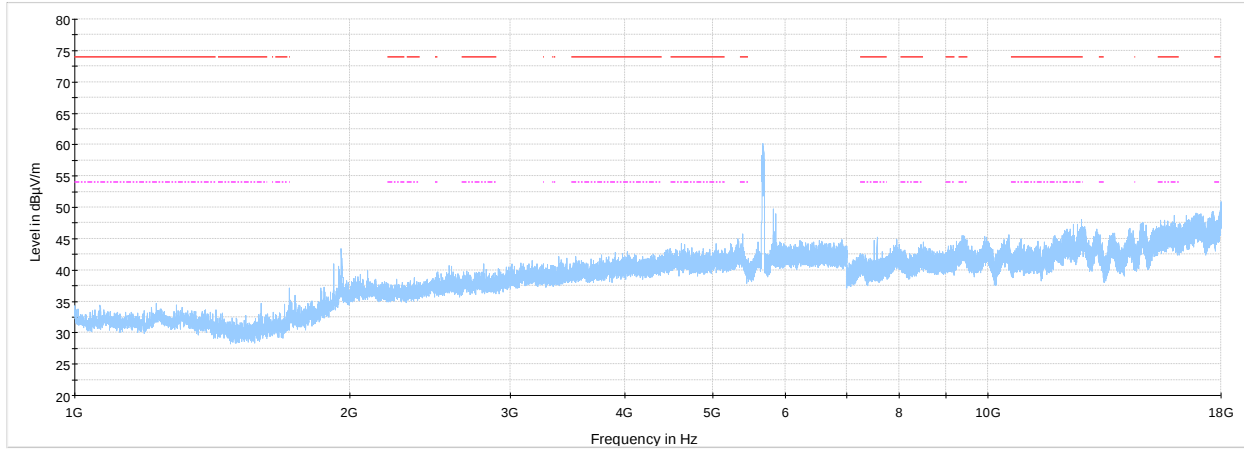
Figure 8.6-3: Sample plot, radiated spurious emissions 1-18 GHz on 802.11a ch 120



NEX-449306 Radiated Emission 1-18 GHz, 802.11ac VHT20 channel 120
 Preview Result 1-PK+
 FCC 15.209 and RSS-Gen Restricted bands peak limits
 FCC 15.209 and RSS-Gen Restricted bands average limits
 Final_Result PK+
 Final_Result CAV

Figure 8.6-4: Sample plot, radiated spurious emissions 1-18 GHz on 802.11ac VHT20 ch 120

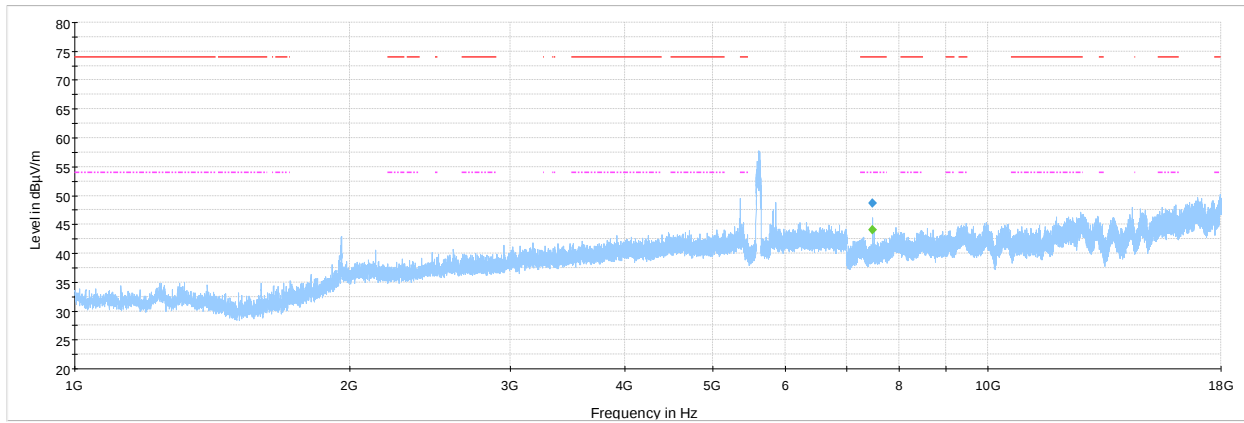
Test data, continued



NEX-449306 Radiated Emission 1-18 GHz, 802.11ac VHT40 channel 134

— Preview Result 1-PK+
 --- FCC 15.209 and RSS-Gen Restricted bands peak limits
 FCC 15.209 and RSS-Gen Restricted bands average limits

Figure 8.6-5: Sample plot, radiated spurious emissions 1-18 GHz on 802.11ac VHT40 ch 134

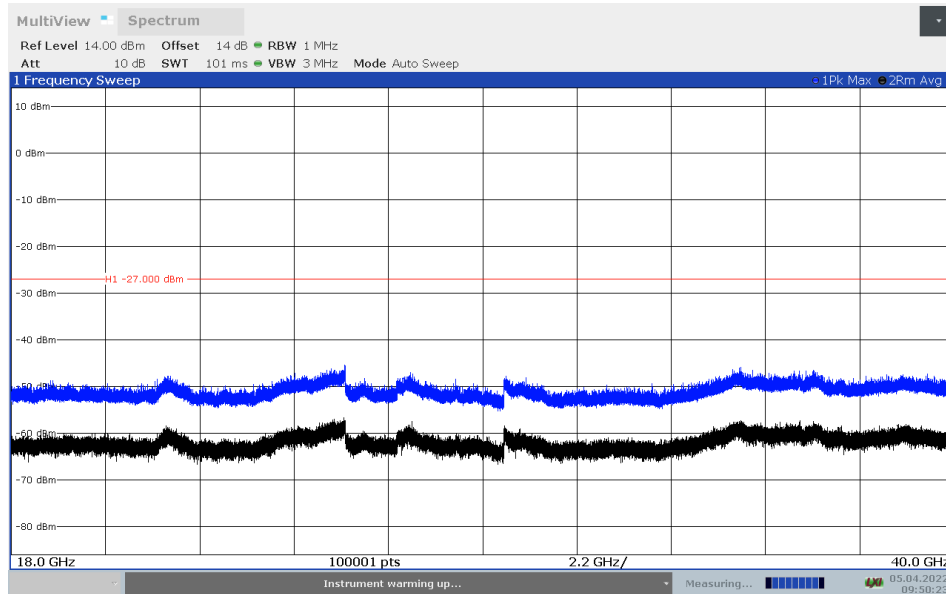


NEX-449306 Radiated Emission 1-18 GHz, 802.11ac VHT80 channel 122

— Preview Result 1-PK+
 --- FCC 15.209 and RSS-Gen Restricted bands peak limits
 FCC 15.209 and RSS-Gen Restricted bands average limits
 ◆ Final_Result PK+
 ◆ Final_Result CAV

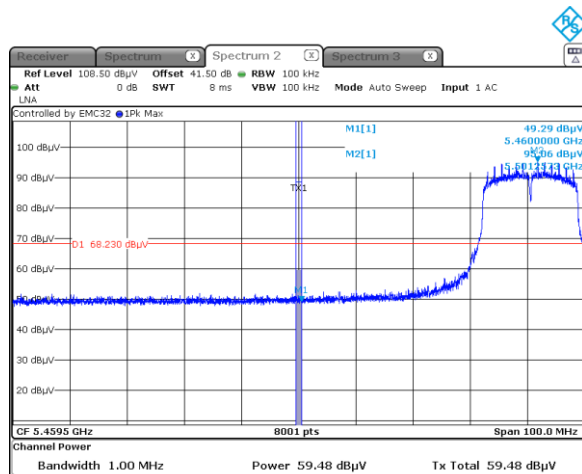
Figure 8.6-6: Sample plot, radiated spurious emissions 1-18 GHz on 802.11ac VHT80 ch 122

Test data, continued



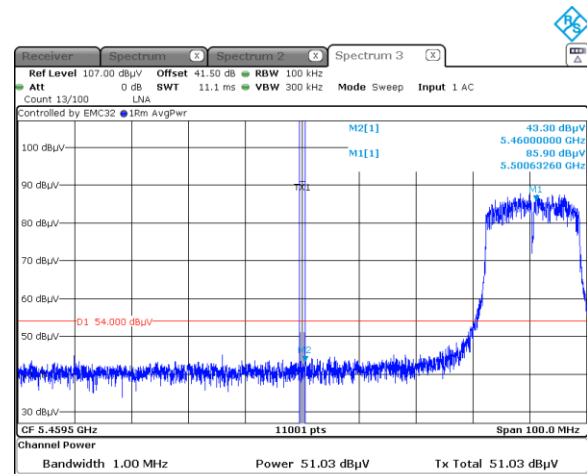
09:50:23 05.04.2022

Figure 8.6-7: Sample plot, radiated spurious emissions 18-40 GHz on 802.11a ch 120



Date: 4 APR 2022 19:49:49

Figure 8.6-8: Radiated band edge 802.11a ch.100 Peak



Date: 4 APR 2022 19:48:56

Figure 8.6-9: Radiated band edge 802.11a ch.100 Average

Test data, continued

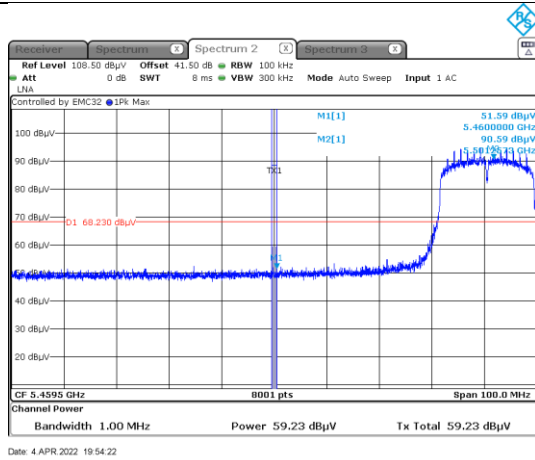


Figure 8.6-10: Radiated band edge 802.11ac VHT20 ch.100 Peak

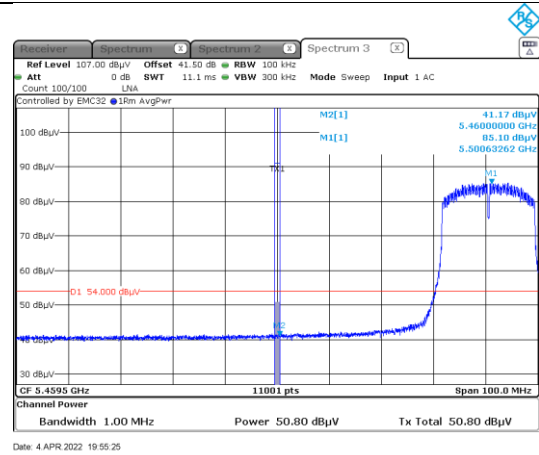


Figure 8.6-11: Radiated band edge 802.11ac VHT20 ch.100 Average

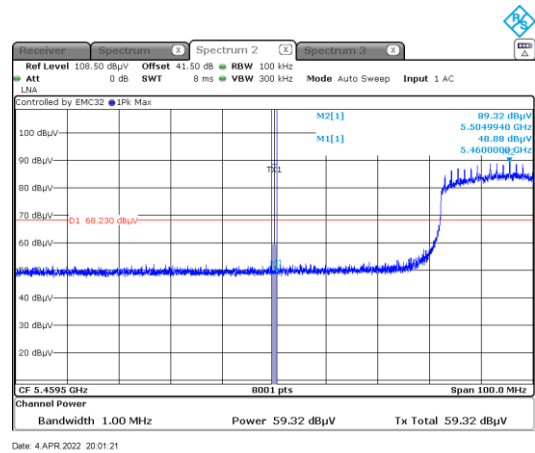


Figure 8.6-12: Radiated band edge 802.11ac VHT40 ch.102 Peak

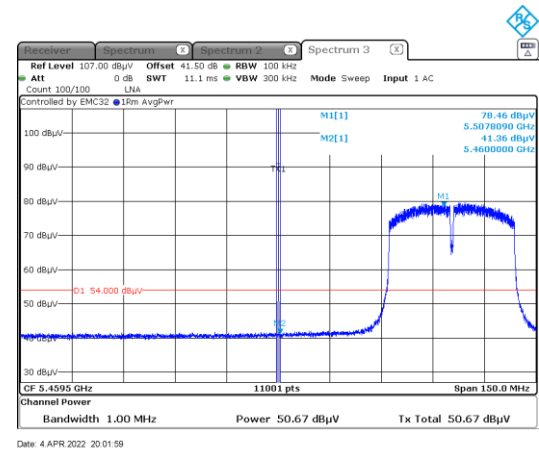


Figure 8.6-13: Radiated band edge 802.11ac VHT40 ch.102 Average

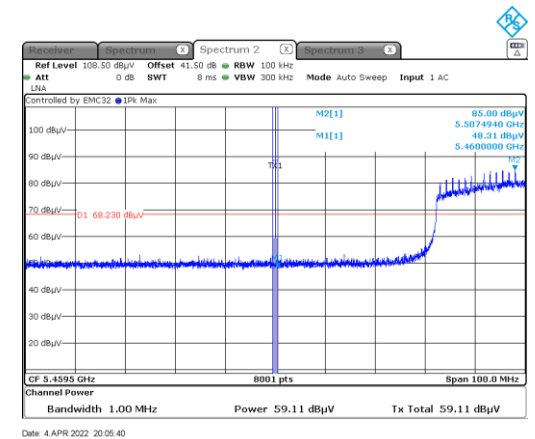


Figure 8.6-14: Radiated band edge 802.11ac VHT80 ch.106 Peak

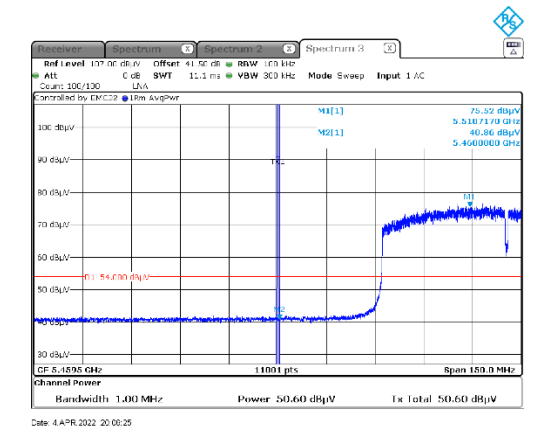


Figure 8.6-15: Radiated band edge 802.11ac VHT80 ch.106 Average

End of the test report