Test report

Customer:

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RF test report

180645-AU01+W01

The Nielsen Company

BLE module 2.4 GHz

Motion Detector

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

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

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1 Summary of test results

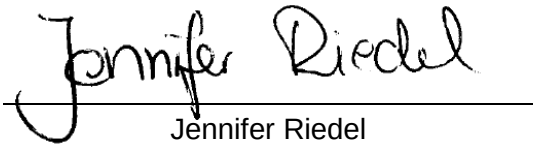
System type: Digital transmission system (DTS)

47 CFR part and section	*Test*	*Page*	*Result*	*Note(s)*
15.207	AC power line conducted emissions 150 kHz to 30 MHz	---	Not applicable	1,5
15.247(a)(1) KDB 558074, section 8.2	20 dB bandwidth	---	Not applicable	2
15.247(a)(2) KDB 558074, section 8.2	6 dB bandwidth	27	Passed	3
2.202(a) ANSI C63.10	Occupied bandwidth (99 %)	31	For reference only	3
15.247(b) KDB 558074, section 8.3	Conducted output power	35	Passed	---
15.247(e) KDB 558074, section 8.4	Power spectral density	39	Passed	---
15.247(d) KDB 558074, sections 8.5 & 8.6	Antenna-port conducted measurements	---	Not applicable	4, 6
15.247(d) KDB 558074, section 13	Band-edge compliance	43	Passed	---
15.247(d) KDB 558074, sections 11 & 12	Emissions outside the operating frequency band(s) specified 9 kHz to 10th harmonic			
	9 kHz to 30 MHz	48	Passed	---
	30 MHz to 1 GHz	52	Passed	---
	1 GHz to 10th harmonic	56	Passed	---
2.109	Human exposure evaluation	70	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”).
5 EUT is DC supplied.
6 Antenna port is only temporary, so the conducted spurious emissions are shown in clause 6.6.

Straubing, April 1, 2019



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Test engineer
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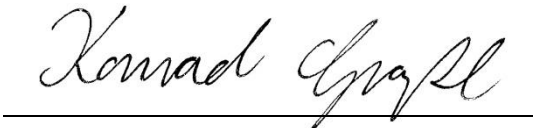

Konrad Graßl
Head of radio department
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2 Referenced publications

Publication	*Title*
CFR 47 Part 2 October 2017	Code of Federal Regulations, Title 47 (Telecommunication), Part 2 (Frequency allocation and radio treaty matters; General rules and regulations) of the Federal Communication Commission (FCC)
CFR 47 Part 15 October 2017	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 August 24, 2018	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS), Frequency Hopping Spread Spectrum Sytem, and Hybrid System Devices Operating Under §15.247 of the FCC Rules
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

3 Equipment under test (EUT)

All Information in this clause is declared by customer.

3.1 General information

Product type:	BLE module 2.4 GHz		
Model name:	Motion Detector		
Serial number(s):	prototype		
Applicant:	The Nielsen Company		
Manufacturer:	The Nielsen Company		
Version:	Hardware:	REV 5	
	Software:	S132 v5.0.0	
Additional modifications:	None		
FCC ID:	2ASUZ003		
Power supply:	DC supply		
	Nominal voltage:	3.3 V	
Temperature range:	0 °C to +40 °C (customer defined)		
Device type:	☒ Portable	☐ Mobile	☐ Fixed

3.2 Radio specifications

System type[1]:	Digital transmission system (DTS)		
Application frequency band:	2400.0 MHz - 2483.5 MHz		
Frequency range used:	2402.0 MHz - 2480.0 MHz		
Operating frequencies:	2402.0 MHz - 2480.0 MHz		
Short description:	The EUT is a motion detector module using Bluetooth Low Energy (BLE) technique in the 2.4 GHz band.		
Antenna:	Type:	Chip antenna	
	Manufacturer:	Johanson Technology	
	Part number:	2450AT18B100	
	Gain:	0.5 dBi (maximum)	
	Connector:	☐ external	☐ internal
		☐ temporary	☒ none (integral antenna)
		Note: The antenna connector is only temporary.	

[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:	2402 MHz to 2480 MHz
Number of RF channels:	40
Channel spacing:	2 MHz
Modulation:	GFSK

Channel no.	Operating frequency	Test(s) performed	Channel no.	Operating frequency	Test(s) performed
0	2402 MHz	☒	20	2442 MHz	☒
01	2404 MHz	☐	21	2444 MHz	☐
02	2406 MHz	☐	22	2446 MHz	☐
03	2408 MHz	☐	23	2448 MHz	☐
04	2410 MHz	☐	24	2450 MHz	☐
05	2412 MHz	☐	25	2452 MHz	☐
06	2414 MHz	☐	26	2454 MHz	☐
07	2416 MHz	☐	27	2456 MHz	☐
08	2418 MHz	☐	28	2458 MHz	☐
09	2420 MHz	☐	29	2460 MHz	☐
10	2422 MHz	☐	30	2462 MHz	☐
11	2424 MHz	☐	31	2464 MHz	☐
12	2426 MHz	☐	32	2466 MHz	☐
13	2428 MHz	☐	33	2468 MHz	☐
14	2430 MHz	☐	34	2470 MHz	☐
15	2432 MHz	☐	35	2472 MHz	☐
16	2434 MHz	☐	36	2474 MHz	☐
17	2436 MHz	☐	37	2476 MHz	☐
18	2438 MHz	☐	38	2478 MHz	☐
19	2440 MHz	☐	39	2480 MHz	☒

Table 1: Radio specifications of EUT

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			
BLE module 2.4 GHz	Motion Detector	prototype	The Nielsen Company.
Support equipment			
USB bridge	---	---	The Nielsen Company
Notebook	Lifebook A557	E001053	FUJITSU
Power supply for notebook	ADP-65JHAB	E001053	FUJITSU

Table 2: Devices used for testing

Port	*Classification (see note 1)*	*Cable type*	*Fixed*	*Cable length*		*Note*
				used	*maximum*	
U.FL antenna port	Antenna cable	Unshielded	☐	0.08 m	---	
Power and data connector (6 pins)	DC power and Signal/control	Unshielded	☐	0.20 m	---	2

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 The connector is used for power supply and configuration.

[2] As specified by manufacturer.

4.2 Mode of operation

4.2.1 Test software used for all tests

The test software is part of the firmware of the EUT. It is controlled via the UART bridge. As shown in Figure 1, the software nRFgo Studio is used.

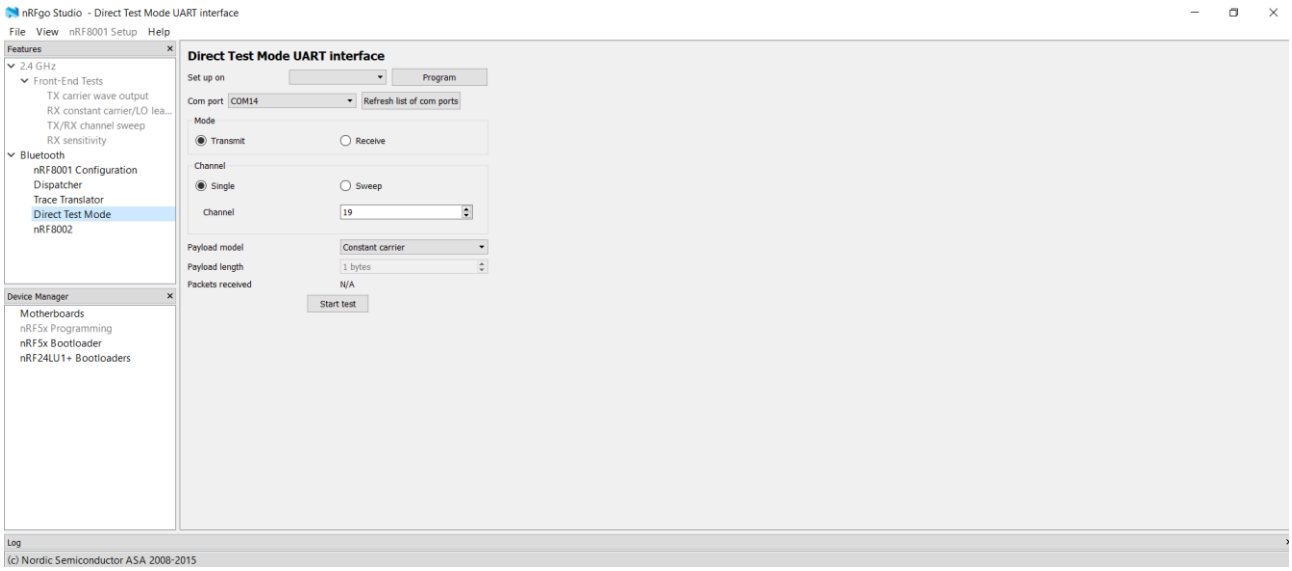


Figure 1: Used test software

Besides selecting the mode (Transmit or receive) the appropriate channel can be chosen from 0 to 39. For modulated signal, the Payload model “PRBS9” is used. After pressing “Start test” the EUT starts to transmit or receive on the selected channel.

4.2.2 Test modes applied

For the measurements the testing mode “PBRS9” for modulated TX carrier is used with the carrier frequency set to the appropriate channel using “Ch = 0”, “Ch = 20” or “Ch = 39”, as applicable. For further details see clause 4.2.1.

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

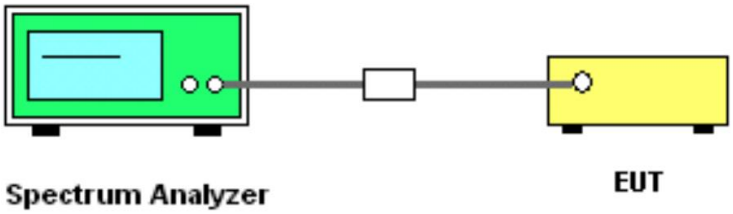


Figure 2: Setup for antenna-port conducted measurements

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), the test equipment is configured according to Public Notice DA 00-705, for 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 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.

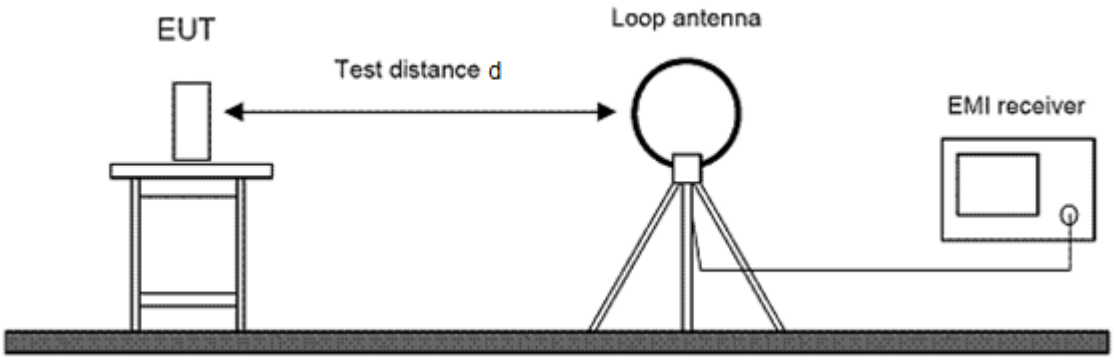


Figure 3: Setup for radiated emissions test below 30 MHz

5.4 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.

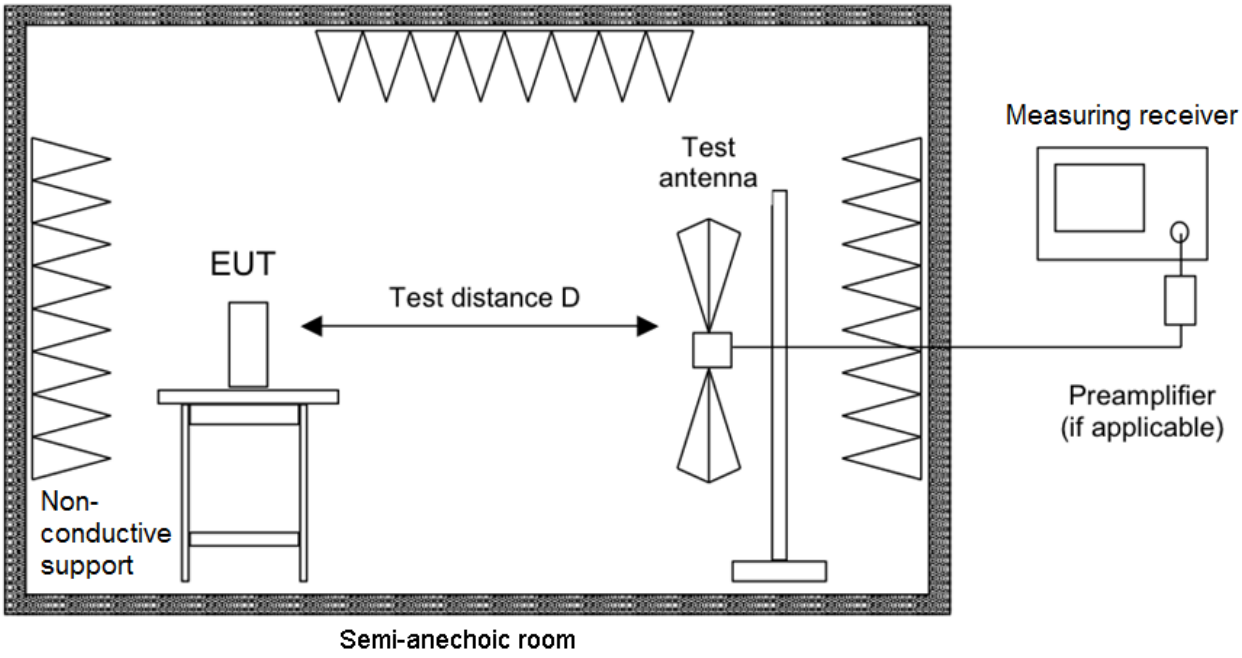


Figure 4: Setup for radiated emissions test from 30 MHz to 1 GHz

5.5 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

5.5.1 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.

5.5.2 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.

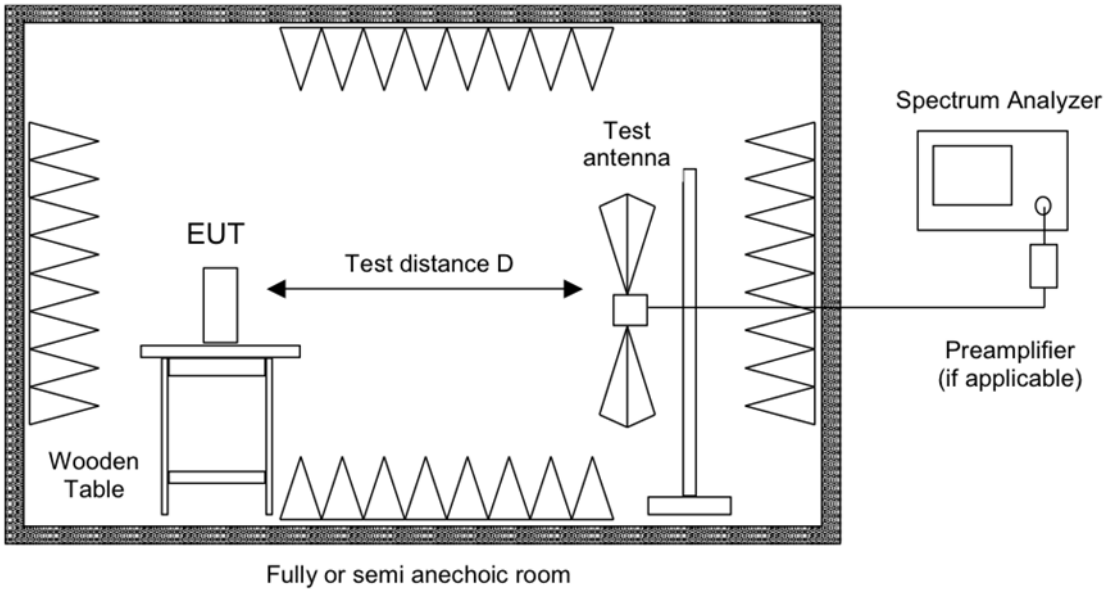


Figure 5: Setup for radiated emissions test above 1 GHz

5.6 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

5.6.1 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.

5.6.2 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.

5.6.3 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.

5.7 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

5.7.1 Digital transmission systems (DTS)

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

The spectrum analyzer settings are as follows:

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

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

5.8 Power spectral density

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

The spectrum analyzer settings are as follows:

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

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

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

The power spectral density is required for digital transmission systems (DTS), only. It does not apply to frequency hopping systems (FHSS).

6 Test results

This clause gives details about the test results as collected in the summary of test results on page 6.

6.1 6 dB bandwidth

Section(s) in 47 CFR Part 15: Requirement(s): 15.215(c), 15.247(a)(2)
Reference(s): KDB 558074 D01, section 8

Performed by:	Jennifer Riedel	Date(s) of test:	31/01/2019
Climatic conditions:	Ambient temperature 22.1 °C	Relative humidity 41.1 %	Barometric pressure 978.3 hPa
Result[3]:	☒ Test passed	☐ Test not passed	

6.1.1 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

[3] For information about measurement uncertainties see page 72.

6.1.2 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 bandwidth of the emission 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.

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. The minimum 6 dB bandwidth shall be at least 500 kHz.

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

6.1.3 Test procedure

The 6 dB bandwidth is measured using the test procedure as described in clause 5.6.2 and referring to the

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

6.1.4 Test results

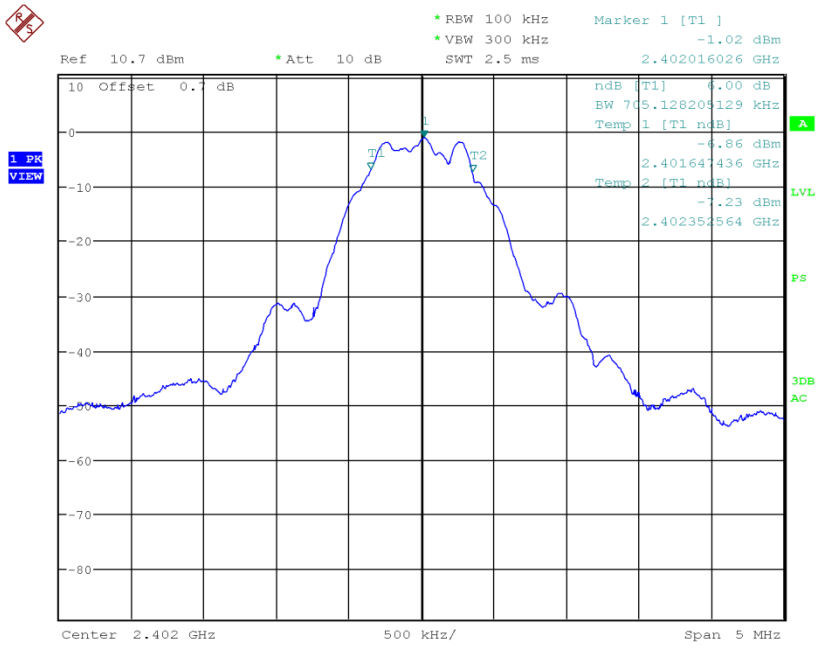


Figure 6: Chart of 6 dB bandwidth test on channel 0

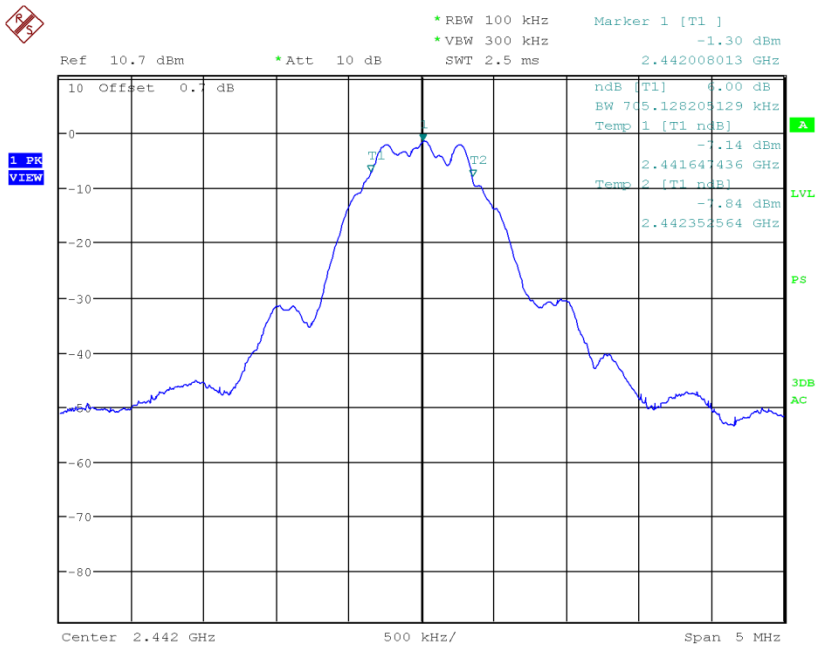


Figure 7: Chart of 6 dB bandwidth test on channel 20

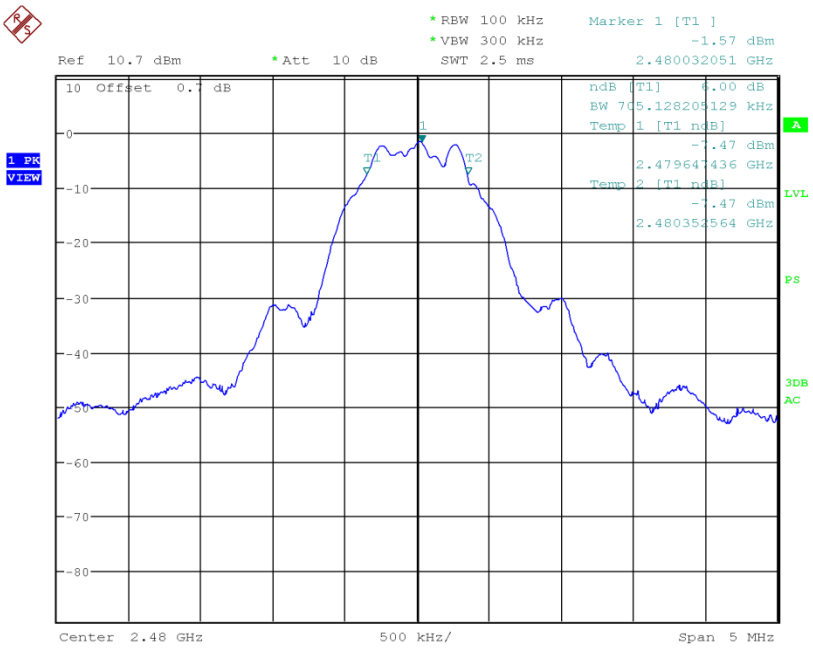


Figure 8: Chart of 6 dB bandwidth test on channel 39

Channel	*6 dB bandwidth*		*Band edge left*		*Band edge right*		*Result*
	Value [kHz]	*Limit [kHz]*	*Frequency [MHz]*	*Limit [MHz]*	*Frequency [MHz]*	*Limit [MHz]*	
0	705.128	≥ 500	2401.64744	2400.0	2402.35256	2483.5	Passed
20	705.128	≥ 500	2441.64744	2400.0	2442.35256	2483.5	Passed
39	705.128	≥ 500	2479.64744	2400.0	2480.35256	2483.5	Passed

Table 9: Results of 6 dB channel bandwidth test

6.2 Occupied bandwidth

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

Performed by:	Jennifer Riedel	Date(s) of test:	31/01/2019
Climatic conditions:	Ambient temperature 22.1 °C	Relative humidity 41.1 %	Barometric pressure 978.3 hPa
Result[4]:	☒ 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
☐	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 72.

6.2.2 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.

6.2.3 Test procedure

The occupied bandwidth is measured using the test procedure as described in clause 5.6.3 and referring to the

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

6.2.4 Test results

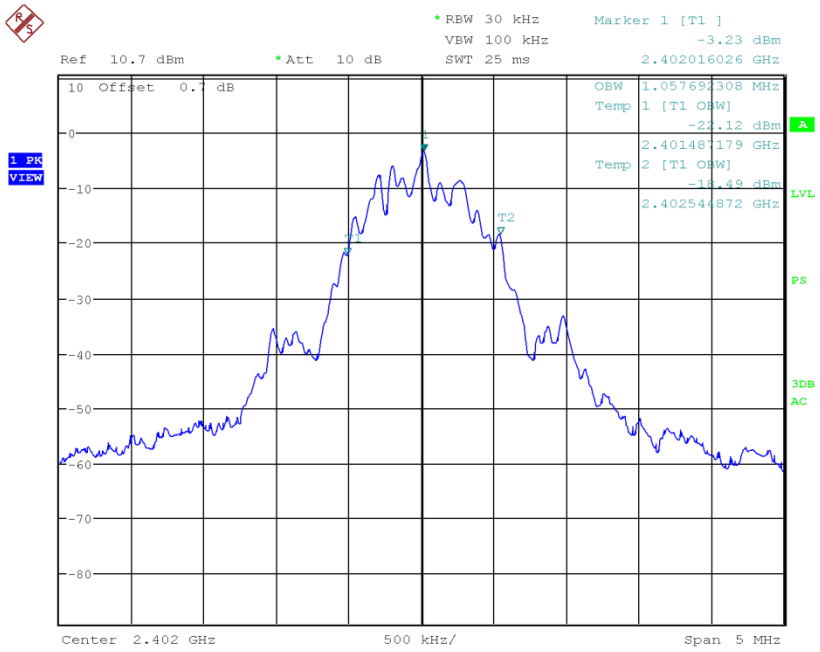


Figure 9: Chart of occupied bandwidth test on channel 0

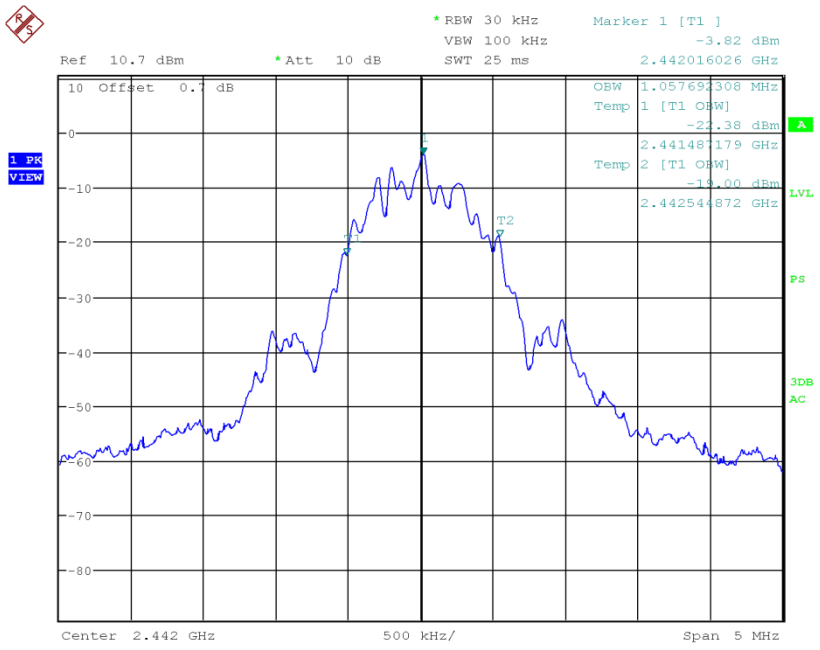


Figure 10: Chart of occupied bandwidth test on channel 20

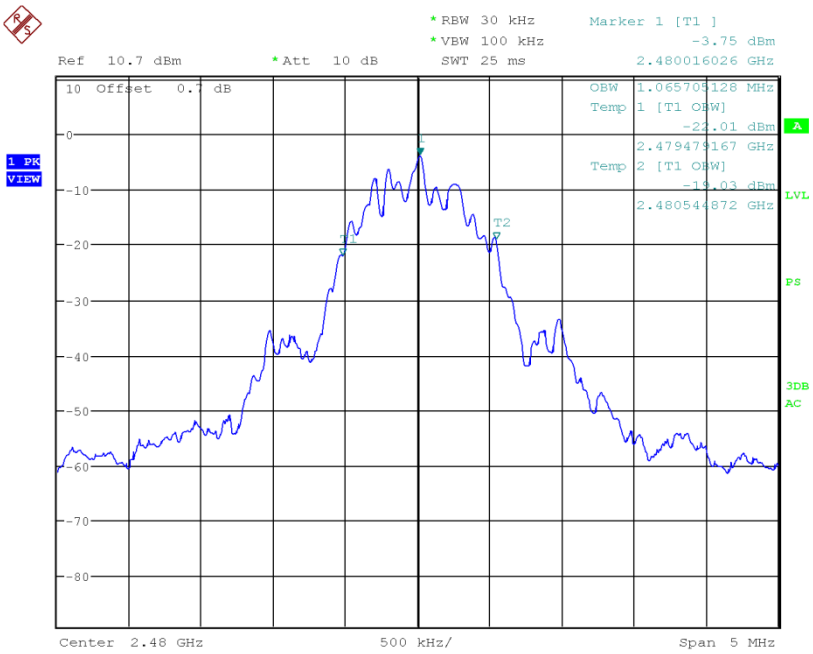


Figure 11: Chart of occupied bandwidth test on channel 39

Channel	*99 % occupied bandwidth [kHz]*	*Result*
0	1057.692	Recorded
20	1057.692	Recorded
39	1065.705	Recorded

Table 10: Results of occupied bandwidth test

6.3 Conducted output power

Section(s) in 47 CFR Part 15: Requirement(s): 15.247(b)
Reference(s): KDB 558074 D01, section 9

Performed by:	Jennifer Riedel	Date(s) of test:	31/01/2019
Climatic conditions:	Ambient temperature 22.1 °C	Relative humidity 41.1 %	Barometric pressure 978.3 hPa
Result[5]:	☒ 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

[5] For information about measurement uncertainties see page 72.

6.3.2 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.

6.3.3 Test procedure

The maximum peak conducted output power 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 5.5.

6.3.4 Test results

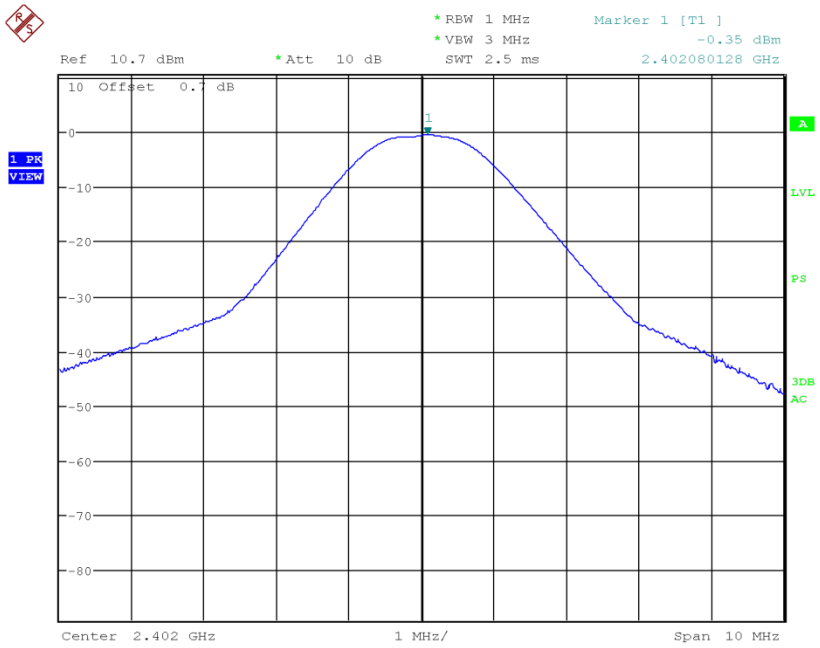


Figure 12: Chart of conducted output power on channel 0

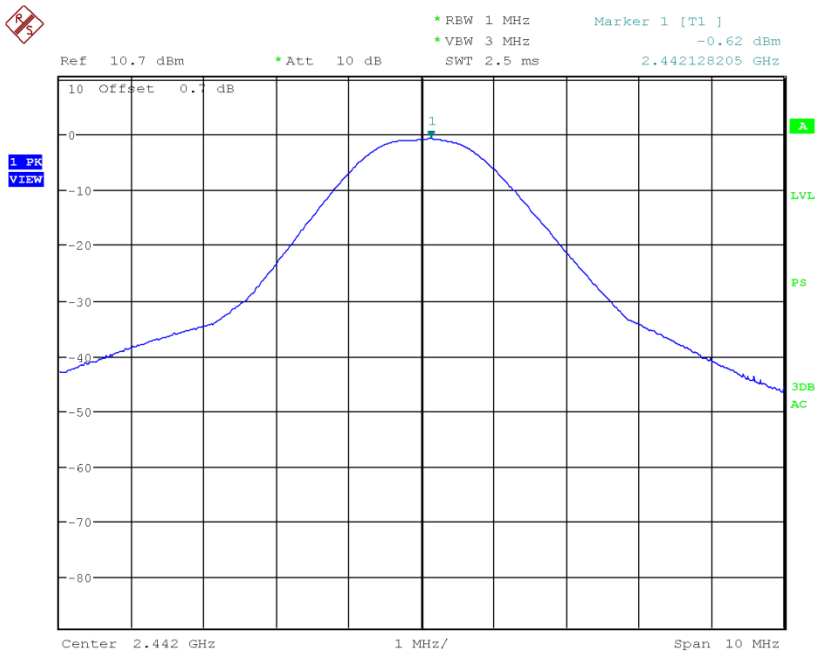


Figure 13: Chart of conducted output power on channel 20

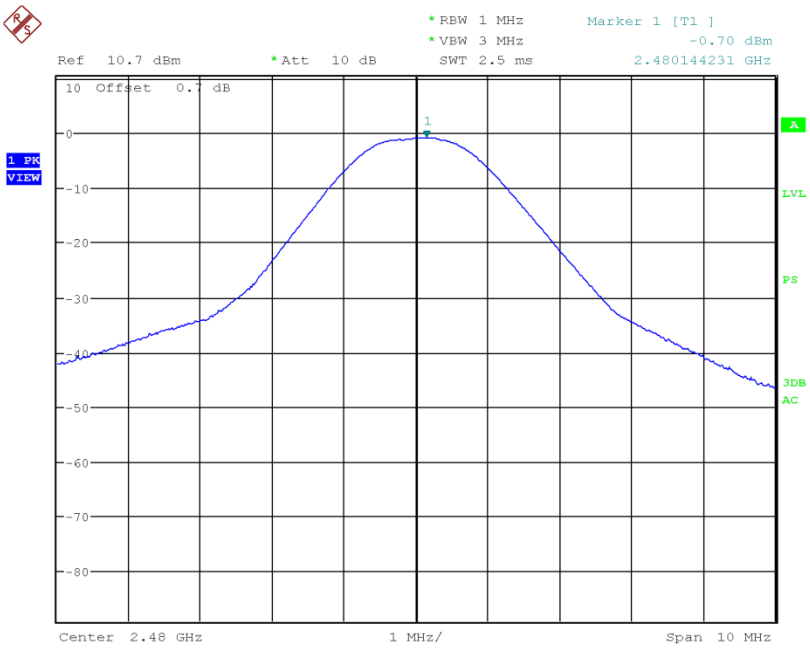


Figure 14: Chart of conducted output power on channel 39

Channel	*Frequency [MHz]*	*Conducted output power [dBm]*	*Limit*[6]		*Margin [dB]*	*Results*
			[dBm]	*[W]*		
0	2402.080	-0.35	30	1	30.35	Passed
20	2442.128	-0.62	30	1	30.62	Passed
39	2480.144	-0.70	30	1	30.70	Passed

Table 11: Results of conducted output power

[6] 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. For information about the EUT see clause 3.

6.4 Power spectral density

Section(s) in 47 CFR Part 15: Requirement(s): 15.247(e)
Reference(s): KDB 558074 D01, section 10

Performed by:	Jennifer Riedel	Date(s) of test:	31/01/2019
Climatic conditions:	Ambient temperature 22.1 °C	Relative humidity 41.1 %	Barometric pressure 978.3 hPa
Result[7]:	☒ 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

[7] For information about measurement uncertainties see page 72.

6.4.2 Limits

As specified in section 15.247(e) of 47 CFR Part 15, for digitally modulated systems (DTS), the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

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

For frequency hopping systems (FHSS), measuring the power spectral density is not applicable.

6.4.3 Test procedure

The power spectral density 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 5.5.

6.4.4 Test results

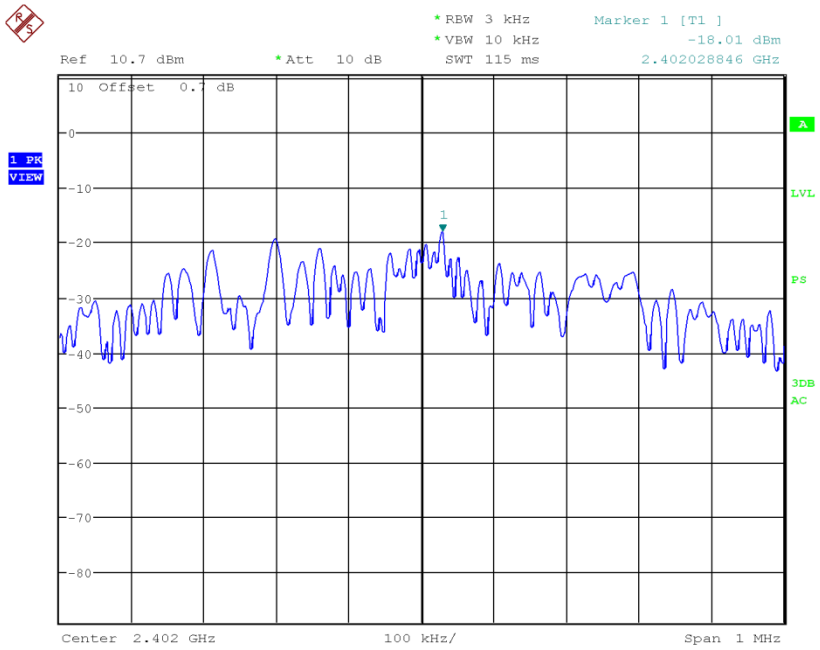


Figure 15: Chart of power spectral density on channel 0

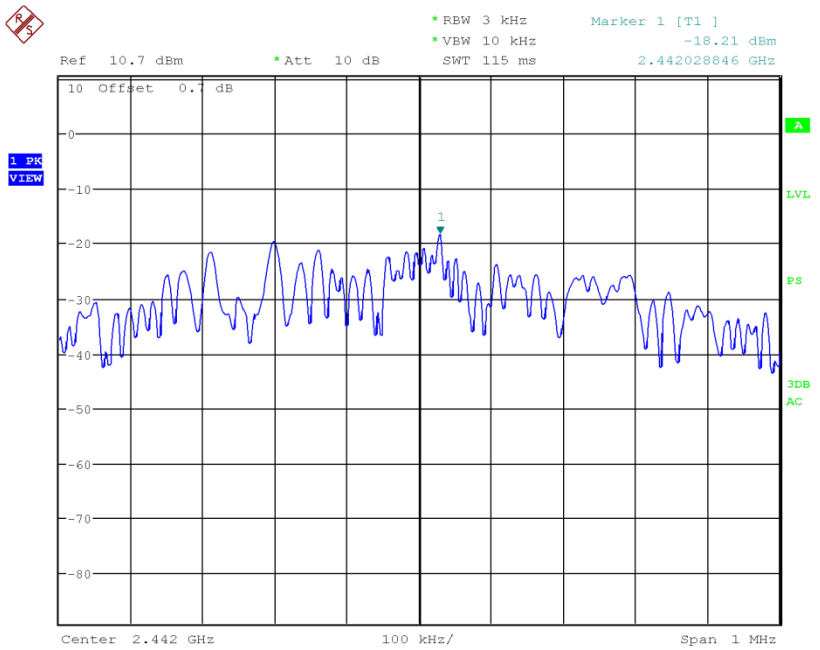


Figure 16: Chart of power spectral density on channel 20

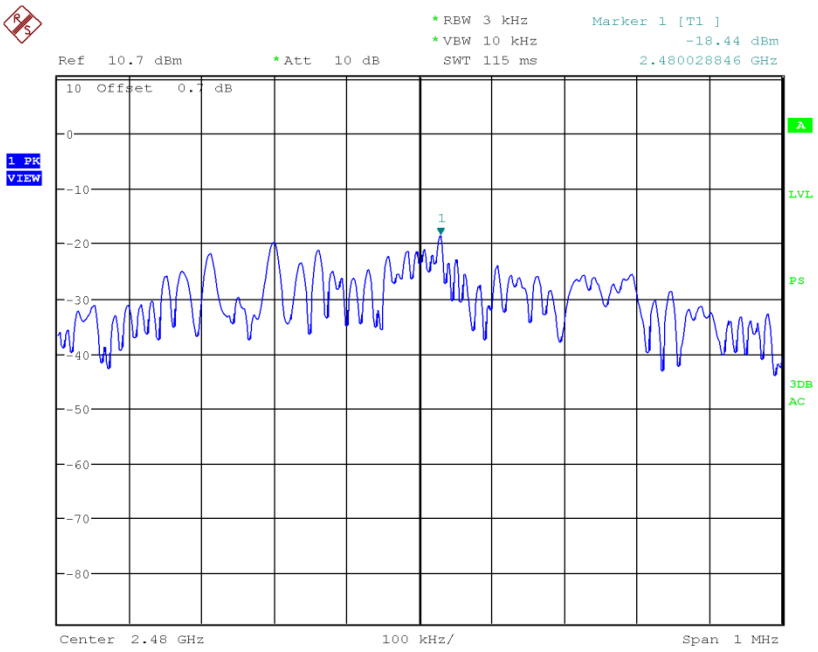


Figure 17: Chart of power spectral density on channel 39

Channel	*Frequency [MHz]*	*Power spectral density[dBm]*	*Limit*[8] *[dBm]*	*Margin [dB]*	*Results*
0	2402.029	-18.01	8	26.01	Passed
20	2442.029	-18.21	8	26.21	Passed
39	2480.029	-18.44	8	26.44	Passed

Table 12: Results of power spectral density

[8] 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. For information about the EUT *see* clause 3.

6.5 Band-edge measurements

Section(s) in 47 CFR Part 15: Requirement(s): 15.247(d)
Reference(s): KDB 558074 D01, section 13

Result[9]: ☒ 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

[9] For information about measurement uncertainties see page 72.

6.5.2 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 13: 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 13) must also comply with the radiated emission limits specified in §15.209(a)

6.5.3 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 5.5.

6.5.4 Test results

Performed by:	Jennifer Riedel	Date(s) of test:	31/01/2019
Climatic conditions:	Ambient temperature 22.1 °C	Relative humidity 41.1 %	Barometric pressure 978.3 hPa

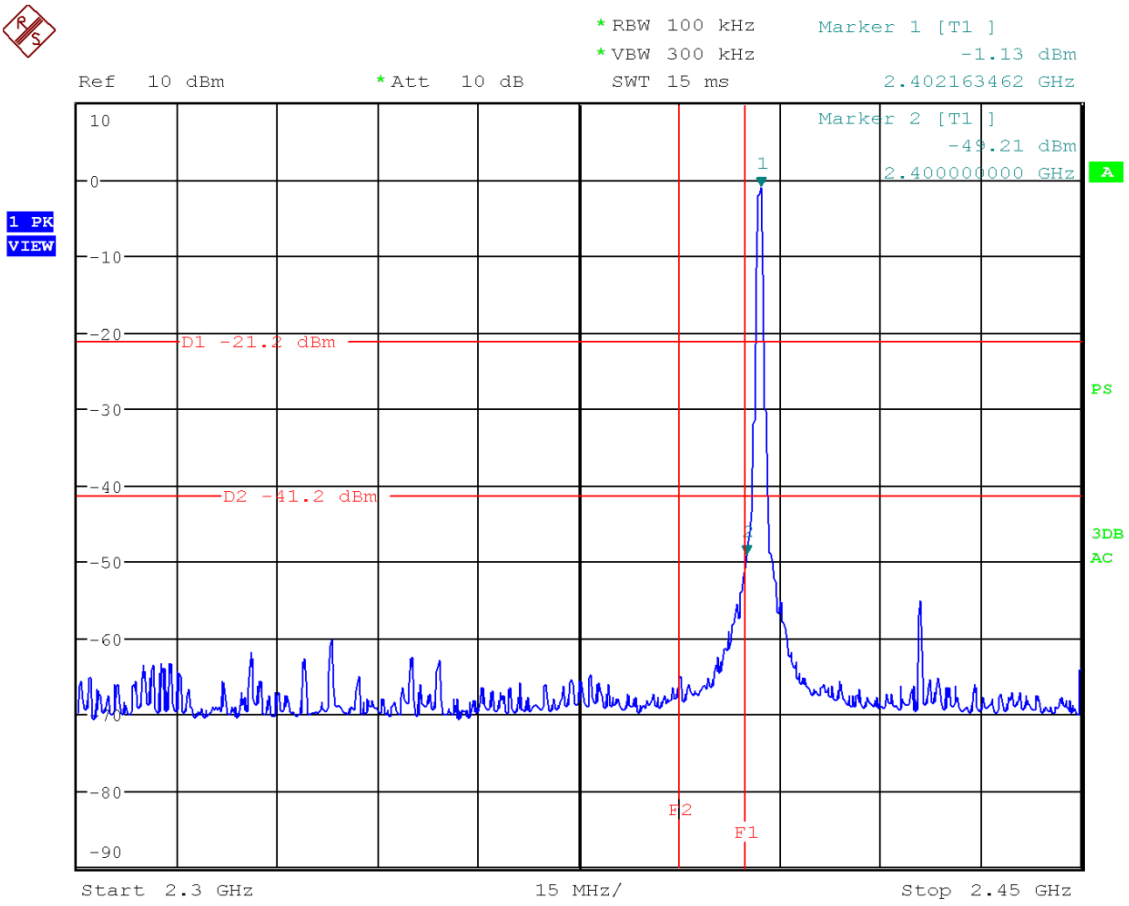


Figure 18: Chart of band-edge measurement on channel 0 with peak detector

As shown in Figure 18, the difference between the peak value of the carrier (Marker 1) and the peak value of the band-edge at 2400 MHz (Delta 2) is -49.21 dB which is more than the necessary 20 dB according to clause 11.11.1 in ANSI C63.10-2013.

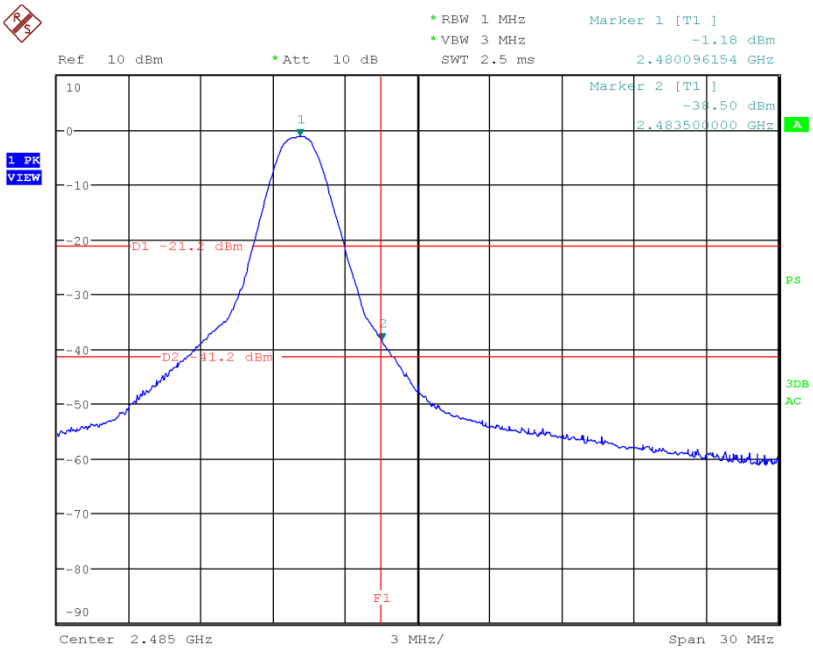


Figure 19: Chart of band-edge measurement on channel 39 of peak detector

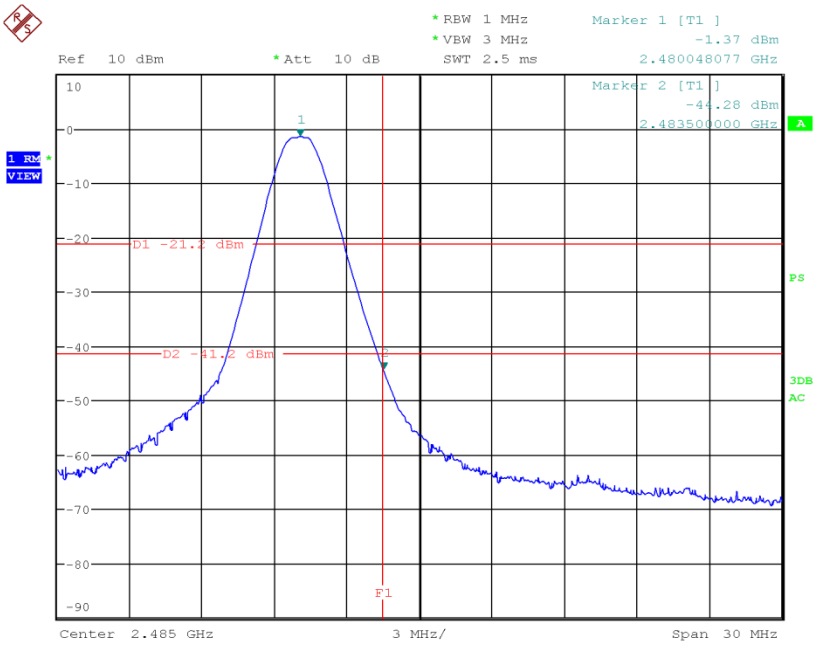


Figure 20: Chart of band-edge measurement on channel 39 of RMS detector

Frequency (MHz)	*MaxPeak (dBm)*	*RMS (dBm)*	*Limit (dBm)*[1]	*Margin (dB)*	*Meas. Time (ms)*
2480.000	-1.18	-1.37	---	---	2.5
2483.500	-38.50	---	-23.20	15.30	2.5
2483.500	---	-44.28	-43.20	1.08	2.5

Table 14: Test results of band-edge measurements on channel 39

Note 1: Conducted limit = Field strength limit (radiated) – 95.2 – antenna gain

6.6 Emissions outside the operating frequency band(s) specified

6.6.1 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

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

6.6.1.1 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

[10] For information about measurement uncertainties see page 72.

6.6.1.2 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 13) 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 15.

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 15: 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 15 using the recalculation factor as described in clause 5.3.

6.6.1.3 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.

6.6.1.4 Test results

Performed by:	Jennifer Riedel	Date(s) of test:	20/02/2019
Climatic conditions:	Ambient temperature 24.9 °C	Relative humidity 40.1 %	Barometric pressure 975.3 hPa
Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
Antenna alignment:	☒ in parallel	☒ in line	☐ angle ….. °
EUT position[11]:	☒ 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

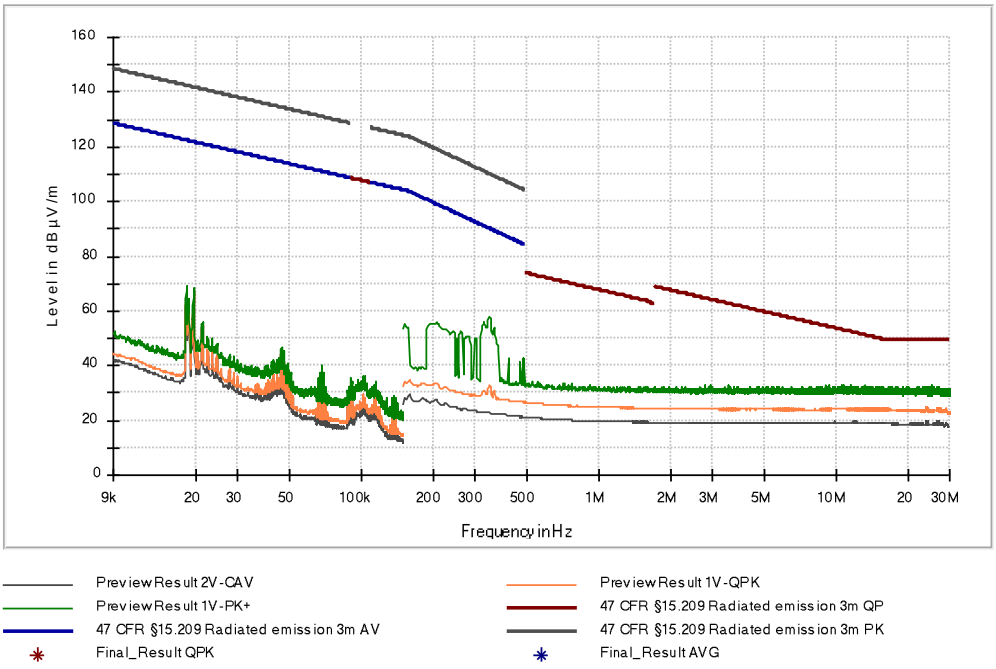


Figure 21: Chart of emissions test below 30 MHz on channel 0 in position X

[11] 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.

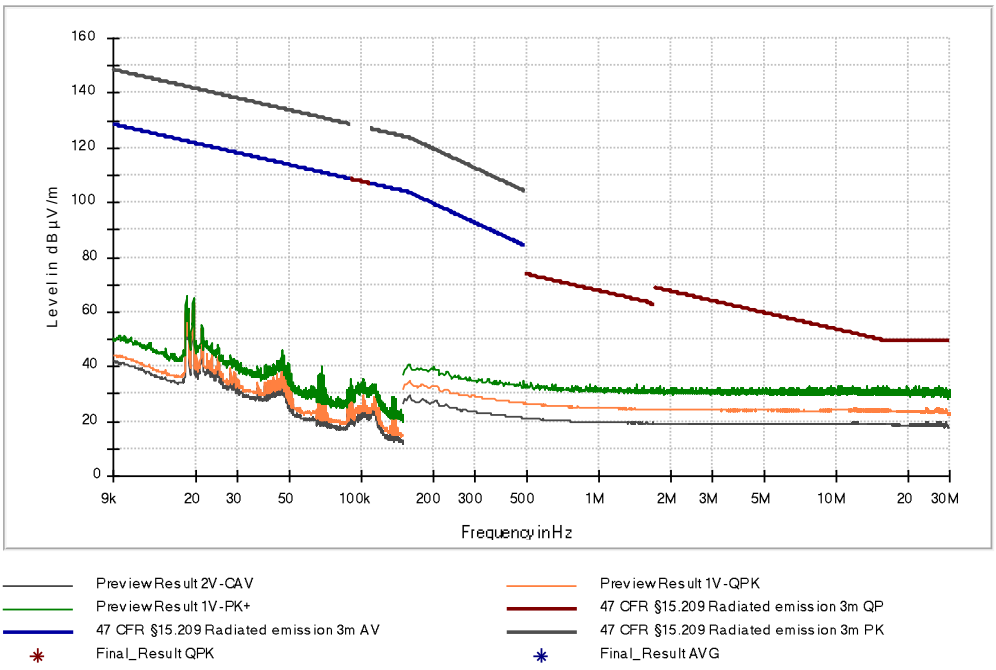


Figure 22: Chart of emissions test below 30 MHz on channel 20 in position X

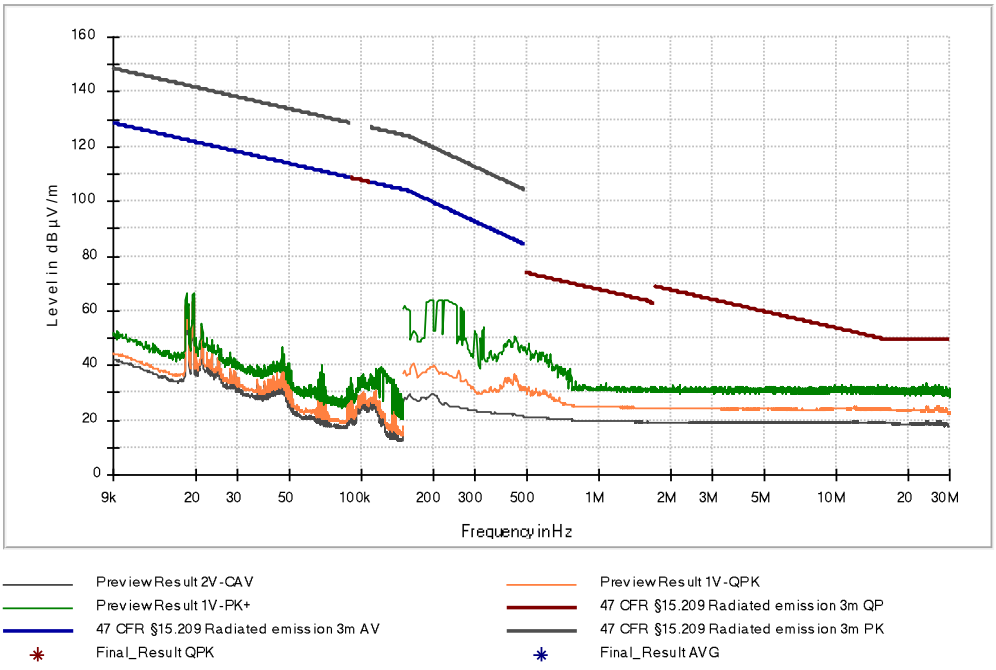


Figure 23: Chart of emissions test below 30 MHz on channel 39 in position X

6.6.2 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

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

6.6.2.1 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
☐	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

[12] For information about measurement uncertainties see page 72.

6.6.2.2 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 13) 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 16.

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

6.6.2.3 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 5.4.

6.6.2.4 Test results

Performed by:	Jennifer Riedel	Date(s) of test:	February 26, 2019
Climatic conditions:	Ambient temperature 21.9 °C	Relative humidity 33.5 %	Barometric pressure 974.6 hPa
Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
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*	
30 MHz – 1 GHz	30 kHz	120 kHz	QP	QP	1 s	1 s	20 dB

Note: Premeasurements have shown that there are no differences between the channels 0, 20 and 39 in the range of 30 MHz to 1 GHz, so the final measurement was only performed on channel 0 representative for all channels.

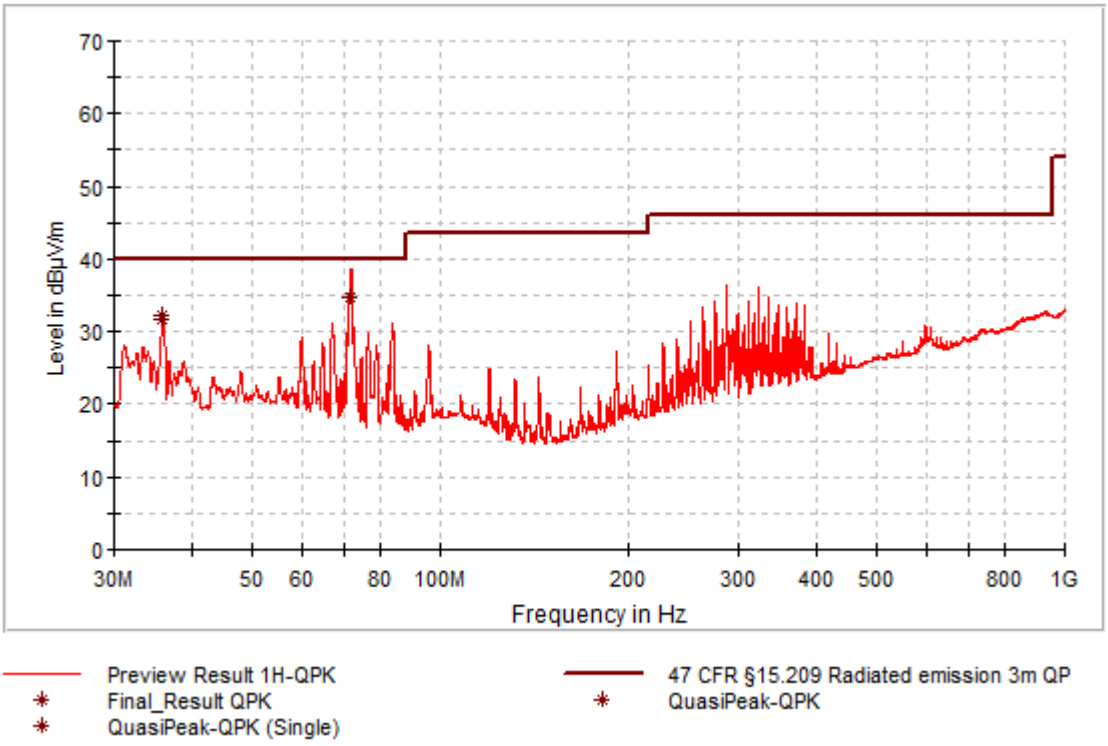


Figure 24: Chart of emissions test from 30 MHz to 1 GHz on channel 0 in position X

[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.

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)*
35.940	X	32.38	QP	40.00	7.62	1000.0	120.000	250.0	H	227.0	11.8
71.820	X	34.73	QP	40.00	5.27	1000.0	120.000	250.0	H	260.0	10.0

Table 17: Results of emissions test from 30 MHz to 1 GHz on channel 0

6.6.3 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

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

6.6.3.1 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 (0.5 GHz - 18 GHz)	BBV 9718 B	Schwarzbeck	W01325
☒	Preamplifier (18 GHz - 40 GHz)	BBV 9721	Schwarzbeck	W01350
☐	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
☒	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

6.6.3.2 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

[14] For information about measurement uncertainties see page 72.

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

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

Table 18: General radiated emission limits above 960 MHz according to §15.209

6.6.3.3 Test procedure

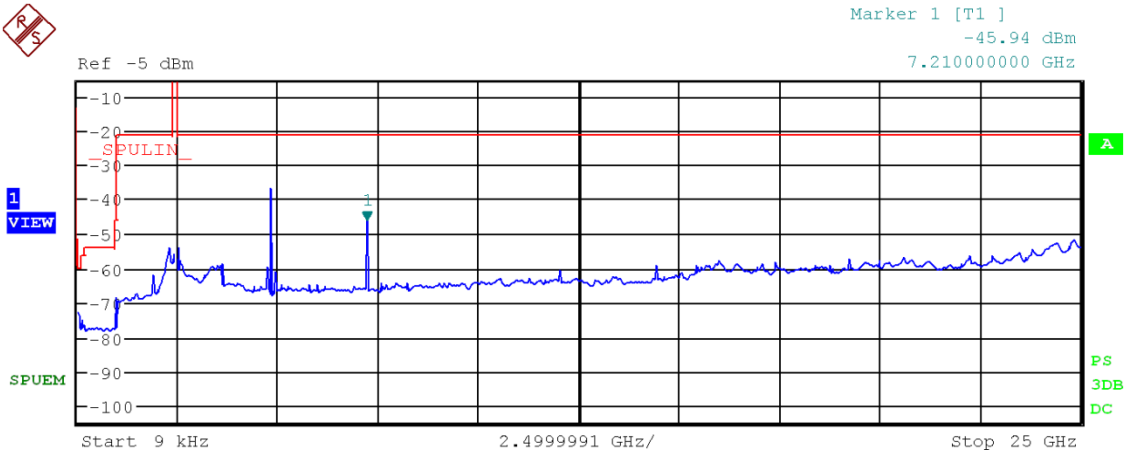
The emissions from 30 MHz to 1 GHz are measured using the

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

6.6.3.4 Test results

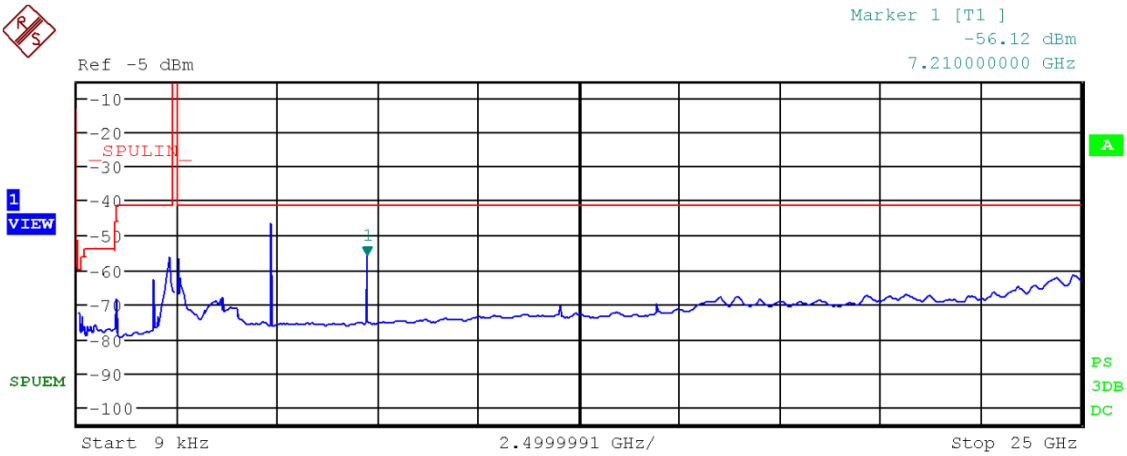
6.6.3.4.1 Conducted

Performed by:	Jennifer Riedel	Date(s) of test:	31/01/2019
Climatic conditions:	Ambient temperature 22.1 °C	Relative humidity 41.1 %	Barometric pressure 978.3 hPa



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
9.000 k	150.000 k	200.00	145.706731 k	-94.20	-57.77
150.000 k	490.000 k	10.00 k	455.150000 k	-84.73	-38.33
490.000 k	1.705 M	10.00 k	1.679931 M	-89.29	-31.22
1.705 M	30.000 M	10.00 k	24.000517 M	-83.86	-32.16
30.000 M	88.000 M	100.00 k	63.988000 M	-73.74	-13.84
88.000 M	216.000 M	100.00 k	127.978667 M	-75.04	-18.64
216.000 M	960.000 M	100.00 k	564.886400 M	-77.19	-23.29
960.000 M	1.000 G	1.00 M	983.116883 M	-68.47	-22.57
1.000 G	2.390 G	1.00 M	2.273703 G	-54.21	-33.01
2.500 G	4.000 G	1.00 M	2.530000 G	-53.83	-32.63
4.000 G	10.000 G	1.00 M	4.795000 G	-36.78	-15.58
10.000 G	25.000 G	1.00 M	24.805000 G	-51.70	-30.50

Figure 25: Chart of emissions test from 9 kHz to 25 GHz on channel 0 – peak detector

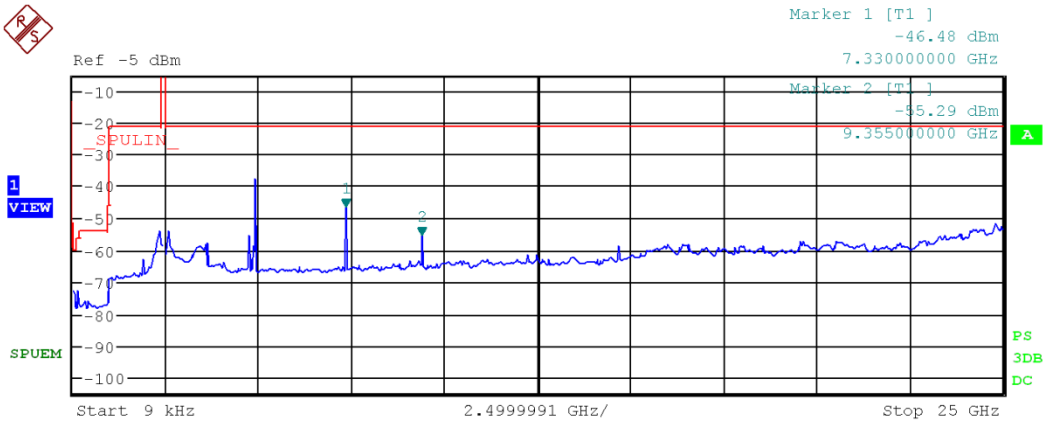


Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
9.000 k	150.000 k	200.00	148.870192 k	-94.66	-57.67
150.000 k	490.000 k	10.00 k	489.388000 k	-86.33	-38.90
490.000 k	1.705 M	10.00 k	1.695726 M	-89.68	-31.47
1.705 M	30.000 M	10.00 k	11.999664 M	-84.81	-33.11
30.000 M	88.000 M	100.00 k	63.988000 M	-72.81	-12.91
88.000 M	216.000 M	100.00 k	127.978667 M	-74.01	-17.61
216.000 M	960.000 M	100.00 k	448.822400 M	-76.17	-22.27
960.000 M	1.000 G	1.00 M	992.467532 M	-68.73	-22.83
1.000 G	2.390 G	1.00 M	2.274167 G	-56.55	-15.35
2.500 G	4.000 G	1.00 M	2.529571 G	-56.72	-15.52
4.000 G	10.000 G	1.00 M	4.795000 G	-46.67	-5.47
10.000 G	25.000 G	1.00 M	24.775000 G	-61.79	-20.59

Figure 26: Chart of emissions test from 9 kHz to 25 GHz on channel 0 – RMS detector

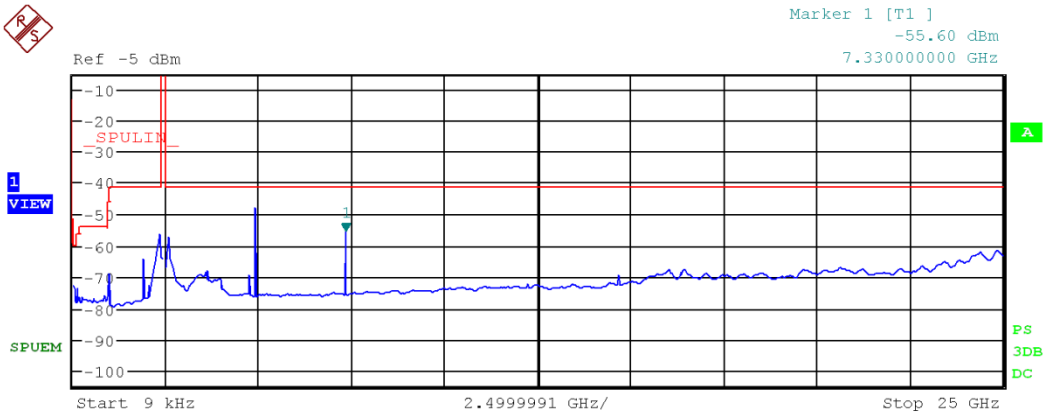
Frequency (MHz)	*Level (dBm)*	*Detector*	*Limit (dBm)*	*Margin (dB)*	*Meas. Time (ms)*	*Bandwidth (kHz)*
63.988	-73.74	PK	-59.90	13.84	100.0	100.000
63.988	-72.81	RMS	-59.90	12.91	100.0	100.000
127.979	-75.04	PK	-56.40	18.64	100.0	100.000
127.979	-74.01	RMS	-56.40	17.61	100.0	100.000
2274.167	-56.55	RMS	-41.20	15.35	100.0	1000.000
2529.571	-56.72	RMS	-41.20	15.52	100.0	1000.000
4795.000	-36.78	PK	-21.20	15.58	100.0	1000.000
4795.000	-46.67	RMS	-41.20	5.47	100.0	1000.000
7210.000	-45.94	PK	-21.20	24.74	100.0	1000.000
7210.000	-56.12	RMS	-41.20	14.92	100.0	1000.000

Table 19: Results of emissions test from 9 kHz to 25 GHz on channel 0



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
9.000 k	150.000 k	200.00	147.288462 k	-93.77	-57.06
150.000 k	490.000 k	10.00 k	487.042000 k	-85.75	-38.39
490.000 k	1.705 M	10.00 k	1.654254 M	-87.71	-29.87
1.705 M	30.000 M	10.00 k	12.000607 M	-83.84	-32.14
30.000 M	88.000 M	100.00 k	63.988000 M	-73.61	-13.71
88.000 M	216.000 M	100.00 k	127.978667 M	-72.78	-16.38
216.000 M	960.000 M	100.00 k	384.838400 M	-76.20	-22.30
960.000 M	1.000 G	1.00 M	962.597403 M	-69.06	-23.16
1.000 G	2.390 G	1.00 M	2.314013 G	-54.16	-32.96
2.500 G	4.000 G	1.00 M	2.569857 G	-53.86	-32.66
4.000 G	10.000 G	1.00 M	4.885000 G	-37.74	-16.54
10.000 G	25.000 G	1.00 M	24.775000 G	-51.86	-30.66

Figure 27: Chart of emissions test from 9 kHz to 25 GHz on channel 20 – peak detector

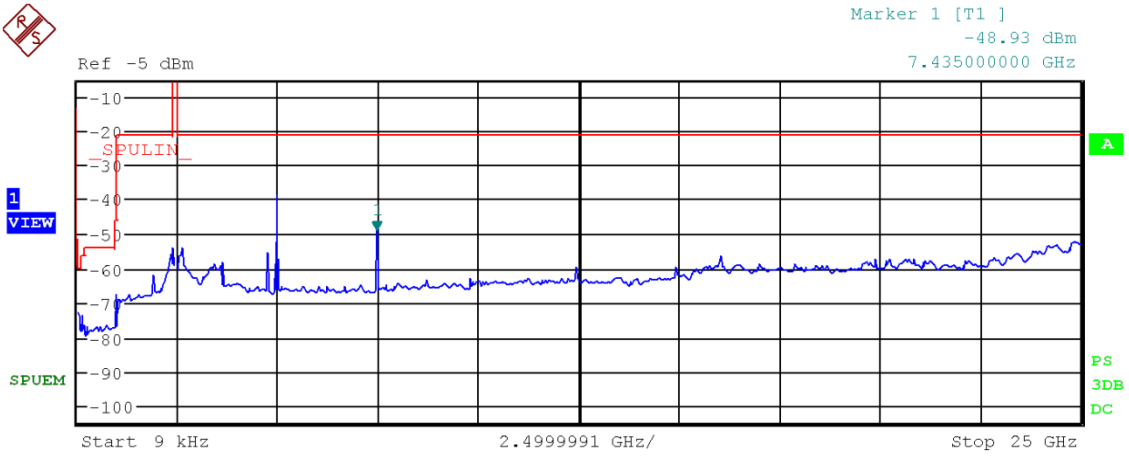


Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
9.000 k	150.000 k	200.00	147.288462 k	-93.77	-57.06
150.000 k	490.000 k	10.00 k	487.110000 k	-85.59	-38.22
490.000 k	1.705 M	10.00 k	1.697143 M	-88.85	-30.63
1.705 M	30.000 M	10.00 k	23.998631 M	-83.61	-31.91
30.000 M	88.000 M	100.00 k	63.988000 M	-73.61	-13.71
88.000 M	216.000 M	100.00 k	128.021333 M	-73.64	-17.24
216.000 M	960.000 M	100.00 k	837.438400 M	-76.33	-22.43
960.000 M	1.000 G	1.00 M	983.636364 M	-69.12	-23.22
1.000 G	2.390 G	1.00 M	2.314013 G	-56.54	-15.34
2.500 G	4.000 G	1.00 M	2.569857 G	-57.17	-15.97
4.000 G	10.000 G	1.00 M	4.885000 G	-47.77	-6.57
10.000 G	25.000 G	1.00 M	24.805000 G	-61.48	-20.28

Figure 28: Chart of emissions test from 9 kHz to 25 GHz on channel 20 – RMS detector

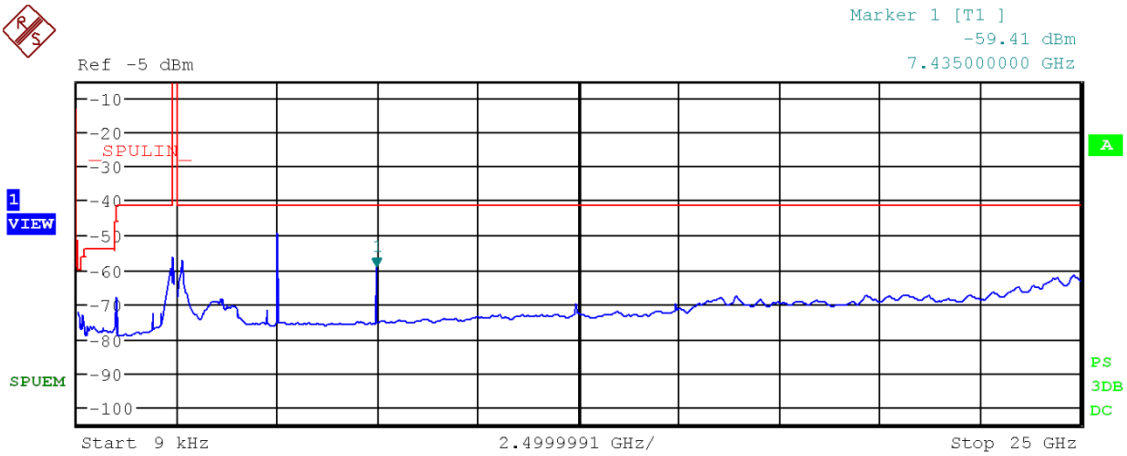
Frequency (MHz)	Level (dBm)	Detector	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)
63.988	-73.61	PK	-59.90	13.71	100.0	100.000
63.988	-73.61	RMS	-59.90	13.71	100.0	100.000
127.979	-72.78	PK	-56.40	16.38	100.0	100.000
128.021	-73.64	RMS	-56.40	17.24	100.0	100.000
2314.013	-56.54	RMS	-41.20	15.97	100.0	1000.000
2569.857	-57.17	RMS	-41.20	15.97	100.0	1000.000
4885.000	-37.74	PK	-21.20	16.54	100.0	1000.000
4885.000	-47.77	RMS	-41.20	6.57	100.0	1000.000
7330.000	-46.48	PK	-21.20	25.28	100.0	1000.000
7330.000	-55.60	RMS	-41.20	14.40	100.0	1000.000
9355.000	-55.29	PK	-41.20	14.09	100.0	1000.000

Table 20: Results of emissions test from 9 kHz to 25 GHz on channel 20



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
9.000 k	150.000 k	200.00	147.288462 k	-93.77	-57.06
150.000 k	490.000 k	10.00 k	474.938000 k	-85.46	-38.46
490.000 k	1.705 M	10.00 k	1.599457 M	-88.22	-30.87
1.705 M	30.000 M	10.00 k	12.000607 M	-83.61	-31.91
30.000 M	88.000 M	100.00 k	63.988000 M	-73.80	-13.90
88.000 M	216.000 M	100.00 k	127.978667 M	-73.98	-17.58
216.000 M	960.000 M	100.00 k	727.326400 M	-76.50	-22.60
960.000 M	1.000 G	1.00 M	989.090909 M	-67.75	-21.85
1.000 G	2.390 G	1.00 M	2.352470 G	-53.92	-32.72
2.500 G	4.000 G	1.00 M	2.608000 G	-54.19	-32.99
4.000 G	10.000 G	1.00 M	4.960000 G	-38.74	-17.54
10.000 G	25.000 G	1.00 M	24.835000 G	-52.04	-30.84

Figure 29: Chart of emissions test from 9 kHz to 25 GHz on channel 39 – peak detector



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
9.000 k	150.000 k	200.00	147.288462 k	-93.10	-56.39
150.000 k	490.000 k	10.00 k	478.644000 k	-85.10	-38.00
490.000 k	1.705 M	10.00 k	1.697588 M	-88.53	-30.31
1.705 M	30.000 M	10.00 k	24.000517 M	-83.83	-32.13
30.000 M	88.000 M	100.00 k	64.026667 M	-73.76	-13.86
88.000 M	216.000 M	100.00 k	128.021333 M	-73.49	-17.09
216.000 M	960.000 M	100.00 k	384.838400 M	-76.61	-22.71
960.000 M	1.000 G	1.00 M	963.636364 M	-68.27	-22.37
1.000 G	2.390 G	1.00 M	2.352007 G	-56.31	-15.11
2.500 G	4.000 G	1.00 M	2.607571 G	-57.13	-15.93
4.000 G	10.000 G	1.00 M	4.960000 G	-49.58	-8.38
10.000 G	25.000 G	1.00 M	24.835000 G	-61.63	-20.43

Figure 30: Chart of emissions test from 9 kHz to 25 GHz on channel 39 – RMS detector

Frequency (MHz)	*Level (dBm)*	*Detector*	*Limit (dBm)*	*Margin (dB)*	*Meas. Time (ms)*	*Bandwidth (kHz)*
63.988	-73.80	PK	-59.90	13.90	100.0	100.000
64.027	-73.76	RMS	-59.90	13.86	100.0	100.000
127.979	-73.98	PK	-56.40	17.58	100.0	100.000
128.021	-73.49	RMS	-56.40	17.09	100.0	100.000
2352.007	-56.31	RMS	-41.20	15.11	100.0	1000.000
2607.571	-57.13	RMS	-41.20	15.93	100.0	1000.000
4960.000	-38.74	PK	-21.20	17.54	100.0	1000.000
4960.000	-49.58	RMS	-41.20	8.38	100.0	1000.000
7435.000	-48.93	PK	-21.20	27.73	100.0	1000.000
7435.000	-59.41	RMS	-41.20	18.21	100.0	1000.000

Table 21: Results of emissions test from 9 kHz to 25 GHz on channel 39

6.6.3.4.2 Radiated

Performed by:	Jennifer Riedel	Date(s) of test:	21/02/2019
Climatic conditions:	Ambient temperature 22.1 °C	Relative humidity 41.2 %	Barometric pressure 974.6 hPa
Test distance:	Exploratory tests: Final tests:	☐ 1 m ☒ 1.5 m	☒ 0.5 m ☐ 1 m
EUT position:	☒ Position X	☒ Position Y	☒ Position Z

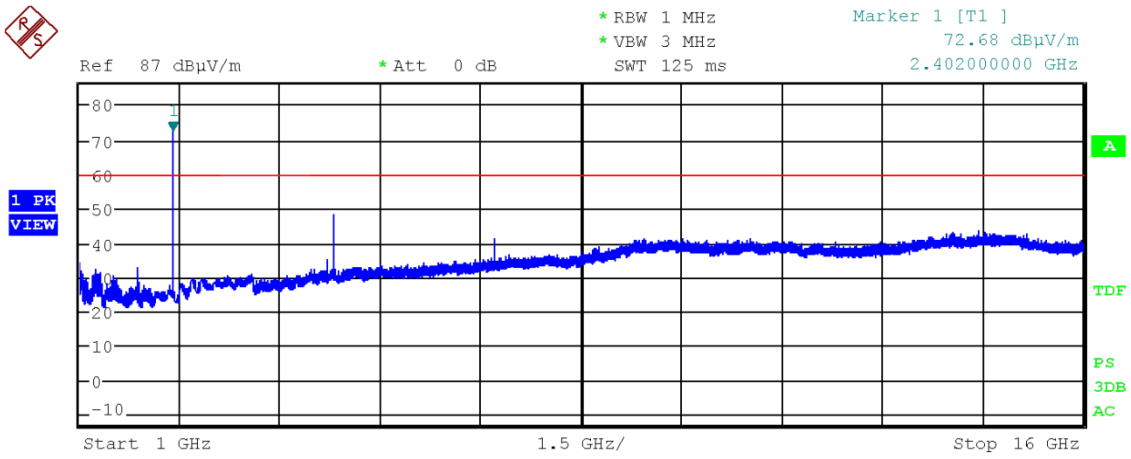
Frequency range	*Step size*	*IF Bandwidth*	*Detector*		*Measurement Time*		*Pre-amplifier*	*Distance*
			Prescan	*Final scan*	*Prescan*	*Final scan*		
1 GHz – 16 GHz	250 kHz	1 MHz	PK + AV	PK + AV	1.5 s	0.1 s	External	3 m

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

Note 1: The measurements from 1 GHz to 16 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 16 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.



#	Frequency	Level	#	Frequency	Level
1	1.011000 GHz	33.49 dBµV	13	1.523000 GHz	30.11 dBµV
2	1.023000 GHz	34.21 dBµV	14	1.562500 GHz	29.27 dBµV
3	1.077500 GHz	29.11 dBµV	15	1.572500 GHz	28.84 dBµV
4	1.099000 GHz	29.45 dBµV	16	1.882000 GHz	32.99 dBµV
5	1.131000 GHz	28.44 dBµV	17	1.890000 GHz	28.49 dBµV
6	1.214000 GHz	30.54 dBµV	18	1.968500 GHz	27.61 dBµV
7	1.250500 GHz	32.08 dBµV	19	2.401500 GHz	72.78 dBµV
8	1.261000 GHz	32.04 dBµV	20	4.713500 GHz	34.93 dBµV
9	1.285500 GHz	31.00 dBµV	21	4.803500 GHz	48.16 dBµV
10	1.297000 GHz	31.00 dBµV	22	7.206500 GHz	41.30 dBµV
11	1.320500 GHz	31.46 dBµV	23	14.434500 GHz	43.59 dBµV
12	1.513500 GHz	30.57 dBµV			

Figure 31: Premeasurement from 1 GHz to 16 GHz on channel 0 in position X at 1.50 m

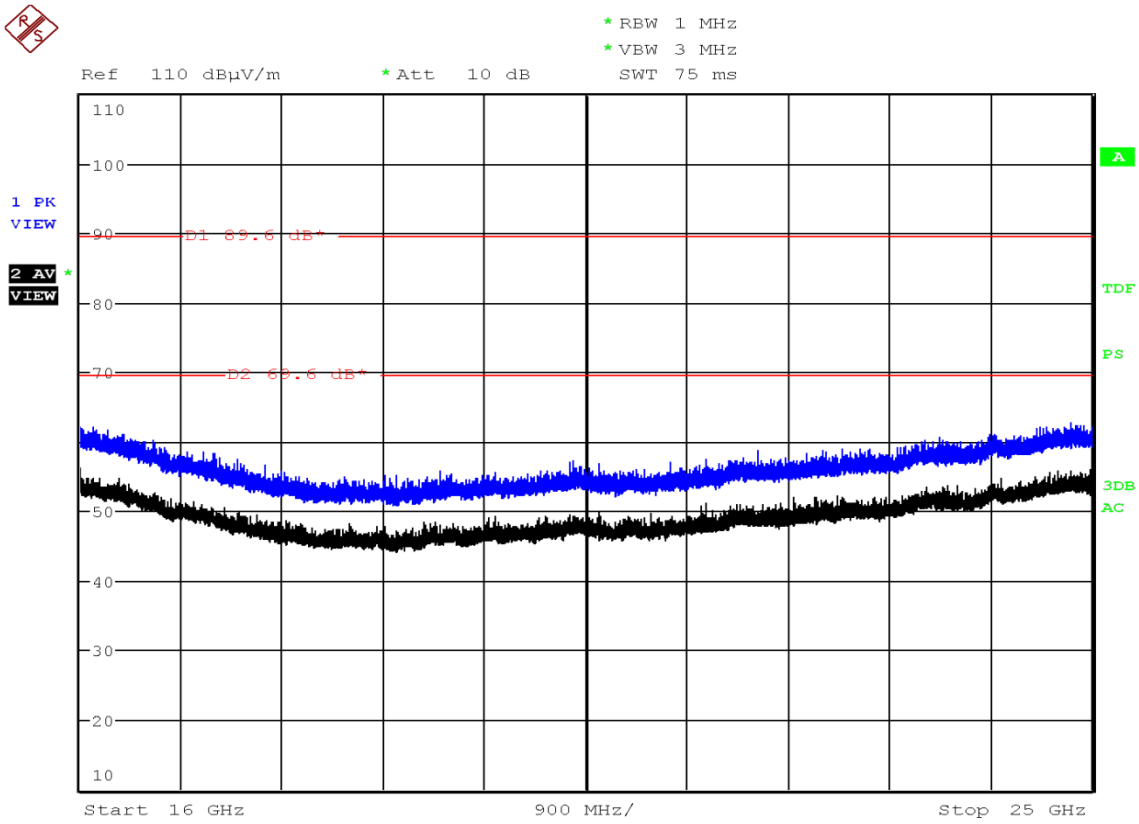
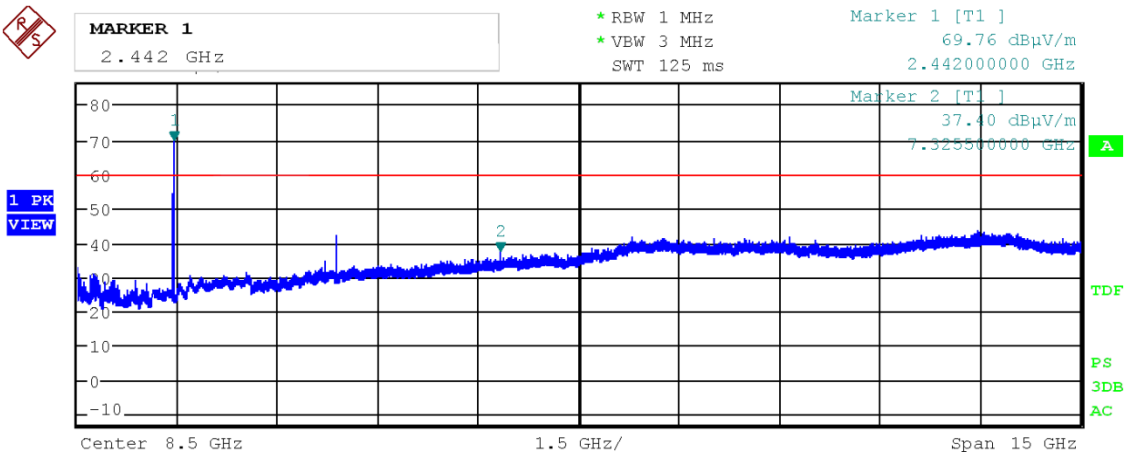


Figure 32: Chart of exploratory emission test from 16 GHz to 25 GHz on channel 0 at 0.5 m

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)*
4803.344	X	46.59	PK	80.00		20.0	1000.000	150.0	H	94.0	-7.2
7206.580	X	41.87	PK	80.00		20.0	1000.000	100.0	H	138.0	-7.2

Table 22: Results of emissions test from 1 GHz to 25 GHz on channel 0

Note: The peak values of the emissions are under the average limit, so the measurement with an average-detector is not necessary according to ANSI C63.10-2013 clause 6.6.4.3, note 1.



#	Frequency	Level	#	Frequency	Level
1	1.024000 GHz	32.77 dBµV	13	3.536000 GHz	31.26 dBµV
2	1.106000 GHz	28.52 dBµV	14	4.714500 GHz	34.76 dBµV
3	1.213000 GHz	30.31 dBµV	15	4.883500 GHz	42.09 dBµV
4	1.249500 GHz	30.31 dBµV	16	9.302000 GHz	41.63 dBµV
5	1.260000 GHz	30.92 dBµV	17	14.444000 GHz	43.36 dBµV
6	1.283500 GHz	30.49 dBµV			
7	1.411000 GHz	28.39 dBµV			
8	1.527500 GHz	28.76 dBµV			
9	1.549500 GHz	29.07 dBµV			
10	1.880500 GHz	29.12 dBµV			
11	2.046000 GHz	27.85 dBµV			
12	2.441500 GHz	69.81 dBµV			

Figure 33: Premeasurement from 1 GHz to 16 GHz on channel 20 in position X at 1.50 m

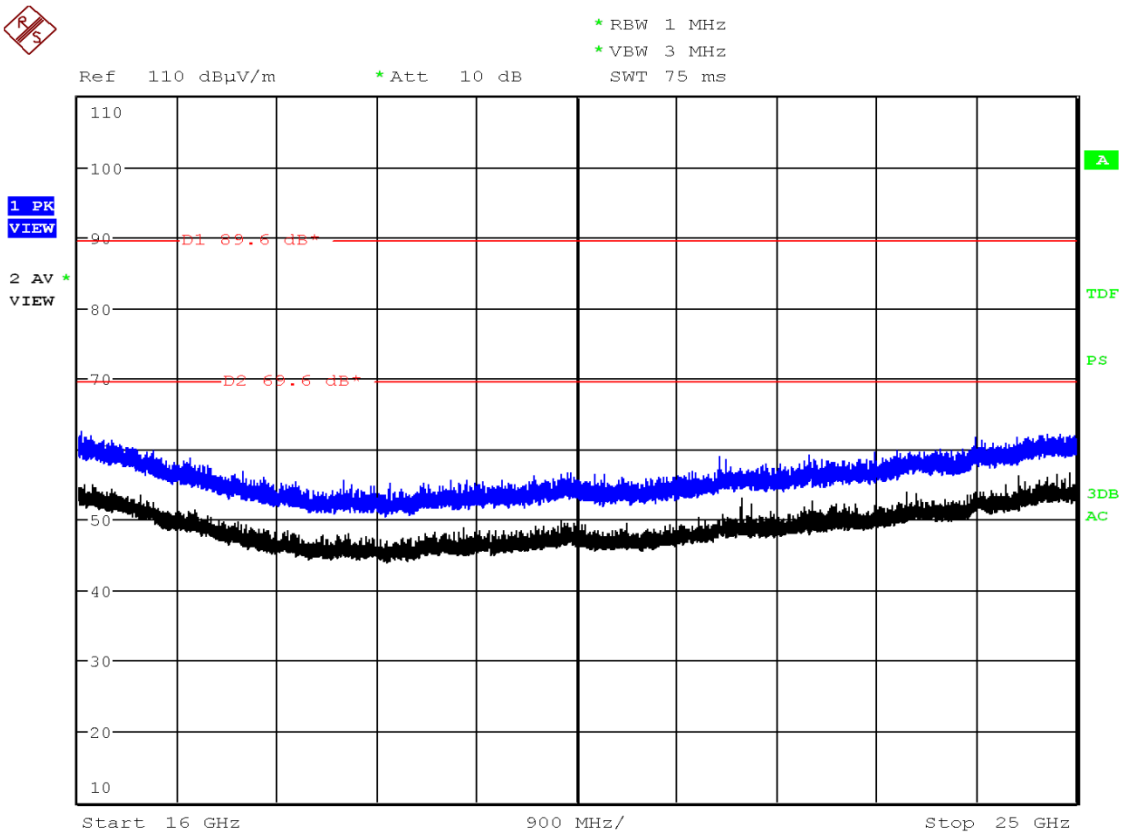
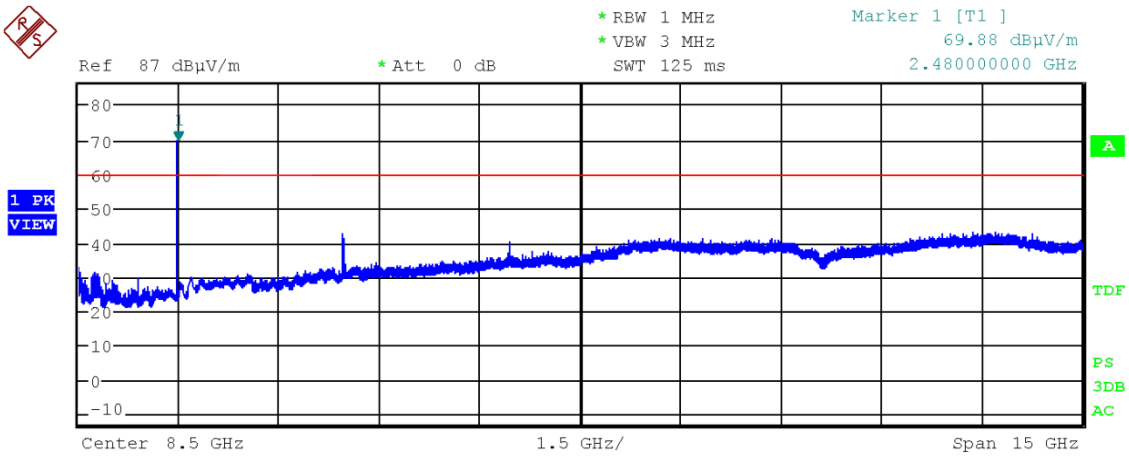


Figure 34: Chart of exploratory emissions test from 16 GHz to 25 GHz on channel 20 at 0.5 m

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)*
4884.040	X	45.25	PK	80.00		20.0	1000.000	140.0	H	96.0	-7.2
7325.332	X	45.24	PK	80.00		20.0	1000.000	230.0	H	43.0	-7.2

Table 23: Results of emissions test from 1 GHz to 25 GHz on channel 20

Note: The peak values of the emissions are under the average limit, so the measurement with an average-detector is not necessary according to ANSI C63.10-2013 clause 6.6.4.3, note 1.



#	Frequency	Level	#	Frequency	Level
1	1.023000 GHz	32.83 dBµV	13	14.361000 GHz	43.10 dBµV
2	1.100000 GHz	28.84 dBµV			
3	1.214500 GHz	29.80 dBµV			
4	1.238500 GHz	30.61 dBµV			
5	1.262500 GHz	31.14 dBµV			
6	1.298000 GHz	30.66 dBµV			
7	1.526500 GHz	28.84 dBµV			
8	1.895500 GHz	29.27 dBµV			
9	2.479500 GHz	69.95 dBµV			
10	4.959500 GHz	42.43 dBµV			
11	7.439500 GHz	40.37 dBµV			
12	11.353500 GHz	41.35 dBµV			

Figure 35: Premeasurement from 1 GHz to 16 GHz on channel 39 in position X at 1.50 m

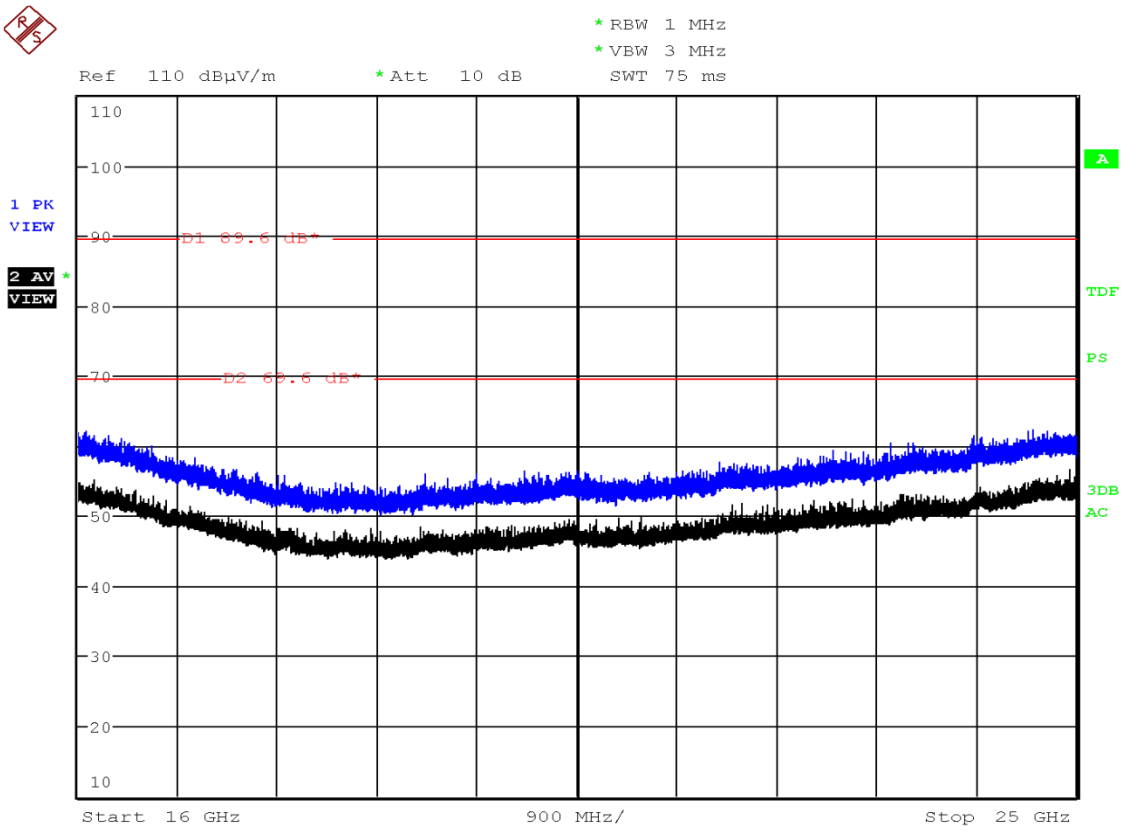


Figure 36: Chart of exploratory emissions test from 16 GHz to 25 GHz on channel 39 at 0.5 m

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)*
4959.956	X	44.92	PK	80.00		20.0	1000.000	133.0	H	95.0	-7.0
7439.308	X	42.22	PK	80.00		20.0	1000.000	135.0	H	178.0	-7.0

Table 24: Results of emissions test from 1 GHz to 25 GHz on channel 39

Note: The peak values of the emissions are under the average limit, so the measurement with an average-detector is not necessary according to ANSI C63.10-2013 clause 6.6.4.3, note 1.

6.7 Human exposure evaluation

See test report 180645-AU01+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
EMI test receiver	ESCI 3	100013	E00001	2018-05	2019-05
Preamplifier (1 GHz - 18 GHz)	ALS05749	001	W01007	2019-01	2020-01
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
Measuring antenna set	---	---	A00088	N/A[3]	
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	2019-04-01	Jennifer Riedel	First edition