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Applicant:

Elatec GmbH
Zeppelinstraße 1
82178 Puchheim
Tel.: +49 89 5529961-0

Test report no.:

200632-AU02+W08

for:

Elatec GmbH
RFID reader / writer
TWN4 Slim LEGIC

according to:

15.225
15.209
RSS-210
15.247
RSS-247

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

ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-12155-01-03

Note:

1 Element Materials Technology Straubing GmbH is the legal successor of EMV Testhaus GmbH. Therefore, until the ongoing procedure for renaming the conformity assessment body applied for at German Accreditation Body DAkkS is completed, the certificates and appropriate annexes of EMV Testhaus GmbH are referred to.

Accreditation:

FCC test firm accreditation expiration date: 2021-05-30
MRA US-EU, FCC designation number: DE0010
FCC registration number: 97268
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
ISED#: 3472A

Location of Testing:

Element Material Technology Straubing GmbH
Tel.: +49 9421 56868-0
Fax: +49 9421 56868-100
Email: info.straubing@element.com
Gustav-Hertz-Straße 35
94315 Straubing, Germany

The technical accuracy is guaranteed through the quality management of Element Material Technology Straubing GmbH.

Table of contents

List of figures

List of tables

1 General remark

According to ANSI C63.10-2013 clause 5.10.6:
If the individual devices in a composite system are subject to different regulatory technical requirements, then each part of the system shall comply with its specific technical requirement. In no event shall the measured emissions of the composite system exceed the highest level permitted for an individual component.
For a composite system, testing for compliance shall be performed with all of the parts in the system functioning. If an unlicensed wireless device incorporated more than one antenna or other radiating source and these radiating sources are designed to emit at the same time, then measurements of conducted and radiated emissions shall be performed with all radiating sources emitting simultaneously. If the composite system contains an unintentional radiator, then that part of the composite system shall be tested in accordance with the test procedures in the latest version of ANSI C63.4, as accepted by the appropriate regulatory agency.

Therefore this test report contains only partial measurements according to the following 47 CFR parts and IC radio standards.

2 Summary of test results

2.1 15.207 / RSS-Gen

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	24	Passed	1

Notes (for information about EUT see clause 4):

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.

2.2 15.225 / RSS-210

47 CFR part and section	*Test*	*Equivalent to IC radio standard(s)*	*Page*	*Result*	*Note(s)*
15.225(d)	Spurious emissions below 30 MHz	RSS-210, section B.6 (a) IV	36	Passed	---
15.225(d)	Spurious emissions from 30 MHz to 1 GHz	RSS-210, section B.6 (a) IV	40	Passed	---
15.225(d)	Spurious emissions above 1 GHz	RSS-210, section B.6 (a) IV	44	Passed	1, 2

Notes (for information about EUT see clause 4):

1 Not applicable if the 10th harmonic of the intentional transmitter is beyond 1 GHz (see 47 CFR Part 15, section 15.33(a)(1), and RSS-Gen, section 6.13)
2 According to 47 CFR Part 15, §15.33 and RSS-Gen, section 6.13.2 (d), the frequency range of investigation for the digital device shall be used if the range of investigation determined by the highest internal frequency of the digital device is higher then the 10th harmonic of the intentional radiator

2.3 15.209 / RSS-210

47 CFR part and section	*Test*	*Equivalent to IC radio standard(s)*	*Page*	*Result*	*Note(s)*
15.209(a)	Spurious emissions below 30 MHz	RSS-210 section 7.3	36	Passed	---
15.209(a)	Spurious emissions from 30 MHz to 1 GHz	RSS-210 section 7.3	40	Passed	---
15.209(a)	Spurious emissions above 1 GHz	RSS-210 section 7.3	44	Passed	1, 2

Note(s) (for information about EUT see clause 4):

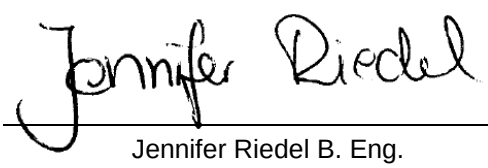
1 Not applicable if the 10th harmonic of the intentional transmitter is beyond 1 GHz (please see 47 CFR Part 15, section 15.33(a)(1), and RSS-Gen, section 6.13.2(a)

2 According to 47 CFR Part 15, §15.33 (a)(5) and RSS-Gen, section 6.13.2 (d), the frequency range of investigation for the digital device shall be used if the range of investigation determined by the highest internal frequency of the digital device is higher then the 10th harmonic of the intentional radiator

2.4 15.247 / RSS-247

47 CFR part and section (partly)	*Test*	*Equivalent to IC radio standard(s)*	*Page*	*Result*	*Note(s)*
15.247(b)	Calculated conducted output power	RSS-247, section 5.4	30	Passed	---
15.247(d)	Band-edge measurements	RSS-247, section 5.5	33	Passed	---
15.247(d)	Spurious emissions below 30 MHz	RSS-247, section 5.5	36	Passed	---
15.247(d)	Spurious emissions from 30 MHz to 1 GHz	RSS-247, section 5.5	40	Passed	---
15.247(d)	Spurious emissions above 1 GHz	RSS-247, section 5.5	44	Passed	---

Straubing, February 8, 2021



Jennifer Riedel B. Eng.
Radio Test Engineer

Konrad Graßl
Department Manager Radio

3 Referenced publications

Publication	*Title*
CFR 47 Part 2 November 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 November 2019	Code of Federal Regulations, Title 47 (Telecommunication), Part 15 (Radio Frequency Devices) of the Federal Communication Commission (FCC)
KDB 174176 D01 June 03, 2015	AC power-line conducted emissions Frequently Asked Questions
KDB Publication no. 412172 August 7, 2015	Guidelines for determining the Effective Radiated Power (ERP) and Equivalent Isotropically Radiated Power (EIRP) of an RF transmitting system
KDB Publication no. 558074 April 02, 2019	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
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-210, Issue 10 December 2019	Spectrum Management and Telecommunications Radio Standards Specification Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment
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

4 Equipment under test (EUT)

All Information in this clause is declared by customer.

4.1 General information

Product type:	RFID reader / writer		
Model name:	TWN4 Slim LEGIC		
Serial number(s):	2021024617		
Manufacturer:	Elatec GmbH		
Version:	Hardware:	T4QC-DC3B7-PRODA	
	Software:	TWN_NKx403_C6T106	
Short description:	EUT is a RFID reader / writer operating at the frequencies 125 kHz and 13.56 MHz. Additionally, a fully certified Bluetooth Low Energy module is integrated.		
Additional modifications:	None		
FCC ID:	WP5TWN4F16		
IC registration number:	7948A-TWN4F16		
Power supply:	DC supply		
	Nominal voltage:	5 V	
Device type:	☐ Portable	☐ Mobile	☒ Fixed

4.2 Radio specifications

RF technology 1:	RFID		
Operating frequency 1:	125 kHz		
RF technology 2:	RFID		
Application frequency band 2:	13.110 MHz – 14.010 MHz		
Operating frequency 2:	13.56 MHz		
RF technology 3:	Digital transmission system (DTS)		
Application frequency band 3:	2400.0 MHz - 2483.5 MHz		
Operating frequencies 3:	2402 MHz – 2480 MHz		
Antenna 1:	Type:	Loop antenna	
	Connector:	☐ external	☐ internal
		☐ temporary	☒ none (integral antenna)
Antenna 2:	Type:	Loop antenna	
	Connector:	☐ external	☐ internal
		☐ temporary	☒ none (integral antenna)
Antenna 3:	Type:	Chip antenna	
	Gain	0.5 dBi	
	Connector:	☐ external	☐ internal
		☐ temporary	☒ none (integral antenna)

Channel	*Frequency (MHz)*
Low	2402

Table 1: Tested BLE channel

Note(s):
1 According to test report “200698-AU01+W02 Test report” of test laboratory Element Materials Technology Straubing GmbH for all tests the frequency 2402 MHz was tested as worst case.

5 Test configuration and mode of operation

5.1 Test configuration

Device	*Type designation*	*Serial or inventory no.*	*Manufacturer*
RFID reader / writer	TWN4 Slim LEGIC	2021024617	Elatec GmbH

Table 2: EUT used for testing

Device	*Type designation*	*Serial or inventory no.*	*Manufacturer*
RFID-tag	125 kHz	---	Elatec GmbH
RFID-tag	13.56 MHz	---	Elatec GmbH
Laptop	Lifebook A531	E001053	FUJITSU
Power supply for laptop	AC adapter	E001053	FUJITSU
Smartphone	SAMSUNG GALAXY J3	W01394	SAMSUNG

Table 3: Support equipment used for testing

Port	*Classification*	*Cable type*	*Note*
USB	DC power and Signal/control	Shielded	

Table 4: Ports of EUT

5.2 Mode of operation

The appropriate test mode was loaded on the EUT via the software “AppBlaster”.

For all tests except AC power line conducted emissions the software “TWN4_NKx403_C6T106_CH00_125kHz.bix” was used. In this case, the EUT was continuously searching for the 125 kHz tag and transmitting a modulated signal on 2402 MHz.

Additionally, for all tests except AC power line conducted emissions the software “TWN4_NKx403_C6T106_CH00_13.56MHz.bix” was used. In this case, the EUT was continuously searching for the 13.56 MHz tag and transmitting a modulated signal on 2402 MHz.

For AC power line conducted emissions the software “TWN4_NKx403_C6T106_Continous_M1_LEGIC_Connect_125kHz_13.56MHz.bix” was used. In this case, the EUT was continuously searching for the 125 kHz tag and the 13.56 MHz tag and was simultaneously connected to a smartphone via BLE. An app was continuously exchanging data with the EUT.

6 Photo documentation

For pictures of the Test setups see Annex A, for pictures of the EUT see Annex B.

7 Test procedures

7.1 General specifications

7.1.1 Test setups

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

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

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

7.1.2 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.

7.2 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.

7.3 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 5: 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 6.

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 6: 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 6).
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.

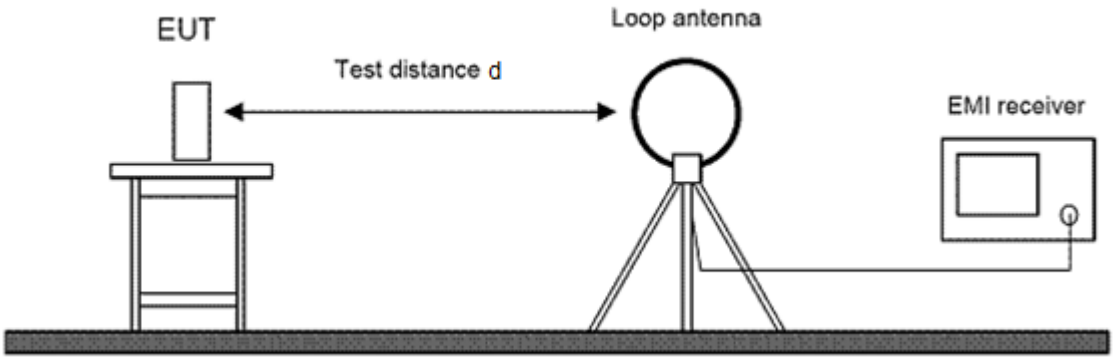


Figure 1: Setup for radiated emissions test below 30 MHz

7.4 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 7.

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 7: 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 7).
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.

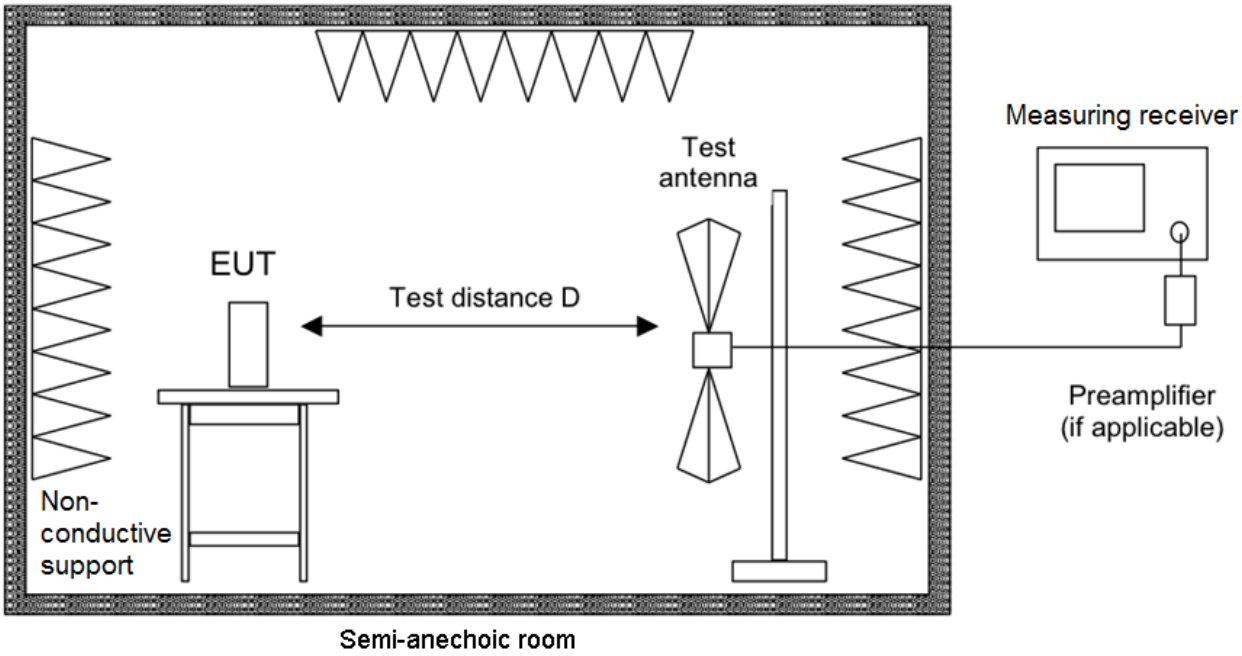


Figure 2: Setup for radiated emissions test from 30 MHz to 1 GHz

7.5 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

7.5.1 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 8.

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 8: 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.

7.5.2 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 9.

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

Table 9: 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 9).
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.

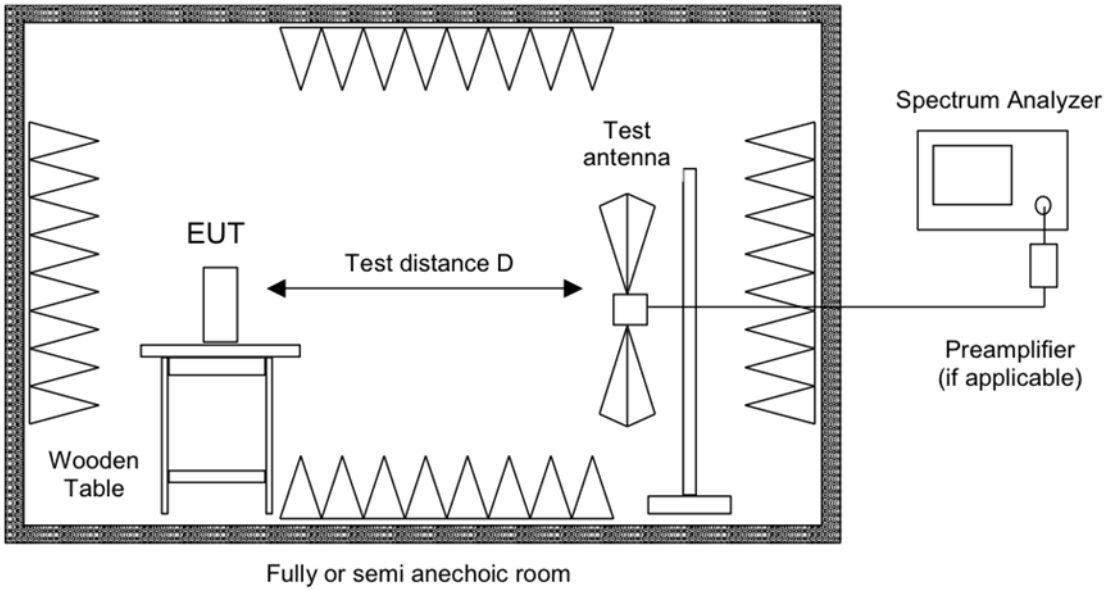


Figure 3: Setup for radiated emissions test above 1 GHz

7.6 Maximum peak conducted output power

In case of antenna-port conducted tests 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 7.1.2

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

The spectrum analyzer settings are as follows:

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

8 Test results

This clause gives details about the test results as collected in the summary of test results on page 7.

For information about measurement uncertainties see page 52.

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

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

8.1 AC powerline conducted emissions

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

Performed by:	Jennifer Riedel B. Eng.	Date(s) of test:	January 14, 2021; February 5, 2021
Result:	☒ Test passed	☐ Test not passed	

8.1.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
Shielded room	P92007	Siemens Matsushita	E00107
EMI test receiver	ESW 44	Rohde & Schwarz	E00895
Artificial mains network	ESH2-Z5	Rohde & Schwarz	E00004
Attenuator (10 dB)	50FHB-010-10	JFW Industries	E00471
Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777

8.1.1 Limits

According to 15.207(a) and RSS-Gen section 8.8:
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 10.

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

Table 10: Limits for AC powerline conducted emissions according to 15.207(a) and RSS-Gen, section 8.8

*Decreases with the logarithm of the frequency

8.1.2 Test procedure

The AC powerline conducted emissions are measured using the test procedure as described in clause 7.2 and referring to the test method for conducted measurements as described in clause 7.2.

8.1.3 Test results

Note(s):
1 The notebook was powered with 120 V / 60 Hz.
2 All three technologies were active at the same time.
3 The frequency 13.56 MHz is the carrier frequency and not in consideration in this test.
4 No assessable emissions were detected.

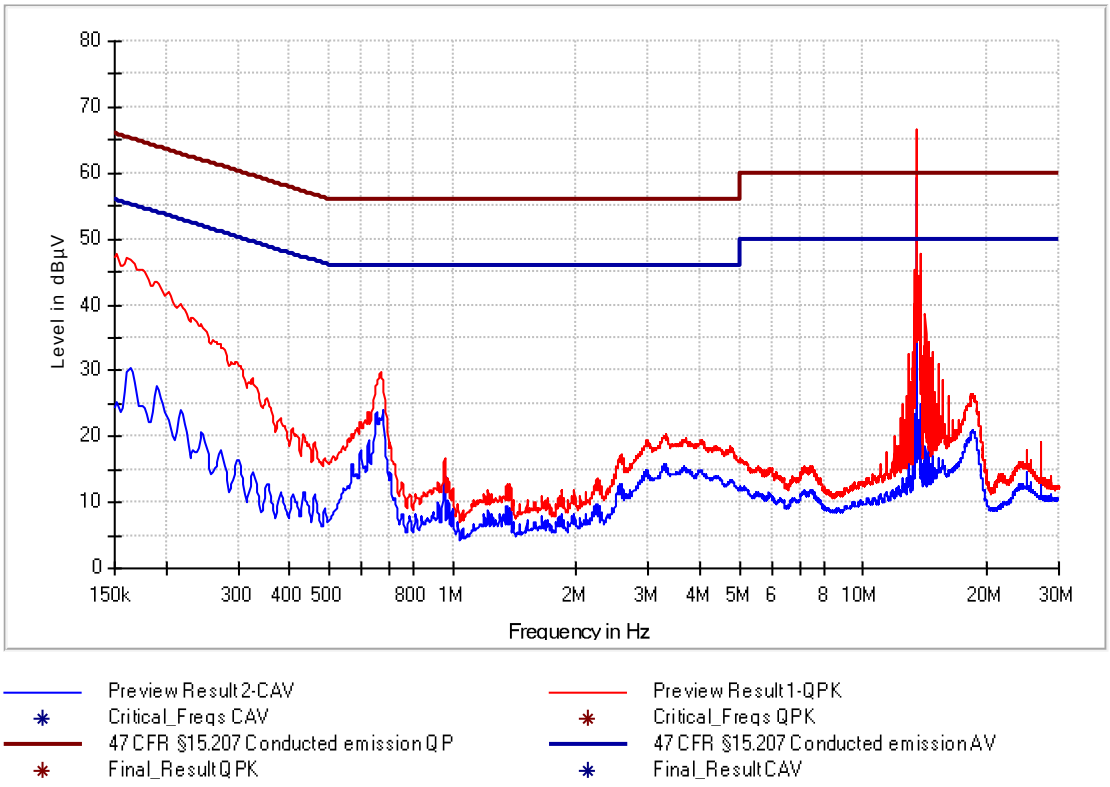


Figure 4: Chart of AC power-line conducted emissions test – phase L1

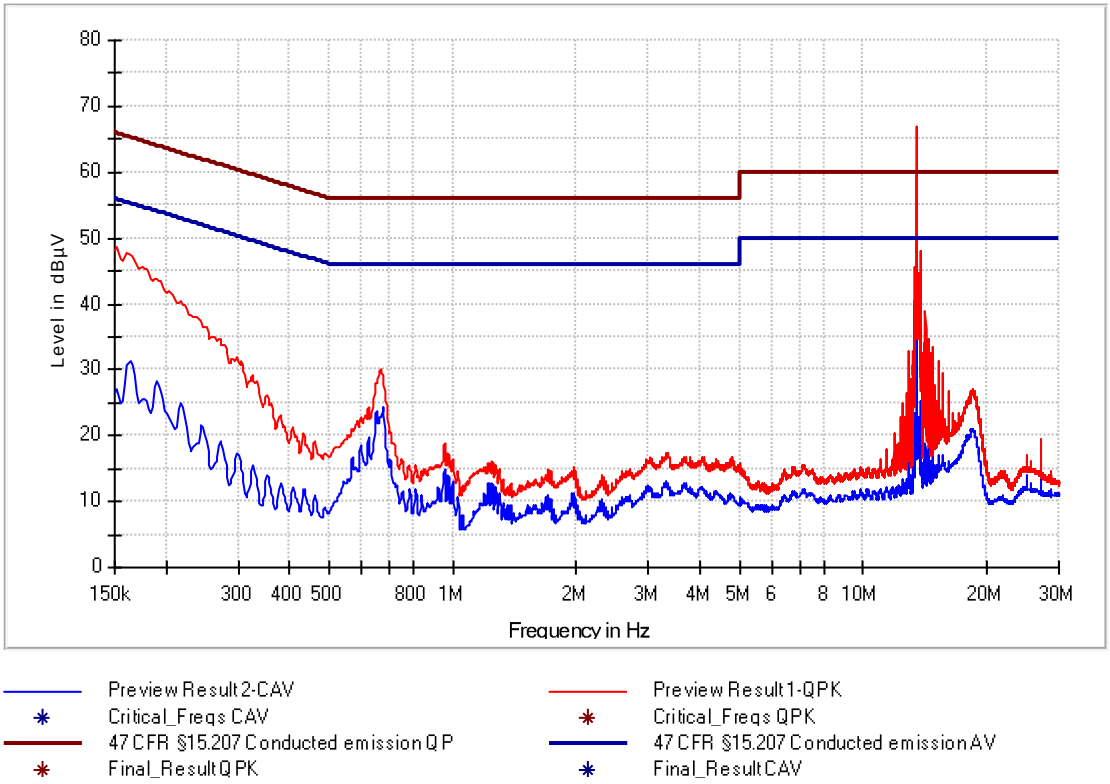


Figure 5: Chart of AC power-line conducted emissions test – phase N

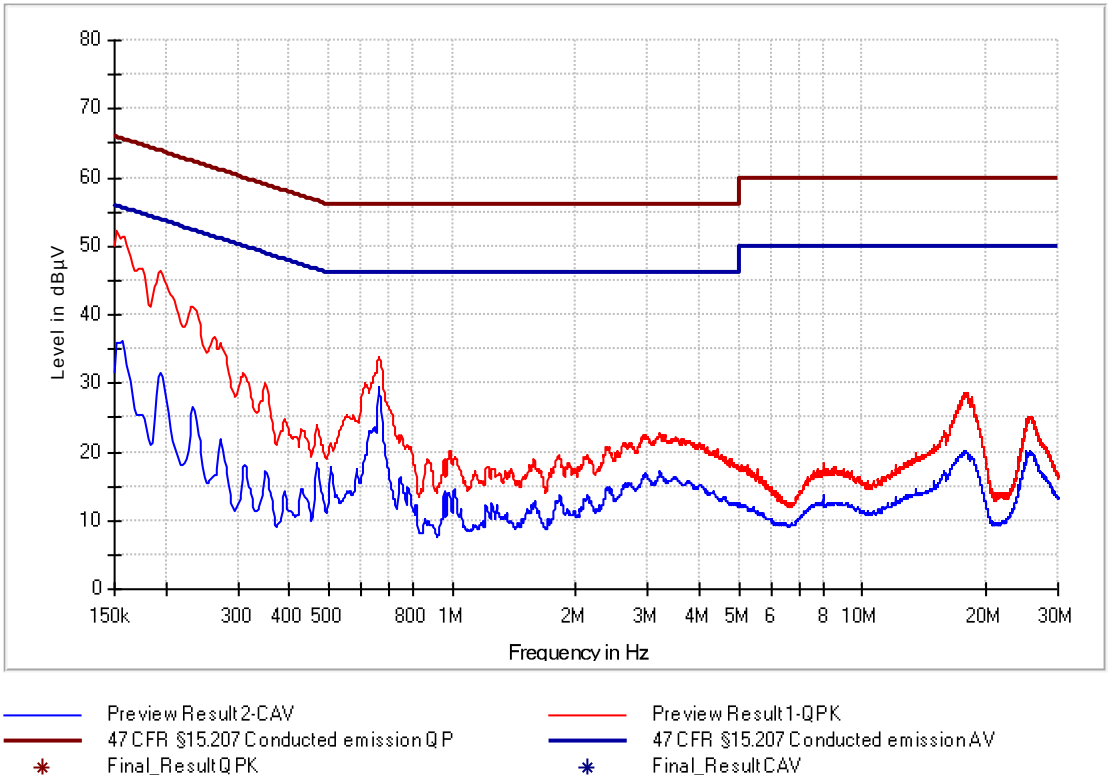


Figure 6: Chart of AC powerline conducted emissions on L1 – with termination of the 13.56 MHz technology

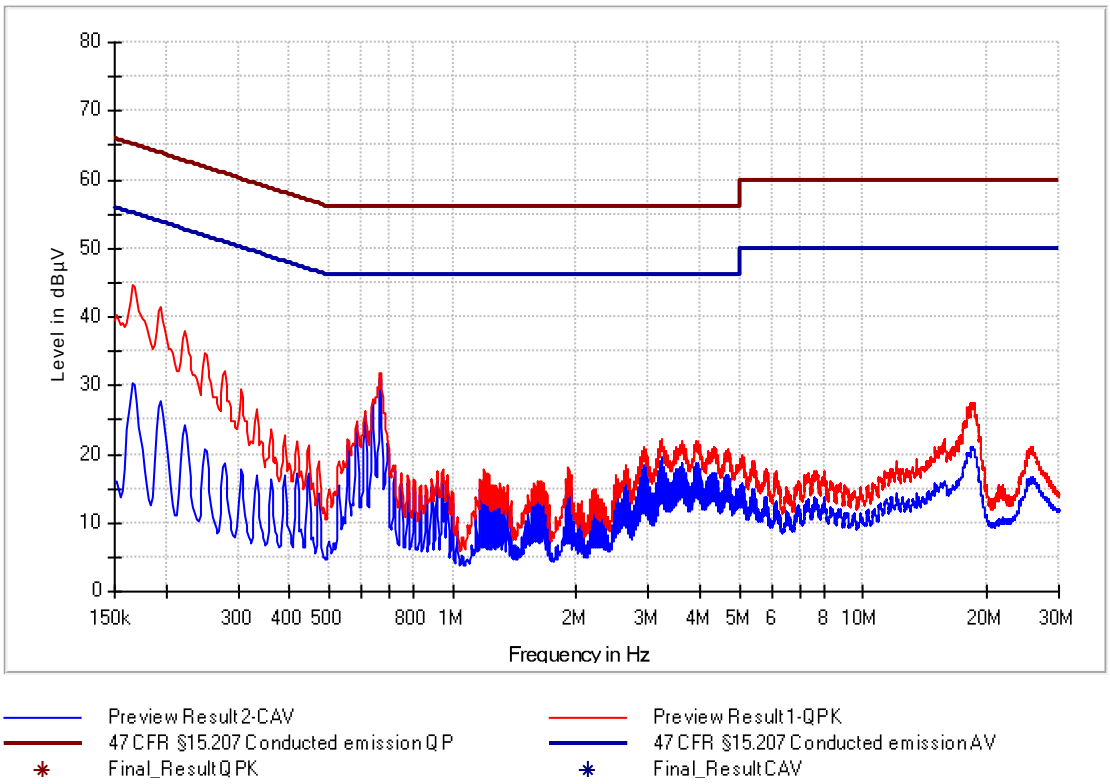


Figure 7: Chart of AC powerline conducted emissions on N – with termination of the 13.56 MHz technology

8.2 Calculated conducted output power

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

Performed by:	Jennifer Riedel B. Eng.	Date(s) of test:	January 14, 2021
Result:	☒ Test passed	☐ Test not passed	

8.2.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
Free space semi-anechoic chamber (FS-SAC)	FS-SAC	ELEMENT STRAUBING	E00100
EMI test receiver	ESW 44	Rohde & Schwarz	E00895
Horn antenna	BBHA 9120D	Schwarzbeck	W00053
Cable set FS-SAC	RF cable(s)	Teledyne Reynolds Huber + Suhner Teledyne Reynolds	E00435 E00307 E00433

8.2.2 Limits

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

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

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

8.2.3 Test procedure

The maximum peak conducted output power is measured using the test procedure as described in clause 7.6 and referring to the test method for radiated measurements as described in clause 7.5, subtracting the gain and calculate the conducted power.

8.2.4 Test results

Test distance:	☒ 3 m	☐ 10 m	☐ 1.50 m
EUT position:	☒ Position X	☒ Position Y	☒ Position Z

Note(s):
1 BLE and 13.56 MHz were active for this test.
2 The gain of the antenna is below 6 dBi, therefore a reduction of the conducted limit was not applied.
3 Premeasurements were performed to declare the worst case which is documented below.
4 The EIRP was calculated as defined in ANSI C63.10-2013, clause 12.7.3:

$$EIRP\ (dBm) = Field\ strength\ at\ 3\ m\ \left(\frac{dB\mu V}{m}\right) - 95.2$$

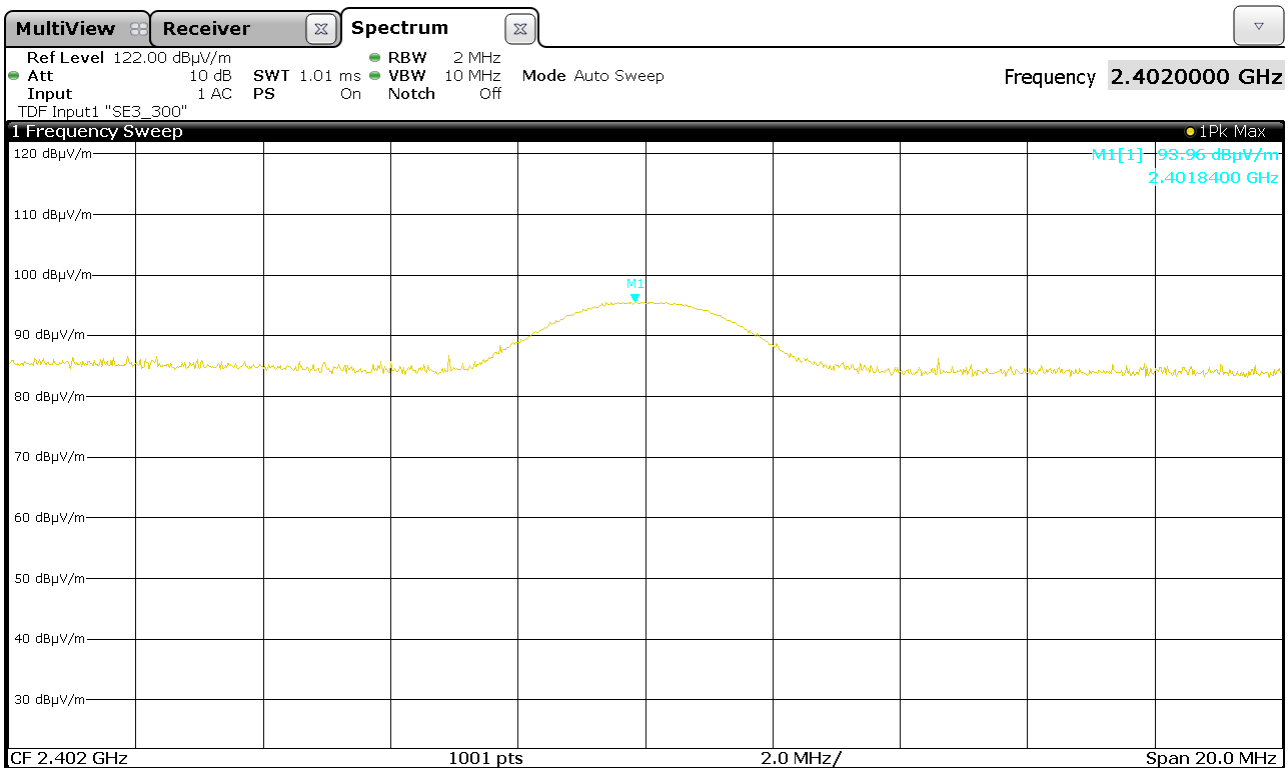


Figure 8: Chart of field strength at 3 m on lowest channel, with Peak-detector, EUT position Z, antenna polarization horizontal

Channel	*Field strength at 3 m (dBµV/m)*	*EIRP (dBm)*	*Antenna gain (dBi)*	*Calculated conducted output power (dBm)*	*Limit (dBm)*	*Margin (dB)*	*Results*
Low	93.96	-1.24	0.5	-0.74	30.00	30.74	Passed

Table 11: Results of calculated conducted output power

8.3 Band-edge measurements

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

Performed by:	Jennifer Riedel B. Eng.	Date(s) of test:	January 14, 2021
Result:	☒ Test passed	☐ Test not passed	

8.3.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
Free space semi-anechoic chamber (FS-SAC)	FS-SAC	ELEMENT STRAUBING	E00100
EMI test receiver	ESR 7	Rohde & Schwarz	E00739
Horn antenna	BBHA 9120D	Schwarzbeck	W00053
Cable set FS-SAC	RF cable(s)	Teledyne Reynolds Huber + Suhner Teledyne Reynolds	E00435 E00307 E00433

8.3.2 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 12: 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 12) must also comply with the radiated emission limits specified in §15.209(a)

8.3.3 Test procedure

The band-edge measurements are performed using the test procedure for radiated measurements as described in clause 7.5.

8.3.4 Test results

Test distance:	☒ 3 m	☐ 10 m	☐ 1.50 m
EUT position:	☒ Position X	☒ Position Y	☒ Position Z

Note(s):
1. BLE and 13.56 MHz were active for this test.
2. Premeasurements were performed to declare the worst case which is documented below.

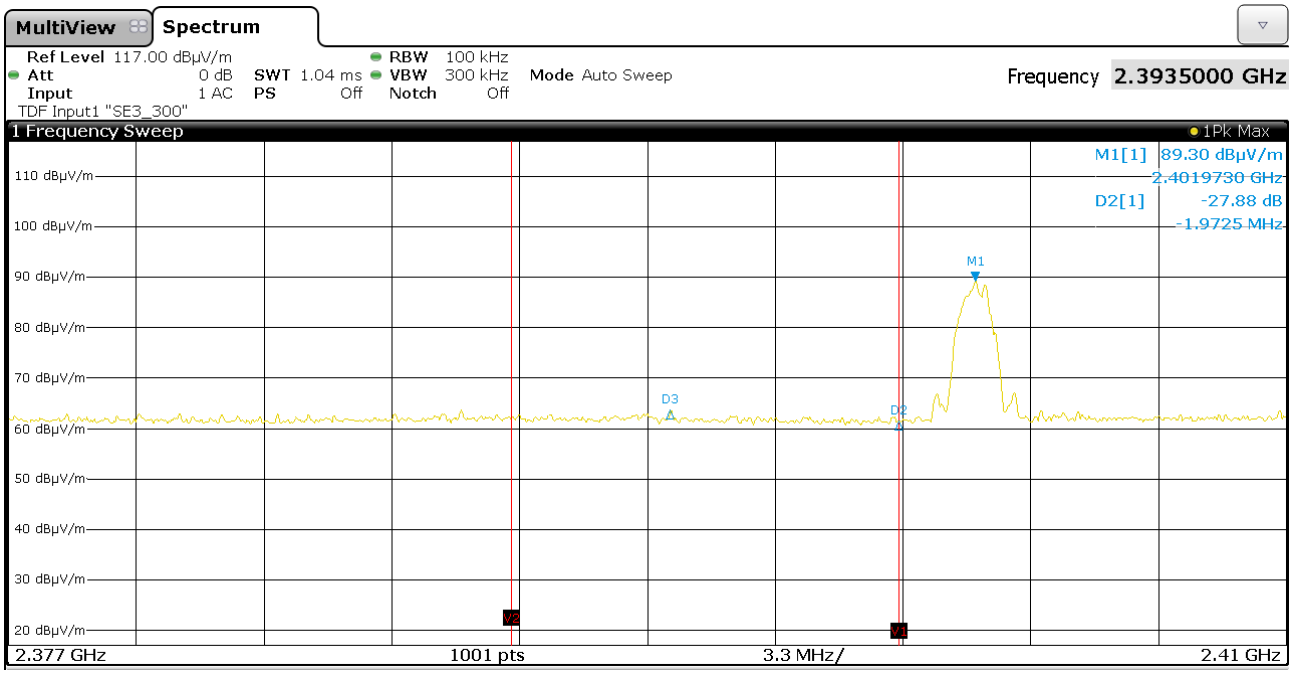


Figure 9: Chart of band-edge measurement on lowest channel and 13.56 MHz, EUT in position Z, measurement antenna in horizontal polarization

Frequency (MHz)	*Measured Margin (dB)*	*Minimum Margin (dB)*	*Result*
2400.000	27.88	≥ 20	Passed
2394.094	25.68	≥ 20	Passed

Table 13: Test results of band-edge measurements on lowest channel and 13.56 MHz

8.4 Spurious emissions below 30 MHz

Section(s) in 47 CFR Part 15:	Requirement(s):	15.209(a) 15.225(d) 15.247(d)
	Reference(s):	KDB 558074 D01, clauses 8.5 and 8.6 ANSI C63.10, clause 6.4
Section(s) in RSS:	Requirement(s):	RSS-210, section B.6 (a) IV RSS-247, section 5.5
	Reference(s):	KDB 558074 D01, clauses 8.5 and 8.6 ANSI C63.10, clause 6.4

Performed by:	Jennifer Riedel B. Eng.	Date(s) of test:	January 18, 2021
Result:	☒ Test passed	☐ Test not passed	

8.4.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
Compact Diagnostic Chamber (CDC)	VK041.0174	Albatross Projects	E00026
EMI test receiver	ESR 7	Rohde & Schwarz	E00739
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-MEB (V10.35)	Rohde & Schwarz	E00778

8.4.2 Limits

According to §15.225(d):
The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in §15.209.

According to RSS-210, section B.6 (a) IV:
RSS-Gen general field strength limits for frequencies outside the band 13.110-14.010 MHz.

Frequency	*Field strength*		*Measurement distance*
(MHz)	*(µA/m)*	*(dBµA/m)*	*(m)*
0.009 – 0.490	6.37/F(kHz) (0.708 – 0.013)	-2.999 – -37.721	300
0.490 – 1.705	63.7/F(kHz) (0.13 – 0.037)	-17.721 – -28.636	30
1.705 – 30	0.08	-21.94	30

Table 14: General radiated emission limits up to 30 MHz according to RSS 210

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 and Table 14, using the recalculation factor as described in clause 7.3.

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 12) 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 7.3.

8.4.3 Test procedure

The emissions below 30 MHz are measured using the test procedure for radiated measurements as described in clause 7.2.

8.4.4 Test results

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

Note(s):
1. BLE and 125 kHz were active at the same time.
2. Premeasurements were performed to declare the worst-case which is documented below.
3. No assessable emissions could be detected.
4. The emission at 125 kHz is the operating frequency of the EUT and is not in consideration in this test.

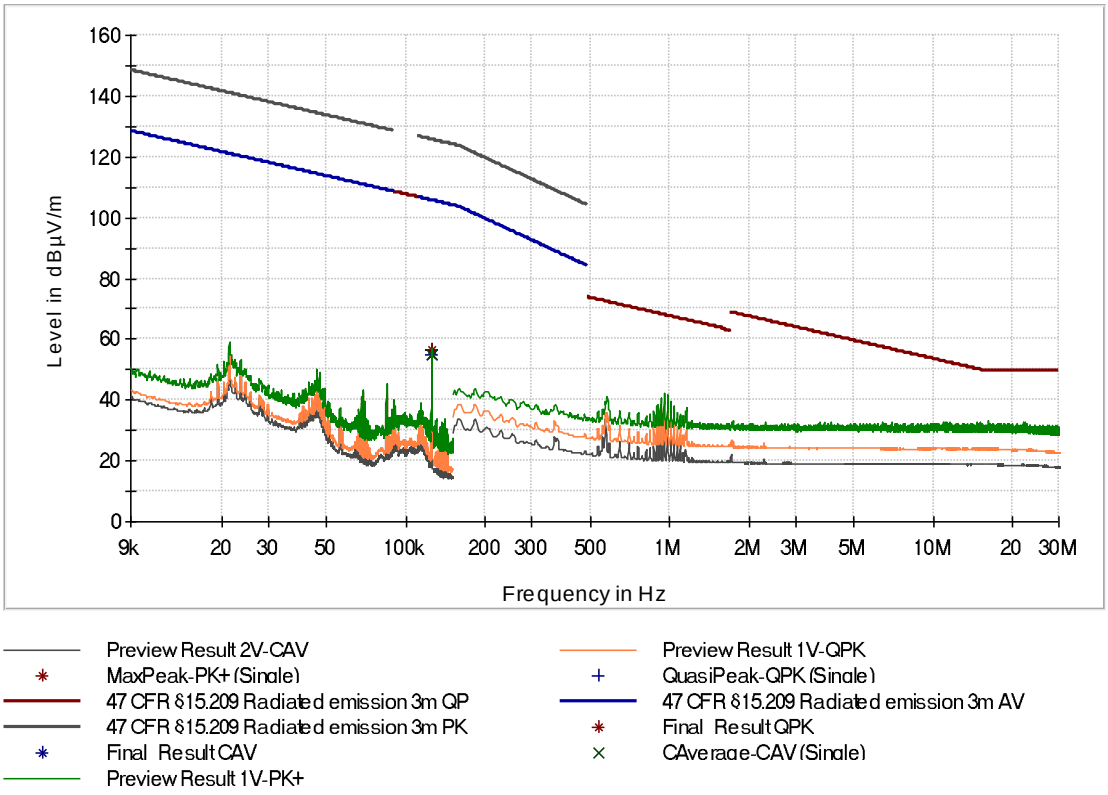


Figure 10: Chart of emissions test below 30 MHz on lowest channel and 125 kHz, EUT position Y, without tag, antenna parallel at 3 m

Note(s):
1 BLE and 13.56 MHz were active at the same time.
2 Premeasurements were performed to declare the worst-case which is documented below.
3 No assessable emissions could be detected.
4 The emission at 13.56 MHz is the operating frequency of the EUT and is not in consideration in this test.

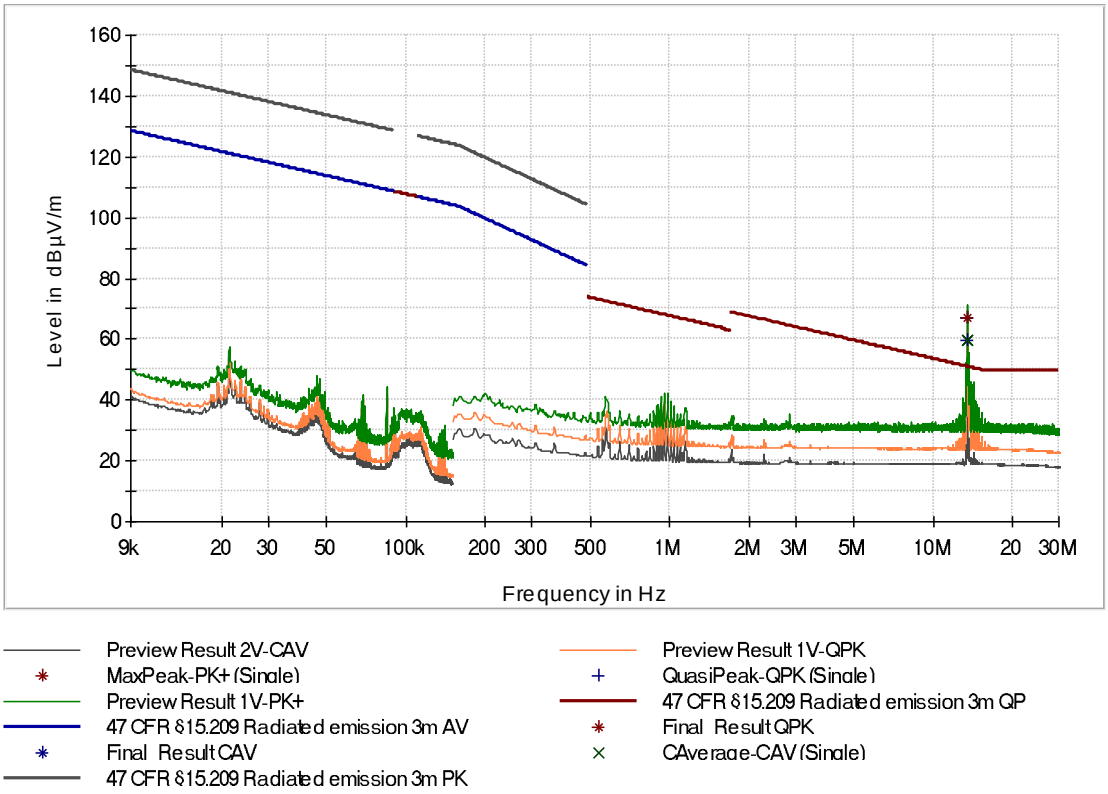


Figure 11: Chart of emissions test below 30 MHz on lowest channel and 13.56 MHz, EUT position Y, without tag, antenna parallel at 3 m

8.5 Spurious emissions from 30 MHz to 1 GHz

Section(s) in 47 CFR Part 15:	Requirement(s):	15.209(a) 15.225 (d) 15.247(d)
	Reference(s):	KDB 558074 D01, clauses 8.4 and 8.5 ANSI C63.10, clause 6.5
Section(s) in RSS:	Requirement(s):	RSS-210, section B.6 (a) IV RSS-247, section 5.5
	Reference(s):	KDB 558074 D01, clauses 8.4 and 8.5 ANSI C63.10, clause 6.5

Performed by:	Jennifer Riedel B. Eng.	Date(s) of test:	January 7, 2021 January 14, 2021
Result:	☒ Test passed	☐ Test not passed	

8.5.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
Semi-anechoic chamber	SAC3	Albatross Projects	E00716
EMI test receiver	ESR 7	Rohde & Schwarz	E00739
TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
Cable set SAC	RF cable(s)	Huber + Suhner	E00755 E01033 E01034
Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778

8.5.2 Limits

According to §15.225(d):
The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in §15.209.

According to RSS-210, section B.6 (a) IV:
RSS-Gen general field strength limits for frequencies outside the band 13.110-14.010 MHz.

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 12) must also comply with the radiated emission limits specified in §15.209(a).

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 and RSS-Gen

8.5.3 Test procedure

The emissions from 30 MHz to 1 GHz are measured using the test procedure for radiated measurements as described in clause 7.4.

8.5.4 Test results

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

Note(s):
1 BLE and 125 kHz were active at the same time.
2 Premeasurements were performed to declare the worst case which is documented below.

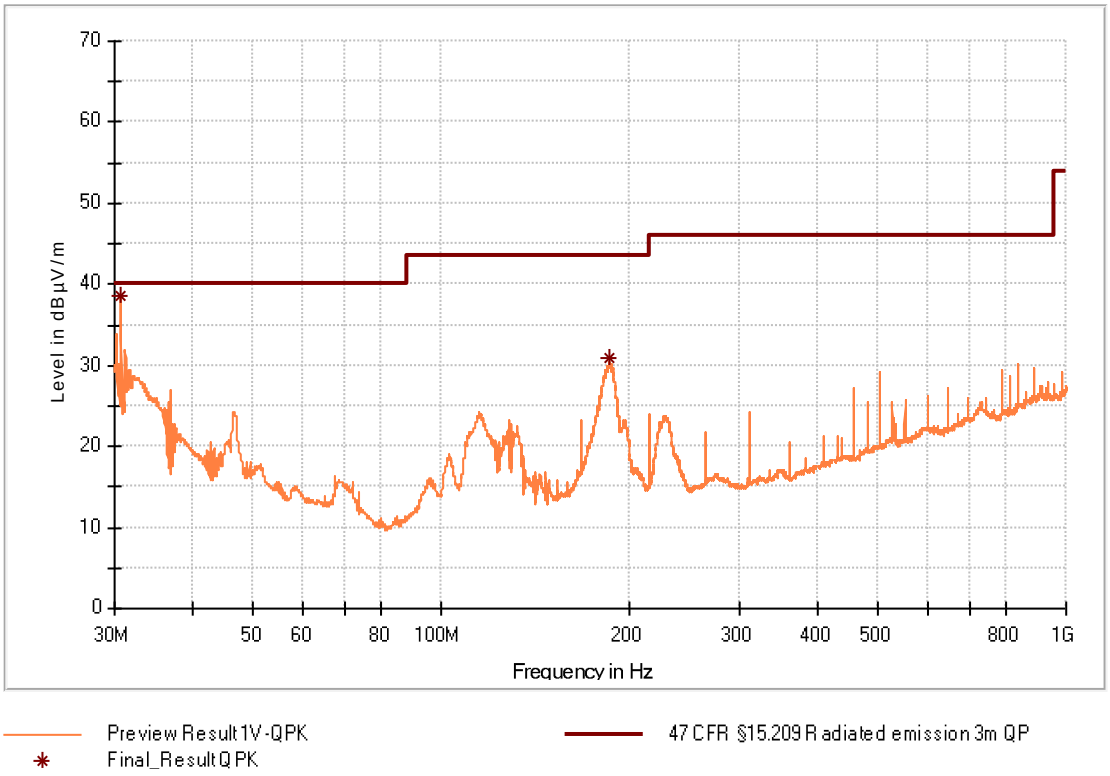


Figure 12: Chart of emissions test from 30 MHz to 1 GHz on lowest channel and 125 kHz, EUT position X, with tag, antenna polarization vertical at 3 m

Frequency (MHz)	*QuasiPeak (dBµV/m)*	*Limit (dBµV/m)*	*Margin (dB)*	*Height (cm)*	*Azimuth (deg)*	*Result*
30.720000	38.57	40.00	1.43	100.0	0.0	Passed
186.390000	30.80	43.50	12.70	100.0	171.0	Passed

Table 17: Final results of emissions test from 30 MHz to 1 GHz on lowest channel and 125 kHz, EUT position X, with tag, antenna polarization vertical at 3 m

Note(s):
1 BLE and 13.56 MHz were active at the same time.
2 Premeasurements were performed to declare the worst case which is documented below.

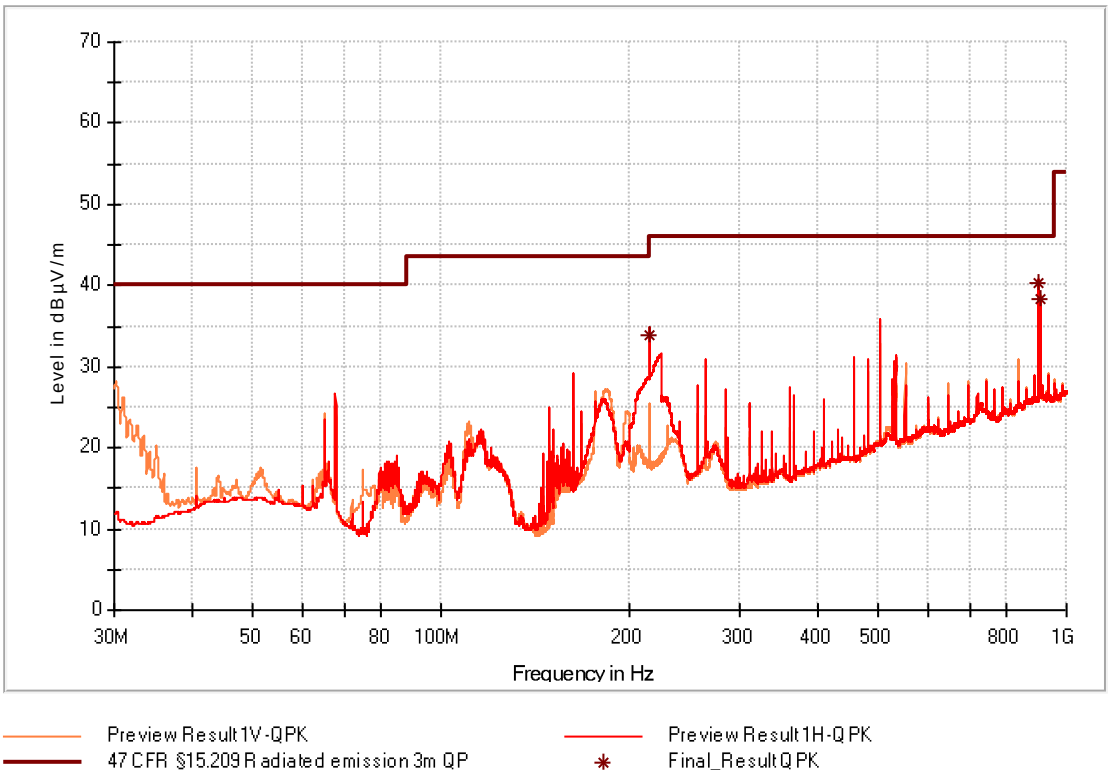


Figure 13: Chart of emissions test from 30 MHz to 1 GHz on lowest channel and 13.56 MHz, EUT position X, with tag at 3 m

Frequency (MHz)	*QuasiPeak (dBµV/m)*	*Limit (dBµV/m)*	*Margin (dB)*	*Height (cm)*	*Pol.*	*Azimuth (deg)*	*Result*
216.000000	33.95	43.50	9.55	150.0	H	171.0	Passed
903.600000	40.39	46.00	5.61	167.0	H	102.0	Passed
907.020000	38.32	46.00	7.68	350.0	V	135.0	Passed

Table 18: Final results of emissions test from 30 MHz to 1 GHz on lowest channel and 13.56 MHz, EUT position X, with tag at 3 m

8.6 Spurious emissions above 1 GHz

Section(s) in 47 CFR Part 15:	Requirement(s):	15.209(a) 15.225(d) 15.247(d)
	Reference(s):	KDB 558074 D01, clauses 8.4 and 8.5 ANSI C63.10, clause 6.5
Section(s) in RSS:	Requirement(s):	RSS-210, section B.6 (a) IV RSS-247, section 5.5
	Reference(s):	KDB 558074 D01, clauses 8.4 and 8.5 ANSI C63.10, clause 6.5

Performed by:	Jennifer Riedel B. Eng.	Date(s) of test:	January 14, 2021; January 20, 2021
Result:	☒ Test passed	☐ Test not passed	

8.6.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
EMI test receiver	ESW 44	Rohde & Schwarz	E00895
EMI test receiver	ESU 26	Rohde & Schwarz	W00002
Horn antenna	BBHA 9120D	Schwarzbeck	W00052
Horn antenna	BBHA 9170	Schwarzbeck	W01350
Preamplifier (1 GHz – 18 GHz)	ALS05749	Aldetec	W01007
Preamplifier (18 GHz – 40 GHz)	BBV 9721	Schwarzbeck	W01350
Cable set SAC	RF cable(s)	Huber + Suhner	E00755 E01033 E01034
Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777

8.6.2 Limits

According to §15.225(d):
The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in §15.209.

According to RSS-210, section B.6 (a) IV:
RSS-Gen general field strength limits for frequencies outside the band 13.110-14.010 MHz.

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 12) must also comply with the radiated emission limits specified in §15.209(a).

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

Table 19: General radiated emission limits above 960 MHz according to §15.209 and RSS-Gen

8.6.3 Test procedure

The emissions from 1 GHz to 25 GHz are measured using the test procedure for radiated measurements as described in clause 7.5.

8.6.4 Test results

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

Note(s):
1 Premeasurements were performed to declare the worst case which is documented below.
2 The measurements from 1 GHz to 18 GHz are made at a measurement distance of 3.0 m.
3 The exploratory measurements from 18 GHz to 25 GHz are made at a measurement distance of 0.5 m. However, the limit lines for these tests are referenced to the limit lines at a measurement distance of 3 m (Offset – 15.6 dB).
4 BLE and 125 kHz were active at the same time.
5 According to clause 6.6.4.3 of ANSI C63.10-2013 note 1, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement.

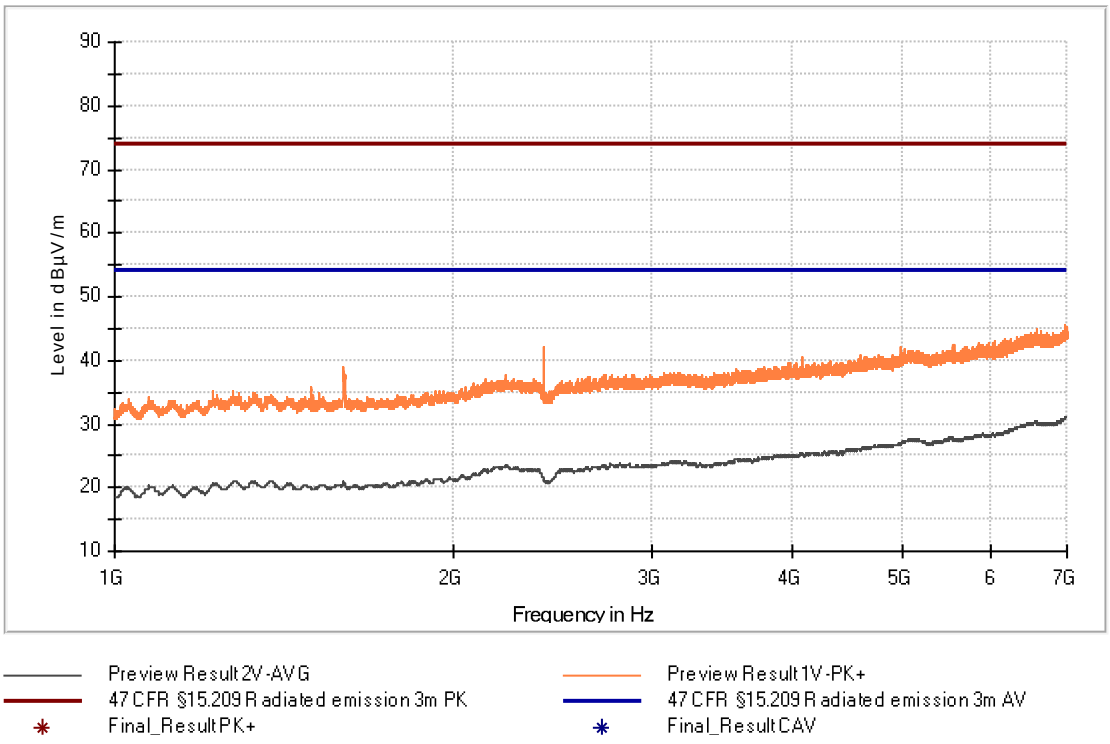


Figure 14: Chart of emissions test from 1 GHz to 7 GHz on lowest channel and 125 kHz, EUT in position Z, with tag and vertical polarization, with notch filter

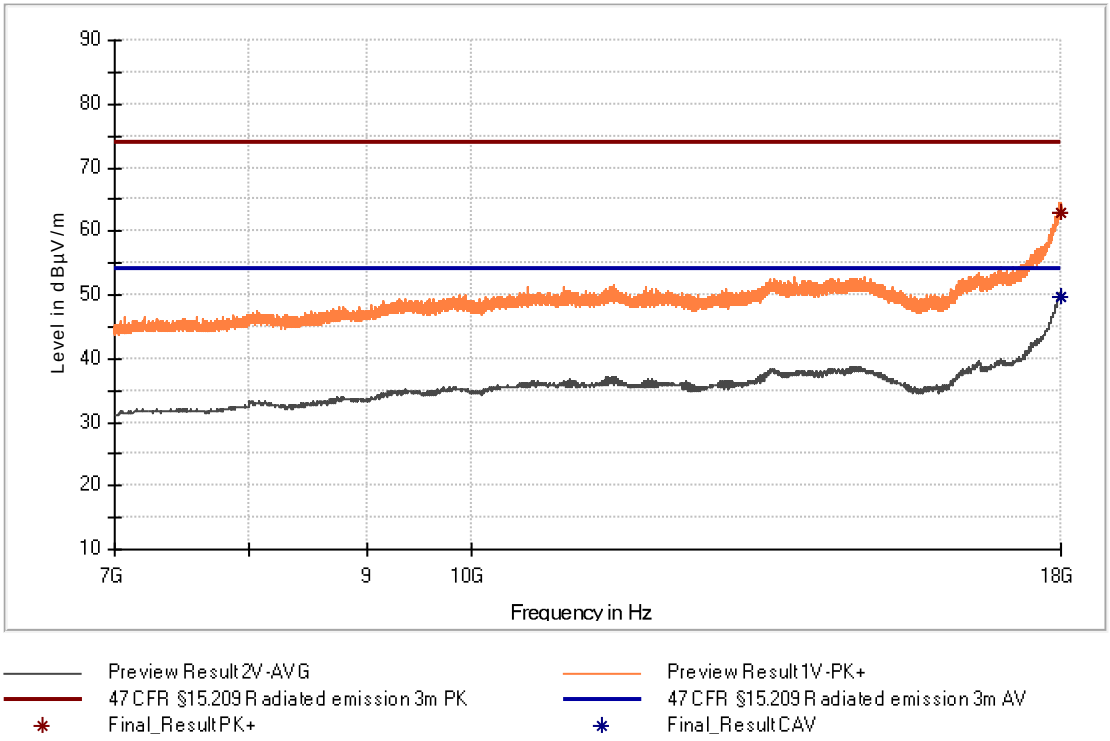


Figure 15: Chart of emissions test from 7 GHz to 18 GHz on lowest channel and 125 kHz, EUT in position Z, with tag and vertical polarization

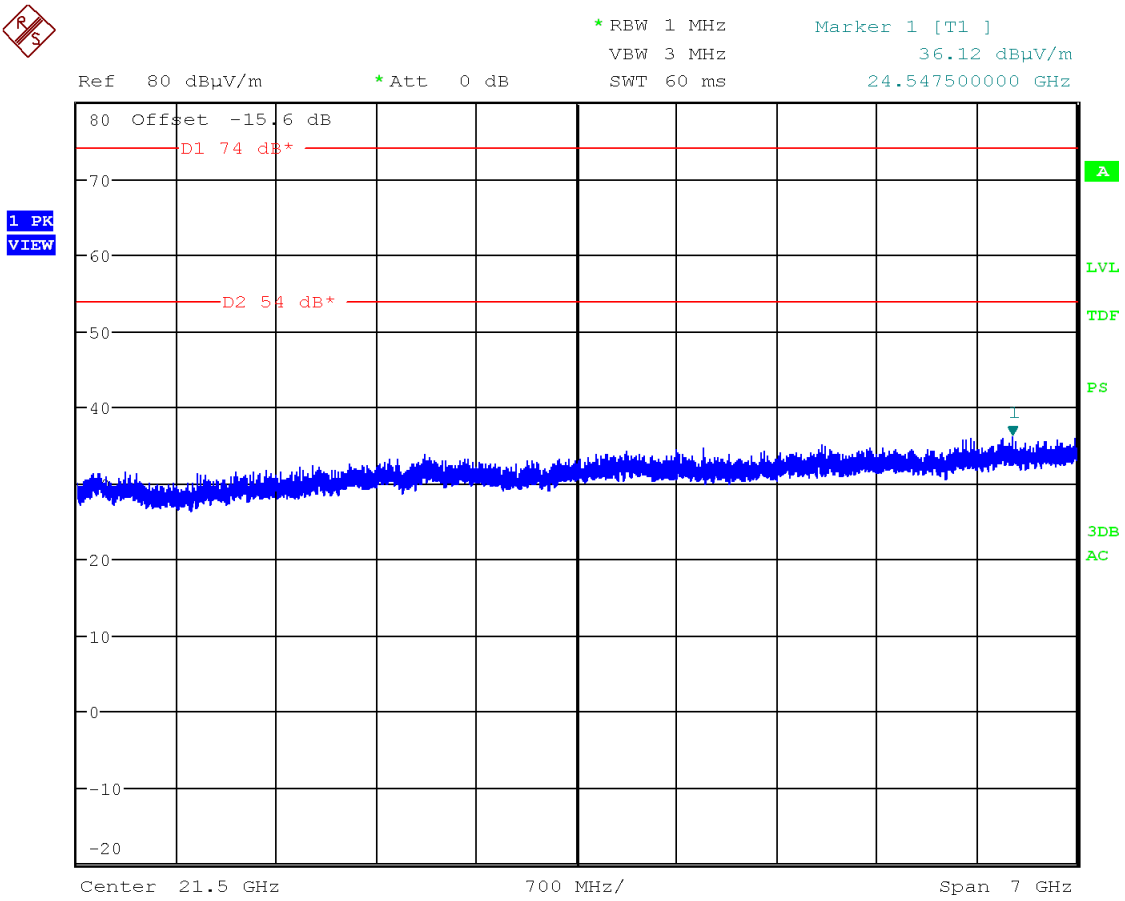


Figure 16: Chart of exploratory emission test from 18 GHz to 25 GHz on lowest channel and 125 kHz

Frequency (MHz)	*MaxPeak (dBµV/m)*	*Average (dBµV/m)*	*Limit (dBµV/m)*	*Margin (dB)*	*Height (cm)*	*Azimuth*
17988.000	63.02	---	74.00	10.98	154.0	305.0
17988.000	---	49.64	54.00	4.36	154.0	305.0

Table 20: Results of emissions test from 1 GHz to 25 GHz on lowest channel and 125 kHz

Note(s):
1 Premeasurements were performed to declare the worst case which is documented below.
2 The measurements from 1 GHz to 18 GHz are made at a measurement distance of 3.0 m.
3 The exploratory measurements from 18 GHz to 25 GHz are made at a measurement distance of 0.5 m. However, the limit lines for these tests are referenced to the limit lines at a measurement distance of 3 m (Offset – 15.6 dB).
4 BLE and 13.56 MHz were active at the same time.
5 According to clause 6.6.4.3 of ANSI C63.10-2013 note 1, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement.

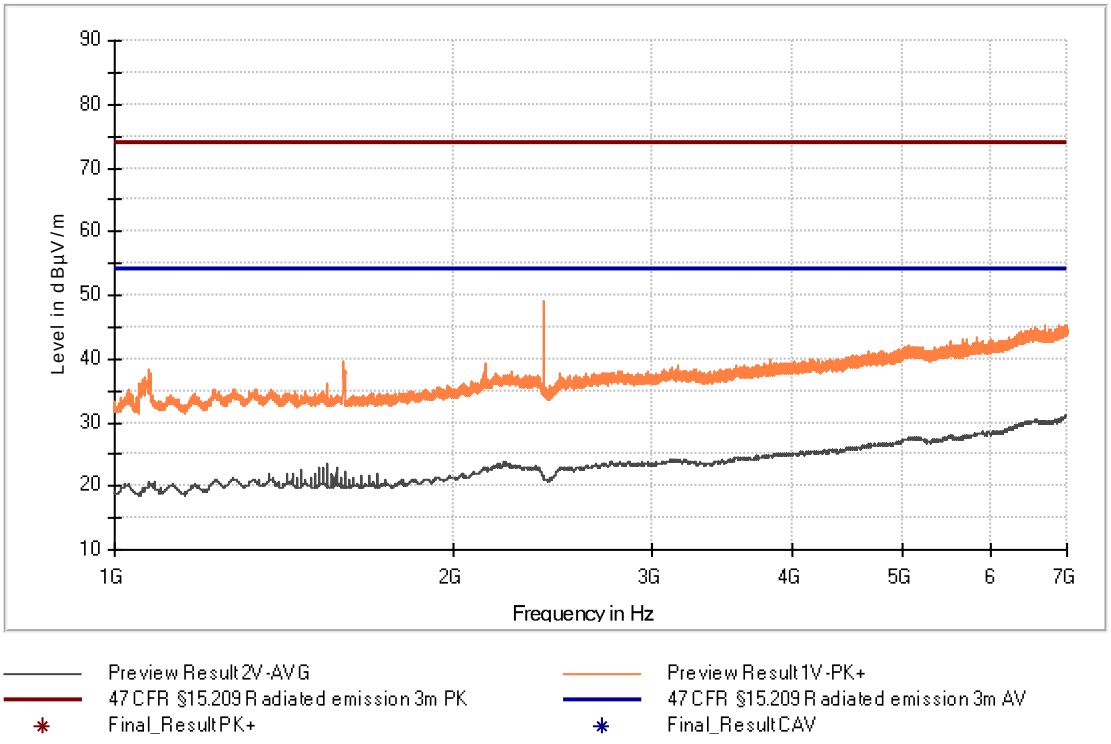


Figure 17: Chart of emissions test from 1 GHz to 7 GHz on lowest channel and 13.56 MHz, EUT in position Z, with tag and vertical polarization, with notch filter

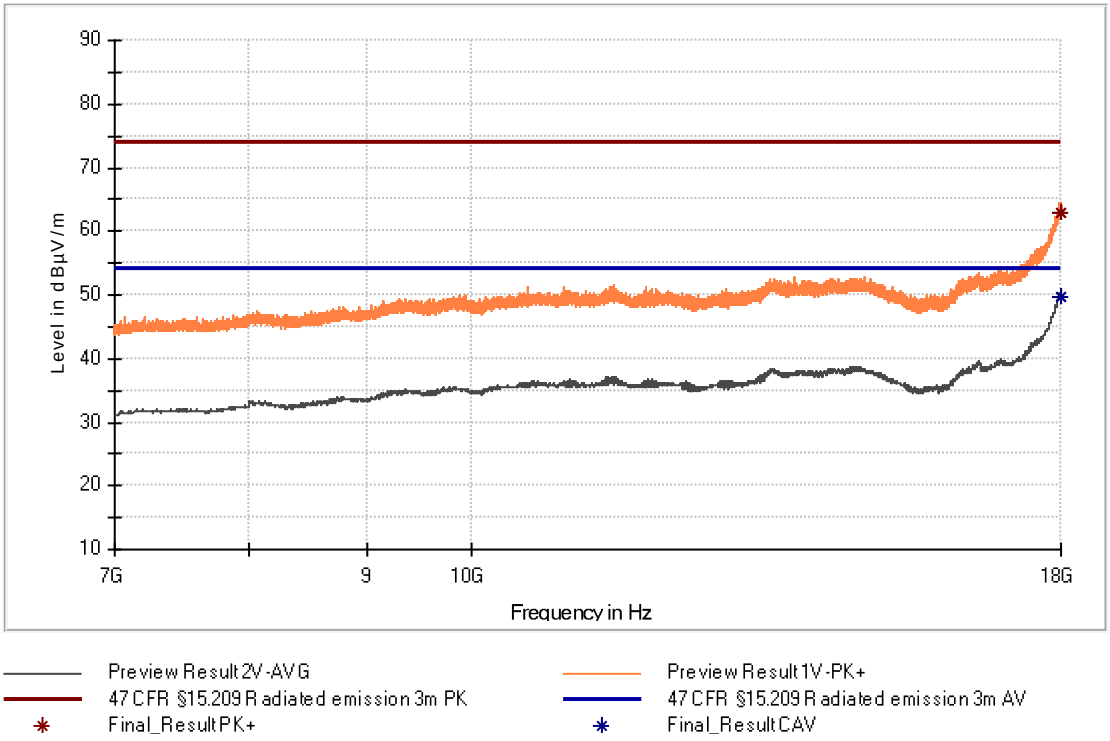


Figure 18: Chart of emissions test from 7 GHz to 18 GHz on lowest channel and 13.56 MHz, EUT in position Z, with tag and vertical polarization

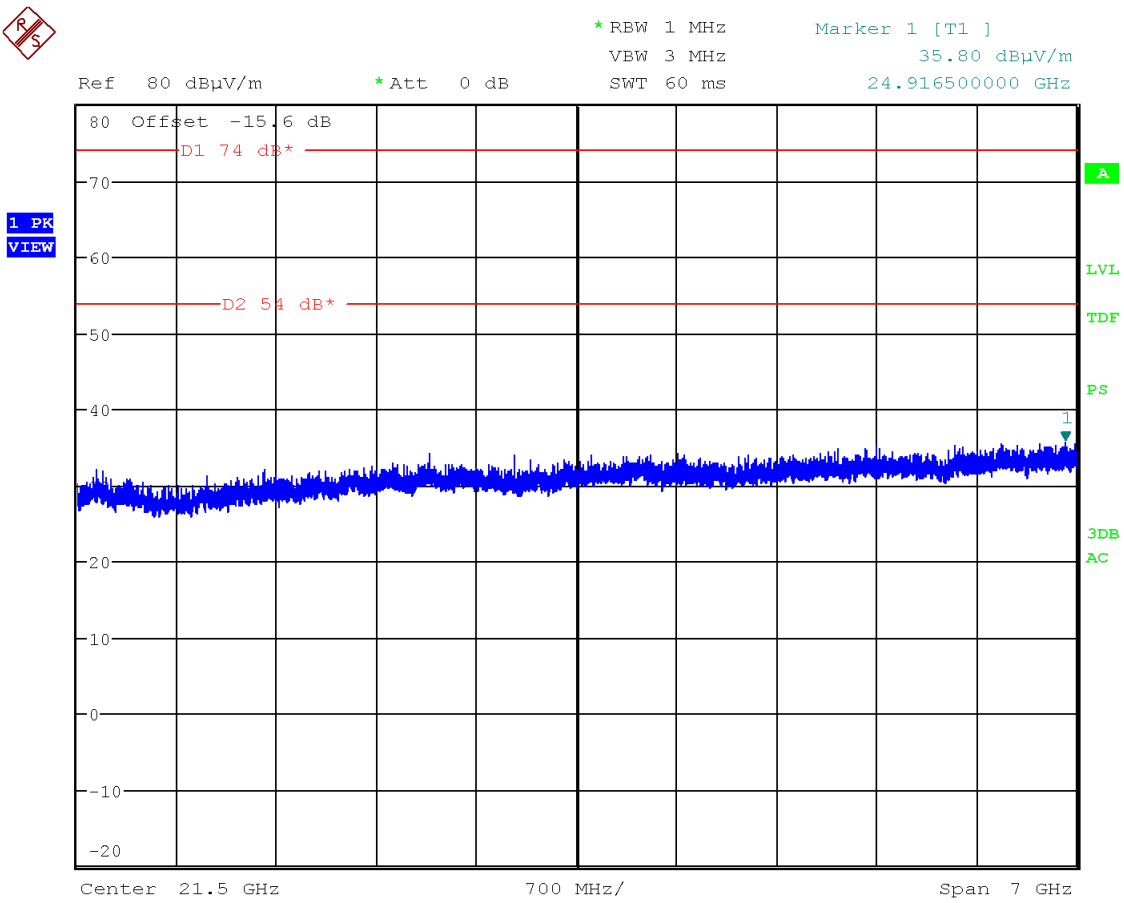


Figure 19: Chart of exploratory emission test from 18 GHz to 25 GHz on lowest channel and 13.56 MHz

Frequency (MHz)	*MaxPeak (dBµV/m)*	*Average (dBµV/m)*	*Limit (dBµV/m)*	*Margin (dB)*	*Height (cm)*	*Azimuth*
17988.000	63.03	---	74.00	10.97	154.0	305.0
17988.000	---	49.62	54.00	4.38	154.0	305.0

Table 21: Results of emissions test from 1 GHz to 25 GHz on lowest channel and 13.56 MHz

9 Equipment calibration status

Description	*Modell number*	*Serial number*	*Inventory number(s)*	*Last calibration*	*Next calibration*
EMI test receiver	ESW44	101538	E00895	2020-08	2022-08
EMI test receiver	ESU26	100026	W00002	2020-06	2022-06
EMI test receiver	ESR7	101059	E00739	2019-08	2021-08
EMI test receiver	ESCI3	100328	E00552	2020-10	2022-10
EMI test receiver	ESCI3	100013	E00001	2020-05	2022-05
Preamplifier (0.55 GHz - 18 GHz)	BBV 9718 B	00032	W01325	2020-10	2021-10
Preamplifier (18 GHz - 40 GHz)	BBV 9721	43	W01350	2020-11	2021-11
Preamplifier (1 GHz - 18 GHz)	ALS05749	001	W01007	2021-01	2022-01
Loop antenna	HFH2-Z2	871398/0050	E00060	2020-10	2021-10
LISN	ESH2-Z5	881362/037	E00004	Note 1	
LISN	ESH2-Z5	893406/009	E00005	2020-10	2021-10
Field probe	RF-R 400-1	02-2030	E00270	Note 2	
TRILOG broadband antenna (SAC3)	VULB 9162	9162-041	E00643	2018-03	2021-03
Horn antenna	BBHA 9120D	9120D-592	W00053	2020-04	2023-04
Horn antenna	BBHA 9170	9170-332	W00055	2020-04	2023-04
Shielded room	P92007	B 83117 C 1109 T 211	E00107	N/A	
Compact diagnostic chamber (CDC)	VK041.0174	D62128-A502-A69-2-0006	E00026	N/A	
Semi-anechoic chamber (SAC) with floor absorbers	FS-SAC	---	E00100	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	2020-04	2021-04
	LCF12-50J	---	E01215	2020-04	2021-04
	LMR400	1718020006	E00920	2021-01	2022-01
	RG214 Hiflex	171802007	E00921	2021-01	2022-01
Cable set anechoic chamber	262-0942-1500	005	E00435	2020-10	2021-10
	SF104EA/2x11PC35-42/5m	11144/4EA	E00307	2020-12	2021-12
	262-0942-1500	003	E00433	2020-10	2021-10
Cable set of semi-anechoic chamber SAC3	SF104EA/11PC35/11PC35/10000MM	501347/4EA	E00755	2020-12	2021-12
	SF104E/11PC35/11PC35/2000MM	507410/4E	E01035	2020-12	2021-12
	SF104E/11PC35/11PC35/2000MM	507411/4E	E01034	2020-09	2021-09

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

10 Measurement uncertainties

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

Note(s):

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

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

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

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

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

11 Revision history

Revision	*Date*	*Issued by*	*Description of modifications*
0	2021-02-08	Jennifer Riedel B. Eng.	First edition

Template: RF_FCC_IC_Colocation_V1.1