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Applicant:

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Test report no.:

220041-AU03+W01

for:

Narda Safety Test Solutions GmbH
Broadband Field meter
NBP Fieldman

according to:

47 CFR Part 15, §15.247
RSS-247

ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-12155-01-04

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Department of Innovation, Science and Economic Development Canada (ISED)
as a recognized testing laboratory
CAB identifier: DE0011
Company number: 3472A

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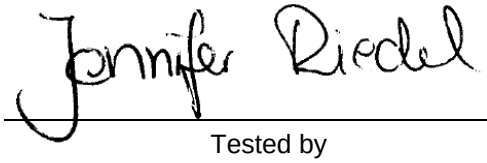
1 Summary of test results

System type: Digital transmission system (DTS)

47 CFR part and section	*Test*	*Equivalent to IC radio standard(s)*	*Page*	*Result*	*Note(s)*
15.207	AC power line conducted emissions 150 kHz to 30 MHz	RSS-Gen, section 8.8	28	Passed	2
---	Duty cycle	---	32	Recorded	---
15.247(a)(2)	6 dB bandwidth	RSS-247, section 5.2(a)	42	Passed	---
---	Occupied bandwidth	RSS-Gen, section 6.7	49	For reference only	---
15.247(b)	Conducted output power	RSS-247, section 5.4	56	Passed	---
15.247(e)	Power spectral density	RSS-247, section 5.2(b)	63	Passed	---
15.247(d)	Band-edge measurements	RSS-247, section 5.5	70	Passed	---
15.247(d)	Antenna-port conducted measurements	RSS-247, section 5.5	80	Passed	3
15.247(d)	Radiated emissions below 30 MHz	RSS-247, section 5.5	92	Passed	---
15.247(d)	Radiated emissions from 30 MHz to 1 GHz	RSS-247, section 5.5	95	Passed	---
15.247(d)	Radiated emissions from 1 GHz to 25 GHz (10th harmonic)	RSS-247, section 5.5	98	Passed	---
15.247(i)	Radio frequency radiation exposure	RSS-Gen, Section 3.4	---	Not performed	4

Note(s):
1 For information about EUT see clause 3.
2 Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.
3 If antenna port conducted tests cannot be performed (e.g. for portable or handheld devices with integral antenna), then radiated tests are performed for demonstrating compliance to the conducted emission requirements (see “Spurious radiated emissions 9 kHz to 10th harmonic”).
4 Radio frequency radiation exposure is in consideration in another test report.

Straubing, October 24, 2022



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2 Referenced publications

Publication	*Title*
CFR 47 Part 2 October 2021	Code of Federal Regulations, Title 47 (Telecommunication), Part 2 (Frequency allocation and radio treaty matters; General rules and regulations) of the Federal Communication Commission (FCC)
CFR 47 Part 15 October 2021	Code of Federal Regulations, Title 47 (Telecommunication), Part 15 (Radio Frequency Devices) of the Federal Communication Commission (FCC)
KDB Publication no. 412172 August 7, 2015	Guidelines for determining the Effective Radiated Power (ERP) and Equivalent Isotropically Radiated Power (EIRP) of an RF transmitting system
KDB Publication no. 558074 April 02, 2019	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS), Frequency Hopping Spread Spectrum Sytem, and Hybrid System Devices Operating Under §15.247 of the FCC Rules
ANSI C63.10 June 2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
RSS-Gen Issue 5 April 2018 Amendment 1 (March 2019) Amendment 2 (February 2021)	Spectrum Management and Telecommunications - Radio Standards Specification - General Requirements for Compliance of Radio Apparatus
RSS-247, Issue 2 February 2017	Spectrum Management and Telecommunications - Radio Standards Specification - Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

3 Equipment under test (EUT)

All Information in this clause is declared by customer.

3.1 General information

Product type:	Broadband Field meter		
Model name:	NBP Fieldman		
Serial number(s):	PT-0065		
Manufacturer:	Narda Safety Test Solutions GmbH		
Version:	Hardware:	A-Serie	
	Software:	V0.9.0	
Short description:	EUT is a broadband field meter with a WLAN module operating in the 2.4 GHz band. The EUT also employs BT classic which is in consideration in another test report.		
Additional modifications:	None		
FCC ID:	2A77Y-246001A		
IC registration number:	28882-246001A		
Emission classification:	14M0F7D-- 17M2F7D-- 18M2F7D--		
Power supply:	DC supply		
	Nominal voltage:	5 V	
Device type:	☐ Portable	☒ Mobile	☐ Fixed

3.2 Radio specifications

System type (Note 1):	Digital transmission system (DTS)		
Application frequency band:	2400.0 MHz - 2483.5 MHz		
Number of RF channels:	1		
Nominal bandwidth:	5 MHz		
Modulation(s):	IEEE 802.11 b, g and n (HT20)		
Antenna:	Type:	Chip antenna	
	Gain:	2.2 dBi (maximum)	
	Model:	W3006	
	Manufacturer:	PulseLarsen	
	Connector:	☐ external	☐ internal
		☐ temporary	☒ none (integral antenna)

Note(s):
1. "DTS" is the equipment class for digital transmission systems, "DSS" for all other Part 15 spread spectrum transmitters as used for equipment authorization system form 731.

Channel	*Frequency (MHz)*
Low	2412
Middle	2437
High	2462

Table 1: Tested channel(s)

3.3 Photo documentation

For external photos of the EUT see annex B, for internal ones see annex C.
Photos taken during testing including EUT positions can be found in annex A.

4 Test configuration and mode of operation

4.1 Test configuration

Device	*Type designation*	*Serial or inventory no.*	*Manufacturer*
Broadband Field meter	NBP Fieldman	PT-0065	Narda Safety Test Solutions GmbH

Table 2: EUT used for testing

Device	*Type designation*	*Serial or inventory no.*	*Manufacturer*
E-field probe	Probe HFD-0191	---	Narda Safety Test Solutions GmbH
Laptop	Lifebook A531	E001053	FUJITSU
Power supply for laptop	AC adapter	E001053	FUJITSU
Power adapter	PN453I	---	Shenzhen Xinspower Technology Co., Ltd.

Table 3: Support equipment used for testing

Port	*Classification*
Ethernet	Signal/control
USB	DC power

Table 4: Ports of EUT and appropriate cables

4.2 Mode of operation

The EUT was connected to the laptop via Ethernet and the software “NappyBee EOL Tester” was used to set the appropriate parameters, e.g. channel and modulation type. When pressing the button “Set” the EUT was transmitting a modulated signal.

5 Test procedures

5.1 General specifications

5.1.1 Test setups

Tabletop devices are placed on a non-conductive table with a height of 0.8 m. In case of AC power-line conducted emissions test, the rear of the EUT is located 40 cm to the vertical wall of the RF-shielded (screened) room which is used as vertical conducting plane. For radiated emission measurements above 1 GHz, tabletop devices are placed at a height of 1.5 m above the floor using a support made of styrene placed on top of the non-conductive table.

All other surfaces of tabletop or floor-standing EUTs are at least 80 cm from any other grounded conducting surface. This includes the case or cases of one or more LISNs when performing an AC power-line conducted emissions test.

Radiated emission measurements of equipment that can be used in multiple orientations (e.g. portable or handheld devices) are performed with the EUT in each of three orthogonal axis positions.

5.1.2 Conversion to conducted test results

If test procedures described herein are based on the use of an antenna-port conducted test configuration, but the EUT cannot provide such a configuration (e.g., portable or handheld devices with integral antenna), radiated tests are performed for demonstrating compliance to the conducted requirements.

If a radiated test configuration has to be used, then the measured power or field strength levels are converted to equivalent conducted power levels for comparison to the applicable limit. For this purpose, at first the radiated field strength or power levels are converted to EIRP as described in annex G of ANSI C63.10 and KDB Publication 412172, document D01. The equivalent conducted power is then determined by subtracting the EUT transmit antenna gain from the EIRP (assuming logarithmic representation).

For devices utilizing multiple antenna technologies, KDB Publication 662911 applies.

5.2 Antenna-port conducted measurements

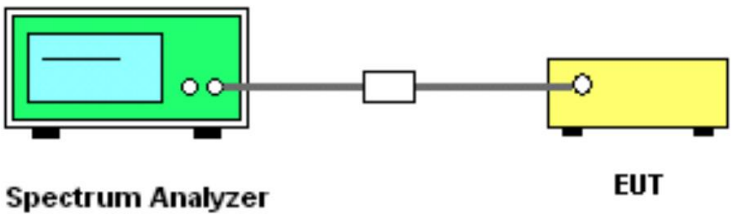

Figure 1: Setup for antenna-port conducted measurements

The RF signal of the EUT is measured conducted at the antenna port. In case of no permanent antenna connector available, a temporary antenna connector should be supplied by the manufacturer. The specific insertion loss of the signal path, which is matched to 50 Ohm, is determined. The test receiver is set to analyzer mode with pre-selector activated. The measurement readings on the test receiver are corrected by the signal path loss.

For frequency hopping systems (FHSS) and digital transmission systems (DTS) the settings as specified by KDB Publication 558074, document D01, are used.

If a radiated test configuration has to be used, conversion to conducted test results is performed according to clause 5.1.2.

5.3 AC powerline conducted emissions

AC power-line conducted emissions are measured according to clause 6.2 of ANSI C63.10 over the frequency range from 150 kHz to 30 MHz to determine the line-to-ground radio-noise voltage that is conducted from all of the EUT current-carrying power input terminals that are directly (or indirectly via separate transformers or power supplies) connected to a public power network. The tests are performed in a shielded room.

If the EUT normally receives power from another device that in turn connects to the public utility ac power lines, measurements are 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 is 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.

Frequency (f)	*Measurement receiver bandwidth*	*Step size*	*Detector type*		
			Prescan	*Prescan with FFT*	*Final scan*
150 kHz ≤ f < 30 MHz	9 kHz	≤ 4.5 kHz	Peak, Average	Quasi-peak, Average	Quasi-peak, Average

Table 5: Bandwidth and detector type for AC power-line conducted emissions test

The AC power-line conducted emissions test is performed in the following steps:
a) The EUT is arranged as tabletop or floor-standing equipment, as applicable, and connected to a line impedance stabilization network (LISN) with 50 µH / 50 Ω. If required, a second LISN of the same type and terminated by 50 Ω is used for peripheral devices. The EUT is switched on.
b) The measurement equipment is connected to the LISN for the EUT and set-up according to the specifications of the test (see table 5). At the LISN, the neutral line is selected to be tested.

c) The prescan is performed with both detectors activated at the same time. If the test receiver is capable of FFT analysis, it is used for prescan, but not for final scan.
d) When the prescan is completed, maximum levels with less margin than 10 dB or exceeding the limit are determined and collected in a list.
e) With the first frequency of the list selected, a frequency zoom over a range of ten times of the measurement receiver bandwidth around this frequency is performed. If the EUT has no significant drift in frequency, the frequency zoom can be skipped.
f) For final scan, the emission level is measured and the maximum is recorded.
g) Steps e) to f) are repeated for all other frequencies in the list. At least the six highest EUT emissions relative to the limit have to be recorded.
h) Steps c) to g) are repeated for all current-carrying conductors of all of the power cords of EUT, i.e. all phase and (if used) neutral line(s).

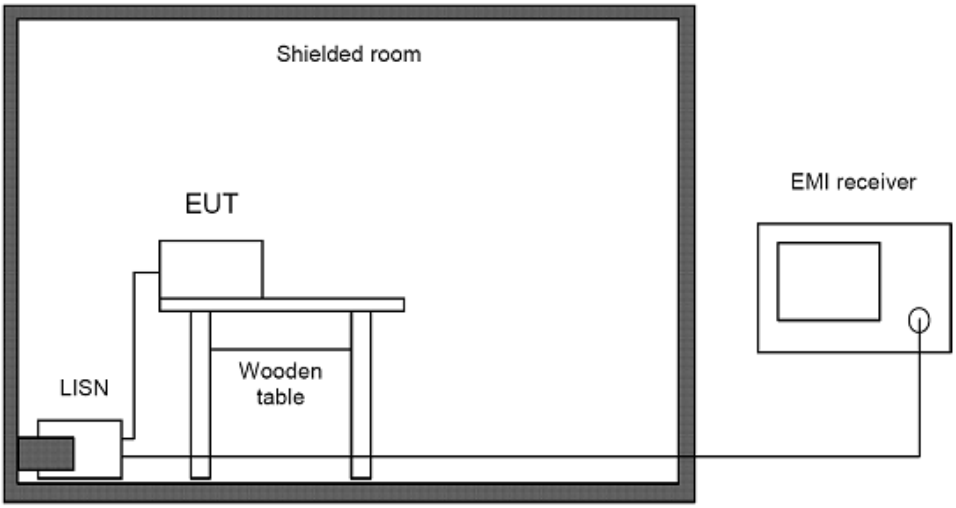

Figure 2: Setup for AC power-line conducted emissions test from 150 kHz to 30 MHz

Phase	*Frequency (MHz)*	*Reading value (dBµV)*	*AMN correction (dB)*	*Cable attenuation + 10 dB attenuator (dB)*	*Correction factor (Corr.) (dB)*	*Level (dBµV)*
L 1	10	10	0.6	10.9	11.5	21.5
N	10	10	1.0	10.9	11.9	21.9

Table 6: Sample calculation

Correction factor = Artifical mains network correction + Cable attenuation + 10 dB

Level = Reading value + Correction factor = 10 dBµV + 11.5 dB = 21.5 dBµV

Prescans are performed with all detectors activated at the same time. If the test receiver is capable of FFT analysis, it is used for prescans, but not for final scans. If no limit is specified for certain detectors, final scan measurement with these detectors may be omitted.

5.4 Radiated emissions below 30 MHz

Radiated emissions below 30 MHz are measured according to clause 6.4 of ANSI C63.10 using an inductive shielded loop antenna. As this antenna measures the magnetic field only, its antenna factors are converted to electric field strength values assuming a free space impedance of 377 Ω as described in clause 4.3.1 of ANSI C63.10. This results in an additional correction of 51.53 dB.

According to clause 6.4.3 of ANSI C63.10, at frequencies below 30 MHz, measurements may be performed at a distance closer than that specified in the requirements. In this case, the results are extrapolated to the specified distance by using a recalculation factor determined according to one of the methods described in clause 6.4.4 of ANSI C63.10, provided that the maximum dimension of the device is equal to or less than 0.625 times the wavelength at the frequency being measured. As the minimum wavelength is 10 meters corresponding to the maximum frequency of 30 MHz, this requirement is fulfilled if the maximum dimension of the device is equal to or less than 6.25 meters.

Unless otherwise stated, the recalculation factor is determined according to clause 6.4.4.2 “Extrapolation from the measurement of a single point” of ANSI C63.10:

$d_{near\ field}$ = 47.77 / f_{MHz}, or
f_{MHz} = 47.77 / $d_{near\ field}$

The frequency f_{MHz} at which the near field distance is equal to the limit and/or test distance is important for selection of the right formula to determine the recalculation factor:

f_{MHz}(300 m) ≈ 0.159 MHz
f_{MHz}(30 m) ≈ 1.592 MHz
f_{MHz}(3 m) ≈ 15.923 MHz

Based on the test distances for the general radiated emission limits as specified in §15.209 of 47 CFR Part 15 or RSS-Gen, the following formulas are used to determine the recalculation factor:

Frequency (f)	d_{limit}	$d_{measure}$	*Formula for recalculation factor*
9 kHz ≤ f ≤ 159 kHz 490 kHz < f ≤ 1.592 MHz	300 m 30 m	3 m	-40 log(d_{limit} / $d_{measure}$)
159 kHz < f ≤ 490 kHz 1.592 MHz < f ≤ 15.923 MHz	300 m 30 m	3 m	-40 log($d_{near\ field}$ / $d_{measure}$) - 20 log(d_{limit} / $d_{near\ field}$)
f > 15.923 MHz	30 m	3 m	-20 log(d_{limit} / $d_{measure}$)

Table 7: Recalculation factors for extrapolation

Prescans for radiated measurements below 30 MHz are performed in a fully anechoic room (called “CDC”). The measurement distance is 3 meters. The emissions of the EUT are recorded with an EMI test receiver configured as described in table 8.

Frequency (f)	*Measurement receiver bandwidth*	*Step size*	*Detector type*		
			Prescan	*Prescan with FFT*	*Final scan*
9 kHz ≤ f < 150 kHz	200 Hz	≤ 100 Hz	Peak, Average	Peak Quasi-peak, Average	Peak Quasi-peak, Average
150 kHz ≤ f < 30 MHz	9 kHz	≤ 4.5 kHz	Peak, Average	Peak Quasi-peak, Average	Peak Quasi-peak, Average

Table 8: Bandwidth and detector type for radiated emissions test below 30 MHz

Frequency (MHz)	*Reading value (dBµV)*	*Antenna correction (dB/m)*	*Cable attenuation (dB)*	*Correction factor (Corr.) (dB)*	*Level (dBµV/m)*
10	20.00	19.59	0.33	19.92	39.92

Table 9: Sample calculation

Correction factor = Antenna correction + Cable attenuation

Level = Reading value + Correction factor = 20 dBµV + 19.92 dB = 39.92 dBµV/m

Prescans are performed with all detectors activated at the same time. If the test receiver is capable of FFT analysis, it is used for prescans, but not for final scans. If no limit is specified for certain detectors, final scan measurement with these detectors may be omitted.

The radiated emissions test below 30 MHz is performed in the following steps:

a) The loop antenna is positioned with its plane perpendicular to the ground with the lowest height of the antenna 1 m above the ground.
b) The EUT is placed in its standard position on a turntable capable of rotation through 360° in the horizontal plane and arranged as tabletop or floor-standing equipment, as applicable. The EUT is switched on.
c) The measurement equipment is connected to the loop antenna and set-up according to the specifications of the test (see table 8).
d) The EUT is turned to a position likely to get the maximum and the test antenna is rotated to detect the maximum of the fundamental in this EUT position.
e) Then the EUT is rotated in a horizontal plane through 360° in steps of 45°. Starting at 0°, at each table position the spectrum for the full frequency range is recorded. If the emission at a certain frequency is higher than the levels already recorded, the current table position is noted as the maximum position.
f) After the last prescan, the significant maximum emissions and their table positions are determined and collected in a list.
g) With the test receiver set to the first frequency of the list, the EUT is rotated by ±45° around the table position found during prescans while measuring the emission level continuously. For final scan, the worst-case table position is set and the maximum emission level is recorded.
h) Step g) is repeated for all other frequencies in the list.
i) Finally, for frequencies with critical emissions the loop antenna is rotated again to find the maximum of emission. At least, frequency and level of the six highest emissions relative to the limit have to be recorded. However, emissions more than 20 dB below the limit do not need to be reported.

If the EUT may be used in various positions, steps a) to i) are repeated in two other orthogonal positions. If the EUT may be used in one position only, steps a) to i) are repeated in one orthogonal position.

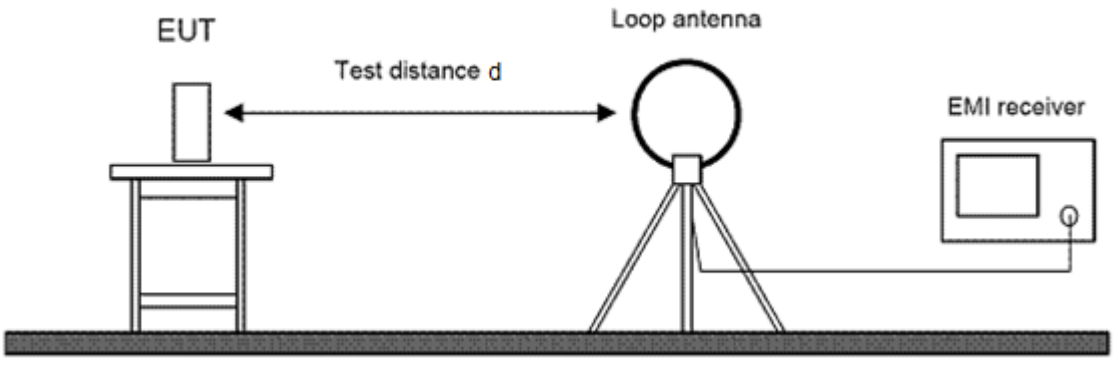

Figure 3: Setup for radiated emissions test below 30 MHz

5.5 Radiated emissions from 30 MHz to 1 GHz

Radiated emissions in the frequency range 30 MHz to 1 GHz are measured according to clause 6.5 of ANSI C63.10 using a semi-anechoic chamber (SAC) with a ground plane on the floor. The measurement distance is 3 meters. The emissions of the EUT are recorded with an EMI test receiver configured as described in table 10.

Frequency (f)	*Measurement receiver bandwidth*	*Step size*	*Detector type*		
			Prescan	*Prescan with FFT*	*Final scan*
30 MHz ≤ f ≤ 1 GHz	120 kHz	≤ 60 kHz	Peak	Quasi-peak	Quasi-peak

Table 10: Bandwidth and detector type for radiated emissions test from 30 MHz to 1 GHz

Frequency (MHz)	*Reading value (dBµV)*	*Antenna correction (dB/m)*	*Cable attenuation (dB)*	*Correction factor (Corr.) (dB)*	*Level (dBµV/m)*
100	30.00	11.71	1.06	12.77	42.77

Table 11: Sample calculation

Correction factor = Antenna correction + Cable attenuation

Level = Reading value + Correction factor = 30 dBµV + 12.77 dB = 42.77 dBµV/m

The measurement antenna is a combination of a biconical antenna and a logarithmic-periodic dipole array antenna. It is mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization and in a height between 1 m and 4 m above the ground plane.

If the test receiver is capable of FFT analysis, it is used for prescans, but not for final scans.

The radiated emissions test from 30 MHz to 1 GHz is performed in the following steps:

a) The measurement antenna is oriented initially for vertical polarization.
b) The EUT is placed in its standard position on a turntable capable of rotation through 360° in the horizontal plane and arranged as tabletop or floor-standing equipment, as applicable. The EUT is switched on.
c) The measurement equipment is connected to the measurement antenna and set-up according to the specifications of the test (see table 10).
d) The table position is set to 0°.
e) The antenna height is set to 1 m.
f) The spectrum for the full frequency range is recorded. If the emission at a certain frequency is higher than the levels already recorded, the polarization and height of the measurement antenna as well as the current table position are noted as the maximum position.
g) The antenna height is increased to 4 m in steps of 50 cm. At each height, step f) is repeated.
h) The polarization of the measurement antenna is changed to horizontal.
i) The antenna height is decreased from 4 m to 1 m in steps of 50 cm. At each height, step f) is repeated.
j) The EUT is rotated in a horizontal plane through 360° in steps of 60°. At each table position, steps e) to i) are repeated.
k) After the last prescan, the significant maximum emissions with their polarizations and heights of the measurement antenna as well as their table positions are determined and collected in a list.
l) With the test receiver set to the first frequency of the list, the measurement antenna is set to the polarization and height and the table is moved to the position as determined during prescans.
m) The antenna is moved by ±50 cm around this height and the EUT is rotated by ±60° around this table position while measuring the emission level continuously.
n) For final scan, the worst-case positions of antenna and table are set and the maximum emission level is recorded.
o) Steps l) to n) are repeated for all other frequencies in the list. At least, frequency and level of the six highest emissions relative to the limit have to be recorded. However, emissions more than 20 dB below the limit do not need to be reported.

If the EUT may be used in various positions, steps a) to o) are repeated in two other orthogonal positions.

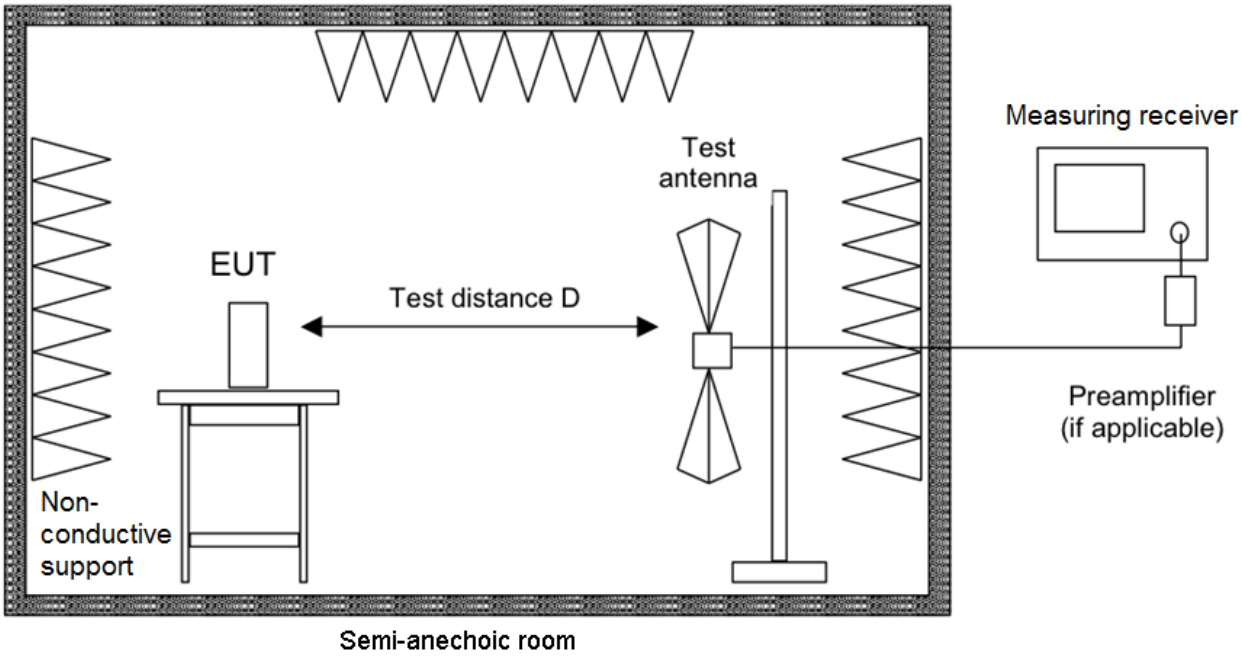

Figure 4: Setup for radiated emissions test from 30 MHz to 1 GHz

5.6 Radiated emissions above 1 GHz

Radiated emissions above 1 GHz are measured according to clause 6.6 of ANSI C63.10 by conducting exploratory and final radiated emission tests. According to clause 6.6.4.1 of ANSI C63.10, measurements may be performed at a distance closer than that specified in the requirements. However, an attempt shall be made to avoid making final measurements in the near field of both the measurement antenna and the EUT.

For measurement of radiated emissions above 1 GHz, horn antennas are used.

Test chamber	*Frequency (MHz)*	*Reading value (dBµV)*	*Antenna correction (dB/m)*	*Correction pre-amplifier (dB)*	*Cable attenuation (dB)*	*Correction factor (Corr.) (dB)*	*Level (dBµV/m)*
SAC3	2400	50.00	27.76	-47.91	5.24	-14.92	35.08
FS-SAC	2400	50.00	27.76	-34.57	3.51	-3.30	46.70

Table 12: Sample calculation

Correction factor = Antenna correction + Correction pre-amplifier + Cable attenuation

SAC3:
Level = Reading value + Correction factor = 50.00 dBµV - 14.92 dB/m = 35.08 dBµV/m

FS-SAC:
Level = Reading value + Correction factor = 50.00 dBµV - 3.30 dB/m = 46.70 dBµV/m

5.6.1 Exploratory radiated emissions measurements

Exploratory radiated emissions above 1 GHz are measured in a semi-anechoic chamber with RF absorbing material on the floor or a fully anechoic room. They are performed by moving the receiving antenna over all sides of the EUT at a closer distance (e.g. 0.5 or 1 m) while observing the display of the test receiver to find the emissions to be re-tested during final radiated emission measurements.

According to clause 5.3.3 of ANSI C63.10, when performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade of distance (inverse of linear distance for field-strength measurements). To simplify testing and documentation, the limits are increased accordingly instead of decreasing the results.

The emissions of the EUT are displayed and recorded with an EMI test receiver operating in the spectrum analyzer mode using the settings as described in table 13.

Frequency (f)	*Resolution bandwidth*	*Video bandwidth*	Sweep time	*Trace detector(s)*	*Trace mode(s)*	*Test*
f ≥ 1 GHz	1 MHz	3 MHz	AUTO	Max Peak, Average	Clear Write	Searching
					Max Hold	Recording

Table 13: Bandwidth and trace settings for exploratory radiated emissions test above 1 GHz

If during exploratory radiated emissions measurements no levels to be re-tested are found, the final radiated emissions measurement may be omitted. In this case, the chart of the exploratory radiated emissions measurements has to be reported.

5.6.2 Final radiated emissions measurements

Final radiated emissions above 1 GHz are measured in the semi-anechoic chamber (SAC3) or Free space semi-anechoic chamber (FS-SAC) with RF absorbing material on the floor between measurement antenna and EUT. The measurement distance is 3 meters in the semi-anechoic chamber (SAC3) or 1.5 m in the Free space semi-anechoic chamber (FS-SAC). The emissions of the EUT are recorded with an EMI test receiver configured as described in table 14.

Frequency (f)	*Measurement receiver bandwidth*	*Step size*	*Detector type*	
			Prescan	*Final scan*
f ≥ 1 GHz	1 MHz	≤ 500 kHz	Peak, Average	Peak, Average

Table 14: Bandwidth and detector type for final radiated emissions test above 1 GHz

Prescans are performed with both detectors activated at the same time. If the test receiver is capable of FFT analysis, it is used for prescans, but not for final scans.

The horn antenna is mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization and to be moved in a scan height range between 1 m and the scan height upper range defined in clause 6.6.3.3 of ANSI C63.10. When the EUT is manipulated through three different orientations, the scan height upper range for the measurement antenna is limited to 2.5 m above the ground plane.or 0.5 m above the top of the EUT, whichever is higher. Otherwise, the scan height upper range is 4 m above the ground plane.
To keep the emission signal within the illumination area of the 3 dB beamwidth of the measurement antenna, the automatic tilt function of the antenna support device is used to point the antenna at an angle toward the source of the emission.

The final radiated emissions test above 1 GHz is performed in the following steps:

a) The measurement antenna is oriented initially for vertical polarization.
b) The EUT is placed in its standard position on a turntable capable of rotation through 360° in the horizontal plane and arranged as tabletop or floor-standing equipment, as applicable. The EUT is switched on.
c) The measurement equipment is connected to the measurement antenna and set-up according to the specifications of the test (see table 14).
d) The table position is set to 0°.
e) The antenna height is set to 1 m.
f) The spectrum for the full frequency range is recorded. If the emission at a certain frequency is higher than the levels already recorded, the polarization and height of the measurement antenna as well as the current table position are noted as the maximum position.
g) The antenna height is increased to the scan height upper range in steps of 50 cm. At each height, step f) is repeated.
h) The polarization of the measurement antenna is changed to horizontal.
i) The antenna height is decreased from the scan height upper range to 1 m in steps of 50 cm. At each height, step f) is repeated.
j) The EUT is rotated in a horizontal plane through 360° in steps of 30°. At each table position, steps e) to i) are repeated.
k) After the last prescan, the significant maximum emissions with their polarizations and heights of the measurement antenna as well as their table positions are determined and collected in a list.
l) With the test receiver set to the first frequency of the list, the measurement antenna is set to the polarization and height and the table is moved to the position as determined during prescans.
m) The antenna is moved by ±50 cm around this height and the EUT is rotated by ±30° around this table position while measuring the emission level continuously.
n) For final scan, the worst-case positions of antenna and table are set and the maximum emission level is recorded.
o) Steps l) to n) are repeated for all other frequencies in the list. At least, frequency and level of the six highest emissions relative to the limit have to be recorded. However, emissions more than 20 dB below the limit do not need to be reported.

If the EUT may be used in various positions, steps a) to o) are repeated in two other orthogonal positions.

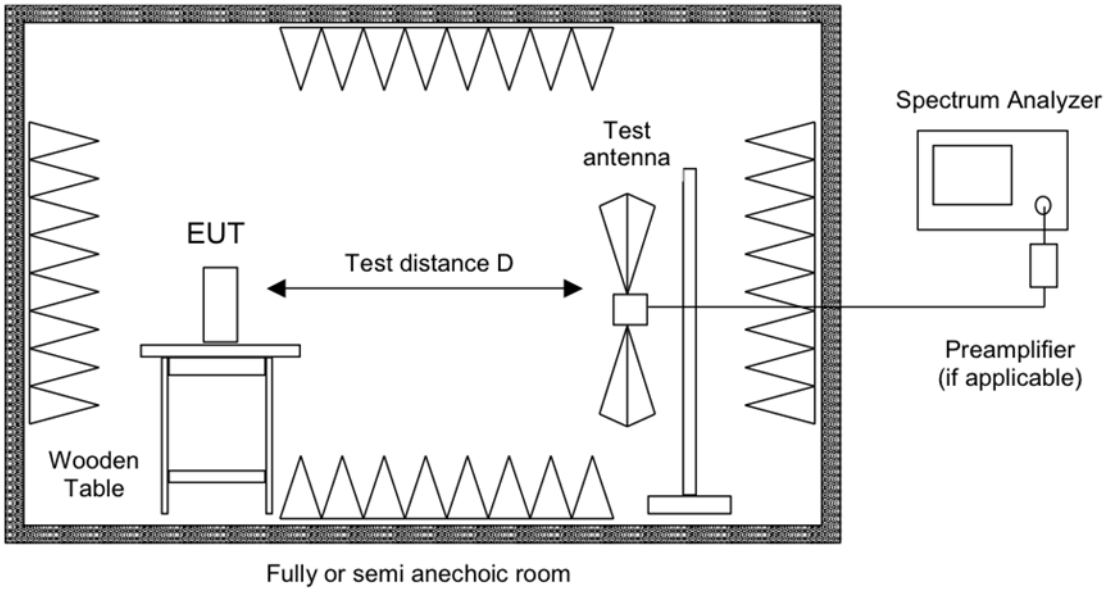

Figure 5: Setup for radiated emissions test above 1 GHz

5.7 Bandwidth measurements

In case of antenna-port conducted tests as described in clause 5.2 cannot be performed, according to section 3.0 of KDB 558074 D01, results of radiated tests are used for demonstrating compliance to the conducted emission requirements. For details about conversion see clause 5.1.2

5.7.1 6 dB bandwidth (DTS bandwidth)

The 6 dB bandwidth or DTS bandwidth is measured according to clause 8.0 of KDB Publication 558074, document D01, using the following settings:

a) Resolution bandwidth RBW = 100 kHz
b) Video bandwidth (VBW) ≥ 3 x RBW
c) Detector = Peak
d) Trace mode = max hold
e) Sweep = auto couple

After the trace is stabilized, the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

If using the automatic bandwidth measurement capability of the test instrument (6 dB down function), care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB. In addition, it has to be checked that this function delivers the two outermost amplitude points.

5.7.2 99 % occupied bandwidth

According to section 6.7 of RSS-Gen, the occupied bandwidth (OBW) is defined as the 99 % emission bandwidth.

The span of the spectrum analyzer is set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
The resolution bandwidth is in the range of 1 % to 5 % of the occupied bandwidth and the video bandwidth is not smaller than three times the resolution bandwidth. Video averaging is not permitted.
If possible, the detector of the spectrum analyzer is set to “Sample”. However, if the device is not transmitting continuously, a peak, or peak hold is used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement).

To measure the 99 % emission bandwidth, the OBW function of the test receiver is used with the power bandwidth set to 99 %. This function indicates the lowest frequency (starting from the left side of the span) and the highest frequency (starting from the right side of the span) where 0.5% of the total sum is reached. The difference between the two frequencies is the 99 % occupied bandwidth.

5.8 Maximum peak conducted output power

In case of antenna-port conducted tests as described in clause 5.2 cannot be performed, according to section 3.0 of KDB 558074 D01, results of radiated tests are used for demonstrating compliance to the conducted emission requirements. For details about conversion see clause 5.1.2

The maximum conducted output power test method for digital transmission systems (DTS) refers to section 8.3.1.1 of KDB Publication 558074, document D01.

The spectrum analyzer settings are as follows:

a) Span ≥ 3 x RBW, centered on a channel
b) RBW ≥ DTS bandwidth
c) VBW ≥ 3 x RBW
d) Sweep time = auto coupled
e) Detector function = peak
f) Trace mode = max hold
g) Reference level = more than 10·log(OBW/RBW) dB above peak of spectral envelope

After the trace is stabilized, the marker-to-peak function is used to set the marker to the peak of the emission. The indicated level is the maximum peak conducted output power.

5.9 Power spectral density

The power spectral density test method for DTS systems refers to section 8.4 of KDB Publication 558074, document D01.

The spectrum analyzer settings are as follows:

a) Span = 1.5 times the DTS bandwidth, centered on a channel
b) RBW: 3 kHz ≤ RBW ≤ 100 kHz
c) VBW ≥ 3 x RBW
d) Sweep time = auto coupled or ≥ span/RBW in seconds, whichever is greater
e) Detector function = peak
f) Trace mode = max hold
g) Reference level = more than 10·log(OBW/RBW) dB above peak of spectral envelope

After the trace is stabilized, the marker-to-peak function is used to set the marker to the peak of the emission. The indicated level is the power spectral density.

In case of antenna-port conducted tests as described in clause 5.2 cannot be performed, according to section 3.0 of KDB 558074 D01, results of radiated tests are used for demonstrating compliance to the conducted emission requirements. For details about conversion see clause 5.1.2

5.10 Duty cycle

Measurements of duty cycle and transmission duration shall be performed using one of the following techniques:

a) A diode detector and an oscilloscope that together have a sufficiently short response time to permit accurate measurements of the ON and OFF times of the transmitted signal.
b) The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the ON and OFF times of the transmitted signal:
    1) Set the center frequency of the instrument to the center frequency of the transmission.
    2) Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value.
    3) Set VBW ≥ RBW. Set detector = peak or average.
    4) The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring the duty cycle shall not be used if T ≤ 16.7 μs.)

6 Test results

This clause gives details about the test results as collected in the summary of test results on page 8.

For information about measurement uncertainties see page 105.

The climatic conditions are recorded during the tests. It is ensured that the climatic conditions are within the following ranges:

Ambient temperature	*Ambient humidity*	*Ambient pressure*
15°C to 35°C	30 % to 75 %	86 kPa to 106 kPa

Note(s):
1. All tests were performed at 120 V and 60 Hz.

6.1 AC powerline conducted emissions

Section(s) in 47 CFR Part 15:	Requirement(s):	15.207(a)
	Reference(s)	ANSI C63.10, clause 6.2
Section(s) in RSS:	Requirement(s):	RSS-Gen, section 8.8
	Reference(s):	ANSI C63.10, clause 6.2

Performed by:	Jennifer Riedel B. Eng.	Date(s) of test:	July 25, 2022
Result:	☒ Test passed	☐ Test not passed	

6.1.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
Shielded room	P92007	Siemens Matsushita	E00107
EMI test receiver	ESR 7	Rohde & Schwarz	E01549
Artificial mains network	ESH2-Z5	Rohde & Schwarz	E00004
Attenuator (10 dB)	50FHB-010-10	JFW Industries	E00471
Cable set shielded room	RG 223/U RG 223/U	AME HF-Technik AME HF-Technik	E00741 E00804
Test software	EMC32-(M)EB, V10.60.20	Rohde & Schwarz	E00777, E00778 or E01073

6.1.2 Limits

According to §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 ohms 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.

According to §15.207(c):
Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

According to RSS-Gen, section 8.8:
Unless stated otherwise in the applicable RSS, for radio apparatus that are designed to be connected to the public utility AC power network, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the range 150 kHz to 30 MHz shall not exceed the limits in of the following table, as measured using a 50 µH / 50 Ω line impedance stabilization network. This requirement applies for the radio frequency voltage measured between each power line and the ground terminal of each AC power-line mains cable of the EUT.

For an EUT that connects to the AC power lines indirectly, through another device, the requirement for compliance with the limits in the following table shall apply at the terminals of the AC power-line mains cable of a representative support device, while it provides power to the EUT. The lower limit applies at the boundary between the frequency ranges. The device used to power the EUT shall be representative of typical applications.

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

Table 15: Limits for AC powerline conducted emissions according to 15.207(a) and RSS-Gen, section 8.8

*Decreases with the logarithm of the frequency

6.1.3 Test procedure

The AC powerline conducted emissions are measured using the test procedure as described in clause 5.3.

6.1.4 Test results

Note(s):
1. No assessable emissions were detected.
2. The EUT was continuously transmitting on channel 2412 MHz in modulation IEEE 802.11 b.

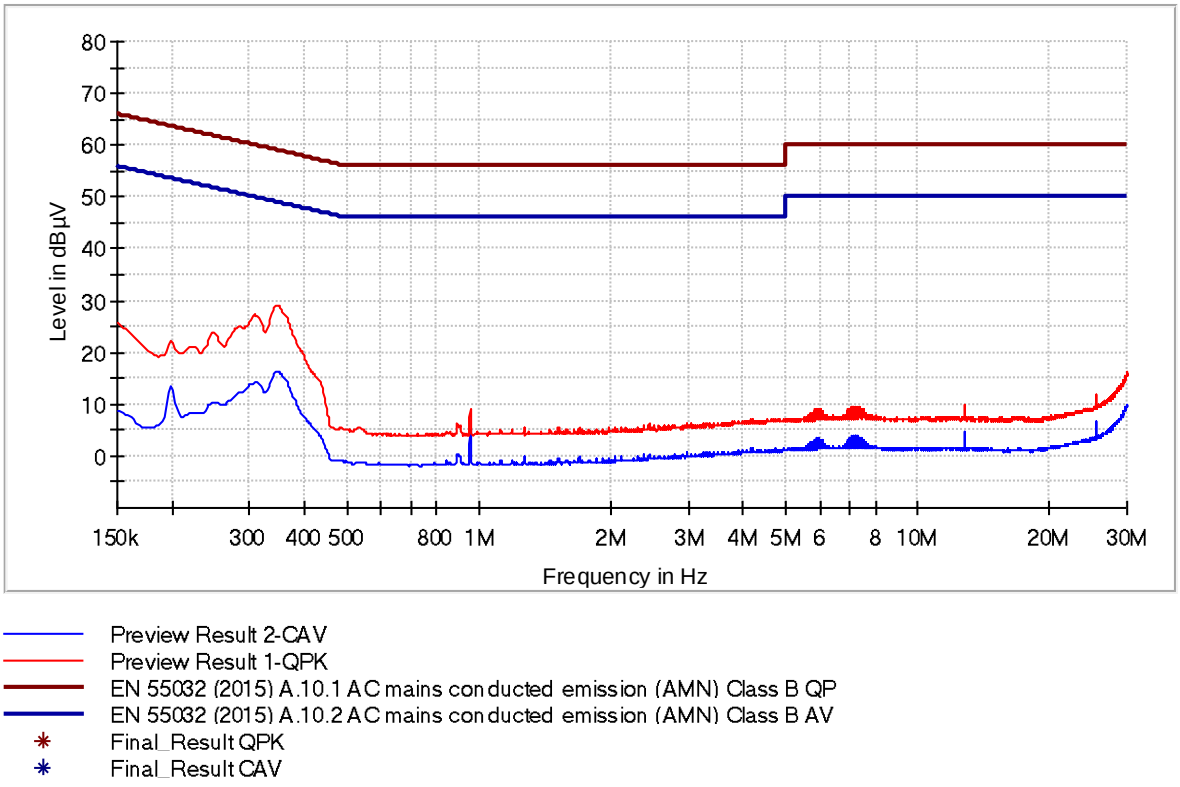

Figure 6: Chart of AC powerline conducted emissions on L1

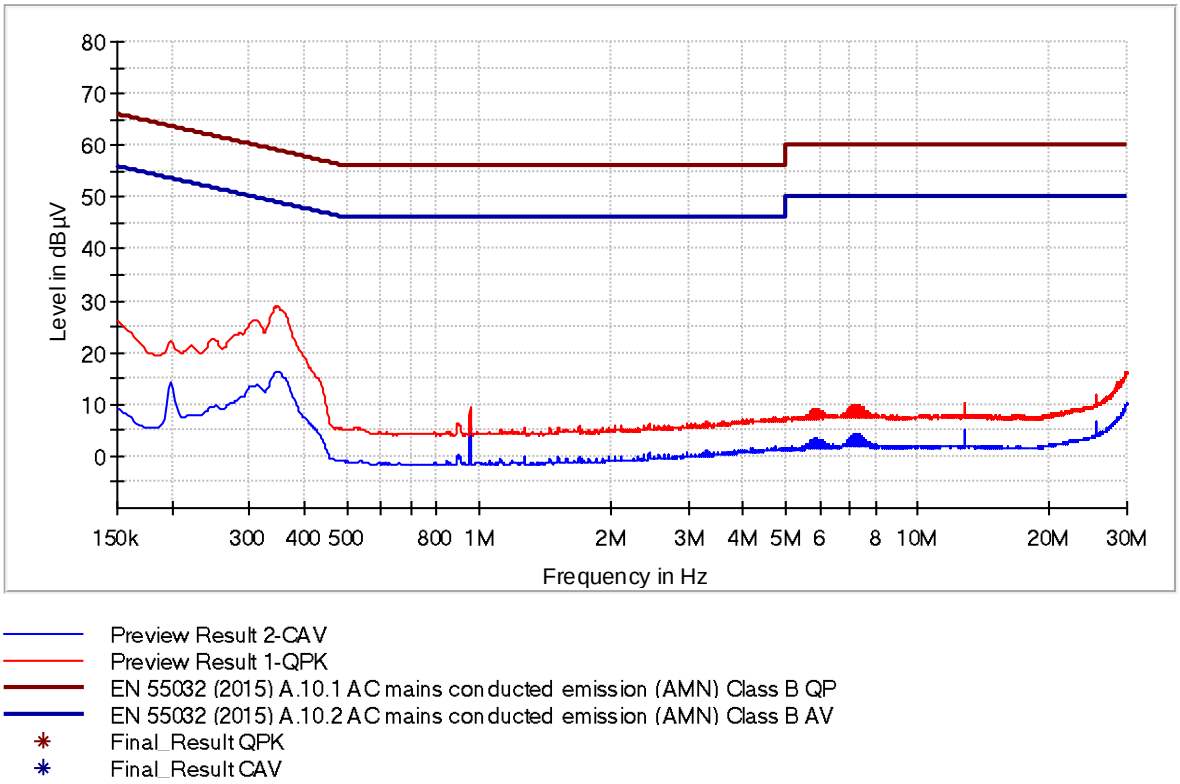

Figure 7: Chart of AC powerline conducted emissions on N

6.2 Duty cycle

Section(s) in 47 CFR Part 15:	Requirement(s):	KDB558074 D01, clause 6
	Reference(s):	KDB558074 D01, clause 6 ANSI C63.10, clause 11.6
Section(s) in RSS:	Requirement(s):	KDB558074 D01, clause 6
	Reference(s):	KDB558074 D01, clause 6 ANSI C63.10, clause 11.6

Performed by:	Jennifer Riedel B. Eng.	Date(s) of test:	June 27, 2022
Result:	☒ Test passed	☐ Test not passed	

6.2.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
EMI test receiver	ESU 26	Rohde & Schwarz	W00002

6.2.2 Limits

According to KDB 558074 D01 v05r02 clause 6:

When continuous transmission cannot be achieved and sweep triggering/signal gating cannot be implemented, alternate procedures are provided than can be used to measure the average power; however, they will require an additional measurement of the transmitter duty cycle. Within this guidance document, the duty cycle refers to the fraction of time over which the transmitter is on and is transmitting at its maximum power control level. The duty cycle is considered to be constant if variations are less than ± 2 %, otherwise the duty cycle is considered to be non-constant.

6.2.3 Test procedure

The duty cycle is measured using the test procedure as described in clause 5.10 and referring to the

☒ test method for conducted measurements as described in clause 5.2.
☐ test method for radiated measurements as described in clause 5.6.

6.2.4 Test results

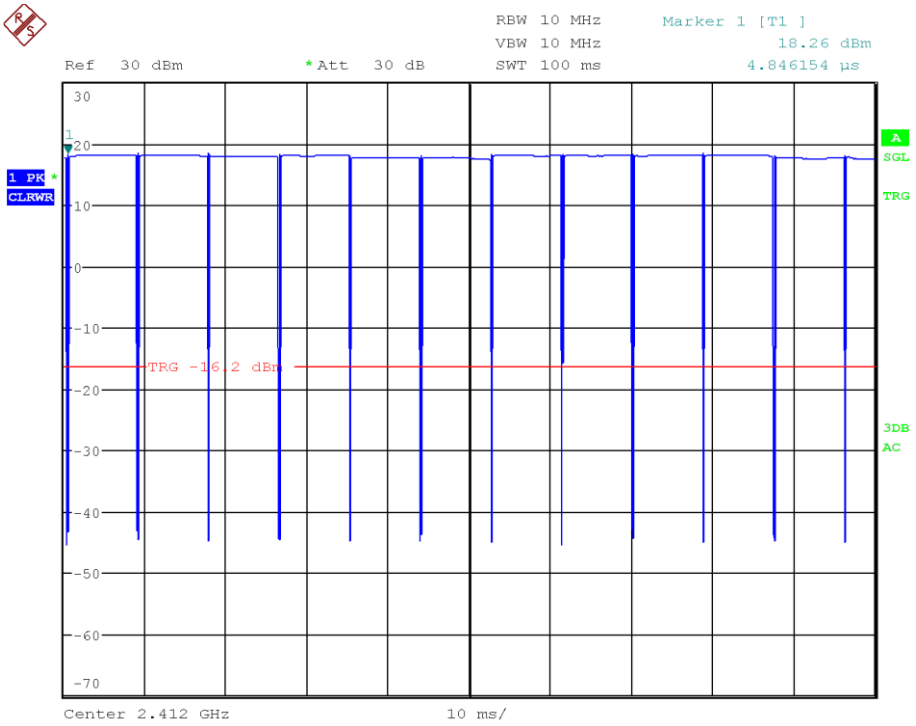

Figure 8: Chart of duty cycle on lowest channel (modulation IEEE 802.11 b) in 100 ms

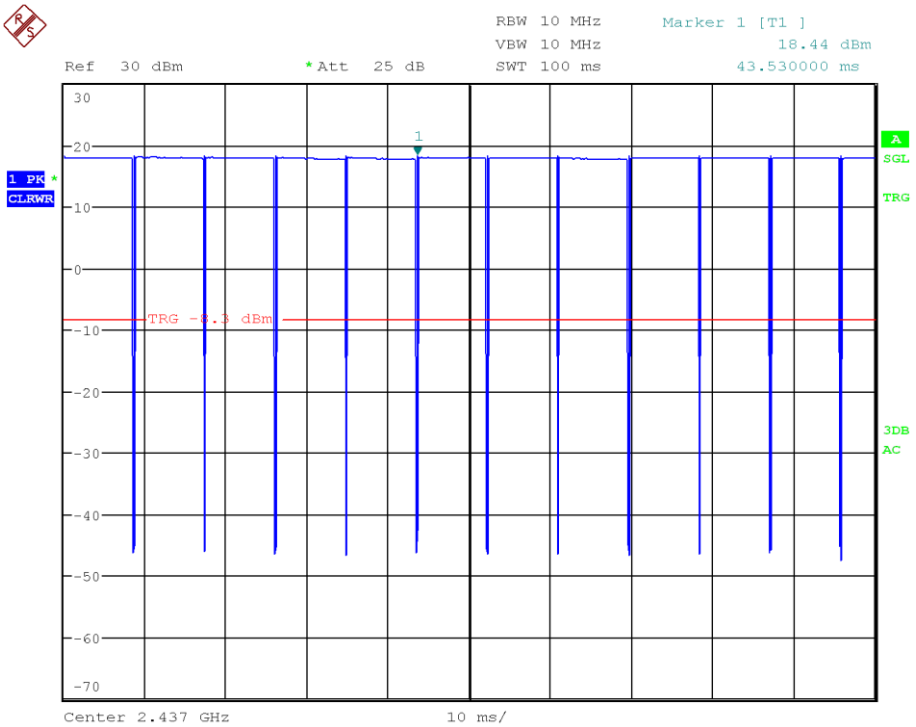

Figure 9: Chart of duty cycle on middle channel (modulation IEEE 802.11 b) in 100 ms

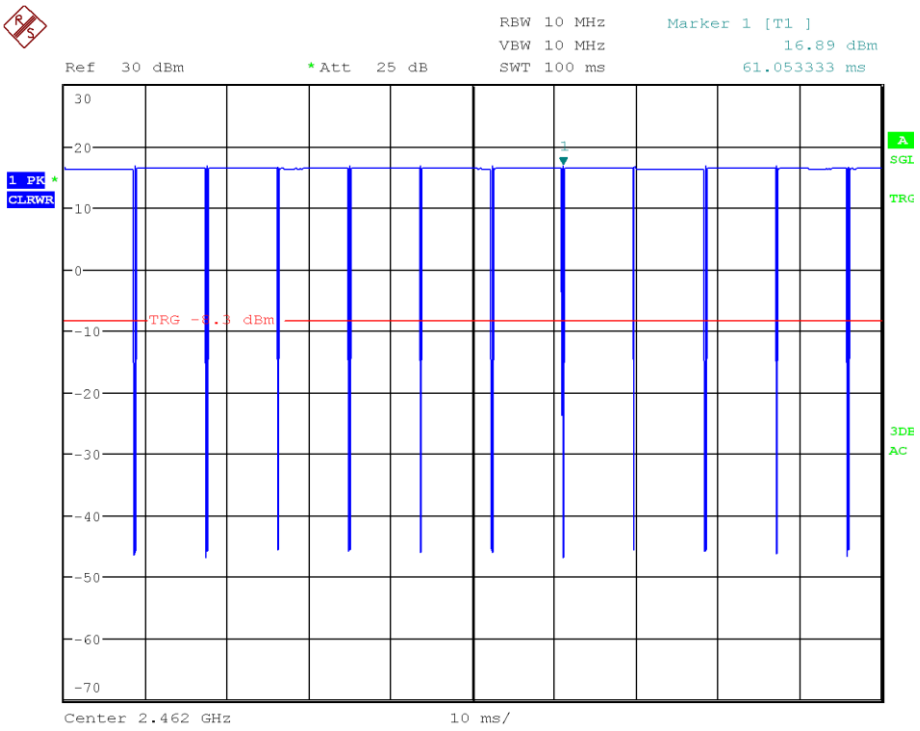

Figure 10: Chart of duty cycle on highest channel (modulation IEEE 802.11 b) in 100 ms

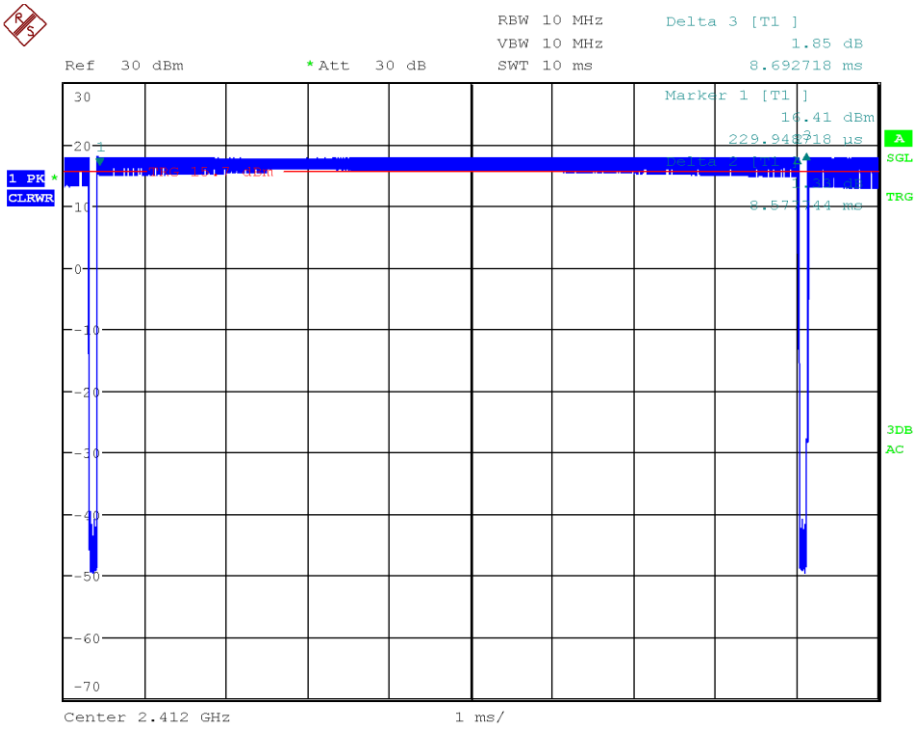

Figure 11: Chart of burst on lowest channel (modulation IEEE 802.11 b)

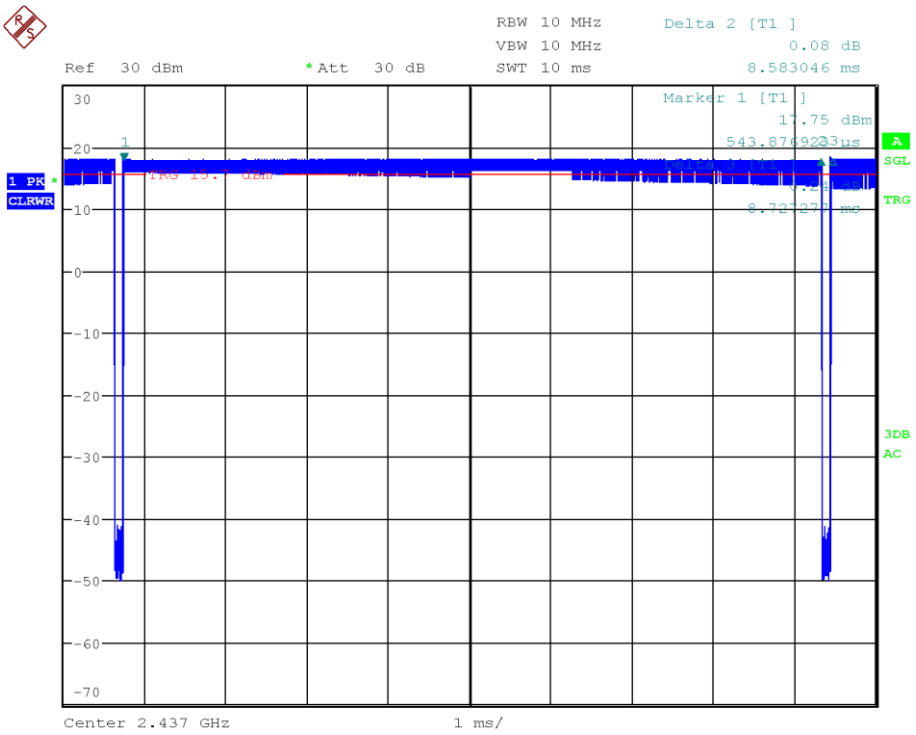

Figure 12: Chart of burst on middle channel (modulation IEEE 802.11 b)

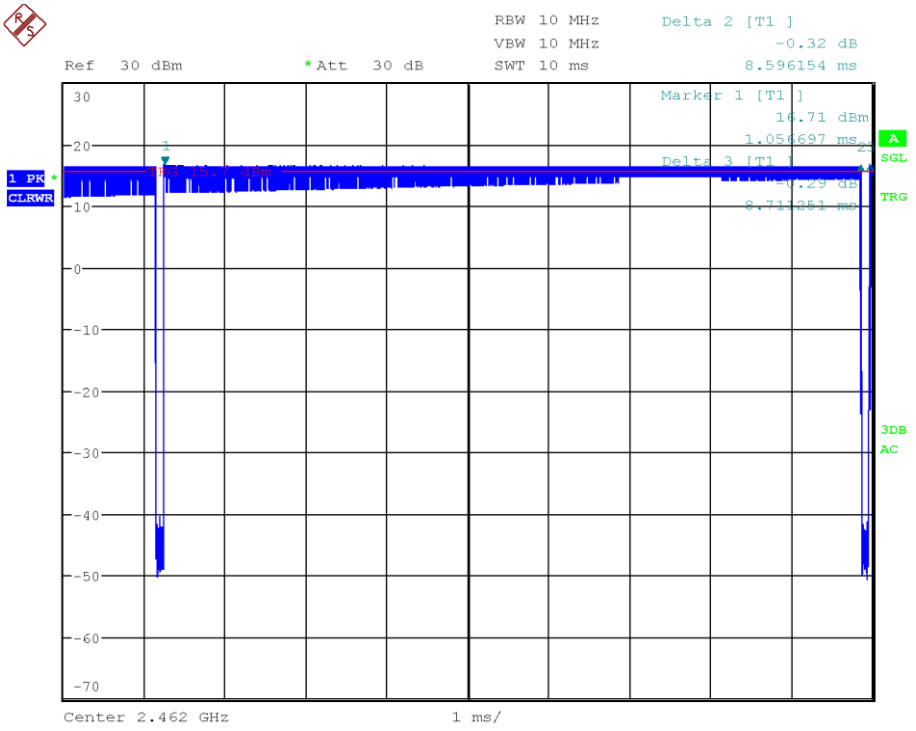

Figure 13: Chart of burst on highest channel (modulation IEEE 802.11 b)

Channel	*Number of bursts in 100 ms*	*Burst length (ms)*	*Duty cycle (%)*
low	11	8.578	94.36
middle	11	8.727	96.00
high	11	8.711	95.82

Table 16: Results of duty cycle in modulation IEEE 802.11 b

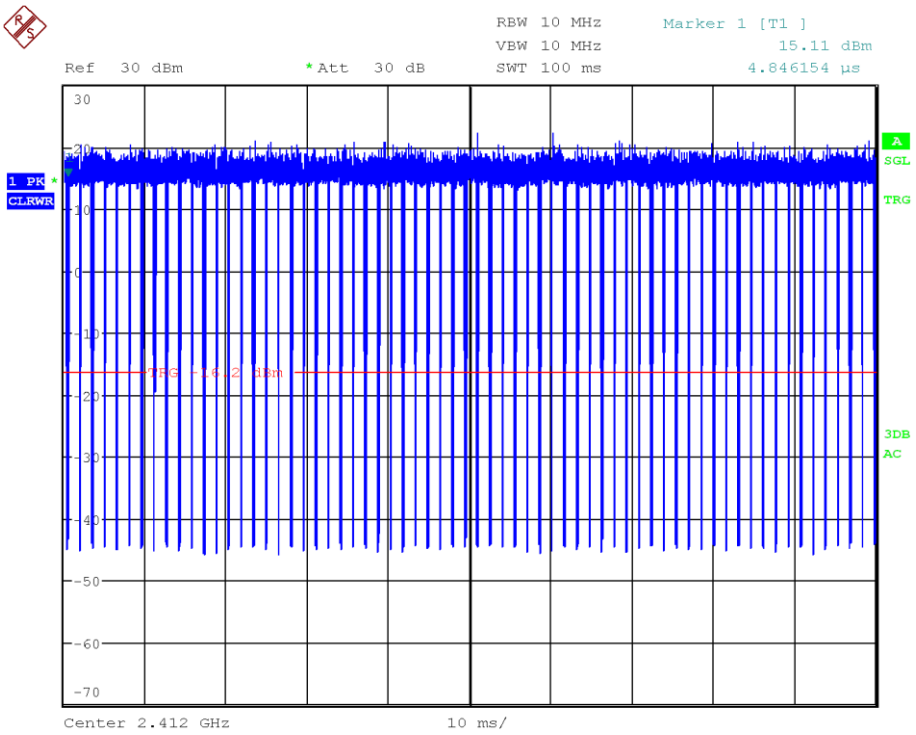

Figure 14: Chart of duty cycle on lowest channel (modulation IEEE 802.11 g) in 100 ms

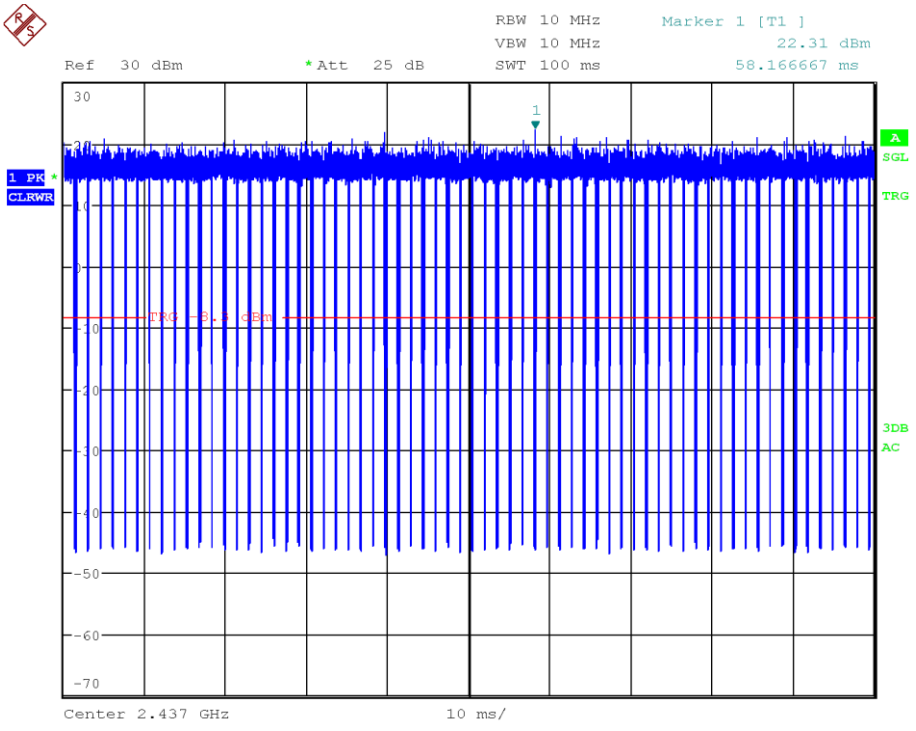

Figure 15: Chart of duty cycle on middle channel (modulation IEEE 802.11 g) in 100 ms

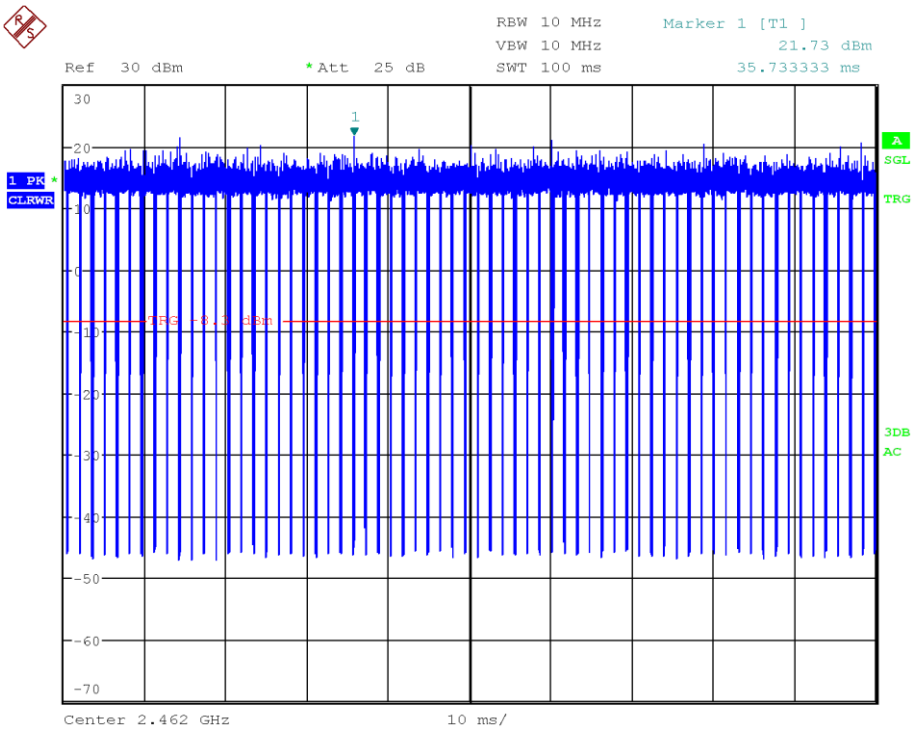

Figure 16: Chart of duty cycle on highest channel (modulation IEEE 802.11 g) in 100 ms

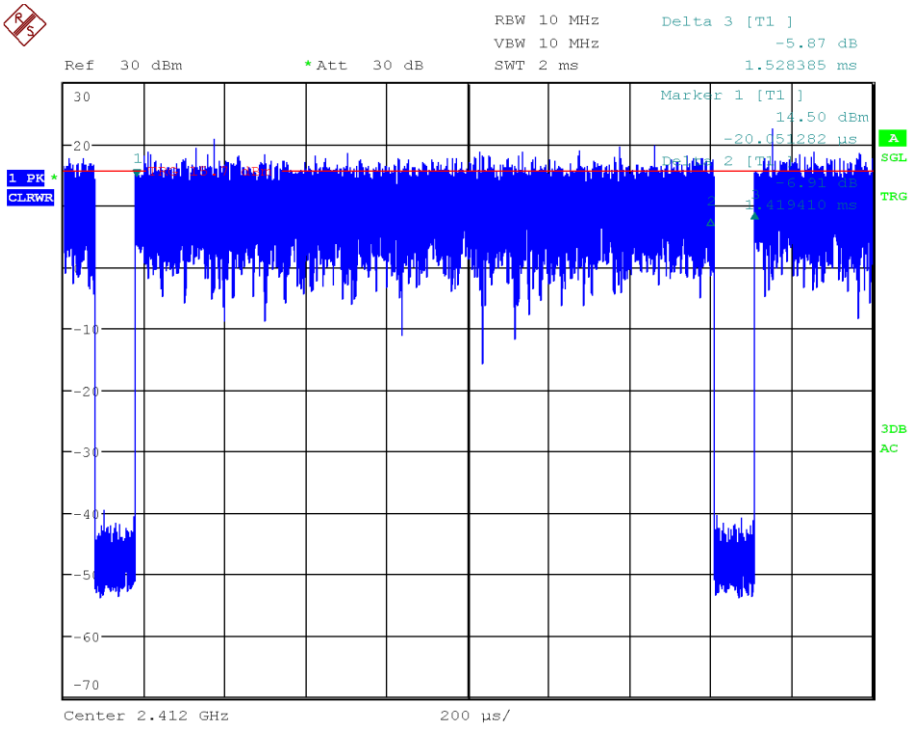

Figure 17: Chart of burst on lowest channel (modulation IEEE 802.11 g)

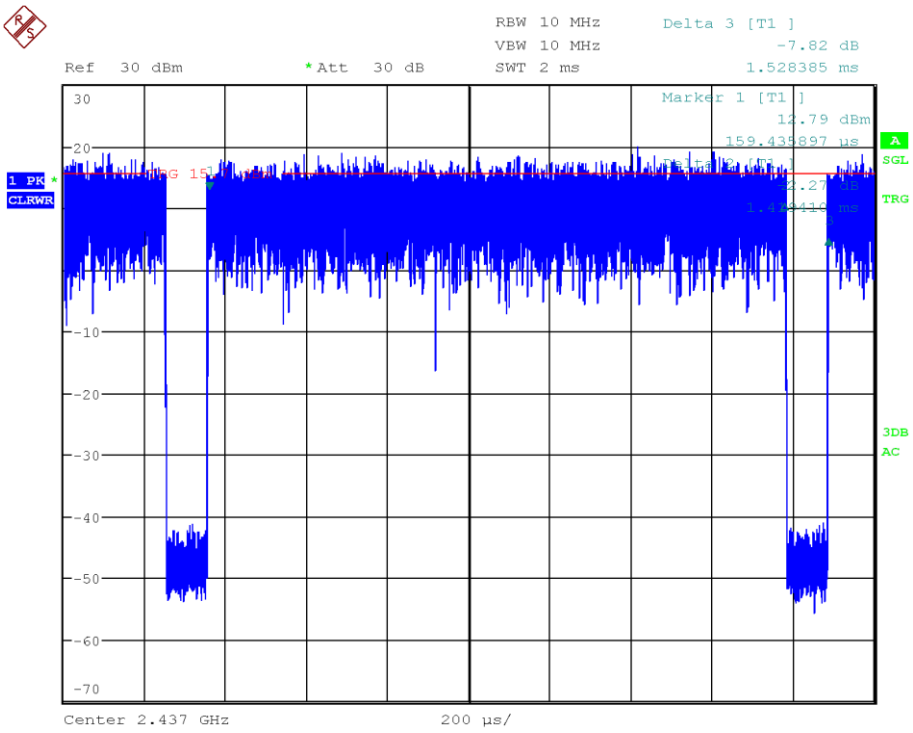

Figure 18: Chart of burst on middle channel (modulation IEEE 802.11 g)

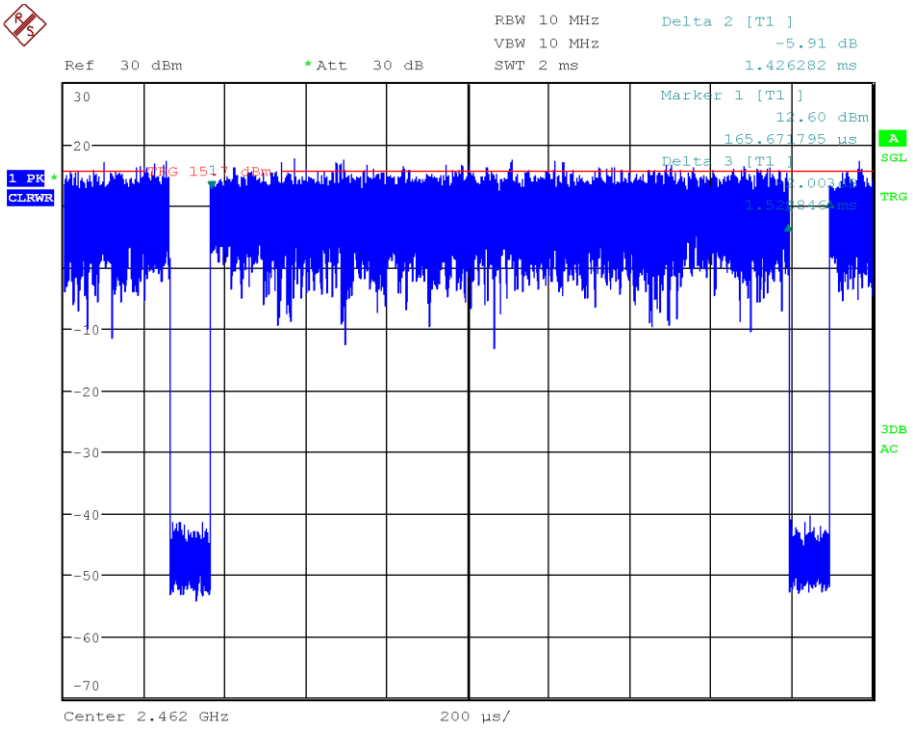

Figure 19: Chart of burst on highest channel (modulation IEEE 802.11 g)

Channel	*Number of bursts in 100 ms*	*Burst length (ms)*	*Duty cycle (%)*
low	65	1.419	92.24
middle	65	1.419	92.24
high	65	1.426	92.69

Table 17: Results of duty cycle in modulation IEEE 802.11 g

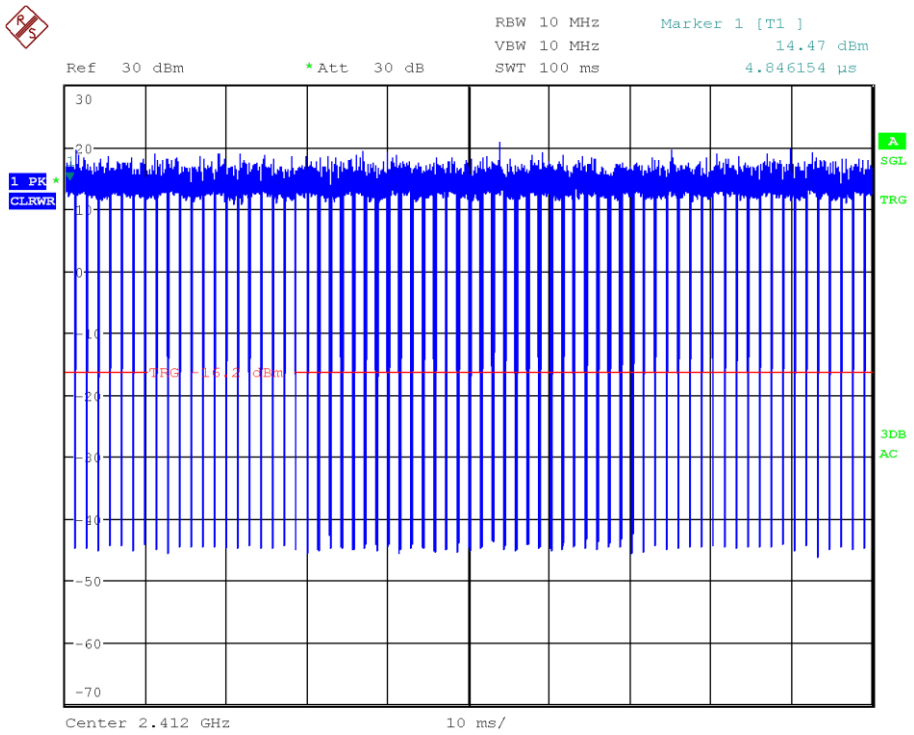

Figure 20: Chart of duty cycle on lowest channel (modulation IEEE 802.11 n (HT20)) in 100 ms

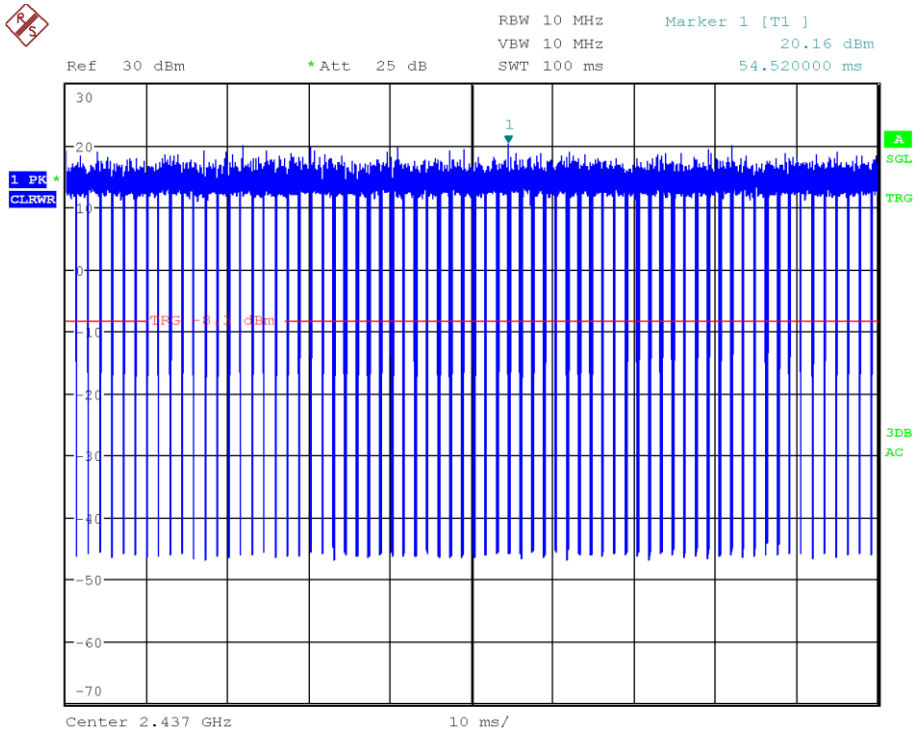

Figure 21: Chart of duty cycle on middle channel (modulation IEEE 802.11 n (HT20)) in 100 ms

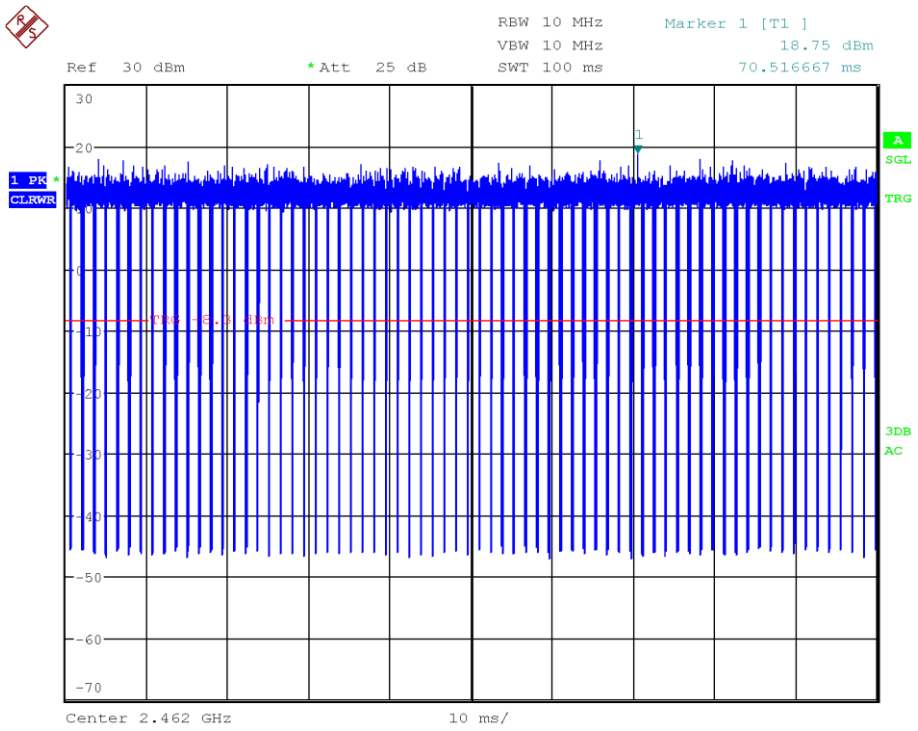

Figure 22: Chart of duty cycle on highest channel (modulation IEEE 802.11 n (HT20)) in 100 ms

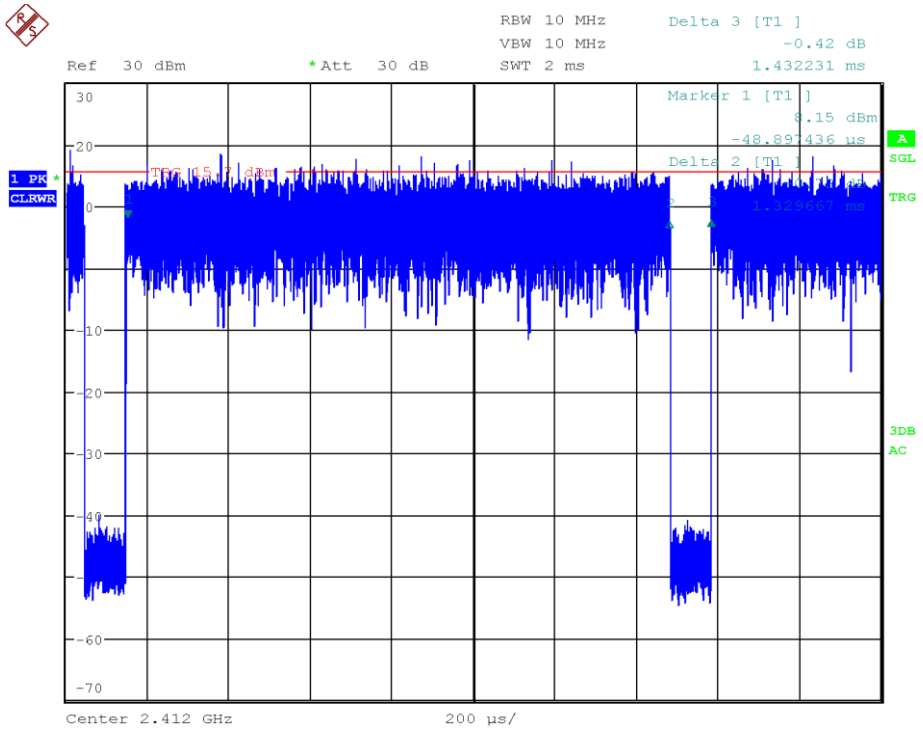

Figure 23: Chart of burst on lowest channel (modulation IEEE 802.11 n (HT20))

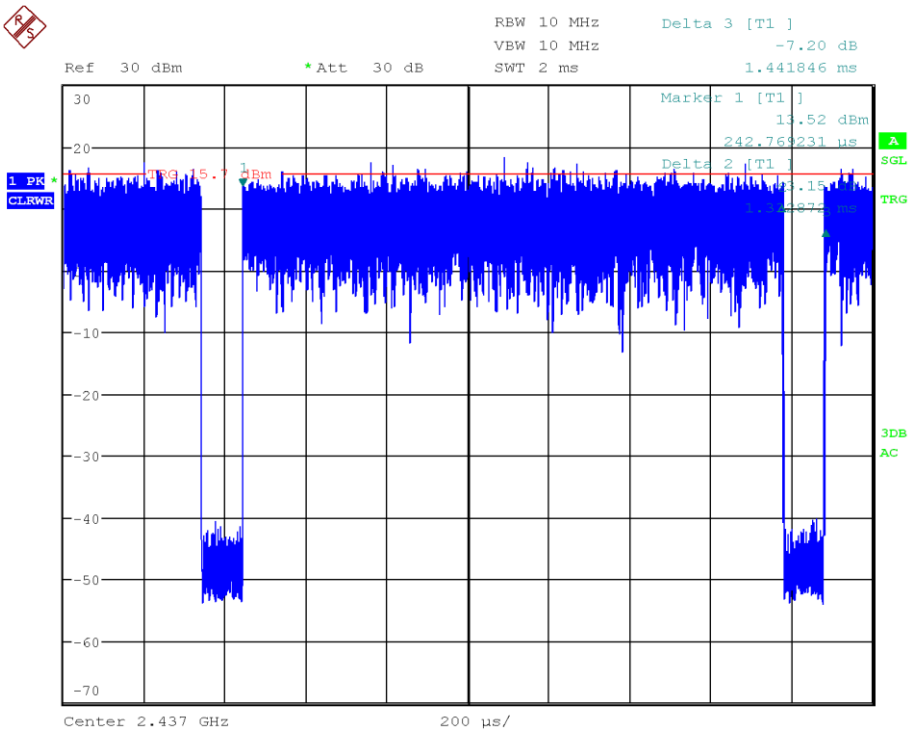

Figure 24: Chart of burst on middle channel (modulation IEEE 802.11 n (HT20))

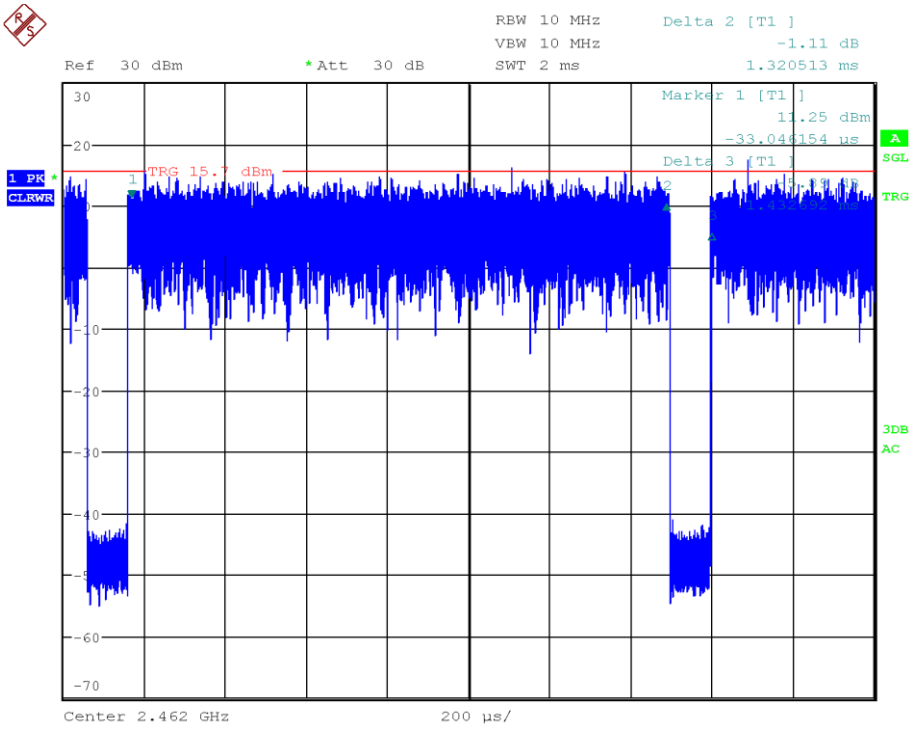

Figure 25: Chart of burst on highest channel (modulation IEEE 802.11 n (HT20))

Channel	*Number of bursts in 100 ms*	*Burst length (ms)*	*Duty cycle (%)*
low	69	1.330	91.77
middle	69	1.323	91.29
high	69	1.321	91.15

Table 18: Results of duty cycle in modulation IEEE 802.11 n (HT20)

6.3 6 dB bandwidth

Section(s) in 47 CFR Part 15:	Requirement(s):	15.247(a)(2)
	Reference(s):	KDB558074 D01, clause 8.2 ANSI C63.10, clause 11.8
Section(s) in RSS:	Requirement(s):	RSS-247, section 5.2(a)
	Reference(s):	KDB558074 D01, clause 8.2 ANSI C63.10, clause 11.8

Performed by:	Jennifer Riedel B. Eng.	Date(s) of test:	June 27, 2022
Result:	☒ Test passed	☐ Test not passed	

6.3.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
EMI test receiver	ESW 44	Rohde & Schwarz	E00895

6.3.2 Limits

According to §15.247(a)(2) and RSS-247 section 5.2(a):
Systems using digital modulation techniques (DTS) may operate in the 2400-2483.5 MHz band. The minimum 6 dB bandwidth shall be at least 500 kHz.

6.3.3 Test procedure

The 6 dB bandwidth is measured using the test procedure as described in clause 5.7.1 and referring to the

☒ test method for conducted measurements as described in clause 5.2.
☐ test method for radiated measurements as described in clause 5.6.

6.3.4 Test results

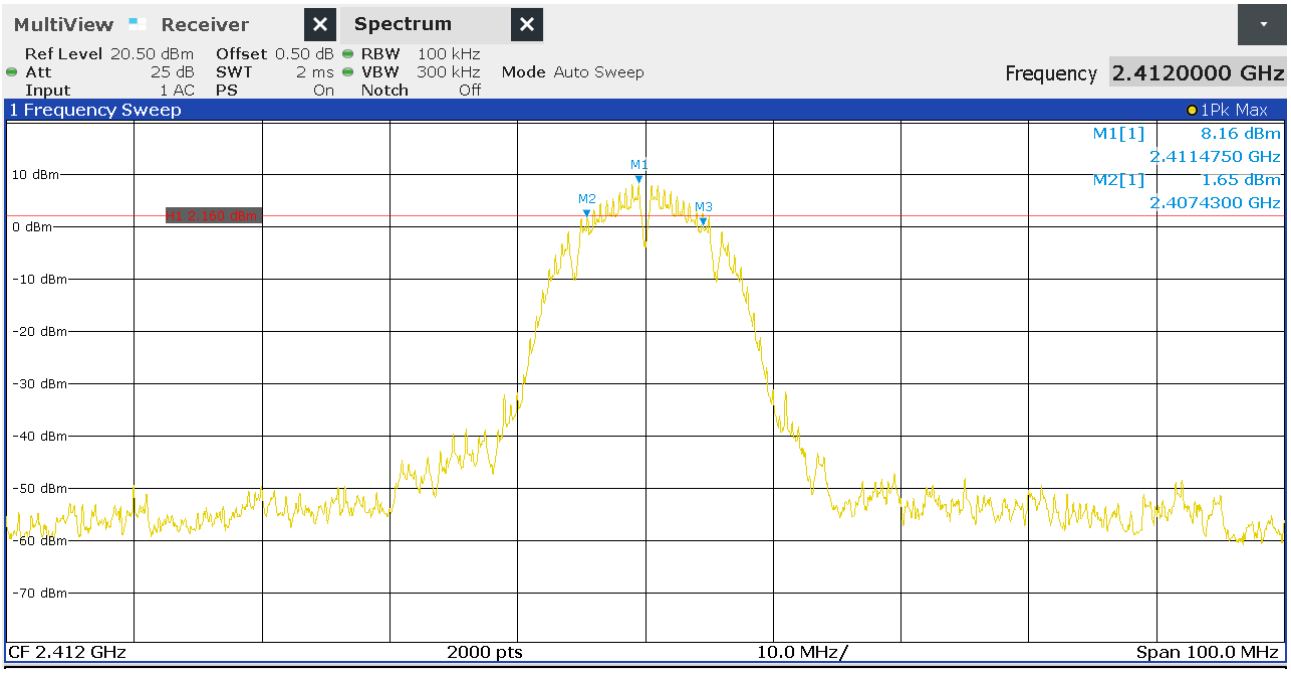

Figure 26: Chart of 6 dB bandwidth test on lowest channel in modulation IEEE 802.11 b

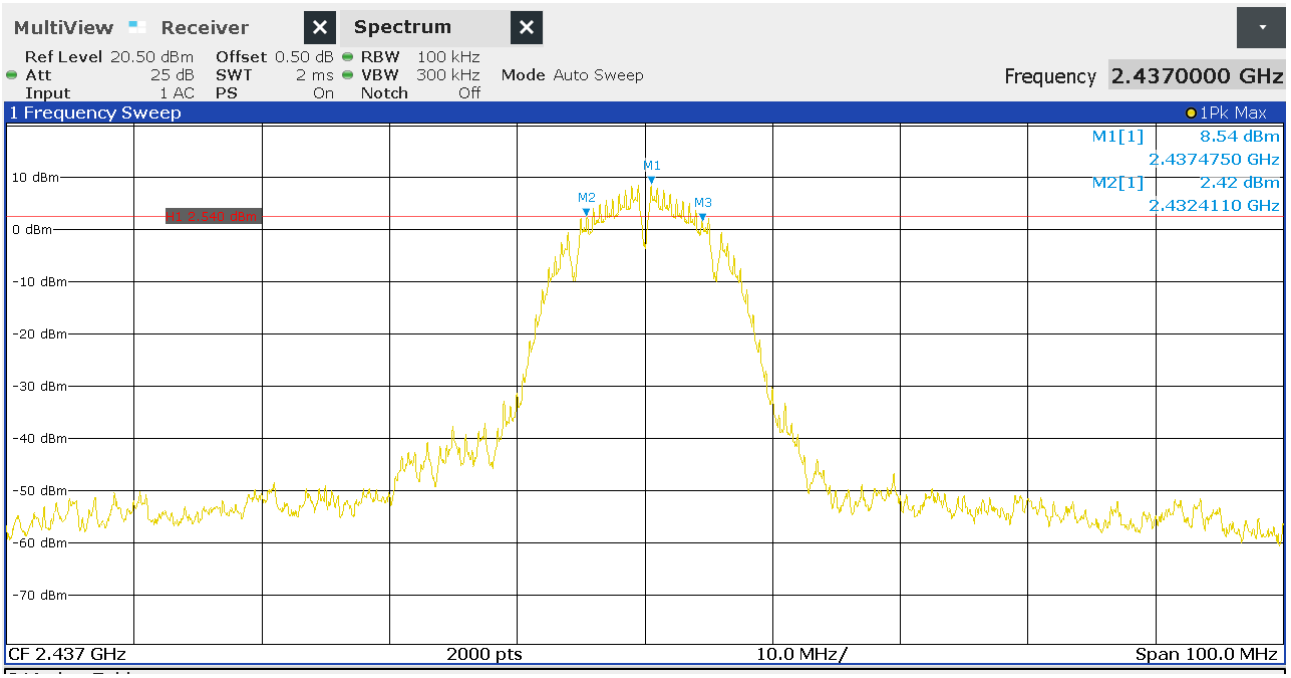

Figure 27: Chart of 6 dB bandwidth test on middle channel in modulation IEEE 802.11 b

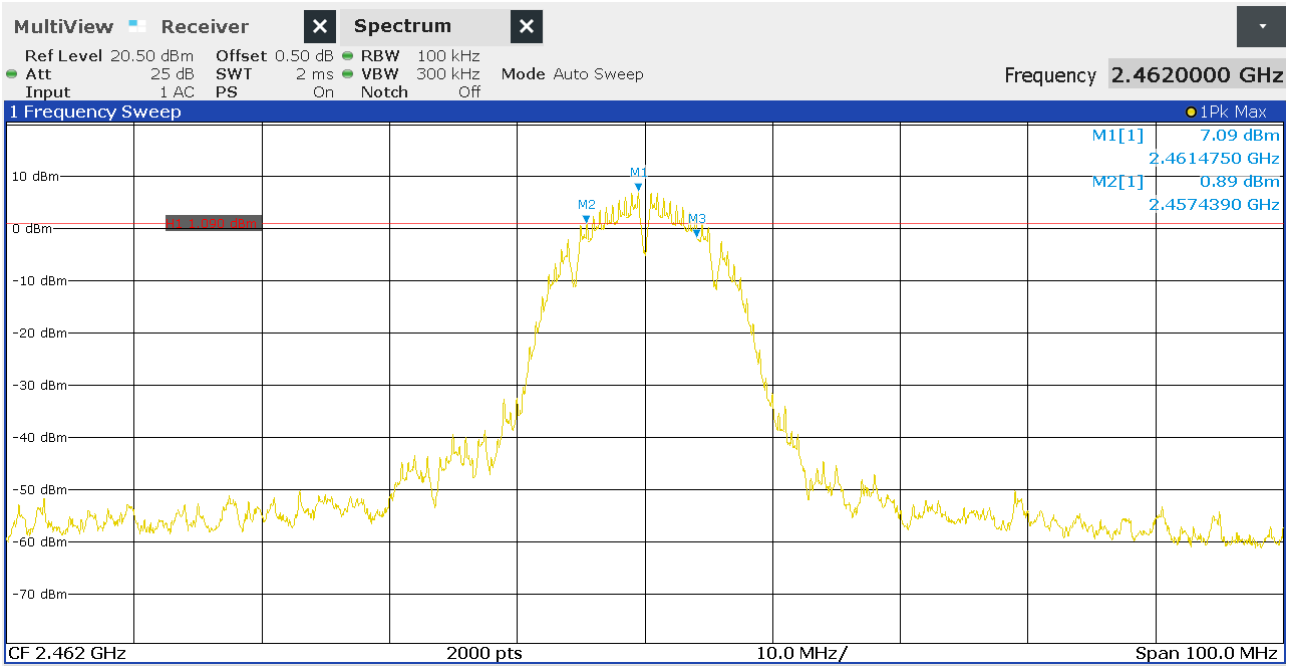

Figure 28: Chart of 6 dB bandwidth test on highest channel in modulation IEEE 802.11 b

Channel	*6 dB bandwidth (MHz)*	*Bandwidth limit (kHz)*	*Lower frequency of bandwidth (MHz)*	*Lower frequency of designated band (MHz)*	*Upper frequency of bandwidth (MHz)*	*Upper frequency of designated band (MHz)*	*Result*
low	9.08	≥ 500	2416.511	2400.000	2407.430	2483.500	Passed
middle	9.11	≥ 500	2432.411	2400.000	2441.525	2483.500	Passed
high	8.62	≥ 500	2457.439	2400.000	2466.061	2483.500	Passed

Table 19: Results of 6 dB bandwidth test in modulation IEEE 802.11 b

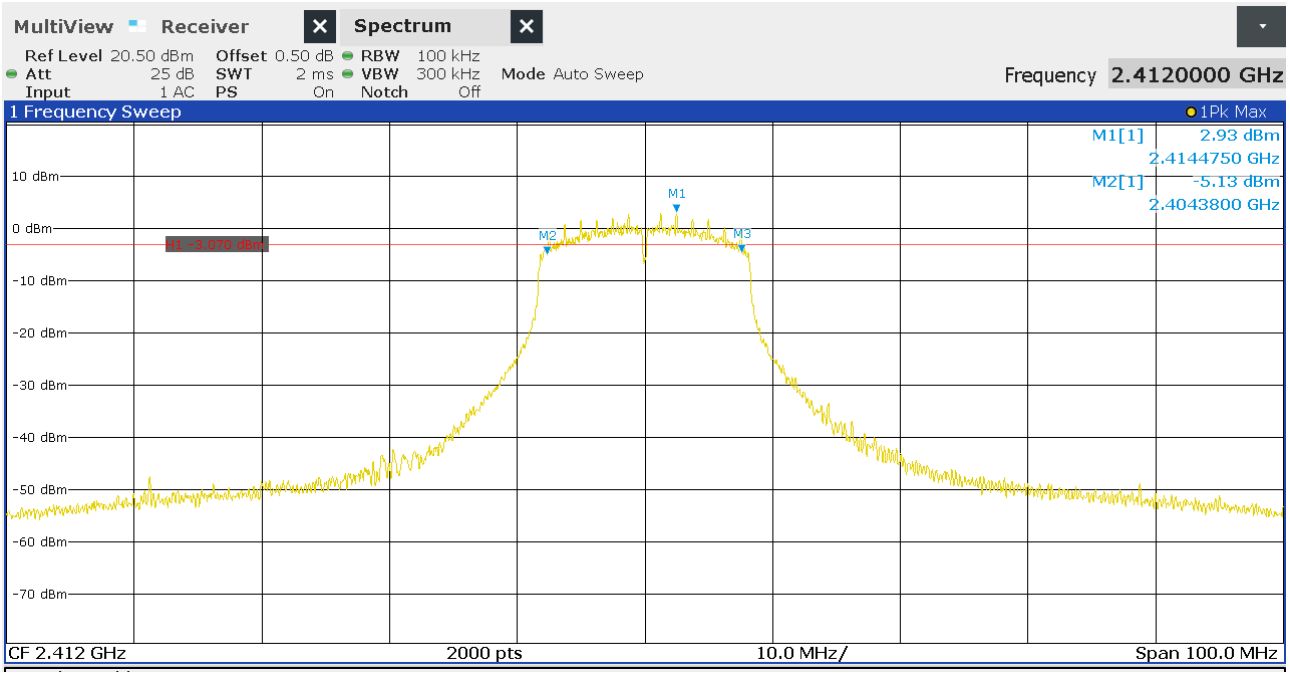

Figure 29: Chart of 6 dB bandwidth test on lowest channel in modulation IEEE 802.11 g

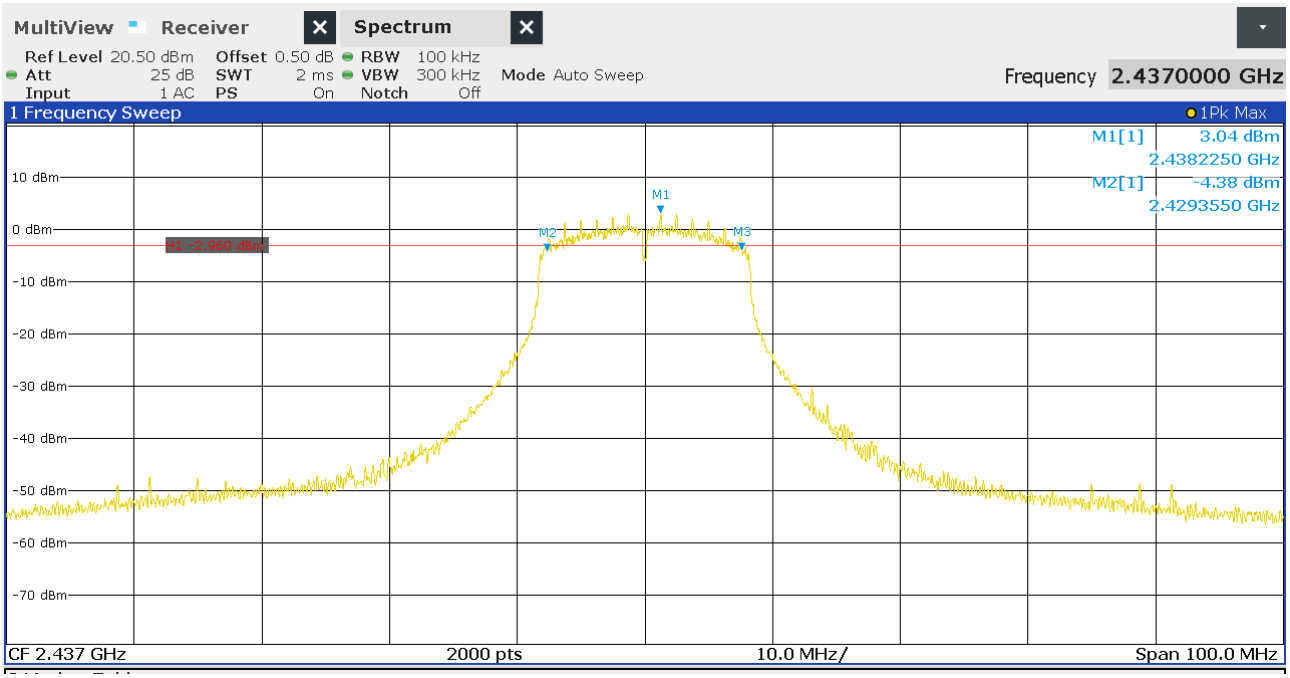

Figure 30: Chart of 6 dB bandwidth test on middle channel in modulation IEEE 802.11 g

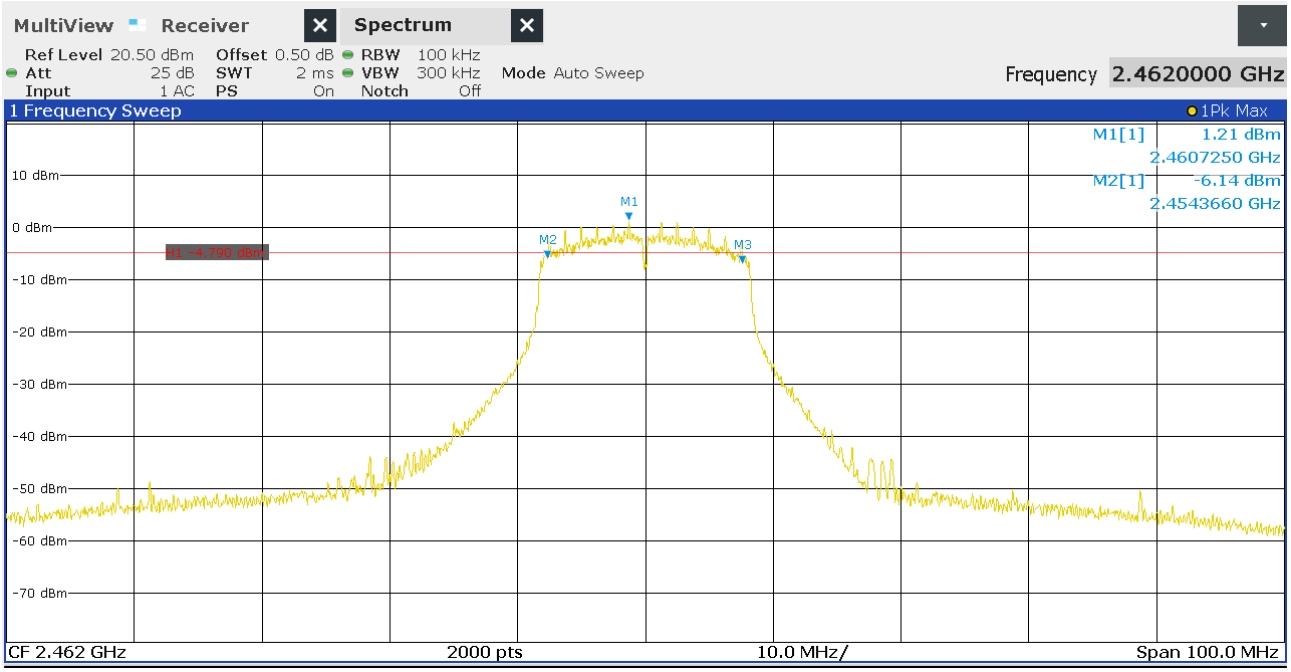

Figure 31: Chart of 6 dB bandwidth test on highest channel in modulation IEEE 802.11 g

Channel	*6 dB bandwidth (MHz)*	*Bandwidth limit (kHz)*	*Lower frequency of bandwidth (MHz)*	*Lower frequency of designated band (MHz)*	*Upper frequency of bandwidth (MHz)*	*Upper frequency of designated band (MHz)*	*Result*
low	15.21	≥ 500	2404.380	2400.000	2419.590	2483.500	Passed
middle	15.21	≥ 500	2429.355	2400.000	2444.562	2483.500	Passed
high	15.19	≥ 500	2454.366	2400.000	2469.558	2483.500	Passed

Table 20: Results of 6 dB bandwidth test in modulation IEEE 802.11 g

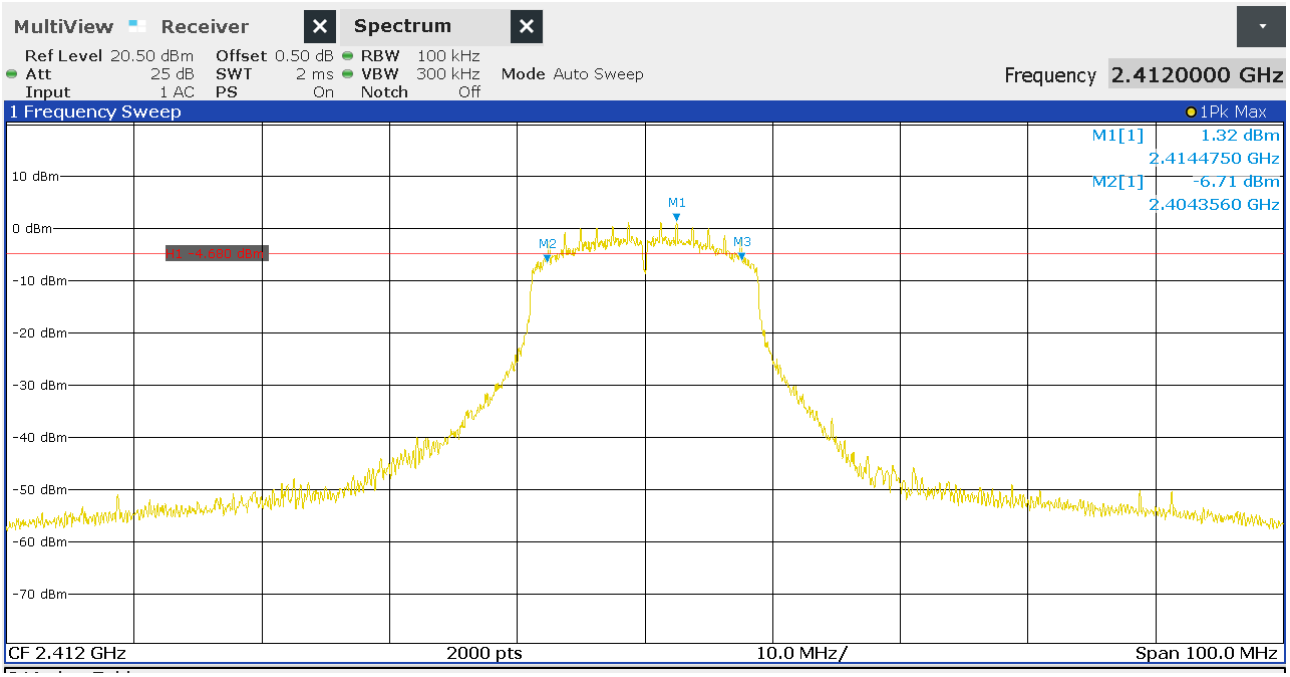

Figure 32: Chart of 6 dB bandwidth test on lowest channel in modulation IEEE 802.11 n (HT20)

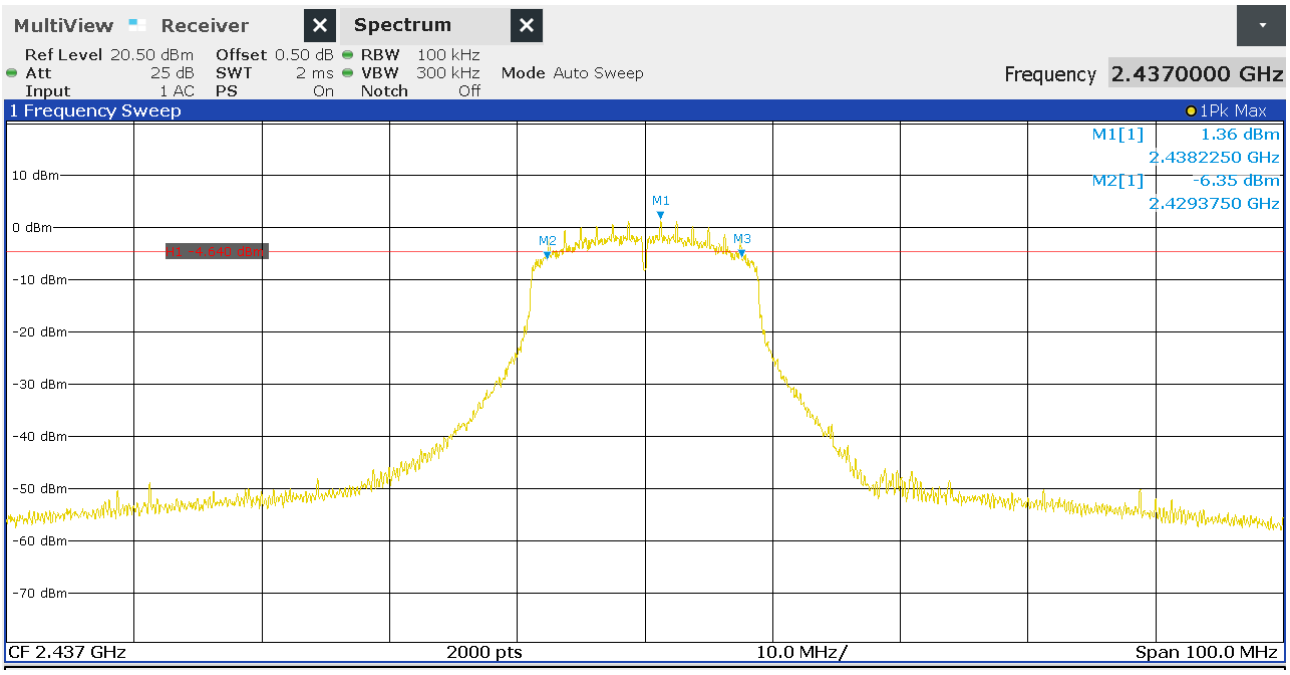

Figure 33: Chart of 6 dB bandwidth test on middle channel in modulation IEEE 802.11 n (HT20)

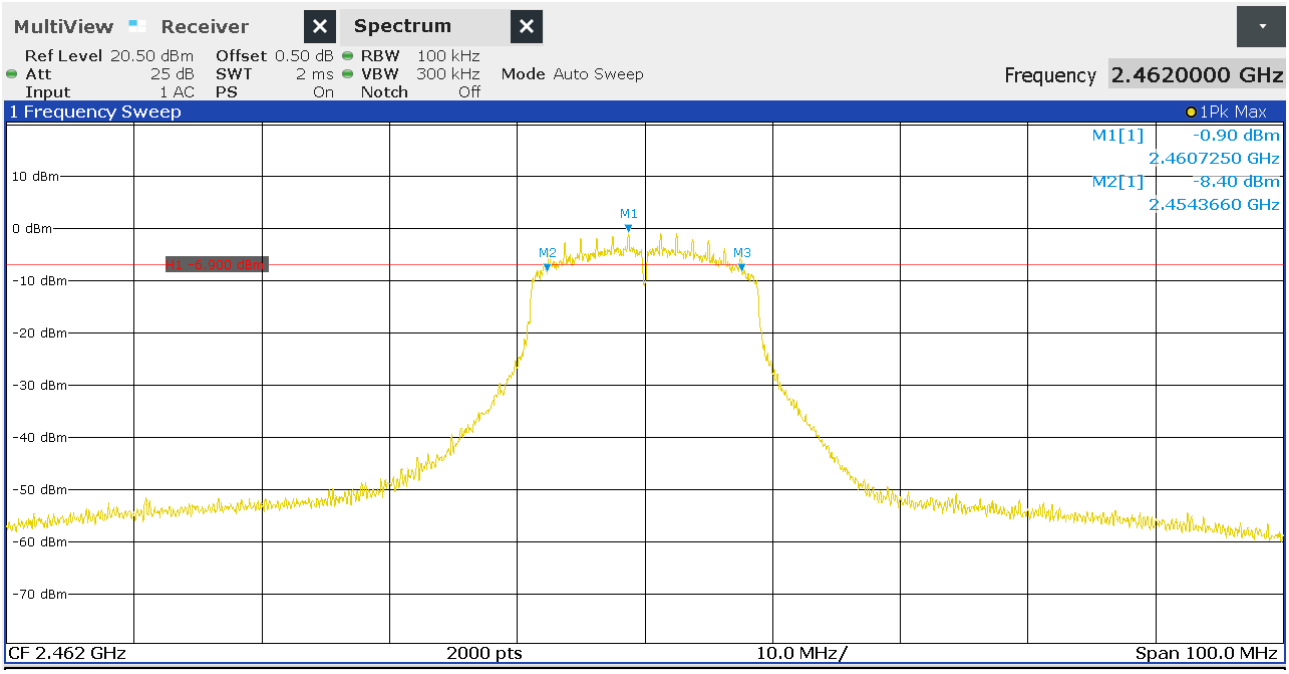

Figure 34: Chart of 6 dB bandwidth test on highest channel in modulation IEEE 802.11 n (HT20)

Channel	*6 dB bandwidth (MHz)*	*Bandwidth limit (kHz)*	*Lower frequency of bandwidth (MHz)*	*Lower frequency of designated band (MHz)*	*Upper frequency of bandwidth (MHz)*	*Upper frequency of designated band (MHz)*	*Result*
low	15.23	≥ 500	2404.356	2400.000	2419.585	2483.500	Passed
middle	15.20	≥ 500	2429.375	2400.000	2444.575	2483.500	Passed
high	15.19	≥ 500	2454.366	2400.000	2469.558	2483.500	Passed

Table 21: Results of 6 dB bandwidth test in modulation IEEE 802.11 n (HT20)

6.4 Occupied bandwidth

Section(s) in 47 CFR Part 15:	Requirement(s):	---
	Reference(s):	KDB 558074 D01, section 5.2
Section(s) in RSS:	Requirement(s):	RSS-Gen, section 6.7
	Reference(s):	KDB 558074 D01, section 5.2 ANSI C63.10, clause 6.9

Performed by:	Jennifer Riedel B. Eng.	Date(s) of test:	July 8, 2022
Result:	☒ Test passed	☐ Test not passed	

6.4.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
EMI test receiver	ESU 26	Rohde & Schwarz	W00002

6.4.2 Limits

According to section 5.2 of KDB Publication 558074, document D01:
The 99 % occupied bandwidth is necessary for setting the proper reference level and input attenuation.

According to RSS-Gen, section 6.7:
The occupied bandwidth or the “99% emission bandwidth” has to be reported for all equipment in addition to the specified bandwidth required in RSS-247.

6.4.3 Test procedure

The occupied bandwidth is measured using the test procedure as described in clause 5.7.2 and referring to the

☒ test method for conducted measurements as described in clause 5.2.
☐ test method for radiated measurements as described in clause 5.6.

6.4.4 Test results

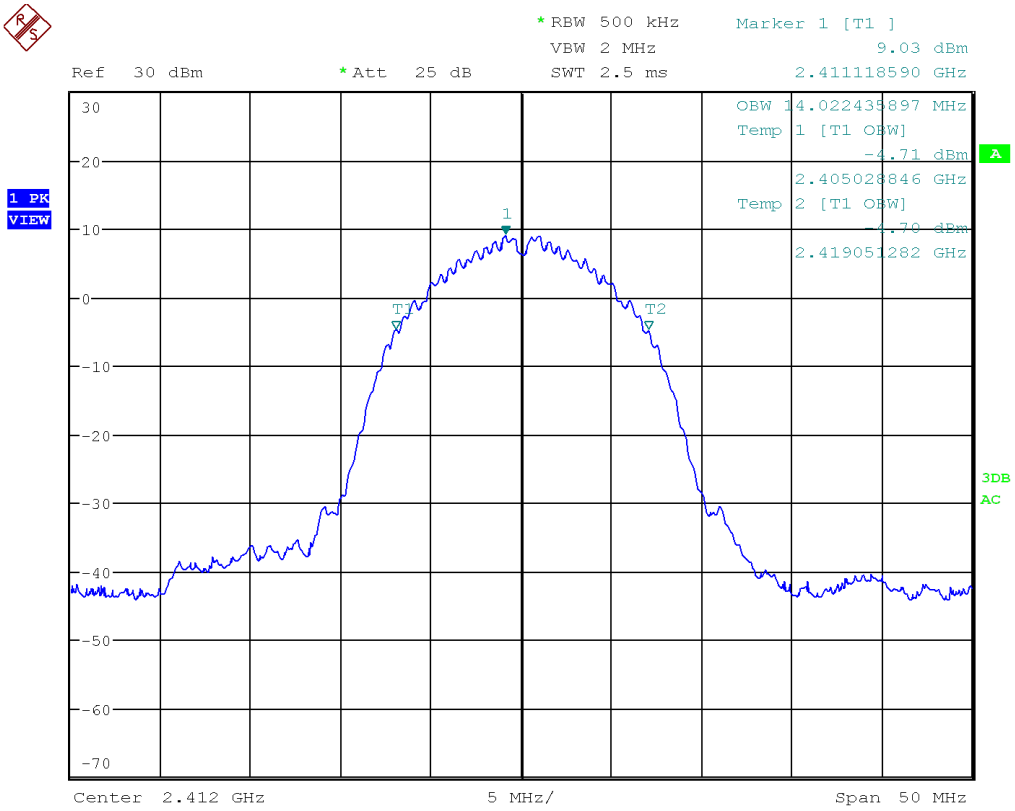

Figure 35: Chart of occupied bandwidth test on lowest channel in modulation IEEE 802.11 b

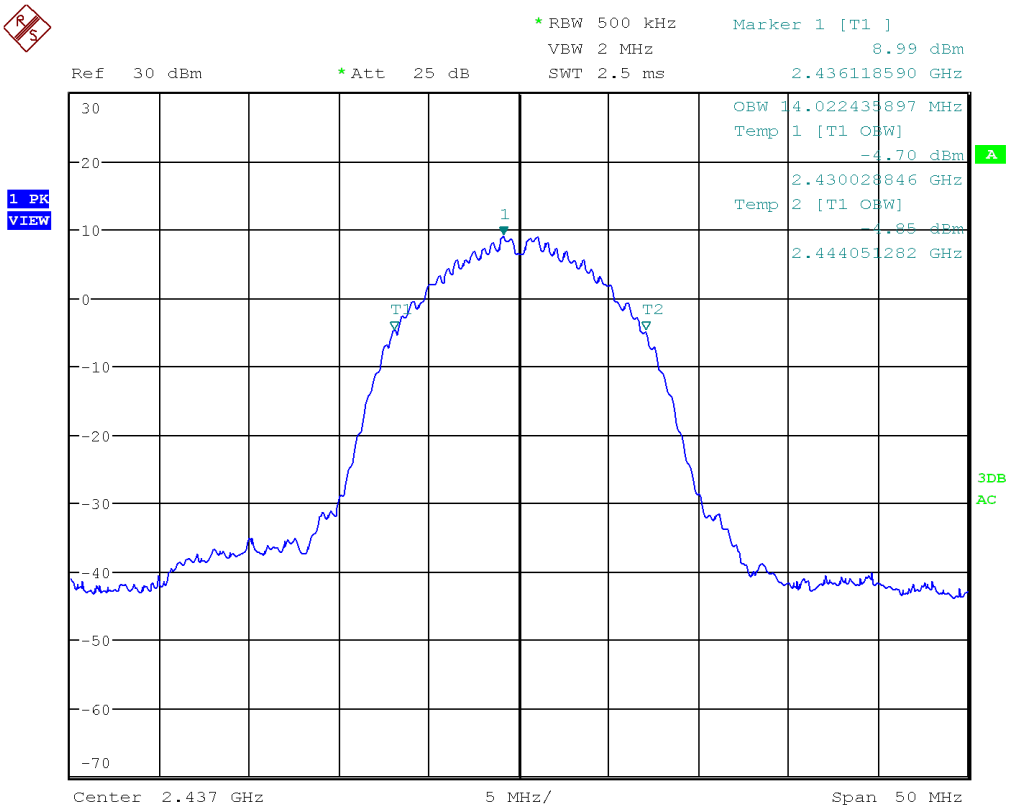

Figure 36: Chart of occupied bandwidth test on middle channel in modulation IEEE 802.11 b

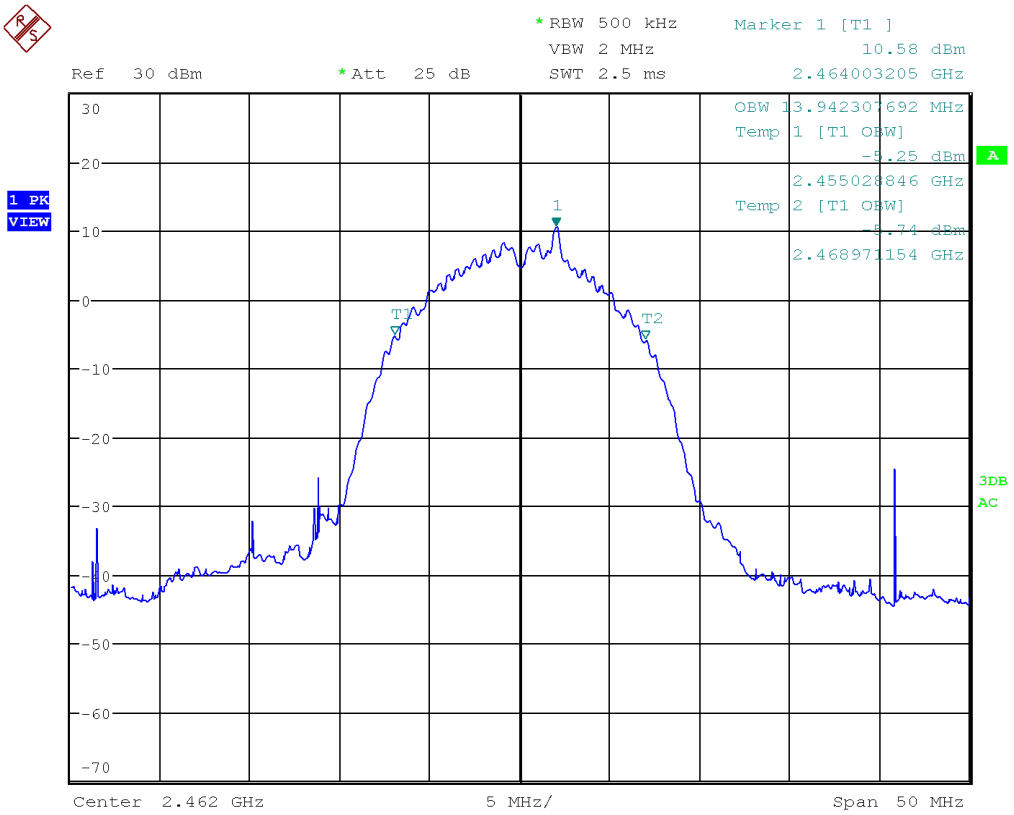

Figure 37: Chart of occupied bandwidth test on highest channel in modulation IEEE 802.11 b

Channel	*99 % occupied bandwidth (MHz)*	*Result*
low	14.022	Recorded
middle	14.022	Recorded
high	13.942	Recorded

Table 22: Results of occupied bandwidth test in modulation IEEE 802.11 b

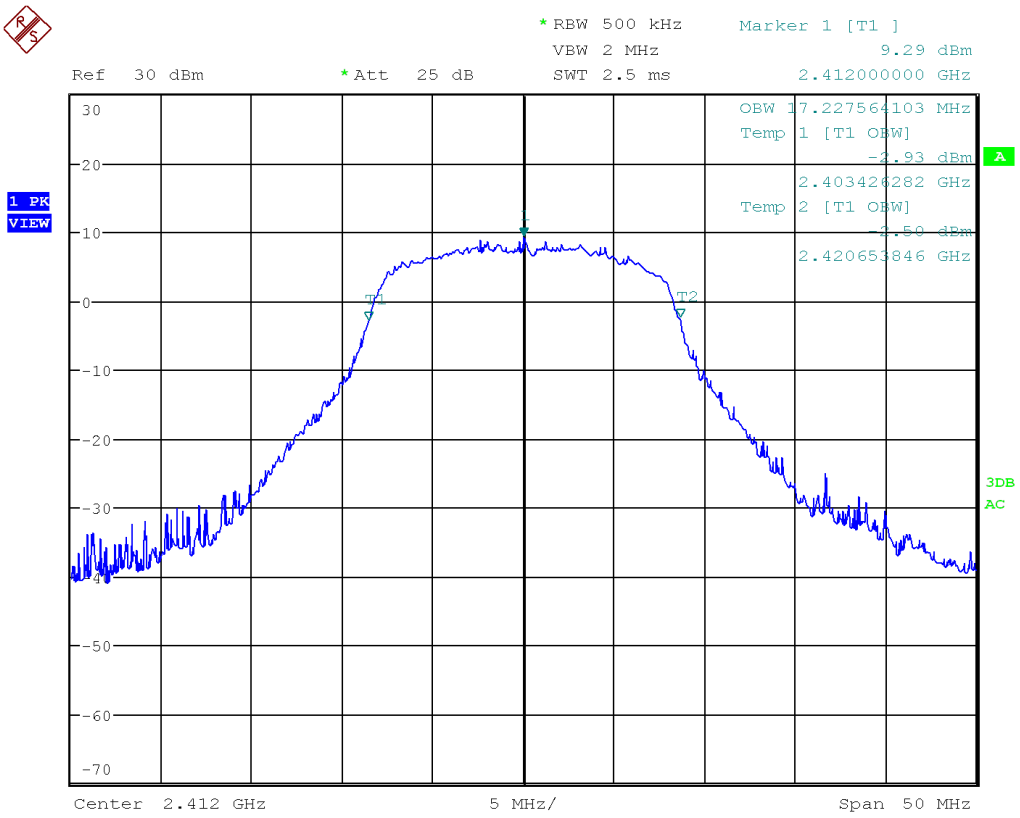

Figure 38: Chart of occupied bandwidth test on lowest channel in modulation IEEE 802.11 g

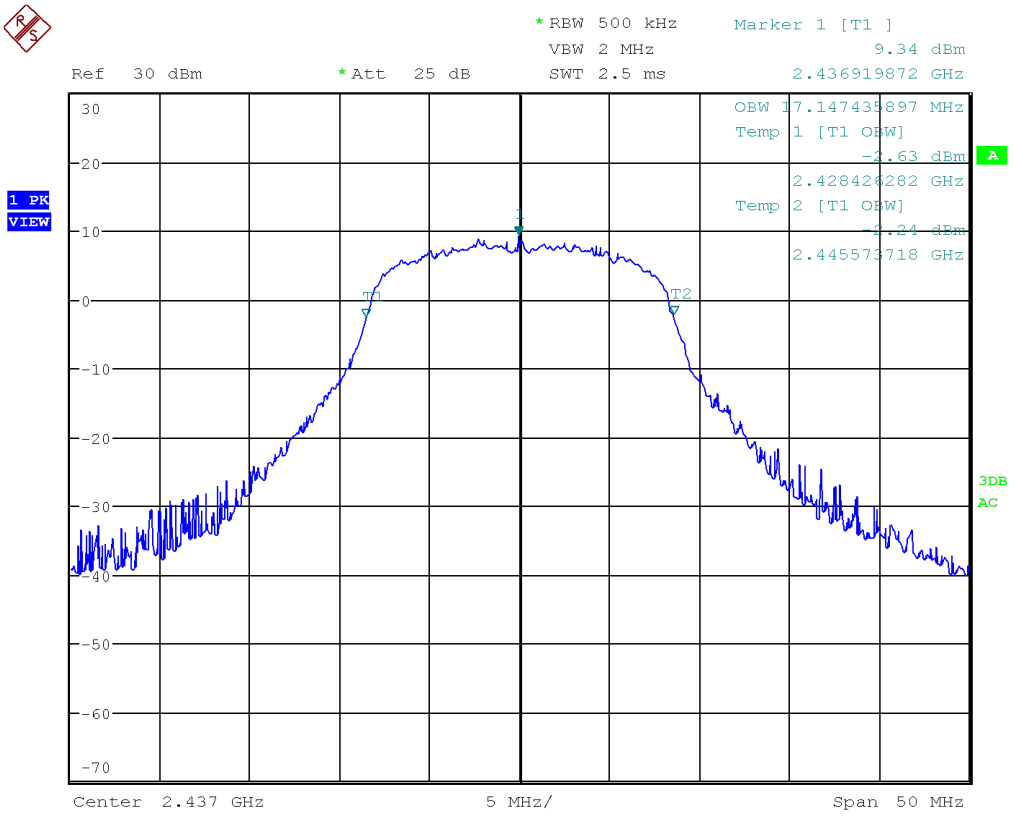

Figure 39: Chart of occupied bandwidth test on middle channel in modulation IEEE 802.11 g

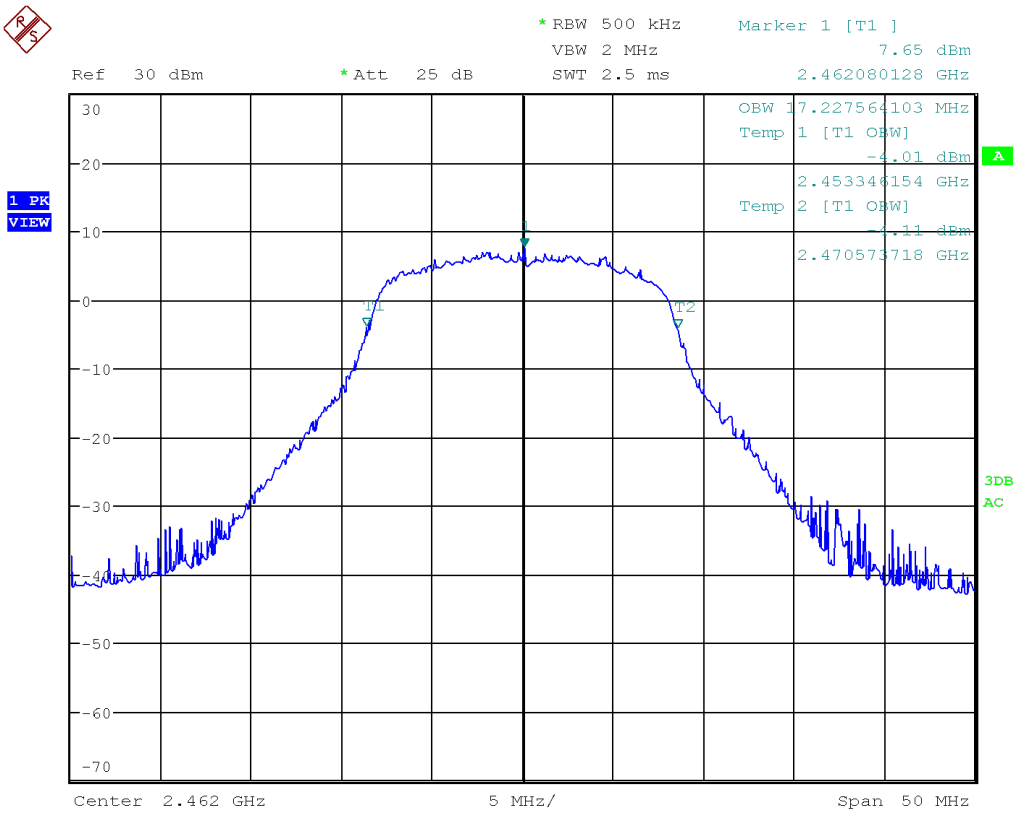

Figure 40: Chart of occupied bandwidth test on highest channel in modulation IEEE 802.11 g

Channel	*99 % occupied bandwidth (MHz)*	*Result*
low	17.228	Recorded
middle	17.147	Recorded
high	14.228	Recorded

Table 23: Results of occupied bandwidth test in modulation IEEE 802.11 g

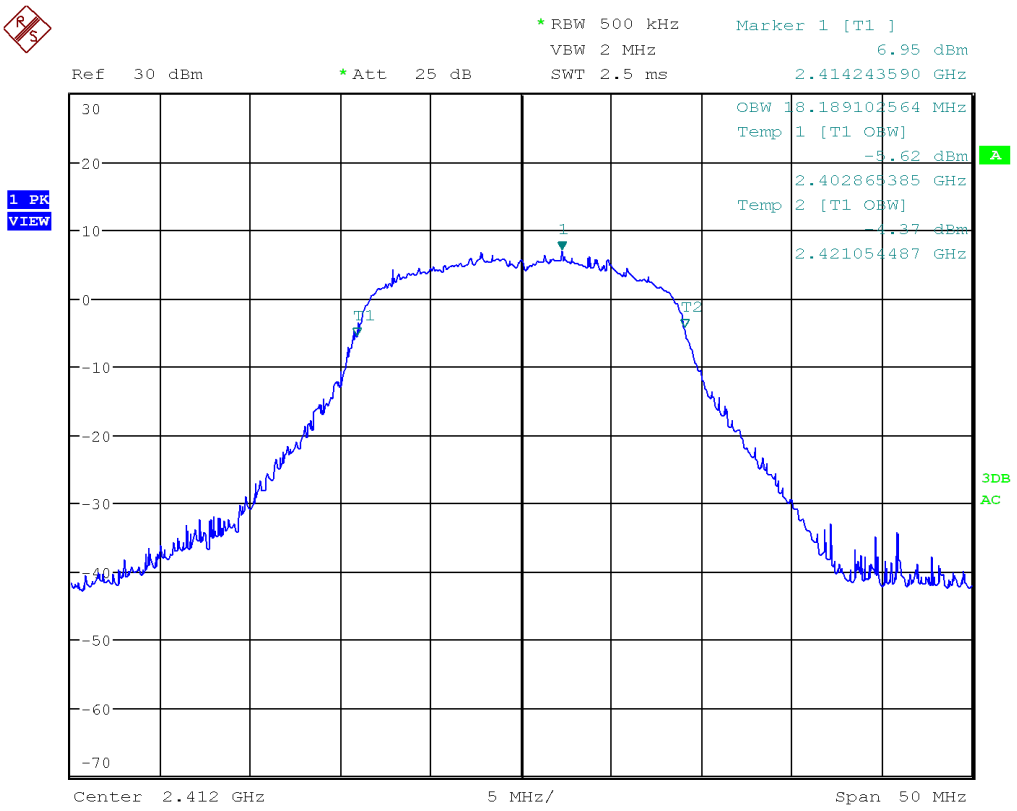

Figure 41: Chart of occupied bandwidth test on lowest channel in modulation IEEE 802.11 n (HT20)

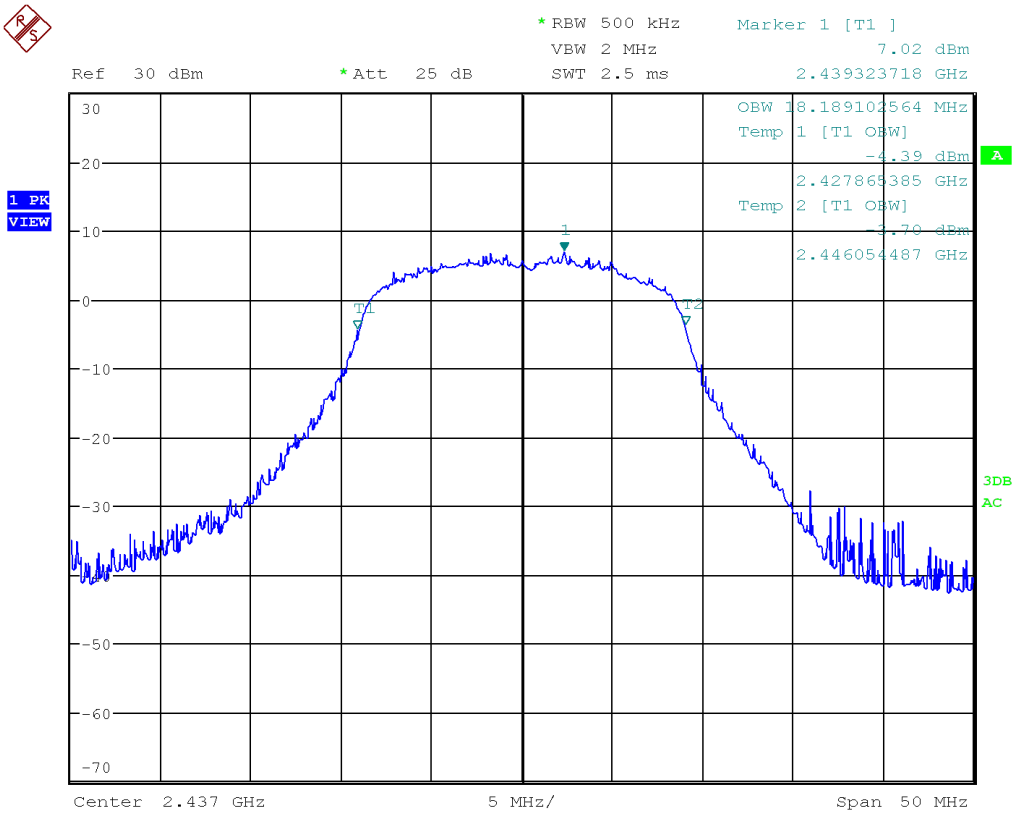

Figure 42: Chart of occupied bandwidth test on middle channel in modulation IEEE 802.11 n (HT20)

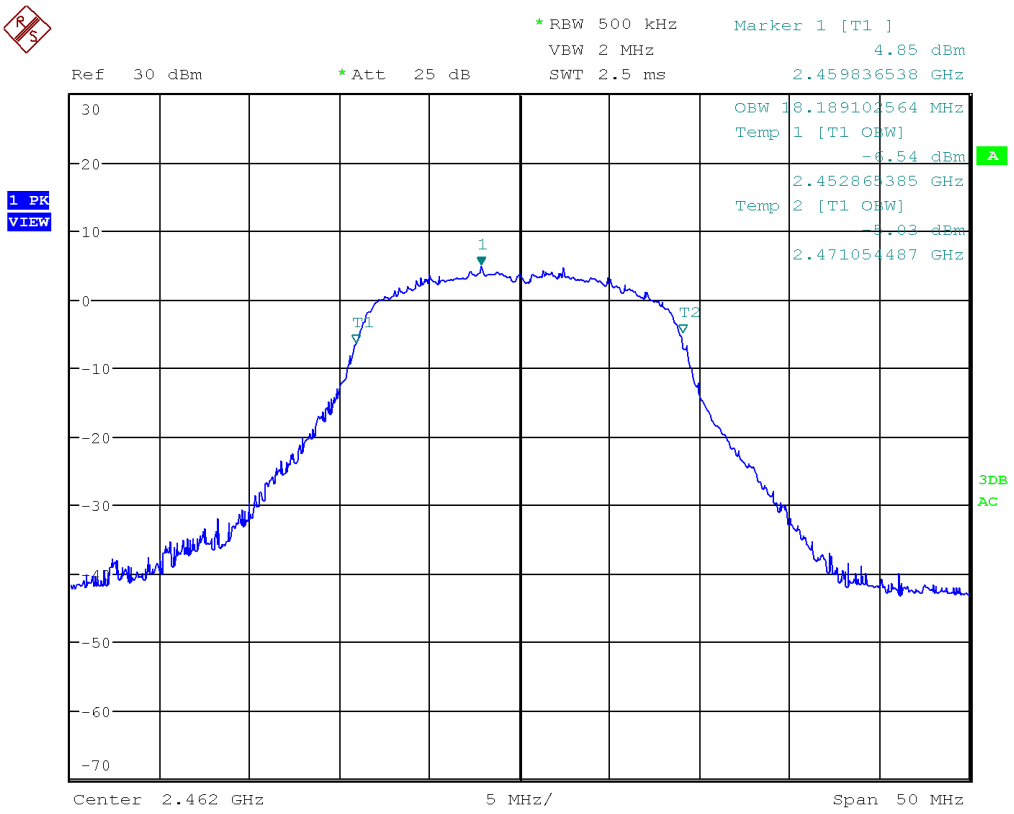

Figure 43: Chart of occupied bandwidth test on highest channel in modulation IEEE 802.11 n (HT20)

Channel	*99 % occupied bandwidth (MHz)*	*Result*
low	18.189	Recorded
middle	18.189	Recorded
high	18.189	Recorded

Table 24: Results of occupied bandwidth test in modulation IEEE 802.11 n (HT20)

6.5 Conducted output power

Section(s) in 47 CFR Part 15:	Requirement(s):	15.247(b)
	Reference(s):	KDB 558074 D01, clause 8.3 ANSI C63.10, clause 11.9
Section(s) in RSS:	Requirement(s):	RSS-247, section 5.4(d)
	Reference(s):	KDB 558074 D01, clause 8.3 ANSI C63.10, clause 11.9

Performed by:	Jennifer Riedel B. Eng.	Date(s) of test:	June 30, 2022
Result:	☒ Test passed	☐ Test not passed	

6.5.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
EMI test receiver	ESW 44	Rohde & Schwarz	E00895

6.5.2 Limits

According to §15.247(b)(3):
For systems using digital modulation in the 2400-2483.5 MHz band: 1 Watt (30 dBm).
As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

According to §15.247(b)(4):
The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

According to RSS-247, section 5.4(d):
For DTSs employing digital modulation techniques operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).
As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

6.5.3 Test procedure

The maximum peak conducted output power is measured using the test procedure as described in clause 5.8 and referring to the

☒ test method for conducted measurements as described in clause 5.2.
☐ test method for radiated measurements as described in clause 5.6.

6.5.4 Test results

Note(s):
1. The gain of the antenna is below 6 dBi, therefore a reduction of the conducted limit was not applied.

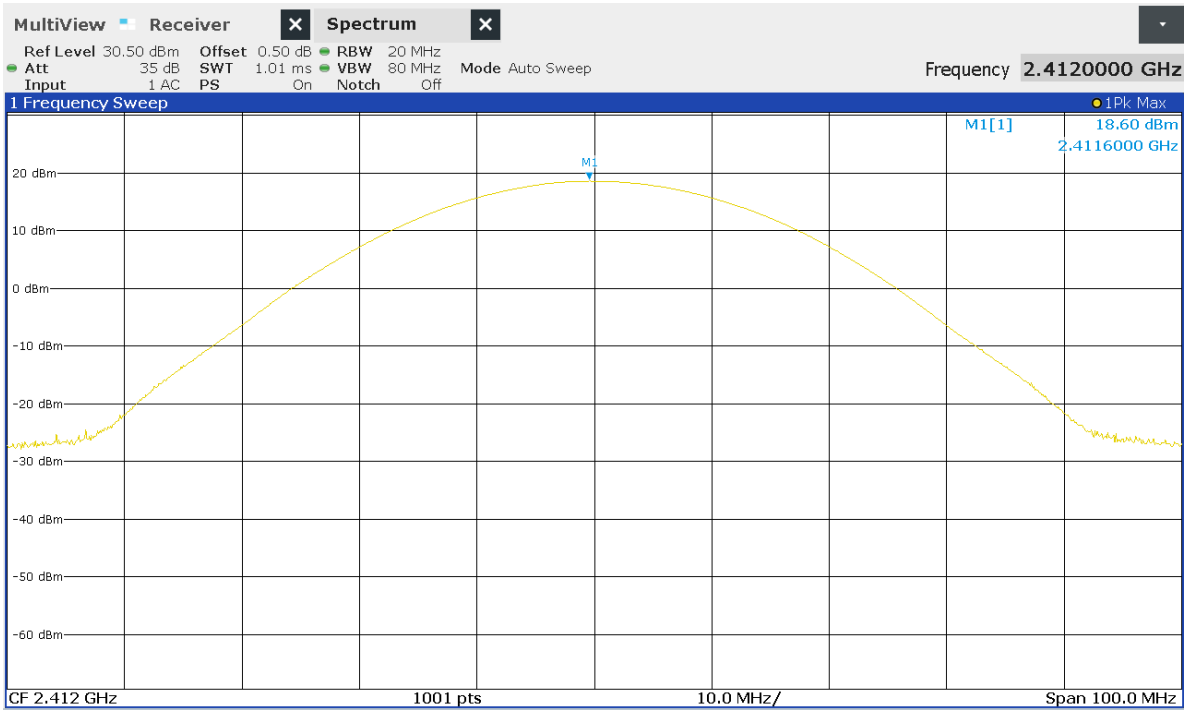

Figure 44: Chart of conducted output power on lowest channel in modulation IEEE 802.11 b

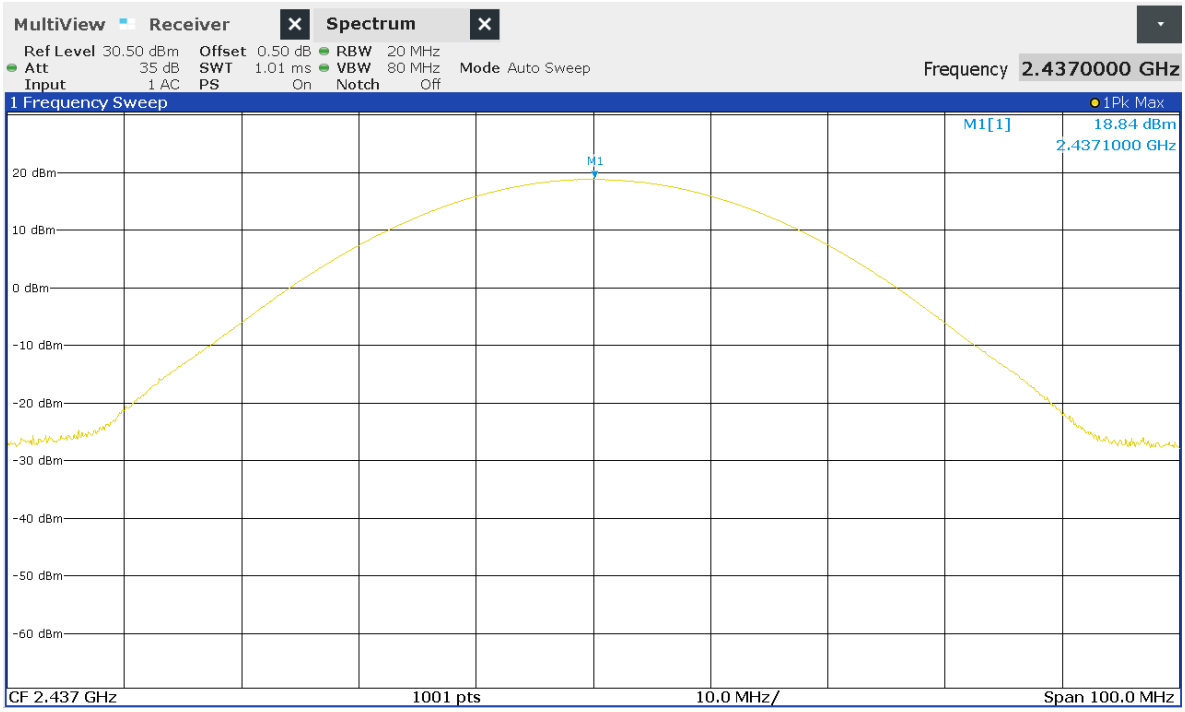

Figure 45: Chart of conducted output power on middle channel in modulation IEEE 802.11 b

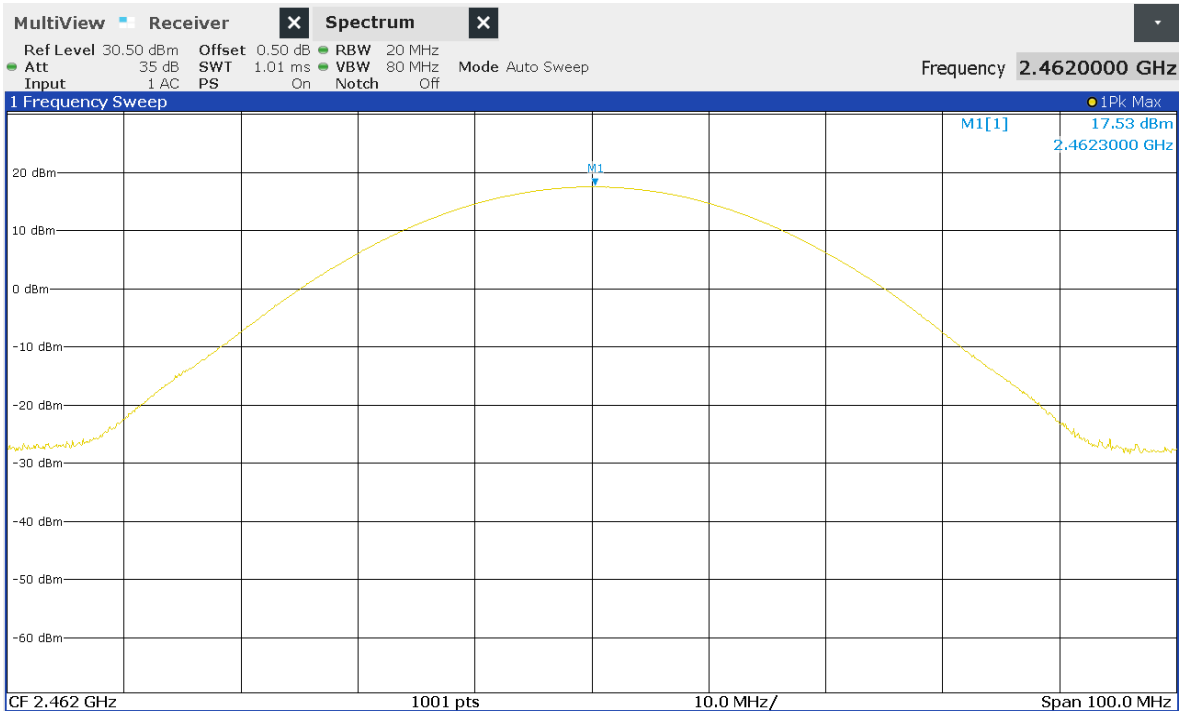

Figure 46: Chart of conducted output power on highest channel in modulation IEEE 802.11 b

Channel	*Conducted output power (dBm)*	*Limit (dBm)*	*Margin (dB)*	*Results*
low	18.60	30.00	11.40	Passed
middle	18.84	30.00	11.16	Passed
high	17.53	30.00	12.47	Passed

Table 25: Results of conducted output power in modulation IEEE 802.11 b

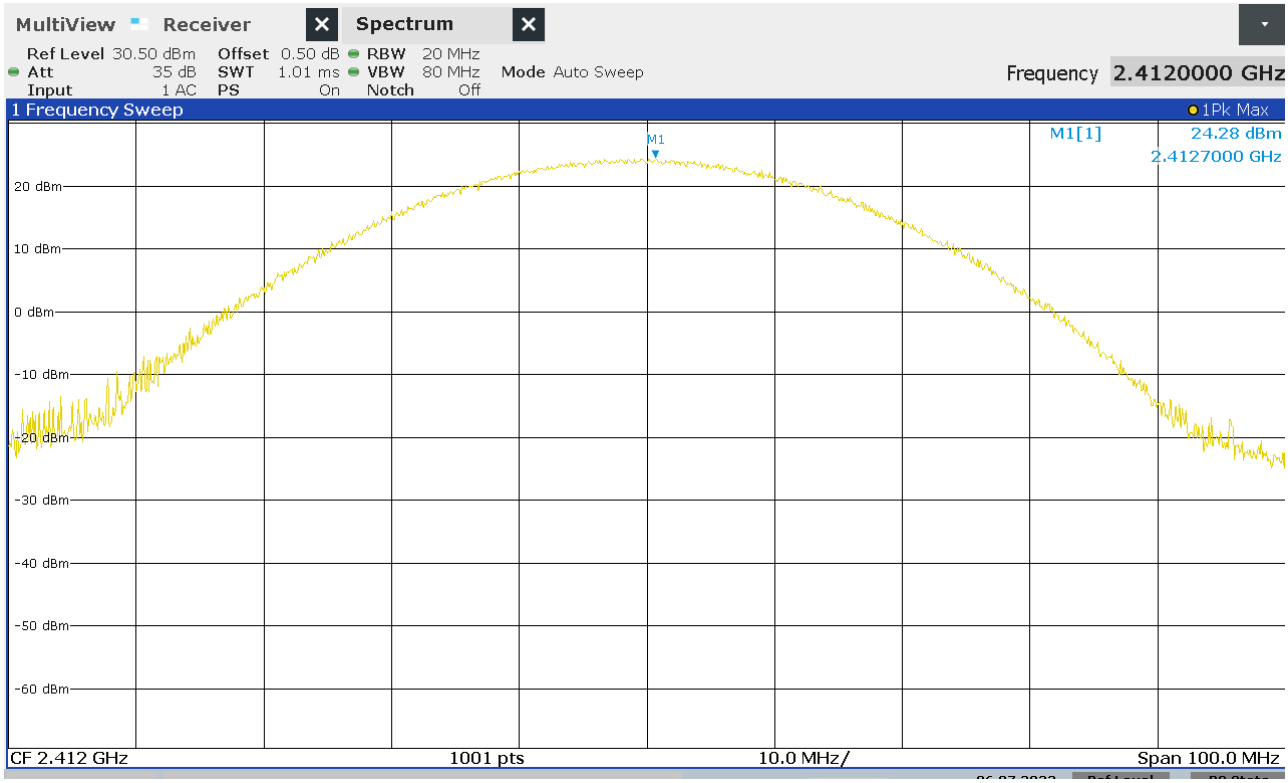

Figure 47: Chart of conducted output power on lowest channel in modulation IEEE 802.11 g

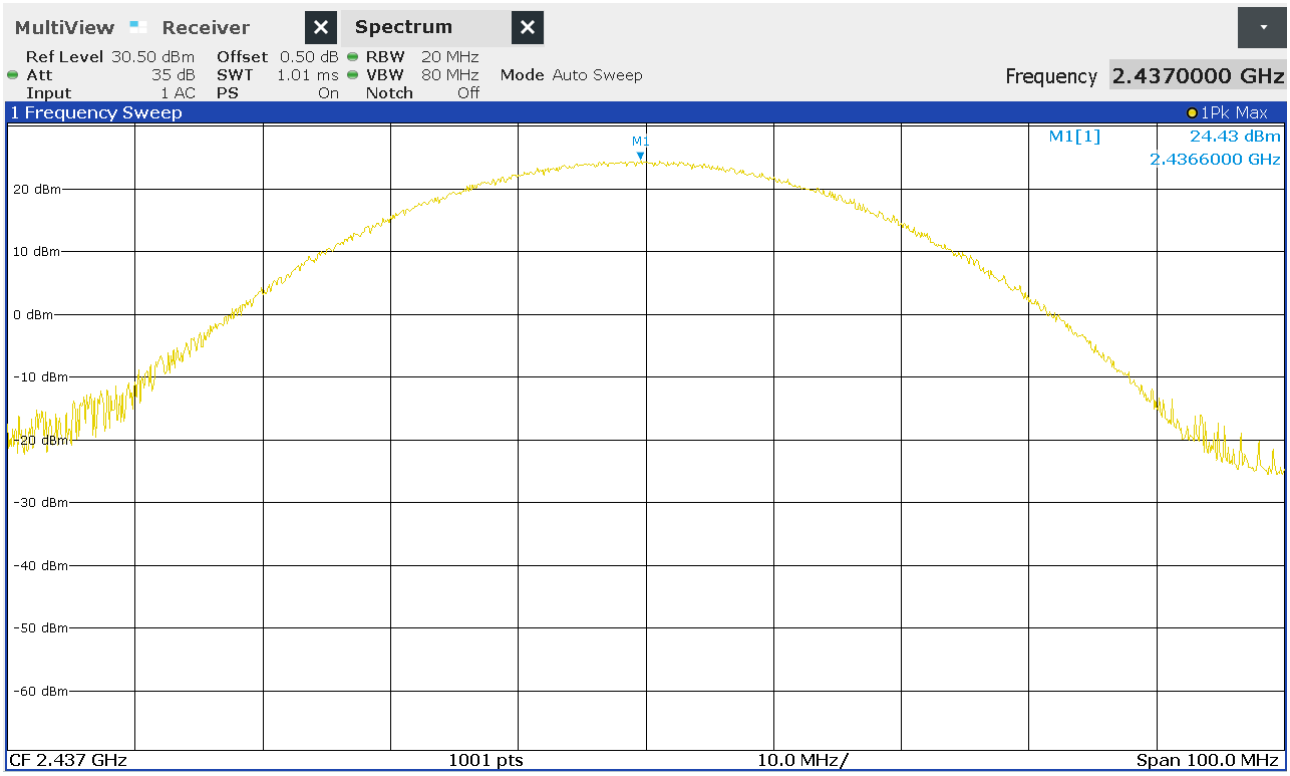

Figure 48: Chart of conducted output power on middle channel in modulation IEEE 802.11 g

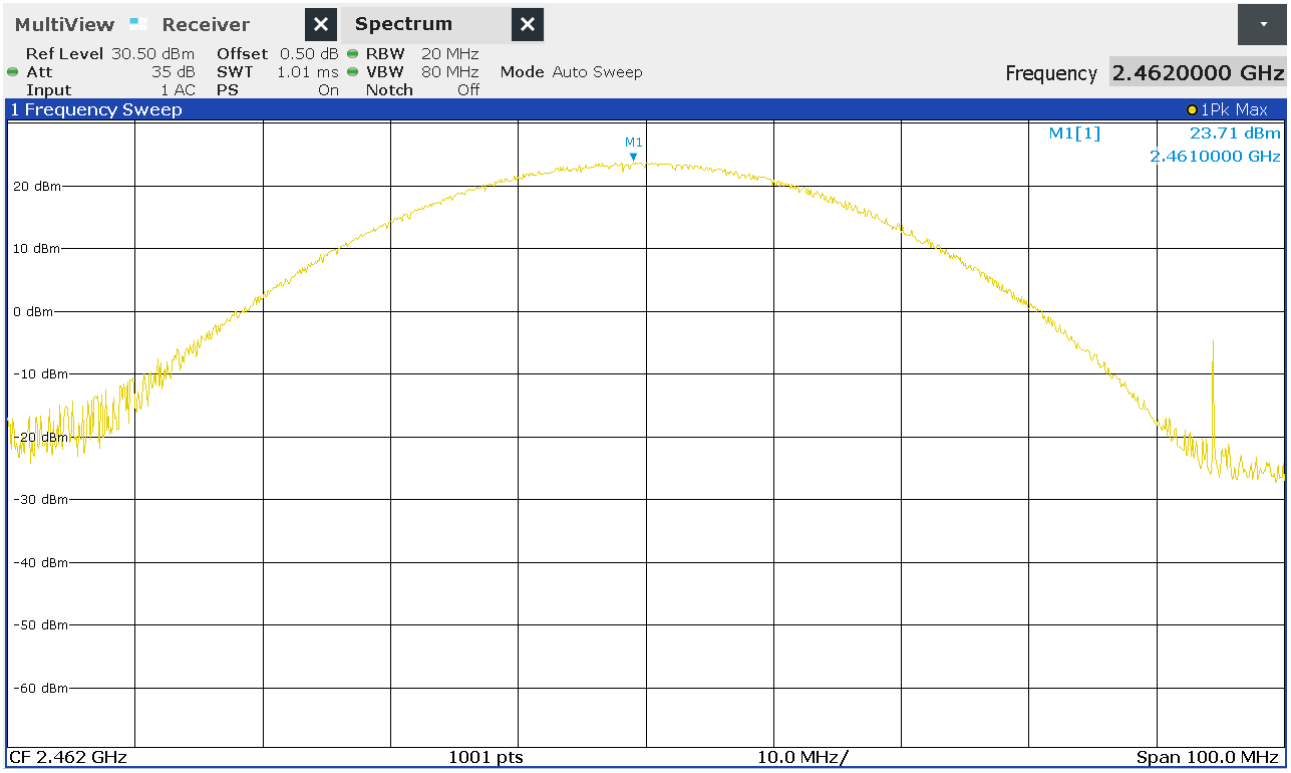

Figure 49: Chart of conducted output power on highest channel in modulation IEEE 802.11 g

Channel	*Conducted output power (dBm)*	*Limit (dBm)*	*Margin (dB)*	*Results*
low	24.28	30.00	5.72	Passed
middle	24.43	30.00	5.57	Passed
high	23.71	30.00	6.29	Passed

Table 26: Results of conducted output power in modulation IEEE 802.11 g

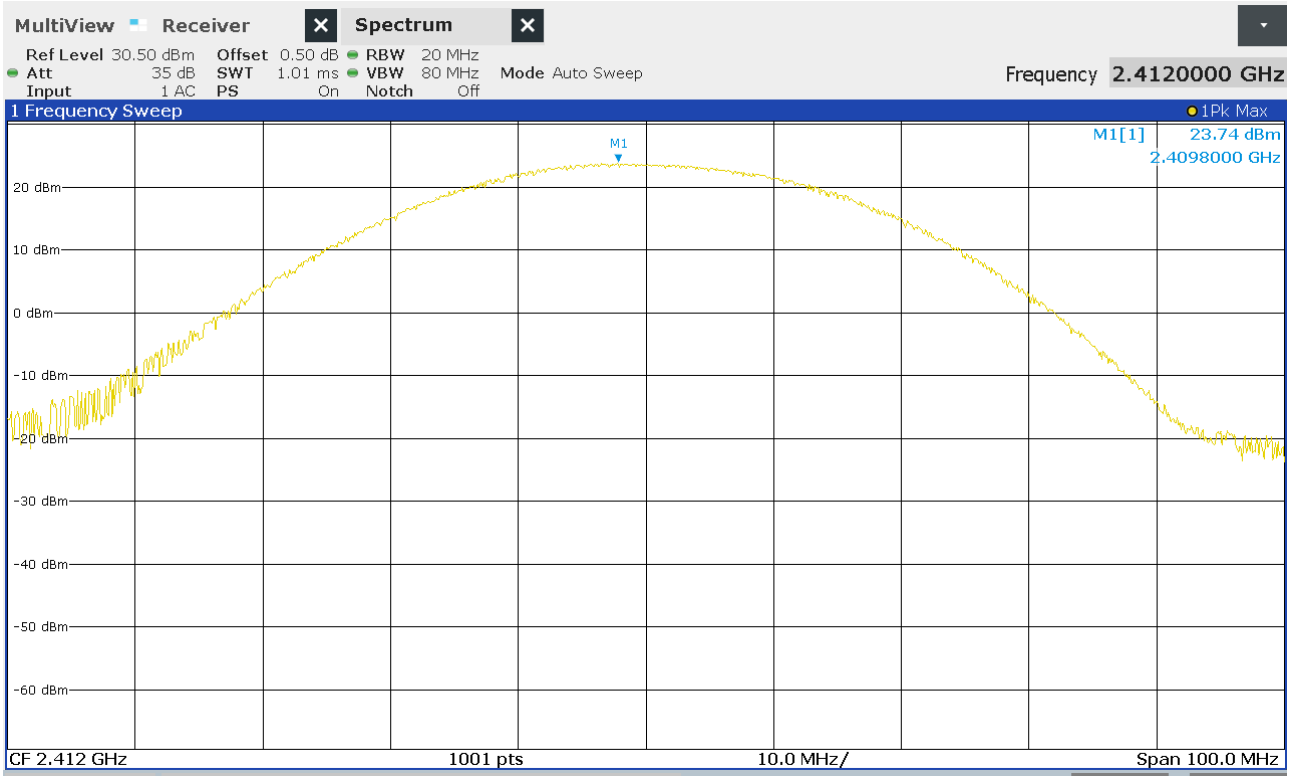

Figure 50: Chart of conducted output power on lowest channel in modulation IEEE 802.11 n (HT20)

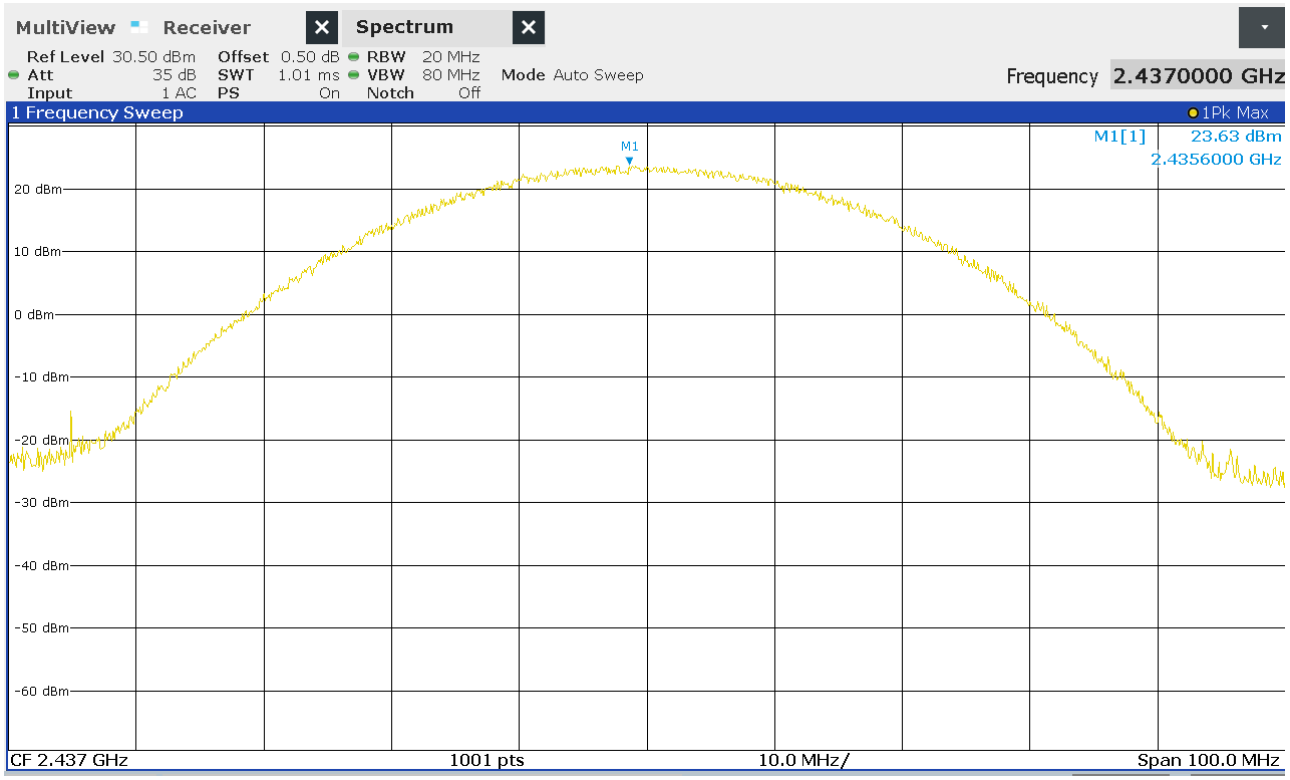

Figure 51: Chart of conducted output power on middle channel in modulation IEEE 802.11 n (HT20)

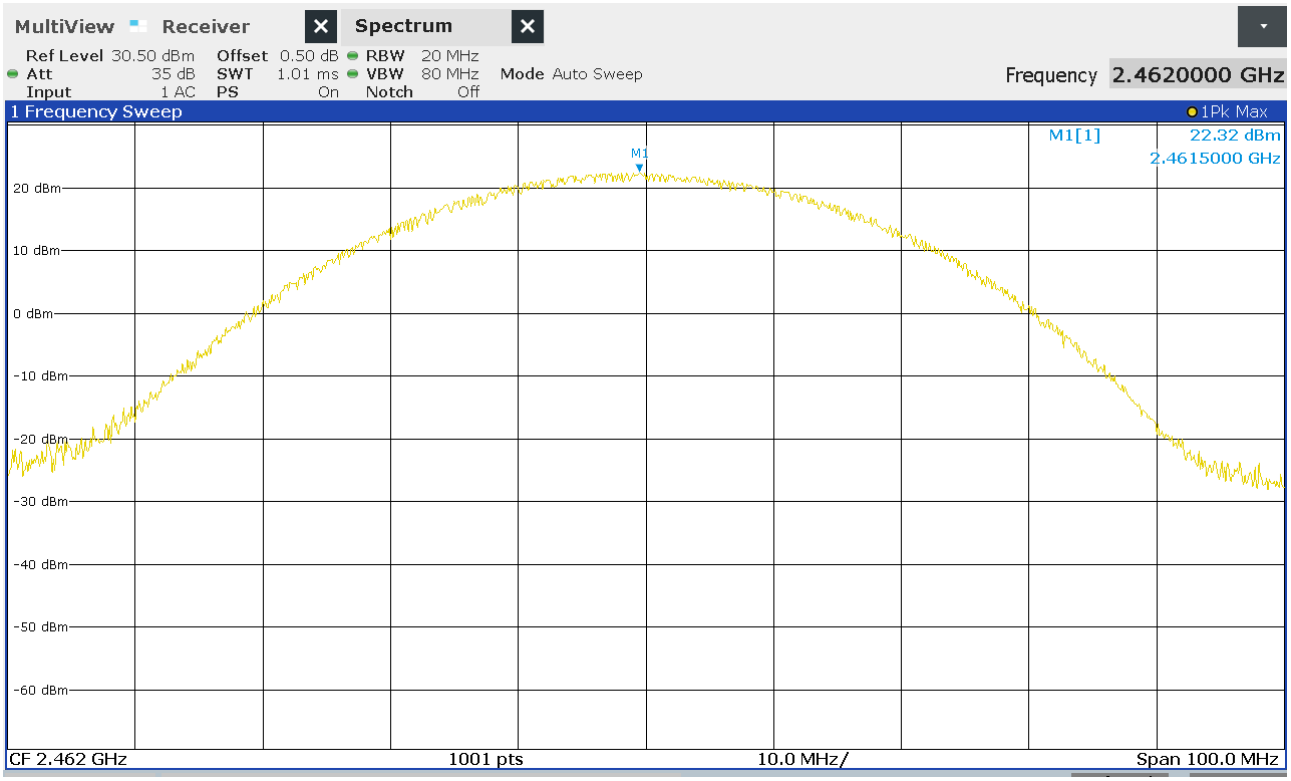

Figure 52: Chart of conducted output power on highest channel in modulation IEEE 802.11 n (HT20)

Channel	*Conducted output power (dBm)*	*Limit (dBm)*	*Margin (dB)*	*Results*
low	23.74	30.00	6.26	Passed
middle	23.63	30.00	6.37	Passed
high	22.32	30.00	7.68	Passed

Table 27: Results of conducted output power in modulation IEEE 802.11 n (HT20)

6.6 Power spectral density

Section(s) in 47 CFR Part 15:	Requirement(s):	15.247(e)
	Reference(s):	KDB 558074 D01, clause 8.4 ANSI C63.10, clause 11.10
Section(s) in RSS:	Requirement(s):	RSS-247, section 5.2(b)
	Reference(s):	KDB 558074 D01, clause 8.4 ANSI C63.10, clause 11.10

Performed by:	Jennifer Riedel B. Eng.	Date(s) of test:	July 8, 2022
Result:	☒ Test passed	☐ Test not passed	

6.6.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
EMI test receiver	ESU 26	Rohde & Schwarz	W00002

6.6.2 Limits

According to §15.247(e) and RSS-247 section 5.2(b):
For digitally modulated systems (DTS), the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

The same method of determining the conducted output power shall be used to determine the power spectral density.

6.6.3 Test procedure

The power spectral density is measured using the test procedure as described in clause 5.9 and referring to the

☒ test method for conducted measurements as described in clause 5.2.
☐ test method for radiated measurements as described in clause 5.6.

6.6.4 Test results

Note(s):
1. The gain of the antenna is below 6 dBi, therefore a reduction of the conducted limit was not applied.

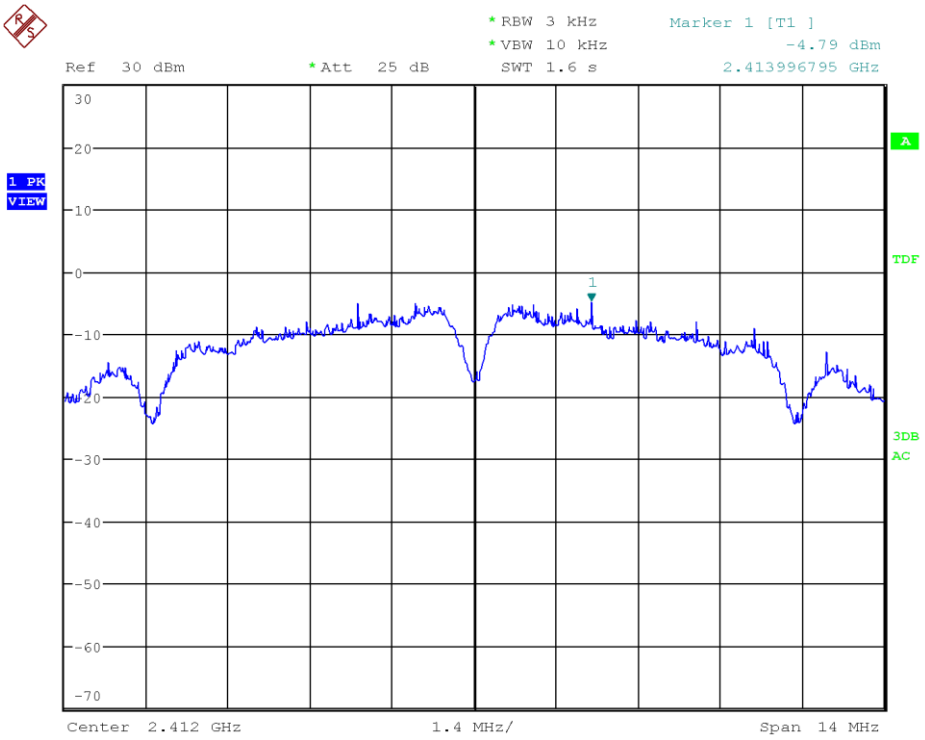

Figure 53: Chart of power spectral density on lowest channel in modulation IEEE 802.11 b

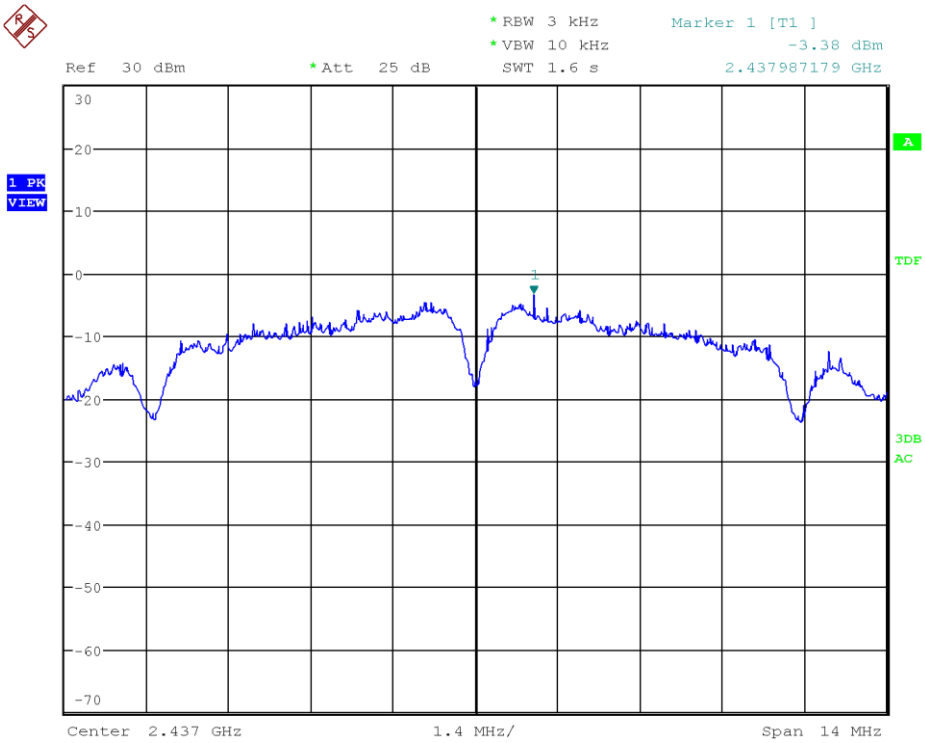

Figure 54: Chart of power spectral density on middle channel in modulation IEEE 802.11 b

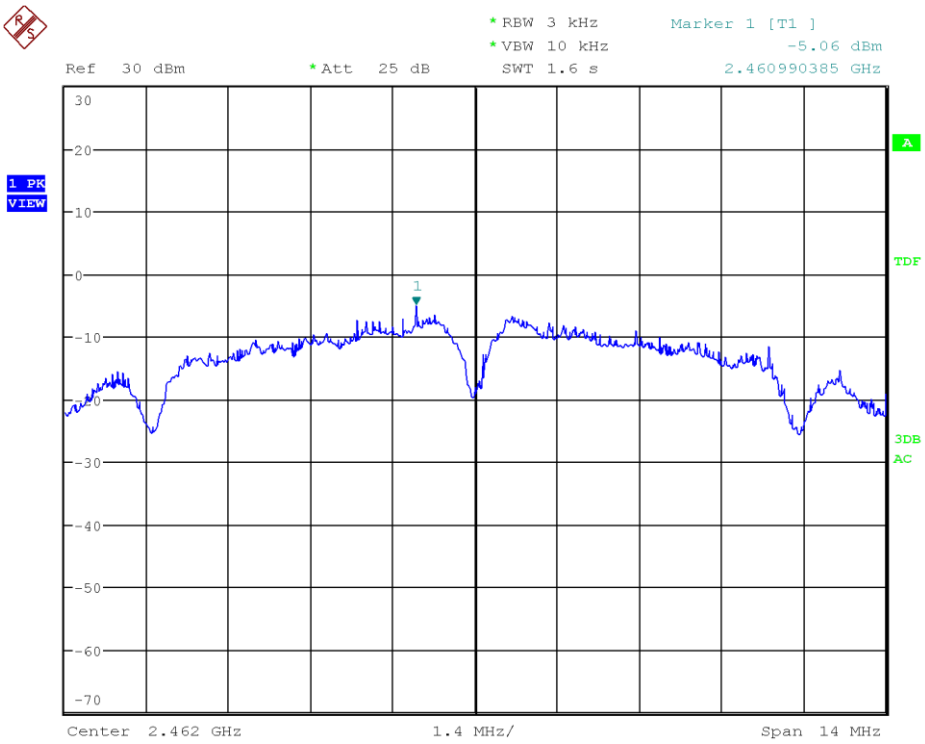

Figure 55: Chart of power spectral density on highest channel in modulation IEEE 802.11 b

Channel	*Power spectral density (dBm/3 kHz)*	*Limit (dBm/3 kHz)*	*Margin (dB)*	*Results*
low	-4.79	8.00	12.79	Passed
middle	-3.38	8.00	11.38	Passed
high	-5.06	8.00	13.06	Passed

Table 28: Results of conducted power spectral density in modulation IEEE 802.11 b

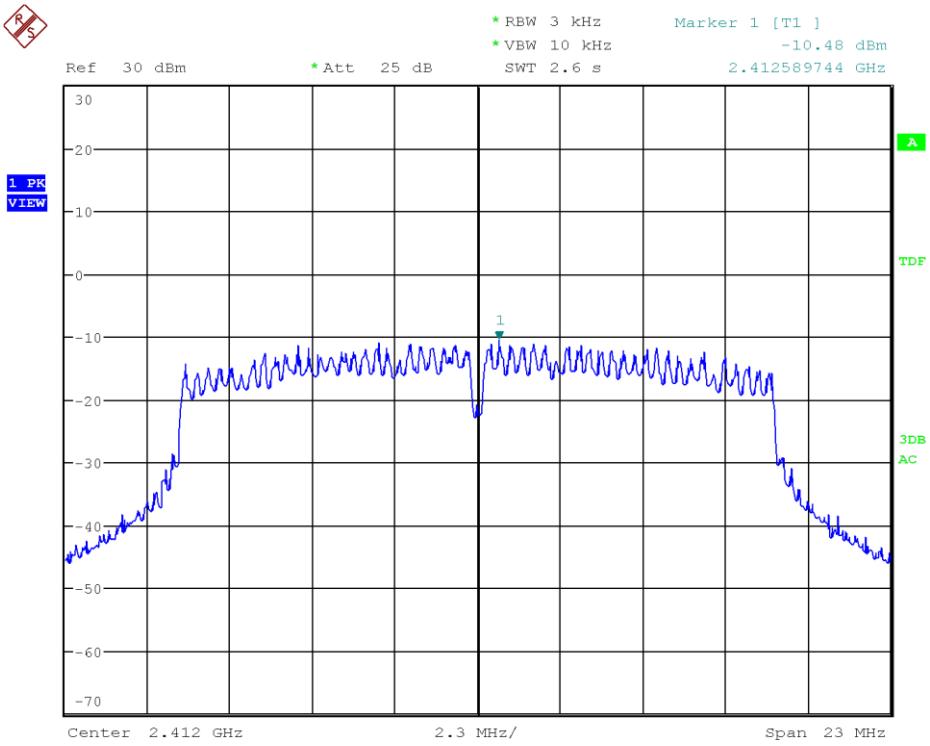

Figure 56: Chart of power spectral density on lowest channel in modulation IEEE 802.11 g

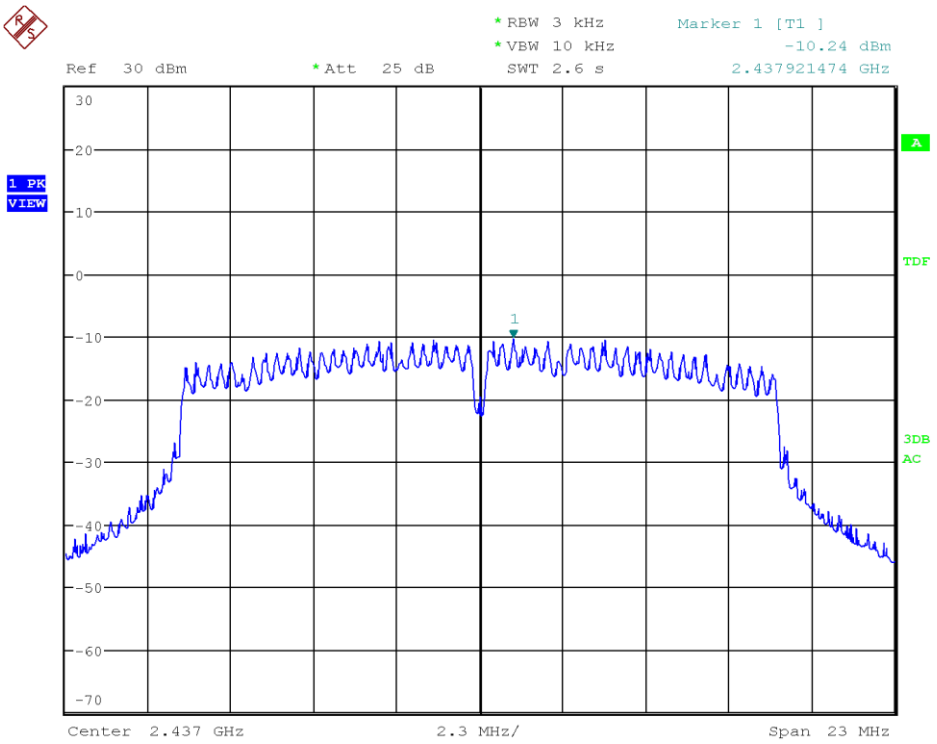

Figure 57: Chart of power spectral density on middle channel in modulation IEEE 802.11 g

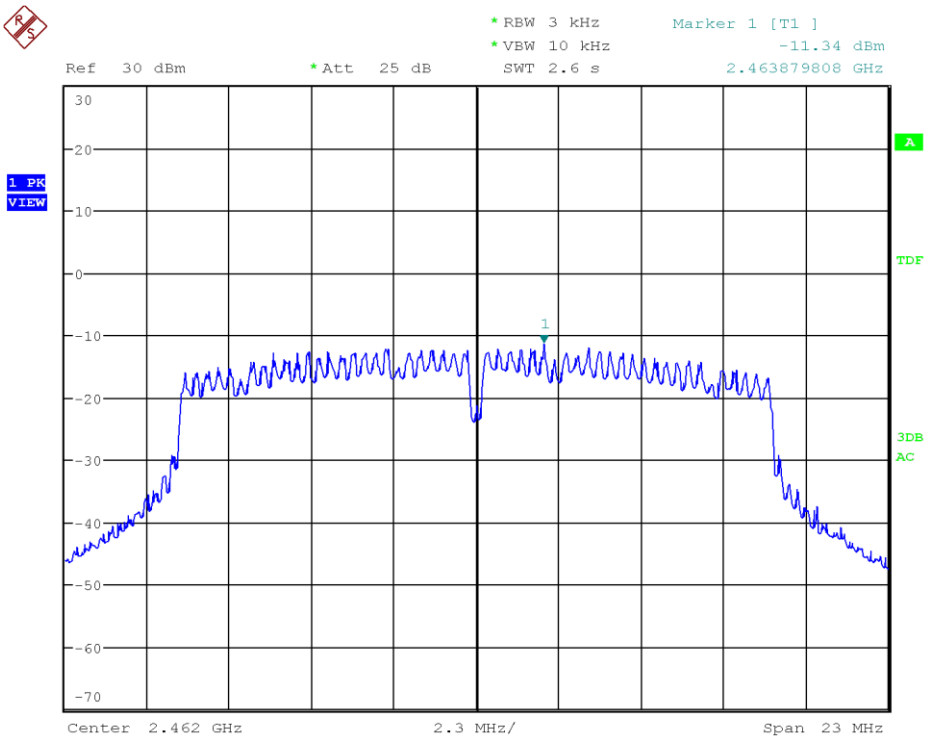

Figure 58: Chart of power spectral density on highest channel in modulation IEEE 802.11 g

Channel	*Power spectral density (dBm/3 kHz)*	*Limit (dBm/3 kHz)*	*Margin (dB)*	*Results*
low	-10.48	8.00	18.48	Passed
middle	-10.24	8.00	18.24	Passed
high	-11.34	8.00	19.34	Passed

Table 29: Results of conducted power spectral density in modulation IEEE 802.11 g

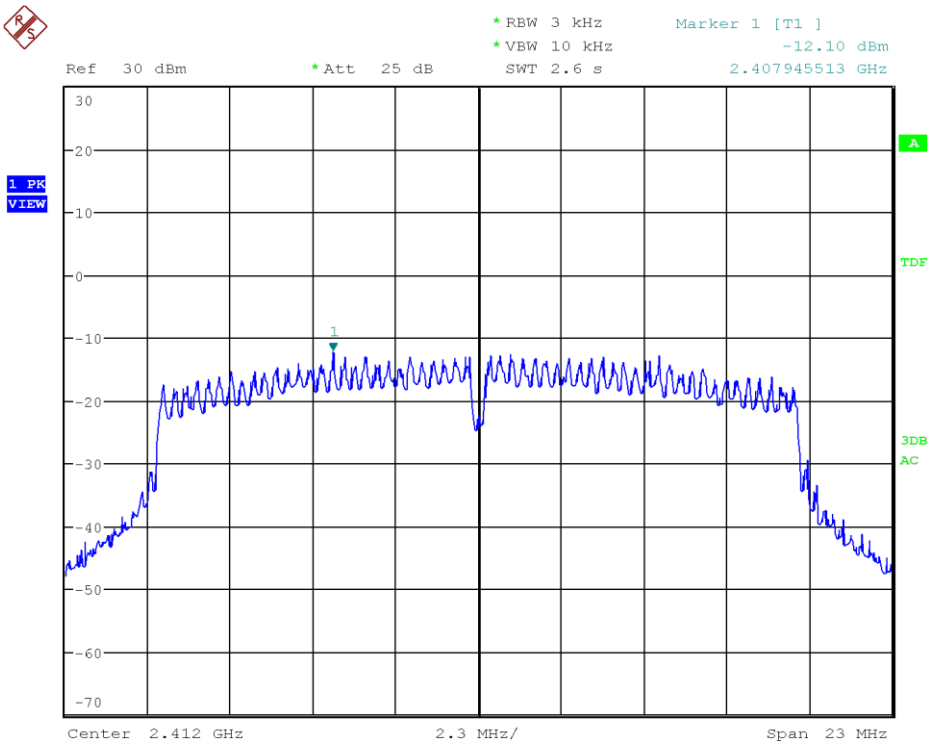

Figure 59: Chart of power spectral density on lowest channel in modulation IEEE 802.11 n (HT20)

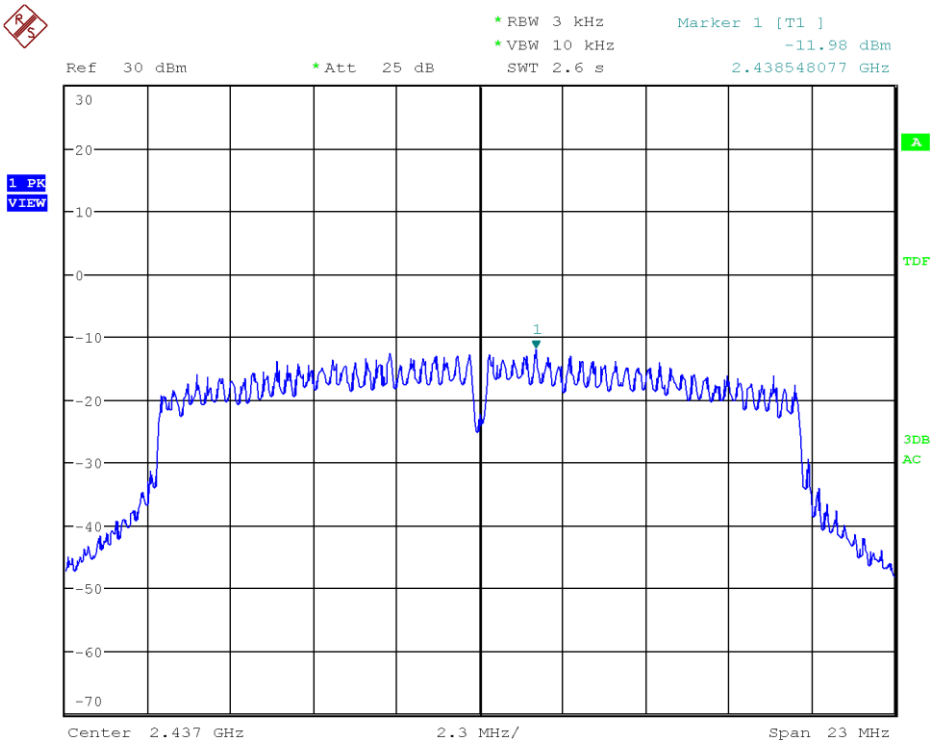

Figure 60: Chart of power spectral density on middle channel in modulation IEEE 802.11 n (HT20)

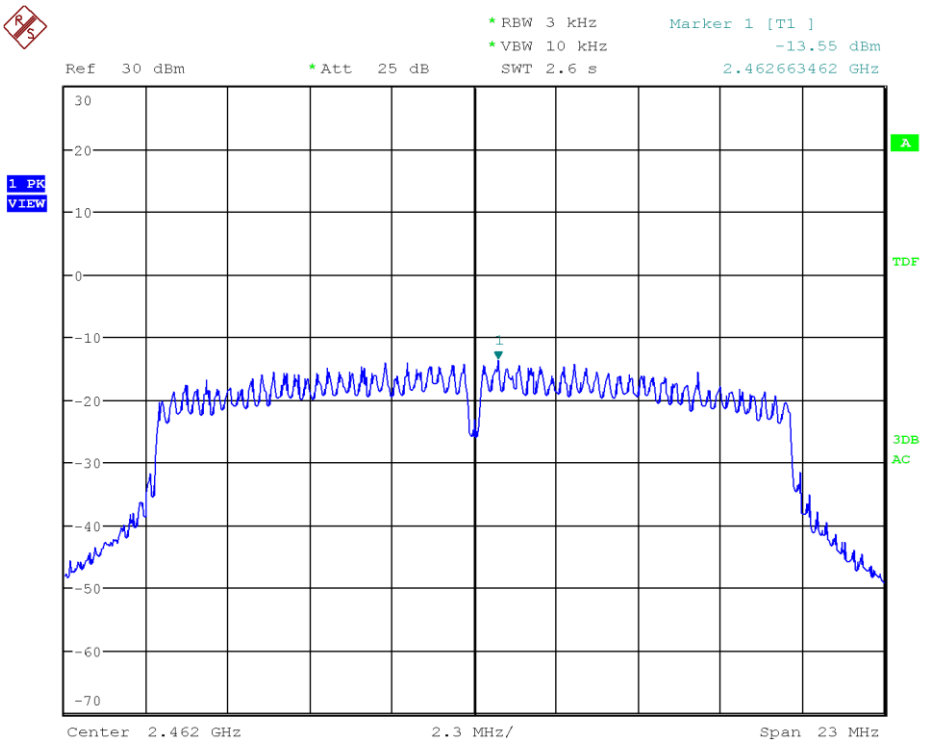

Figure 61: Chart of power spectral density on highest channel in modulation IEEE 802.11 n (HT20)

Channel	*Power spectral density (dBm/3 kHz)*	*Limit (dBm/3 kHz)*	*Margin (dB)*	*Results*
low	-12.10	8.00	20.10	Passed
middle	-11.98	8.00	19.98	Passed
high	-13.55	8.00	21.55	Passed

Table 30: Results of conducted power spectral density in modulation IEEE 802.11 n (HT20)

6.7 Band-edge measurements

Section(s) in 47 CFR Part 15:	Requirement(s):	15.247(d)
	Reference(s):	KDB 558074 D01, clause 8.7 ANSI C63.10, clause 11.13
Section(s) in RSS:	Requirement(s):	RSS-247, section 5.5
	Reference(s):	KDB 558074 D01, clause 8.7 ANSI C63.10, clause 11.13

Performed by:	Jennifer Riedel B. Eng.	Date(s) of test:	October 19, 2022
Result:	☒ Test passed	☐ Test not passed	

6.7.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
EMI test receiver	ESU 26	Rohde & Schwarz	W00002

6.7.2 Limits

According to §15.247(d) and RSS-247 section 5.5:
In any 100 kHz bandwidth outside of the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. In addition, radiated emissions which fall in the restricted bands (see table 31) must also comply with the radiated emission limits specified in §15.209(a) and RSS-Gen section 8.10.

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			

Table 31: Restricted bands of operation according to §15.205 and RSS-Gen section 8.10

6.7.3 Test procedure

The band-edge measurements are performed using the

☒ test procedure for conducted measurements as described in clause 5.2.
☐ test procedure for radiated measurements as described in clause 5.6.

6.7.4 Test results

Note(s):
1. The margin was corrected by the antenna gain of 2.2 dBi.

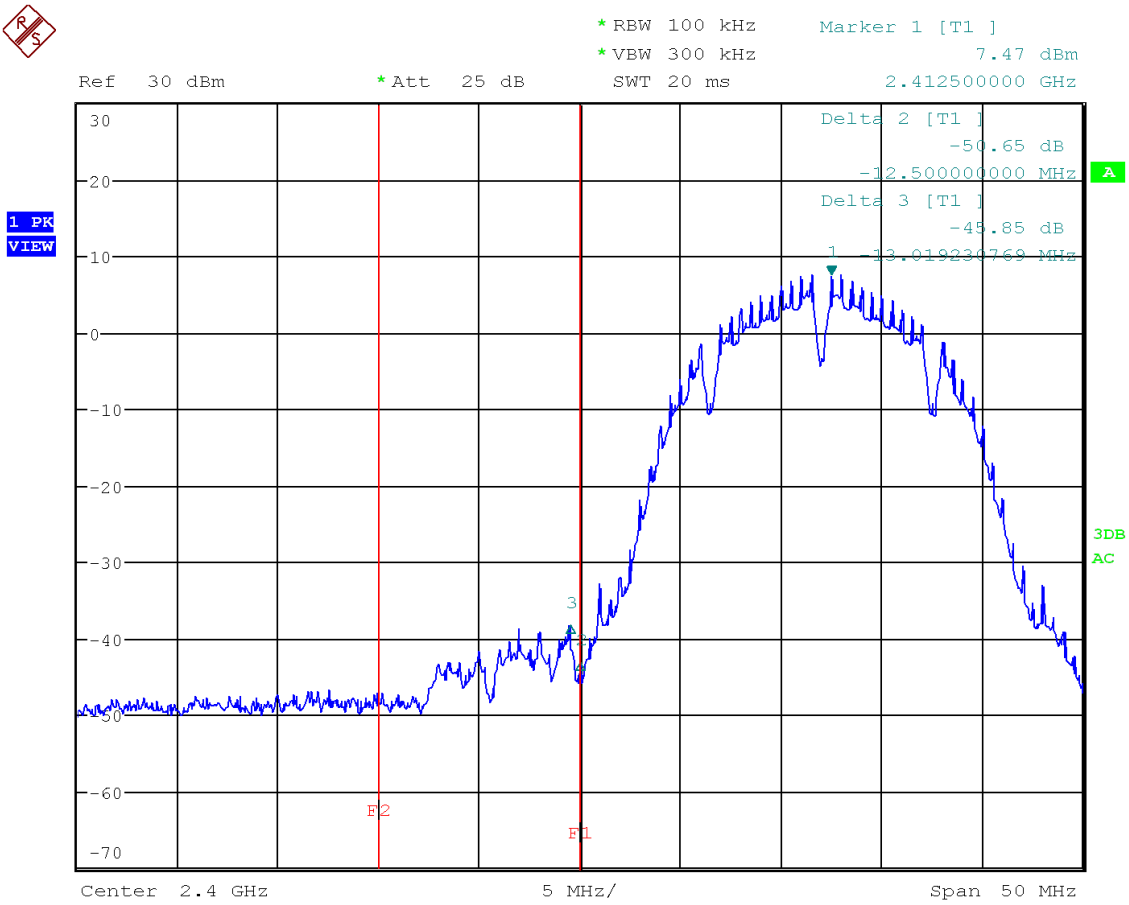

Figure 62: Chart of band-edge measurement on lowest channel in modulation IEEE 802.11 b

Frequency (MHz)	*Measured Margin (dB)*	*Limit of minimum margin*	*Result*
2399.481	43.65	≥ 20	Passed
2400.000	48.36	≥ 20	Passed

Table 32: Result of band-edge measurement on lowest channel in modulation IEEE 802.11 b

Note(s):
1. Conducted limit = Field strength limit at 3 m (radiated) – 95.2 – antenna gain (Minimum 2 dBi)
2. The average value was corrected by the appropriate duty cycle factor.

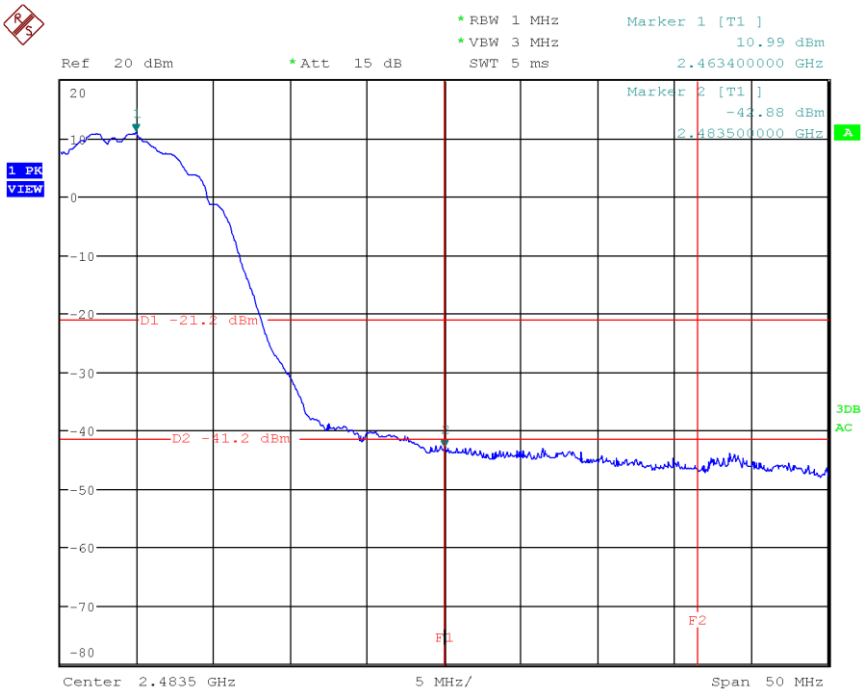

Figure 63: Chart of band-edge measurement on highest channel (PK) in modulation IEEE 802.11 b

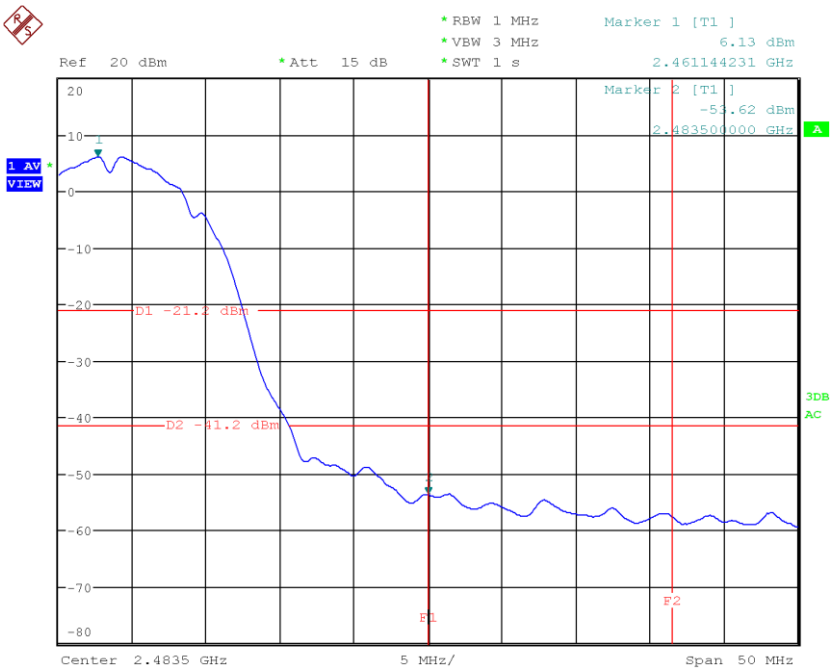

Figure 64: Chart of band-edge measurement on highest channel (AV) in modulation IEEE 802.11 b

Frequency (MHz)	*Max Peak (dBm)*	*AV (dBm)*	*Limit (dBm)*	*Margin (dB)*	*Result*
2483.500	-42.88	---	-23.40	19.48	Passed
2483.500	---	-53.25	-43.40	9.82	Passed

Table 33: Test results of band-edge measurements on highest channel in modulation IEEE 802.11 b

Note(s):
1. The margin was corrected by the antenna gain of 2.2 dBi.

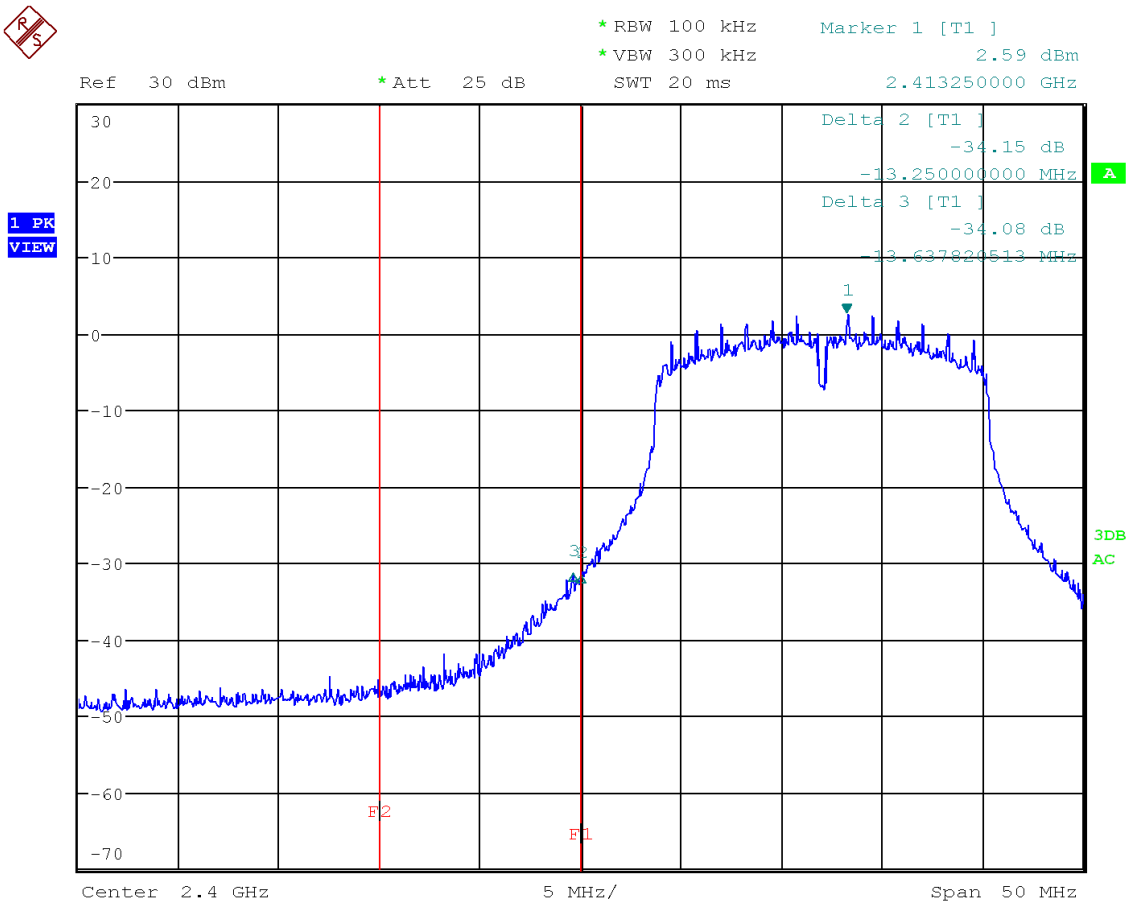

Figure 65: Chart of band-edge measurement on lowest channel in modulation IEEE 802.11 g

Frequency (MHz)	*Measured Margin (dB)*	*Limit of minimum margin*	*Result*
2399.612	31.88	≥ 20	Passed
2400.000	31.95	≥ 20	Passed

Table 34: Result of band-edge measurement on lowest channel in modulation IEEE 802.11 g

Note(s):
1. Conducted limit = Field strength limit at 3 m (radiated) – 95.2 – antenna gain (Minimum 2 dBi)
2. The average value was corrected by the appropriate duty cycle factor.

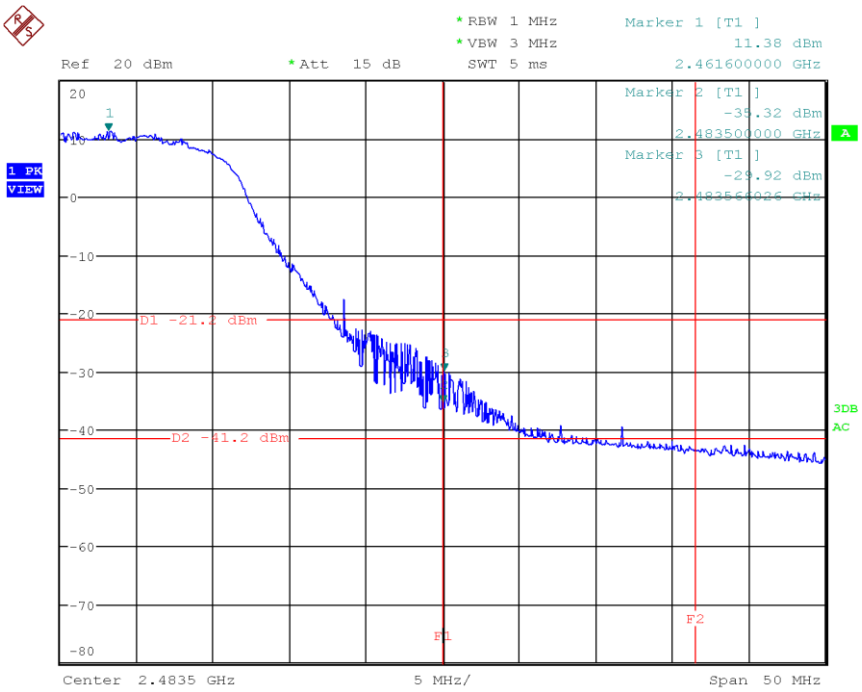

Figure 66: Chart of band-edge measurement on highest channel (PK) in modulation IEEE 802.11 g

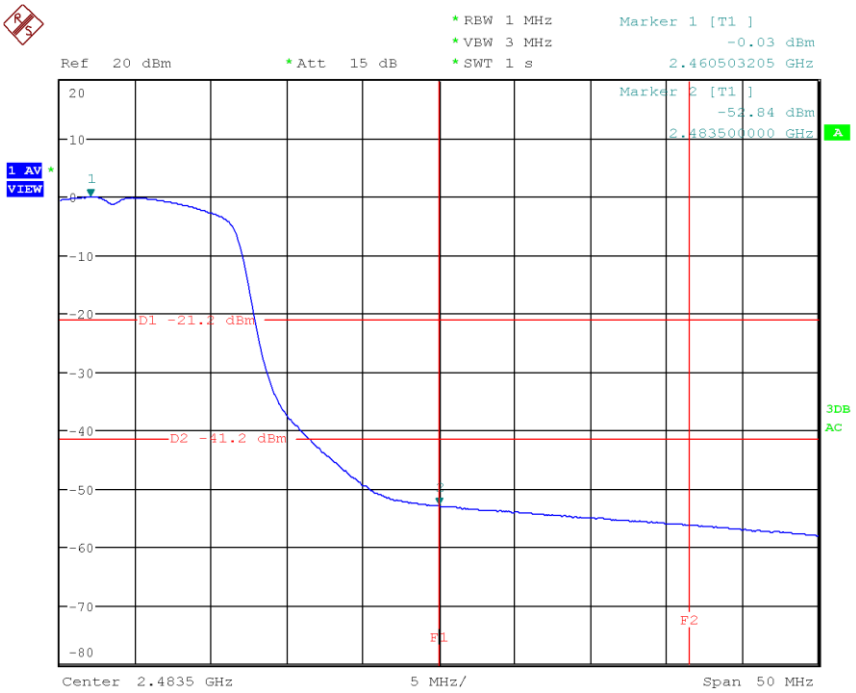

Figure 67: Chart of band-edge measurement on highest channel (AV) in modulation IEEE 802.11 g

Frequency (MHz)	*Max Peak (dBm)*	*AV (dBm)*	*Limit (dBm)*	*Margin (dB)*	*Result*
2483.500	-35.32	---	-23.40	11.92	Passed
2483.500	---	-51.89	-43.40	8.49	Passed
2483.566	-29.92	---	-23.40	6.52	Passed

Table 35: Test results of band-edge measurements on highest channel in modulation IEEE 802.11 g

Note(s):
1. The margin was corrected by the antenna gain of 2.2 dBi.

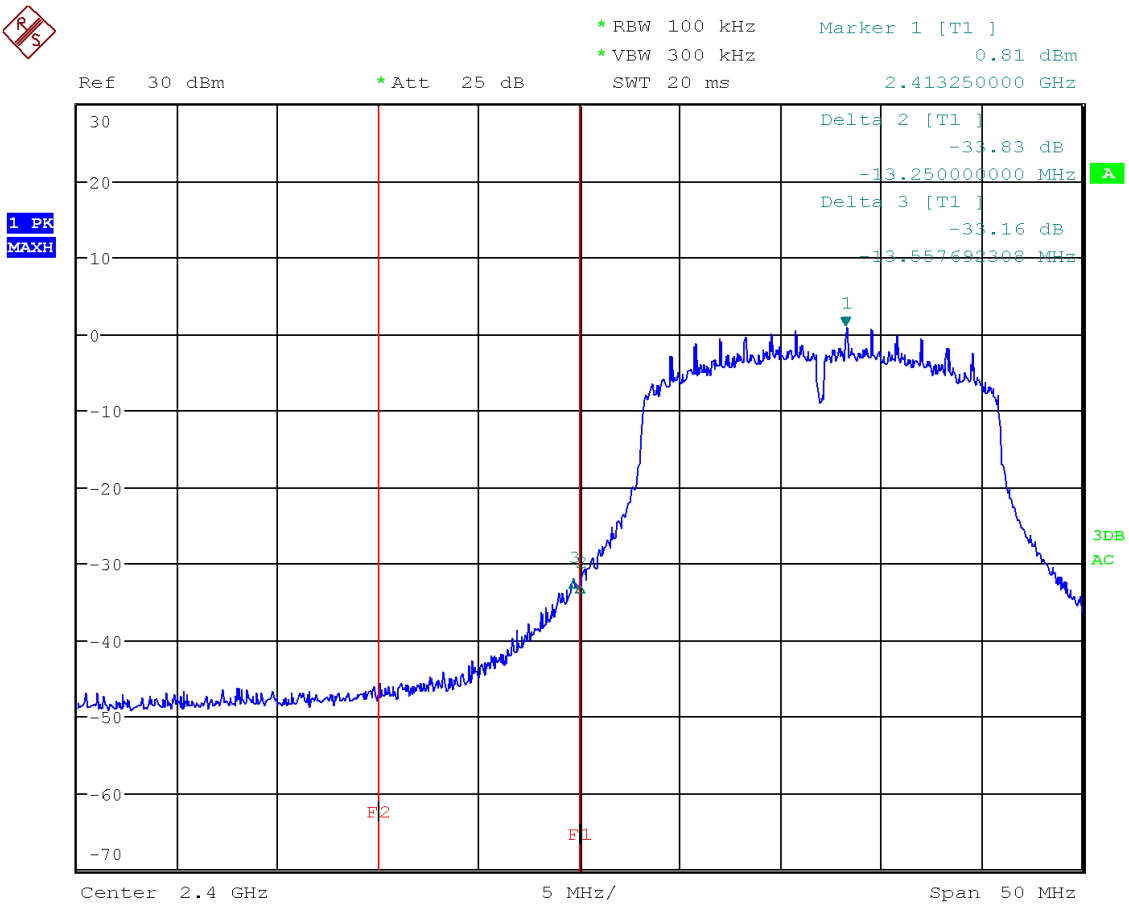

Figure 68: Chart of band-edge measurement on lowest channel in modulation IEEE 802.11 n (HT20)

Frequency (MHz)	*Measured Margin (dB)*	*Limit of minimum margin*	*Result*
2399.692	30.96	≥ 20	Passed
2400.000	31.63	≥ 20	Passed

Table 36: Result of band-edge measurement on lowest channel in modulation IEEE 802.11 n (HT20)

Note(s):
1. Conducted limit = Field strength limit at 3 m (radiated) – 95.2 – antenna gain (Minimum 2 dBi)
2. The average value was corrected by the appropriate duty cycle factor.

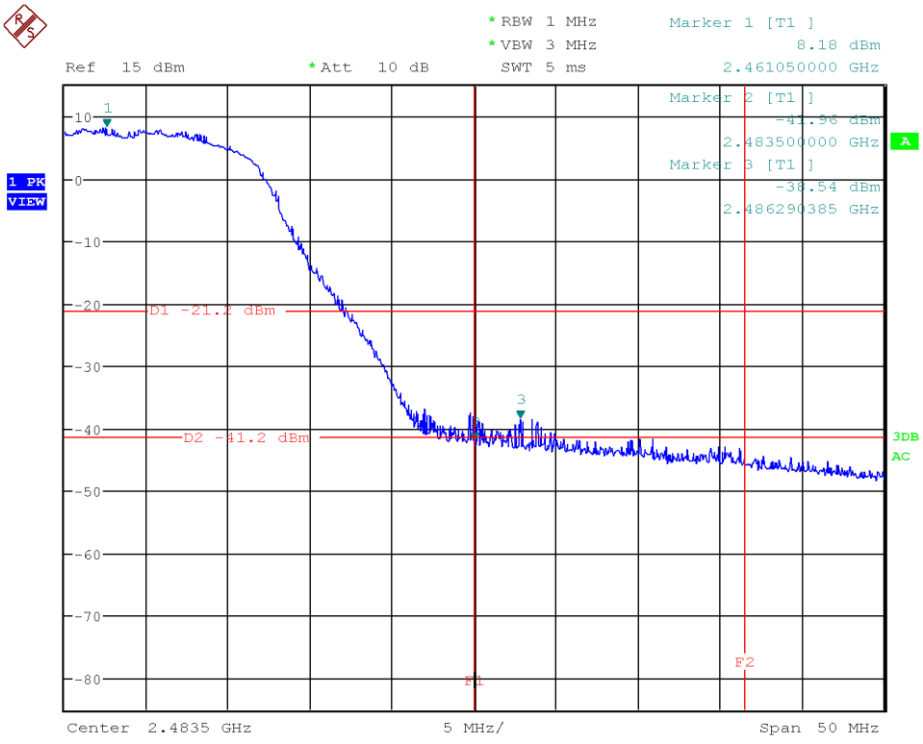

Figure 69: Chart of band-edge measurement on highest channel (PK) in modulation IEEE 802.11 n (HT20)

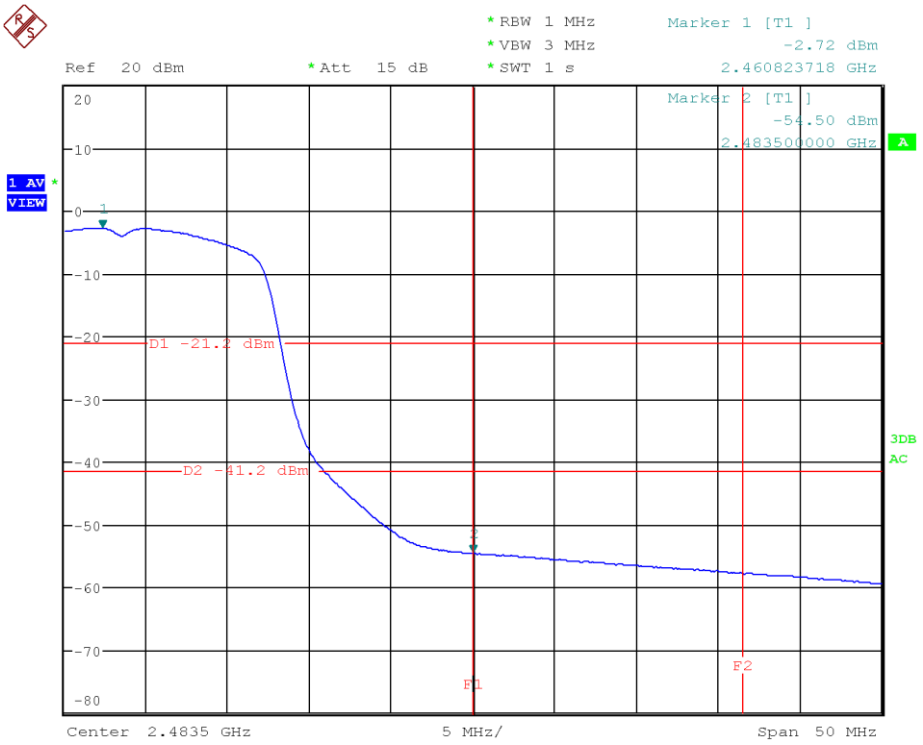

Figure 70: Chart of band-edge measurement on highest channel (AV) in modulation IEEE 802.11 n (HT20)

Frequency (MHz)	*Max Peak (dBm)*	*AV (dBm)*	*Limit (dBm)*	*Margin (dB)*	*Result*
2483.500	-41.96	---	-23.40	18.56	Passed
2483.500	---	-53.35	-43.40	9.95	Passed
2486.290	-38.54	---	-23.40	15.14	Passed

Table 37: Test results of band-edge measurements on highest channel in modulation IEEE 802.11 n (HT20)

6.8 Antenna-port conducted measurements

Section(s) in 47 CFR Part 15:	Requirement(s):	15.247(d)
	Reference(s):	KDB 558074 D01, clauses 8.6 ANSI C63.10, clause 11.12.2
Section(s) in RSS:	Requirement(s):	RSS-247, section 5.5
	Reference(s):	KDB 558074 D01, clauses 8.6 ANSI C63.10, clause 11.12.2

Performed by:	Jennifer Riedel B. Eng.	Date(s) of test:	June 27, 2022
Result:	☒ Test passed	☐ Test not passed	

6.8.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
EMI test receiver	ESU 26	Rohde & Schwarz	W00002

6.8.2 Limits

According to §15.247(d) and RSS-247 section 5.5:
In any 100 kHz bandwidth outside of the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.
In addition, radiated emissions which fall in the restricted bands (see table 31) must also comply with the radiated emission limits specified in §15.209(a) and RSS-Gen section 8.10.

Frequency	*Field strength*		*Measurement distance*
(MHz)	*(µV/m)*	*(dBµV/m)*	*(m)*
0.009 – 0.490	2400/F(kHz) (266.67 – 4.90)	48.52 – 13.80	300
0.490 – 1.705	24000/F(kHz) (48.98 – 14.08)	33.80 – 22.97	30
1.705 – 30	30	29.54	30
30 – 88	100	40.00	3
88 – 216	150	43.52	3
216 - 960	200	46.02	3
Above 960	500	53.98	3

Table 38: General radiated emission limits from 9 kHz to 25 GHz according to §15.209

Frequency	*Magnetic field strength*		*Measurement distance*
(MHz)	*(µA/m)*	*(dBµA//m)*	*(m)*
0.009 – 0.490	6.37/F(kHz)	-2.999 – -37.721	300
0.490 – 1.705	63.7/F(kHz)	-17.721 – -28.636	30
1.705 – 30	0.08	-21.94	30

Table 39: General radiated emission limits from 9 kHz to 30 MHz according to RSS-Gen section 8.9

Frequency	*Field strength*		*Measurement distance*
(MHz)	*(µV/m)*	*(dBµV/m)*	*(m)*
30 – 88	100	40.00	3
88 – 216	150	43.52	3
216 - 960	200	46.02	3
Above 960	500	53.98	3

Table 40: General radiated emission limits from 30 MHz to 25 GHz according to RSS-Gen section 8.9

In case of measurements are performed at other distances than that specified in the requirements, the limits in the charts and tables reported with the test results are derived from the general radiated emission limits as listed in table 50 using the recalculation factor as described in clause 5.3.

6.8.3 Test procedure

The emissions from 9 kHz to 25 GHz are measured using the

☒ test procedure for conducted measurements as described in clause 5.2.
☐ test procedure for radiated measurements as described in clause 5.3.

6.8.4 Test results

Note(s)

1 The power limit lines in all charts are calculated from the field strength limits at 3 m measurement distance with an antenna gain of 0 dBi. The maximum antenna gain is 2.2 dBi. According to ANSI C63.10 clause 11.12.2.6, the gain of the transmitting antenna must be added to the measured output power, either the maximum in-band gain of the antenna across all operating bands or 2 dBi, whichever is greater.

2 The operating frequency band from 2400 MHz to 2483.5 MHz is not shown in the charts because it is not in consideration in this clause.

3 The average value was corrected by the appropriate duty cycle factor.

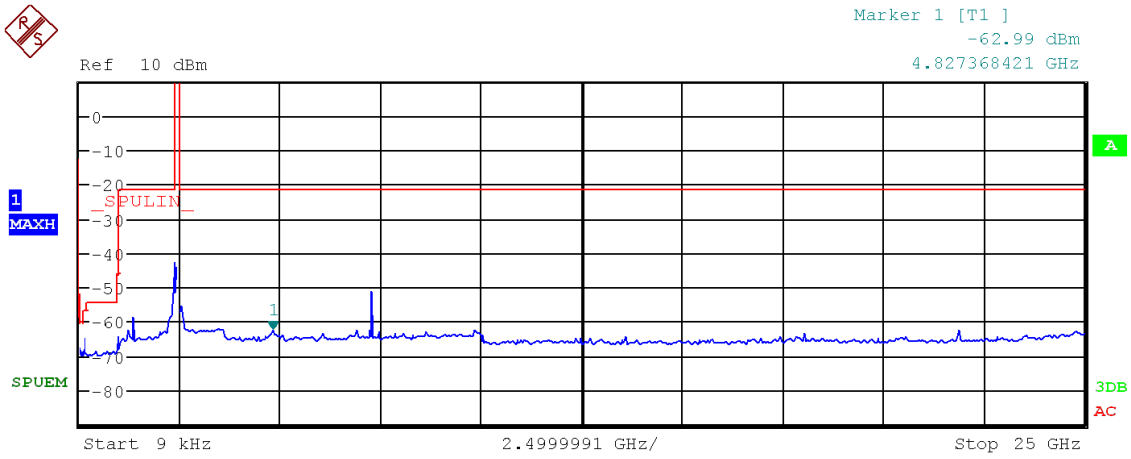

Figure 71: Chart of emissions test from 9 kHz to 25 GHz on lowest channel in modulation IEEE 802.11 b, PK-detector

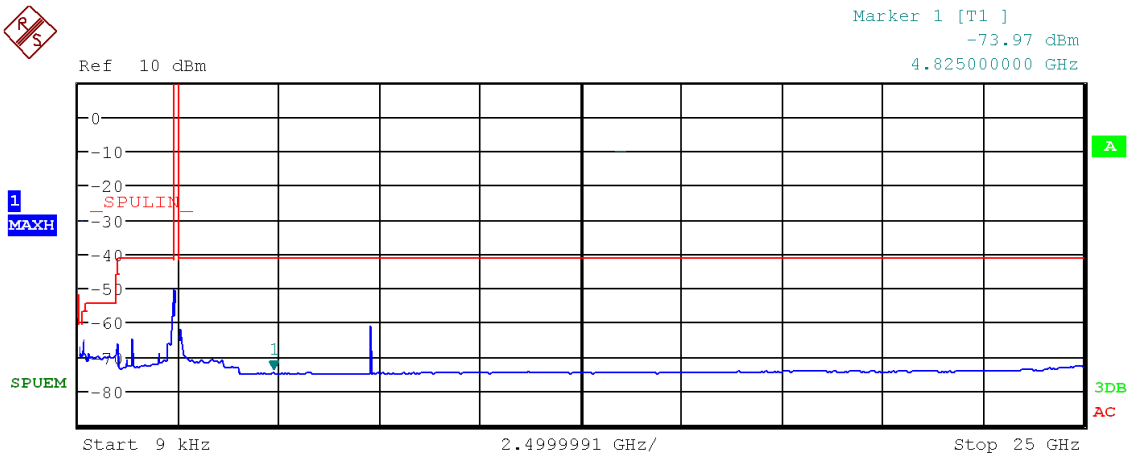

Figure 72: Chart of emissions test from 9 kHz to 25 GHz on lowest channel in modulation IEEE 802.11 b, AV-detector

Frequency (MHz)	*Level (dBm)*	*Detector*	*Limit (dBm)*	*Margin (dB)*
2382.123	-40.55	PK	-21.20	19.35
2381.660	-47.45	AV	-41.20	6.25
4827.368	-60.79	PK	-21.20	39.59
4825.000	-71.27	AV	-41.20	30.07
7236.842	-49.09	PK	-21.20	27.89
7240.000	-58.64	AV	-41.20	17.44

Table 41: Results of emissions test from 9 kHz to 25 GHz on lowest channel in modulation IEEE 802.11 b

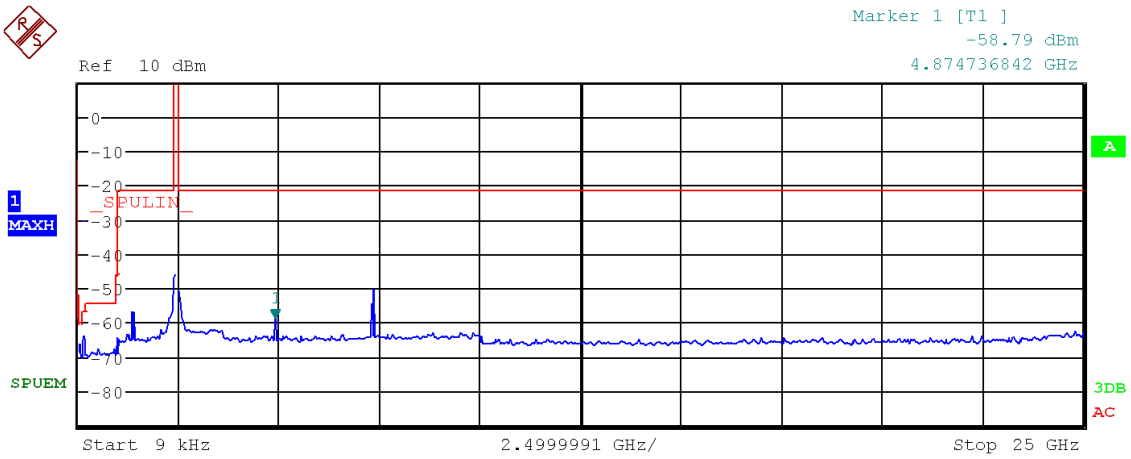

Figure 73: Chart of emissions test from 9 kHz to 25 GHz on middle channel in modulation IEEE 802.11 b, PK-detector

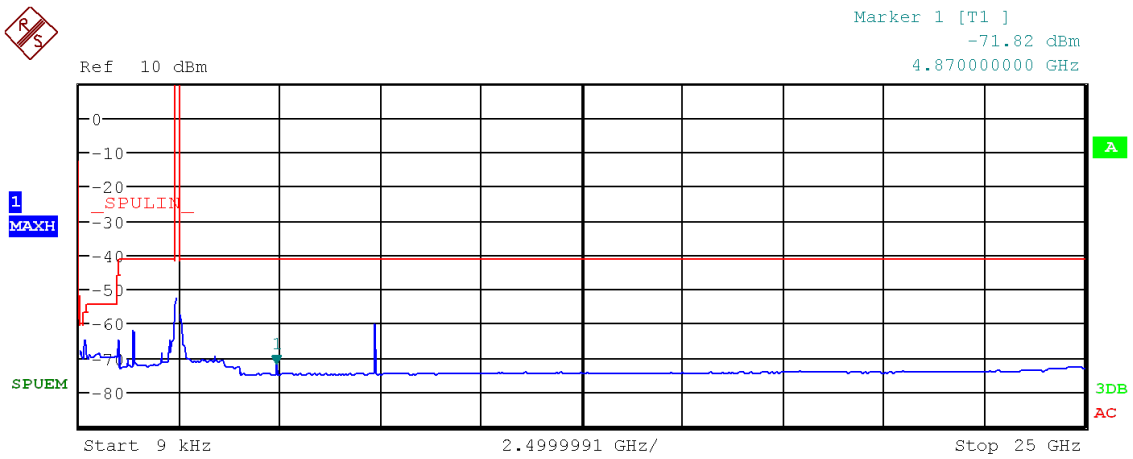

Figure 74: Chart of emissions test from 9 kHz to 25 GHz on middle channel in modulation IEEE 802.11 b, AV-detector

Frequency (MHz)	*Level (dBm)*	*Detector*	*Limit (dBm)*	*Margin (dB)*
2374.710	-44.83	PK	-21.20	23.63
2389.537	-50.27	AV	-41.20	9.07
4874.737	-56.59	PK	-21.20	35.39
4870.000	-69.27	AV	-41.20	28.07
7312.632	-47.95	PK	-21.20	26.75
7315.000	-57.69	AV	-41.20	16.49

Table 42: Results of emissions test from 9 kHz to 25 GHz on middle channel in modulation IEEE 802.11 b

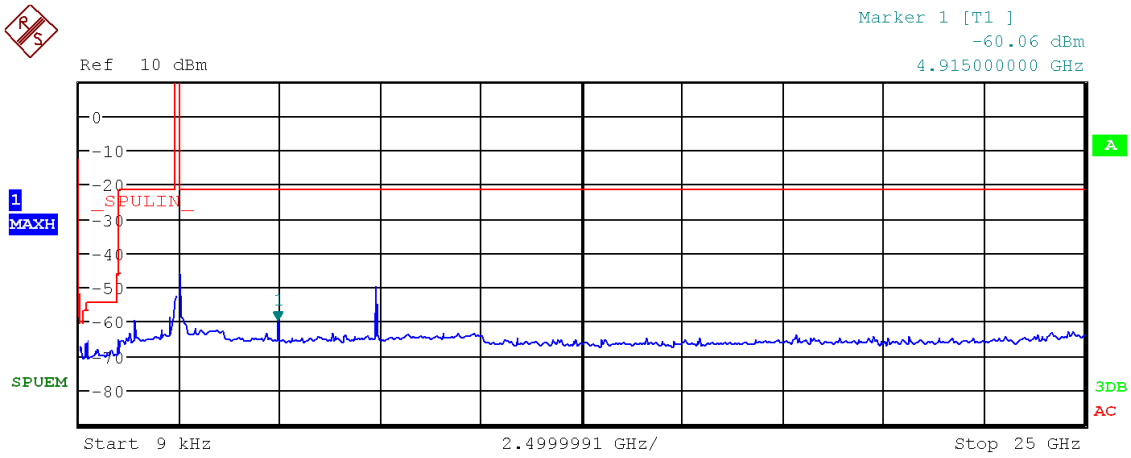

Figure 75: Chart of emissions test from 9 kHz to 25 GHz on highest channel in modulation IEEE 802.11 b, PK-detector

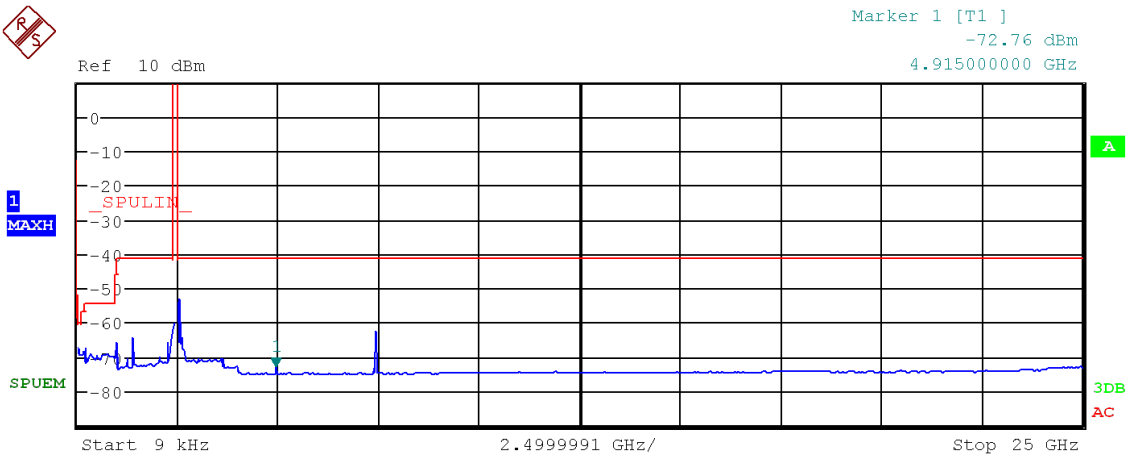

Figure 76: Chart of emissions test from 9 kHz to 25 GHz on highest channel in modulation IEEE 802.11 b, AV-detector

Frequency (MHz)	*Level (dBm)*	*Detector*	*Limit (dBm)*	*Margin (dB)*
2502.751	-43.72	PK	-21.20	22.52
2503.857	-50.50	AV	-41.20	9.30
4915.000	-57.86	PK	-21.20	36.66
4915.000	-70.19	AV	-41.20	28.89
7388.421	-47.53	PK	-21.20	26.33
7390.000	-59.80	AV	-41.20	18.60

Table 43: Results of emissions test from 9 kHz to 25 GHz on highest channel in modulation IEEE 802.11 b

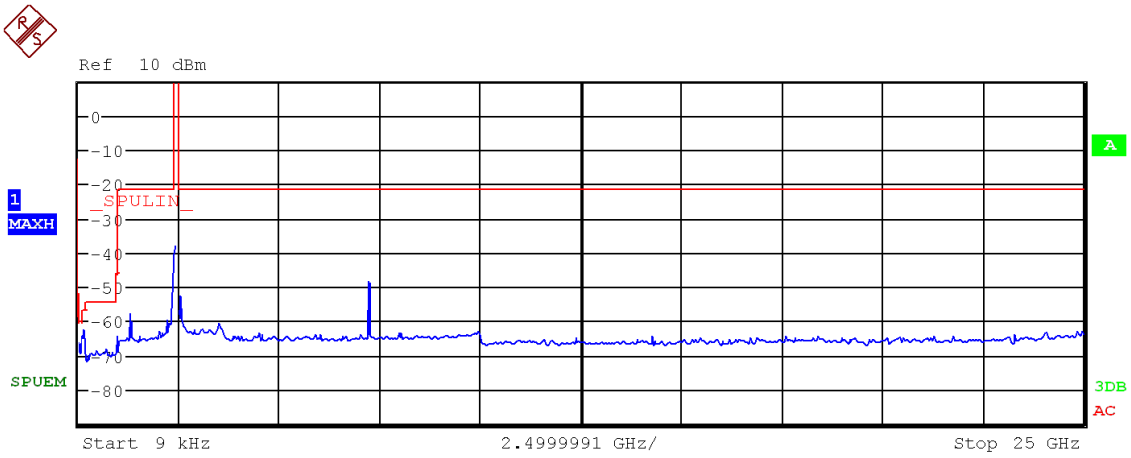

Figure 77: Chart of emissions test from 9 kHz to 25 GHz on lowest channel in modulation IEEE 802.11 g, PK-detector

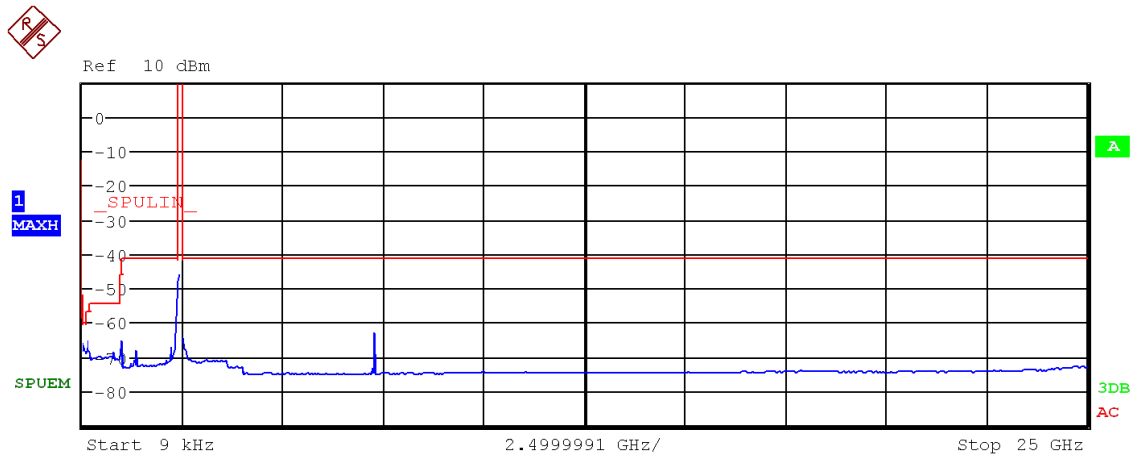

Figure 78: Chart of emissions test from 9 kHz to 25 GHz on lowest channel in modulation IEEE 802.11 g, AV-detector

Frequency (MHz)	*Level (dBm)*	*Detector*	*Limit (dBm)*	*Margin (dB)*
2389.537	-35.91	PK	-21.20	14.71
2389.537	-44.48	AV	-41.20	3.28
7227.368	-46.27	PK	-21.20	25.07
7225.000	-59.99	AV	-41.20	18.79

Table 44: Results of emissions test from 9 kHz to 25 GHz on lowest channel in modulation IEEE 802.11 g

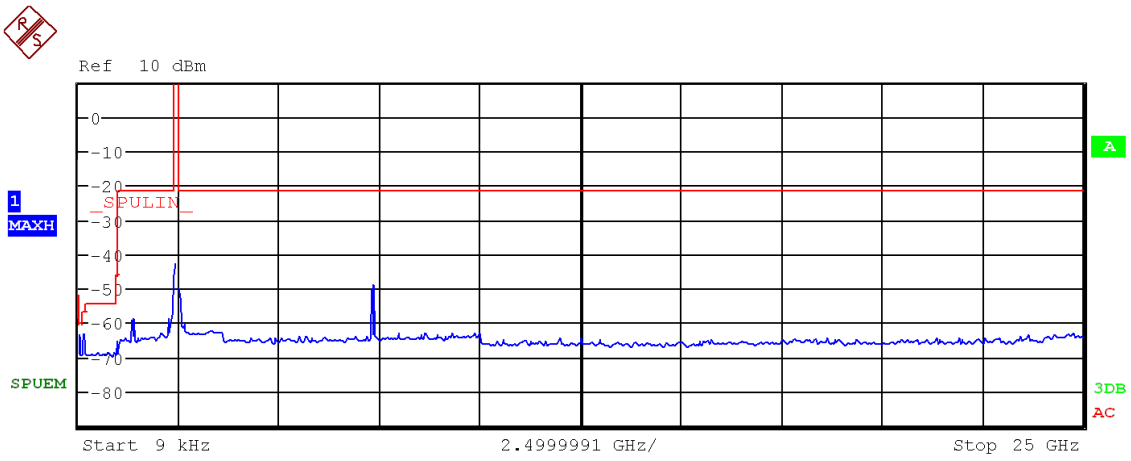

Figure 79: Chart of emissions test from 9 kHz to 25 GHz on middle channel in modulation IEEE 802.11 g, PK-detector

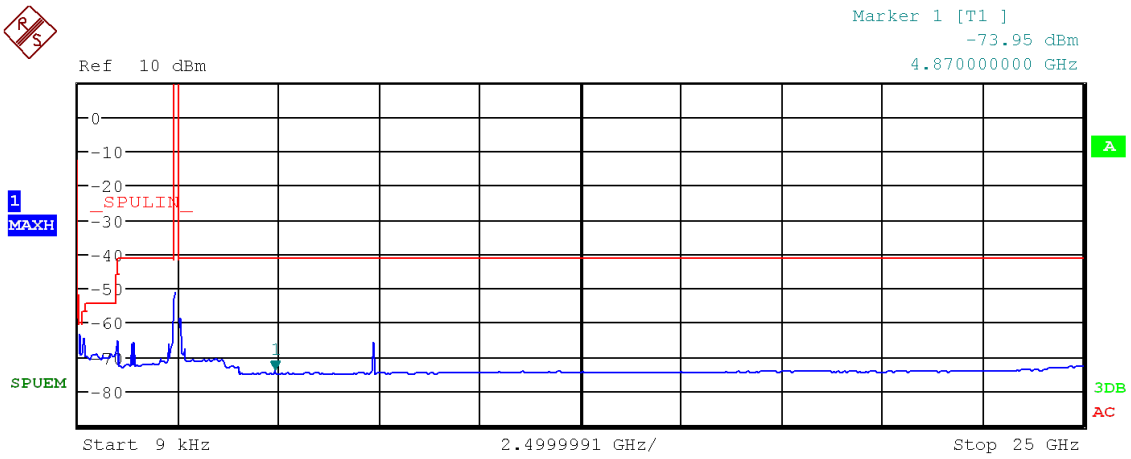

Figure 80: Chart of emissions test from 9 kHz to 25 GHz on middle channel in modulation IEEE 802.11 g, AV-detector

Frequency (MHz)	*Level (dBm)*	*Detector*	*Limit (dBm)*	*Margin (dB)*
2389.073	-40.65	PK	-21.20	19.45
2389.537	-47.94	AV	-41.20	6.74
2502.571	-47.48	PK	-21.20	26.28
2500.429	-55.57	AV	-41.20	14.37
7309.474	-46.79	PK	-21.20	44.59
7315.000	-62.81	AV	-41.20	21.61

Table 45: Results of emissions test from 9 kHz to 25 GHz on middle channel in modulation IEEE 802.11 g

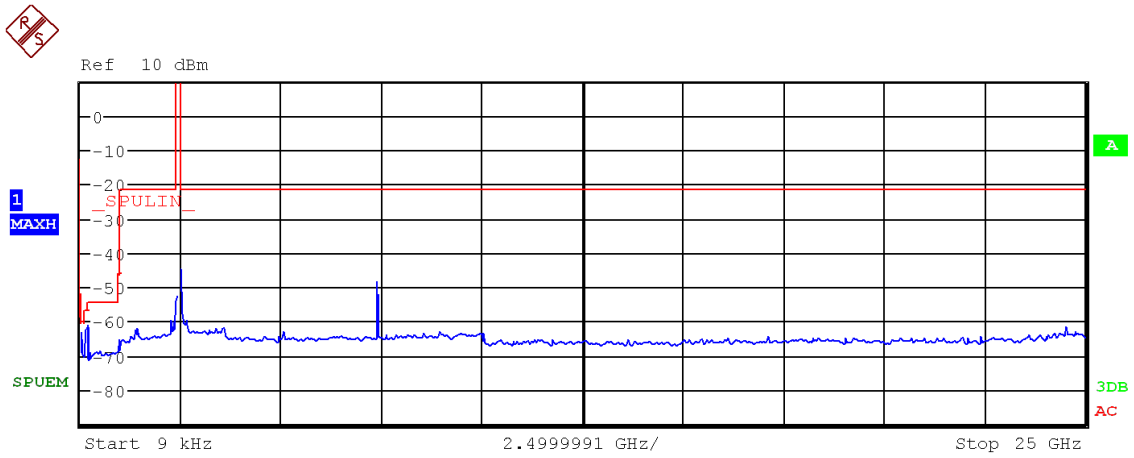

Figure 81: Chart of emissions test from 9 kHz to 25 GHz on highest channel in modulation IEEE 802.11 g, PK-detector

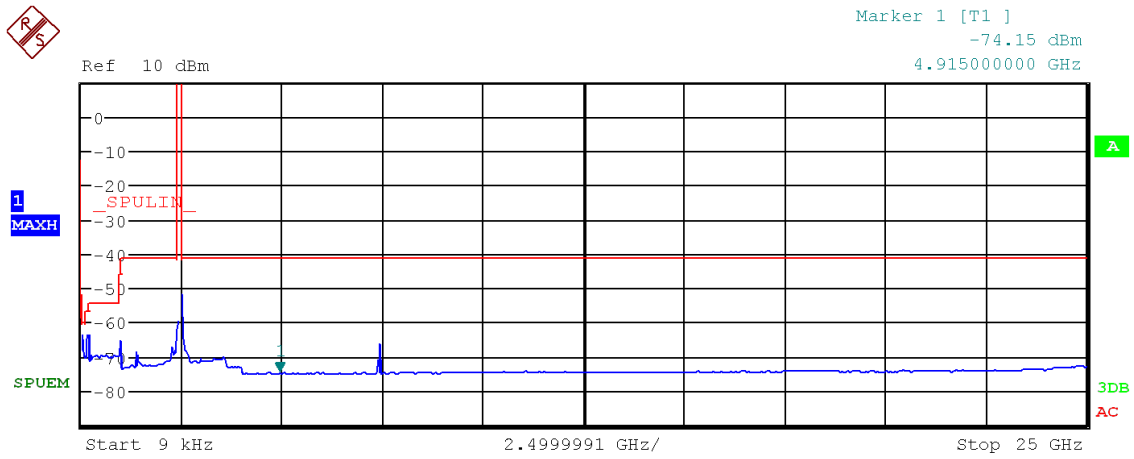

Figure 82: Chart of emissions test from 9 kHz to 25 GHz on highest channel in modulation IEEE 802.11 g, AV-detector

Frequency (MHz)	*Level (dBm)*	*Detector*	*Limit (dBm)*	*Margin (dB)*
2500.857	-42.46	PK	-21.20	21.26
2502.571	-48.49	AV	-41.20	7.29
7385.263	-46.11	PK	-21.20	24.91
7390.000	-63.34	AV	-41.20	22.14

Table 46: Results of emissions test from 9 kHz to 25 GHz on highest channel in modulation IEEE 802.11 g

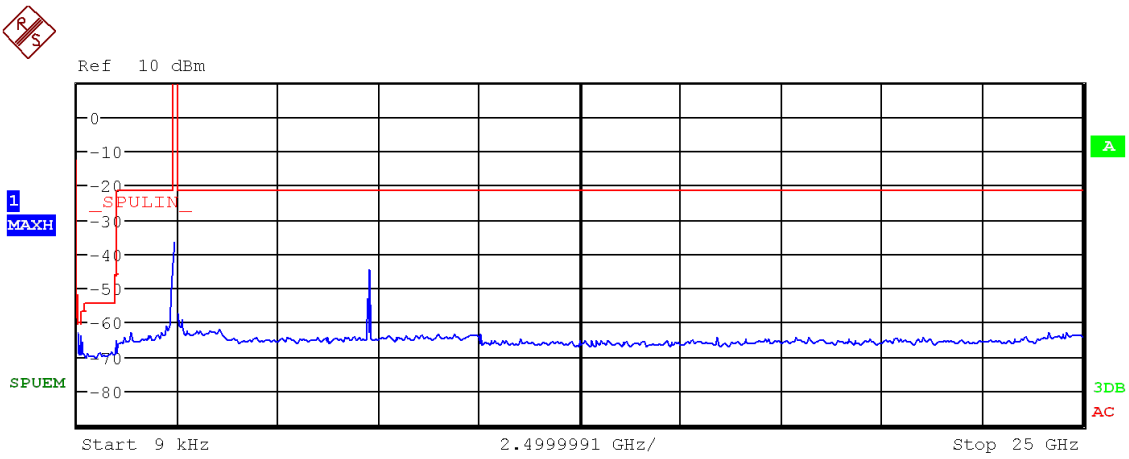

Figure 83: Chart of emissions test from 9 kHz to 25 GHz on lowest channel in modulation IEEE 802.11 n (HT20), PK-detector

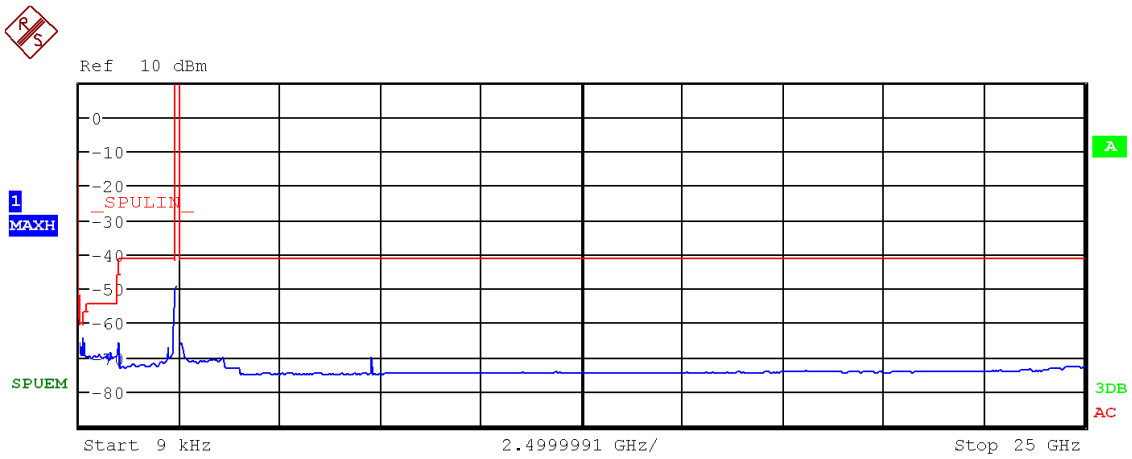

Figure 84: Chart of emissions test from 9 kHz to 25 GHz on lowest channel in modulation IEEE 802.11 n (HT20), AV-detector

Frequency (MHz)	*Level (dBm)*	*Detector*	*Limit (dBm)*	*Margin (dB)*
2383.513	-34.38	PK	-21.20	13.18
2386.757	-45.97	AV	-41.20	4.77
7246.316	-42.53	PK	-21.20	21.33
7240.000	-66.77	AV	-41.20	25.57

Table 47: Results of emissions test from 9 kHz to 25 GHz on lowest channel in modulation IEEE 802.11 n (HT20)

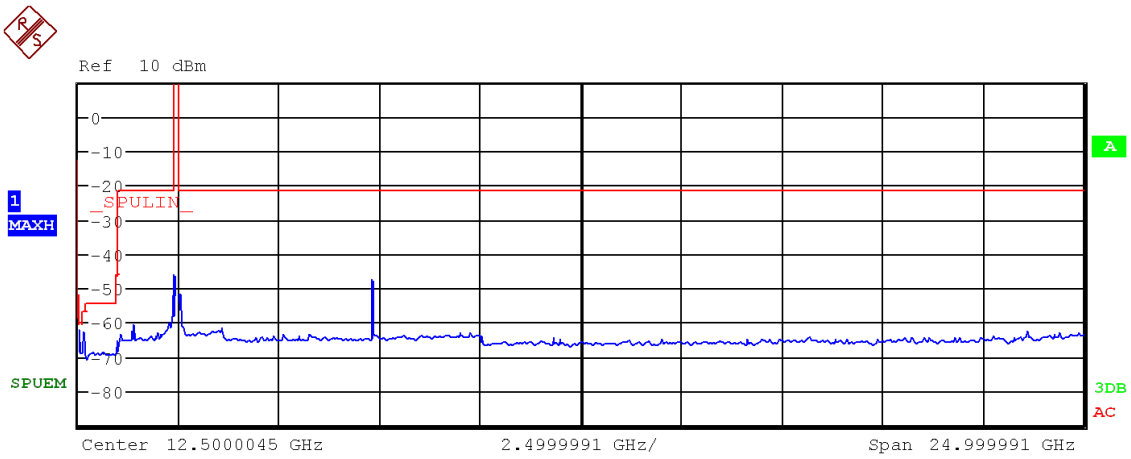

Figure 85: Chart of emissions test from 9 kHz to 25 GHz on middle channel in modulation IEEE 802.11 n (HT20), PK-detector

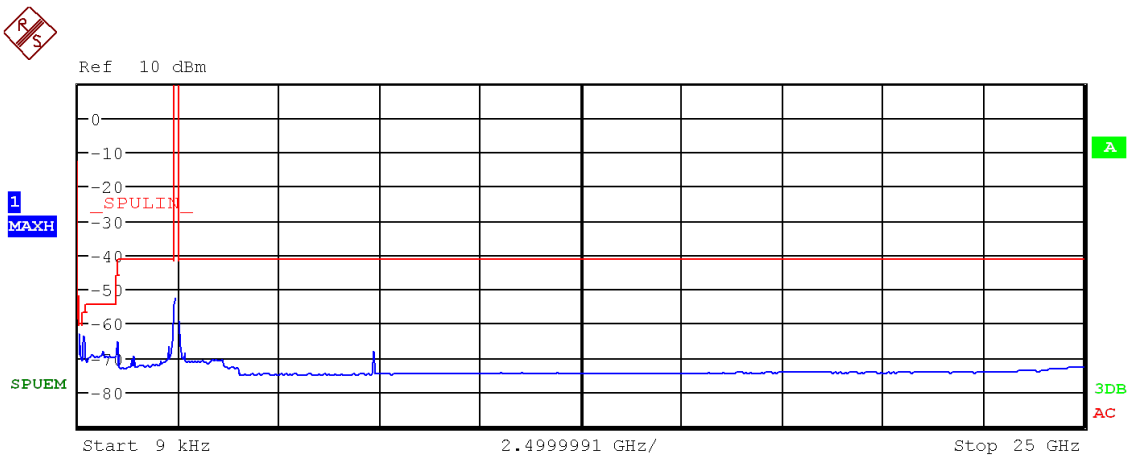

Figure 86: Chart of emissions test from 9 kHz to 25 GHz on middle channel in modulation IEEE 802.11 n (HT20), AV-detector

Frequency (MHz)	*Level (dBm)*	*Detector*	*Limit (dBm)*	*Margin (dB)*
2378.417	-44.12	PK	-21.20	22.92
2389.537	-49.90	AV	-41.20	8.70
2501.286	-49.48	PK	-21.20	28.28
2503.429	-56.03	AV	-41.20	14.83
7306.316	-45.41	PK	-21.20	24.21
7315.000	-64.82	AV	-41.20	23.62

Table 48: Results of emissions test from 9 kHz to 25 GHz on middle channel in modulation IEEE 802.11 n (HT20)

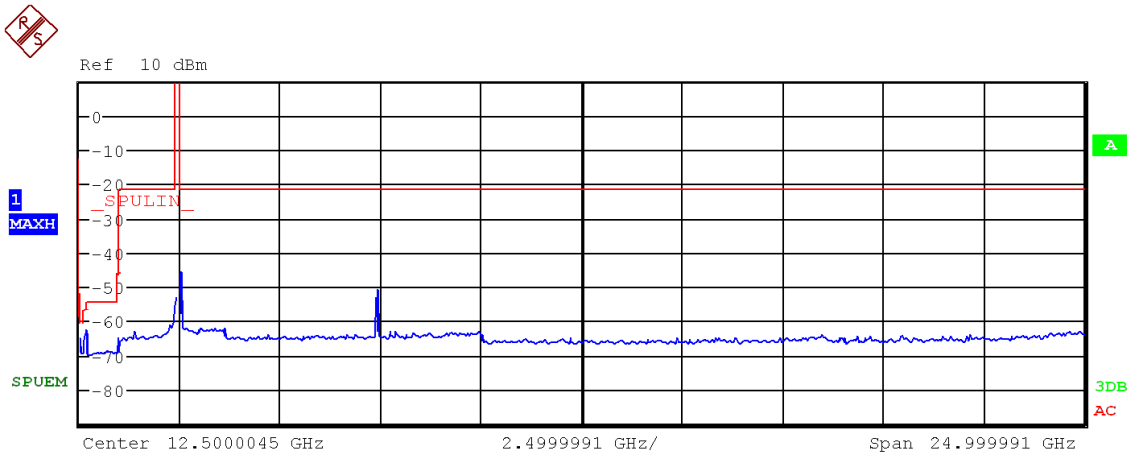

Figure 87: Chart of emissions test from 9 kHz to 25 GHz on highest channel in modulation IEEE 802.11 n (HT20), PK-detector

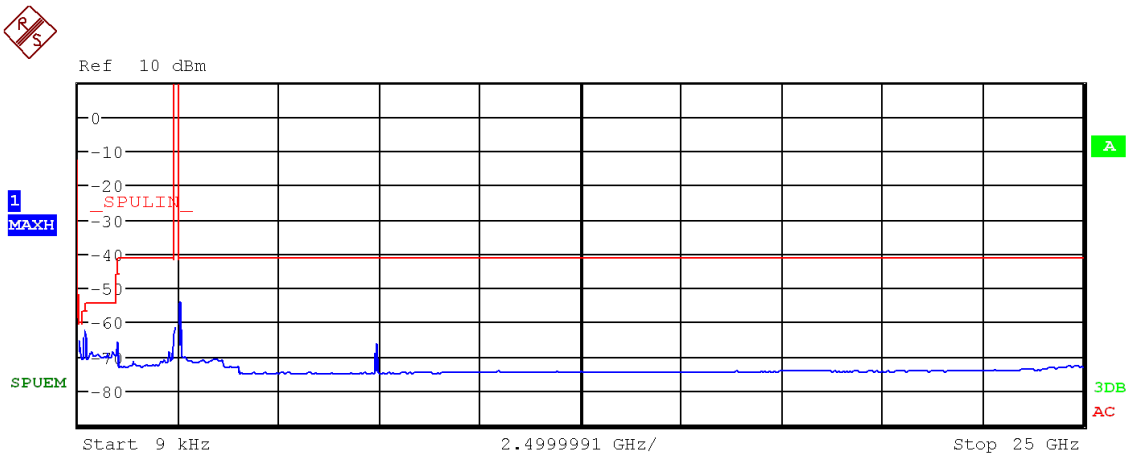

Figure 88: Chart of emissions test from 9 kHz to 25 GHz on highest channel in modulation IEEE 802.11 n (HT20), AV-detector

Frequency (MHz)	*Level (dBm)*	*Detector*	*Limit (dBm)*	*Margin (dB)*
2505.143	-43.45	PK	-21.20	22.25
2505.571	-50.78	AV	-41.20	9.58
7397.895	-48.71	PK	-21.20	27.51
7390.000	-63.01	AV	-41.20	21.81

Table 49: Results of emissions test from 9 kHz to 25 GHz on highest channel in modulation IEEE 802.11 n (HT20)

6.9 Radiated emissions below 30 MHz

Section(s) in 47 CFR Part 15:	Requirement(s):	15.247(d)
	Reference(s):	KDB 558074 D01, clauses 8.5 and 8.6 ANSI C63.10, clause 6.4
Section(s) in RSS:	Requirement(s):	RSS-247, section 5.5
	Reference(s):	KDB 558074 D01, clauses 8.5 and 8.6 ANSI C63.10, clause 6.4

Performed by:	Jennifer Riedel B. Eng.	Date(s) of test:	July 14, 2022
Result:	☒ Test passed	☐ Test not passed	

6.9.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
Compact Diagnostic Chamber (CDC)	VK041.0174	Albatross Projects	E00026
EMI test receiver	ESW 44	Rohde & Schwarz	E00895
Loop antenna	HFH2-Z2	Rohde & Schwarz	E00060
Cable set CDC	RF cable(s)	Huber + Suhner AME HF-Technik AME HF-Technik Stabo	E00446 E00920 E00921 E01215
Test software	EMC32-(M)EB, V10.60.20	Rohde & Schwarz	E00777, E00778 or E01073

6.9.2 Limits

According to §15.247(d) and RSS-247 section 5.5:
In any 100 kHz bandwidth outside of the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.
In addition, radiated emissions which fall in the restricted bands (see table 31) must also comply with the radiated emission limits specified in §15.209(a) and RSS-Gen section 8.10.
For the frequency range 9 kHz to 30 MHz, these limits are shown in table 50 and Table 51.

Frequency	*Field strength*		*Measurement distance*
(MHz)	*(µV/m)*	*(dBµV/m)*	*(m)*
0.009 – 0.490	2400/F(kHz) (266.67 – 4.90)	48.52 – 13.80	300
0.490 – 1.705	24000/F(kHz) (48.98 – 14.08)	33.80 – 22.97	30
1.705 – 30	30	29.54	30

Table 50: General radiated emission limits up to 30 MHz according to §15.209

Frequency	*Magnetic field strength*		*Measurement distance*
(MHz)	*(µA/m)*	*(dBµA//m)*	*(m)*
0.009 – 0.490	6.37/F(kHz)	-2.999 – -37.721	300
0.490 – 1.705	63.7/F(kHz)	-17.721 – -28.636	30
1.705 – 30	0.08	-21.94	30

Table 51: General radiated emission limits from 9 kHz to 30 MHz according to section 8.9 of RSS-Gen

In case of measurements are performed at other distances than that specified in the requirements, the limits in the charts and tables reported with the test results are derived from the general radiated emission limits as listed in table 50 using the recalculation factor as described in clause 5.3.

6.9.3 Test procedure

The emissions below 30 MHz are measured using the

☐ test procedure for conducted measurements as described in clause 5.2.
☒ test procedure for radiated measurements as described in clause 5.3.

The following parameters are set:

Frequency range	*IF Bandwidth*	*Preamplifier*
9 kHz – 150 kHz	200 Hz	Off
150 kHz – 30 MHz	9 kHz	Off

6.9.4 Test results

Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
Antenna alignment:	☒ in parallel	☒ in line	☐ angle ….. °
EUT position:	☒ Position X	☒ Position Y	☒ Position Z

Note(s):

1 Pre-measurements were performed to declare the worst case which is documented below.
2 No assessable emissions could be detected.
3 According to clause 6.8 the modulation IEEE 802.11 n (HT20) for channel 01 and 06 and the modulation IEEE 802.11 g for channel 11 were tested as worst cases.
4 Pre-measurements have shown that there are no differences between the tested channels below 30 MHz, so the final measurement was only performed on highest channel.
5 The limits in CFR 47, Part 15, Subpart C, paragraph 15.209(a), are identical to those in RSS-Gen section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377 Ohms. For example, the measurement at frequency X kHz resulted in a level of Y dBuV/m, which is equivalent to Y – 51.5 = Z dBuA/m, which has the same margin, W dB, to the corresponding RSS-210 limit as it has to 15.209(a) limit.
6 The antenna port of the EUT was terminated with 50 Ω for this test

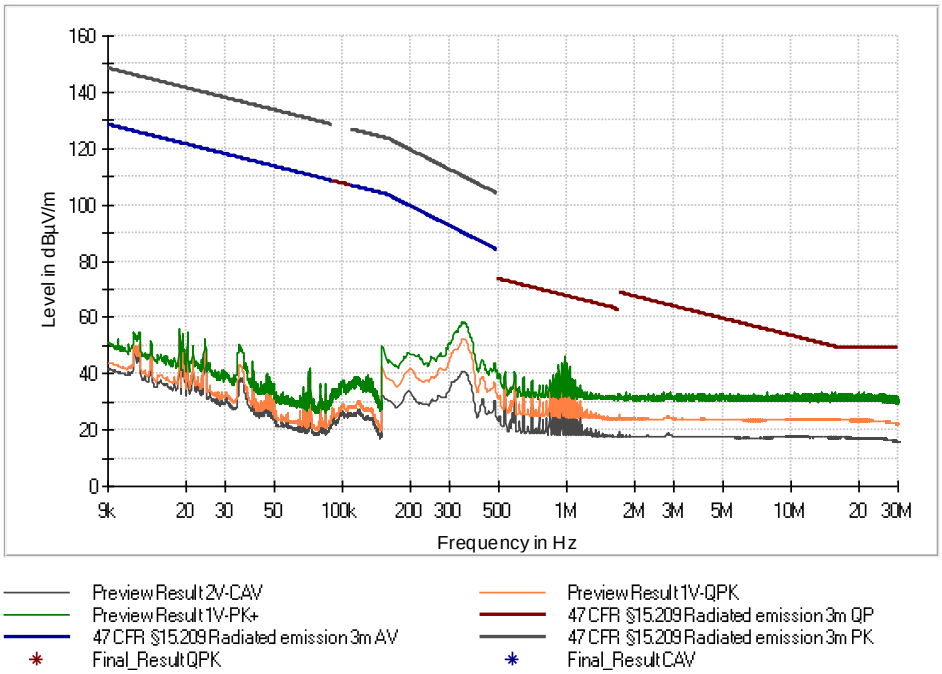

Figure 89: Chart of emissions test below 30 MHz on highest channel in modulation IEEE 802.11 g, EUT position X, antenna in line to the EUT

6.10 Radiated emissions from 30 MHz to 1 GHz

Section(s) in 47 CFR Part 15:	Requirement(s):	15.247(d)
	Reference(s):	KDB 558074 D01, clauses 8.4 and 8.5 ANSI C63.10, clause 6.5
Section(s) in RSS:	Requirement(s):	RSS-247, section 5.5
	Reference(s):	KDB 558074 D01, clauses 8.4 and 8.5 ANSI C63.10, clause 6.5

Performed by:	Jennifer Riedel B. Eng.	Date(s) of test:	July 27, 2022
Result:	☒ Test passed	☐ Test not passed	

6.10.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
EMI test receiver	ESR 7	Rohde & Schwarz	E00739
TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
Cable set SAC	RF cable(s)	Huber + Suhner	E00755 E01033 E01034
Test software	EMC32-(M)EB, V10.60.20	Rohde & Schwarz	E00777, E00778 or E01073

6.10.2 Limits

According to §15.247(d) and RSS-247 section 5.5:
In any 100 kHz bandwidth outside of the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.
In addition, radiated emissions which fall in the restricted bands (see table 31) must also comply with the radiated emission limits specified in §15.209(a) and RSS-Gen section 8.10.
For frequencies equal to and above 30 MHz, these limits are shown in table 52.

Frequency	*Field strength*		*Measurement distance*
(MHz)	*(µV/m)*	*(dBµV/m)*	*(m)*
30 – 88	100	40.00	3
88 – 216	150	43.52	3
216 - 960	200	46.02	3
Above 960	500	53.98	3

Table 52: General radiated emission limits ≥ 30 MHz according to §15.209 and RSS-Gen section 8.9

6.10.3 Test procedure

The emissions from 30 MHz to 1 GHz are measured using the

☐ test procedure for conducted measurements as described in clause 5.2.
☒ test procedure for radiated measurements as described in clause 5.5.

The following parameters are set:

Frequency range	*IF Bandwidth*	*Preamplifier*
30 MHz – 1 GHz	120 kHz	20 dB

6.10.4 Test results

Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
Polarization:	☒ horizontal	☒ vertical	
EUT position:	☒ Position X	☒ Position Y	☒ Position Z

Note(s)
1 Pre-measurements were performed to declare the worst case which is documented below.
2 According to clause 6.8 the modulation IEEE 802.11 n (HT20) for channel 01 and 06 and the modulation IEEE 802.11 g for channel 11 were tested as worst cases.
3 Pre-measurements have shown that there are no differences between the tested channels in the range of 30 MHz to 1 GHz, so the final measurement was only performed on lowest channel.
4 The antenna port of the EUT was terminated with 50 Ω for this test

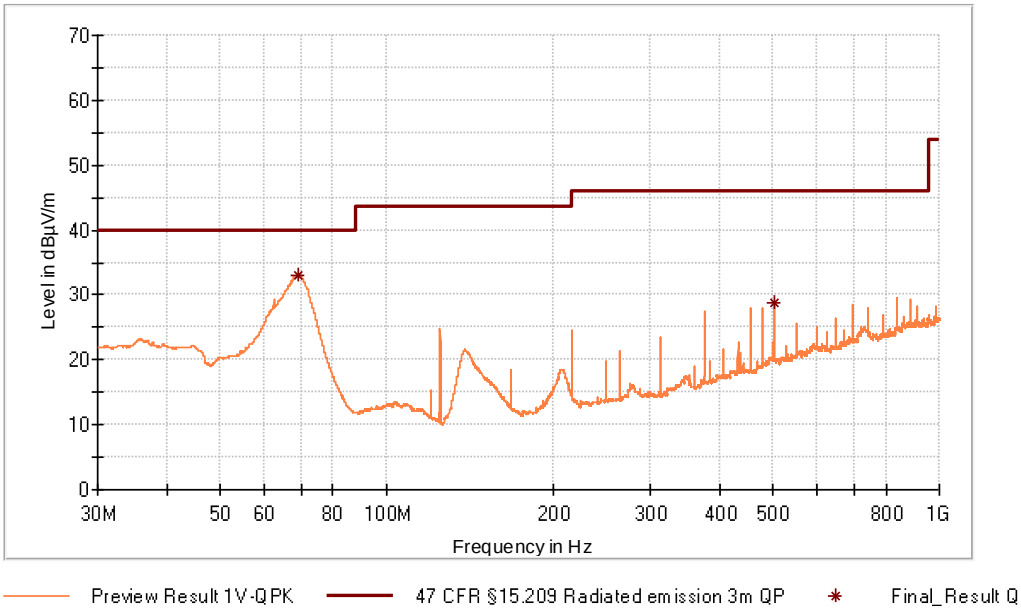

Figure 90: Chart of emissions test from 30 MHz to 1 GHz on lowest channel in modulation IEEE 802.11 n (HT20), EUT position Y, antenna polarization vertical

Frequency (MHz)	*Field strength (dBµV/m at 3 m)*	*Limit (dBµV/m) at 3 m*	*Margin (dB)*	*Height (cm)*	*Pol.*	*Azimuth (deg)*	*Corr. (dB/m)*	*Result*
69.390000	33.13	40.00	6.87	100.0	V	152.0	10.8	Passed
504.000000	28.75	46.00	17.25	100.0	V	1.0	19.6	Passed

Table 53: Results of emissions test from 30 MHz to 1 GHz on lowest channel in modulation IEEE 802.11 n (HT20), EUT position Y, antenna polarization vertical

6.11 Radiated emissions from 1 GHz to 25 GHz (10th harmonic)

Section(s) in 47 CFR Part 15:	Requirement(s):	15.247(d)
	Reference(s):	KDB 558074 D01, clauses 8.4 and 8.5 ANSI C63.10, clause 6.6
Section(s) in RSS:	Requirement(s):	RSS-247, section 5.5
	Reference(s):	KDB 558074 D01, clauses 8.4 and 8.5 ANSI C63.10, clause 6.6

Performed by:	Jennifer Riedel B. Eng.	Date(s) of test:	June 28, 2022; July 13, 2022
Result:	☒ Test passed	☐ Test not passed	

6.11.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
Free space semi-anechoic chamber (FS-SAC)	FS-SAC	ELEMENT STRAUBING	E00100
EMI test receiver	ESW 44	Rohde & Schwarz	E00895
Preamplifier (0.5 GHz - 18 GHz)	BBV 9718 B	Schwarzbeck	W01325
Preamplifier (18 GHz – 40 GHz)	BBV 9721	Schwarzbeck	W01350
Highpass filter	WHK10-2700-3000-10000-40SS	Wainwright Instruments	W00774
Highpass filter	WHKX10-5850-6500-18000-40SS	Wainwright Instruments	W00699
Horn antenna	BBHA 9120D	Schwarzbeck	W00053
Horn antenna	BBHA 9170	Schwarzbeck	W00055
Cable set FS-SAC	RF cable(s)	Teledyne Reynolds Huber + Suhner Teledyne Reynolds	E00435 E00307 E00433

6.11.2 Limits

According to §15.247(d) and RSS-247 section 5.5:
In any 100 kHz bandwidth outside of the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.
In addition, radiated emissions which fall in the restricted bands (see table 31) must also comply with the radiated emission limits specified in §15.209(a) and RSS-Gen section 8.10.
For frequencies above 960 MHz, these limits are shown in table 54.

Frequency	*Field strength*		*Measurement distance*
(MHz)	*(µV/m)*	*(dBµV/m)*	*(m)*
Above 960	500	54	3

Table 54: General radiated emission limits above 960 MHz according to §15.209 and RSS-Gen

6.11.3 Test procedure

The emissions from 1 GHz to 25 GHz are measured using the

☐ test procedure for conducted measurements as described in clause 5.2.
☒ test procedure for radiated measurements as described in clause 5.6.

6.11.4 Test results

Test distance:	Exploratory tests: Final tests:	☐ 1 m ☐ 3 m	☒ 0.5 m ☒ 1.5 m
EUT position:	☒ Position X	☒ Position Y	☒ Position Z

Note(s):

1 The measurements from 1 GHz to 17 GHz are made at a measurement distance of 1.5 m. However, the limit lines for these tests are referenced to the limit lines at a measurement distance of 3 m (Offset – 6 dB).

2 The exploratory measurements from 17 GHz to 25 GHz are made at a measurement distance of 0.5 m. However, the limit lines for these tests are referenced to the limit lines at a measurement distance of 3 m (Offset – 15.6 dB).

3 Pre-measurements were performed to declare the worst case which is documented below. The table results show the final measurements of the emissions detected in the pre-measurements which are shown in this test report.

4 According to clause 6.6.4.3, note 1 of ANSI C63.10, if the maximized peak measured value complies with the average limit, than it is unnecessary to perform an average measurement.

5 According to clause 6.8 the modulation IEEE 802.11 n (HT20) for channel 01 and 06 and the modulation IEEE 802.11 g for channel 11 were tested as worst cases.

6 The antenna port of the EUT was terminated with 50 Ω for this test

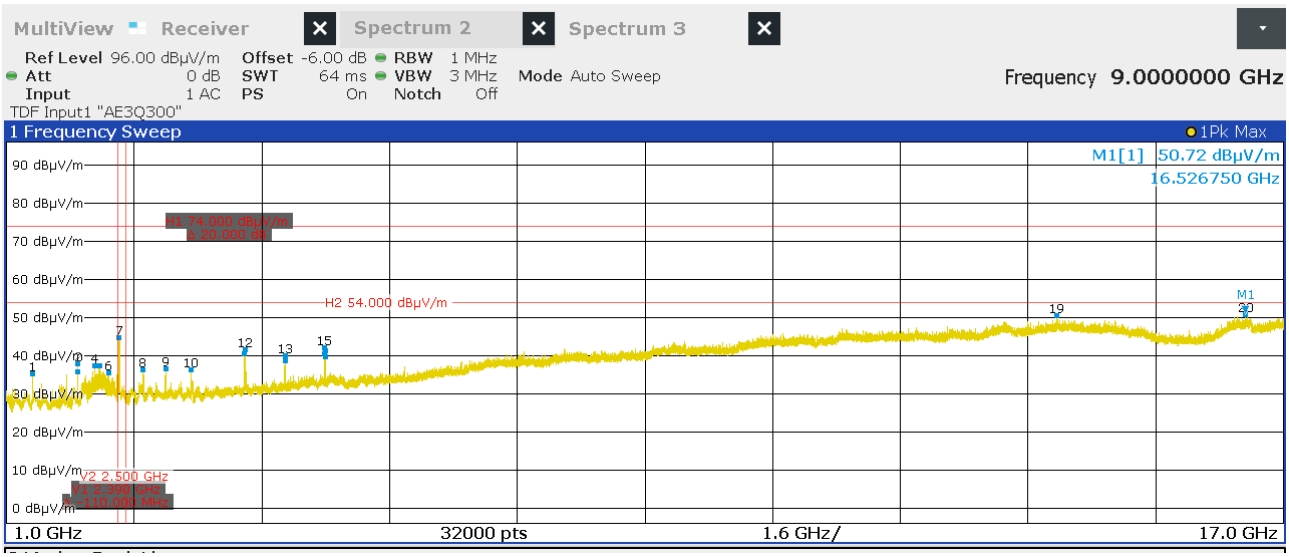

Figure 91: Chart of radiated emissions pre-measurement from 1 GHz to 17 GHz on lowest channel in modulation IEEE 802.11 n (HT20), EUT position Z, antenna polarization vertical

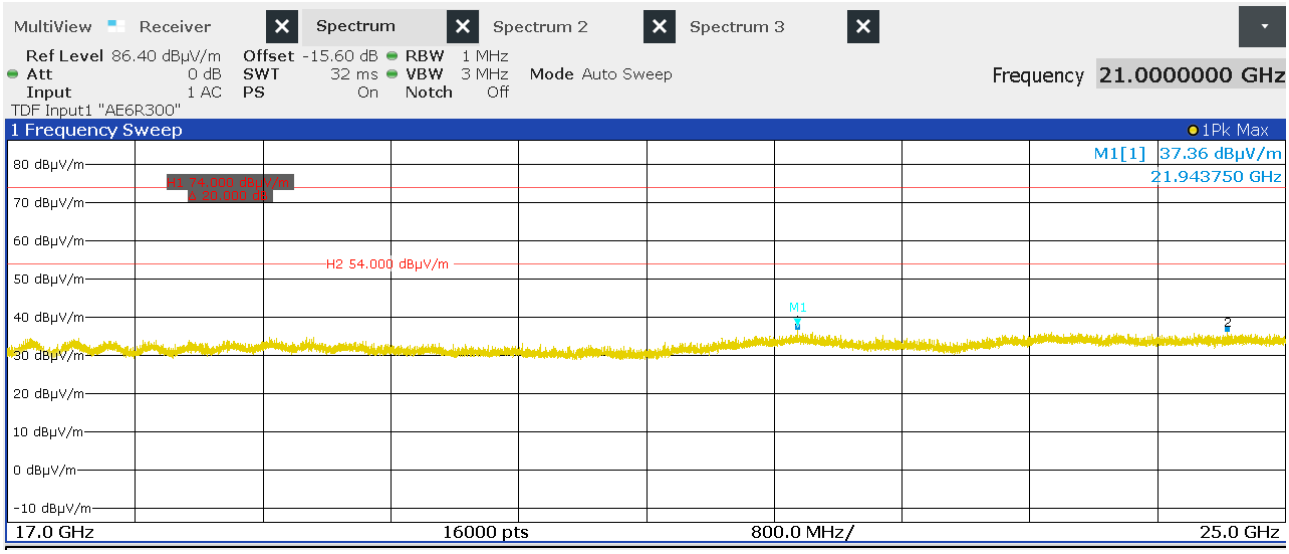

Figure 92: Chart of exploratory radiated emissions measurement from 17 GHz to 25 GHz on lowest channel in modulation IEEE 802.11 n (HT20)

Frequency (MHz)	*EUT Pos.*	*Field strength (dBµV/m) at 3 m*	*Detector*	*Limit (dBµV/m) at 3 m*	*Margin (dB)*	*Height (cm)*	*Pol.*	*Azimuth (deg)*
4825.369	Z	44.82	PK	74.00	29.18	250.0	V	210.0
14158.000	Z	49.66	PK	74.00	24.34	250.0	V	170.0
16423.760	Z	48.95	PK	74.00	25.05	200.0	V	145.0

Table 55: Results of radiated emissions test from 1 GHz to 25 GHz on lowest channel in modulation IEEE 802.11 n (HT20)

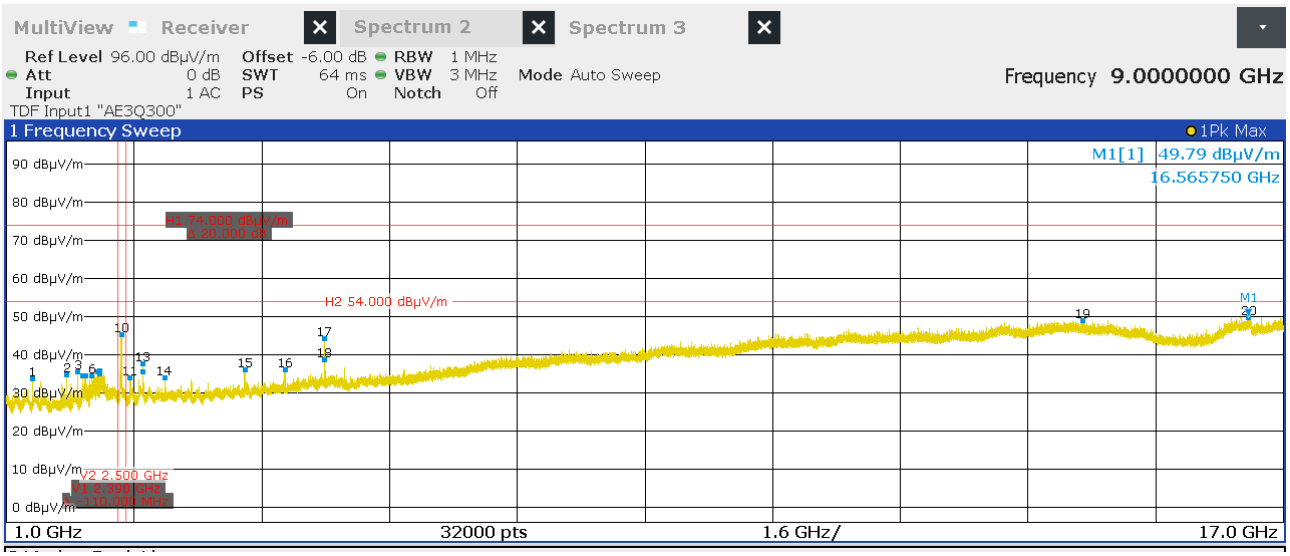

Figure 93: Chart of radiated emissions pre-measurement from 1 GHz to 17 GHz on middle channel in modulation IEEE 802.11 n (HT20), EUT position Z, antenna polarization vertical

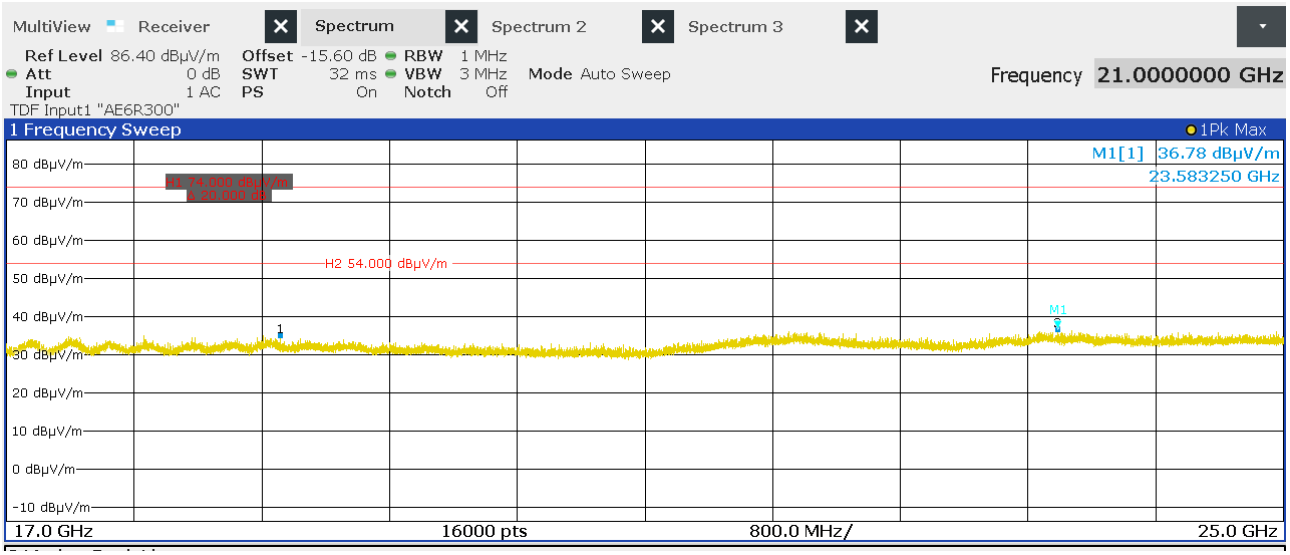

Figure 94: Chart of exploratory radiated emissions measurement from 17 GHz to 25 GHz on middle channel in modulation IEEE 802.11 n (HT20)

Frequency (MHz)	*EUT Pos.*	*Field strength (dBµV/m) at 3 m*	*Detector*	*Limit (dBµV/m) at 3 m*	*Margin (dB)*	*Height (cm)*	*Pol.*	*Azimuth (deg)*
4884.290	Z	45.03	PK	74.00	28.97	250.0	V	200.0
14390.510	Z	49.23	PK	74.00	24.34	250.0	V	170.0
16423.760	Z	48.95	PK	74.00	25.05	200.0	V	145.0

Table 56: Results of radiated emissions test from 1 GHz to 25 GHz on middle channel in modulation IEEE 802.11 n (HT20)

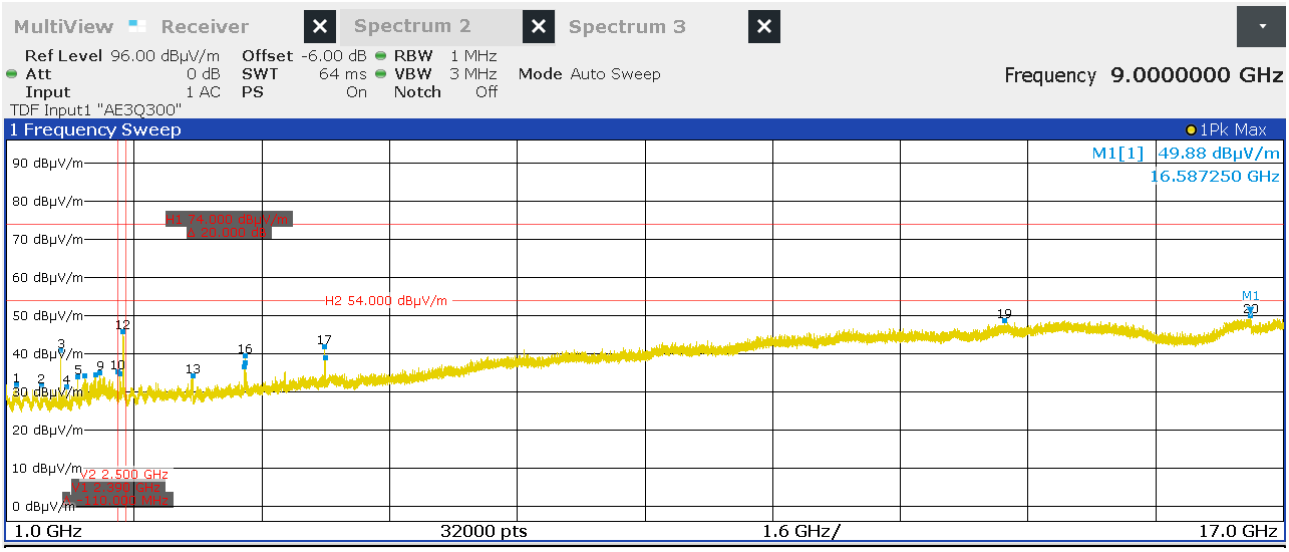

Figure 95: Chart of emissions test from 1 GHz to 17 GHz on highest channel in modulation IEEE 802.11 g, EUT position Z, antenna polarization vertical

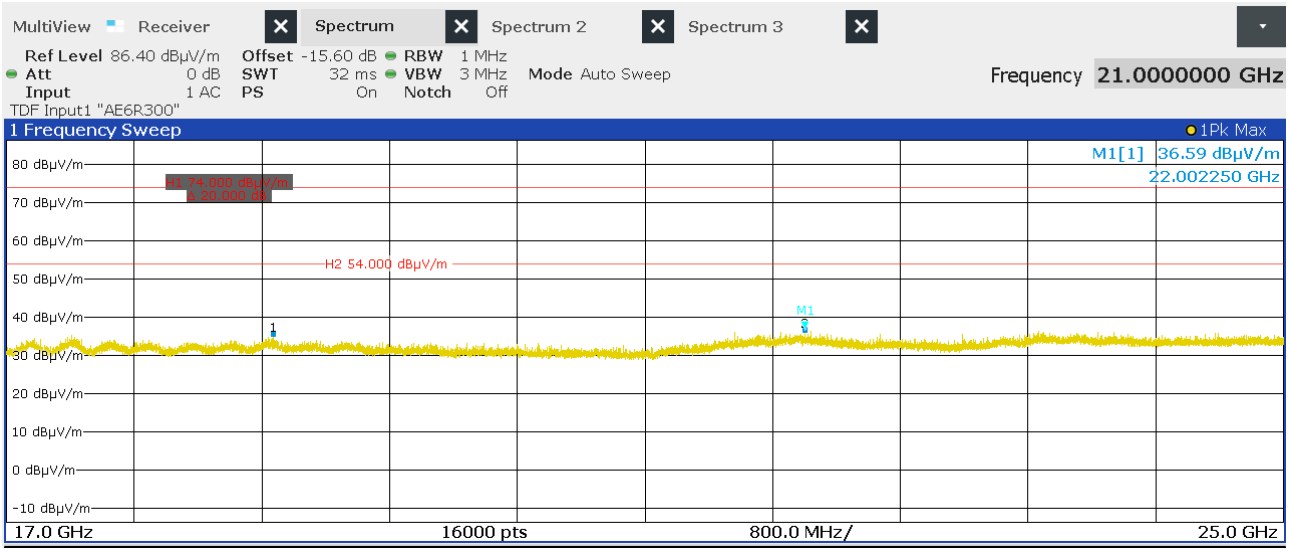

Figure 96: Chart of exploratory radiated emissions measurement from 17 GHz to 25 GHz on highest channel in modulation IEEE 802.11 g

Frequency (MHz)	*EUT Pos.*	*Level (dBµV/m) at 3 m*	*Detector*	*Limit (dBµV/m) at 3 m*	*Margin (dB)*	*Height (cm)*	*Pol.*	*Azimuth (deg)*
4924.360	Z	44.96	PK	74.00	29.04	250.0	V	185.0
13047.710	Z	46.41	PK	74.00	27.59	250.0	V	170.0
16565.830	Z	48.14	Pk	74.00	25.86	200.0	V	138.0

Table 57: Results of emissions test from 1 GHz to 25 GHz on highest channel in modulation IEEE 802.11 g

7 Equipment calibration status

Description	*Modell number*	*Serial number*	*Inventory number(s)*	*Last calibration*	*Next calibration*
EMI test receiver	ESW44	101538	E00895	2020-08	2022-08
EMI test receiver	ESU26	100026	W00002	2022-06	2024-06
EMI test receiver	ESR7	101059	E00739	2020-08	2022-08
EMI test receiver	ESCI3	100328	E00552	2020-10	2022-10
EMI test receiver	ESCI3	100013	E00001	2022-05	2024-05
Preamplifier (1 GHz – 18 GHz)	BBV 9718 B	00032	W01325	2021-09	2022-10
Preamplifier (18 GHz – 40 GHz)	BBV 9721	43	W01350	2021-11	2022-11
Preamplifier (1 GHz - 18 GHz)	ALS05749	001	W01007	2022-01	2023-01
Loop antenna	HFH2-Z2	871398/0050	E00060	2021-10	2023-10
LISN	ESH2-Z5	881362/037	E00004	Note 1	
LISN	ESH2-Z5	893406/009	E00005	2021-10	2023-10
Field probe	RF-R 400-1	02-2030	E00270	Note 2	
TRILOG broadband antenna (SAC3)	VULB 9162	9162-041	E00643	2021-03	2024-03
Horn antenna	BBHA 9120D	9120D-592	W00053	2020-04	2023-04
Horn antenna	BBHA 9170	9170-332	W00055	2020-04	2023-04
Shielded room	P92007	B 83117 C 1109 T 211	E00107	N/A	
Compact diagnostic chamber (CDC)	VK041.0174	D62128-A502-A69-2-0006	E00026	N/A	
Semi-anechoic chamber (SAC) with floor absorbers	FS-SAC	---	E00100	2021-03	2024-03
Semi-anechoic chamber (SAC)	SAC3	C62128-A520-A643-x-0006	E00716	2021-03	2024-03
Cable set CDC	RG214/U	---	E00446	2022-04	2023-04
	LCF12-50J	---	E01215	2022-04	2023-04
	LMR400	1718020006	E00920	2022-01	2023-01
	RG214 Hiflex	171802007	E00921	2022-01	2023-01
Cable set anechoic chamber	262-0942-1500	005	E00435	2021-10	2022-10
	SF104EA/2x11PC35-42/5m	11144/4EA	E00307	2021-12	2022-12
	262-0942-1500	003	E00433	2021-10	2022-10
Cable set of semi-anechoic chamber SAC3	SF104EA/11PC35/11PC35/10000MM	501347/4EA	E00755	2021-12	2022-12
	SF104E/11PC35/11PC35/2000MM	507410/4E	E01035	2021-12	2022-12
	SF104E/11PC35/11PC35/2000MM	507411/4E	E01034	2021-09	2022-09

Note(s)
1. Only used for decoupling of support equipment.
2. Only used for relative measurements.

8 Measurement uncertainties

Description	*Uncertainty*	U_{Limit}	*Note(s)*	*k=*
AC power line conducted emission	± 3.0 dB	± 3.4 dB	2b), 3b)	2
Carrier frequency separation	± 1.5 %	± 5 %	2a), 3a)	2
Number of hopping frequencies	± 1.5 %	± 5 %	2a), 3a)	2
Time of occupancy (dwell time)	± 1.5 %	± 5 %	2a), 3a)	2
Bandwidth tests	± 2.0 %	± 5 %	2a), 3a)	2
Maximum conducted output power (conducted)	± 2.9 dB	± 3.0 dB	2a), 3a)	2
Power spectral density (conducted)	± 2.9 dB	± 3.0 dB	2a), 3a)	2
Conducted spurious emissions	± 2.9 dB	± 3.0 dB	2a), 3a)	2
Radiated emissions				
from 9 kHz to 30 MHz	± 3.8 dB	± 4.0 dB	2b), 3b)	2
from 30 MHz to 1 GHz	± 6.1 dB	± 6.3 dB	2b), 3b)	2
from 1 GHz to 6 GHz	± 4.6 dB	± 5.2 dB	2b), 3b)	2
from 6 GHz to 18 GHz	± 5.0 dB	± 5.5 dB	2b), 3b)	2
from 18 GHz to 26.5 GHz	± 5.4 dB	± 6.0 dB	2b), 3c)	2
from 26.5 GHz to 40 GHz	± 6.2 dB	± 6.5 dB	2b), 3c)	2

Note(s):

1 The uncertainty stated is the expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k. For a confidence level of 95 % the coverage factor k is 2.

2 The values of the measurement uncertainty as listed above are calculated according to
   a) ETSI TR 100 028-1 V1.4.1 and ETSI TR 100 028-2 V1.4.1
   b) CISPR 16-4-2:2011-06 + A1:2014-02 + A2:2018-08

3 The limits for the measurement uncertainty as listed above are
   a) derived from ETSI EN 300 328 V2.1.1
   b) equal to U_{CISPR} taken from CISPR 16-4-2:2011-06 + A1:2014-02 + A2:2018-08
   c) defined by the test laboratory

4 Simple acceptance is applied as the decision rule while keeping the specified limits (U_{Limit}) for the expanded measurement uncertainty (i.e. Test Uncertainty Ratio TUR ≥ 1:1). That means, compliance is based on the recorded level by the lab irrespective of the expanded measurement uncertainty value but with a limitation to it.

5 All used test instruments as well as the test accessories are calibrated at regular intervals.

9 Revision history

Revision	*Date*	*Issued by*	*Description of modifications*
0	2022-10-24	Jennifer Riedel B. Eng.	First edition

Template: RF_15.247_RSS-247_V1.7