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RADIO TEST REPORT – 431080-2R3TRFWL

Type of assessment:
Final product testing

Applicant:
Carestream Health, Inc.

Product name (type):
DRX Core 3543C

Model:
2272233012

Model Variants:
DRX Plus 3543, 2272233001, 2272233002, 2272233101, 2272233102, 2272233011, 2272233111, 2272233112

FCC ID:
U72DRXPSLV2

IC ID:
7027A-DRXPSLV2

Specifications:

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

Date of issue: June 8, 2021

Mark Libbrecht, Wireless/EMC Specialist	Mark Libbrecht
Tested by	Signature
Andrey Adelberg, Senior EMC/RF Specialist	Adelberg
Reviewed by	Signature

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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
662911 D01 Multiple Transmitter Output v02r01 (October 31, 2013)	Emissions Testing of Transmitters with Multiple Outputs in the Same Band
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	April 19, 2021	Original report issued
R1TRF	May 10, 2021	Product information updated section 5.3 and 5.4
R2TRF	May 26, 2021	Product model number information updated section 5.3 and cover page
R3TRF	June 8, 2021	Update output power measurements using correct system settings. Sections updated – 5.4, 5.5.1, 8.7.4.

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

Emissions were maximized with the EUT in X,Y and Z orientations. Y orientation was found to have the greatest transmit power as displayed in setup photos.
These detectors are all built with the exact same radios, antennas, housing, and core plates.
The differences are in the size (3543 vs. 4343), the x-ray scintillator (CsI vs. GOS), and the shielding (HPX uses tungsten, all others use lead).

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	Carestream Health, Inc.
Applicant address	1049 W. Ridge Road, Rochester, NY 14615, United States
Manufacture name	Same as applicant
Manufacture address	Same as applicant

5.3 EUT information

Product	DRX Core 3543C
Model	2272233012
Model variant(s)	DRX Plus 3543, 2272233001, 2272233002, 2272233101, 2272233102, 2272233011, 2272233111, 2272233112
Serial number	184830120793
Part number	None
Power supply requirements	Battery: 14.8 V(DC)
Product description and theory of operation	The Carestream detector (EUT) is used to capture radiographic images of human anatomy for display. The detector captures the XRay levels with its sensors and provides them to a networked client for display. The Carestream detectors (EUT) operate in typical hospital settings. The detector connects to a client over Ethernet or WIFI networks. The detector is powered by battery or a tether connection which also is providing the Ethernet connection. The detector is using the Linux operating system as a platform for its embedded firmware. The embedded firmware uses the open source settings to meet all external network requirements.

5.4 Radio technical information

Applicant IC company number	7027A
IC UPN number	DRXPSLV2
All used IC test site(s) Reg. number	24676
RSS number and Issue number	RSS-247 Issue 2, Feb 2017
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)	5180
Frequency Max (MHz)	5240
Channel numbers	36–48
RF power Max (W), Conducted	802.11a: 0.0178 (12.5 dBm) @ 5200 MHz 802.11ac: 0.0174 (12.4 dBm) @ 5200 MHz
Field strength, dBµV/m @ 3 m	N/A
Measured BW (kHz), 99% OBW	802.11a: 16.5 MHz 802.11ac: 17.6 MHz
Type of modulation	802.11a/ac: OFDM (QPSK, BPSK, 16-QAM, 64-QAM)
Emission classification	W7D
Transmitter spurious, dBµV/m @ 3 m	50.4 dBµV/m (Average), @ 5150 MHz
Antenna information	2 × 2 MIMO, Uncorrelated antennas (90° phase shift) type: PCB trace antenna, manufacturer: Carestream Health Inc., model: None, Gain: 1.2 dBi (Peak)

5.5 EUT setup details

5.5.1 Radio exercise details

Operating conditions	Detector firmware version: 91.25.10.79.26.05
Transmitter state	Transmitter set in to continuous transmit mode. Power setting used for all measurements = 44 802.11a data rate set to 54M 802.11ac data rate set to VHT2MCS0
Receiver state	Idle

Table 5.5-1: *EUT sub assemblies*

Description	Brand name	Model, Part number, Serial number, Revision level
DRX Core 3543C Detector	Carestream	MN: 2272233012, PN: None, SN: 184830120793
DRX-1 System battery (rechargeable 14.8 V_{DC})	Inventus Power Mexico	Model: DRX-1 System battery 3, PN: None, SN: 012000093
Service Tether (AC/DC Converter)	LI Tone Electronics Co, LTD.	MN: LTE120E-SW-3, PN: None, SN: 155000281

Table 5.5-2: *EUT interface ports*

Description	Qty.
Magnetic I/O / power port	1

Table 5.5-3: *Support equipment*

Description	Brand name	Model, Part number, Serial number, Revision level
Laptop	Dell Latitude	SN: FA003070, MN: E6440

Table 5.5-4: *Inter-connection cables*

Cable description	From	To	Length (m)
Magnetic I/O / power port	EUT	Service tether charger port/ Ethernet port	> 1
Ethernet	Service Tether cable	PC	1
AC mains	AC/DC Converter	AC mains	> 1

EUT setup configuration, continued

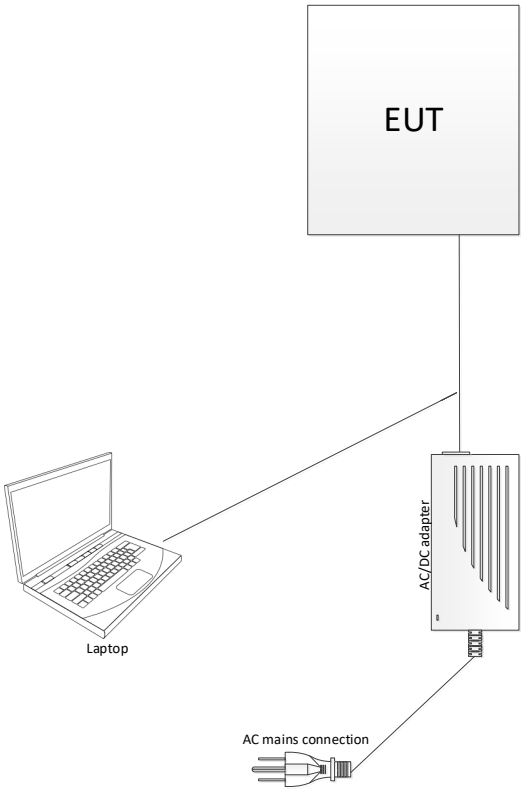


Figure 5.5-1: *Radiated testing block diagram*

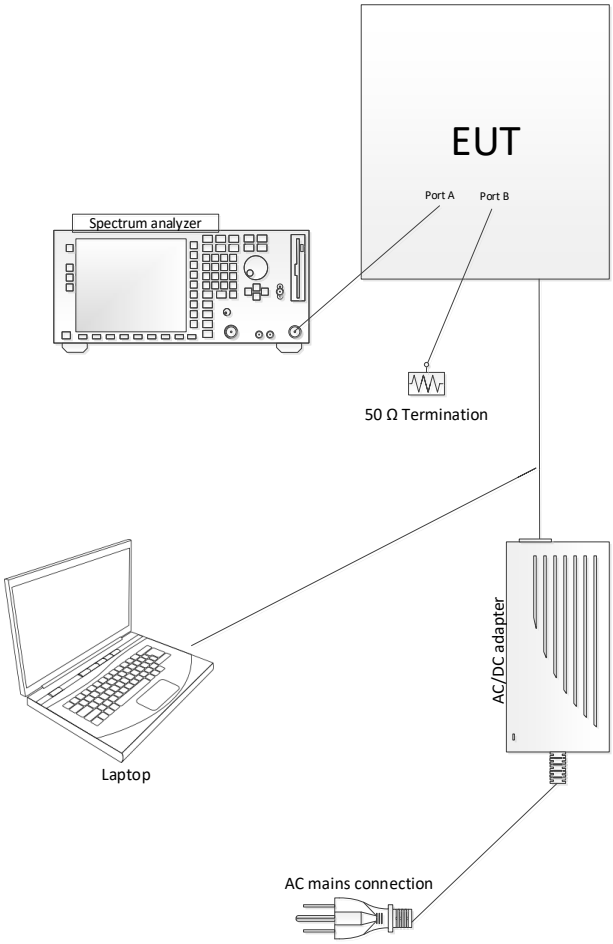


Figure 5.5-2: *Antenna port testing block diagram*

Section 6 Summary of test results

6.1 Testing location

Test location (s)	Cambridge

6.2 Testing period

Test start date	March 5, 2021	Test end date	June 7, 2021

6.3 Sample information

Receipt date	February 24, 2021	Nemko sample ID number(s)	1

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 a battery operated device, the testing was performed using fresh batteries.

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 a battery operated device, the testing was performed using fresh batteries.

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
6.3	Dynamic Frequency Selection (DFS) for devices operating in the bands 5250–5350 MHz, 5470–5600 MHz and 5650–5725 MHz	Not applicable

Notes: [1] The EUT employs digital modulations, such as: 802.11a, 802.11n HT20 and 802.11n HT40

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	April 10, 2021
Flush mount turntable	SUNAR	FM2022	FA003006	—	NCR
Controller	SUNAR	SC110V	FA002976	—	NCR
Antenna mast	SUNAR	TLT2	FA003007	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESR26	FA002969	1 year	November 12, 2021
Spectrum analyzer	Rohde & Schwarz	FSW43	FA002971	1 year	November 13, 2021
Horn antenna (1–18 GHz)	ETS Lindgren	3117	FA002911	1 year	April 11, 2021
Horn antenna (1–18 GHz)	EMCO	3115	FA000649	1 year	January 21, 2022
Preamp (1–18 GHz)	ETS Lindgren	124334	FA002956	1 year	April 5, 2022
Bilog antenna (20–2000 MHz)	Sun AR	JB1	FA003009	1 year	February 2, 2022
Horn antenna (18–40 GHz)	EMCO	3116B	FA002948	1 year	January 22, 2022
50 Ω coax cable	Huber + Suhner	None	FA003047	1 year	December 17, 2021
50 Ω coax cable	Huber + Suhner	None	FA003044	1 year	December 17, 2021
5.15 – 5.35 GHz notch filter	Microwave circuits	N0452501	FA003030	1 year	April 8, 2021
Two-line v-network	Rohde & Schwarz	ENV216	FA002965	1 year	November 30, 2021

Note: NCR - no calibration required

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	Mark Libbrecht	Test date	March 5, 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	Mark Libbrecht	Test date	March 5, 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, 802.11a/ac 20 MHz BW*

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low channel, MHz	Mid channel, MHz	High channel, MHz
5150	5250	100	5180	5200	5240

Note: EUT is limited to operation in 20 MHz bandwidth

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	Mark Libbrecht	Test date	March 5, 2021

8.3.3 Observations, settings and special notes

EUT utilizes 2 × 2 MIMO antenna configuration. EUT antennas are 90° phase shifted (Uncorrelated)

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 Trace Antenna	Carestream Health, Inc.	None	1.2 dBi	U.FL

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	Mark Libbrecht	Test date	March 5, 2021

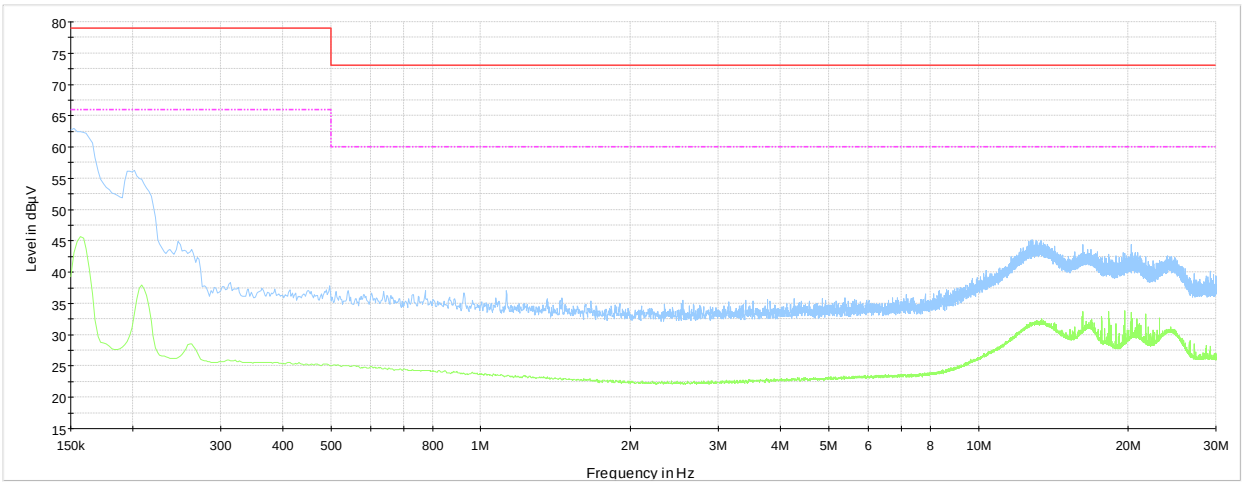
8.4.3 Observations, settings and special notes

Port under test – Coupling device	AC Mains – Artificial Mains Network (AMN)
EUT power input during test	14.8 V_{DC} (via external 100–240 V_{AC}, 50/60 Hz power adapter)
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.

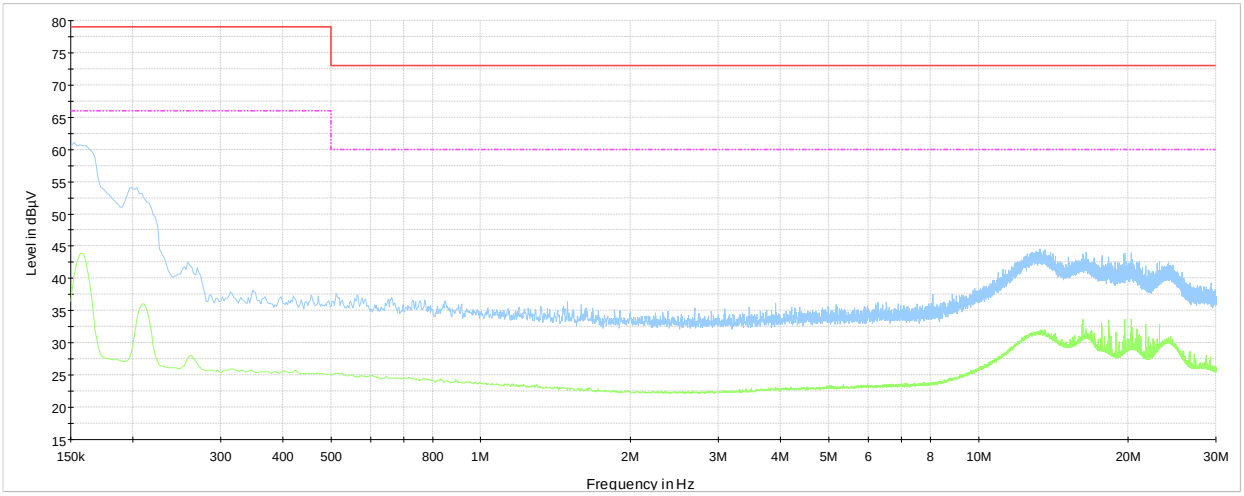
Conducted AC line emissions test was performed as per ANSI C63.10, Clause 6.2. Spectrum analyser settings:

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



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	Mark Libbrecht	Test date	March 5, 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:

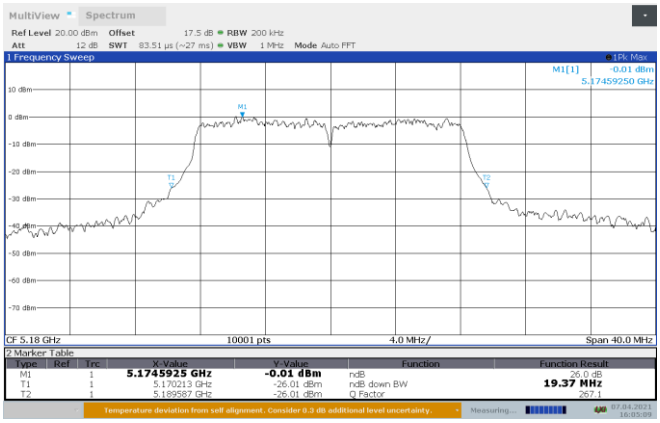
Resolution bandwidth	approximately 1% of the emission bandwidth
Video bandwidth	> RBW
Detector mode	Peak
Trace mode	Max Hold

8.5.4 Test data

Table 8.5-1: *26 dB bandwidth results*

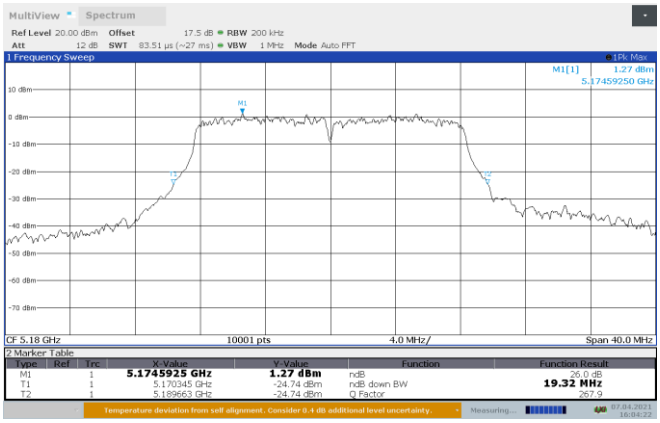
Modulation	Antenna Port	Frequency, MHz	26 dB bandwidth, MHz
802.11a	A	5180	19.4
802.11a	A	5200	19.3
802.11a	A	5240	19.2
802.11a	B	5180	19.3
802.11a	B	5200	19.3
802.11a	B	5240	19.1
802.11ac	A	5180	19.8
802.11ac	A	5200	19.8
802.11ac	A	5240	19.8
802.11ac	B	5180	19.7
802.11ac	B	5200	19.6
802.11ac	B	5240	19.9

Test data, continued



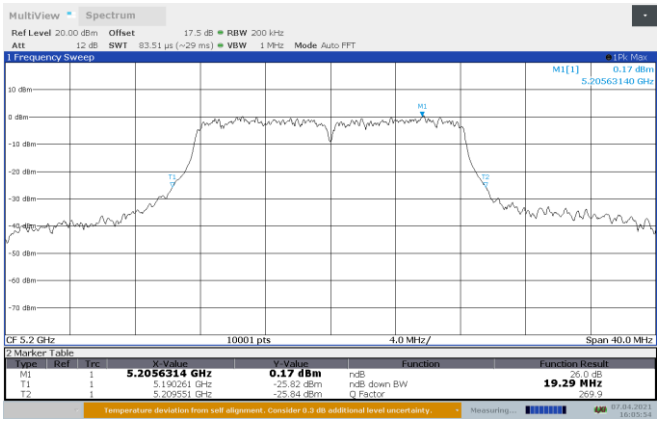
16:05:09 07.04.2021

Figure 8.5-1: *26 dB bandwidth on 802.11a, Low channel Port A*



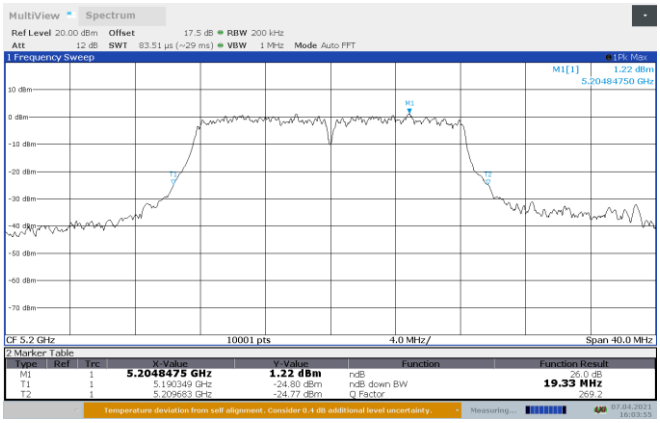
16:04:22 07.04.2021

Figure 8.5-2: *26 dB bandwidth on 802.11a, Low channel Port B*



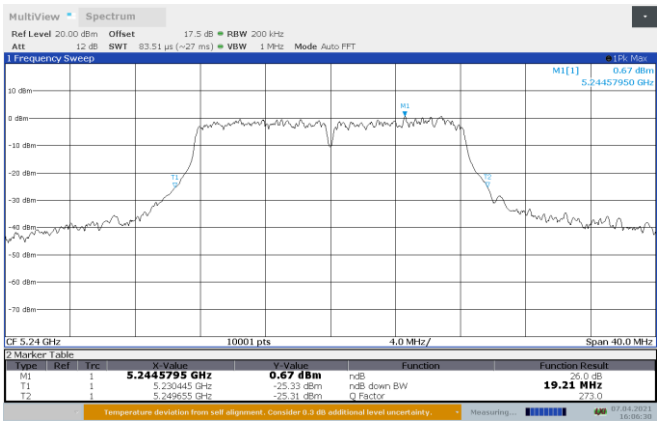
16:05:55 07.04.2021

Figure 8.5-3: *26 dB bandwidth on 802.11a, Mid channel Port A*



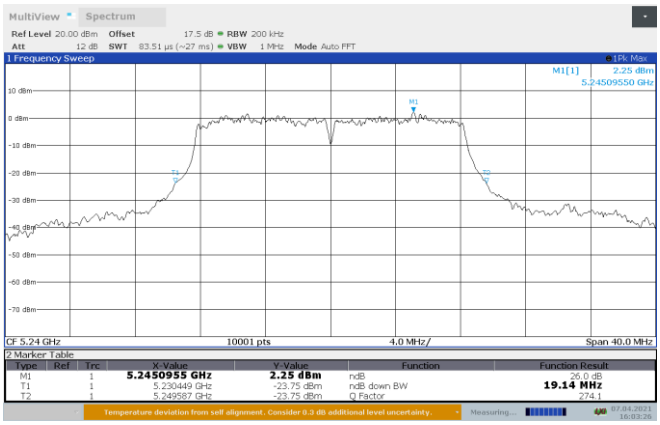
16:03:55 07.04.2021

Figure 8.5-4: *26 dB bandwidth on 802.11a, Mid channel Port B*



16:06:30 07.04.2021

Figure 8.5-5: *26 dB band bandwidth on 802.11a, High channel Port A*



16:03:27 07.04.2021

Figure 8.5-6: *26 dB bandwidth on 802.11a, High channel Port B*

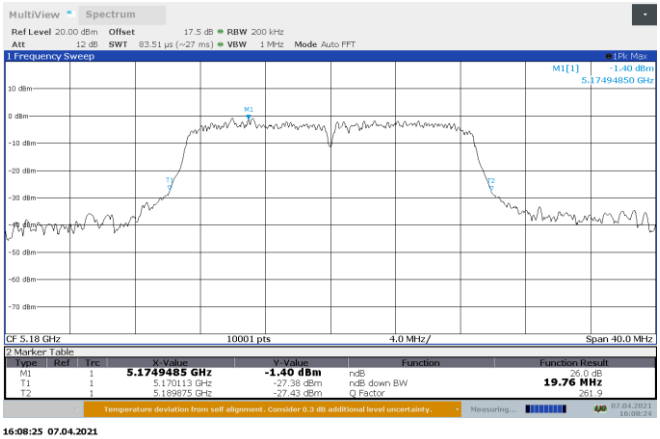


Figure 8.5-7: *26 dB bandwidth on 802.11ac, Low channel Port A*

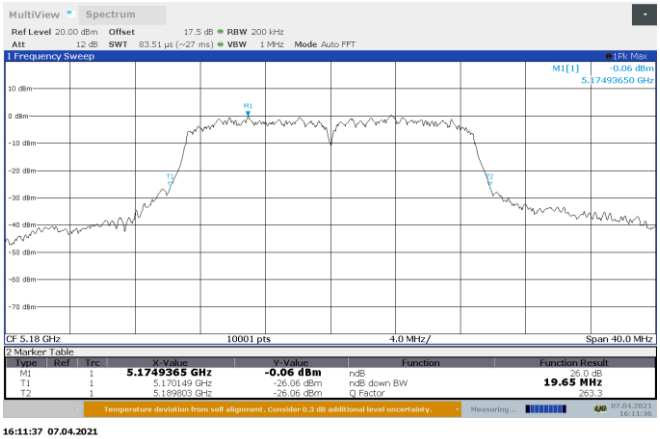


Figure 8.5-8: *26 dB bandwidth on 802.11ac, Low channel Port B*

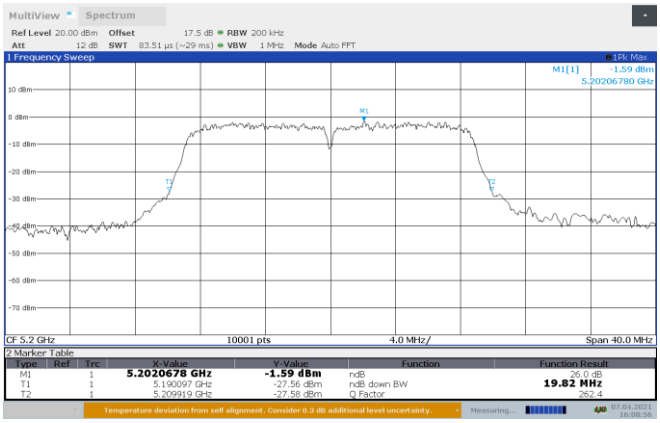


Figure 8.5-9: *26 dB bandwidth on 802.11ac, Mid channel Port A*

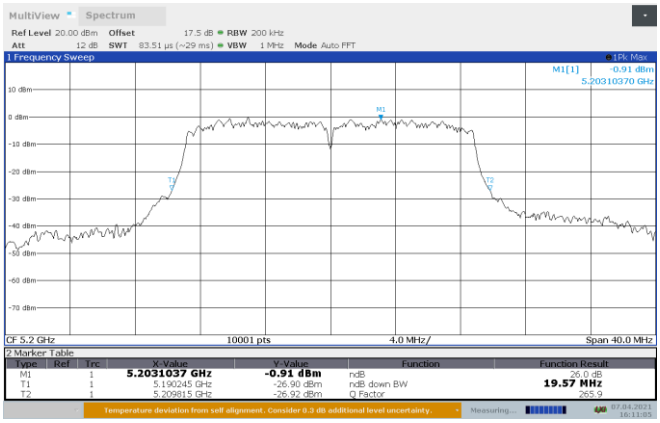


Figure 8.5-10: *26 dB bandwidth on 802.11ac, Mid channel Port B*

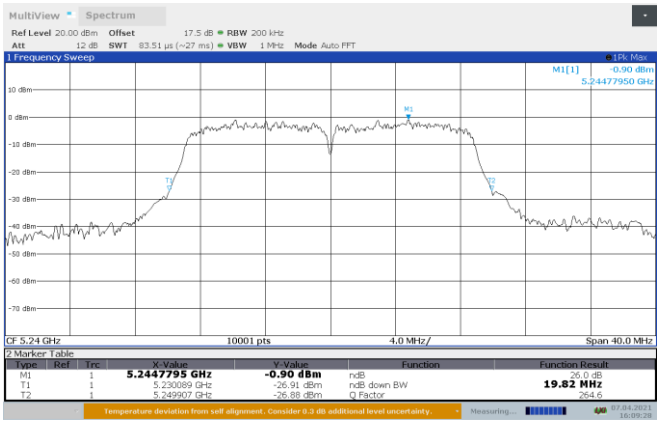


Figure 8.5-11: *26 dB band bandwidth on 802.11ac, High channel Port A*

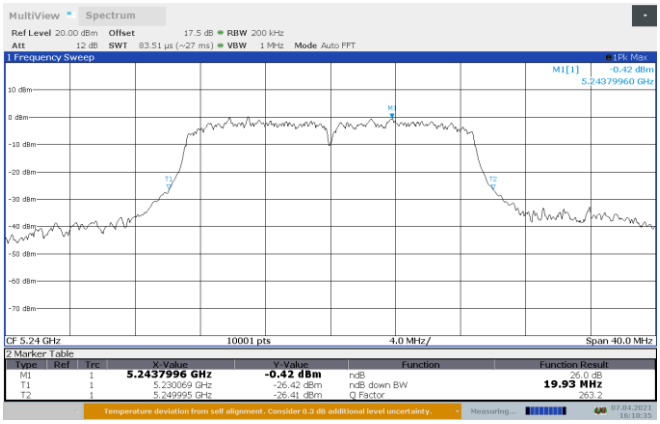


Figure 8.5-12: *26 dB bandwidth on 802.11ac, High channel Port B*

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).

RSS-247, Clause 6..2.1.2:

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.

8.6.2 Test summary

Verdict	Pass		
Tested by	Mark Libbrecht	Test date	March 5, 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 - 5 % OBW
Video bandwidth:	≥3 × RBW
Detector mode:	Peak
Trace mode:	Max Hold

8.6.4 Test data

Table 8.6-1: *99% bandwidth results*

Modulation	Antenna Port	Frequency, MHz	99% bandwidth, MHz
802.11a	A	5180	16.5
802.11a	A	5200	16.5
802.11a	A	5240	16.5
802.11a	B	5180	16.5
802.11a	B	5200	16.5
802.11a	B	5240	16.5
802.11ac	A	5180	17.6
802.11ac	A	5200	17.6
802.11ac	A	5240	17.5
802.11ac	B	5180	17.6
802.11ac	B	5200	17.5
802.11ac	B	5240	17.5

Table 8.6-2: *RSS-247 clause 6.2.1.2 results*

Modulation	Antenna Port	Frequency, MHz	Upper 99% OBW Marker (MHz)	Band edge limit (MHz)	Margin (MHz)
802.11a	A	5240	5248.3	5250	1.7
802.11a	B	5240	5248.3	5250	1.7
802.11ac	A	5240	5248.8	5250	1.2
802.11ac	B	5240	5248.7	5250	1.3

Test data, continued

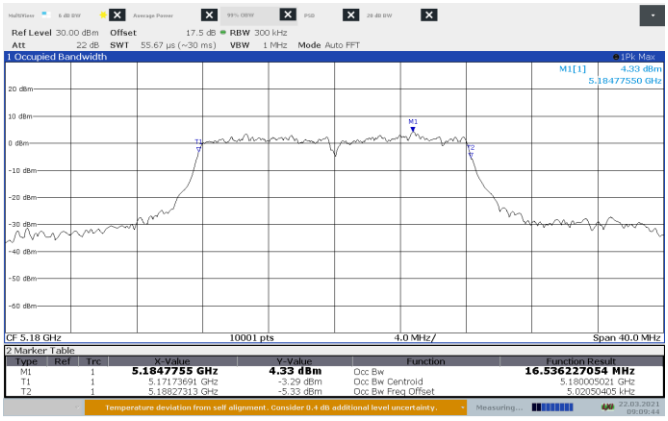


Figure 8.6-1: *99% bandwidth on 802.11a, Low channel Port A*

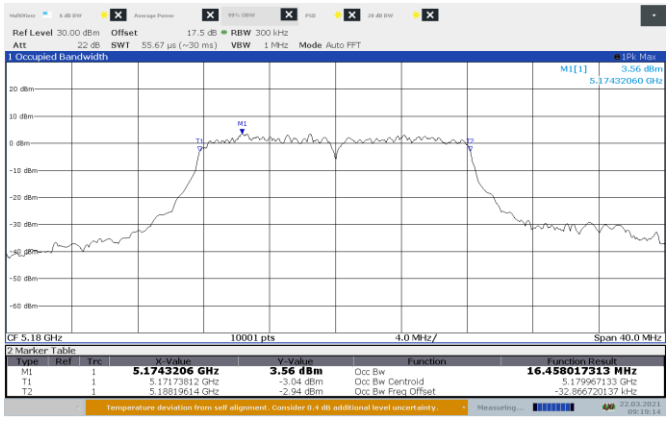


Figure 8.6-2: *99% bandwidth on 802.11a, Low channel Port B*

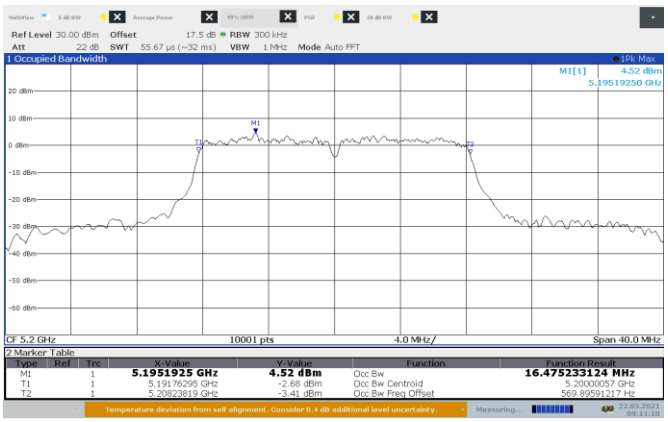


Figure 8.6-3: *99% bandwidth on 802.11a, Mid channel Port A*

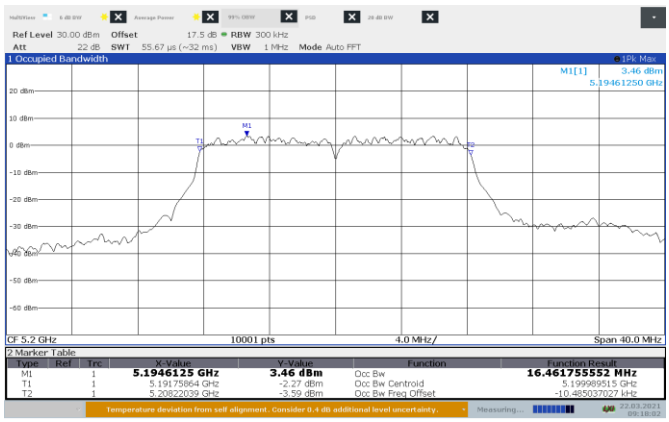


Figure 8.6-4: *99% bandwidth on 802.11a, Mid channel Port B*

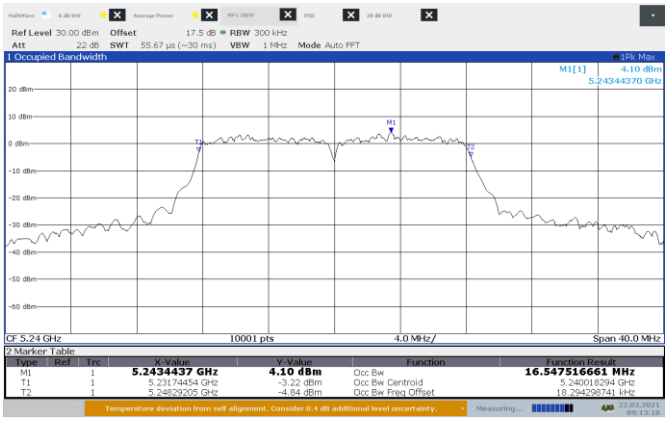


Figure 8.6-5: *99% band bandwidth on 802.11a, High channel Port A*

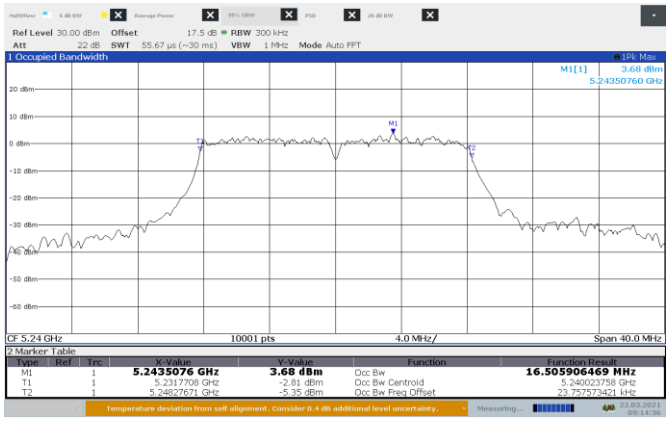


Figure 8.6-6: *99% bandwidth on 802.11a, High channel Port B*

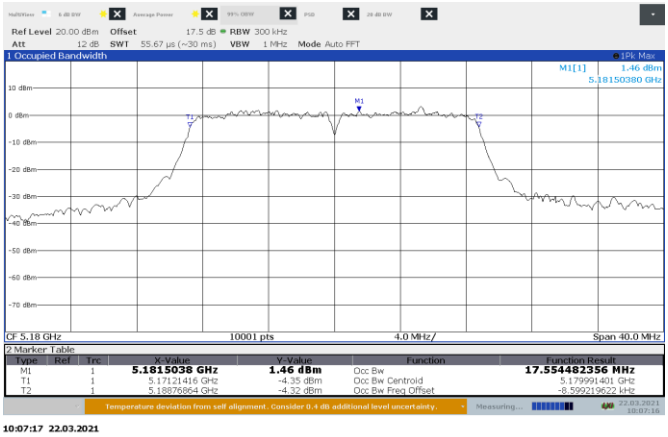


Figure 8.6-7: *99% bandwidth on 802.11ac, Low channel Port A*

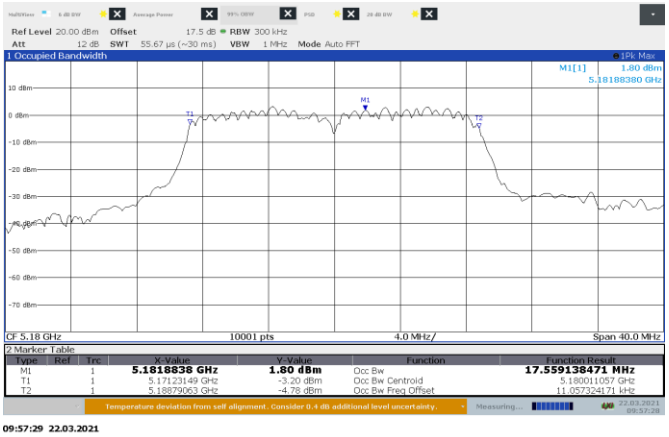


Figure 8.6-8: *99% bandwidth on 802.11ac, Low channel Port B*

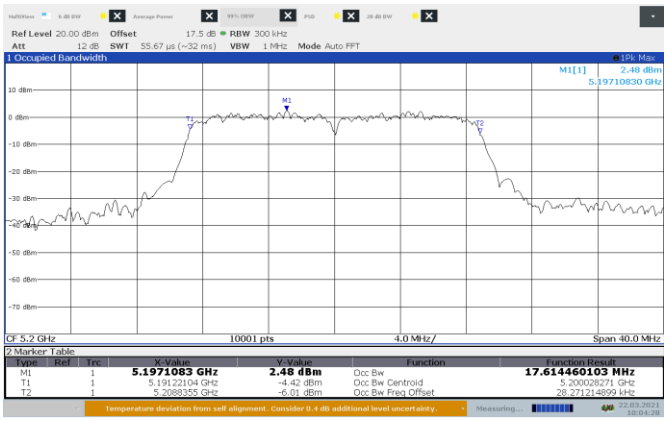


Figure 8.6-9: *99% bandwidth on 802.11ac, Mid channel Port A*

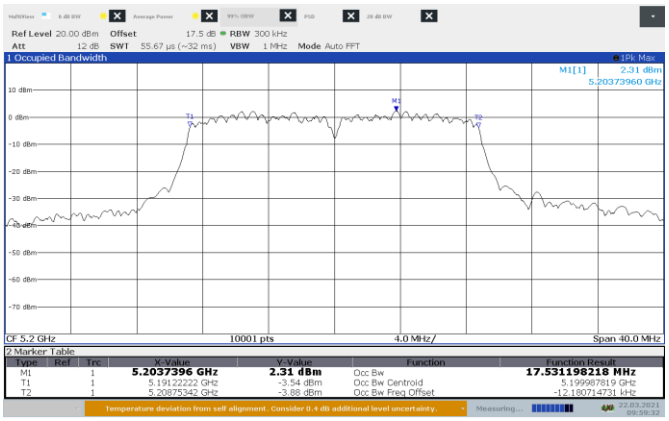


Figure 8.6-10: *99% bandwidth on 802.11ac, Mid channel Port B*

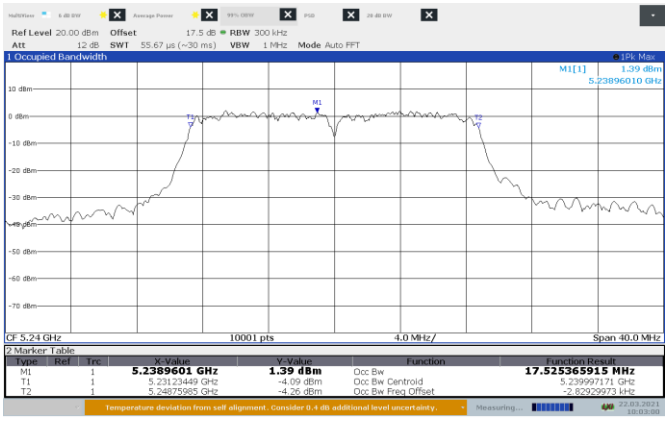


Figure 8.6-11: *99% band bandwidth on 802.11ac, High channel Port A*

Figure 8.6-12: *99% bandwidth on 802.11ac, High channel Port B*

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.

(i) For an outdoor access point operating in the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For 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	Mark Libbrecht	Test date	March 22, 2021

8.7.3 Observations, settings and special notes

Combined average output power was calculated as follows: $P_{combined} = 10 \times log_{10}\left(\left(10^{P_{ch0}/10}\right) + \left(10^{P_{ch1}/10}\right)\right)$

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

Combined PPSD was calculated as follows: $PPSD_{combined} = 10 \times log_{10}\left(\left(10^{PSD_{ch0}/10}\right) + \left(10^{PSD_{ch1}/10}\right)\right)$

Directional gain for MIMO 2 × 2 (CDD/TXBF) is Uncorrelated (90° phase shift) = 1.2 dBi

Directional gain is less than 6 dBi; therefore, the conducted output power limit is 30 dBm

The 99 % measured occupied bandwidth for 802.11a was 16.5 MHz

IC EIRP limit for 802.11a was calculated as follows: 10 + 10 × Log_{10} (16.5) = 22.17 dBm < 23 dBm; therefore, the limit is 22.2 dBm

The 99 % measured occupied bandwidth for 802.11ac was 17.6 MHz

IC EIRP limit for 802.11ac was calculated as follows: 10 + 10 × Log_{10} (17.6) = 22.46 dBm < 23 dBm; therefore, the limit is 22.5 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-1 or SA-1 Alternative (averaging with the EUT transmitting at full power throughout each sweep).
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	Max Hold
Power aggregation	Over 26 dB EBW or 99% OBW

8.7.4 Test data

Table 8.7-1: *Output power measurements results for FCC, MIMO 2×2 Uncorrelated*

Modulation	Frequency, MHz	Measured average conducted output power, dBm			Power limit, dBm	Margin, dB
		Port A	Port B	Combined		
802.11a	5180	8.7	10.2	12.5	24.0	11.5
	5200	8.7	10.2	12.5	24.0	11.5
	5240	8.1	9.9	12.1	24.0	11.9
802.11ac	5180	9.2	8.9	12.1	24.0	11.9
	5200	9.7	9.0	12.4	24.0	11.6
	5240	9.7	8.6	12.2	24.0	11.8

Table 8.7-2: *PSD measurements results for FCC, MIMO 2×2 Uncorrelated*

Modulation	Frequency, MHz	Measured Power Spectral Density (PSD), dBm/MHz			PPSD limit, dBm/MHz	Margin, dB
		Port A	Port B	Combined		
802.11a	5180	-0.3	-0.4	2.7	11.0	8.3
	5200	-0.2	-0.3	2.8	11.0	8.2
	5240	-0.5	-0.5	2.5	11.0	8.5
802.11ac	5180	-1.0	-1.0	2.0	11.0	9.0
	5200	-0.5	-0.4	2.6	11.0	8.4
	5240	-0.6	-0.7	2.4	11.0	8.6

Table 8.7-3: *Output power measurements and EIRP calculations results for ISED, MIMO 2×2 Uncorrelated*

Modulation	Frequency, MHz	Measured average conducted output power, dBm			Antenna gain, dBi	Equivalent Isotropically Radiated Power, dBm		
		Port A	Port B	Combined		Calculated	Limit	Margin*
802.11a	5180	8.7	10.2	12.5	1.2	13.7	22.2	8.5
	5200	8.7	10.2	12.5	1.2	13.7	22.2	8.5
	5240	8.1	9.9	12.1	1.2	13.3	22.2	8.9
802.11ac	5180	9.2	8.9	12.1	1.2	13.3	22.5	9.2
	5200	9.7	9.0	12.4	1.2	13.6	22.5	8.9
	5240	9.7	8.6	12.2	1.2	13.4	22.5	9.1

Notes: * - Margin obtained in dB units

Table 8.7-4: *PSD measurements results for ISED, MIMO 2×2 Uncorrelated*

Modulation	Frequency, MHz	Measured power spectral density (PSD), dBm/MHz			Antenna gain, dBi	EIRP PSD, dBm/MHz		
		Port A	Port B	Combined		Calculated	Limit	Margin*
802.11a	5180	-0.3	-0.4	2.7	1.2	3.9	10.0	6.1
	5200	-0.2	-0.3	2.8	1.2	4.0	10.0	6.0
	5240	-0.5	-0.5	2.5	1.2	3.7	10.0	6.3
802.11ac	5180	-1.0	-1.0	2.0	1.2	3.2	10.0	6.8
	5200	-0.5	-0.4	2.6	1.2	3.8	10.0	6.2
	5240	-0.6	-0.7	2.4	1.2	3.6	10.0	6.4

Notes: * - Margin obtained in dB units

Test data, continued

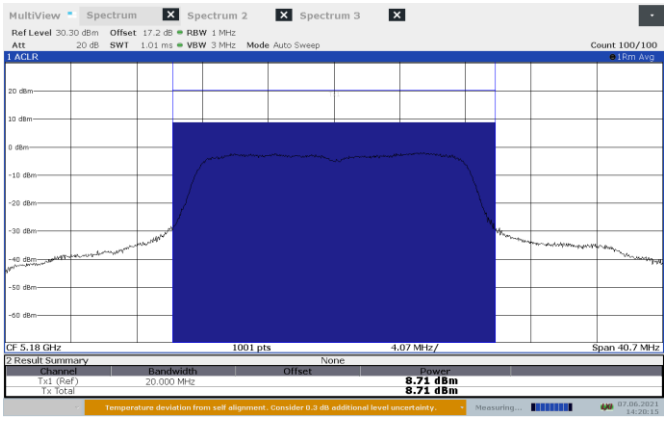


Figure 8.7-1: *Conducted output power on 802.11a, Port A Low channel*

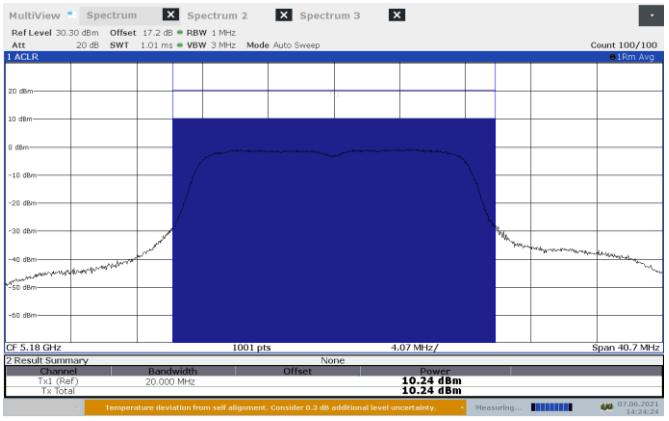


Figure 8.7-2: *Conducted output power on 802.11a, Port B Low channel*

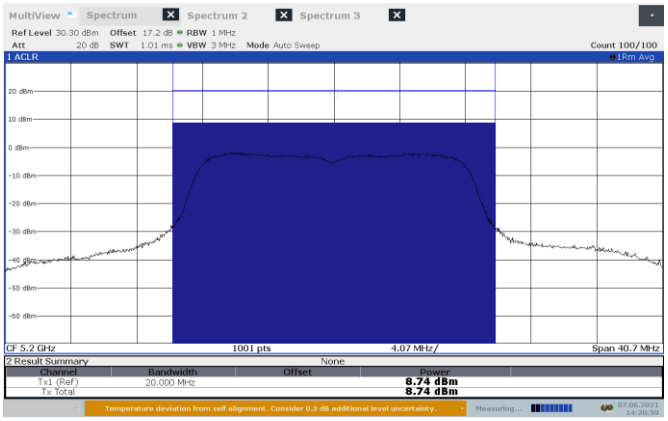


Figure 8.7-3: *Conducted output power on 802.11a, Port A Mid channel*

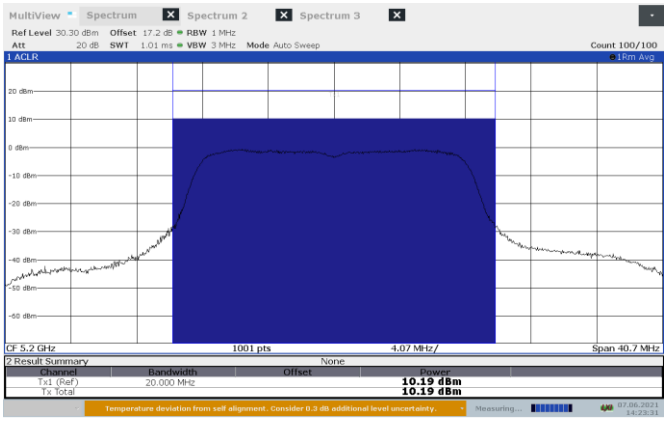


Figure 8.7-4: *Conducted output power on 802.11a, Port B Mid channel*

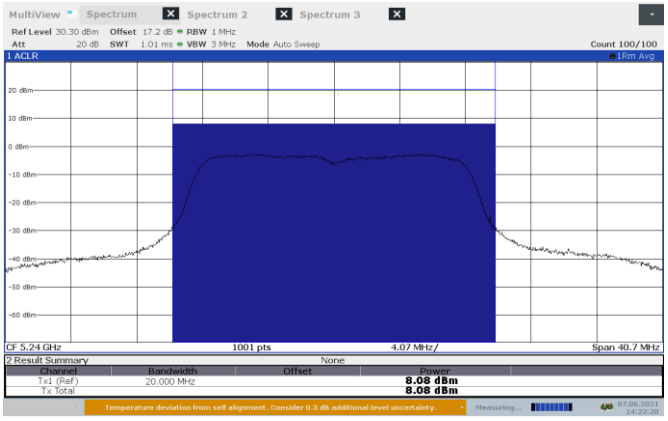


Figure 8.7-5: *Conducted output power on 802.11a, Port A High channel*

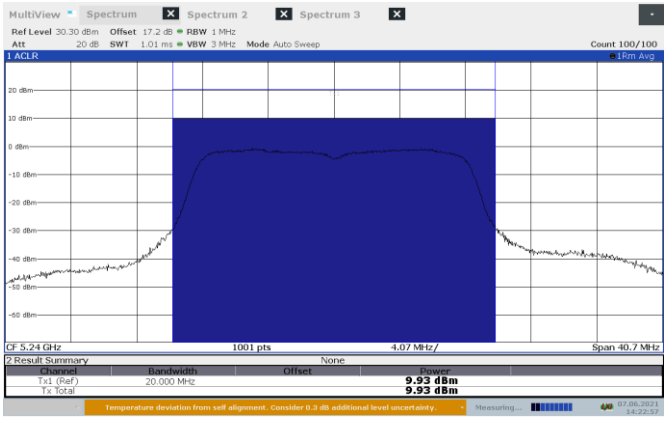


Figure 8.7-6: *Conducted output power on 802.11a, Port B High channel*

Test data, continued

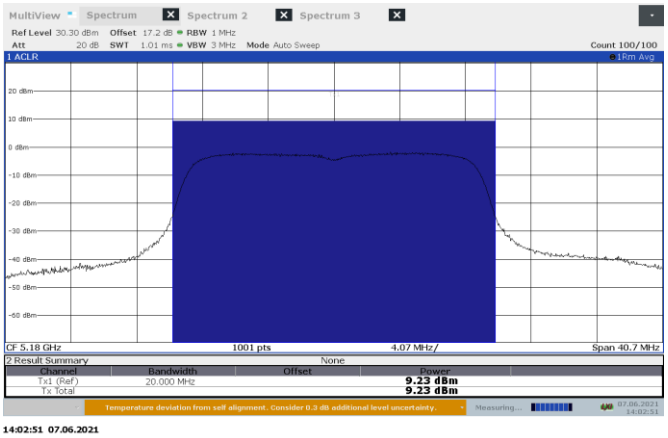


Figure 8.7-7: *Conducted output power on 802.11ac, Port A Low channel*

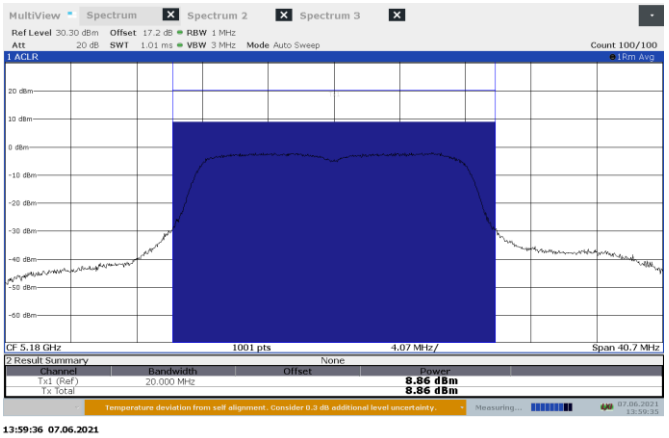


Figure 8.7-8: *Conducted output power on 802.11ac, Port B Low channel*

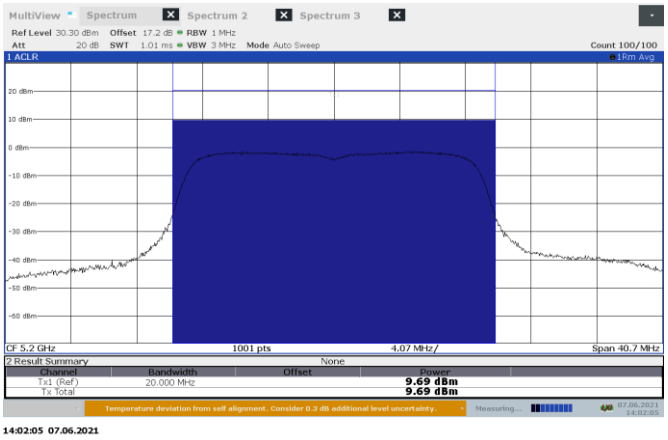


Figure 8.7-9: *Conducted output power on 802.11ac, Port A Mid channel*

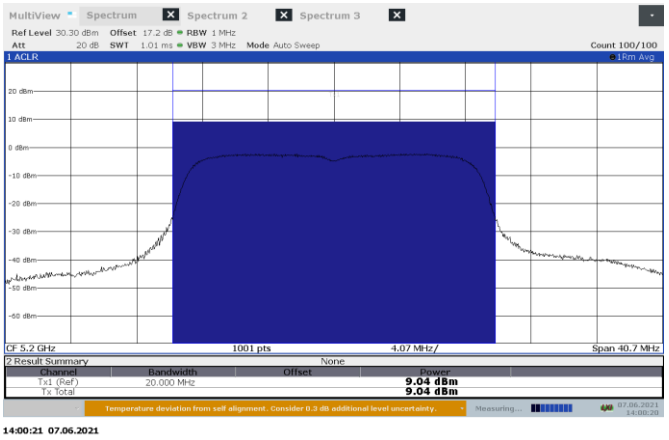


Figure 8.7-10: *Conducted output power on 802.11ac, Port B Mid channel*

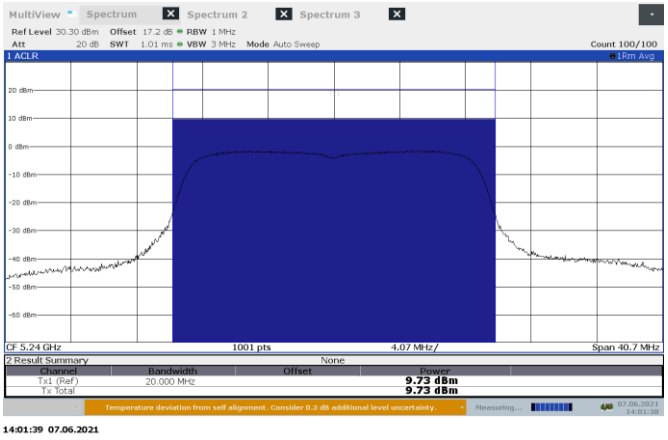


Figure 8.7-11: *Conducted output power on 802.11ac, Port A High channel*

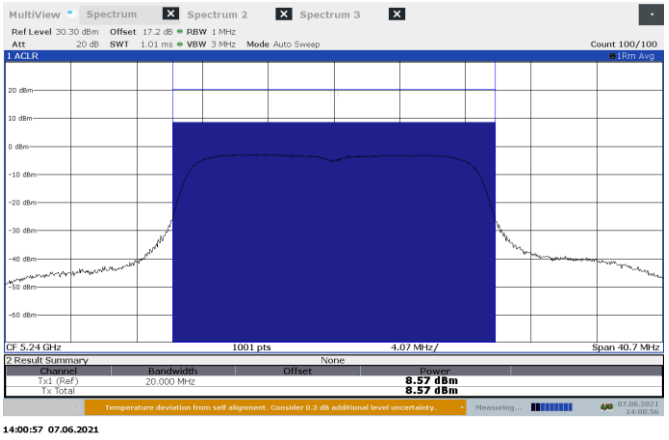


Figure 8.7-12: *Conducted output power on 802.11ac, Port B High channel*

Test data, continued

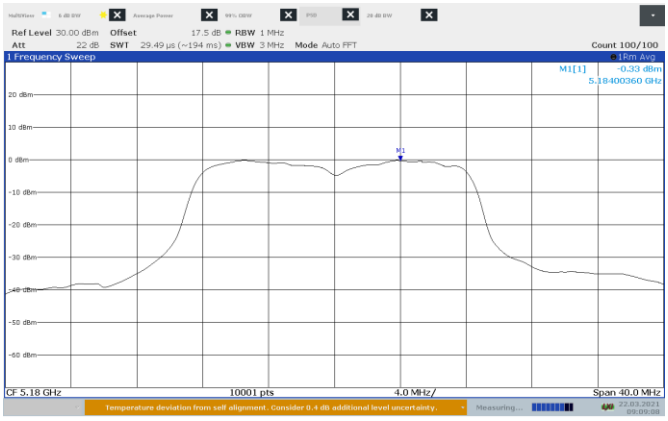


Figure 8.7-13: *Conducted PSD on 802.11a, Port A Low channel*

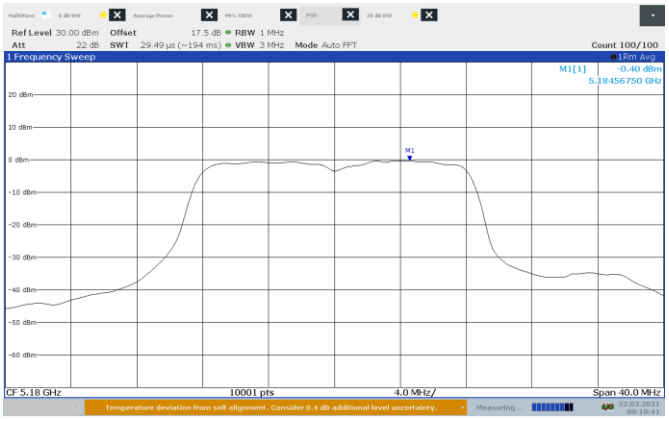


Figure 8.7-14: *Conducted PSD on 802.11a, Port B Low channel*

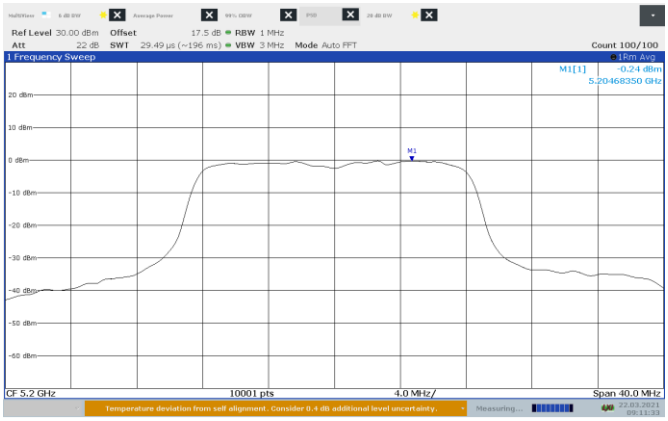


Figure 8.7-15: *Conducted PSD on 802.11a, Port A Mid channel*

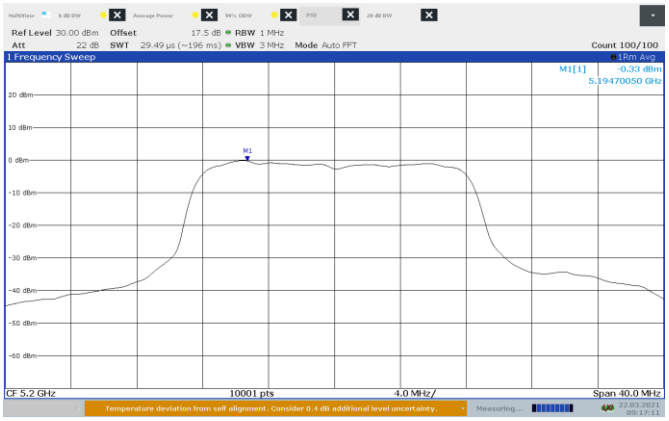


Figure 8.7-16: *Conducted PSD on 802.11a, Port B Mid channel*

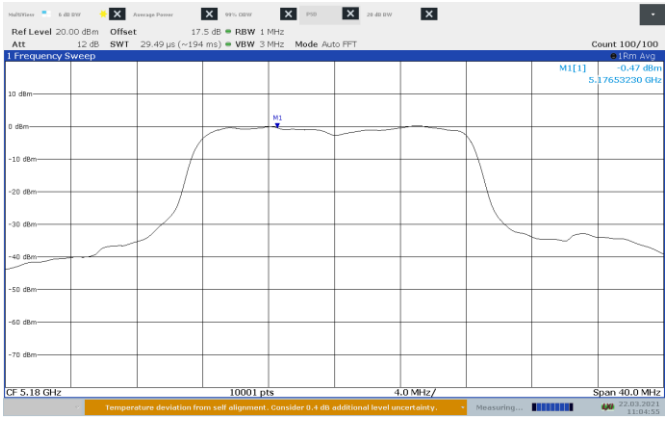


Figure 8.7-17: *Conducted PSD on 802.11a, Port A High channel*

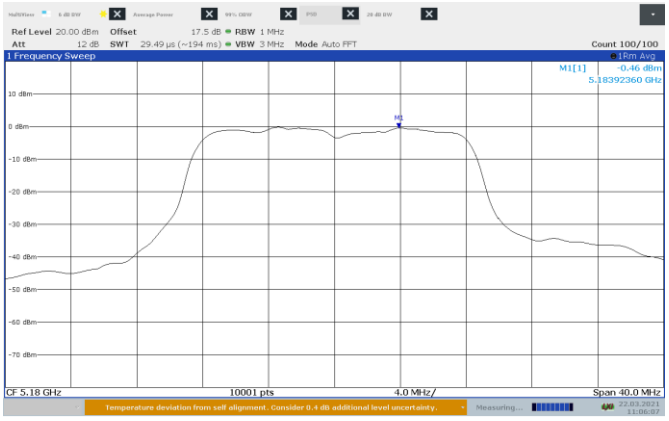


Figure 8.7-18: *Conducted PSD on 802.11a, Port B High channel*

Test data, continued

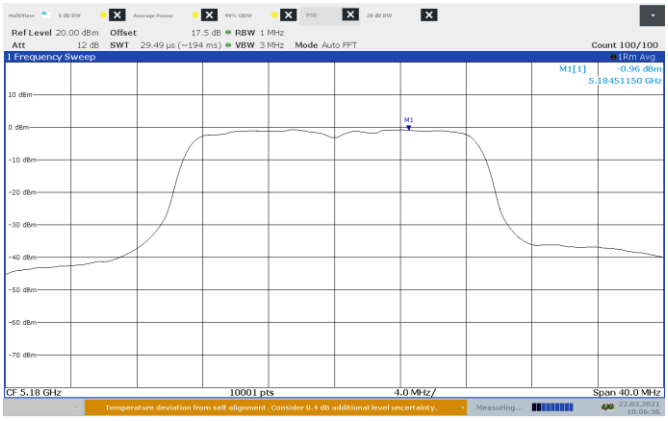


Figure 8.7-19: *Conducted PSD on 802.11ac, Port A Low channel*

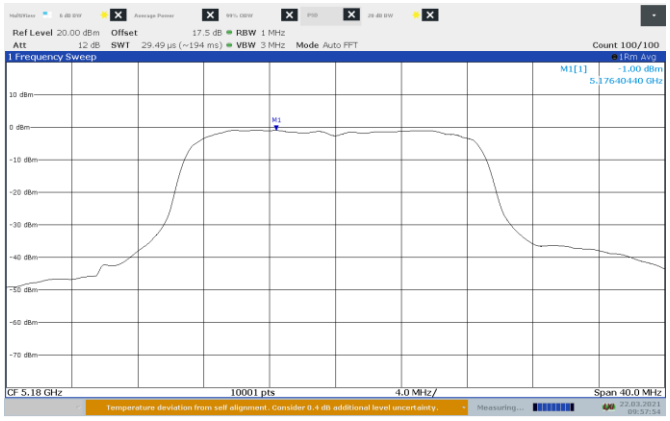


Figure 8.7-20: *Conducted PSD on 802.11ac, Port B Low channel*

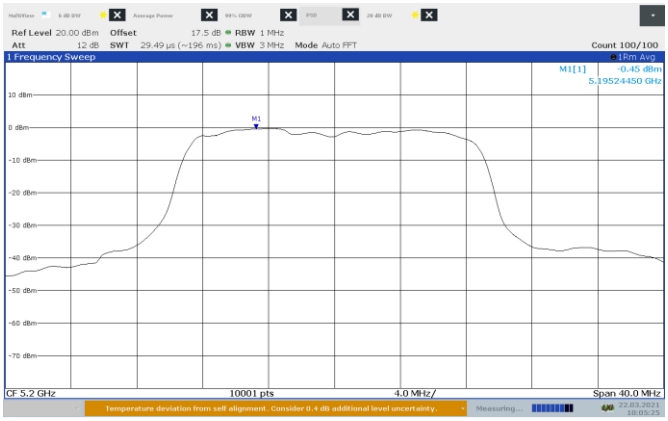


Figure 8.7-21: *Conducted PSD on 802.11ac, Port A Mid channel*

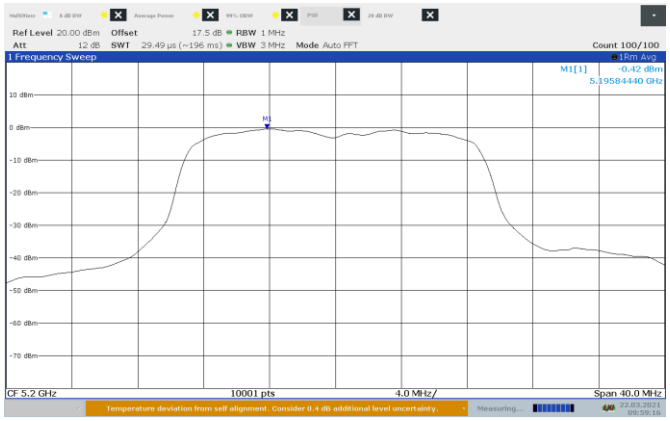


Figure 8.7-22: *Conducted PSD on 802.11ac, Port B Mid channel*

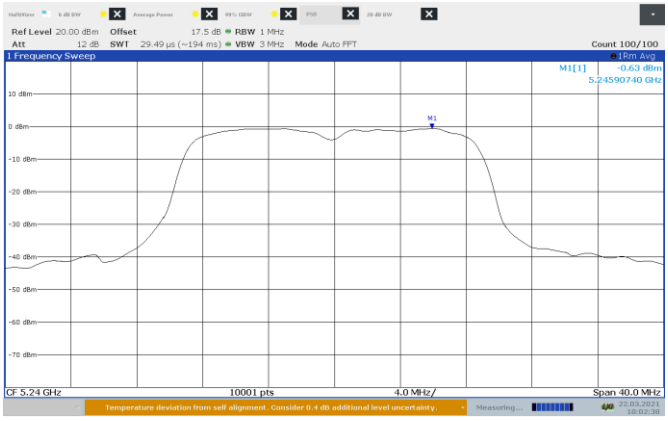


Figure 8.7-23: *Conducted PSD on 802.11ac, Port A High channel*

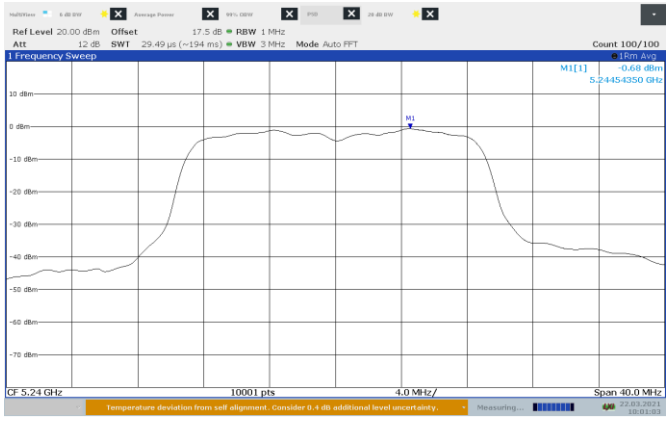


Figure 8.7-24: *Conducted PSD on 802.11ac, Port B High channel*

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	Mark Libbrecht	Test date	March 8, 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 with 100 % duty cycle. The EUT was transmitting on both MIMO chains simultaneously
- Radiated measurements 30 MHz – 18 GHz were performed at a distance of 3 m.
- Radiated measurements 18–25 GHz were performed at a distance of 1 m
- Radiated measurements 25–40 GHz were performed at a distance of 10 cm
- The spurious emission was tested per ANSI C63.10, Clause 12.7 and 789033 D02, Clause II(G).
- As per section ANSI 63.10 (2013) clause 5.6.2 spurious emissions were measured for the modulation with highest power level and spectral density: 802.11a

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

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

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

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	RMS
Trace mode:	Power average
Number of averaging traces:	≥ 100
Integration Bandwidth	1 MHz

Spectrum analyser for peak conducted measurements outside restricted bands:

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

Conducted emissions measurements outside restricted bands were performed on each individual MIMO chain. The limit was adjusted to include antenna directional gain of 1.2 dBi and a compensation of two antenna ports: −27 dBm/MHz − 10 × $\log_{10}$ (2) – 1.2 dBi = -31.2 dBm/MHz

8.8.4 Test data

Table 8.8-4: *Radiated field strength measurement results*

Modulation	Channel	Frequency, MHz	Peak Field strength, dBµV/m			Average Field strength, dBµV/m		
			Measured	Limit	Margin, dB	Measured	Limit	Margin, dB
802.11a	Low	5150.0	60.4	74.0	13.6	50.4	54.0	3.6
802.11ac	Low	5150.0	60.7	74.0	13.3	50.3	54.0	3.7

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

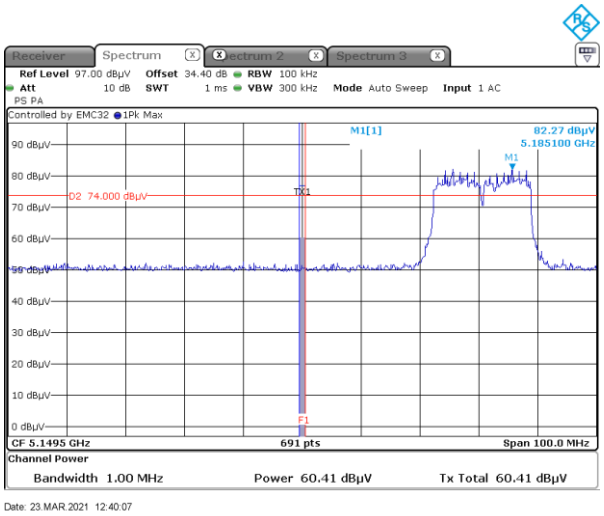


Figure 8.8-1: *Radiated restricted band edge on 802.11a, low channel, Peak*

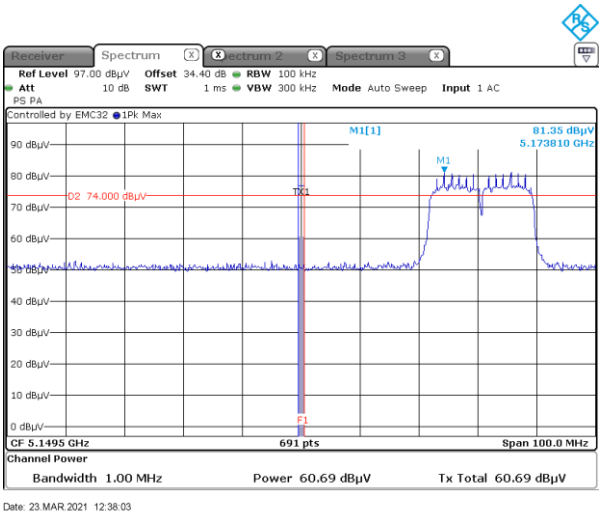


Figure 8.8 3: *Radiated restricted band edge on 802.11ac, low channel Peak*

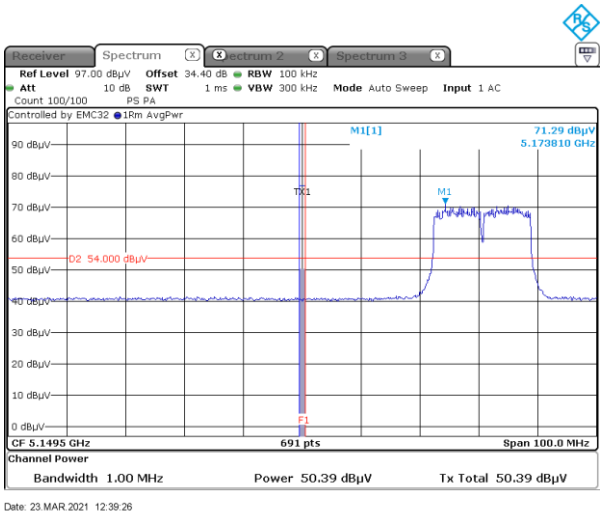


Figure 8.8-2: *Radiated restricted band edge on 802.11a, low channel, Average*

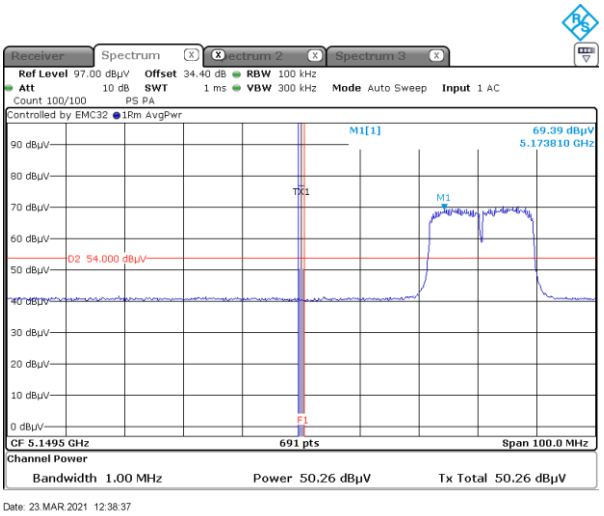


Figure 8.8 3: *Radiated restricted band edge on 802.11ac, low channel Average*

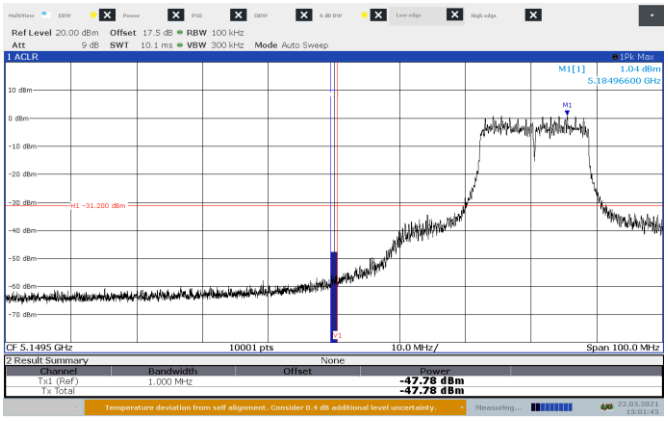


Figure 8.8-3: *Conducted lower band edge on 802.11a, Port A*

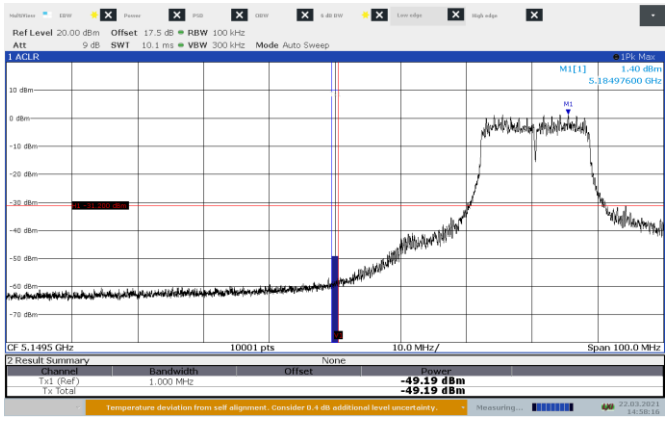


Figure 8.8-4: *Conducted lower band edge on 802.11a, Port B*

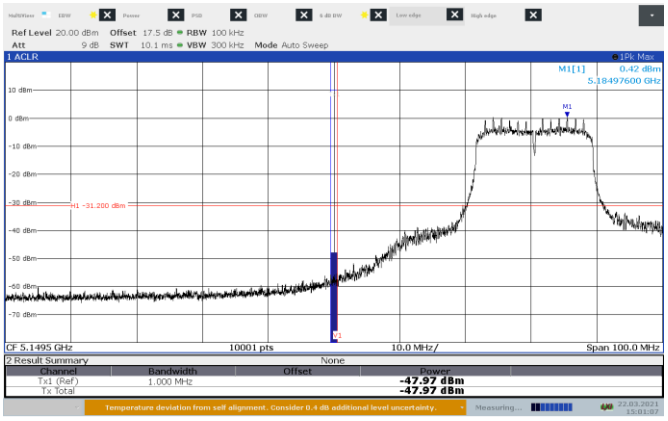


Figure 8.8-5: *Conducted lower band edge on 802.11ac, Port A*

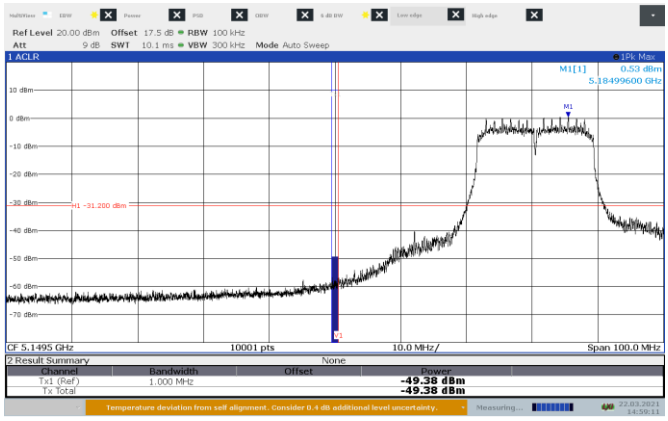


Figure 8.8-6: *Conducted lower band edge on 802.11ac, Port B*

Test data, continued

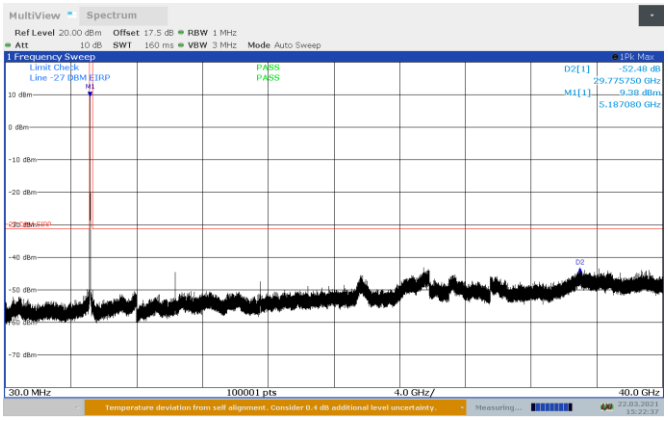


Figure 8.8-7: *Conducted spurious emissions on 802.11a, low channel Port A*

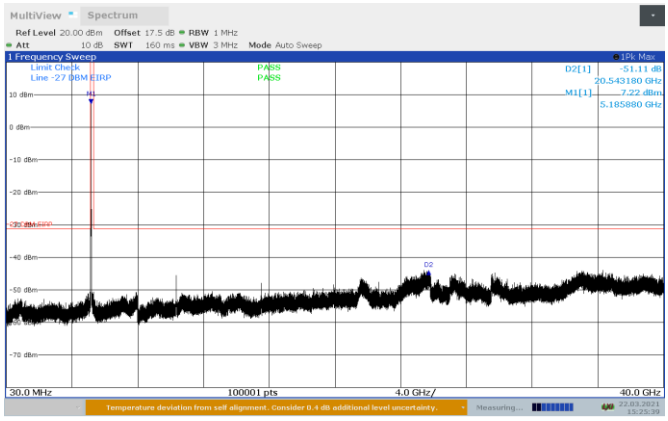


Figure 8.8-8: *Conducted spurious emissions on 802.11ac, low channel Port A*

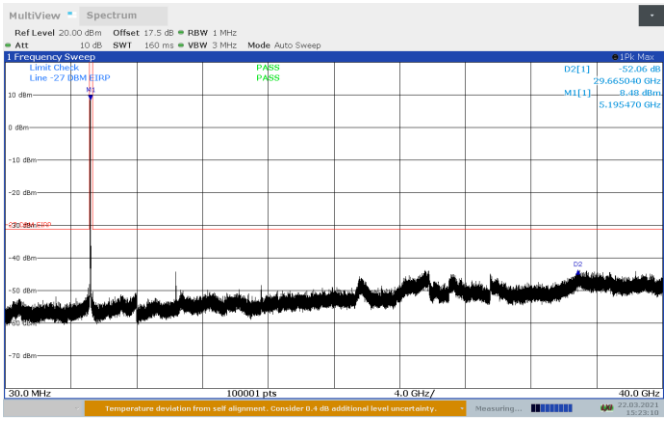


Figure 8.8-9: *Conducted spurious emissions on 802.11a, mid channel Port A*

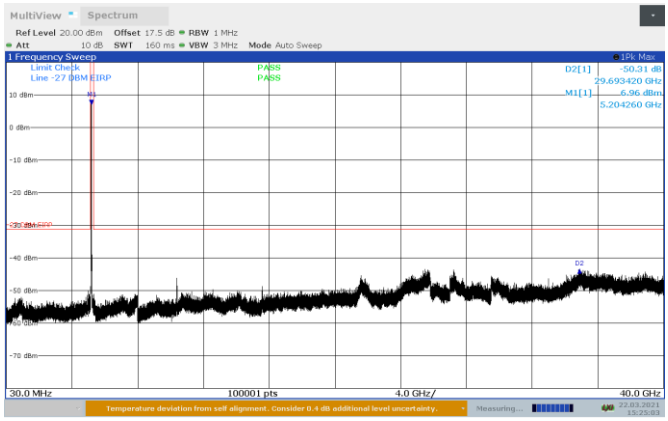


Figure 8.8-10: *Conducted spurious emissions on 802.11ac, mid channel Port A*

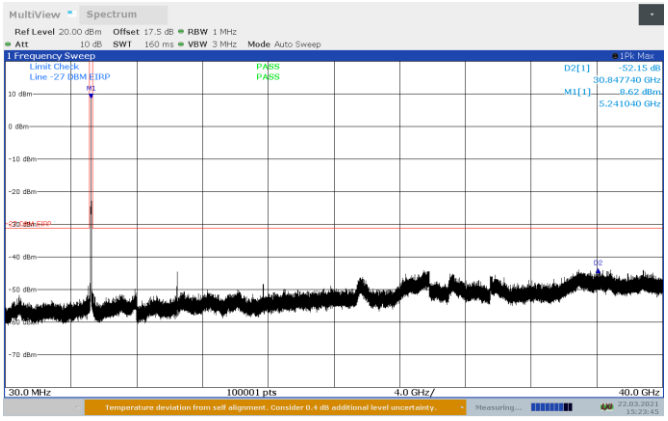


Figure 8.8-11: *Conducted spurious emissions on 802.11a, high channel Port A*

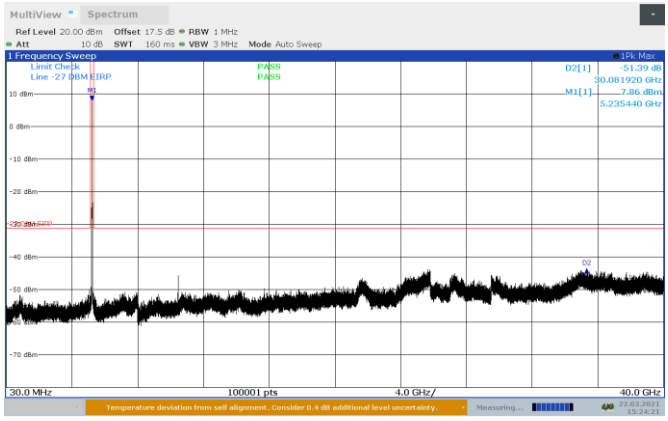


Figure 8.8-12: *Conducted spurious emissions on 802.11ac, high channel Port A*

Test data, continued

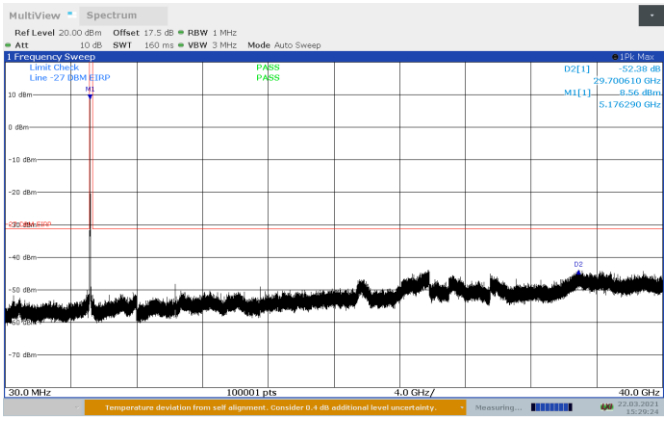


Figure 8.8-13: *Conducted spurious emissions on 802.11a, low channel Port B*

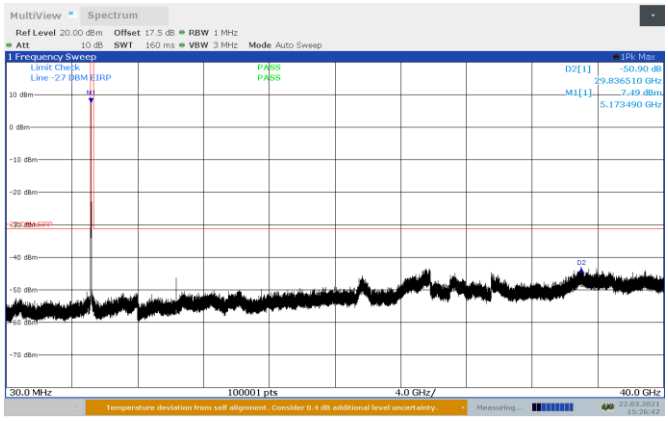


Figure 8.8-14: *Conducted spurious emissions on 802.11ac, low channel Port B*

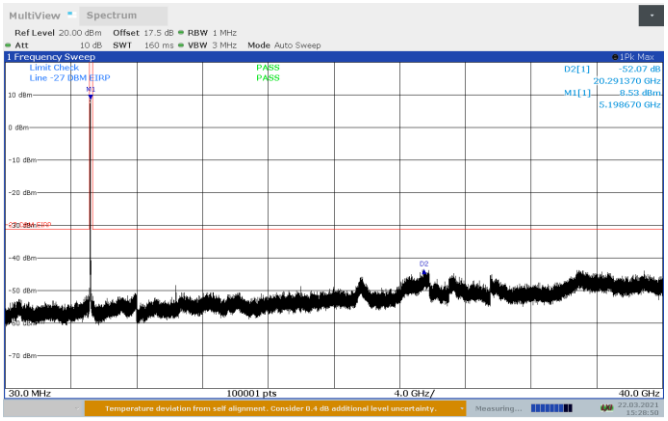


Figure 8.8-15: *Conducted spurious emissions on 802.11a, mid channel Port B*

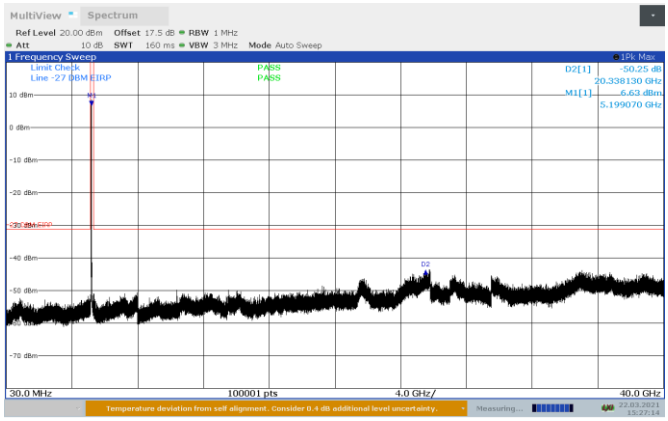


Figure 8.8-16: *Conducted spurious emissions on 802.11ac, mid channel Port B*

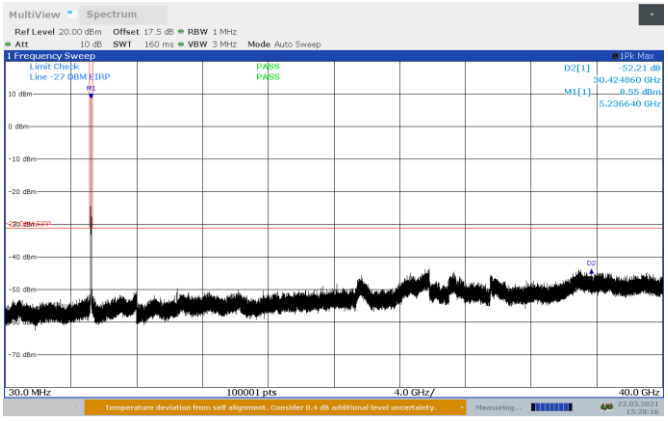


Figure 8.8-17: *Conducted spurious emissions on 802.11a, high channel Port B*

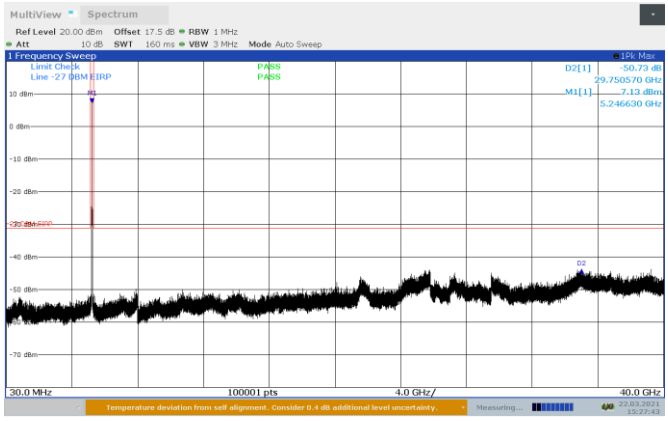


Figure 8.8-18: *Conducted spurious emissions on 802.11ac, high channel Port B*

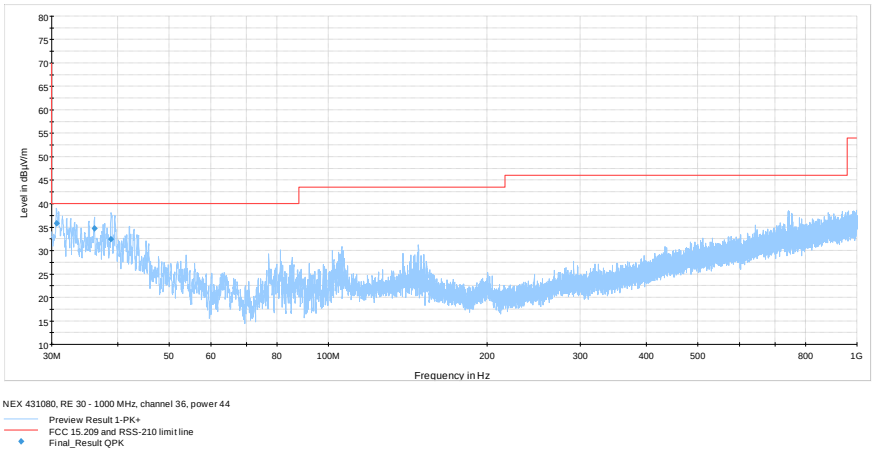


Figure 8.8-19: *Radiated spurious emissions 30 MHz – 1 GHz on 802.11a, Low Channel*

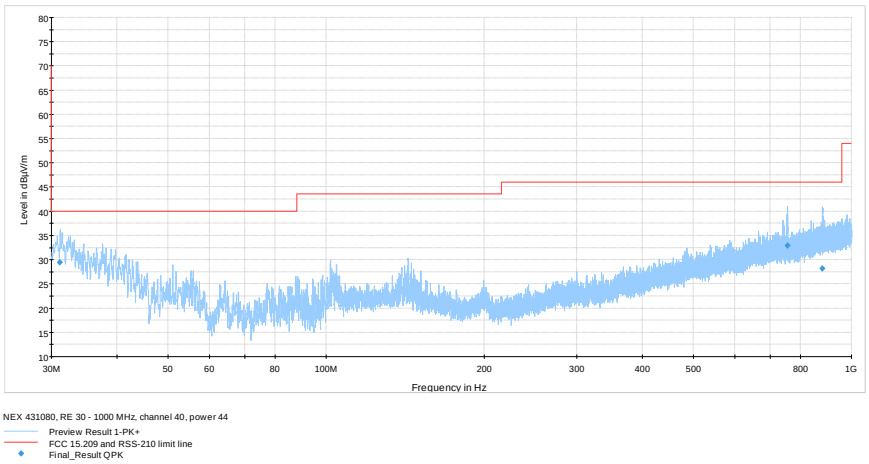


Figure 8.8-20: *Radiated spurious emissions 30 MHz – 1 GHz on 802.11a, Mid Channel*

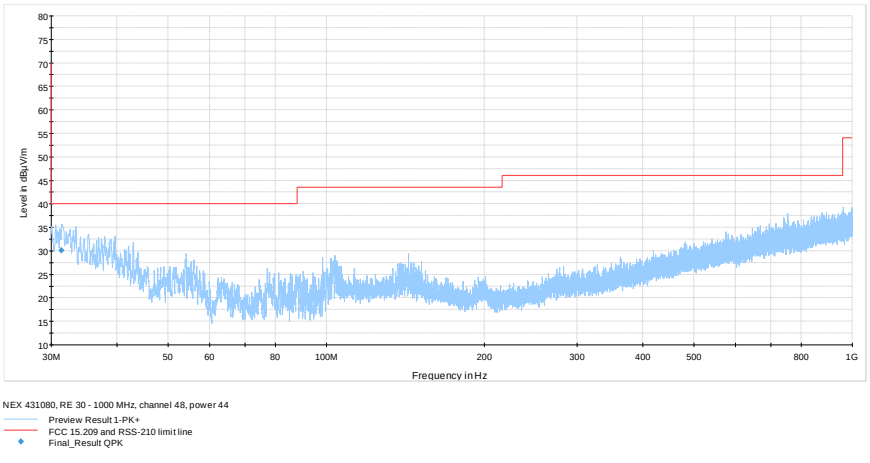


Figure 8.8-21: *Radiated spurious emissions 30 MHz – 1 GHz on 802.11a, High Channel*

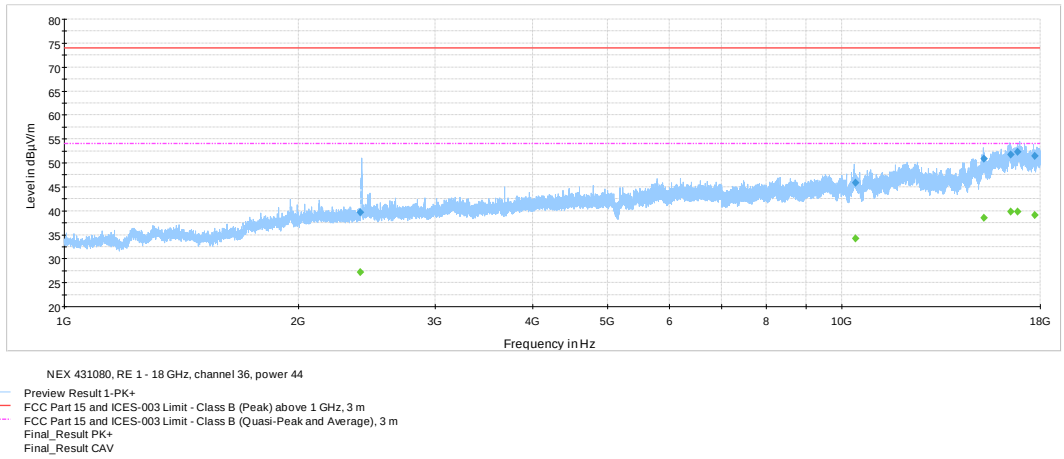


Figure 8.8-22: *Radiated spurious emissions 1 – 18 GHz on 802.11a, Low Channel*

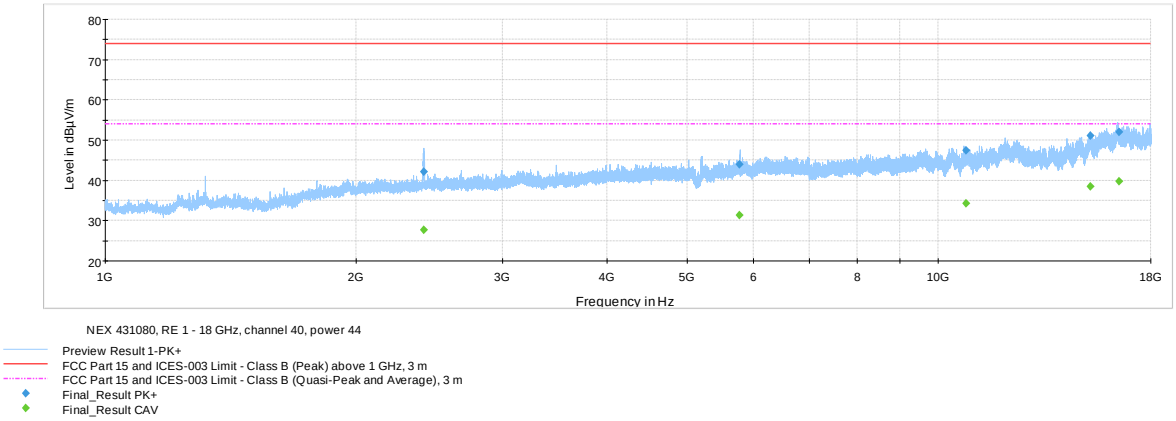


Figure 8.8-23: *Radiated spurious emissions 1 – 18 GHz on 802.11a, Mid Channel*

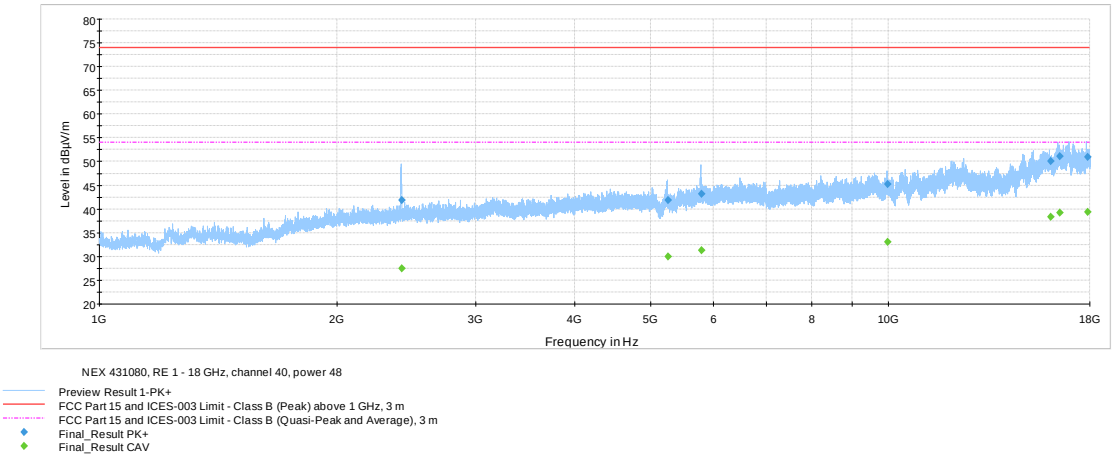


Figure 8.8-24: *Radiated spurious emissions 1 – 18 GHz on 802.11a, High Channel*

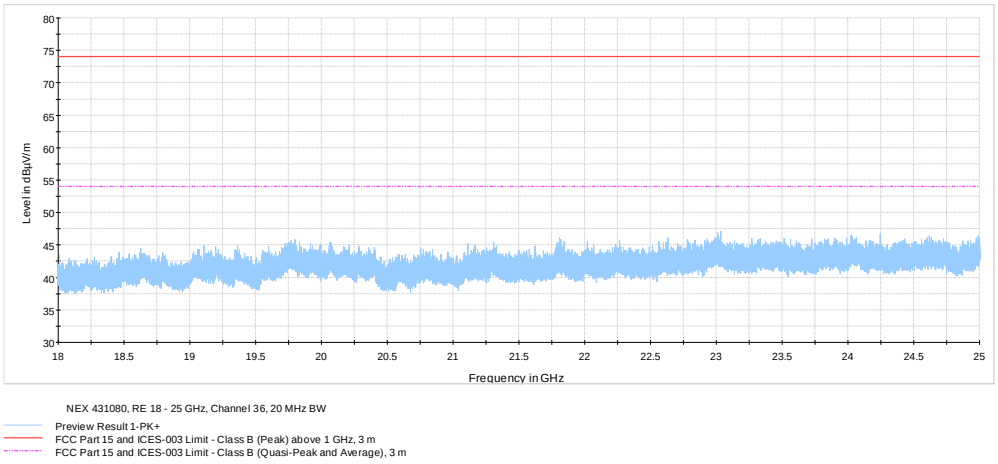


Figure 8.8-25: *Radiated spurious emissions 18 – 25 GHz on 802.11a, Low Channel*

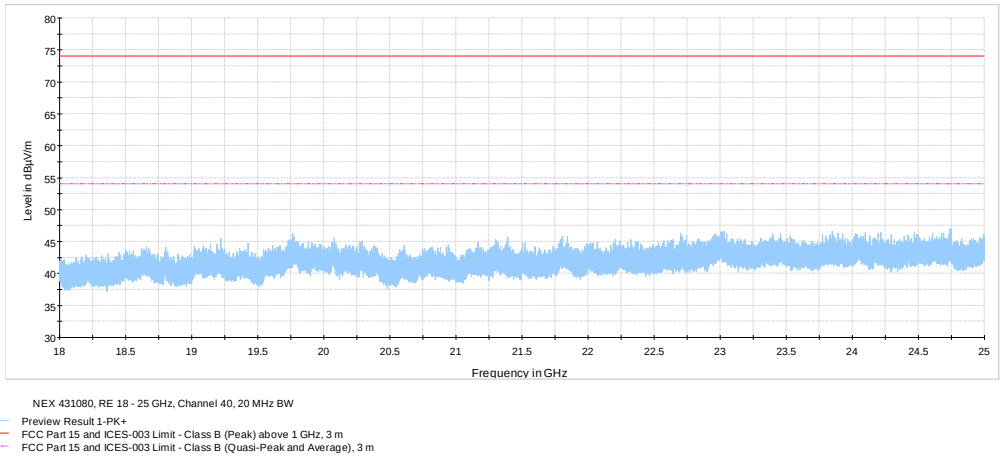


Figure 8.8-26: *Radiated spurious emissions 18 – 25 GHz on 802.11a, Mid Channel*

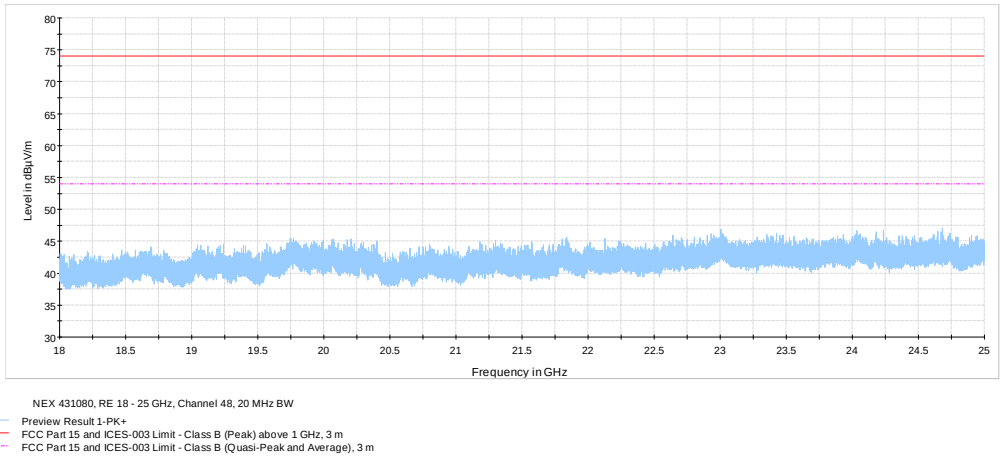


Figure 8.8-27: *Radiated spurious emissions 18 – 25 GHz on 802.11a, High Channel*

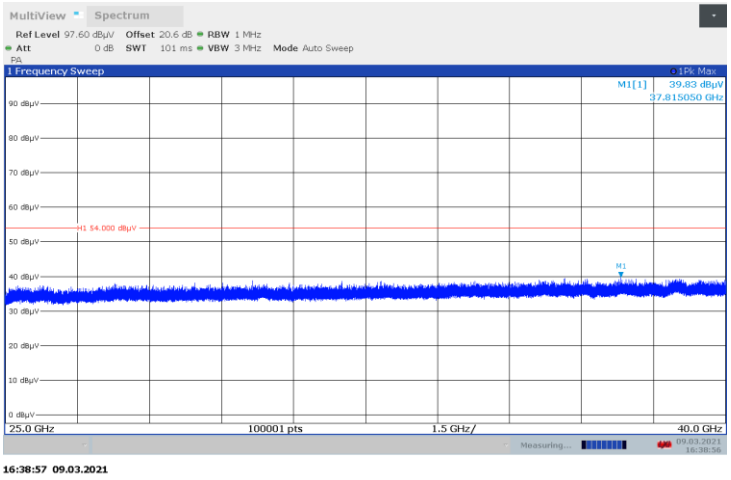


Figure 8.8-28: *Radiated spurious emissions 18 – 25 GHz on 802.11a, Low Channel*

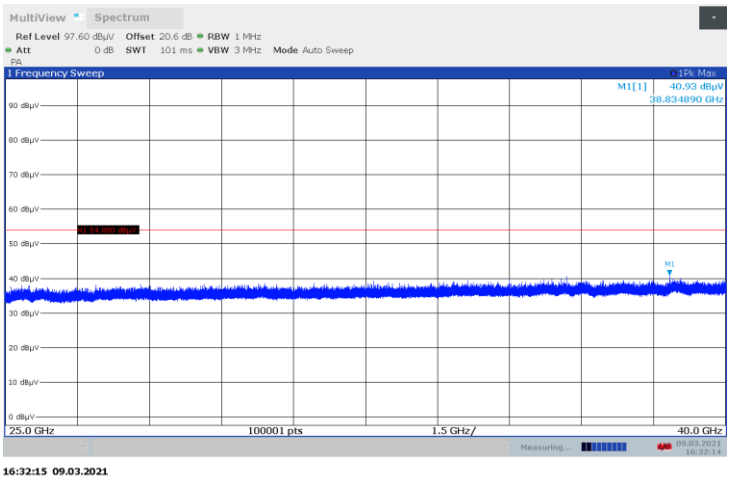


Figure 8.8-29: *Radiated spurious emissions 18 – 25 GHz on 802.11a, Mid Channel*

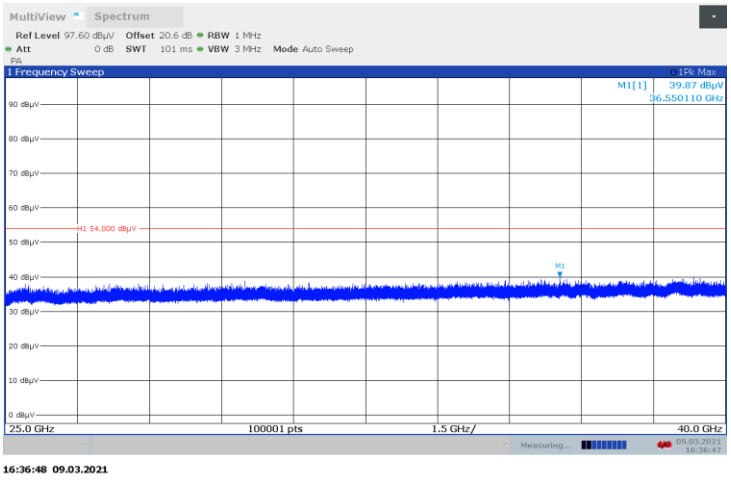


Figure 8.8-30: *Radiated spurious emissions 18 – 25 GHz on 802.11a, High Channel*

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	Mark Libbrecht	Test date	March 11, 2021

8.9.3 Observations, settings and special notes

Thermal operating range per user manual is +15°C - +35°C

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

8.9.4 Test data

Table 8.9-1: *Frequency drift measurement*

Test conditions	Frequency, GHz	Drift, Hz
+35 °C, Nominal	5.239988537	-29189
+30 °C, Nominal	5.239995329	-22397
+20 °C, +15 %	5.240014396	-3330
+20 °C, Nominal	5.240017726	*Reference*
+20 °C, −15 %	5.240015292	-2434
+15 °C, Nominal	5.240012678	-5048

Test data, continued

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

Modulation	−26 dBc lower cross point, GHz	Max negative drift, Hz	Drifted lower cross point, GHz	Band edge, GHz	Margin, MHz
802.11a	5.170213	-29189	5.170183811	5.15	20.183811
802.11ac	5.170113	-29189	5.170083811	5.15	20.083811

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

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

Modulation	−26 dBc upper cross point, GHz	Max positive drift, Hz	Drifted upper cross point, GHz	Band edge, GHz	Margin, kHz
802.11a	5.2496550	0	5.2496550	5.25	345.0
802.11ac	5.2499995	0	5.2499995	5.25	0.5

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

End of the test report