Test report

Customer:

PowerBox-Systems GmbH

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RF test report

171026-AU02+W01

PowerBox-Systems GmbH

Remote control

Core

DAkkS Deutsche Akkreditierungsstelle D-PL-12155-01-00

EMV **TESTHAUS** GmbH

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Accreditation:

Test Firm Type “accredited”: Valid until 2019-06-05
MRA US-EU, FCC designation number: DE0010
BnetzA-CAB-02/21-02/5 Valid until 2023-11-26

Recognized on March 14th, 2019 by the
Department of Innovation, Science and Economic Development (ISED) Canada
as a wireless testing laboratory
CAB identifier: DE0011

Location of Testing:

EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing

The technical accuracy is guaranteed through the quality management of the EMV **TESTHAUS** GmbH.

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1 Summary of test results

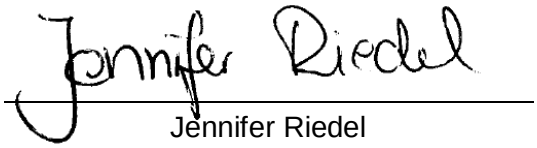
System type: Frequency hopping system (DSS)

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	33	Passed	1
15.247(a)(1) ANSI C63.10	20 dB bandwidth	RSS-247, section 5.1(b)	38	Passed	2
2.202(a) ANSI C63.10	Occupied bandwidth (99 %)	RSS-Gen, section 6.7	42	For reference only	3
15.247(b) ANSI C63.10	Conducted output power	RSS-Gen, section 6.12 RSS-247, section 5.4	46	Passed	---
15.247(a) ANSI C63.10	Carrier frequency separation	RSS-247, section 5.2(b)	52	Passed	---
15.247(a) ANSI C63.10	Number of hopping frequencies		55	Passed	---
15.247(a) ANSI C63.10	Time of occupancy (dwell time)		58		
15.247(d) ANSI C63.10	Spurious RF conducted emissions	RSS-247, section 5.5	---	Not applicable	4
15.247(d) ANSI C63.10	Band-edge compliance	RSS-247, section 5.5	54	Passed	---
15.247(d) ANSI C63.10	Emissions outside the operating frequency band(s) specified 9 kHz to 10th harmonic	RSS-Gen, section 6.13 RSS-247, section 5.5			
	9 kHz to 30 MHz		73	Passed	---
	30 MHz to 1 GHz		76	Passed	---
	1 GHz to 10th harmonic		80	Passed	---
2.109	RF radiation exposure evaluation for portable devices	RSS-Gen, section 3.4 (exempted from SAR and RF evaluation)	83	Passed	---

Notes (for information about EUT see clause 3):

1 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.
2 For systems using digital modulation techniques (DTS), the 6 dB bandwidth (DTS bandwidth) is regarded as the bandwidth of the emission and measuring the 20 dB bandwidth is not required.
3 For frequency hopping systems, measuring the 6 dB bandwidth (DTS bandwidth) is not required.
4 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”).

Straubing, April 8, 2019



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2 Referenced publications

Publication	*Title*
CFR 47 Part 2 March 2019	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 March 2019	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. 447498 October 23, 2015	RF exposure procedures and equipment authorization policies for mobile and portable devices
KDB Publication no. 558074 February 11, 2019	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
KDB Publication no. 662911 October 31, 2013	Emissions Testing of Transmitters with Multiple Outputs in the Same Band (e.g., MIMO, Smart Antenna, etc)
ANSI C63.10 June 2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
RSS-Gen, Issue 5 March 2019	Spectrum Management and Telecommunications - Radio Standards Specification - General Requirements for Compliance of Radio Apparatus
RSS-102, Issue 5 March 2015	Spectrum Management and Telecommunications - Radio Standards Specification - Radio Frequency Exposure Compliance of Radiocommunications Apperatus
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:	Remote control		
Model name:	Core		
Serial number(s):	prototypes		
Applicant:	PowerBox-Systems GmbH		
Manufacturer:	PowerBox-Systems GmbH		
Version:	Hardware:	Mainboard: V07 RF-Antenna: V05	
	Software:	Version 0.5	
Additional modifications:	None		
FCC ID:	2ASCM-PBXCORE		
IC registration number:	24594 - PBXCORE		
Power supply:	Battery supply		
	Nominal voltage:	7.2 V	
Device type:	☒ Portable	☐ Mobile	☐ Fixed

3.2 Radio specifications

System type[1]:	Frequency hopping system (DSS)		
Application frequency band:	2400.0 MHz - 2483.5 MHz		
Operating frequencies:	2401.7 MHz – 2466.3 MHz		
Short description:	The EUT is a control system for model airplanes which is working in the 2.4 GHz band.		
Number of transmit chains:	2 Note: The two antennas do not work simultaneously.		
Antenna:	Type:	Patch antenna	
	Gain:	5.0 dBi (maximum)	
	Connector:	☐ external	☐ internal
		☐ temporary	☒ none (integral antenna)
		Note: The temporary antenna connectors are only used for conducted measurements.	

[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.

Frequency range used:	2401.7 MHz to 2466.3 MHz
Number of RF channels:	65
Channel spacing:	1 MHz
Modulation:	GFSK

Channel	*Frequency [MHz]*
Low	2401.7
Middle	2434.4
High	2466.3

Table 1: Radio specifications of EUT

Note: Only the three channels being tested are listed above.

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*
		EUT	
Remote control for conducted measurements	Core	prototype with black cover and antenna ports	PowerBox-Systems GmbH
Remote control for radiated measurements < 30 MHz	Core	prototype with black cover	PowerBox Systems GmbH
Remote control for radiated measurements > 30 MHz	Core	prototype with silver cover	PowerBox Systems GmbH

Table 2: Devices used for testing

Port	*Classification (see note 1)*	*Cable type*	*Fixed*	*Cable length*		*Note*
				used	*maximum*	
Antenna ports (SMA)	Signal/control	---	☐	---	---	
Power supply port	DC power connected to dedicated AC/DC power supply	---	☐	---	---	

Table 3: Ports of EUT and appropriate cables[2]

Notes:
1 Ports of EUT are classified as “AC power”, “DC power”, “DC power connected to dedicated AC/DC power supply”, “Signal/control” or “Wired network”.

[2] As specified by manufacturer.

4.2 Mode of operation

4.2.1 Declaration of the manufacturer

4.2.1.1 Band usage

The system utilises the 2.4 GHz ISM band. The data are transmitted in time slices using the frequency-hopping process. The length of a time slice is 10 ms (transmitting 4 ms, quiet 6 ms). The transceiver IC employed (CC2500) supports 256 channels, of which 240 are used in the system (channel spacing 333251.9531 Hz).

4.2.1.2 Frequency-hopping process

The hopping sequence is 640 hops long and utilises 68 of the 204 channels which are available. In order to minimise the probability of collisions the hops are distributed within the band in accordance with a pseudo-random algorithm (Park-Miller-Carta-PRNG) which is additional controlled by a routine which ensures that one physical channel can be used only one time every 100ms. The seed for the PRNG is a random number which is generated in the transmitter, and a connection ID. The transmitter manages the connection ID for each model, and it changes every time a binding or importing process occurs. The synchronisation between transmitter and receiver is done by slowing down the hopping speed of the receiver.
As stated above one physical channel can be used repeating only after 10 hops which is 100ms. So in that way the maximum usage of a channel one time in 100ms.

The hopping sequence is stored in the FLASH as a complex data structure (`T_HoppingSequence`); it is renewed after every binding process and after each change of model in the transmitter. A dedicated FLASH page of at least 4 KB is used for this.

4.2.1.3 Listen before Talk

For adaptive systems the ETSI norm EN 300328 V1.8.1 dictates that an occupied channel must not be used again without consideration. The norm expects that transmission on a channel does not occur until a certain minimum period of reception has elapsed on that channel, and transmission only occurs if the channel is found to be ‘not in use’ (“Listen before Talk”). However, the norm allows fast switching between adaptive and non-adaptive behaviour.

The following solution is implemented in the Core system:

- after a change of frequency the system ‘listens in’ to the channel for a minimum period of 1 ms.
- if the channel is found to be occupied (RSSI > -72 dbm), then the subsequent transmission takes place at the reduced power of 28 mW, and the system adheres to the norm for non-adaptive systems (Medium Utilisation factor < 10%). The reduced transmission power of 28 mW is produced from the max. burst duration of about 3.5 ms with a frame length of 63 bytes.
- if the channel is free, transmission occurs at full transmitter power (100 mW), and the system adheres to the norm for adaptive systems.
- transmitted power is never reduced on the organisation channels (also permissible for non-adaptive systems).

4.2.1.4 Distribution of roles

- the transmitter plays the active role; it defines the hopping sequence and the timing.
- where necessary, the receivers respond in the same time slice.
- in every frame the transmitter conveys the current index in the hopping sequence, and the receiver which is to answer in this time slice.

4.2.1.5 Behaviour in the case of loss of reception

If a device receives no valid frames in 30 (`RADIO_LIMIT_MISSEDFRAMES`) sequential time slices, it is considered to be 'unconnected'. The transmitter maintains its normal function, and the hopping sequence continues unchanged. The receiver leaves the hopping sequence and continues to receive on the organisation channels alone. This reception frequency is maintained constant for a fairly long time (`RADIO_UNCONNECT_LISTEN`), and the next organisation channel is only selected after this period. Receivers with two RF branches receive on two organisation channels, but offset. If a correct frame is received, the device switches back to the 'connected' state.

4.2.2 Protocol limited duty cycle

As declared of the manufacturer in clause 4.2.1.1 on one channel the EUT only transmits 4 ms in 100 ms, so the duty cycle is 0.04. According to ANSI C63.10 clause 7.5 the duty cycle correction factor results from the following formula:

$$\delta\ (dB) = 20\log(\Delta)$$

δ is the duty cycle correction factor (dB)
Δ is the duty cycle (dimensionless)

For this matter the duty cycle correction factor is:

$$\delta = 20\log(0.04) = -27.96\ dB$$ → -28 dB correction

4.2.3 Test software used for all tests

The test software is part of the firmware of the EUT. It is controlled on the screen of the EUT as shown in Figure 1.

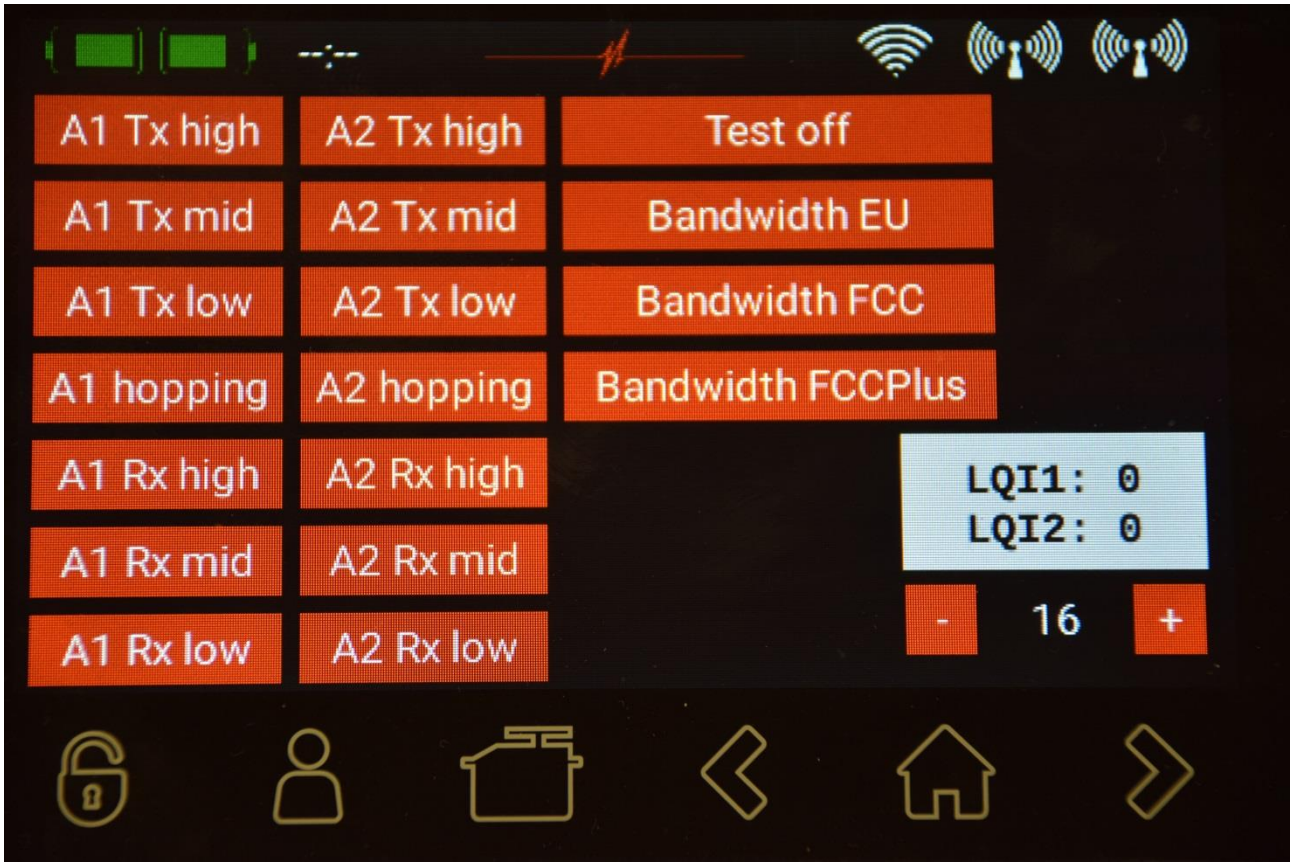

Figure 1: Setting of the required test mode

The parameters on the left activate the antenna port on the right side and vice versa. The channels in TX mode and hopping mode can be selected by pressing the appropriate button. With “test off”, all settings are off. For changing the power setting, the plus and minus buttons at the right corner are used.

Note: For all tests the power setting 12 was used.

4.2.4 Test modes applied

For the measurements the testing mode “AX Tx low/middle/high” for modulated TX carrier is used with the carrier frequency set to the appropriate channel of the measured antenna. For measurements in the hopping mode the testing mode “hopping” is used. For further details see clause 4.2.3.

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.

Floor-standing devices are placed either directly on the reference ground-plane or on insulating material (see clause 6.3.3 of ANSI C63.4-2014 for more details).

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

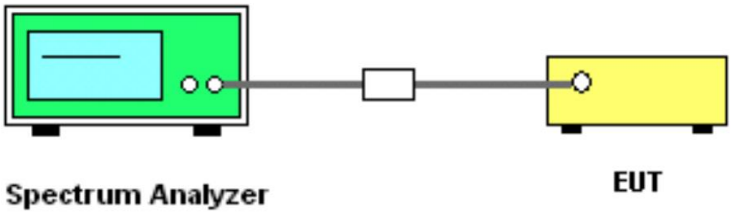

Figure 2: Setup for antenna-port conducted measurements

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 powerline conducted emissions from 150 kHz to 30 MHz are measured according to clause 6.2 of ANSI C63.10.

The test is carried out in a shielded room using a line impedance stabilization network (LISN) 50 µH/50 Ohm and an EMI test receiver which is connected to the LISN and set to a measurement bandwidth of 9 kHz in the frequency range from 150 kHz to 30 MHz.

The EUT is placed on a table and connected to the LISN. To accelerate the measurement the detector of the EMI test receiver is set to peak and the whole frequency range from 150 kHz to 30 MHz is scanned. All peak values with less than 10 dB to quasi-peak limit or exceeding the limit are marked and re-measured with quasi-peak detector.

If the values are under the average limit no additional measurement is necessary. In case there are still values between quasi-peak and average limit these values are re-measured with average detector.

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, 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 4: 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 5.

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

Sample calculation:

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

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 5).
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.

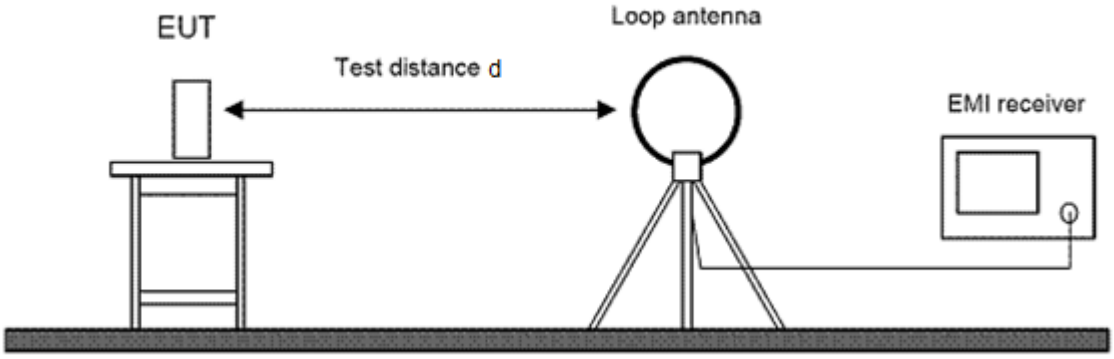

Figure 3: Setup for radiated emissions test below 30 MHz

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 6.

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

Sample calculation:

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

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 6).
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.

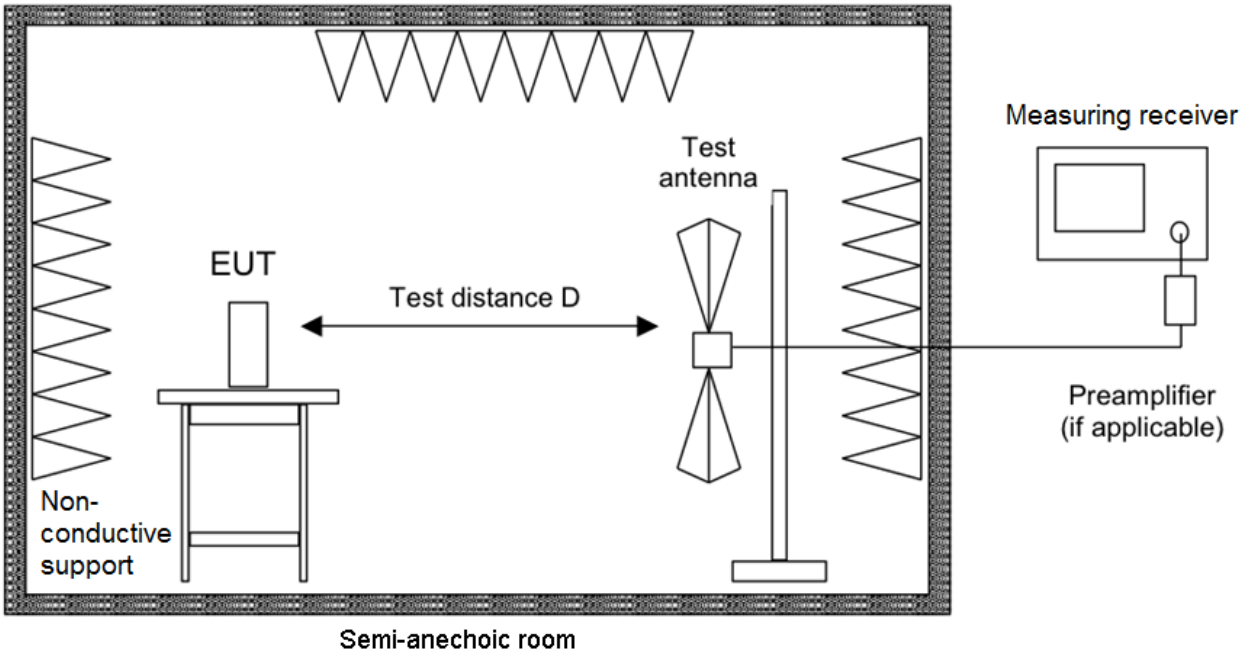

Figure 4: Setup for radiated emissions test from 30 MHz to 1 GHz

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.

Sample calculation:

Frequency (MHz)	Reading value (dBµV)	Antenna correction (dB/m)	Correction pre-amplifier (dB)	Cable attenuation (dB)	Correction factor (Corr.) (dB)	Level (dBµV/m)
2400	50.00	27.76	-34.57	3.51	-3.30	46.70

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

Level = Reading value + Correction factor = 50.00 dBµV – 3.30 dB = 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 7.

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 7: 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 a semi-anechoic chamber (SAC) with RF absorbing material on the floor between measurement antenna and EUT. 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	*Final scan*
f ≥ 1 GHz	1 MHz	≤ 500 kHz	Peak, Average	Peak, Average

Table 8: 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 8).
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.

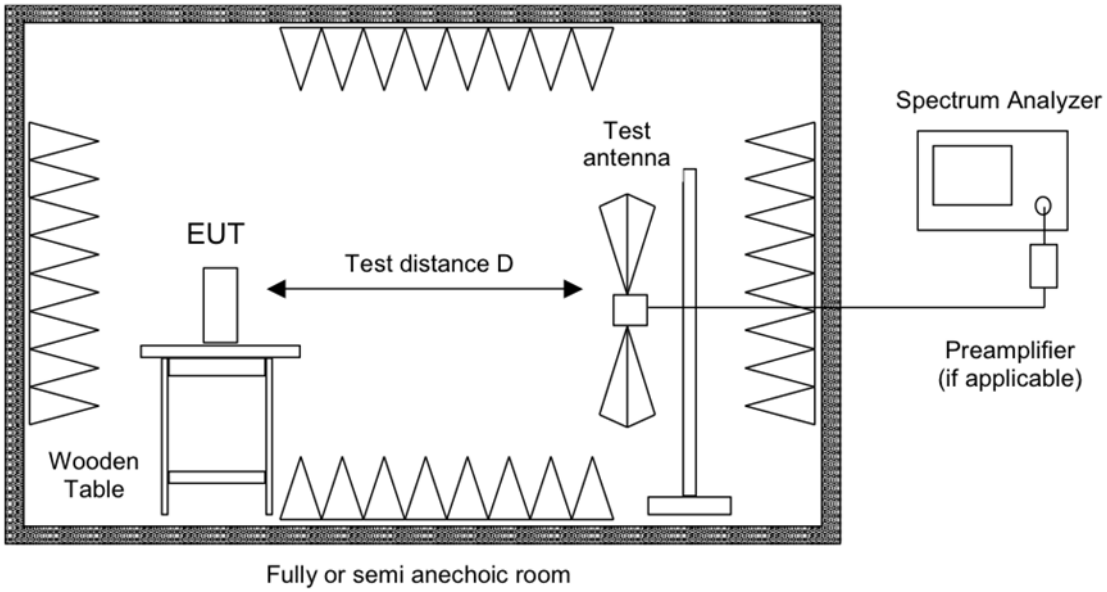

Figure 5: Setup for radiated emissions test above 1 GHz

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 20 dB bandwidth of the emission

The 20 dB bandwidth of the emission is measured according to clause 6.9.2 of ANSI C63.10 as the width of the spectral envelope of the modulated signal, at an amplitude level reduced by a ratio of 20 dB down from the reference value.

The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the EMI receiver or spectrum analyzer is between two times and five times the 20 dB bandwidth. The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1 % to 5 % of the 20 dB bandwidth and the video bandwidth (VBW) shall be approximately three times RBW.

The reference level of the instrument is set as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (20 dB bandwidth/RBW)] below the reference level.

The 20 dB bandwidth of the emission is not required for digital transmission systems (DTS). For these systems, the 6 dB bandwidth applies.

5.7.2 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.

The 6 dB bandwidth is not required for frequency hopping systems (FHSS). For these systems the 20 dB bandwidth applies.

5.7.3 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

5.8.1 Frequency hopping systems

The maximum conducted output power test method for frequency hopping systems refers to section 7.8.5 of ANSI C63.10.

The spectrum analyzer settings are as follows:

a) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel
b) RBW > 20 dB bandwidth of the emission being measured
c) VBW ≥ RBW
d) Sweep: Auto
e) Detector function = peak
f) Trace mode = max hold
g)

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 Carrier frequency separation

The carrier frequency separation test method for frequency hopping systems refers to section 7.8.2 of ANSI C63.10.

The EUT shall have its hopping function enabled.

The spectrum analyzer settings are as follows:

a) Span: Wide enough to capture the peaks of two adjacent channels
b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel
c) VBW ≥ RBW
d) Sweep time = auto coupled
e) Detector function = peak
f) Trace mode = max hold

After the trace is stabilized, the marker-delta function is used to determine the separation between the peaks of the adjacent channels.

5.10 Number of hopping frequencies

The number of hopping frequencies test method for frequency hopping systems refers to section 7.8.3 of ANSI C63.10.

The EUT shall have its hopping function enabled.

The spectrum analyzer settings are as follows:

a) Span: The frequency band of operation
b) RBW: less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller
c) VBW ≥ RBW
d) Sweep time = auto coupled
e) Detector function = peak
f) Trace mode = max hold
g) Allow the trace to stabilize.

5.11 Time of occupancy (dwell time)

The EUT shall have its hopping function enabled.

The spectrum analyzer settings are as follows:

a) Span: Zero span, centered on a hopping channel
b) RBW ≤ channel spacing and, where possible, the RBW should be set to >> 1/T where T is the expected dwell time per channel
c) Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot
d) Detector function = peak
e) Trace mode = max hold

Use the marker-delta function to determine the transmit time per hop. Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the specified period.

(Number of hops in the period specified in the requirements) = (number of hops on spectrum analyzer) x (period specified in the requirements / analyzer sweep time)

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the specified period.

6 Test results

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

6.1 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	15-35 °C
Humidity:	30-60 %
Atmospheric pressure:	86-106 kPa

6.2 AC powerline conducted emissions

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

Result[3]: ☒ Test passed ☐ Test not passed

6.2.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☐	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☐	Free space semi-anechoic chamber (FS-SAC)	FS-SAC	EMV **TESTHAUS**	E00100
☒	Shielded room	ESCS30	Siemens – Matsushita	E00107
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☒	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☐	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☐	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☒	Line impedance stabilization network	ESH2-Z5	Rohde & Schwarz	E00004
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☐	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☐	Horn antenna	BBHA 9120D	Schwarzbeck	W00052
☐	Horn antenna	BBHA 9170	Schwarzbeck	W00054
☐	Cable set SAC	RF cable(s)	Huber + Suhner	E00755 E01033 E01034
☐	Cable set FS-SAC	RF cable(s)	Teledyne Reynolds Huber + Suhner Teledyne Reynolds	E00435 E00307 E00433
☒	Cable set shielded room	RF cable(s)	Huber + Suhner	E00424
☐	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[3] For information about measurement uncertainties see page 97.

6.2.1 Limits

For intentional radiators that are 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 Table 9.

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 9: Limits for AC powerline conducted emissions

*Decreases with the logarithm of the frequency

6.2.2 Test procedure

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

☒ test method for conducted measurements as described in clause 5.3.
☐ test method for radiated measurements as described in clause 5.6.

6.2.3 Test results

Performed by:	Jennifer Riedel	Date(s) of test:	April 2, 2019

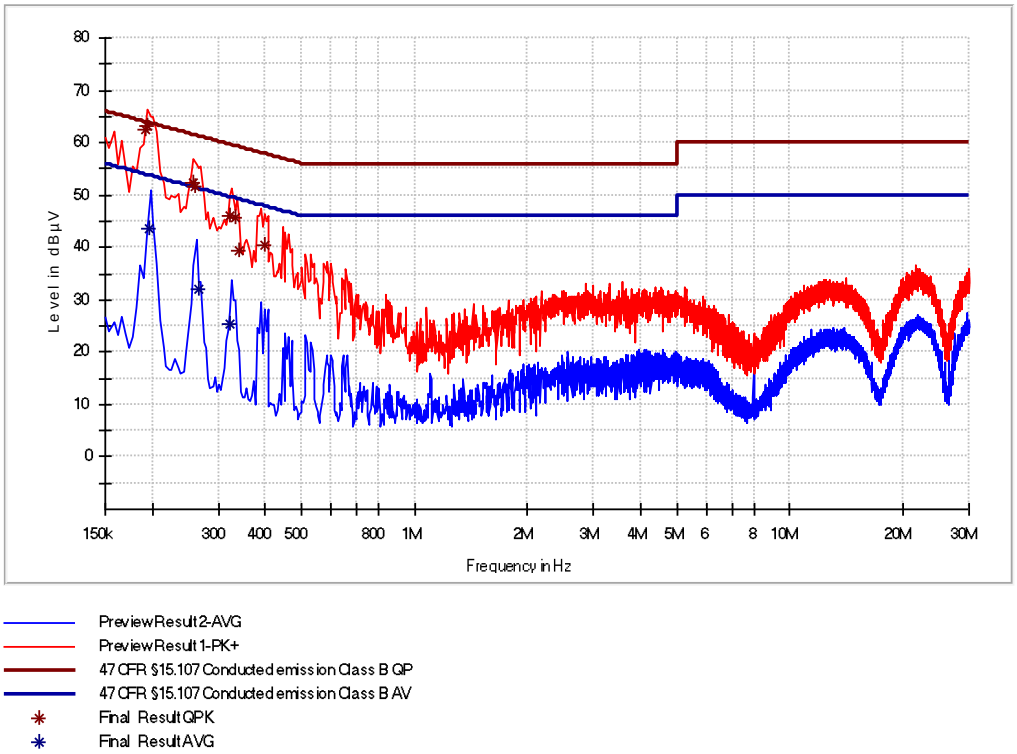

Figure 6: Chart of AC powerline conducted emissions on L1

Frequency (MHz)	*QuasiPeak (dBµV)*	*Average (dBµV)*	*Limit (dBµV)*	*Margin (dB)*	*Meas. Time (ms)*	*Bandwidth (kHz)*	*Line*	*PE*	*Corr. (dB)*
0.193000	62.53	---	63.91	1.38	1000.0	9.000	L1	GND	10.1
0.194000	63.21	---	63.86	0.65	1000.0	9.000	L1	GND	10.1
0.197000	---	43.54	53.74	10.20	1000.0	9.000	L1	GND	10.1
0.257000	52.31	---	61.53	9.22	1000.0	9.000	L1	GND	10.1
0.261000	51.63	---	61.40	9.77	1000.0	9.000	L1	GND	10.1
0.265000	---	32.11	51.27	19.16	1000.0	9.000	L1	GND	10.1
0.321000	---	25.47	49.68	24.21	1000.0	9.000	L1	GND	10.1
0.321000	45.86	---	59.68	13.82	1000.0	9.000	L1	GND	10.1
0.333000	45.52	---	59.38	13.86	1000.0	9.000	L1	GND	10.1
0.341000	39.32	---	59.18	19.86	1000.0	9.000	L1	GND	10.1
0.401000	40.49	---	57.83	17.34	1000.0	9.000	L1	GND	10.1

Table 10: Results of AC powerline conducted emissions on L1

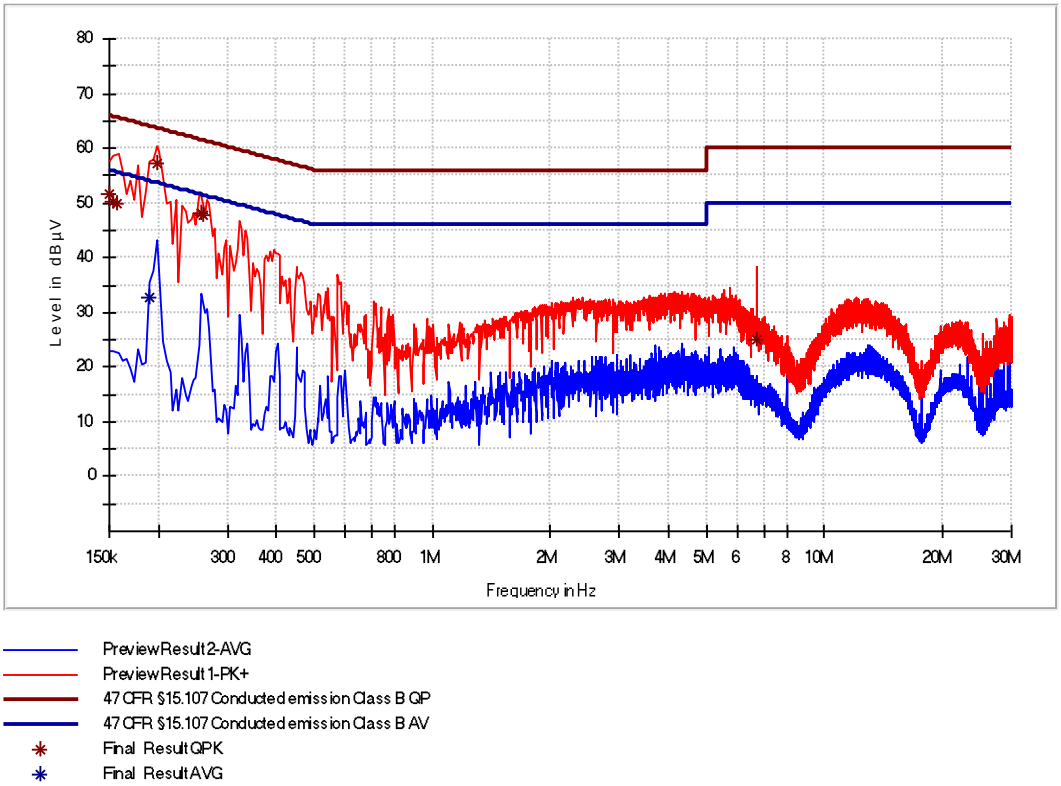

Figure 7: Chart of AC powerline conducted emissions on N

Frequency (MHz)	*QuasiPeak (dBµV)*	*Average (dBµV)*	*Limit (dBµV)*	*Margin (dB)*	*Meas. Time (ms)*	*Bandwidth (kHz)*	*Line*	*PE*	*Corr. (dB)*
0.150000	51.59	---	66.00	14.41	1000.0	9.000	N	GND	10.1
0.154000	50.38	---	65.78	15.40	1000.0	9.000	N	GND	10.1
0.157000	49.86	---	65.62	15.76	1000.0	9.000	N	GND	10.1
0.189000	---	32.70	54.08	21.38	1000.0	9.000	N	GND	10.1
0.198000	57.39	---	63.69	6.30	1000.0	9.000	N	GND	10.1
0.257000	48.30	---	61.53	13.23	1000.0	9.000	N	GND	10.1
0.261000	47.74	---	61.40	13.66	1000.0	9.000	N	GND	10.1
6.745000	24.85	---	60.00	35.15	1000.0	9.000	N	GND	11.1

Table 11: Results of AC powerline conducted emissions on N

6.3 20 dB bandwidth

Section(s) in 47 CFR Part 15: Requirement(s): 15.215(c)

Result[4]: ☒ Test passed ☐ Test not passed

6.3.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☐	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☐	Free space semi-anechoic chamber (FS-SAC)	FS-SAC	EMV **TESTHAUS**	E00100
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☐	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☒	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Preamplifier (1 GHz - 18 GHz)	ALS05749	Aldetec	W01007
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☐	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☐	Horn antenna	BBHA 9120D	Schwarzbeck	W00052
☐	Horn antenna	BBHA 9170	Schwarzbeck	W00054
☐	Cable set SAC	RF cable(s)	Huber + Suhner	E00755 E01033 E01034
☐	Cable set FS-SAC	RF cable(s)	Teledyne Reynolds Huber + Suhner Teledyne Reynolds	E00435 E00307 E00433
☐	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[4] For information about measurement uncertainties see page 97.

6.3.2 Limits

According to §15.215(c), intentional radiators operating under the alternative provisions to the general emission limits must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

The specific rule section under which the equipment operates is §15.247. According to §15.247(a)(2), for systems using digital modulation techniques (DTS), the 6 dB bandwidth (DTS bandwidth) is specified as the bandwidth of the emission. In this case, measuring the 20 dB bandwidth is not required.

6.3.3 Test procedure

The 20 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

Performed by:	Jennifer Riedel	Date(s) of test:	March 25, 2019

Note: The 20 dB bandwidth was measured on the two antenna ports but the charts and test results of only one port are in this test report.

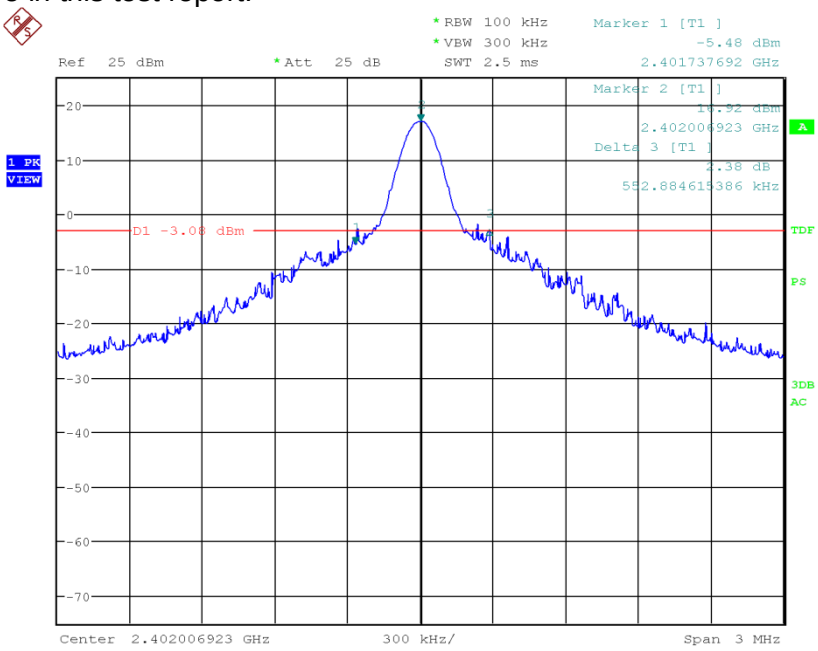

Figure 8: Chart of 20 dB bandwidth on channel low of antenna port 1

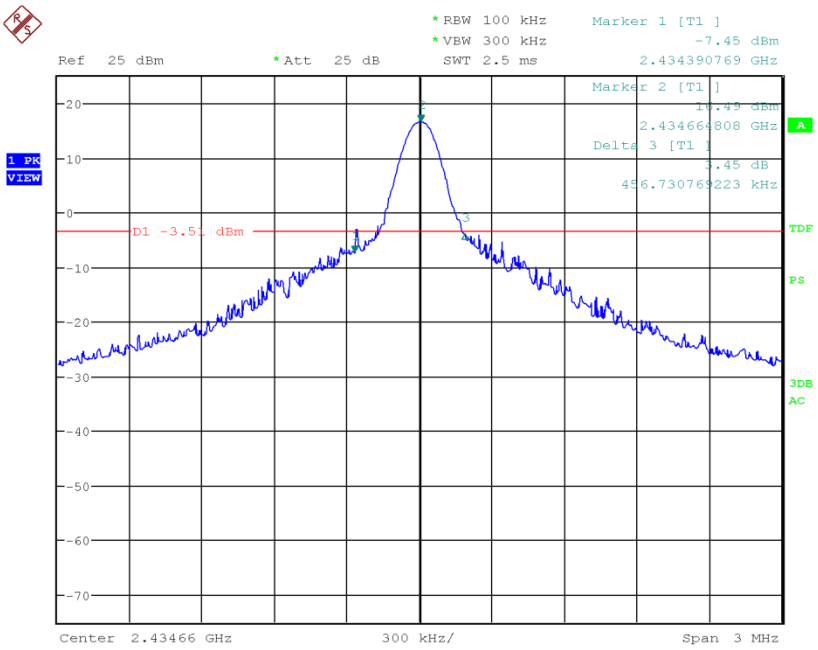

Figure 9: Chart of 20 dB bandwidth on channel middle of antenna port 1

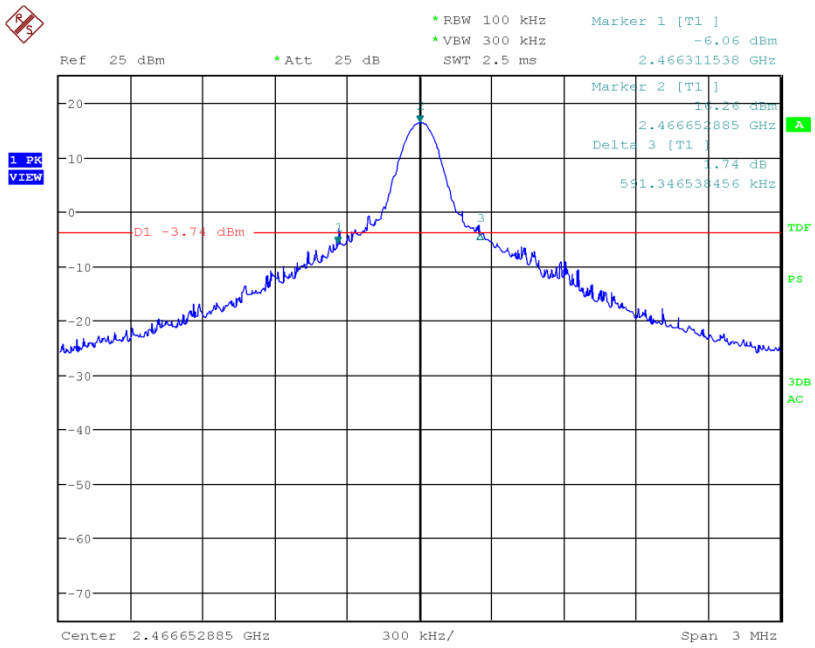

Figure 10: Chart of 20 dB bandwidth test on channel high of antenna port 1

Channel	*20 dB bandwidth*	*Band edge left*		*Band edge right*		*Result*[5]
		Frequency	*Limit*	*Frequency*	*Limit*	
	[kHz]	*[MHz]*	*[MHz]*	*[MHz]*	*[MHz]*	
low	552.885	2401.73769	2400.0	2402.29058	2483.5	Recorded
middle	456.731	2434.39077	2400.0	2434.84750	2483.5	Recorded
high	591.347	2466.31154	2400.0	2466.90289	2483.5	Recorded

Table 12: Results of 20 dB bandwidth tests of antenna port 1

[5] For systems using digital modulation techniques (DTS), the 20 dB bandwidth is recorded for information only.

6.4 Occupied bandwidth

Section(s) in 47 CFR Part 15:	Requirement(s): Reference(s):	2.202(a), KDB 558074 D01, section 5.2 ANSI C63.10, clause 6.9
Section(s) in RSS:	Requirement(s): Reference(s):	RSS-Gen, section 6.7 ANSI C63.10, clause 6.9

Result[6]: ☒ Test passed ☐ Test not passed

6.4.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☐	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☐	Free space semi-anechoic chamber (FS-SAC)	FS-SAC	EMV **TESTHAUS**	E00100
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☐	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☒	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Preamplifier (1 GHz - 18 GHz)	ALS05749	Aldetec	W01007
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☐	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☐	Horn antenna	BBHA 9120D	Schwarzbeck	W00052
☐	Horn antenna	BBHA 9170	Schwarzbeck	W00054
☐	Cable set SAC	RF cable(s)	Huber + Suhner	E00755 E01033 E01034
☐	Cable set FS-SAC	RF cable(s)	Teledyne Reynolds Huber + Suhner Teledyne Reynolds	E00435 E00307 E00433
☐	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[6] For information about measurement uncertainties see page 97.

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.

Although there is no limit specified, the occupied bandwidth has to be recorded and reported.

6.4.3 Test procedure

The occupied bandwidth is measured using the test procedure as described in clause 5.7.3 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

Performed by:	Jennifer Riedel	Date(s) of test:	March 25, 2019

Note: The occupied bandwidth was measured on the two antenna ports but the charts and test results of only one port are in this test report.

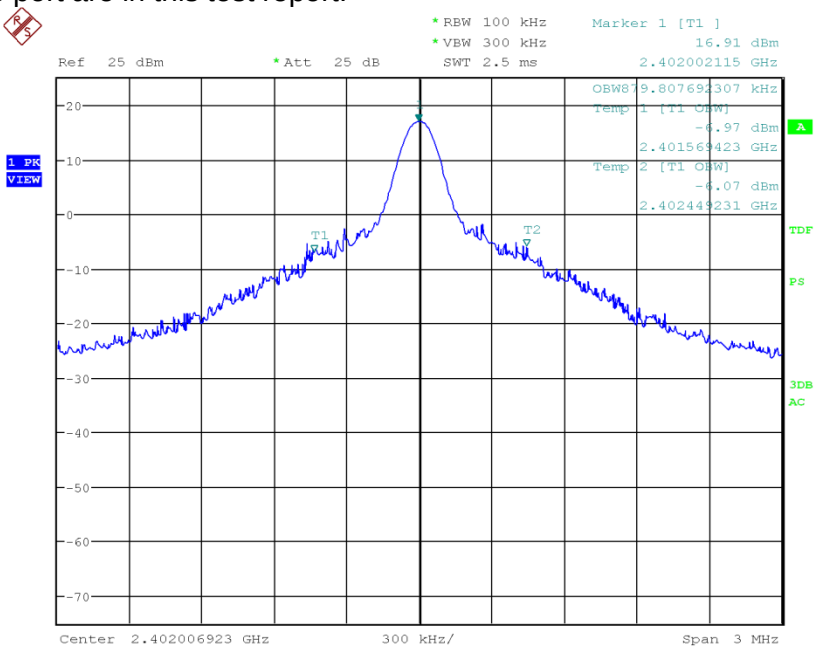

Figure 11: Chart of occupied bandwidth test on channel low of antenna port 1

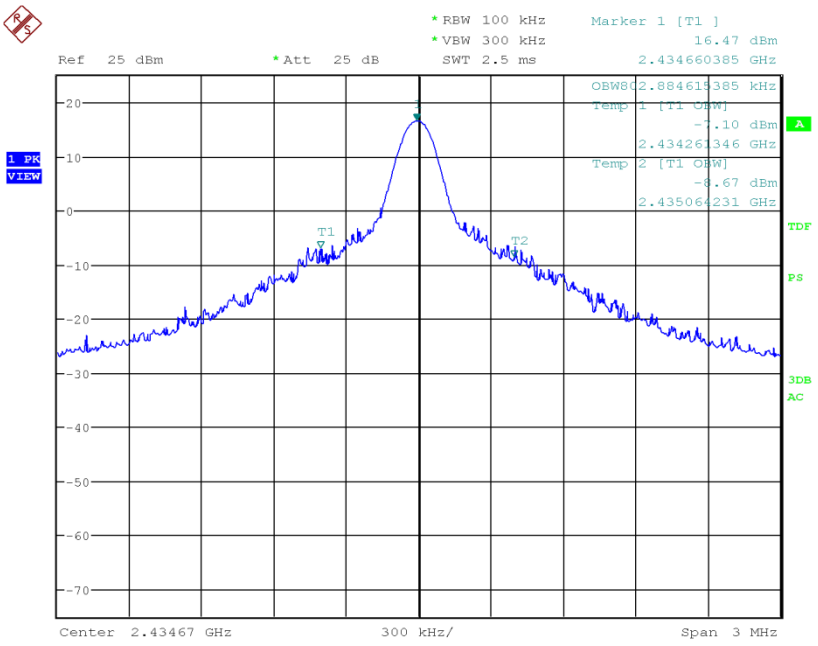

Figure 12: Chart of occupied bandwidth test on channel middle of antenna port 1

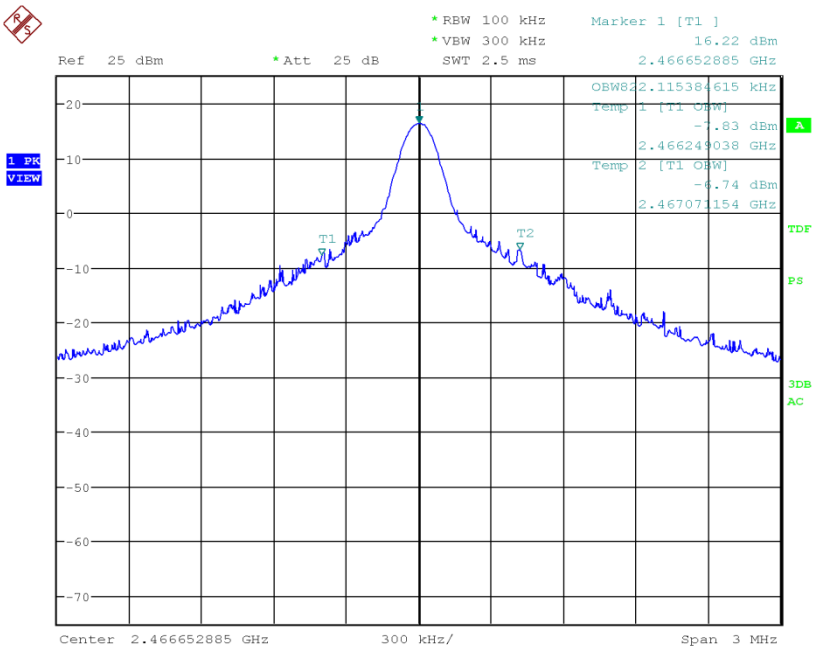

Figure 13: Chart of occupied bandwidth test on channel high of antenna port 1

Channel	*99 % occupied bandwidth [kHz]*	*Result*
low	879.808	Recorded
middle	802.885	Recorded
high	822.115	Recorded

Table 13: Results of occupied bandwidth test of antenna port 1

6.5 Conducted output power

Section(s) in 47 CFR Part 15:	Requirement(s):	15.247(b)
	Reference(s):	KDB 558074 D01, clause 7.8
Section(s) in RSS:	Requirement(s):	RSS-247, section 5.4(b)
	Reference(s):	ANSI C63.10, clause 7.8

Result[7]: ☒ Test passed ☐ Test not passed

6.5.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☐	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☐	Free space semi-anechoic chamber (FS-SAC)	FS-SAC	EMV **TESTHAUS**	E00100
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☐	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☒	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Preamplifier (1 GHz - 18 GHz)	ALS05749	Aldetec	W01007
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☐	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☐	Horn antenna	BBHA 9120D	Schwarzbeck	W00052
☐	Horn antenna	BBHA 9170	Schwarzbeck	W00054
☐	Cable set SAC	RF cable(s)	Huber + Suhner	E00755 E01033 E01034
☐	Cable set FS-SAC	RF cable(s)	Teledyne Reynolds Huber + Suhner Teledyne Reynolds	E00435 E00307 E00433
☐	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[7] For information about measurement uncertainties see page 97.

6.5.2 Limits

As specified in section 15.247(b)(3) of 47 CFR Part 15, for systems using digital modulation (DTS), the maximum peak conducted output power of the intentional radiator shall not exceed 1 Watt (30 dBm).
This limit is based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

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

Performed by:	Jennifer Ebner	Date(s) of test:	March 25, 2019

6.5.4.1 Antenna port 1

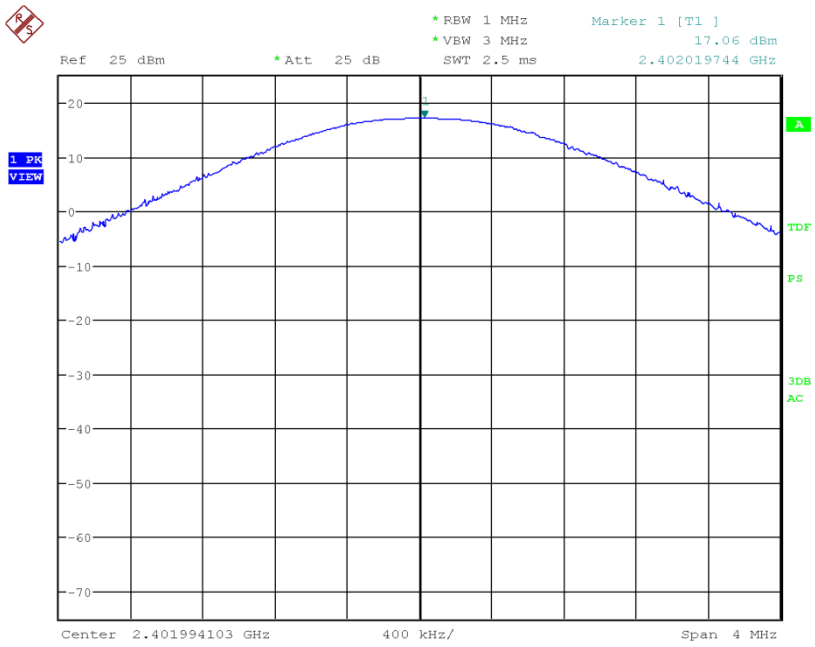

Figure 14: Chart of conducted output power on channel low of antenna port 1

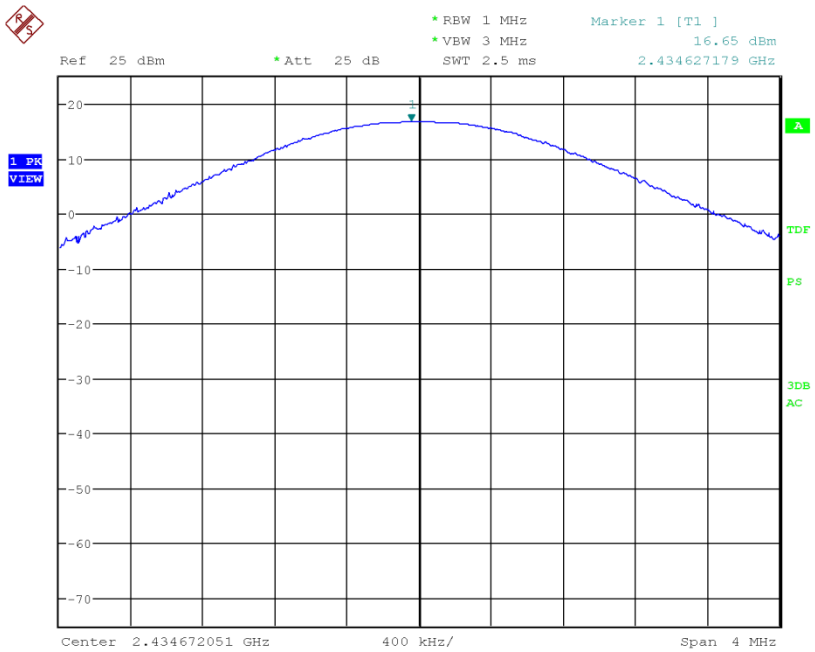

Figure 15: Chart of conducted output power on channel middle of antenna port 1

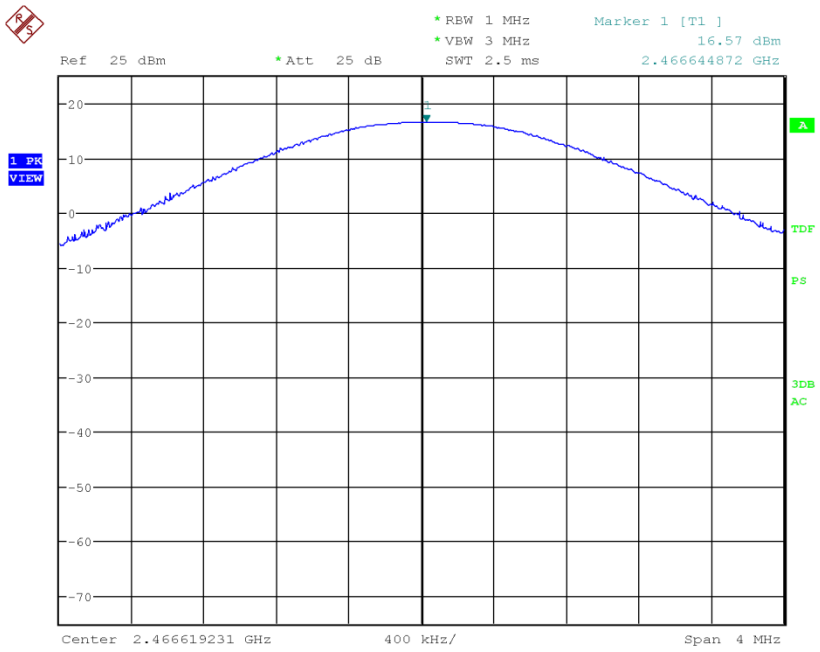

Figure 16: Chart of conducted output power on channel high of antenna port 1

Channel	*Frequency [MHz]*	*Conducted output power [dBm]*	*Limit [dB]*	*Margin*
low	2402.020	17.06	20.97	3.91
middle	2434.627	16.65	20.97	4.32
high	2466.645	16.57	20.97	4.40

Table 14: Results of conducted output power of antenna port 1

6.5.4.2 Antenna port 2

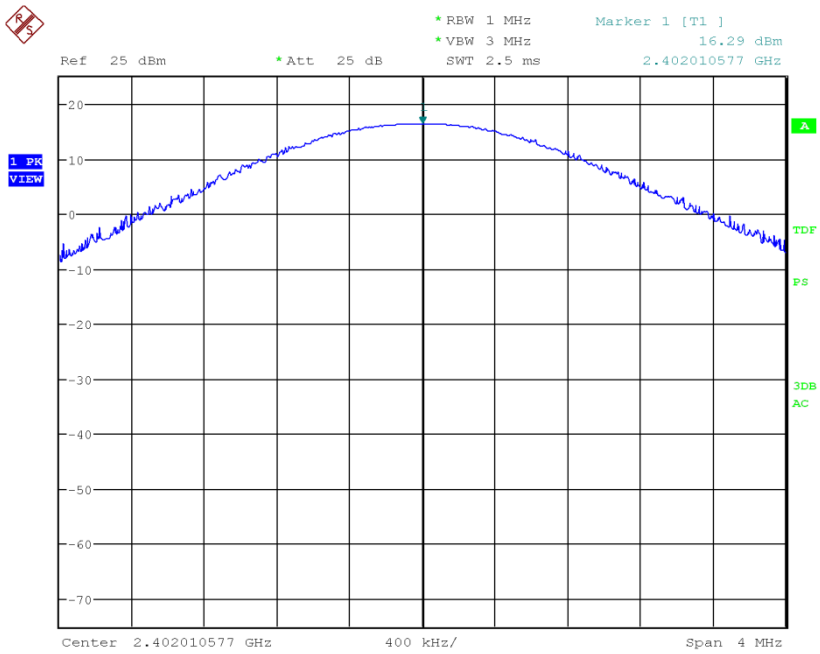

Figure 17: Chart of conducted output power on channel low of antenna port 2

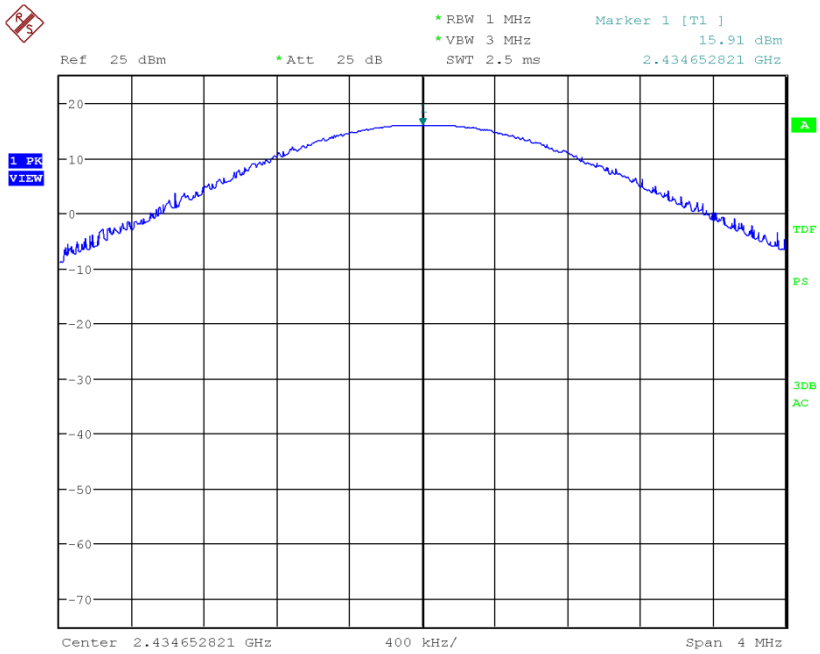

Figure 18: Chart of conducted output power on channel middle of antenna port 2

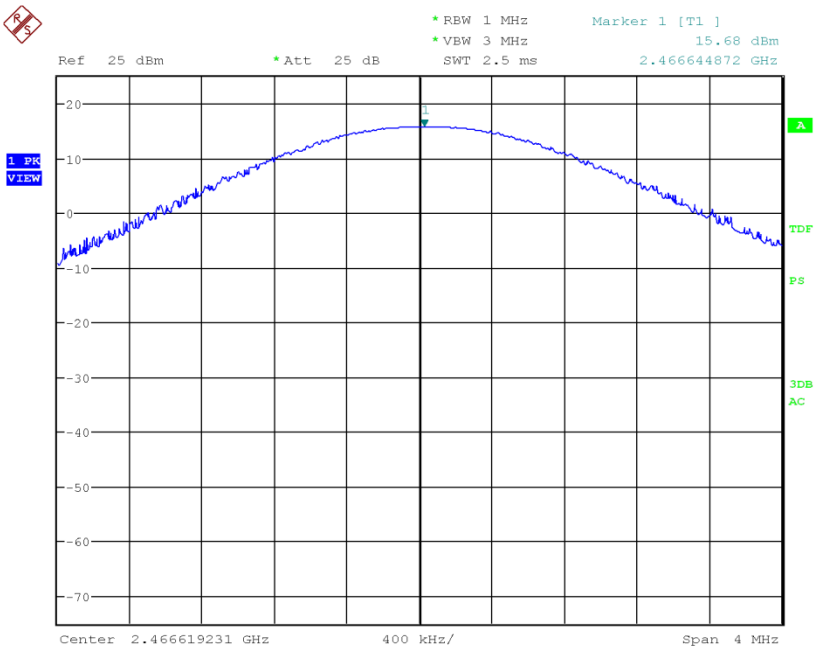

Figure 19: Chart of output power on channel high of antenna port 2

Channel	*Frequency [MHz]*	*Conducted output power [dBm]*	*Limit [dBm]*	*Margin*
low	2402.011	16.29	20.97	4.68
middle	2434.653	15.91	20.97	5.06
high	2466.645	15.68	20.97	5.29

Table 15: Results of conducted output power of antenna port 2

6.6 Carrier frequency separation

Section(s) in 47 CFR Part 15:	Requirement(s):	15.247(a)
	Reference(s):	ANSI C63.10, clause 7.8
Section(s) in RSS:	Requirement(s):	RSS-247, section 5.1(b)
	Reference(s):	ANSI C63.10, clause 7.8

Result[8]: ☒ Test passed ☐ Test not passed

6.6.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☐	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☐	Free space semi-anechoic chamber (FS-SAC)	FS-SAC	EMV **TESTHAUS**	E00100
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☐	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☒	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Preamplifier (1 GHz - 18 GHz)	ALS05749	Aldetec	W01007
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☐	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☐	Horn antenna	BBHA 9120D	Schwarzbeck	W00052
☐	Horn antenna	BBHA 9170	Schwarzbeck	W00054
☐	Cable set SAC	RF cable(s)	Huber + Suhner	E00755 E01033 E01034
☐	Cable set FS-SAC	RF cable(s)	Teledyne Reynolds Huber + Suhner Teledyne Reynolds	E00435 E00307 E00433
☐	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[8] For information about measurement uncertainties see page 97.

6.6.2 Limits

As specified in section 15.247(a) of 47 CFR Part 15, for frequency hopping systems the carrier frequency separation shall not be less than 25 KHz or 20 dB bandwidth of the hopping channel, whichever is greater. For frequency hopping systems operating in the 2400-2483.5 MHz band the carrier frequency separation shall be 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

6.6.3 Test procedure

The carrier frequency separation 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

Performed by:	Jennifer Ebner	Date(s) of test:	March 25, 2019

Note: The carrier frequency separation was measured on both antenna ports. This test report contains only the charts and results of one antenna port.

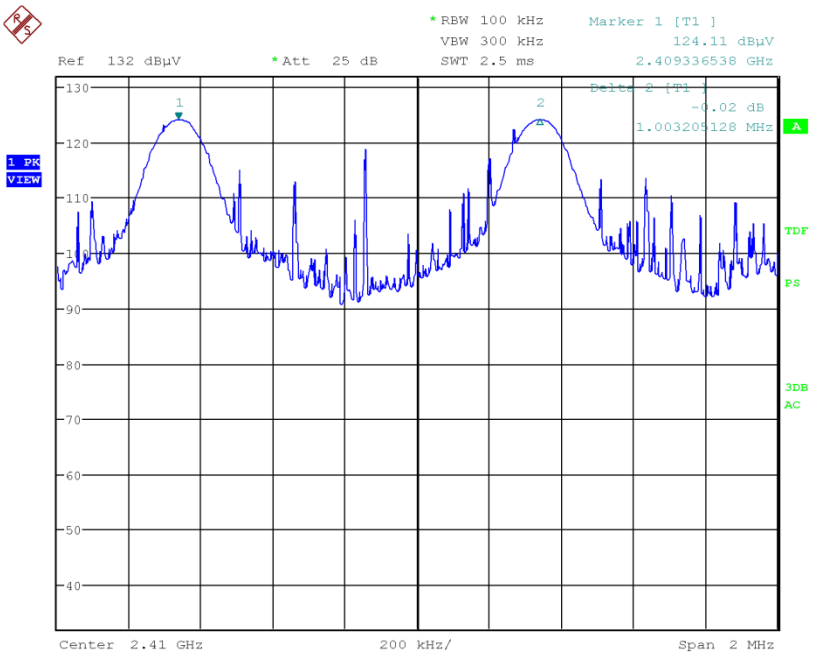

Figure 20: Chart of carrier frequency separation of antenna port 1

Frequency left [MHz]	*Frequency right [MHz]*	*Carrier frequency separation [MHz]*
2409.337	2410.340	1.003

Table 16: Results of carrier frequency separation of antenna port 1

6.7 Number of hopping frequencies

Section(s) in 47 CFR Part 15:	Requirement(s):	15.247(a)
	Reference(s):	ANSI C63.10, clause 7.8
Section(s) in RSS:	Requirement(s):	RSS-247, section 5.1(d)
	Reference(s):	ANSI C63.10, clause 7.8

Result[9]: ☒ Test passed ☐ Test not passed

6.7.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☐	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☐	Free space semi-anechoic chamber (FS-SAC)	FS-SAC	EMV **TESTHAUS**	E00100
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☐	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☒	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Preamplifier (1 GHz - 18 GHz)	ALS05749	Aldetec	W01007
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☐	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☐	Horn antenna	BBHA 9120D	Schwarzbeck	W00052
☐	Horn antenna	BBHA 9170	Schwarzbeck	W00054
☐	Cable set SAC	RF cable(s)	Huber + Suhner	E00755 E01033 E01034
☐	Cable set FS-SAC	RF cable(s)	Teledyne Reynolds Huber + Suhner Teledyne Reynolds	E00435 E00307 E00433
☐	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[9] For information about measurement uncertainties see page 97.

6.7.2 Limits

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

6.7.3 Test procedure

The number of hopping frequencies 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.

6.7.4 Test results

Performed by:	Jennifer Riedel	Date(s) of test:	March 25, 2019

Note: The number of hopping frequencies is tested on both antenna ports. Only the chart and result of one antenna port is shown in this test report.

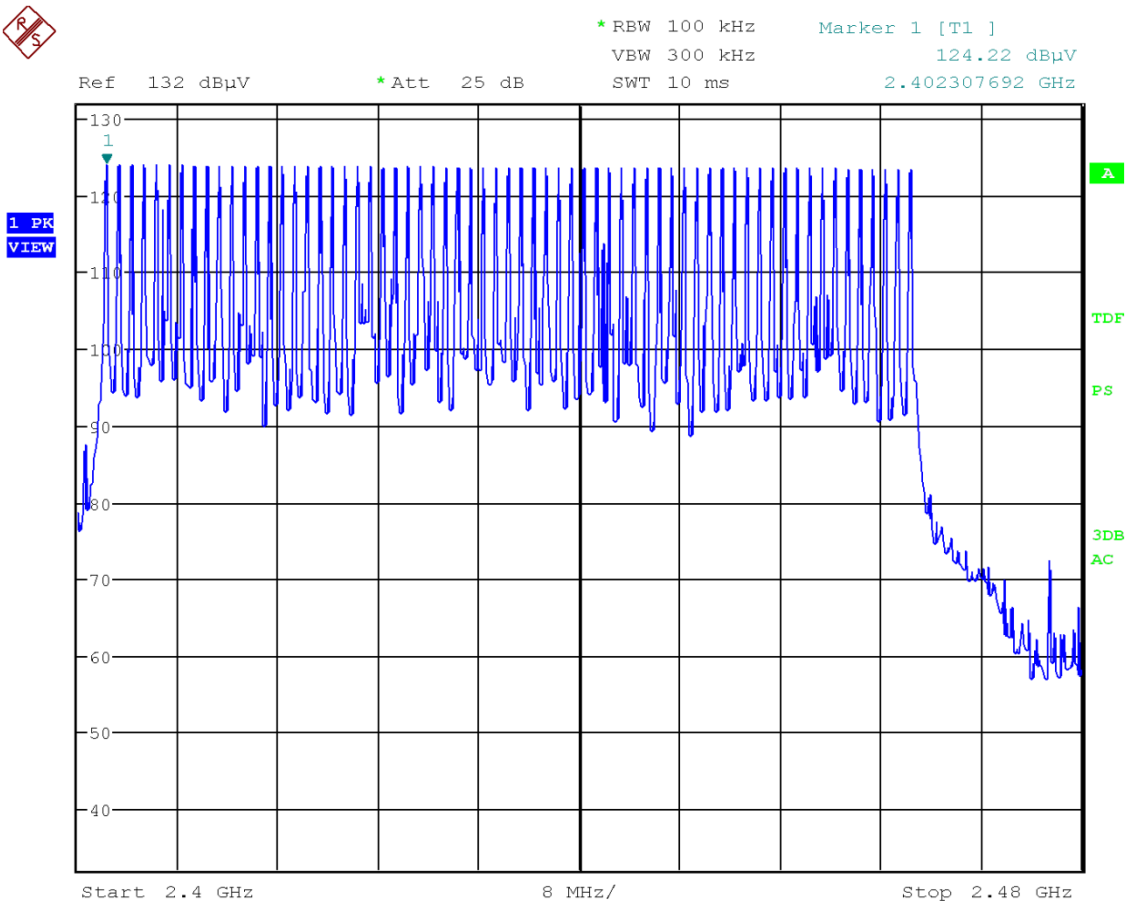

Figure 21: Chart of number of hopping frequencies on antenna port 1

Number of frequencies
65

Table 17: Results of number of hopping frequencies

6.8 Time of occupancy (dwell time)

Section(s) in 47 CFR Part 15:	Requirement(s):	15.247(a)
	Reference(s):	ANSI C63.10, clause 7.8
Section(s) in RSS:	Requirement(s):	RSS-247, section 5.1(d)
	Reference(s):	ANSI C63.10, clause 7.8

Result[10]: ☒ Test passed ☐ Test not passed

6.8.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☐	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☐	Free space semi-anechoic chamber (FS-SAC)	FS-SAC	EMV **TESTHAUS**	E00100
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☐	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☒	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Preamplifier (1 GHz - 18 GHz)	ALS05749	Aldetec	W01007
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☐	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☐	Horn antenna	BBHA 9120D	Schwarzbeck	W00052
☐	Horn antenna	BBHA 9170	Schwarzbeck	W00054
☐	Cable set SAC	RF cable(s)	Huber + Suhner	E00755 E01033 E01034
☐	Cable set FS-SAC	RF cable(s)	Teledyne Reynolds Huber + Suhner Teledyne Reynolds	E00435 E00307 E00433
☐	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[10] For information about measurement uncertainties see page 97.

6.8.2 Limits

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

6.8.3 Test procedure

The time of occupancy is measured using the test procedure as described in clause 5.11and 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.

6.8.4 Test results

Performed by:	Jennifer Riedel	Date(s) of test:	March 25, 2019

Note: The time of occupancy is tested on both antenna ports. In this test report only the chart and result of one antenna port is shown.

As declared in §15.247(a)(iii) the observation period should 0.4 s multiplied by the number of hopping channels. So in this case the observation period is

$$t = 0.4s * 65 = 26s$$

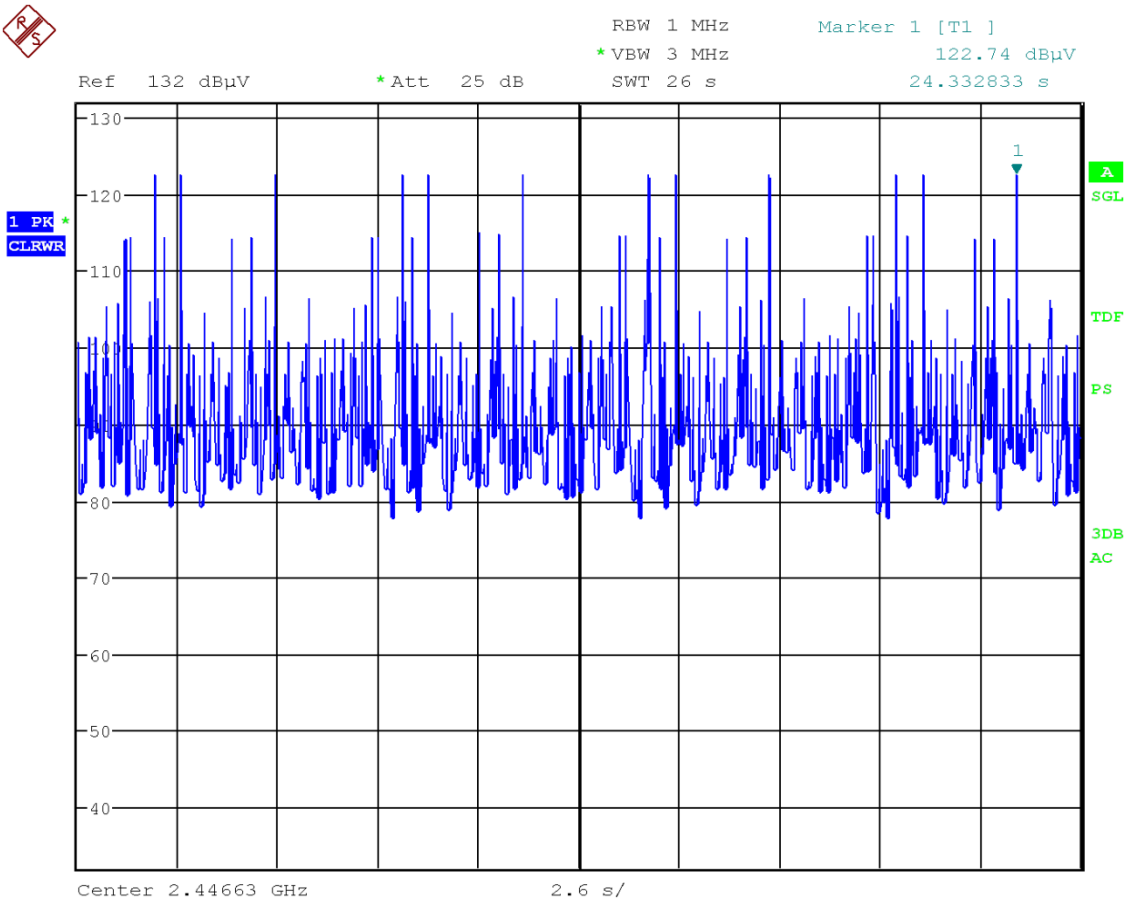

Figure 22: Chart of number of bursts in 26 s

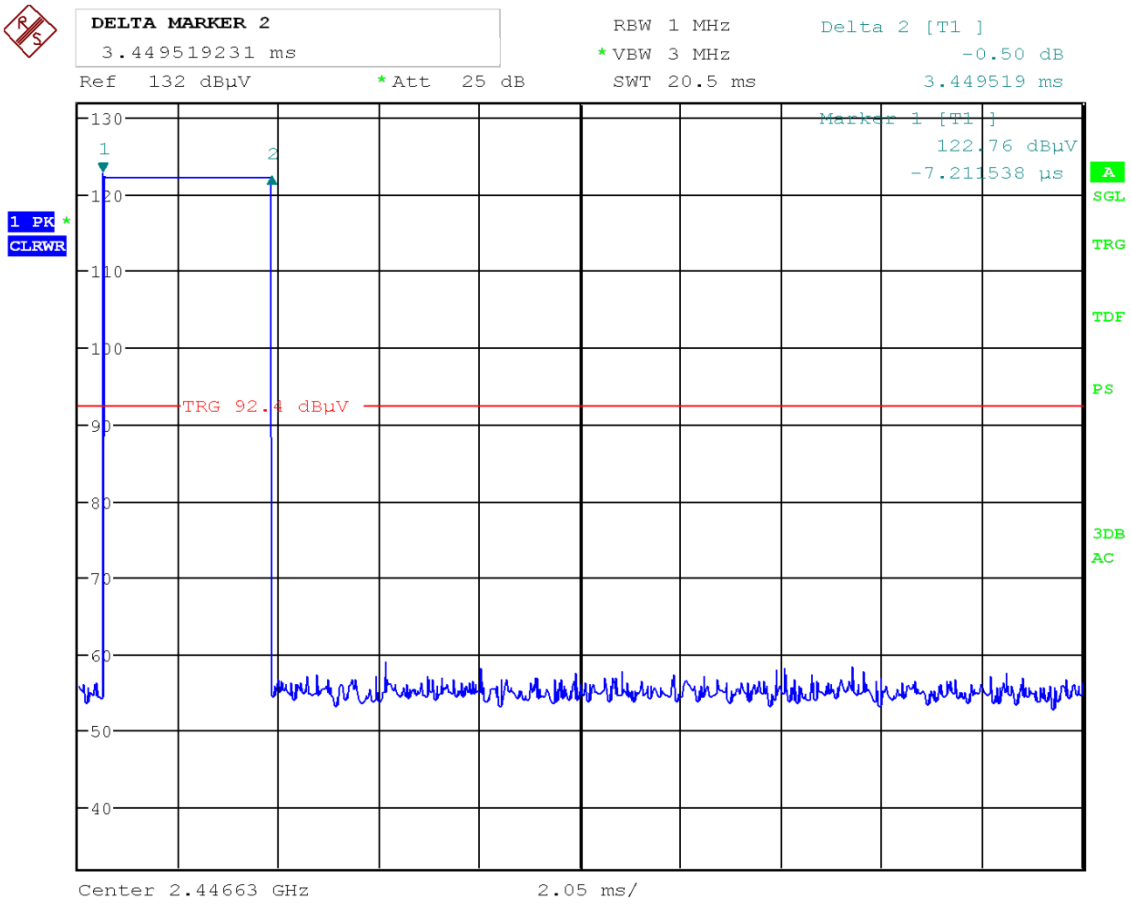

Figure 23: Chart of burst length in 20 ms (trigger offset -0.5 ms)

Number of hops in 26 s: 12

Burst length in 20 ms: 3.45 ms

Time of occupancy = (Number of hops) x (Burst length) = 12 x 3.45 ms = 41.4 ms

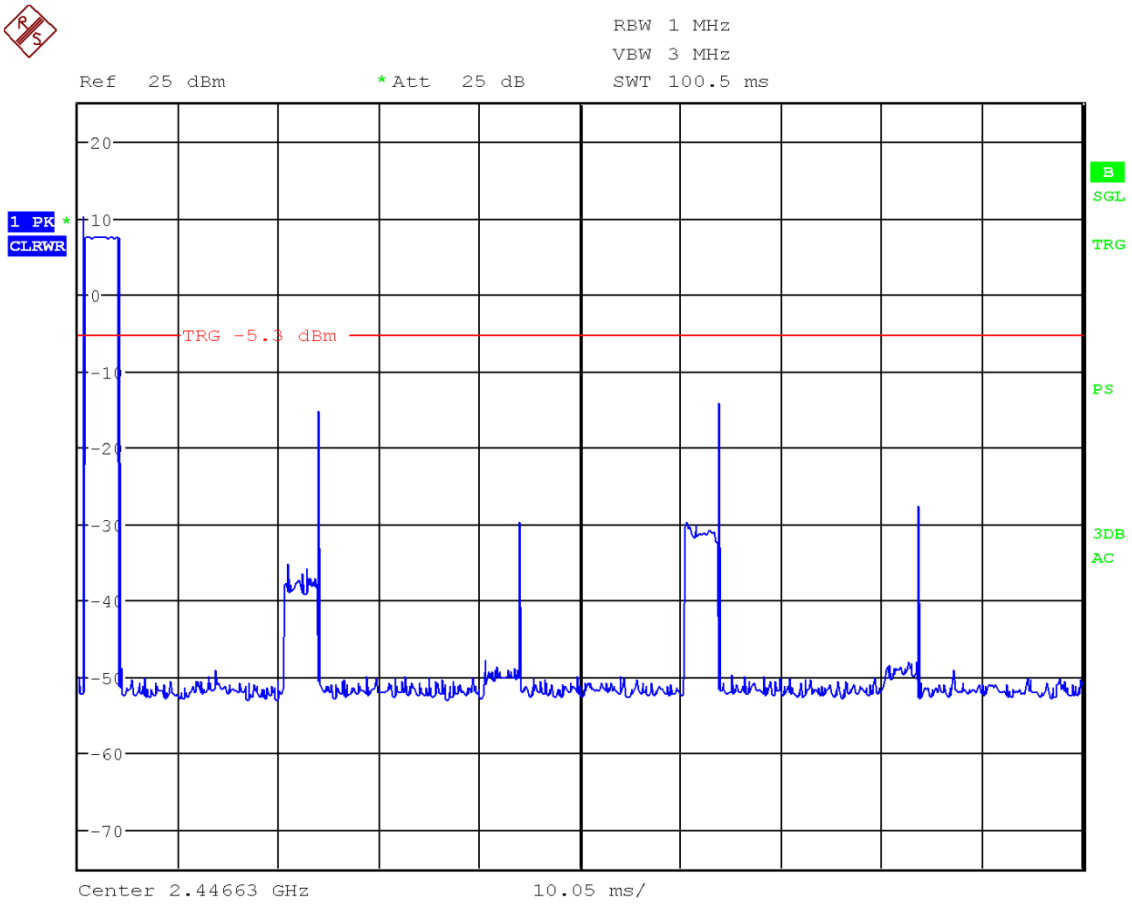

Figure 24: Chart of burst length in 100 ms (trigger offset -0.5 ms)

In 100 ms the EUT does not transmit again as shown in Figure 24.

6.9 Band-edge measurements

Section(s) in 47 CFR Part 15:	Requirement(s):	15.247(d)
	Reference(s):	KDB 558074 D01, section 13
Section(s) in RSS:	Requirement(s):	RSS-247, section 5.5
	Reference(s):	ANSI C63.10, clause 6.10

Result[11]: ☒ Test passed ☐ Test not passed

6.9.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☐	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☒	Free space semi-anechoic chamber (FS-SAC)	FS-SAC	EMV **TESTHAUS**	E00100
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☐	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☒	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Preamplifier (1 GHz - 18 GHz)	ALS05749	Aldetec	W01007
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☐	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☒	Horn antenna	BBHA 9120D	Schwarzbeck	W00052
☐	Horn antenna	BBHA 9170	Schwarzbeck	W00054
☐	Cable set SAC	RF cable(s)	Huber + Suhner	E00755 E01033 E01034
☒	Cable set FS-SAC	RF cable(s)	Teledyne Reynolds Huber + Suhner Teledyne Reynolds	E00435 E00307 E00433
☐	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[11] For information about measurement uncertainties see page 97.

6.9.2 Limits

Only spurious emissions are permitted in any of the frequency bands listed below:

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 18: Restricted bands of operation according to §15.205

According to §15.247(d), 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 18) must also comply with the radiated emission limits specified in §15.209(a)

6.9.3 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.

6.9.4 Test results

Performed by:	Jennifer Riedel	Date(s) of test:	March 21, 2019
Test distance:	☐ 3 m	☐ 10 m	☒ 1.50 m
EUT position:	☒ Position X	☒ Position Y	☒ Position Z

6.9.4.1 Antenna port 1

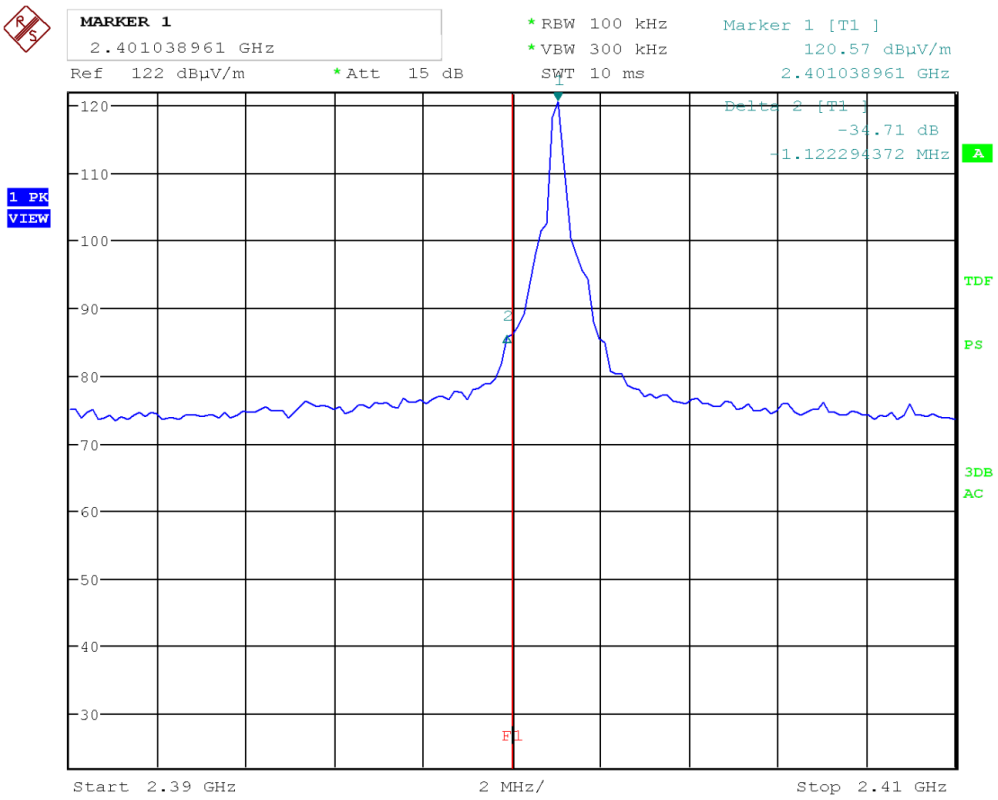

Figure 25: Chart of band-edge measurement on single channel low in horizontal polarization

Carrier frequency:	2401.04 MHz
Field strength of carrier frequency:	120.57 dBµV/m
Band-edge:	2400 MHz
Field strength of band-edge:	85.86 dBµV/m

The field strength of the band-edge is more than 20 dB (34.71 dB) lower than the field strength of the carrier.

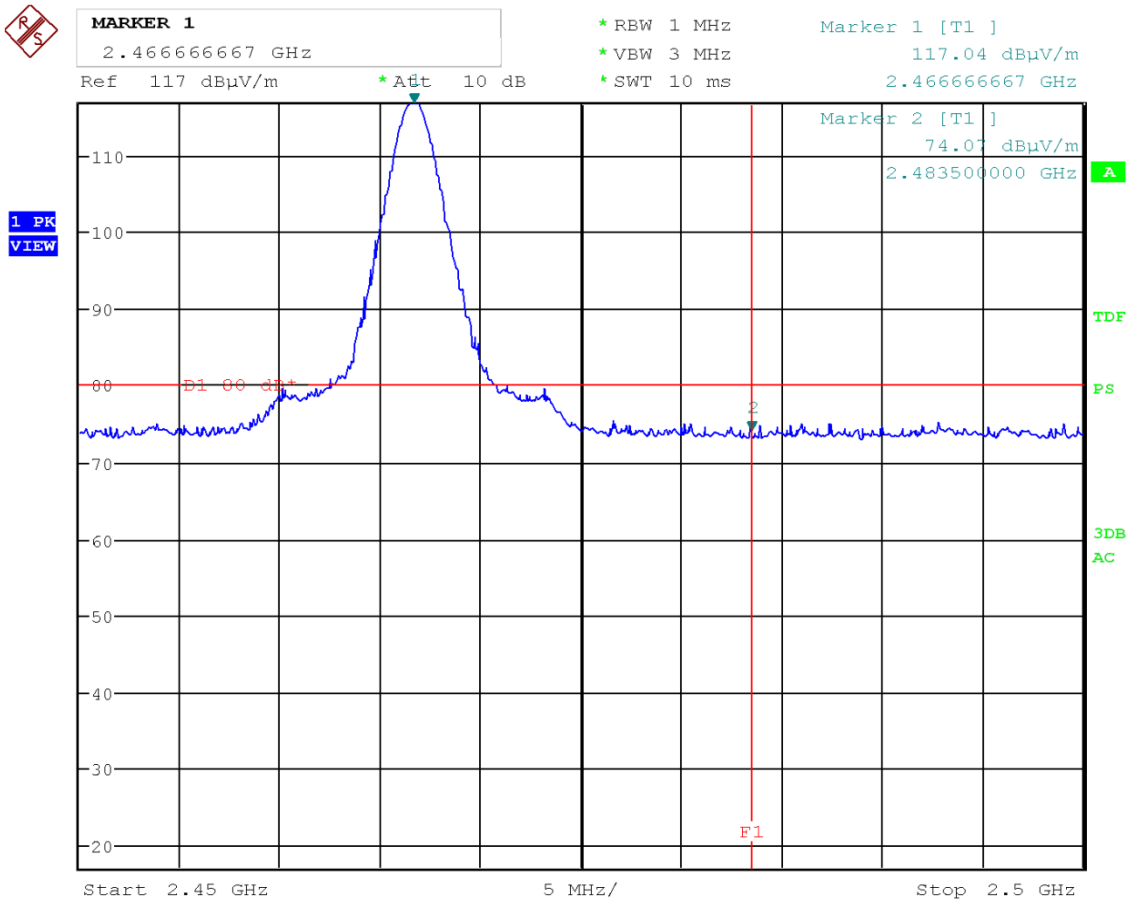

Figure 26: Chart of band-edge measurement on single channel high in horizontal polarization

Frequency [MHz]	*Peak [dbµV/m]*	*Limit PK [dBµV/m][1]*	*Correction factor [dB]*	*Average [dBµV/m][2]*	*Limit AV [dBµV/m][1]*	*Result*
2466.667	117.04	---	---	---	---	Passed
2483.500	74.07	80	-28	46.07	60	Passed

Table 19: Results of band-edge measurement on single channel high

Note 1: Note: The band-edge measurements are made at a measurement distance of 1.5 m. The limit lines for these tests are converted and calculated from the limit lines at a measurement distance of 3 m.

Note 2: The average value is calculated as the difference between the peak value and the duty cycle correction factor which is determined as described in clause 4.2.2.

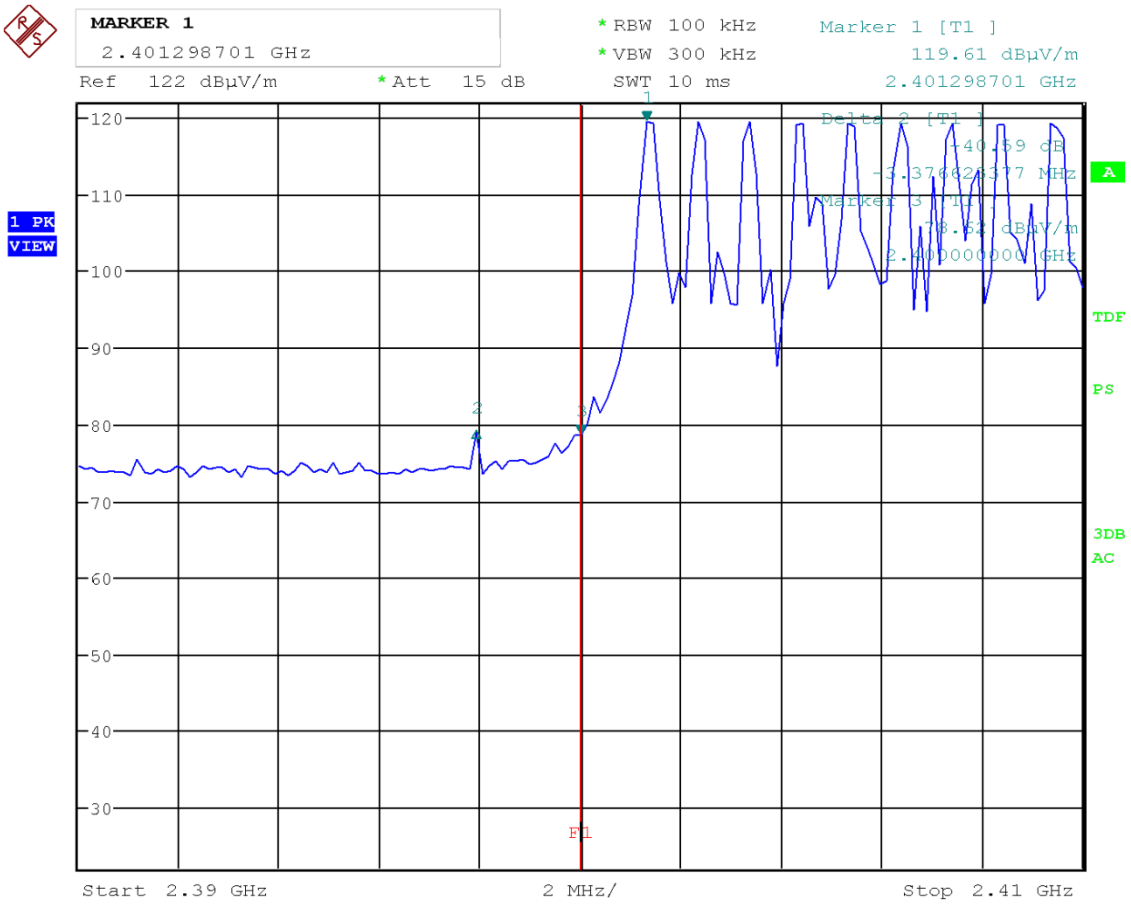

Figure 27: Chart of band-edge measurement in hopping mode in the lower band in horizontal polarization

Carrier frequency:	2401.30 MHz
Field strength of carrier frequency:	119.61 dBµV/m
Band-edge:	2400 MHz
Field strength of band-edge:	78.52 dBµV/m

The field strength of the band-edge is more than 20 dB (41.09 dB) lower than the field strength of the carrier in hopping mode.

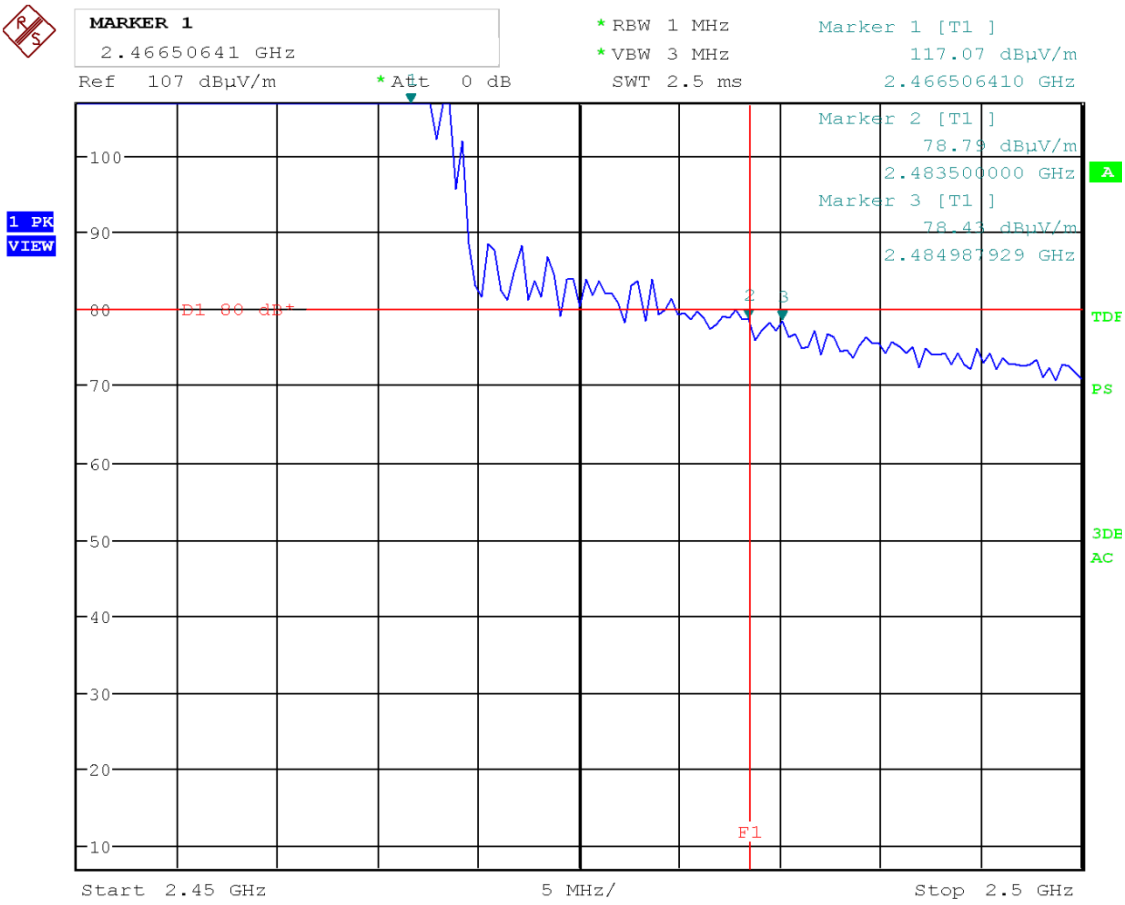

Figure 28: Chart of band-edge measurement in hopping mode in the higher band horizontal polarization

Frequency [MHz]	*Peak [dbµV/m]*	*Limit PK [dBµV/m][1]*	*Correction factor [dB]*	*Average [dBµV/m][2]*	*Limit AV [dBµV/m][1]*	*Result*
2466.506	117.07	---	---	---	---	Passed
2483.500	78.79	80	-28	50.79	60	Passed
2484.988	78.43	80	-28	50.43	60	Passed

Table 20: Results of band-edge measurement in hopping mode

Note 1: Note: The band-edge measurements are made at a measurement distance of 1.5 m. The limit lines for these tests are converted and calculated from the limit lines at a measurement distance of 3 m.

Note 2: The average value is calculated as the difference between the peak value and the duty cycle correction factor which is determined as described in clause 4.2.2.

6.9.4.2 Antenna port 2

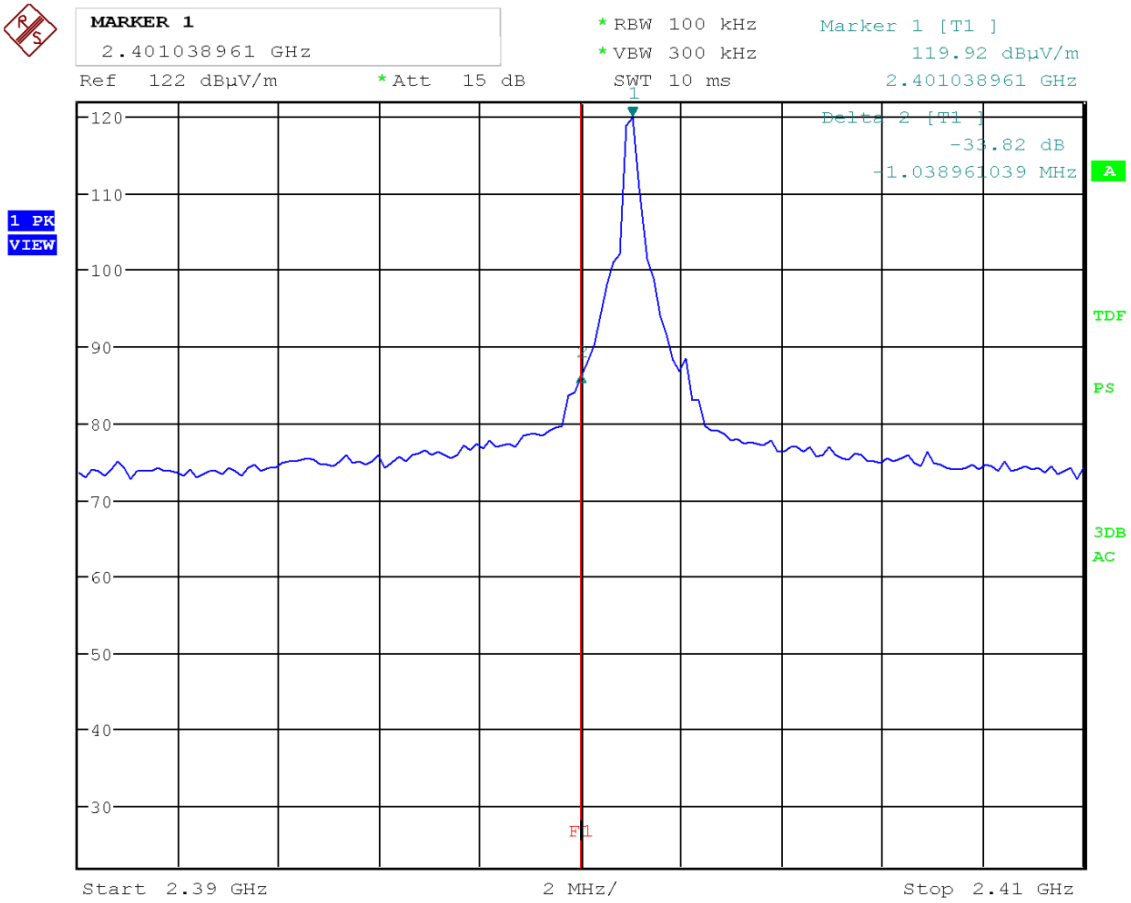

Figure 29: Chart of band-edge measurement on single channel low in horizontal polarization

Carrier frequency:	2401.04 MHz
Field strength of carrier frequency:	119.92 dBµV/m
Band-edge:	2400 MHz
Field strength of band-edge:	86.10 dBµV/m

The field strength of the band-edge is more than 20 dB (33.82 dB) lower than the field strength of the carrier.

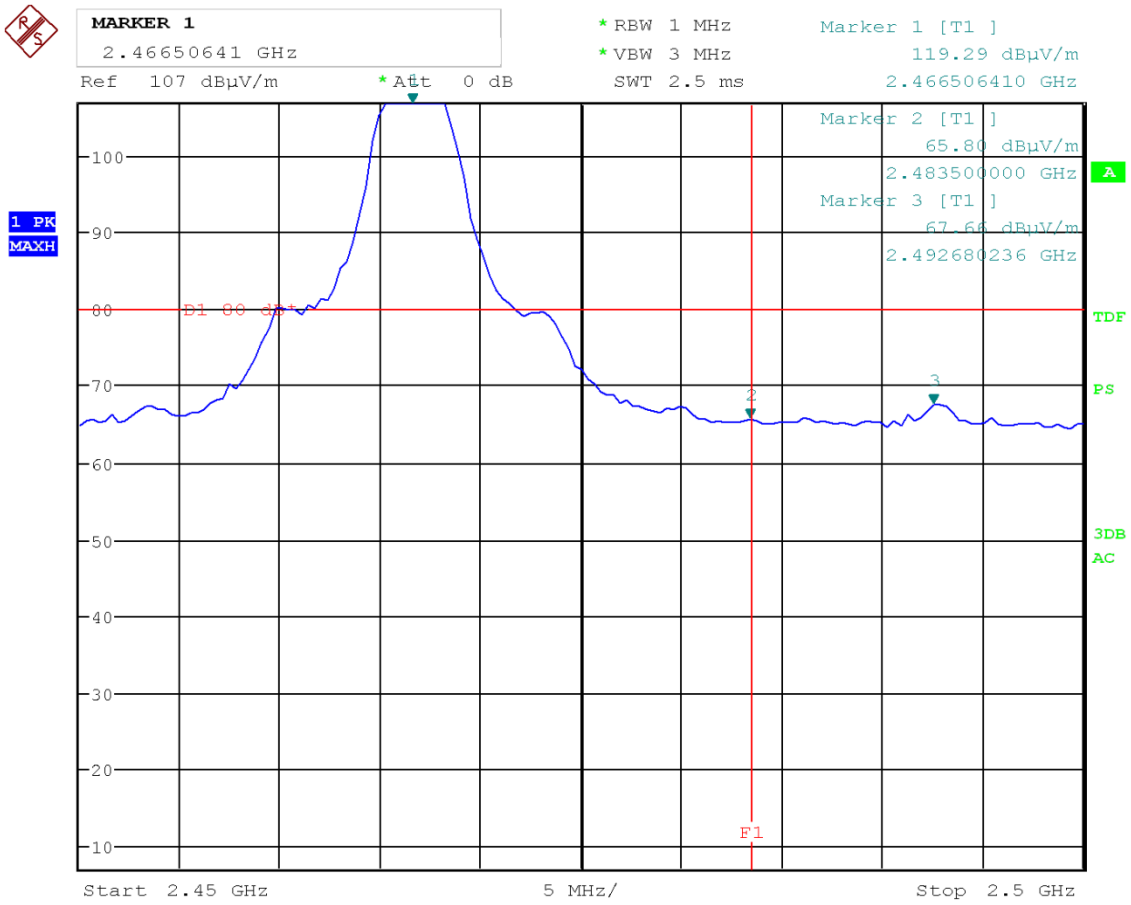

Figure 30: Chart of band-edge measurement on single channel high in horizontal polarization

Frequency [MHz]	*Peak [dbµV/m]*	*Limit PK [dBµV/m][1]*	*Correction factor [dB]*	*Average [dBµV/m][2]*	*Limit AV [dBµV/m][1]*	*Result*
2466.506	119.29	---	---	---	---	Passed
2483.500	65.80	80	-28	37.80	60	Passed
2492.680	67.66	80	-28	39.66	60	Passed

Table 21: Results of band-edge measurement on single channel high

Note 1: Note: The band-edge measurements are made at a measurement distance of 1.5 m. The limit lines for these tests are converted and calculated from the limit lines at a measurement distance of 3 m.

Note 2: The average value is calculated as the difference between the peak value and the duty cycle correction factor which is determined as described in clause 4.2.2.

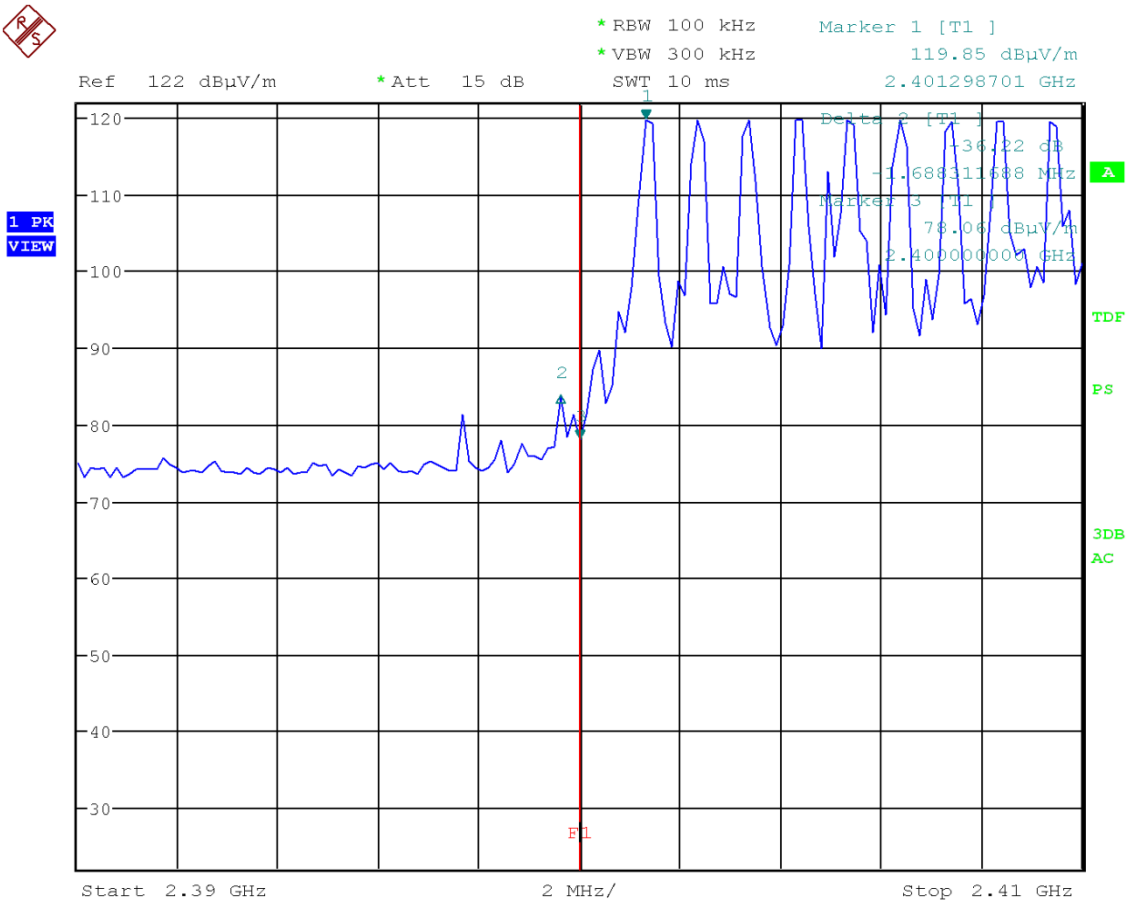

Figure 31: Chart of band-edge measurement in hopping mode in the lower band in horizontal polarization

Carrier frequency:	2401.30 MHz
Field strength of carrier frequency:	119.85 dBµV/m
Band-edge (Marker 3):	2400 MHz
Field strength of band-edge:	78.06 dBµV/m
Frequency (Marker 2):	2399.61 MHz
Field strength of frequency:	83.63 dBµV/m

The field strength of the band-edge and the frequency of Marker 2 are more than 20 dB (41.09 dB and 36.22 dB)) lower than the field strength of the carrier in hopping mode.

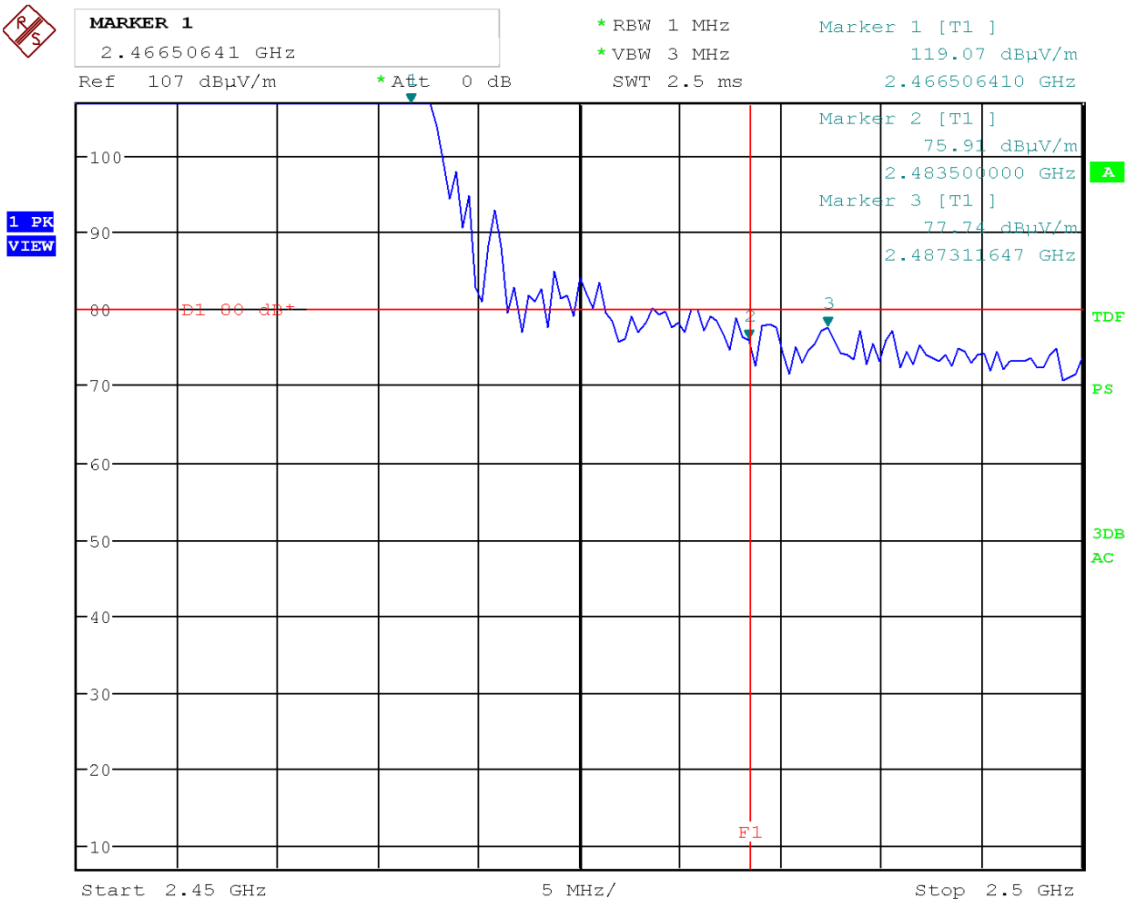

Figure 32: Chart of band-edge measurement in hopping mode in the higher band horizontal polarization

Frequency [MHz]	*Peak [dbµV/m]*	*Limit PK [dBµV/m][1]*	*Correction factor [dB]*	*Average [dBµV/m][2]*	*Limit AV [dBµV/m][1]*	*Result*
2466.506	119.07	---	---	---	---	Passed
2483.500	75.91	80	-28	47.91	60	Passed
2487.312	77.74	80	-28	49.74	60	Passed

Table 22: Results of band-edge measurement in hopping mode

Note 1: Note: The band-edge measurements are made at a measurement distance of 1.5 m. The limit lines for these tests are converted and calculated from the limit lines at a measurement distance of 3 m.

Note 2: The average value is calculated as the difference between the peak value and the duty cycle correction factor which is determined as described in clause 4.2.2.

6.10 Emissions outside the operating frequency band(s) specified

6.10.1 Emissions below 30 MHz

Section(s) in 47 CFR Part 15:	Requirement(s):	15.247(d)
	Reference(s):	KDB 558074 D01, sections 11 and 12
Section(s) in RSS:	Requirement(s):	RSS-247, section 5.5 RSS-Gen, section 6.13
	Reference(s):	ANSI C63.10, clause 6.4

Result[12]: ☒ Test passed ☐ Test not passed

6.10.1.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☒	Compact Diagnostic Chamber (CDC)	VK041.0174	Albatross Projects	E00026
☐	Open area test site (OATS)	---	EMV **TESTHAUS**	E00354
☐	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☒	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☐	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Field probe	RF-R 400-1	Langer EMV-Technik	E00270
☒	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-EB (V10.35)	Rohde & Schwarz	E00777
☒	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[12] For information about measurement uncertainties see page 97.

6.10.1.2 Limits

According to §15.247(d), 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 18) must also comply with the radiated emission limits specified in §15.209(a). For the frequency range 9 kHz to 30 MHz, these limits are shown in table 23.

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

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 23 using the recalculation factor as described in clause 5.3.

6.10.1.3 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.

6.10.1.4 Test results

Performed by:	Jennifer Riedel	Date(s) of test:	October 17, 2018
Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
Antenna alignment:	☒ in parallel	☒ in line	☐ angle ….. °
EUT position[13]:	☒ Position X	☒ Position Y	☒ Position Z

Frequency range	*Step size*	*IF Bandwidth*	*Detector*		*Measurement Time*		*Preamplifier*
			Prescan	*Final scan*	*Prescan*	*Final scan*	
9 kHz – 150 kHz	70.5 Hz	200 Hz	PK	PK,	2 s	1 s	Off
150 kHz – 30 MHz	7.462 kHz	9 kHz	PK	PK	2 s	1 s	Off

Note: Premeasurements have shown there are no differences between the antenna ports and between the channels low, middle and high in the range of 9 kHz to 30 MHz, so the final measurement was only performed on channel low of antenna port 1.

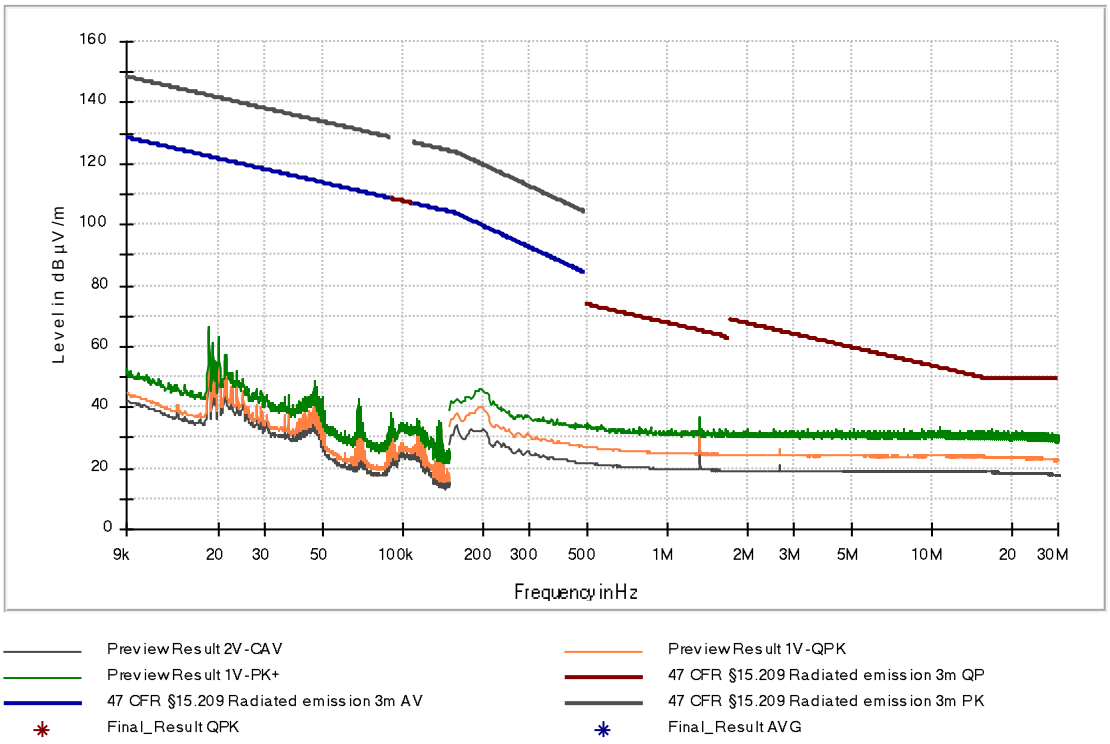

Figure 33: Chart of emissions test below 30 MHz on channel low of antenna port 1

[13] Exploratory measurements are performed in all positions as indicated. However, the figures and result tables within this test report show the worst case position, only.

6.10.2 Emissions from 30 MHz to 1 GHz

Section(s) in 47 CFR Part 15:	Requirement(s):	15.247(d)
	Reference(s):	KDB 558074 D01, sections 11 and 12
Section(s) in RSS:	Requirement(s):	RSS-247, section 5.5 RSS-Gen, section 6.13
	Reference(s):	ANSI C63.10, clause 6.5

Result[14]: ☒ Test passed ☐ Test not passed

6.10.2.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☒	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☐	Free space semi-anechoic chamber (FS-SAC)	FS-SAC	EMV **TESTHAUS**	E00100
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☒	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☐	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Preamplifier (1 GHz - 18 GHz)	ALS05749	Aldetec	W01007
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☒	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☐	Horn antenna	BBHA 9120D	Schwarzbeck	W00052
☐	Horn antenna	BBHA 9170	Schwarzbeck	W00054
☒	Cable set SAC	RF cable(s)	Huber + Suhner	E00755 E01033 E01034
☐	Cable set FS-SAC	RF cable(s)	Teledyne Reynolds Huber + Suhner Teledyne Reynolds	E00435 E00307 E00433
☒	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[14] For information about measurement uncertainties see page 97.

6.10.2.2 Limits

According to §15.247(d), 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 18) must also comply with the radiated emission limits specified in §15.209(a). For frequencies equal to and above 30 MHz, these limits are shown in table 24.

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 24: General radiated emission limits ≥ 30 MHz according to §15.209

6.10.2.3 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.

6.10.2.4 Test results

Performed by:	Jennifer Riedel	Date(s) of test:	July 11, 2018
Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
EUT position[15]:	☒ Position X	☒ Position Y	☒ Position Z

Frequency range	*Step size*	*IF Bandwidth*	*Detector*		*Measurement Time*		*Preamplifier*
			Prescan	*Final scan*	*Prescan*	*Final scan*	
30 MHz – 1 GHz	30 kHz	120 kHz	QP	QP	1 s	1 s	20 dB

Note: Premeasurements have shown there are no differences between the antenna ports and between the channels low, middle and high in the range of 30 MHz to 1 GHz, so the final measurement was only performed on channel low of antenna port 1.

Note: Premeasurements have shown that the worst case polarization of the measurement antenna is vertical, so only vertical polarization was tested.

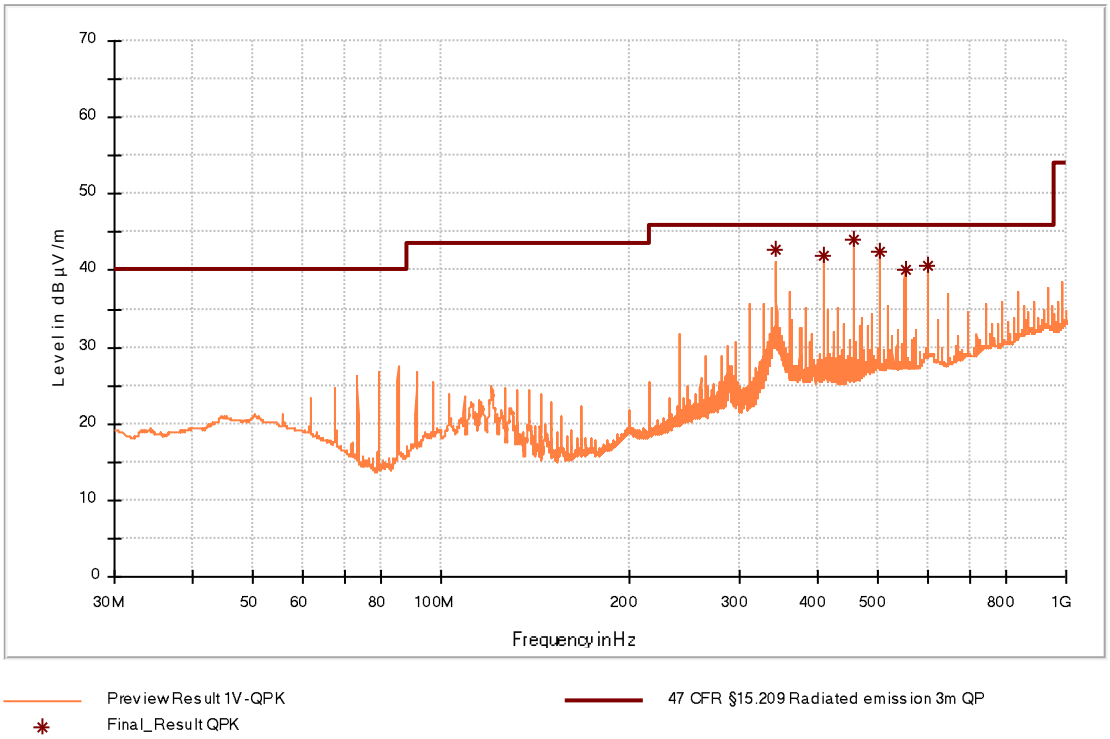

Figure 34: Chart of emissions test from 30 MHz to 1 GHz on channel low of antenna port 1

[15] Exploratory measurements are performed in all positions as indicated. However, the figures and result tables within this test report show the worst case position, only.

Frequency (MHz)	*EUT Pos.*	*Level (dBµV/m)*	*Detector*	*Limit (dBµV/m)*	*Margin (dB)*	*Meas. Time (ms)*	*Bandwidth (kHz)*	*Height (cm)*	*Pol.*	*Azimuth (deg)*	*Corr. (dB/m)*
344.010	Z	42.65	QP	47.00	4.35	1000.0	120.000	124.0	V	295.0	16.9
407.970	Z	41.91	QP	47.00	5.09	1000.0	120.000	112.0	V	0.0	17.9
455.970	Z	44.05	QP	47.00	2.95	1000.0	120.000	100.0	V	0.0	18.5
503.970	Z	42.59	QP	47.00	4.41	1000.0	120.000	100.0	V	0.0	19.5
551.970	Z	40.12	QP	47.00	6.88	1000.0	120.000	101.0	V	0.0	20.4
599.970	Z	40.54	QP	47.00	6.46	1000.0	120.000	101.0	V	123.0	21.6

Table 25: Results of emissions test from 30 MHz to 1 GHz on channel low of antenna port 1

6.10.3 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, sections 11 and 12
Section(s) in RSS:	Requirement(s):	RSS-247, section 5.5 RSS-Gen, section 6.13
	Reference(s):	ANSI C63.10, clause 6.6

Result[16]: ☒ Test passed ☐ Test not passed

6.10.3.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☐	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☒	Free space semi-anechoic chamber (FS-SAC)	FS-SAC	EMV **TESTHAUS**	E00100
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☐	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☒	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☒	Preamplifier (0.5 GHz - 18 GHz)	BBV 9718 B	Schwarzbeck	W01325
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☐	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☒	Horn antenna	BBHA 9120D	Schwarzbeck	W00052
☒	Horn antenna	BBHA 9170	Schwarzbeck	W01350
☒	Preamplifier (18 GHz – 40 GHz)	BBV 9721	Schwarzbeck	W01350
☐	Cable set SAC	RF cable(s)	Huber + Suhner	E00755 E01033 E01034
☒	Cable set FS-SAC	RF cable(s)	Teledyne Reynolds Huber + Suhner Teledyne Reynolds	E00435 E00307 E00433
☐	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[16] For information about measurement uncertainties see page 97.

6.10.3.2 Limits

According to §15.247(d), 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 18) must also comply with the radiated emission limits specified in §15.209(a). For frequencies above 960 MHz, these limits are shown in table 26.

Frequency	*Field strength*		*Measurement distance*
[MHz]	*[µV/m]*	*[dBµV/m]*	*[m]*
Above 960	500	53.98	3

Table 26: General radiated emission limits above 960 MHz according to §15.209

6.10.3.3 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 5.6.

6.10.3.4 Test results

Performed by:	Jennifer Riedel	Date(s) of test:	March 22, 2019; March 26, 2019
Test distance:	Exploratory tests: Final tests:	☐ 1 m ☐ 3 m	☒ 0.5 m ☒ 1.5 m
EUT position[17]:	☒ Position X	☒ Position Y	☒ Position Z

Frequency range	*Step size*	*IF Bandwidth*	*Detector*		*Measurement Time*		*Pre-amplifier*	*Distance*
			Prescan	*Final scan*	*Prescan*	*Final scan*		
1 GHz – 10 GHz	250 kHz	1 MHz	PK + AV	PK + AV	1.5 s	0.1 s	External	3 m

Frequency range	*Resolution bandwidth*	*Video bandwidth*	Sweep time	*Trace detector(s)*	*Trace mode(s)*	*Test*	*Pre-amplifier*	*Dis-tance*
10 GHz – 25 GHz	1 MHz	3 MHz	AUTO	Max Peak	Clear Write	Searching	20 dB	0.5 m
					Max Hold	Recording		

Note 1: The measurements from 1 GHz to 17 GHz are made at a measurement distance of 1.5 m. The limit lines for these tests are converted and calculated from the limit lines at a measurement distance of 3 m.

Note 2: The exploratory measurements from 17 GHz to 25 GHz are made at a measurement distance of 0.5 m. The limit lines for these tests are converted and calculated from the limit lines at a measurement distance of 3 m.

Note 3: Premeasurements are performed in all three positions and antenna polarizations. However, the figures within this test report show only the worst case position and antenna polarization. The table results are the final measurements of the emissions detected in the premeasurements which are shown in this test report.

[17] Exploratory measurements are performed in all positions as indicated. However, the figures and result tables within this test report show the worst case position, only.

6.10.3.4.1 Antenna port 1

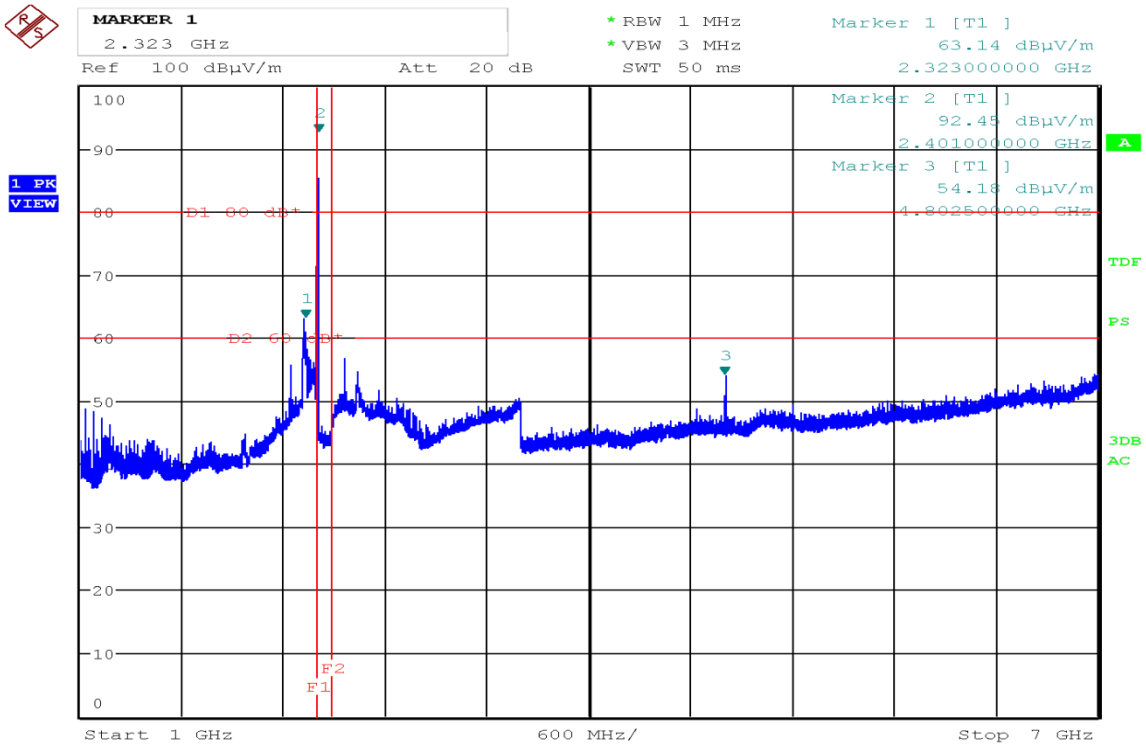

Figure 35: Chart of emissions test from 1 GHz to 17 GHz on channel low of antenna port 1

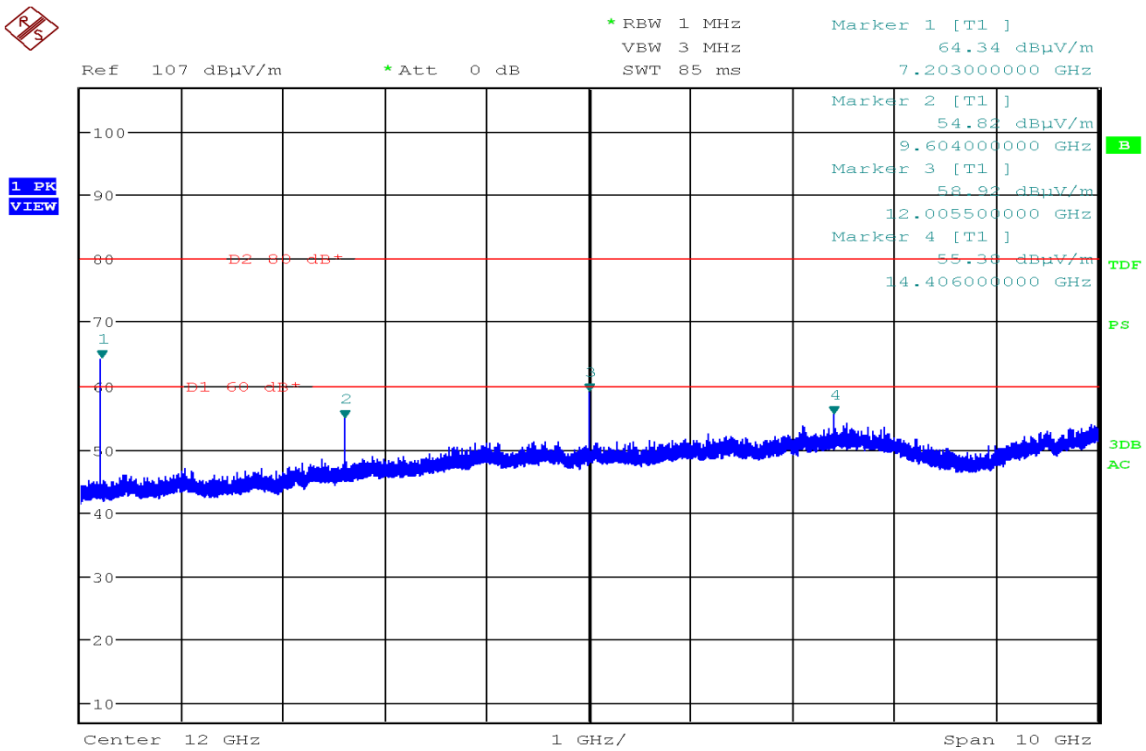

Figure 36: Chart of emissions test from 7 GHz to 17 GHz on channel low of antenna port 1

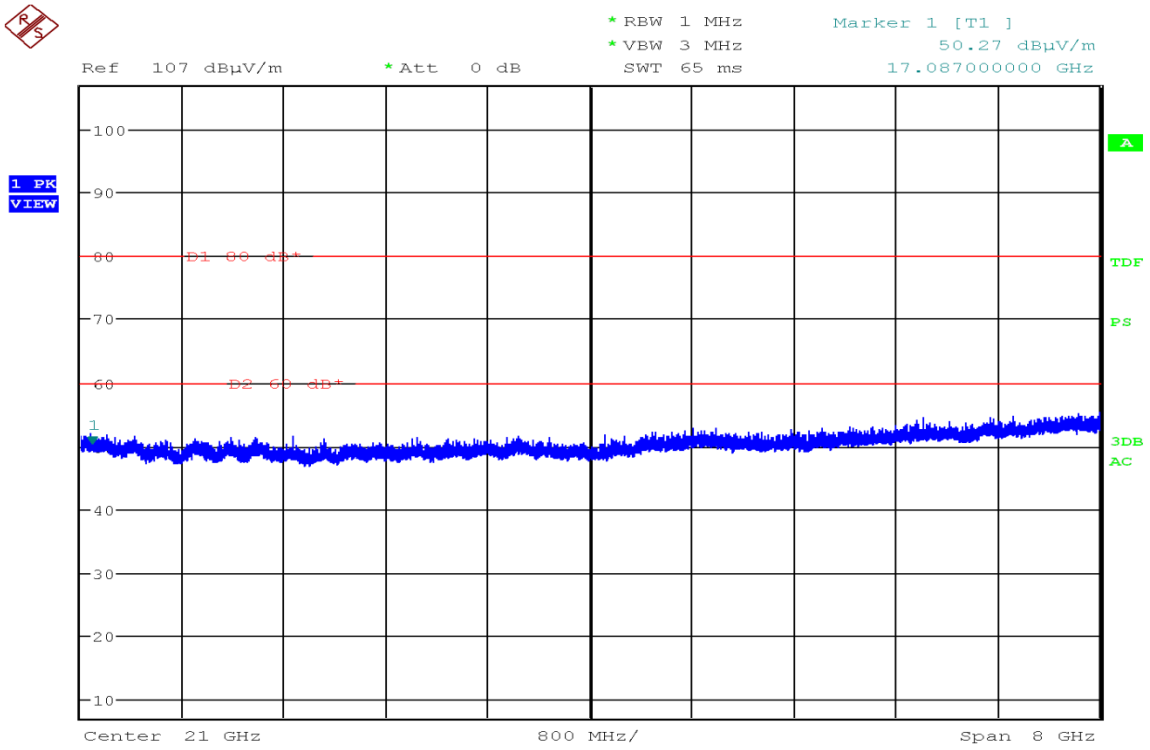

Figure 37: Chart of emissions test from 17 GHz to 25 GHz on channel low of antenna port 1

Frequency (MHz)	*EUT Pos.*	*Level (dBµV/m)*	*Detector*	*Limit (dBµV/m)*	*Margin (dB)*	*Meas. Time (ms)*	*Bandwidth (kHz)*	*Height (cm)*	*Pol.*	*Azimuth (deg)*	*Corr. (dB/m)*
2323.325	Z	63.49	PK	80.00	16.51	2.50	1000.000	150.0	H	180.0	-2.8
2323.000	Z	52.76	AV	60.00	7.24	5.00	1000.000	150.0	H	180.0	-2.8
4801.851	Z	56.31	PK	80.00	23.69	20.0	1000.000	170.0	H	190.0	1.1
7203.013	Y	64.04	PK	80.00	15.96	20.0	1000.000	185.0	H	165.0	8.9
9603.875	Y	56.03	PK	80.00	23.97	20.0	1000.000	190.0	H	225.0	11.6
12004.875	Y	58.99	PK	80.00	21.01	20.0	1000.000	190.0	H	108.0	15.4
14406.000	Y	57.74	PK	80.00	22.26	20.0	1000.000	160.0	H	70.0	18.3

Table 27: Results of emissions test from 1 GHz to 25 GHz on channel low of antenna port 1

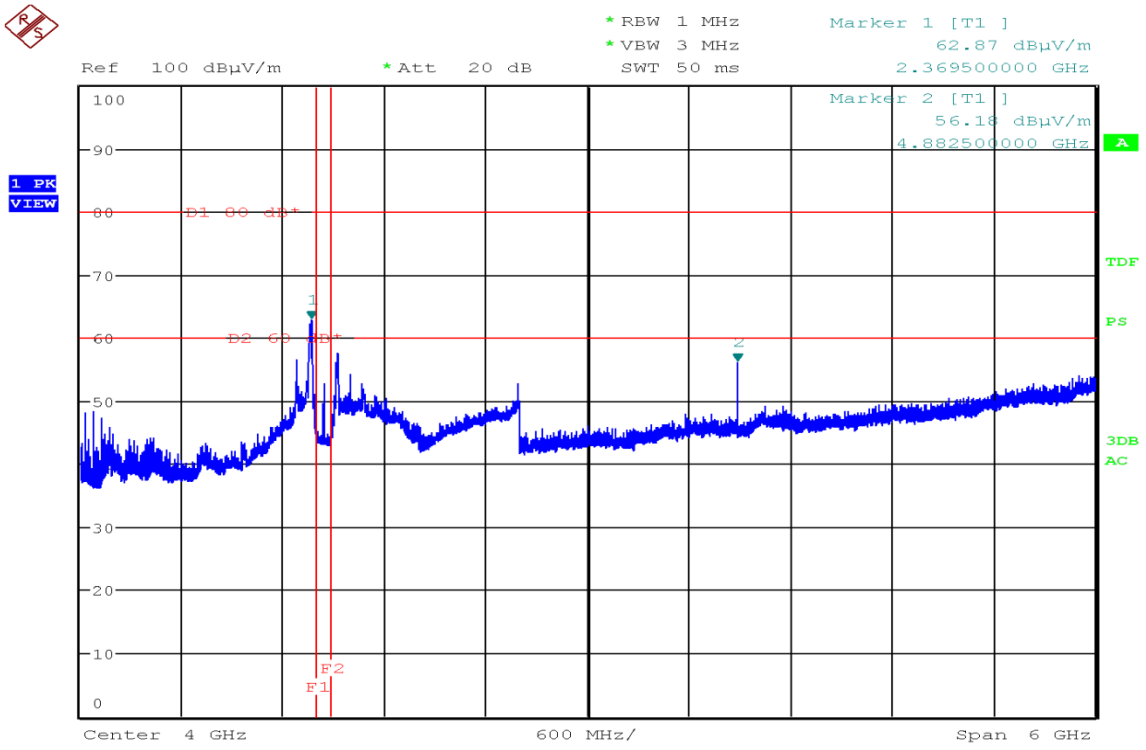

Figure 38: Chart of emissions test from 1 GHz to 7 GHz on channel middle of antenna port 1

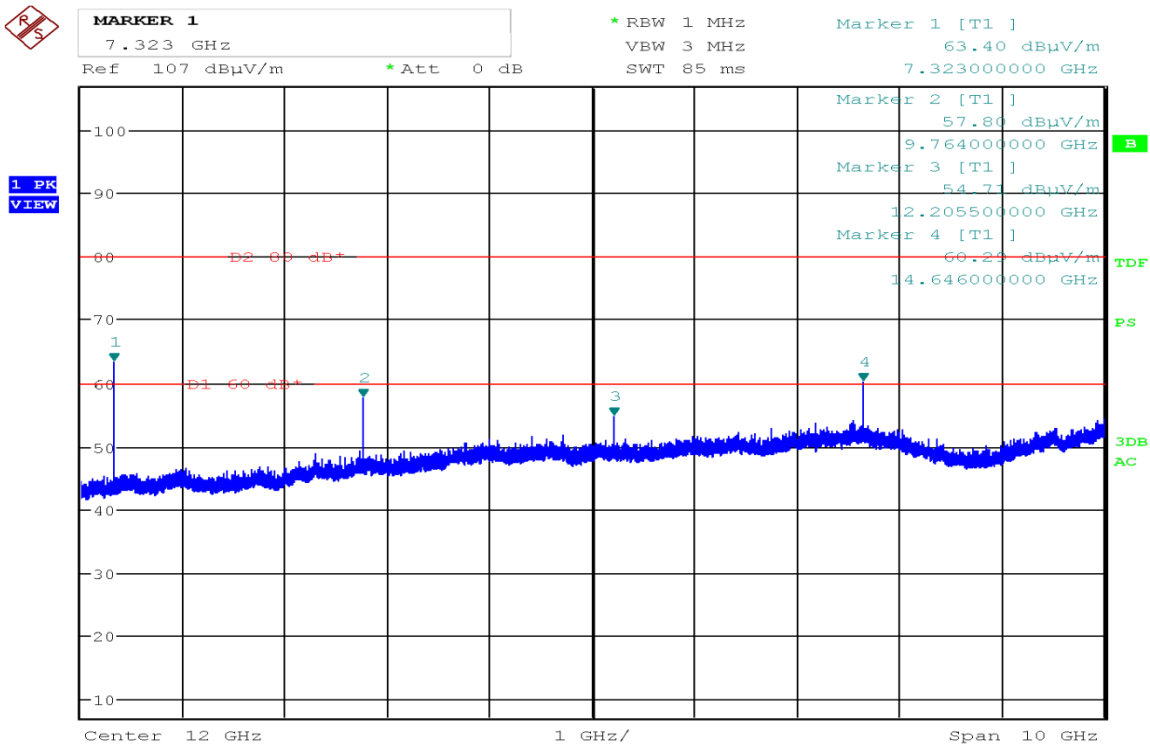

Figure 39: Chart of exploratory emissions test from 7 GHz to 17 GHz on channel middle of antenna port 1

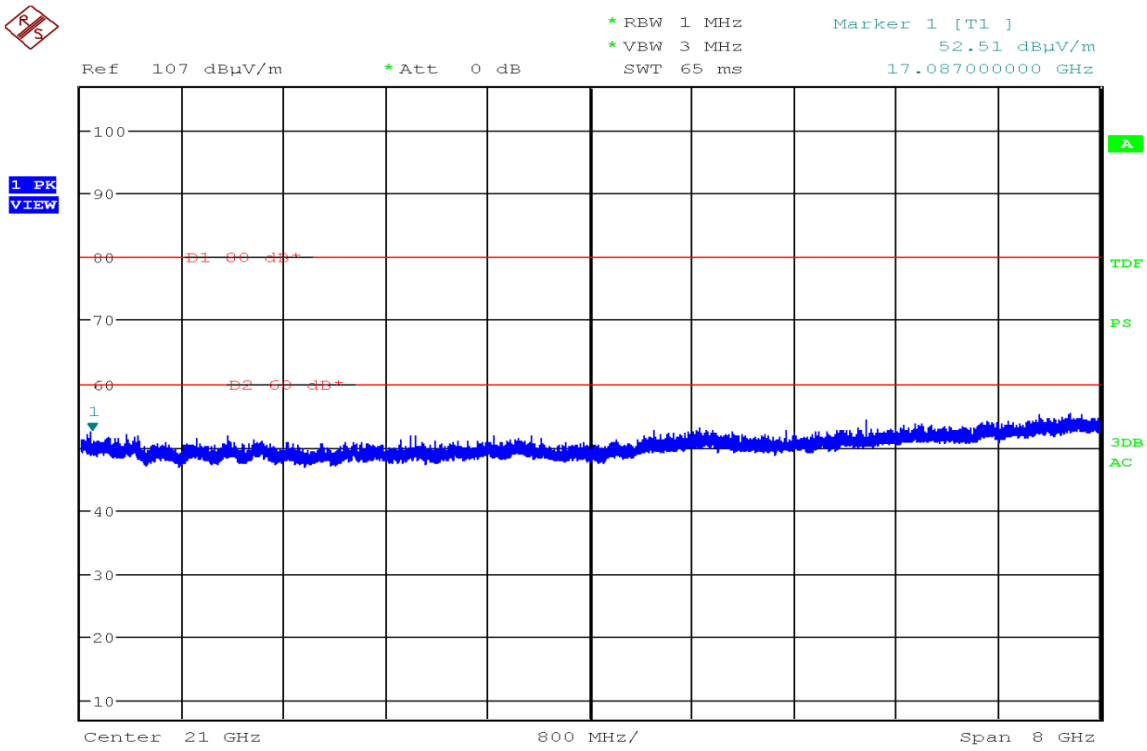

Figure 40: Chart of emissions test from 17 GHz to 25 GHz on channel middle of antenna port 1

Frequency (MHz)	*EUT Pos.*	*Level (dBµV/m)*	*Detector*	*Limit (dBµV/m)*	*Margin (dB)*	*Meas. Time (ms)*	*Bandwidth (kHz)*	*Height (cm)*	*Pol.*	*Azimuth (deg)*	*Corr. (dB/m)*
2369.175	Z	63.61	PK	80.00	16.39	2.50	1000.000	172.0	H	351.0	-3.1
2368.850	Z	54.19	AV	60.00	5.81	5.00	1000.000	172.0	H	351.0	-3.1
4881.851	Z	55.64	PK	80.00	24.36	20.0	1000.000	172.0	H	105.0	0.9
7323.000	Y	64.72	PK	80.00	15.28	20.0	1000.000	130.0	H	165.0	8.7
7323.000	Y	36.72[1]	AV	60.00	23.28	---	---	---	---	---	---
9763.875	Y	58.77	PK	80.00	21.23	20.0	1000.000	165.0	H	135.0	12.3
12205.125	Y	57.28	PK	80.00	22.72	20.0	1000.000	158.0	H	10.0	16.0
14645.750	Y	60.13	PK	80.00	19.87	20.0	1000.000	185.0	H	68.0	18.2
14646.000	Y	56.02	AV	60.00	3.98	500.0	1000.000	185.0	H	68.0	18.2

Table 28: Results of emissions test from 1 GHz to 25 GHz on channel middle of antenna port 1

Note 1: The average value is calculated as the difference between the peak value and the duty cycle correction factor which is determined as described in clause 4.2.2.

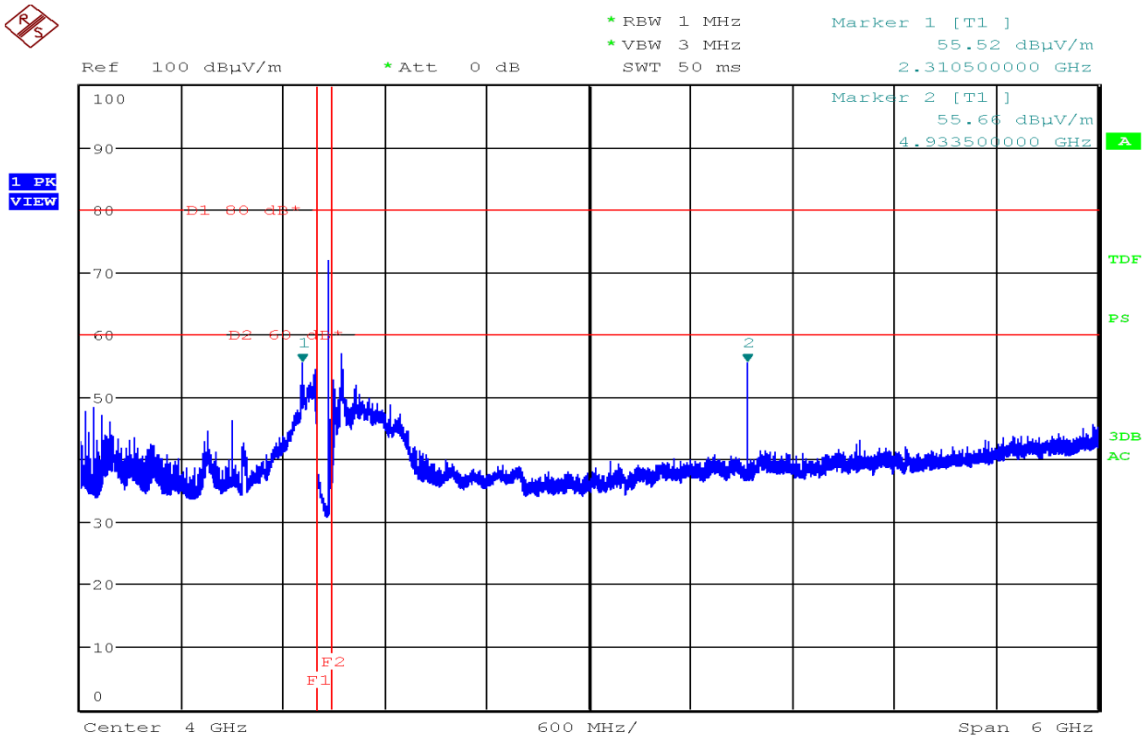

Figure 41: Chart of emissions test from 1 GHz to 7 GHz on channel high of antenna port 1

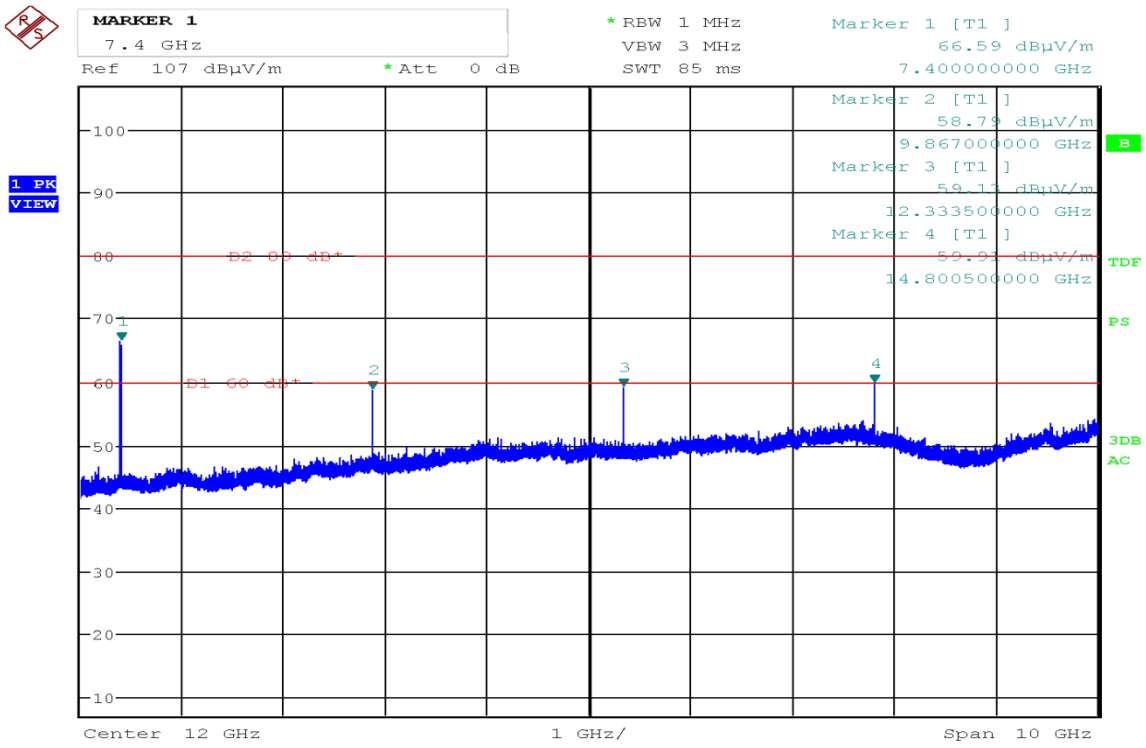

Figure 42: Chart of exploratory emissions test from 7 GHz to 17 GHz on channel high of antenna port 1

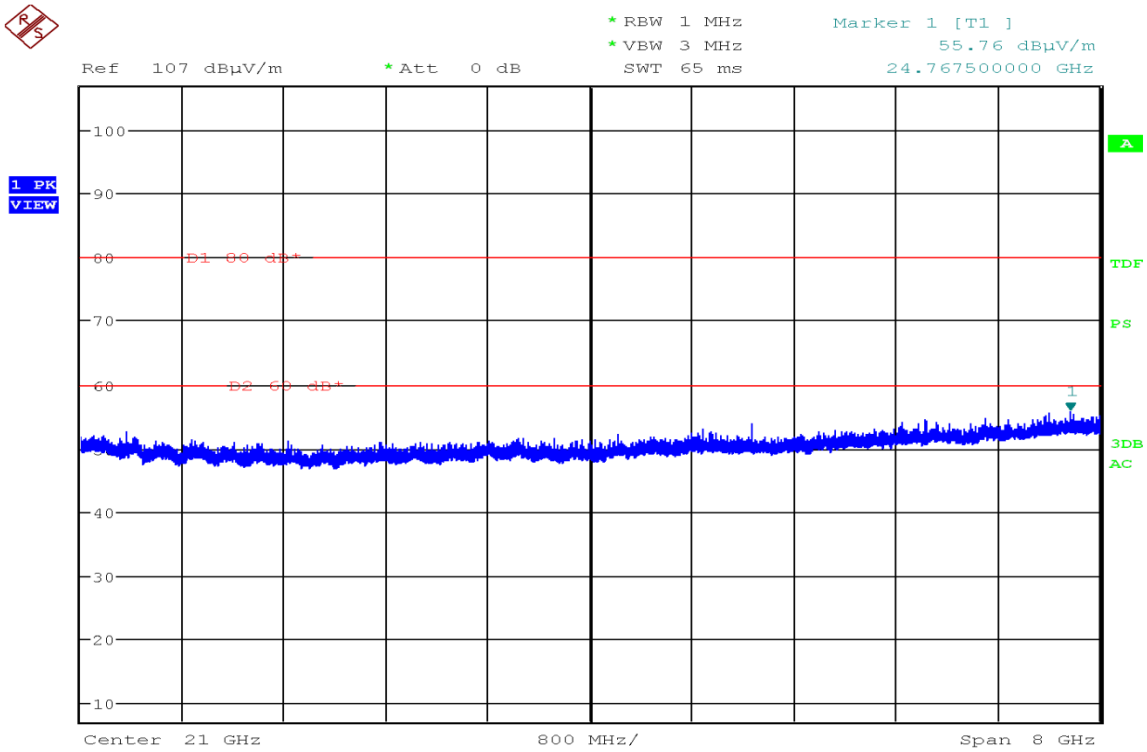

Figure 43: Chart of emissions test from 17 GHz to 25 GHz on channel high of antenna port 1

Frequency (MHz)	*EUT Pos.*	*Level (dBµV/m)*	*Detector*	*Limit (dBµV/m)*	*Margin (dB)*	*Meas. Time (ms)*	*Bandwidth (kHz)*	*Height (cm)*	*Pol.*	*Azimuth (deg)*	*Corr. (dB/m)*
2310.500	Z	55.48	PK	80.00	24.52	2.50	1000.000	185.0	H	4.0	-2.8
4933.500	Z	53.44	PK	80.00	26.56	20.0	1000.000	168.0	H	90.0	1.3
7400.000	Y	67.09	PK	80.00	12.91	20.0	1000.000	150.0	H	170.0	9.2
7400.000	---	39.09[1]	AV	60.00	20.91	---	---	---	---	---	---
9866.625	Y	60.37	PK	80.00	19.63	20.0	1000.000	165.0	H	130.0	12.6
9866.625	Y	58.27	AV	60.00	1.73	500.0	1000.000	165.0	H	130.0	12.6
12333.250	Y	59.45	PK	80.00	20.55	20.0	1000.000	155.0	H	90.0	15.7
14800.250	Y	60.69	PK	80.00	19.31	20.0	1000.000	190.0	H	135.0	17.6
14800.000	Y	57.19	AV	60.00	2.81	500.0	1000.000	190.0	H	135.0	17.6

Table 29: Results of emissions test from 1 GHz to 25 GHz on channel high of antenna port 1

Note 1: The average value is calculated as the difference between the peak value and the duty cycle correction factor which is determined as described in clause 4.2.2.

6.10.3.4.2 Antenna port 2

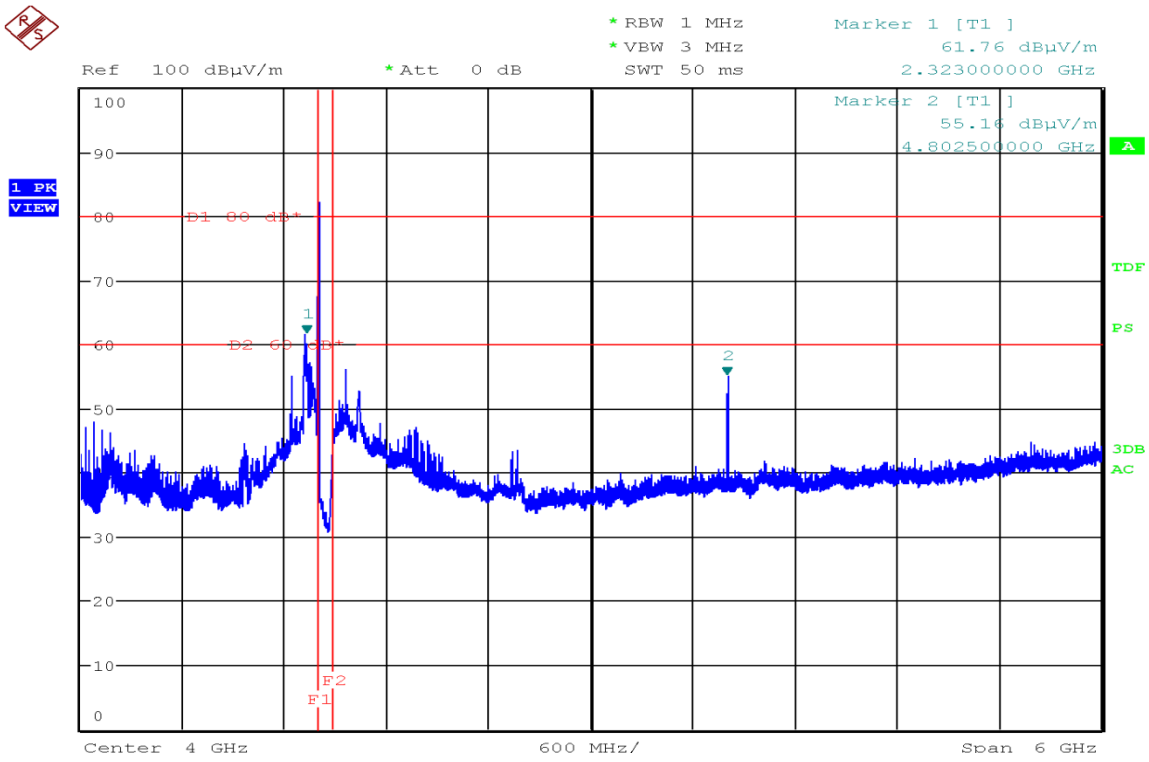

Figure 44: Chart of emissions test from 1 GHz to 17 GHz on channel low of antenna port 2

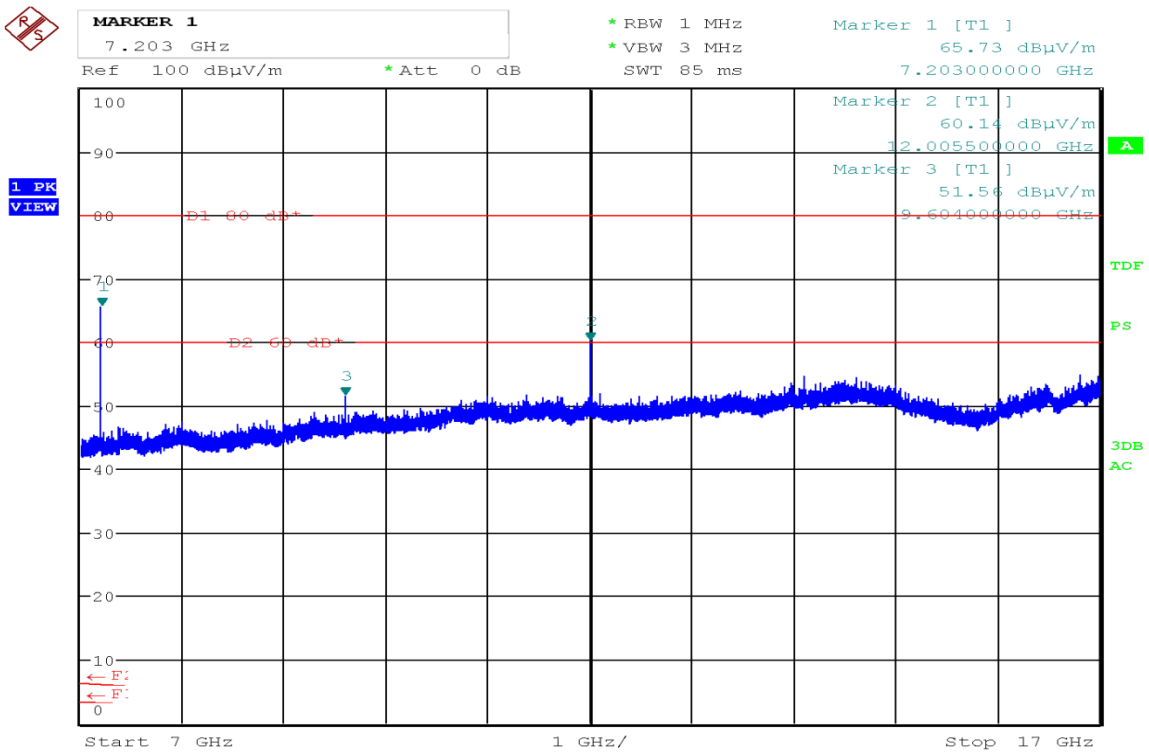

Figure 45: Chart of emissions test from 7 GHz to 17 GHz on channel low of antenna port 2

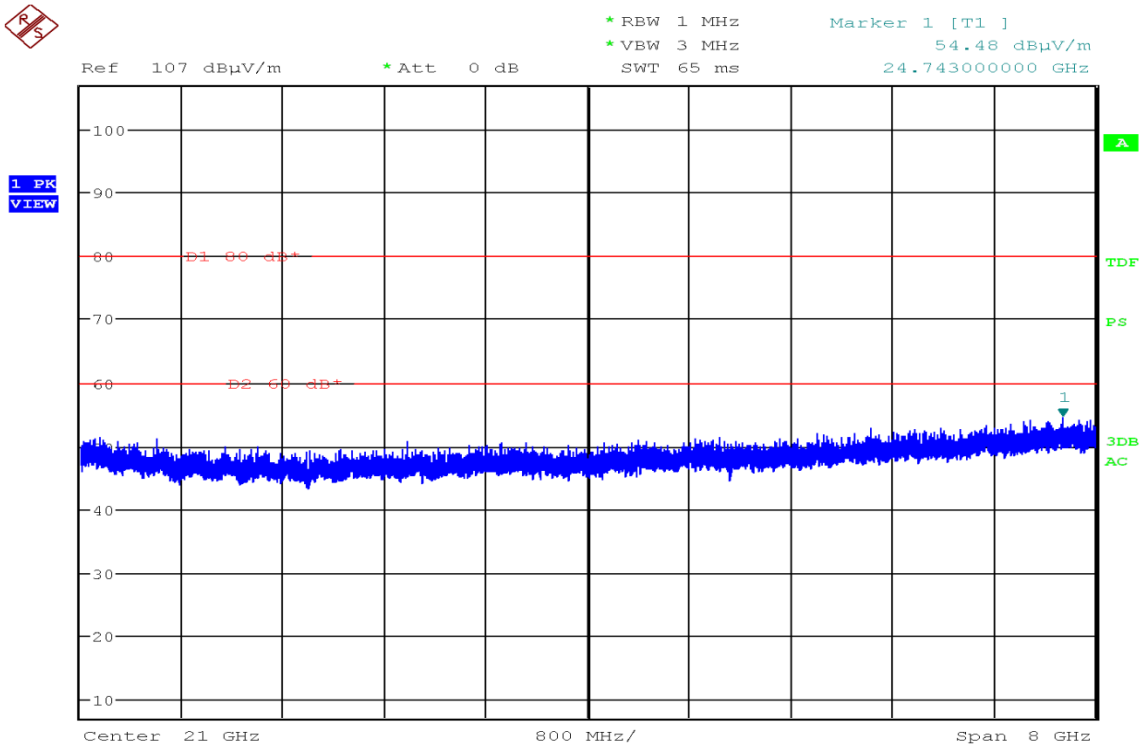

Figure 46: Chart of emissions test from 17 GHz to 25 GHz on channel low of antenna port 2

Frequency (MHz)	*EUT Pos.*	*Level (dBµV/m)*	*Detector*	*Limit (dBµV/m)*	*Margin (dB)*	*Meas. Time (ms)*	*Bandwidth (kHz)*	*Height (cm)*	*Pol.*	*Azimuth (deg)*	*Corr. (dB/m)*
2323.000	Z	62.26	PK	80.00	17.74	2.50	1000.000	175.0	H	360.0	-2.8
2323.000	Z	52.17	AV	60.00	7.83	5.00	1000.000	175.0	H	360.0	-2.8
4802.175	Z	55.68	PK	80.00	24.32	20.0	1000.000	168.0	H	115.0	1.1
7203.013	Y	64.48	PK	80.00	15.52	20.0	1000.000	200.0	H	215.0	8.9
9604.000	Y	52.24	PK	80.00	27.76	20.0	1000.000	200.0	H	75.0	11.6
12005.175	Y	61.13	PK	80.00	18.87	20.0	1000.000	200.0	H	210.0	15.4
12004.851	Y	59.21	AV	60.00	0.79	20.0	1000.000	200.0	H	210.0	15.4

Table 30: Results of emissions test from 1 GHz to 25 GHz on channel low of antenna port 2

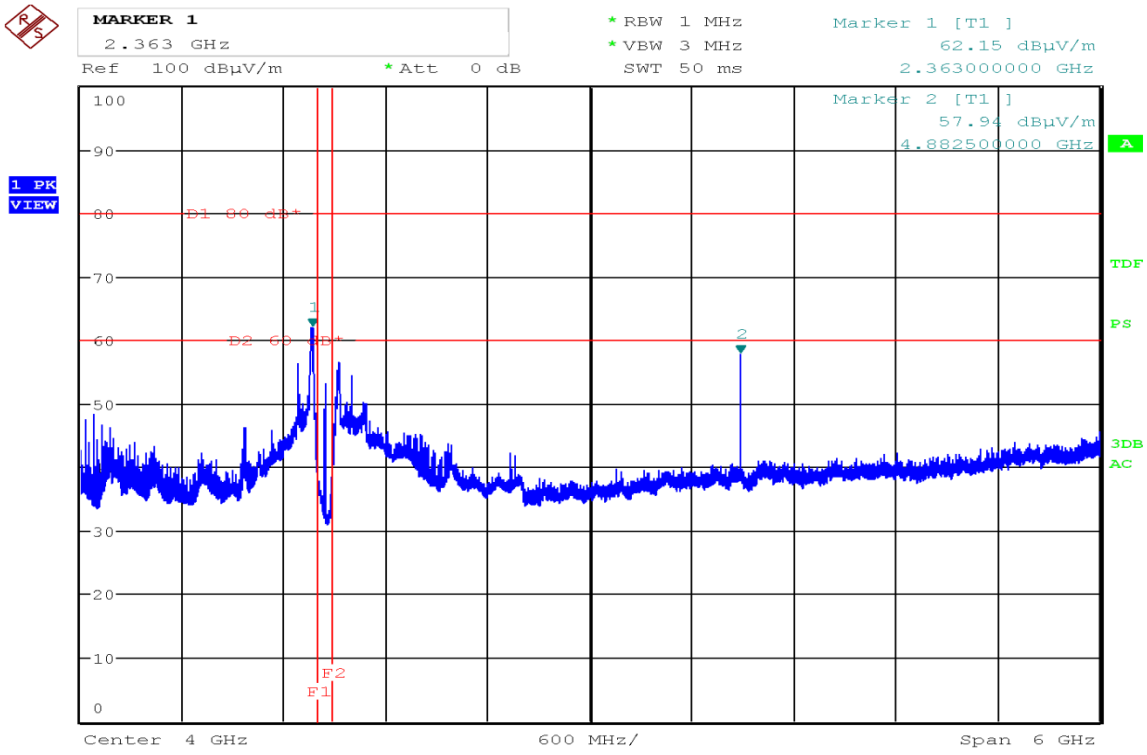

Figure 47: Chart of emissions test from 1 GHz to 7 GHz on channel middle of antenna port 2

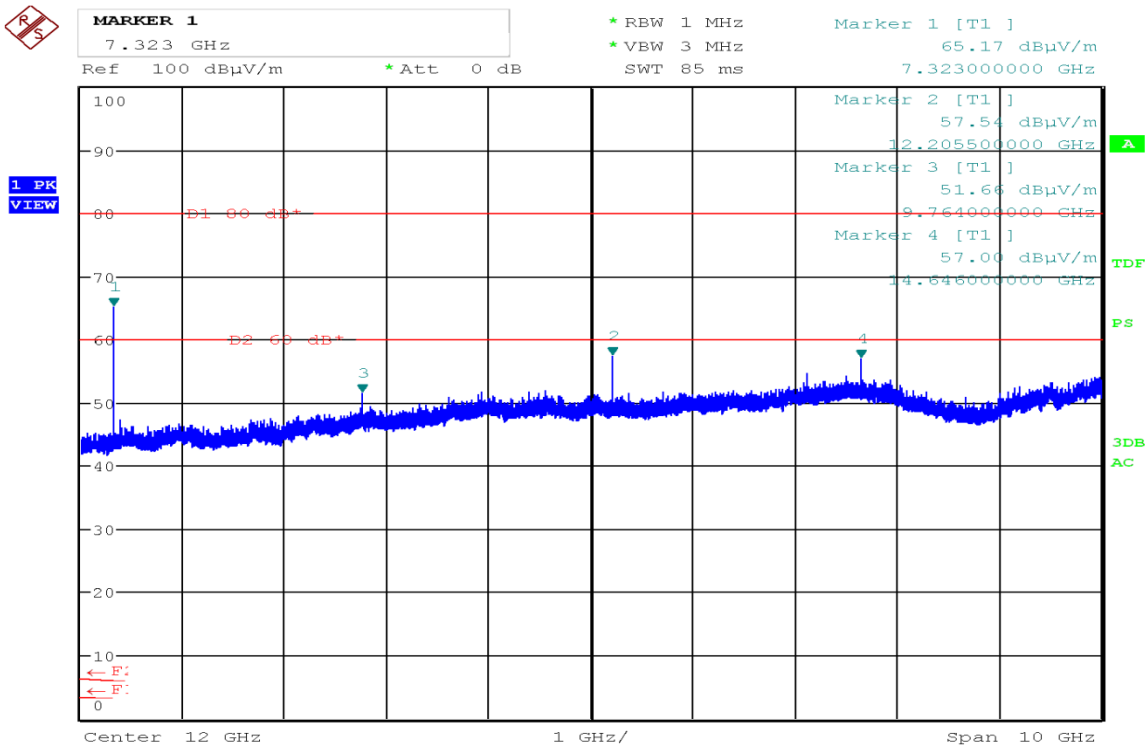

Figure 48: Chart of exploratory emissions test from 7 GHz to 17 GHz on channel middle of antenna port 2

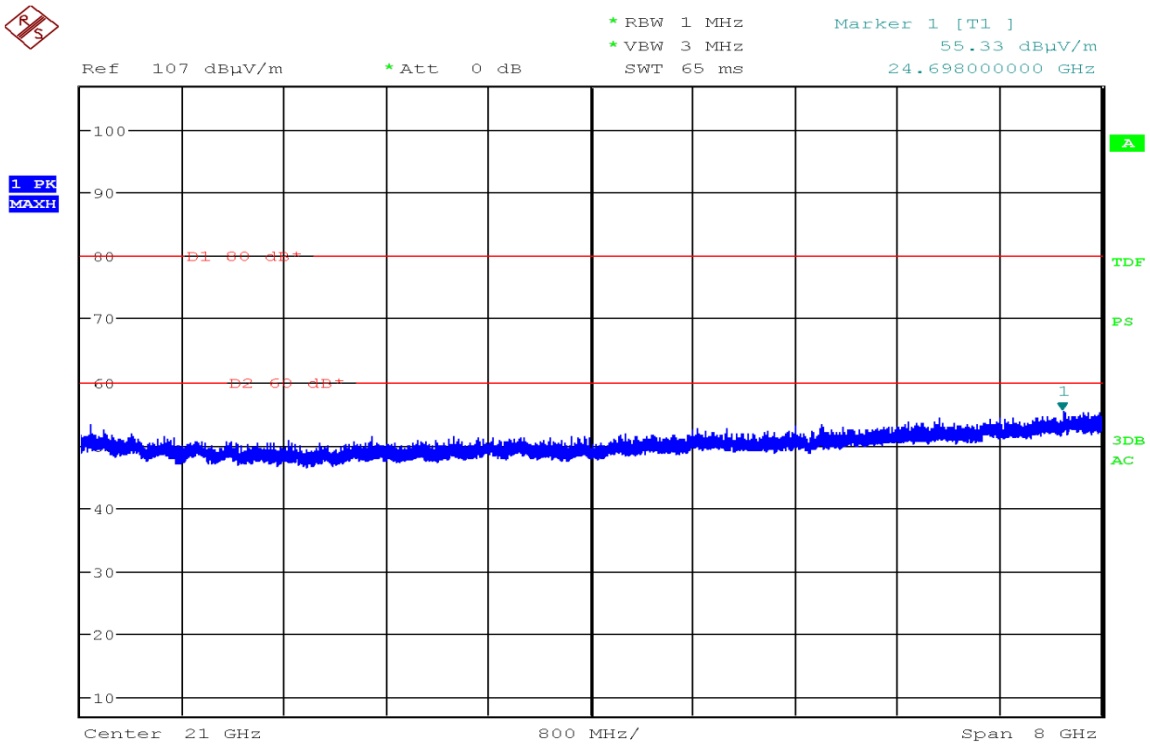

Figure 49: Chart of emissions test from 17 GHz to 25 GHz on channel middle of antenna port 2

Frequency (MHz)	*EUT Pos.*	*Level (dBµV/m)*	*Detector*	*Limit (dBµV/m)*	*Margin (dB)*	*Meas. Time (ms)*	*Bandwidth (kHz)*	*Height (cm)*	*Pol.*	*Azimuth (deg)*	*Corr. (dB/m)*
2369.494	Z	62.75	PK	80.00	17.25	2.50	1000.000	200.0	H	0	-3.1
2363.000	Z	53.66	AV	60.00	6.34	5.00	1000.000	200.0	H	0	-3.0
4881.851	Z	58.60	PK	80.00	21.4	20.0	1000.000	210.0	H	120.0	1.2
7323.000	Y	66.91	PK	80.00	13.09	20.0	1000.000	125.0	H	100.0	8.7
7323.000	Y	38.91[1]	AV	60.00	21.09	---	---	---	---	---	---
9764.000	Y	54.61	PK	80.00	25.39	20.0	1000.000	160.0	H	130.0	12.3
12204.851	Y	60.18	PK	80.00	19.82	20.0	1000.000	135.0	H	108.0	16.0
12204.851	Y	57.86	AV	60.00	2.14	20.0	1000.000	135.0	H	108.0	16.0
14646.000	Y	59.73	PK	80.00	20.27	20.0	1000.000	180.0	H	80.0	18.2

Table 31: Results of emissions test from 1 GHz to 25 GHz on channel middle of antenna port 2

Note 1: The average value is calculated as the difference between the peak value and the duty cycle correction factor which is determined as described in clause 4.2.2.

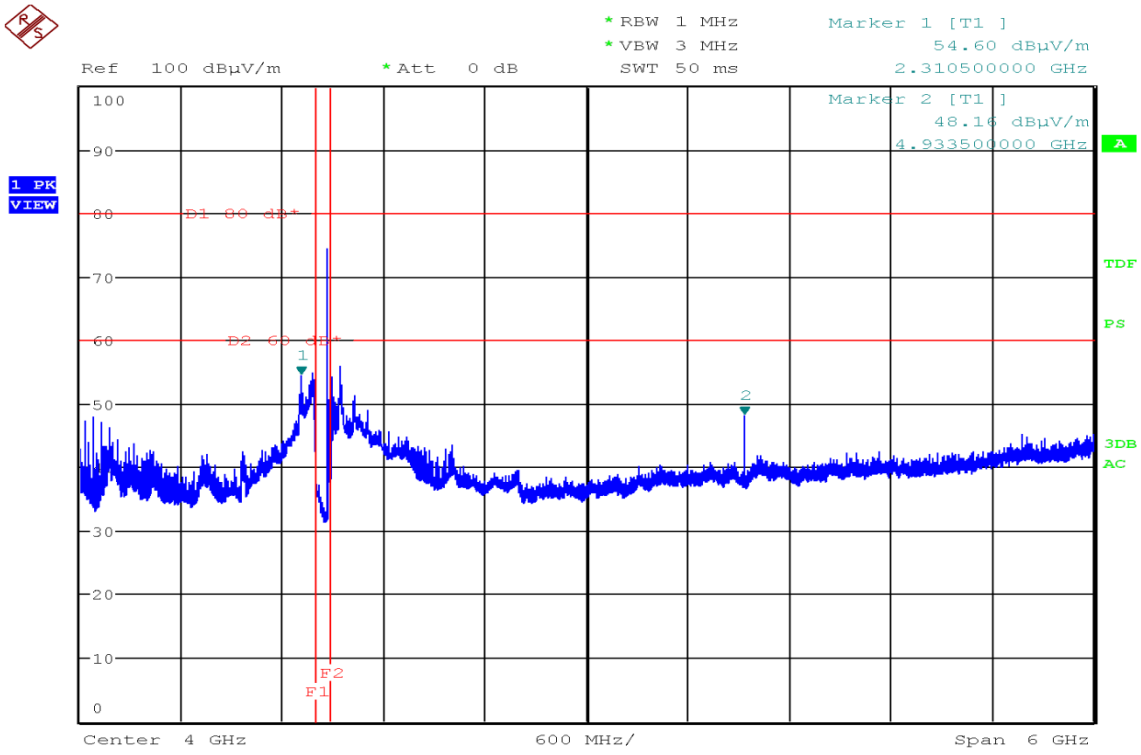

Figure 50: Chart of emissions test from 1 GHz to 7 GHz on channel high of antenna port 2

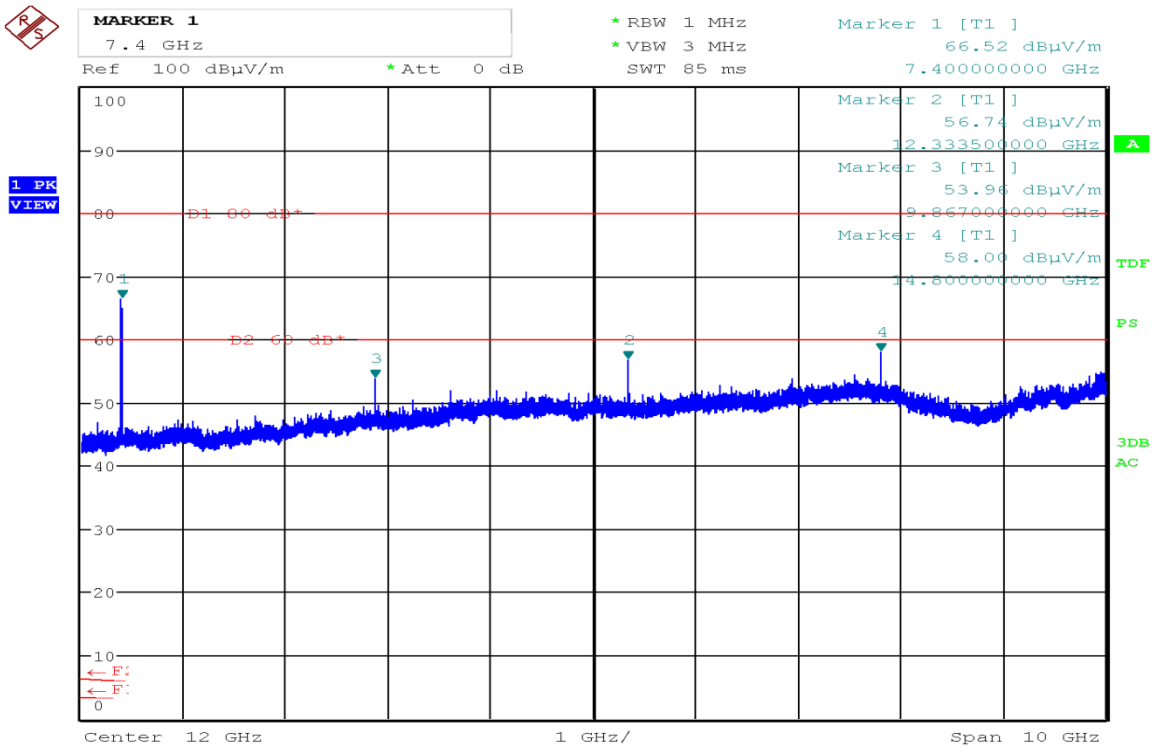

Figure 51: Chart of exploratory emissions test from 7 GHz to 17 GHz on channel high of antenna port 2

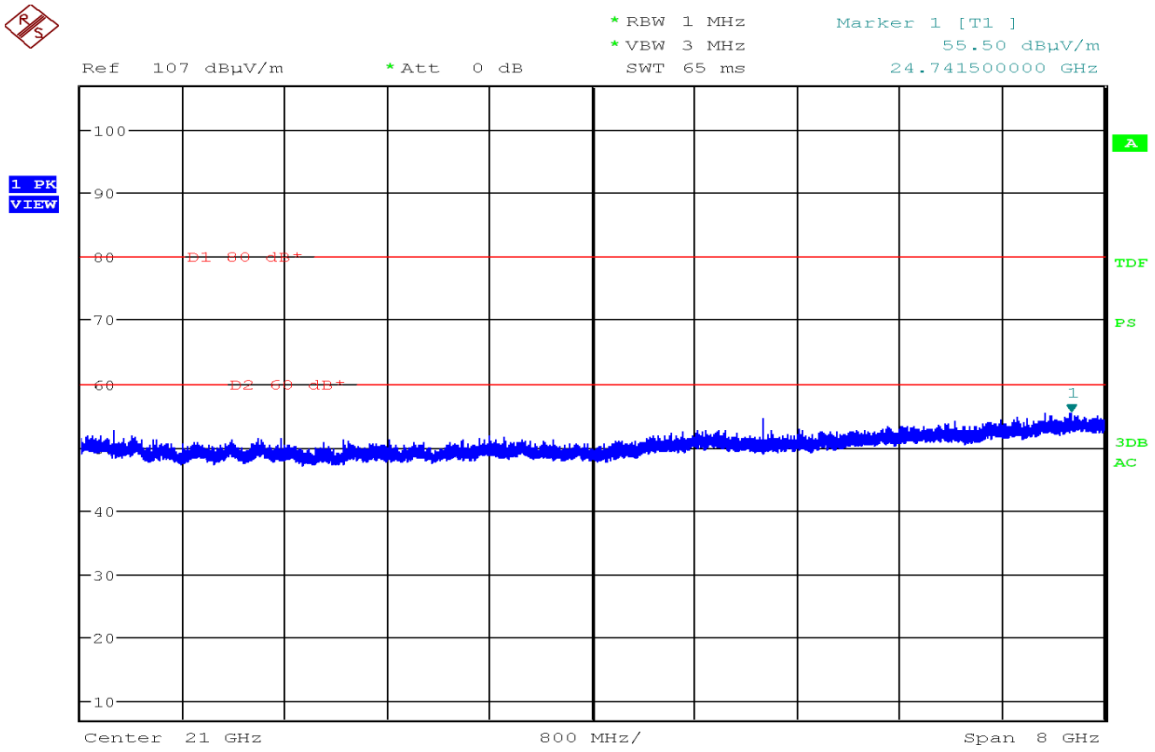

Figure 52: Chart of emissions test from 17 GHz to 25 GHz on channel high of antenna port 2

Frequency (MHz)	*EUT Pos.*	*Level (dBµV/m)*	*Detector*	*Limit (dBµV/m)*	*Margin (dB)*	*Meas. Time (ms)*	*Bandwidth (kHz)*	*Height (cm)*	*Pol.*	*Azimuth (deg)*	*Corr. (dB/m)*
2310.500	Z	55.49	PK	80.00	24.51	2.50	1000.000	165.0	H	355.0	-2.8
4933.175	Z	52.58	PK	80.00	27.42	20.0	1000.000	165.0	H	110.0	1.3
7400.000	Y	66.76	PK	80.00	13.24	20.0	1000.000	185.0	H	215.0	9.2
7400.000	---	38.76[1]	AV	60.00	21.24	---	---	---	---	---	---
9866.351	Y	56.10	PK	80.00	23.90	20.0	1000.000	185.0	H	105.0	12.6
12333.325	Y	59.36	PK	80.00	20.64	20.0	1000.000	185.0	H	215.0	15.7
14800.000	Y	59.25	PK	80.00	20.75	20.0	1000.000	180.0	H	87.0	17.6

Table 32: Results of emissions test from 1 GHz to 25 GHz on channel high of antenna port 2

Note 1: The average value is calculated as the difference between the peak value and the duty cycle correction factor which is determined as described in clause 4.2.2.

6.11 Radio frequency radiation exposure evaluation for portable devices

Section(s) in 47 CFR Chapter I:	Requirement(s):	1.1310, 2.1093, 15.247(i)
	Reference(s):	KDB 447498 D01, section 7
Section(s) in RSS:	Requirement(s):	RSS-Gen, section 3.4
	Reference(s):	RSS-102, section 2.5.2

Result:	☒ Test passed	☐ Test not passed

Note: The radio frequency radiation exposure evaluation is described in test report 171026-AU02+W03.

7 Equipment calibration status

Description	*Modell number*	*Serial number*	*Inventory number(s)*	*Last calibration*	*Next calibration*
EMI test receiver	ESW44	101538	E00895	2018-04	2019-04
EMI test receiver	ESR7	101059	E00739	2018-05	2019-05
Preamplifier (1 GHz - 18 GHz)	ALS05749	001	W01007	2019-01	2020-01
Preamplifier (0.5 GHz – 18 GHz)	BBV 9718 B	00032	W01325	2018-09	2019-09
Preamplifier (18 GHz – 40 GHz)	BBV 9721	9721-043	W01350	2018-11	2019-11
Loop antenna	HFH2-Z2	871398/0050	E00060	2018-10	2020-10
TRILOG broadband antenna (SAC3)	VULB 9162	9162-041	E00643	2018-03	2021-03
Horn antenna	BBHA 9120D	9120D-592	W00052	2017-04	2020-04
Horn antenna	BBHA 9170	9170-332	W00054	2017-04	2020-04
Horn antenna	BBHA 9170	9170-332	W01350	2018-11	2019-11
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	2018-03	2021-03
Semi-anechoic chamber (SAC)	SAC3	C62128-A520-A643-x-0006	E00716	2018-03	2021-03
Cable set CDC	RG214/U	---	E00446	2018-04	2019-04
	LCF12-50J	---	E01215	2018-04	2019-04
	LMR400	1718020006	E00920	2019-01	2020-01
	RG214 Hiflex	171802007	E00921	2019-01	2020-01
Cable set anechoic chamber	262-0942-1500	005	E00435	2018-10	2019-10
	SF104EA/2x11PC35-42/5m	11144/4EA	E00307	2018-12	2019-12
	262-0942-1500	003	E00433	2018-10	2019-10
Cable set of semi-anechoic chamber SAC3	SF104EA/11PC35/11PC35/10000MM	501347/4EA	E00755	2018-12	2019-12
	SF104E/11PC35/11PC35/2000MM	507410/4E	E01033	2018-12	2019-12
	SF104E/11PC35/11PC35/2000MM	507411/4E	E01034	2018-09	2019-09

Note 1: Industry Canada (test sites number 3472A-1 and 3472A-2): 2019-06
Note 2: Expiration date of test firm accreditation for SAC:
FCC test firm type “accredited”: 2019-05

8 Measurement uncertainties

Description	*Uncertainty*	*k=*
AC power line conducted emission	± 4.1 dB	2
Carrier frequency separation Number of hopping frequencies Time of occupancy (dwell time)	± 5.0 %	2
Bandwidth tests	± 2.0 %	
Maximum conducted output power (conducted)	± 1.5 dB	
Power spectral density (conducted)	± 2.9 dB	
Conducted spurious emissions	± 2.9 dB	
Radiated emissions in semi-anechoic chamber		
9 kHz to 30 MHz	± 4.8 dB	2
30 MHz to 300 MHz	± 5.4 dB	2
300MHz to 1 GHz	± 4.7 dB	2
Radiated emissions in semi-anechoic chamber with RF absorbing material on the floor or fully anechoic room		
1 GHz to 25 GHz	± 4.5 dB	2

Comment: 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.

Test related measurement uncertainties have to be taken into consideration when evaluating the test results. All used test instrument as well as the test accessories are calibrated at regular intervals.

9 Revision history

Revision	*Date*	*Issued by*	*Description of modifications*
0	2019-04-08	Jennifer Riedel	First edition