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Radio Radio Radio Radio Radio Radio Radio Radio Radio Radio

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Test report no.:

220365-AU01+W09

for:

Rotronic AG
BLE probe
AwEasy
and
QI charger for BLE probe
AwEasy-Charger

according to:

47 CFR Part 15, §15.209 (partly)
47 CFR Part 15, §15.247 (partly)
RSS-216 (partly)
RSS-247 (partly)

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

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

Accreditation:

FCC test firm accreditation expiration date: 2024-05-17
MRA US-EU, FCC designation number: DE0010
Test firm registration number: 997268
FCC Registration Number (FRN): 0032245045
BnetzA-CAB-02/21-02/6 Valid until 2023-11-26

Recognized until 2025-03-16 by the
Department of Innovation, Science and Economic Development Canada (ISED)
as a recognized testing laboratory
CAB identifier: DE0011
Company number: 3472A

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1 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 15.209

System type: WPT

47 CFR part and section	*Test*	*Page*	*Result*	*Note(s)*
15.207(a)	AC powerline conducted emissions	29	Passed	---
15.209(a)	Radiated emissions below 30 MHz	41	Passed	---
15.209(a)	Radiated emissions from 30 MHz to 1 GHz	47	Passed	---
15.209(a)	Radiated emissions > 1 GHz	51	Passed	---

Note(s):
1 For information about EUT see clause 4.

2.2 RSS-216

System type: WPT

IC standards	*Test*	*Page*	*Result*	*Note(s)*
RSS-216, section 6.2.2.1	AC powerline conducted emissions	29	Passed	---
RSS-216, section 6.2.2.2 and 6.2.3	Radiated emissions below 30 MHz	41	Passed	---
RSS-216, section 6.2.2.2	Radiated emissions from 30 MHz to 1 GHz	47	Passed	---

Notes:
1 For information about EUT see clause 4.
2 RSS-216 specifies limits from 9 kHz to 1 GHz. The highest internal frequency of the BLE probe is 2.5 GHz. Tests > 1 GHz are only applicable in charging mode. The appropriate tests are documented in clause 7.5.

2.3 15.247 and RSS-247

System type: Digital transmission system (DTS)

47 CFR part and section	*Test*	*Equivalent to IC radio standard(s)*	*Page*	*Result*	*Note(s)*
15.207	AC powerline conducted emissions	RSS-Gen, section 8.8	29	Passed	2
15.247(b)	Calculated conducted output power	RSS-247, section 5.4	36	Passed	---
15.247(d)	Radiated emissions below 30 MHz	RSS-247, section 5.5	41	Passed	---
15.247(d)	Radiated emissions from 30 MHz to 1 GHz	RSS-247, section 5.5	47	Passed	---
15.247(d)	Radiated emissions from 1 GHz to 25 GHz (10th harmonic)	RSS-247, section 5.5	51	Passed	---
15.247(i)	Radio frequency radiation exposure	RSS-Gen, Section 3.4	---	Not performed	3

Note(s):
1 For information about EUT see clause 4.
2 Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.
3 Radio frequency radiation exposure is in consideration in another test report.

Straubing, June 22, 2023

Tested by
Konrad Graßl
Department Manager Radio

Approved by
Rainer Heller Dipl.-Ing. (FH)
Reviewer

3 Referenced publications

Publication	*Title*
CFR 47 Part 2 October 2022	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 2022	Code of Federal Regulations, Title 47 (Telecommunication), Part 15 (Radio Frequency Devices) of the Federal Communication Commission (FCC)
KDB 174176 D01 June 3, 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), Frequency Hopping Spread Spectrum Sytem, and Hybrid System Devices Operating Under §15.247 of the FCC Rules
ANSI C63.10 June 2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
RSS-Gen Issue 5 April 2018 Amendment 1 (March 2019) Amendment 2 (February 2021)	Spectrum Management and Telecommunications - Radio Standards Specification - General Requirements for Compliance of Radio Apparatus
RSS-216 Issue 2, January 2016 Amendment 1, September 2020	Spectrum Management and Telecommunications Radio Standards Specification Wireless Power Transfer Devices
ICES-001 Issue 5, July 2020	Spectrum Management and Telecommunications Interference-Causing Equipment Standard Industrial, Scientific and Medical (ISM) 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:	BLE probe		
Model name:	AwEasy		
Serial number:	n/a		
Manufacturer:	Rotronic AG		
Version:	Hardware:	KE_052_013_v100	
	Software:	V84	
Short description:	EUT is a water activity probe with integrated BLE.		
Additional modifications:	None		
FCC ID of integrated radio module:	SQGBL653		
IC registration number of integrated radio module:	3147A-BL653		
Power supply:	Battery supply (NiMH)		
	Nominal voltage:	3.6 V	
Device type:	☒ Portable	☐ Mobile	☐ Fixed

Product type:	QI charger for BLE probe		
Model name:	AwEasy-Charger		
Serial number:	n/a		
Manufacturer:	Rotronic AG		
Version:	Hardware:	KE_052_013_v100	
	Software:	No FW / complies with WPC 1.2 standard	
Short description:	EUT is a wireless power transmitter with additional communication capability.		
Additional modifications:	None		
FCC ID:	2AG4J-AWEY		
IC certification number:	30048-AWEY		
Highest internal frequency:	205 kHz		
Power supply:	DC supply		
	Nominal voltage:	5.0 V	
Device type:	☐ Portable	☒ Mobile	☐ Fixed

4.2 Radio specifications

RF technology 1:

Application(s):	Wireless Power Transmission (WPT) including inherent radio communication functionality or radio determination via the WPT interface or port at the specific WPT frequency ranges		
Operating frequency range(s):	139.5 kHz to 174.7 kHz		
Modulation:	ASK (Backscatter modulation)		
Antenna:	Type:	Power transmitter:	WE-WPCC Wireless Power Transfer Transmitter Coil (760308101104)
		Power receiver:	WPC Wireless Power Transfer Receiver Coil (ID#3004)
	Size:	Power transmitter:	20.5 mm Ø / 14 turns
		Power receiver:	19.0 ± 1 mm Ø / 25 turns
	Connector:	☐ external	☐ internal
		☐ temporary	☒ none (internal antenna)

RF technology 2:

System type (Note 1):	Digital transmission system (DTS)		
Application frequency band:	2400.0 MHz - 2483.5 MHz		
Number of RF channels:	40		
Nominal bandwidth:	2 MHz		
Modulation(s):	GFSK		
Antenna:	Type:	PCB antenna	
	Gain:	-0.94 dBi (maximum)	
	Connector:	☐ external	☐ internal
		☐ temporary	☒ none (integral antenna)

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

4.3 Photo documentation

For external photos see annex B.
Photos taken during testing including EUT positions can be found in annex A.

5 Test configuration and mode of operation

5.1 Test configuration

Device	*Type designation*	*Serial or inventory no.*	*Manufacturer*
QI charger for BLE probe	AwEasy-Charger	n/a	Rotronic AG

Table 1: EUT used for testing

Device	*Type designation*	*Serial or inventory no.*	*Manufacturer*
Power adapter for charger	PS1006-050SIB150	---	Powertron Electronics Corp.
BLE probe	AwEasy	n/a	Rotronic AG

Table 2: Support equipment used for testing

5.2 Mode of operation

The QI charger was attached to the BLE probe. During charging the BLE probe was in continuous advertising mode.

Channel	*Frequency (MHz)*
Low	2402
Middle	2426
High	2480

Table 3: Tested channels of BLE

6 Test procedures

6.1 General specifications

6.1.1 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.

6.1.2 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.

6.2 Antenna-port conducted measurements

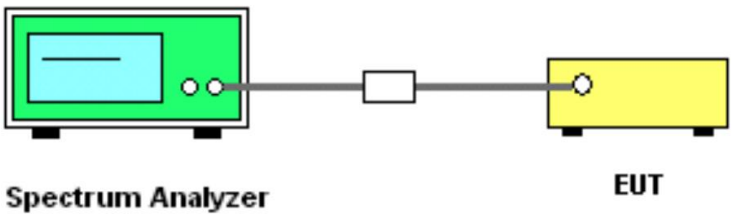

Figure 1: Setup for antenna-port conducted measurements

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

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

If a radiated test configuration has to be used, conversion to conducted test results is performed according to clause 6.1.2.

6.3 AC powerline conducted emissions

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

If the EUT normally receives power from another device that in turn connects to the public utility ac power lines, measurements are made on that device with the EUT in operation to demonstrate that the device continues to comply with the appropriate limits while providing the EUT with power. If the EUT is operated only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines (600 VAC or less) to operate the EUT (such as an adapter), then ac power-line conducted measurements are not required.
For direct current (dc) powered devices where the ac power adapter is not supplied with the device, an “off-the-shelf” unmodified ac power adapter is used. If the device is supposed to be installed in a host (e.g., the device is a module or PC card), then it is tested in a typical compliant host.

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

Table 4: Bandwidth and detector type for AC power-line conducted emissions test

The AC power-line conducted emissions test is performed in the following steps:
a) The EUT is arranged as tabletop or floor-standing equipment, as applicable, and connected to a line impedance stabilization network (LISN) with 50 µH / 50 Ω. If required, a second LISN of the same type and terminated by 50 Ω is used for peripheral devices. The EUT is switched on.

b) The measurement equipment is connected to the LISN for the EUT and set-up according to the specifications of the test (see table 4). At the LISN, the neutral line is selected to be tested.
c) The prescan is performed with both detectors activated at the same time. If the test receiver is capable of FFT analysis, it is used for prescan, but not for final scan.
d) When the prescan is completed, maximum levels with less margin than 10 dB or exceeding the limit are determined and collected in a list.
e) With the first frequency of the list selected, a frequency zoom over a range of ten times of the measurement receiver bandwidth around this frequency is performed. If the EUT has no significant drift in frequency, the frequency zoom can be skipped.
f) For final scan, the emission level is measured and the maximum is recorded.
g) Steps e) to f) are repeated for all other frequencies in the list. At least the six highest EUT emissions relative to the limit have to be recorded.
h) Steps c) to g) are repeated for all current-carrying conductors of all of the power cords of EUT, i.e. all phase and (if used) neutral line(s).

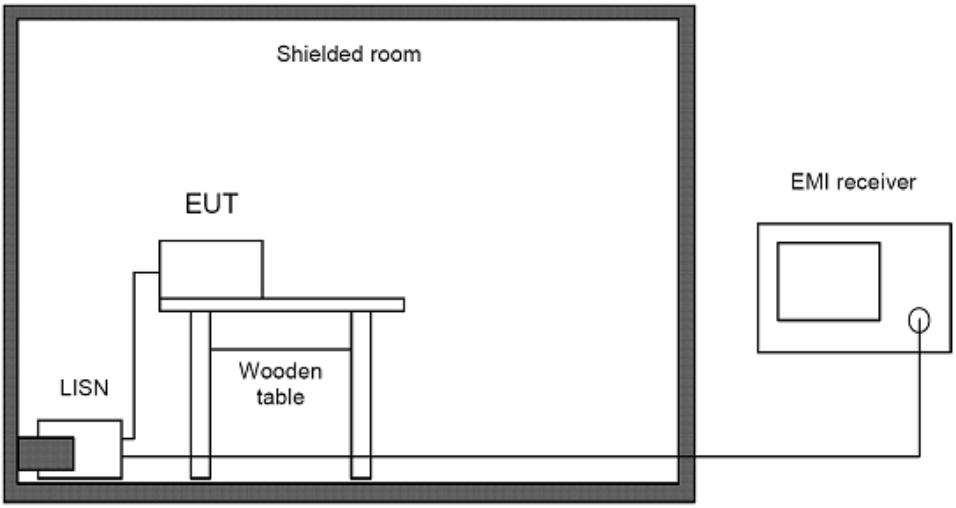

Figure 2: Setup for AC power-line conducted emissions test from 150 kHz to 30 MHz

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

Table 5: Sample calculation

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

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

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

6.4 Radiated emissions below 30 MHz

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

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

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

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

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

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

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

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

Table 6: Recalculation factors for extrapolation

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 7.

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

Table 7: Bandwidth and detector type for radiated emissions test below 30 MHz

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

Table 8: Sample calculation

Correction factor = Antenna correction + Cable attenuation

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

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

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

6.4.1 Automatic test method

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 7).
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 20°. 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 ±180° 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.

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

6.4.2 Manual test method

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 7).
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° continuously. The scan table method in receiver mode of the measurement instrument is used for pre-measurements. The max hold function is used.
f) After the last prescan, the significant maximum emissions are determined and collected in a list.
g) Final scan: by using the bargraph max hold function of the measurement receiver the turntable is set in the worst case position of the fundamental emission. In this position the measurement was performed with the scan table method.

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

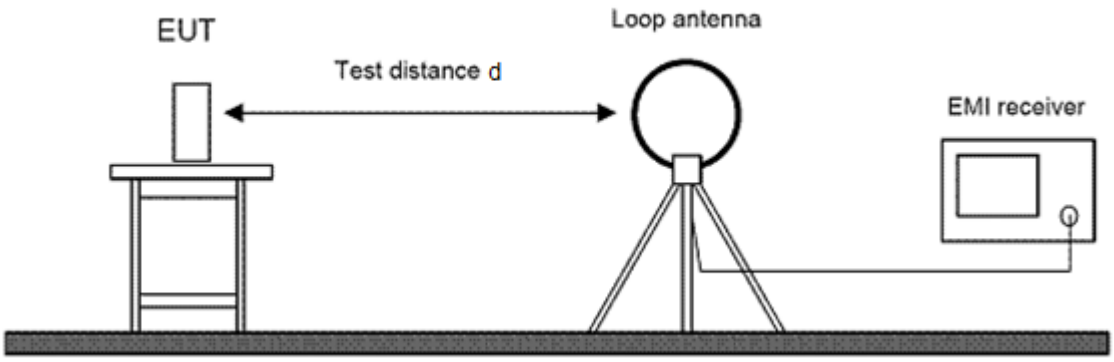

Figure 3: Setup for radiated emissions test below 30 MHz

6.5 Radiated emissions from 30 MHz to 1 GHz

Radiated emissions in the frequency range 30 MHz to 1 GHz are measured according to clause 6.5 of ANSI C63.10 using a semi-anechoic chamber (SAC) with a ground plane on the floor. The measurement distance is 3 meters. The emissions of the EUT are recorded with an EMI test receiver configured as described in table 9.

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

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

Table 10: Sample calculation

Correction factor = Antenna correction + Cable attenuation

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

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

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

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

6.5.1 Automatic test method

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 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 20°. 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 at a height from 1 m to 4 m and the EUT is rotated through 360° 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. 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.
o) Steps l) to n) are repeated for all other frequencies in the list.

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

6.5.2 Manual test method

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. The measurement is performed with peak detector and max hold.
g) The antenna height is increased to 4 m in steps of 50 cm. At each height, step f) is repeated or the measurement is stopped after all heights were measured.
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° continuously. 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 are determined and collected in a list.
h) Final scan: the test receiver is set in the bargraph max hold function and is set to the first frequency of the list, the EUT is rotated by 360° and the antenna is moved from 1 m to 4 m while measuring the emission level continuously. The worst-case table position and the maximum emission level is recorded.
l) Step l) is 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 l) are repeated in two other orthogonal positions.

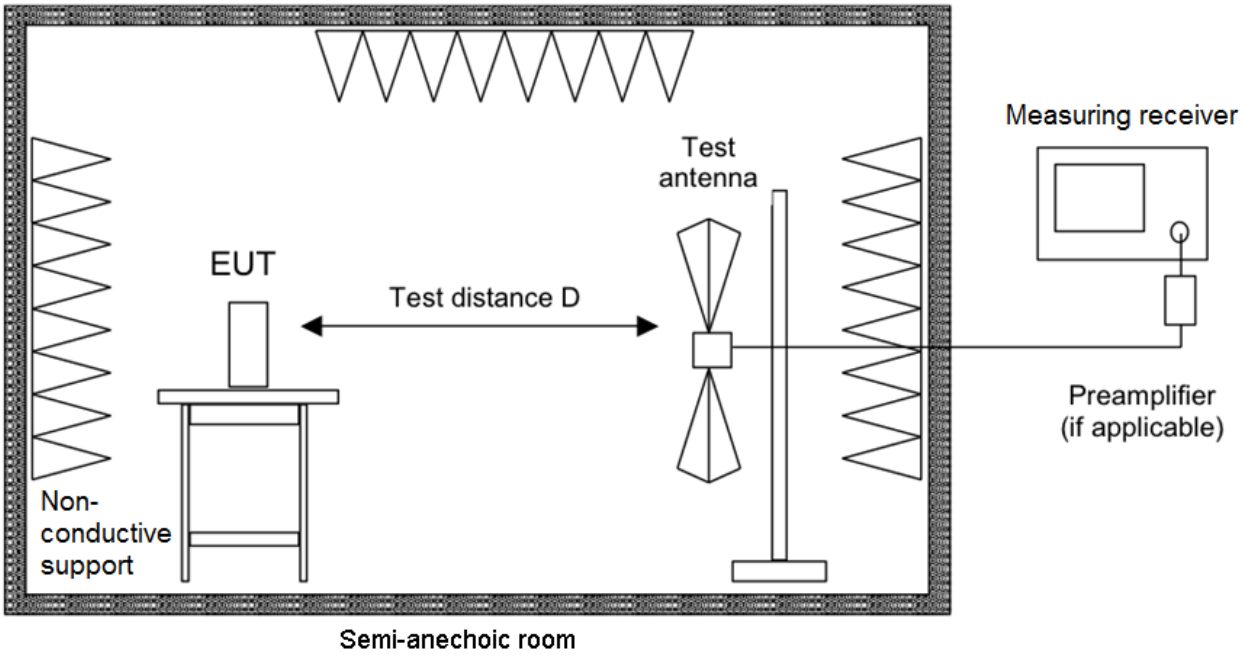

Figure 4: Setup for radiated emissions test from 30 MHz to 1 GHz

6.6 Radiated emissions above 1 GHz

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

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

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

Table 11: Sample calculation

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

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

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

6.6.1 Exploratory radiated emissions measurements

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

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

The emissions of the EUT are displayed and recorded with an EMI test receiver operating in the spectrum analyzer mode using the settings as described in table 12.

Frequency (f)	*Resolution bandwidth*	*Video bandwidth*	Sweep time	*Trace detector(s)*
f ≥ 1 GHz	1 MHz	3 MHz	AUTO	Max Peak, Average

Table 12: 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.

6.6.2 Final radiated emissions measurements

Final radiated emissions above 1 GHz are measured in the semi-anechoic chamber (SAC3) or Free space semi-anechoic chamber (FS-SAC) with RF absorbing material on the floor between measurement antenna and EUT. The measurement distance is 3 meters in the semi-anechoic chamber (SAC3) or 1.5 m in the Free space semi-anechoic chamber (FS-SAC). The emissions of the EUT are recorded with an EMI test receiver configured as described in table 13.

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

Table 13: 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:

6.6.2.1 Automatic measurement method

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 13).
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 20°. 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 from 1 m to 4 m around this height and the EUT is rotated through 360° around while measuring the emission level continuously.
n) The worst-case positions of antenna and table and the maximum emission level are 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.

6.6.2.2 Manual measurement method

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 13).
d) The table position is set to 0°.
e) The antenna height is set to 1 m.
f) The EUT is rotated in a horizontal plane through 360° The spectrum for the full frequency range is recorded using the peak detector.
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) After the last prescan, the significant maximum emissions with their polarizations are determined and collected in a list.
k) For the final scan the test receiver is set to the first frequency of the list. By using the bargraph max hold function of the measurement receiver the emission in consideration is maximised by rotating the EUT in the horizontal plane through 360° and moving the antenna from 1 m to 4 m (2.5 m).
l) The worst-case positions of antenna and table and the maximum emission level are recorded.
m) 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 m) are repeated in two other orthogonal positions.

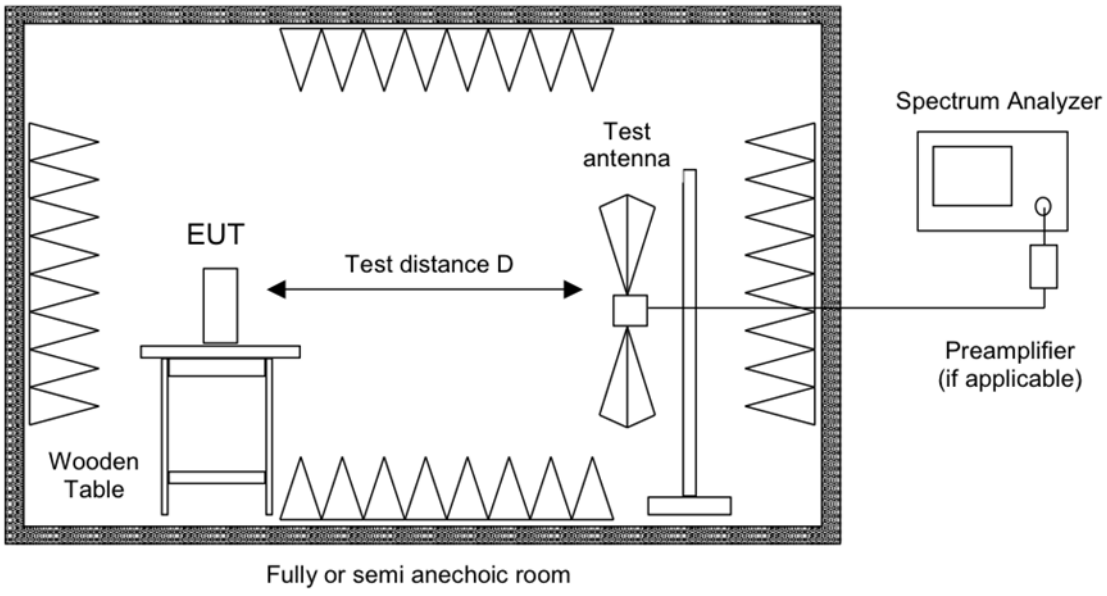

Figure 5: Setup for radiated emissions test above 1 GHz

6.7 Bandwidth measurements

In case of antenna-port conducted tests as described in clause 6.2 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 6.1.2

6.7.1 6 dB bandwidth (DTS bandwidth)

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

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

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

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

6.7.2 99 % occupied bandwidth

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

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

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

6.7.3 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.

6.8 Maximum peak conducted output power

In case of antenna-port conducted tests as described in clause 6.2 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 6.1.2

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

The spectrum analyzer settings are as follows:

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

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

6.9 Power spectral density

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

The spectrum analyzer settings are as follows:

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

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

In case of antenna-port conducted tests as described in clause 6.2 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 6.1.2

7 Test results

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

For information about measurement uncertainties see page 58.

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

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

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

7.1 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
Section(s) in RSS:	Requirement(s):	RSS-216, section 6.2.2.1
	Reference(s):	ICES-001, section 3.3.3

Performed by:	Konrad Graßl	Date(s) of test:	December 9, 2022
Result:	☒ Test passed	☐ Test not passed	

7.1.1 Test equipment

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

7.1.2 Limits

According to §15.207(a):
Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH / 50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

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

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

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

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

Table 14: Limits for AC powerline conducted emissions according to 15.207(a) and RSS-Gen, section 8.8

*Decreases with the logarithm of the frequency

According to section 6.2.2.1 of RSS-216:
WPT subassemblies of WPT source devices shall comply with the mains terminals disturbance voltage limits for induction cooking equipment, as set out in ICES-001, section 3.3.3.

Frequency (MHz)	*Appliances rated 120 V, without an earth connection Quasi-peak (dBµV)*	*Appliances rated 120 V, without an earth connection Average (dBµV)*	*All other appliances Quasi-peak (dBµV)*	*All other appliances Average (dBµV)*
0.009 - 0.05	122	---	110	---
0.05 - 0.15	102 to 92 (Note 2)	---	90 to 80 (Note 2)	
0.15 – 0.5	72 to 62 (Note 2)	62 to 52 (Note 2)	66 to 56 (Note 2)	56 to 46 (Note 2)
0.5 - 5	56	46	56	46
5 - 30	60	50	60	50

Table 15: Conducted emissions limits for induction cooking appliances (AC mains terminals)

Notes:
1. The more stringent limit applies at transition frequencies.
2. The limit level in dBµV decreases linearly with the logarithm of frequency.

7.1.3 Test procedure

The AC powerline conducted emissions are measured using the test procedure as described in clause 6.3.

7.1.4 Test results

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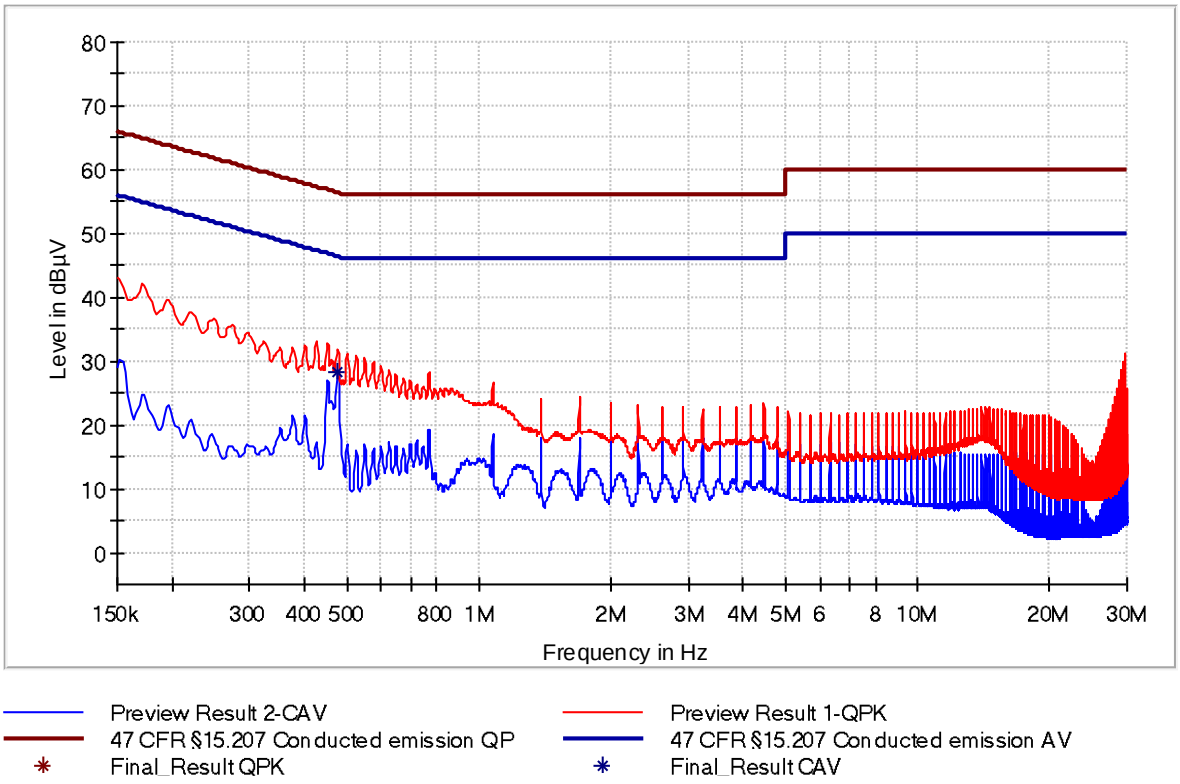

Figure 6: Chart of AC powerline conducted emissions on L1

Frequency (MHz)	*QuasiPeak (dBµV)*	*Average (dBµV)*	*Limit (dBµV)*	*Margin (dB)*	*Meas. Time*	*Bandwidth (kHz)*	*Line*	*PE*	*Corr. (dB)*
0.476250	---	28.30	46.40	18.10	1000.0	9.000	L1	GND	10.1

Table 16: Results of AC powerline conducted emissions on L1

Note(s):
1. No assessable emissions could be detected.

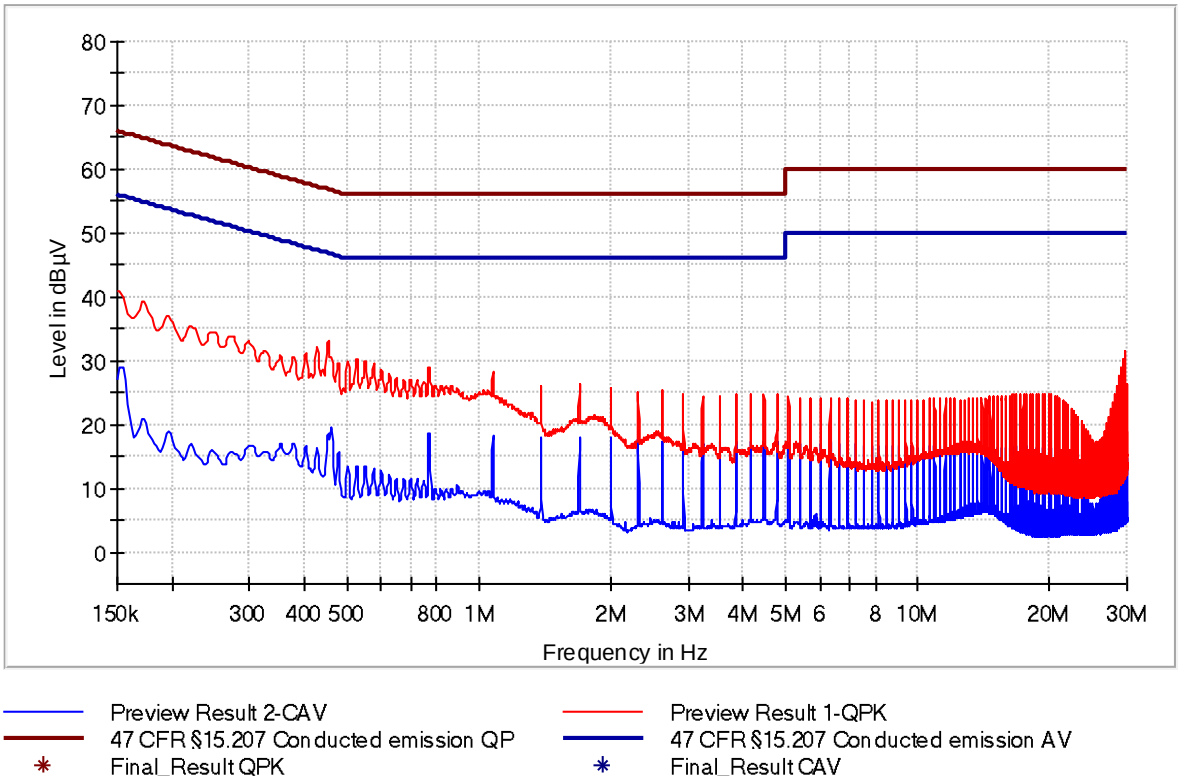

Figure 7: Chart of AC powerline conducted emissions on N

Canada

Note(s):
1. As worst case the limits for all other appliances was applied.

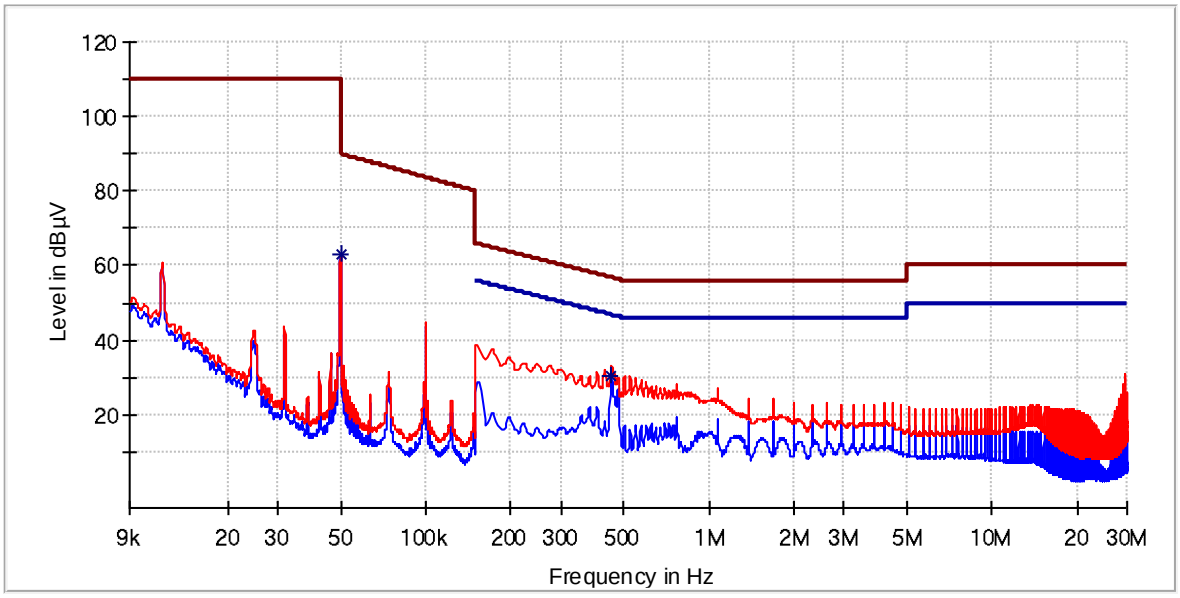

Figure 8: Chart of AC powerline conducted emissions on L1

Frequency (MHz)	*QuasiPeak (dBµV)*	*Average (dBµV)*	*Limit (dBµV)*	*Margin (dB)*	*Meas. Time*	*Bandwidth (kHz)*	*Line*	*PE*	*Corr. (dB)*
0.050000	---	62.90	---	---	1000.0	0.200	L1	GND	10.1
0.453750	---	30.33	46.81	16.48	1000.0	9.000	L1	GND	10.1

Table 17: Results of AC powerline conducted emissions on L1

Note(s):
1. No assessable emissions could be detected.

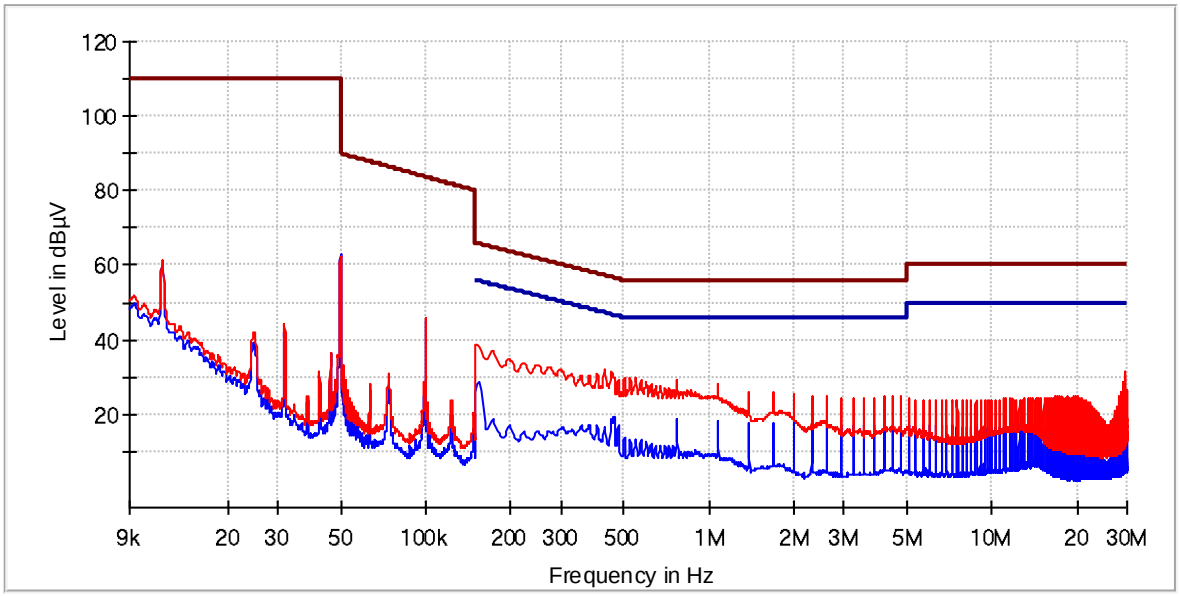

Figure 9: Chart of AC powerline conducted emissions on N

7.2 Calculated conducted output power

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

Performed by:	Konrad Graßl	Date(s) of test:	January 28, 2022
Result:	☒ Test passed	☐ Test not passed	

7.2.1 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
Preamplifier (0.5 GHz - 18 GHz)	BBV 9718 B	Schwarzbeck	W01325
Horn antenna	BBHA 9120D	Schwarzbeck	W00053
Cable set FS-SAC	RF cable(s)	Teledyne Reynolds Huber + Suhner Teledyne Reynolds	E00435 E00307 E00433

7.2.2 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.

7.2.3 Test procedure

The maximum peak conducted output power is measured using the test procedure as described in clause 6.7.3 and referring to the

☐ test method for conducted measurements as described in clause 6.2.
☒ test method for radiated measurements as described in clause 6.6.

7.2.4 Test results

Test distance:	☐ 3 m	☐ 10 m	☒ 1.5 m
Polarization:	☒ horizontal	☒ vertical	
EUT position:	☒ Position X	☒ Position Y	☒ Position Z

Note(s):
1. The gain of the antenna is below 6 dBi, therefore a reduction of the conducted limit was not applied.
2. Pre-measurements were performed to declare the worst case which is documented below.
3. The measurement was performed at a distance of 1.5 m, but was referenced to a distance of 3 m by using an offset of –6 dB.
4. Conducted output power is calculated by subtracting the gain of the EIRP.
5. The EIRP was calculated as defined in ANSI C63.10-2013, clause 12.7.3:

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

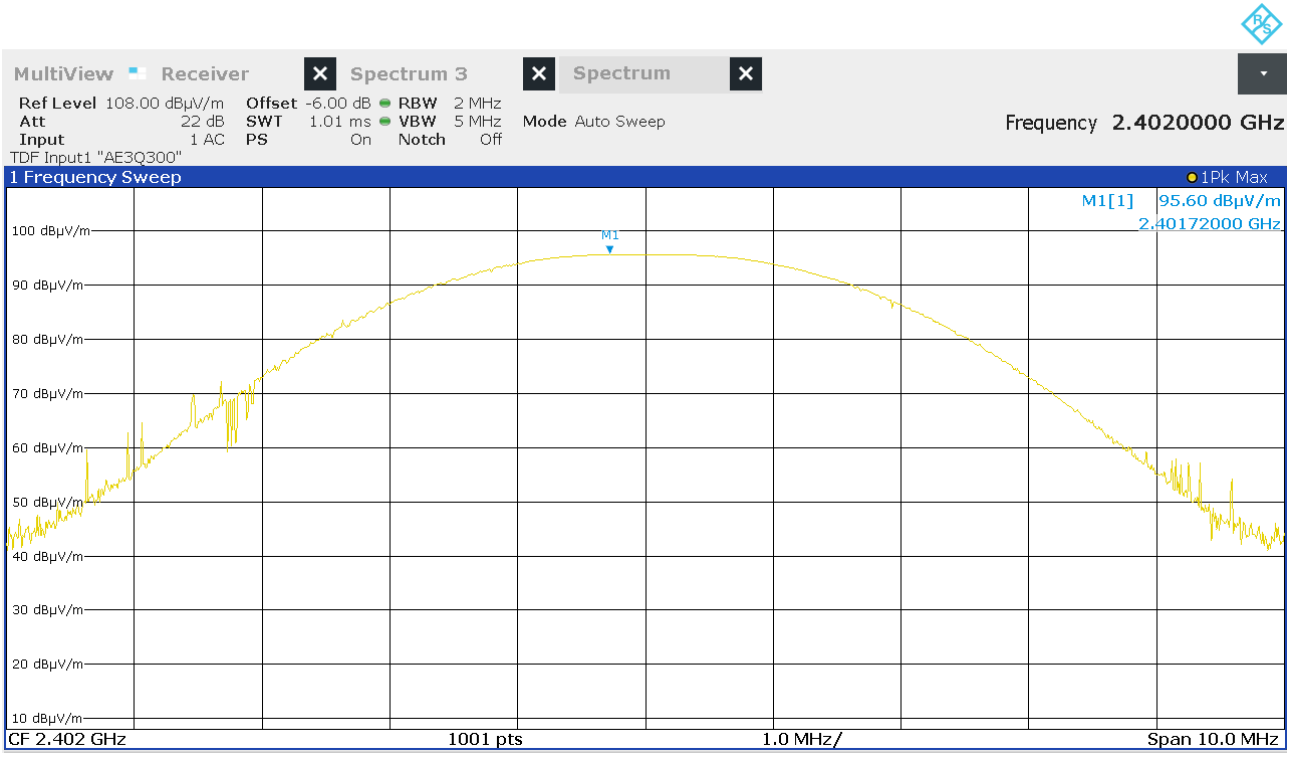

Figure 10: Chart of test of field strength of lowest channel, EUT position Z, antenna polarization vertical

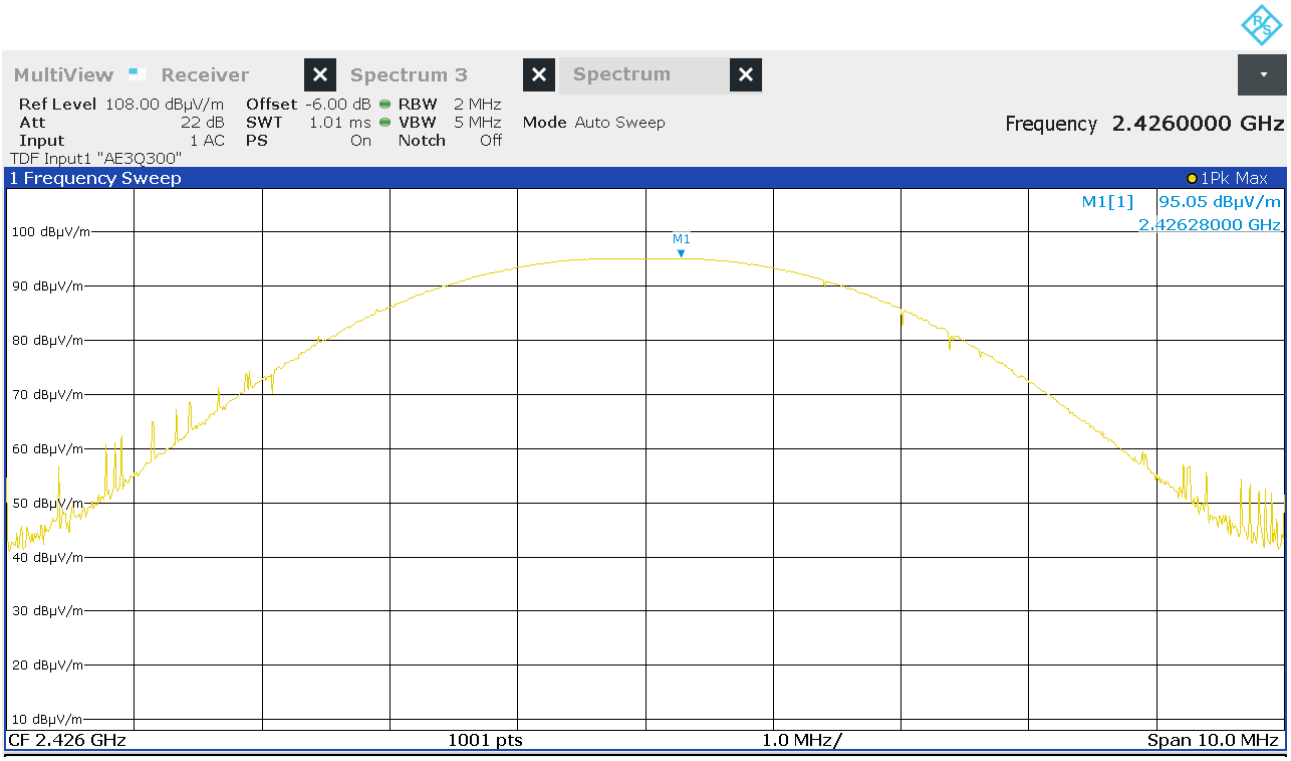

Figure 11: Chart of test of field strength of middle channel, EUT position Z, antenna polarization vertical

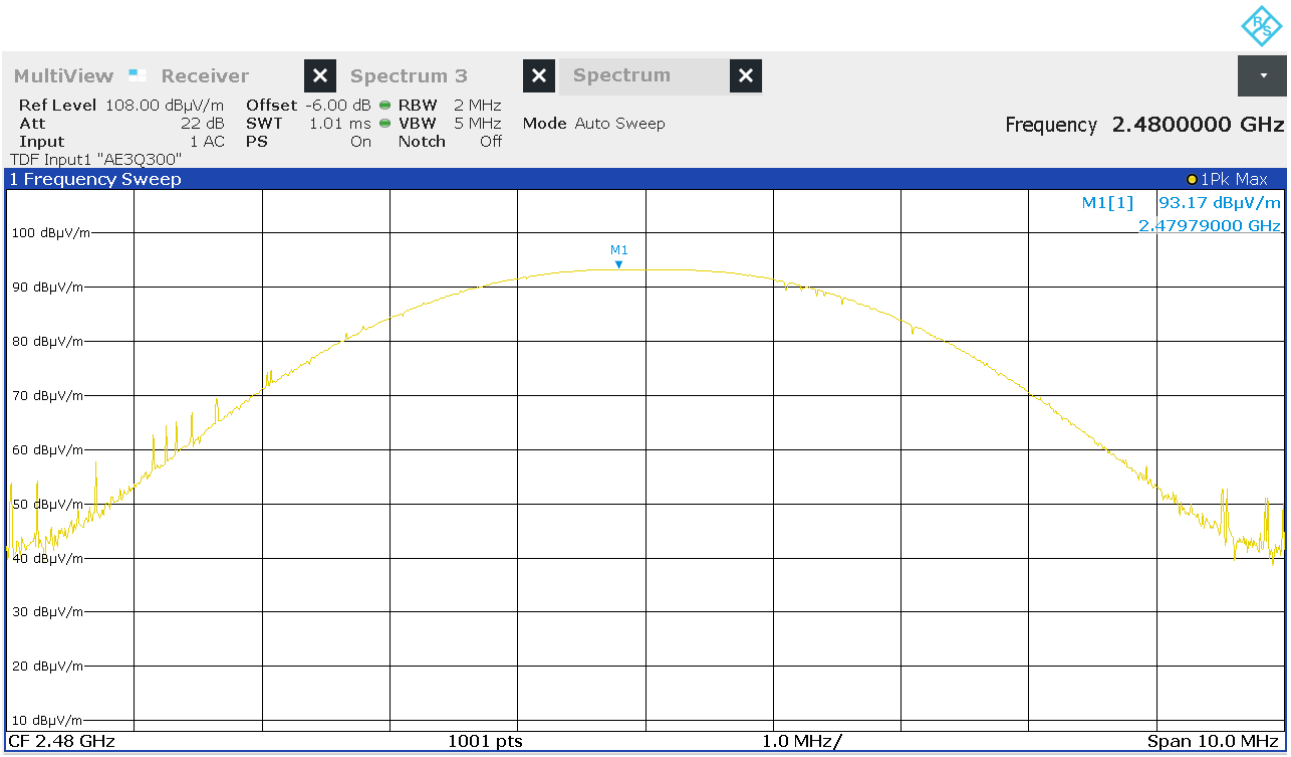

Figure 12: Chart of test of field strength of highest channel, EUT position Z, antenna polarization vertical

Channel	*EUT Pos.*	*Field strength (dBµV/m) at 3 m*	*Detector*	*Height (cm)*	*Pol.*	*Azimuth (deg)*	*Corr. (dB/m)*	*EIRP (dBm)*
Low	Z	95.6	Pk	150	V	318	-2.0	0.4
Middle	Z	95.1	Pk	150	V	318	-2.1	-0.1
high	Z	93.2	Pk	150	V	318	-2.3	-2.0

Table 18: Results of field strength in advertising mode

Channel	*EIRP (dBm)*	*Antenna gain (dBi)*	*Calculated conducted output power (dBm)*	*Limit (dBm)*	*Margin (dB)*	*Results*
Low	0.4	-0.9	1.3	30.0	28.7	Passed
Middle	-0.1	-0.9	0.8	30.0	29.2	Passed
high	-2.0	-0.9	-1.1	30.0	31.1	Passed

Table 19: Results of calculated conducted output power

7.3 Radiated emissions below 30 MHz

Section(s) in 47 CFR Part 15:	Requirement(s):	15.209(a) 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-216, section 6.2.2.2 and 6.2.3 RSS-247, section 5.5
	Reference(s):	KDB 558074 D01, clauses 8.5 and 8.6 ANSI C63.10, clause 6.4 ICES-001

Performed by:	Konrad Graßl	Date(s) of test:	June 14, 2023 June 15, 2023
Result:	☒ Test passed	☐ Test not passed	

7.3.1 Test equipment

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

7.3.2 Limits

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

According to § 15.209(a):
Except as provided elsewhere in subpart 15.209 the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

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

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 21: General radiated emission limits up to 30 MHz according to section 8.9 of RSS Gen

In case of measurements are performed at other distances than that specified in the requirements, the limits in the charts and tables reported with the test results are derived from the general radiated emission limits as listed in table 20 and Table 21, using the recalculation factor as described in clause 6.4.

According to section 6.2.2.2 of RSS-216:
The magnetic field radiated emissions within 9 kHz – 30 MHz from the WPT subassembly of WPT source and client devices and WPT systems shall comply with the limits applicable to induction cooking equipment, as set out in ICES-001, section 3.3.4.1. The preferred test method for WPT devices that may be used in residential environments and that have a maximum dimension of less than or equal to 1.6 m is the test method using the van Veen loop antenna system, as per ICES-001. However, it is acceptable to use the alternate 60 cm loop test method and corresponding limit for these small residential WPT devices (the same as for commercial/industrial and large residential devices).

Frequency range *(MHz])*	*Limit in 3 m distance* *Quasi-peak* *(dBµA/m*
0.009 – 0.07	69
0.07 – 0.15	69 to 39
0.15 – 30	39 to 7

Table 22: Magnetic field strength radiated limits for induction cooking appliances

Note:
1. The limit in dBµA/m decreases linearly with the logarithm of frequency.

According to section 6.2.3 of RSS-216:
Fundamental frequencies and modulation components of Type 2 and Type 3 WPT source subassemblies shall not fall within the restricted bands specified in RSS-Gen.

7.3.3 Test procedure

Radiated emissions below 30 MHz are measured using the manual test procedure as described in clause 6.3.

7.3.4 Test results

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

FCC

Note(s):
1. Pre-measurements were performed to declare the worst-case which is documented below.

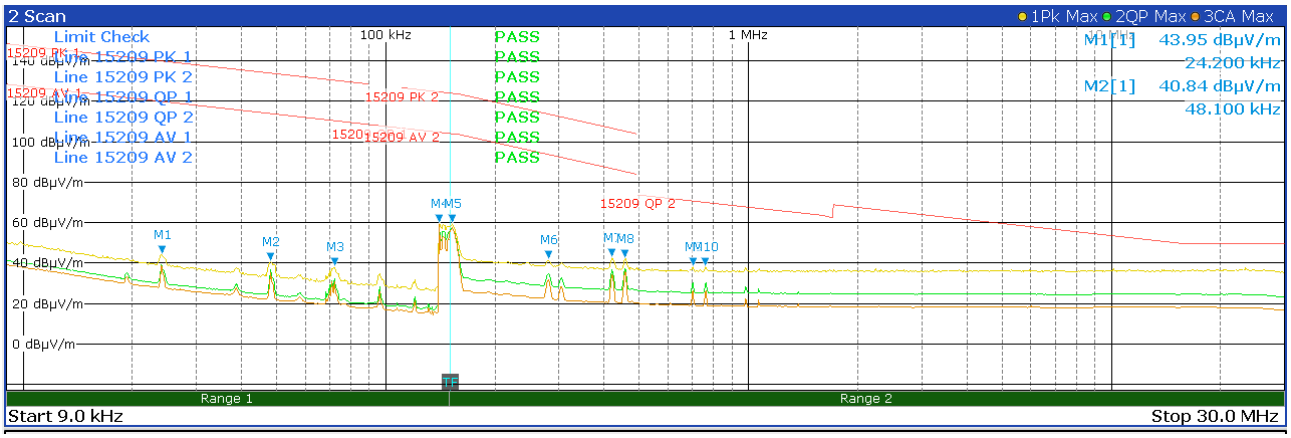

Figure 13: Chart of radiated emissions test below 30 MHz, EUT position X, antenna parallel, Pk

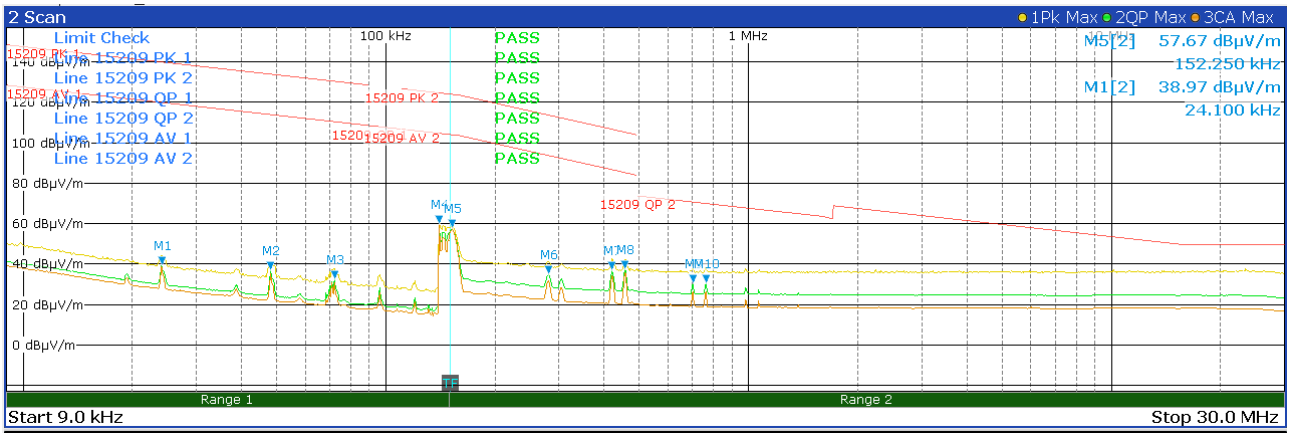

Figure 14: Chart of radiated emissions test below 30 MHz, EUT position X, antenna parallel, QP

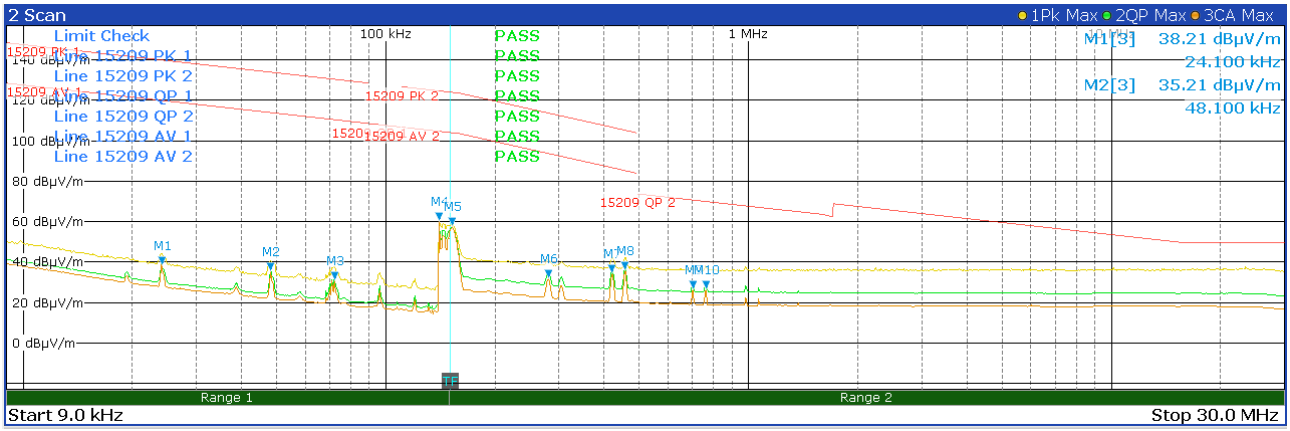

Figure 15: Chart of radiated emissions test below 30 MHz, EUT position X, antenna parallel, AV

Frequency (MHz)	*Field strength (dBµV/m at 3 m)*	*Det.*	*Calculated field strength (dBµV/m)*	*at dist. (m)*	*Limit (dBµV/m)*	*at dist. (m)*	*Margin (dB)*	*Azimuth (deg)*	*Corr. (dB/m)*	*Result*
0.1401	59.9	Pk	-20.1	300	44.7	300	64.8	85	20.0	passed
0.1401	59.7	AV	-20.3	300	24.7	300	45.0	85	20.0	passed
0.1522	59.4	Pk	-20.6	300	44.0	300	64.6	85	20.0	passed
0.1522	57.3	AV	-22.7	300	24.0	300	46.7	85	20.0	passed
0.2805	41.5	Pk	-37.7	300	38.6	300	76.3	85	20.0	passed
0.2805	31.7	AV	-47.5	300	18.6	300	66.1	85	20.0	passed
0.4200	42.6	Pk	-36.6	300	35.1	300	71.7	85	20.0	passed
0.4200	34.3	AV	-44.9	300	15.1	300	60.0	85	20.0	passed
0.4560	42.1	Pk	-37.1	300	34.4	300	71.5	85	20.0	passed
0.4560	35.6	AV	-43.6	300	14.4	300	58.0	85	20.0	passed
0.7012	30.3	QP	-9.7	30	10.7	30	20.4	85	20.0	passed
0.7620	30.3	QP	-9.7	30	10.0	30	19.7	85	20.0	passed

Table 23: Final results of radiated emissions test below 30 MHz, EUT position X, antenna parallel

Canada

Note(s):
1. Pre-measurements were performed to declare the worst-case which is documented below.

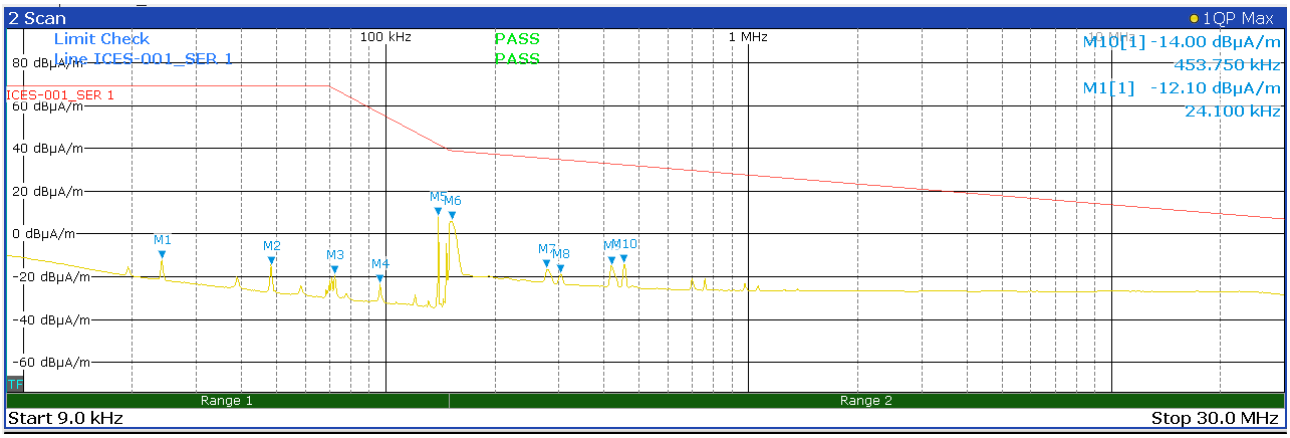

Figure 16: Chart of radiated emissions test below 30 MHz, EUT position X, antenna parallel

Frequency (MHz)	*Field strength (dBµA/m at 3 m)*	*Limit (dBµA/m at 3 m)*	*Margin (dB)*	*Azimuth (deg)*	*Corr. (dB/m)*	*Result*
0.0241	-12.1	69.0	81.1	85	-31.1	passed
0.0482	-15.0	69.0	84.0	85	-31.3	passed
0.0723	-18.8	67.7	86.5	85	-31.4	passed
0.0964	-23.3	56.4	79.7	85	-31.5	passed
0.1395	8.1	41.9	33.8	85	-31.5	passed
0.1522	6.3	38.9	32.6	85	-31.5	passed
0.278.2	-16.3	35.3	51.6	85	-31.5	passed
0.3030	-18.5	34.8	53.3	85	-31.5	passed
0.4200	-14.9	32.8	47.7	85	-31.5	passed
0.4537	-14.0	32.3	46.3	85	-31.5	passed

Table 24: Final results of radiated emissions test below 30 MHz, EUT position X, antenna parallel

7.4 Radiated emissions from 30 MHz to 1 GHz

Section(s) in 47 CFR Part 15:	Requirement(s):	15.209(a) 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-216, section 6.2.2.2 RSS-247, section 5.5
	Reference(s):	KDB 558074 D01, clauses 8.4 and 8.5 ANSI C63.10, clause 6.5 ICES-001

Performed by:	Konrad Graßl	Date(s) of test:	June 16, 2023
Result:	☒ Test passed	☐ Test not passed	

7.4.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
EMI test receiver	ESW 44	Rohde & Schwarz	E00895
TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
Cable set SAC	RF cable(s)	Huber + Suhner	E00755 E01033 E01034
Test software	EMC32-(M)EB, V10.60.20	Rohde & Schwarz	E00777, E00778 or E01073

7.4.2 Limits

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

According to § 15.209(a):
Except as provided elsewhere in subpart 15.209 the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

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

According to section 6.2.2.2 of RSS-216:
The electric field radiated emissions within 30 – 1000 MHz from the WPT subassembly of WPT source and client devices and WPT systems shall comply with the limits applicable to induction cooking equipment, as set out in ICES-001, section 3.3.4.2.

Frequency range *(MHz)*	*OATS or SAC 10 m measurement distance Quasi-peak (dBµV/m)*	*OATS or SAC 3 m measurement distance Quasi-peak (dBµV/m)*
30 – 230	30	40
230 – 1000	37	47

Table 26: Electric field strength radiated emission limits for induction cooking appliances

7.4.3 Test procedure

Radiated emissions from 30 MHz to 1 GHz are measured using the automatic test procedure as described in clause 6.5.

7.4.4 Test results

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

FCC

Note(s):
1. Pre-measurements were performed to declare the worst-case which is documented below.

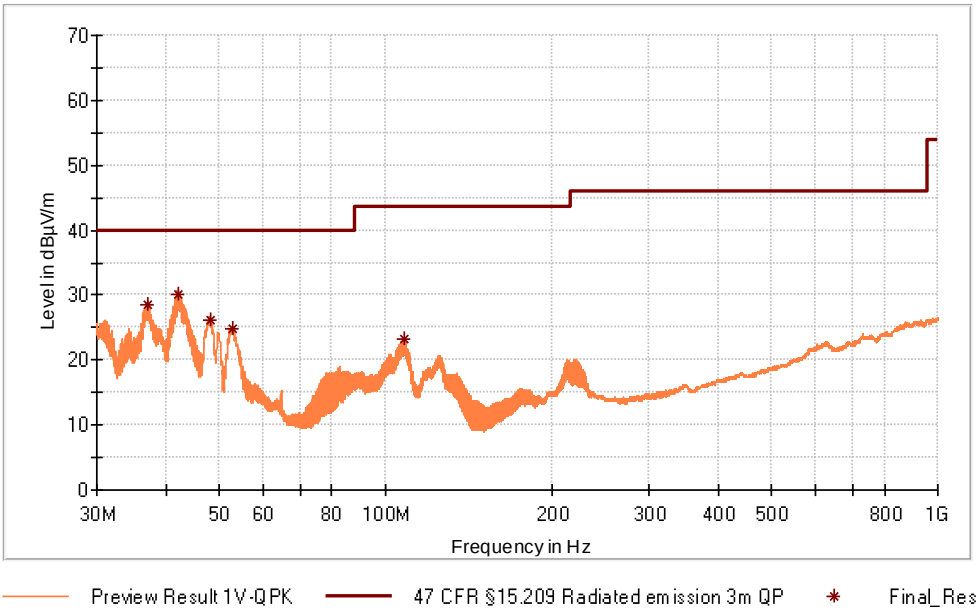

Figure 17: Chart of radiated emissions test from 30 MHz to 1 GHz, EUT position X, antenna vertical

Frequency (MHz)	*Field strength (dBµV/m at 3 m)*	*Limit (dBµV/m) at 3 m*	*Margin (dB)*	*Height (cm)*	*Pol.*	*Azimuth (deg)*	*Corr. (dB/m)*	*Result*
37.080	28.6	40.0	11.4	100	V	0	12.5	Passed
42.270	30.8	40.0	9.2	100	V	0	14.1	Passed
48.06	26.1	40.0	13.9	113	V	0	14.7	Passed
52.770	24.5	40.0	15.5	100	V	60	14.6	Passed
108.060	23.9	40.0	16.1	100	V	52	12.7	Passed

Table 27: Results of radiated emissions test from 30 MHz to 1 GHz, EUT position X, antenna vertical

Canada

Note(s):
1. Pre-measurements were performed to declare the worst-case which is documented below.

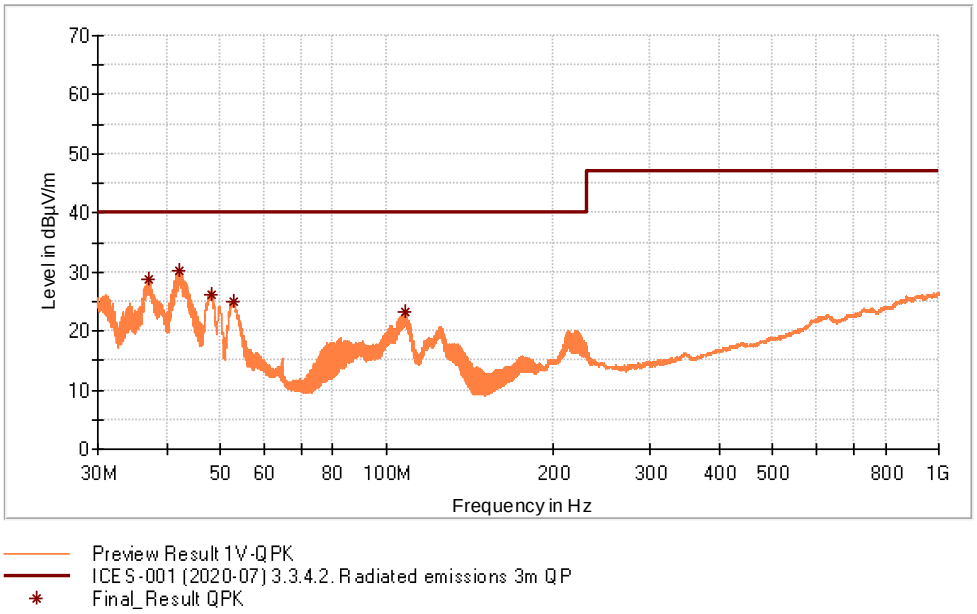

Figure 18: Chart of radiated emissions test from 30 MHz to 1 GHz, EUT position X antenna vertical

Frequency (MHz)	*Field strength (dBµV/m at 3 m)*	*Limit (dBµV/m) at 3 m*	*Margin (dB)*	*Height (cm)*	*Pol.*	*Azimuth (deg)*	*Corr. (dB/m)*	*Result*
37.080	28.6	40.0	11.4	100	V	0	12.5	Passed
42.270	30.1	40.0	9.9	100	V	0	14.1	Passed
48.060	26.1	40.0	13.9	113	V	0	14.7	Passed
52.770	24.9	40.0	15.1	100	V	60	14.6	Passed
108.060	23.2	40.0	16.8	100	V	52	12.7	Passed

Table 28: Results of radiated emissions test from 30 MHz to 1 GHz, EUT position X, antenna vertical

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

Section(s) in 47 CFR Part 15:	Requirement(s):	15.209(a) 15.247(d)
	Reference(s):	KDB 558074 D01, clauses 8.4 and 8.5 ANSI C63.10, clause 6.6
Section(s) in RSS:	Requirement(s):	RSS-247, section 5.5
	Reference(s):	KDB 558074 D01, clauses 8.4 and 8.5 ANSI C63.10, clause 6.6

Performed by:	Konrad Graßl	Date(s) of test:	January 28, 2022
Result:	☒ Test passed	☐ Test not passed	

7.5.1 Test equipment

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

7.5.2 Limits

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

According to § 15.209(a):
Except as provided elsewhere in subpart 15.209 the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

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

Table 29: General radiated emission limits above 960 MHz according to §15.209 and RSS-Gen

7.5.3 Test procedure

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

☐ test procedure for conducted measurements as described in clause 6.2.
☒ test procedure for radiated measurements as described in clause 6.6.

7.5.4 Test results

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

Note(s):

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

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

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

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

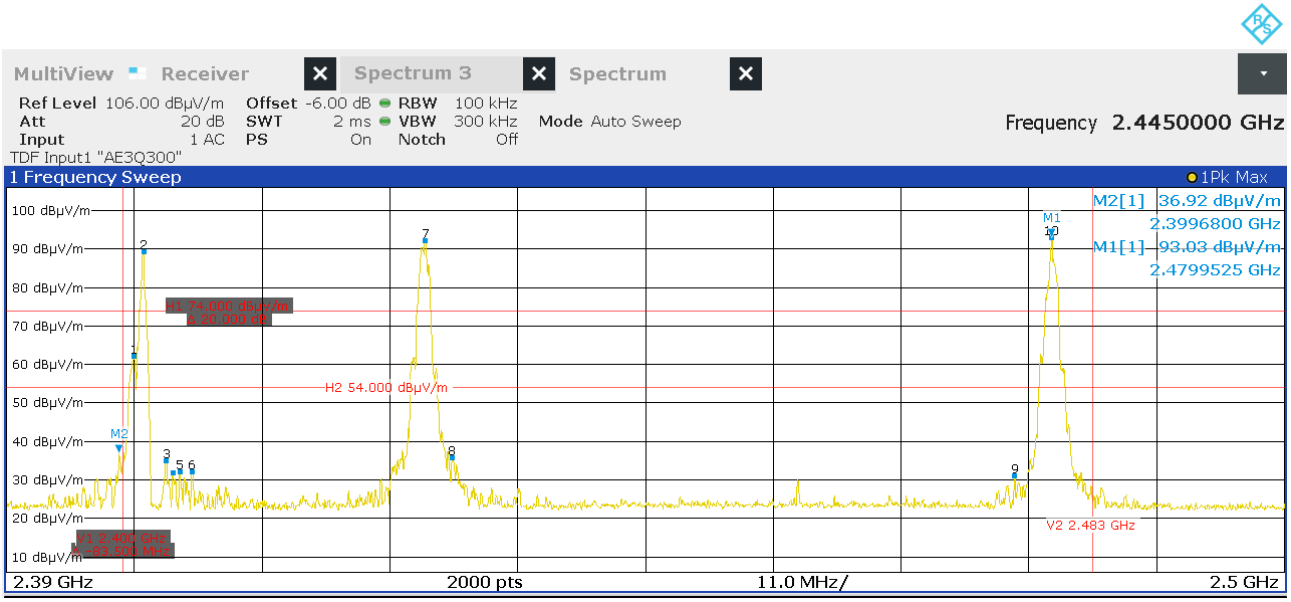

Figure 19: Chart of band-edge measurement, EUT position Z, antenna polarization vertical with peak-detector

Frequency (MHz)	*Measured Margin (dB)*	*Limit of minimum margin*	*Result*
2399.68	45.3	≥ 20	Passed

Table 30: Test results of band-edge measurements on lowest channel, EUT position Z, antenna polarization vertical

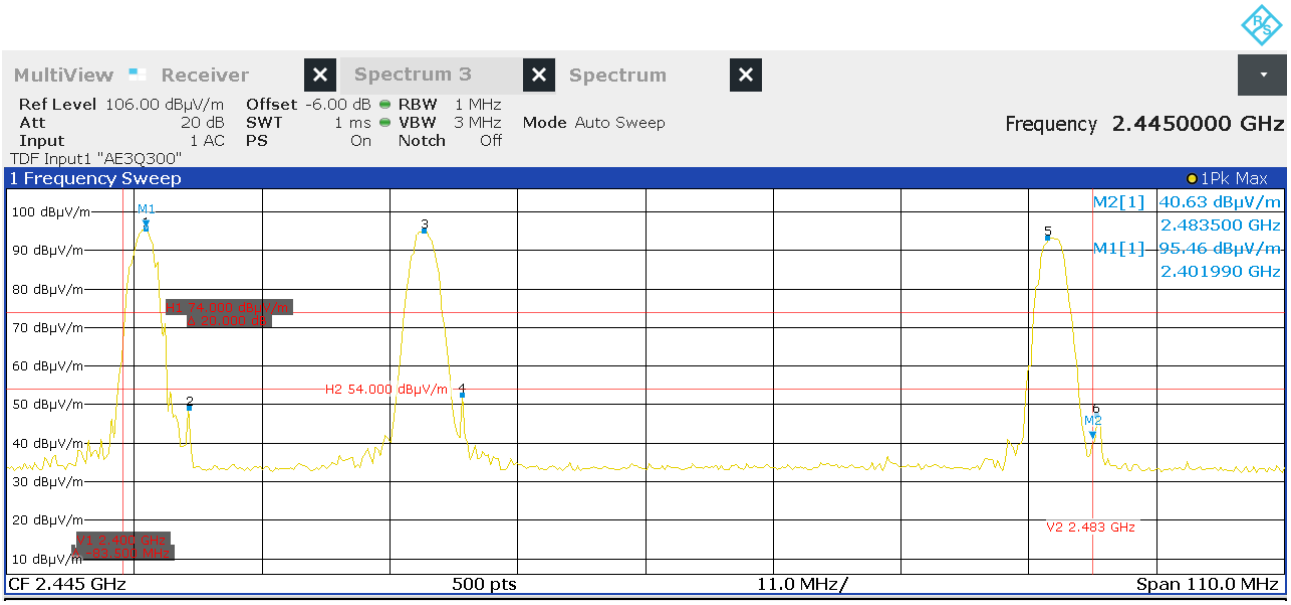

Figure 20: Chart of band-edge measurement, EUT position Z, antenna polarization vertical with peak-detector

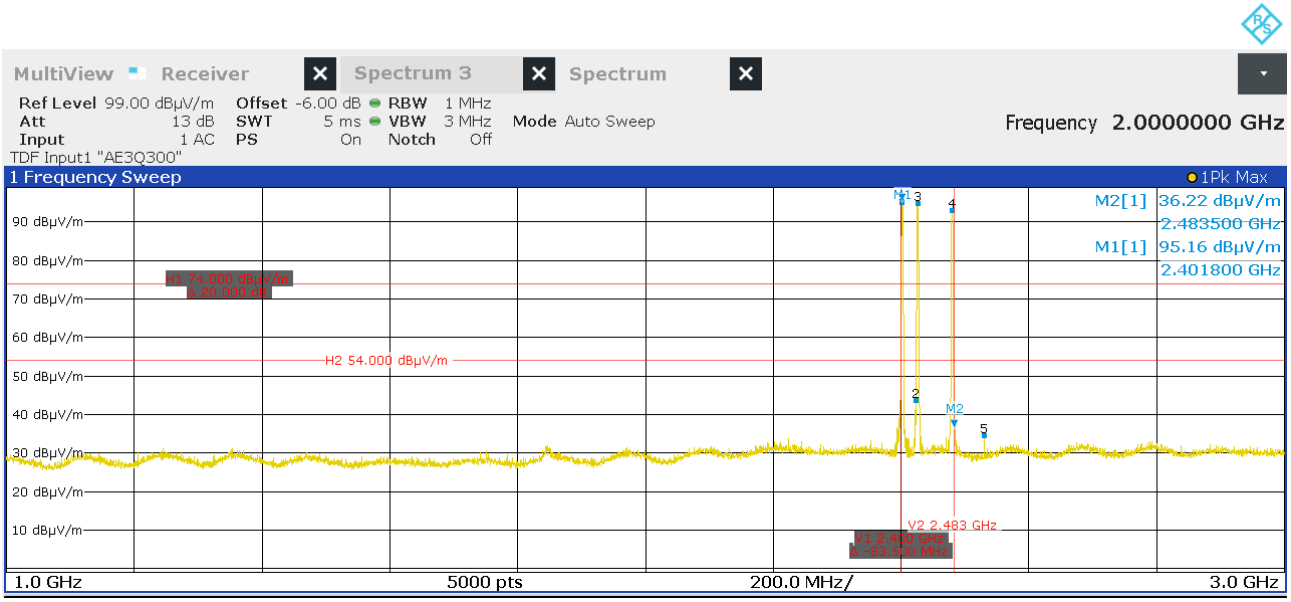

Figure 21: Chart of radiated emissions pre-measurement from 1 GHz to 3 GHz, EUT position Z, antenna polarization vertical with peak detector

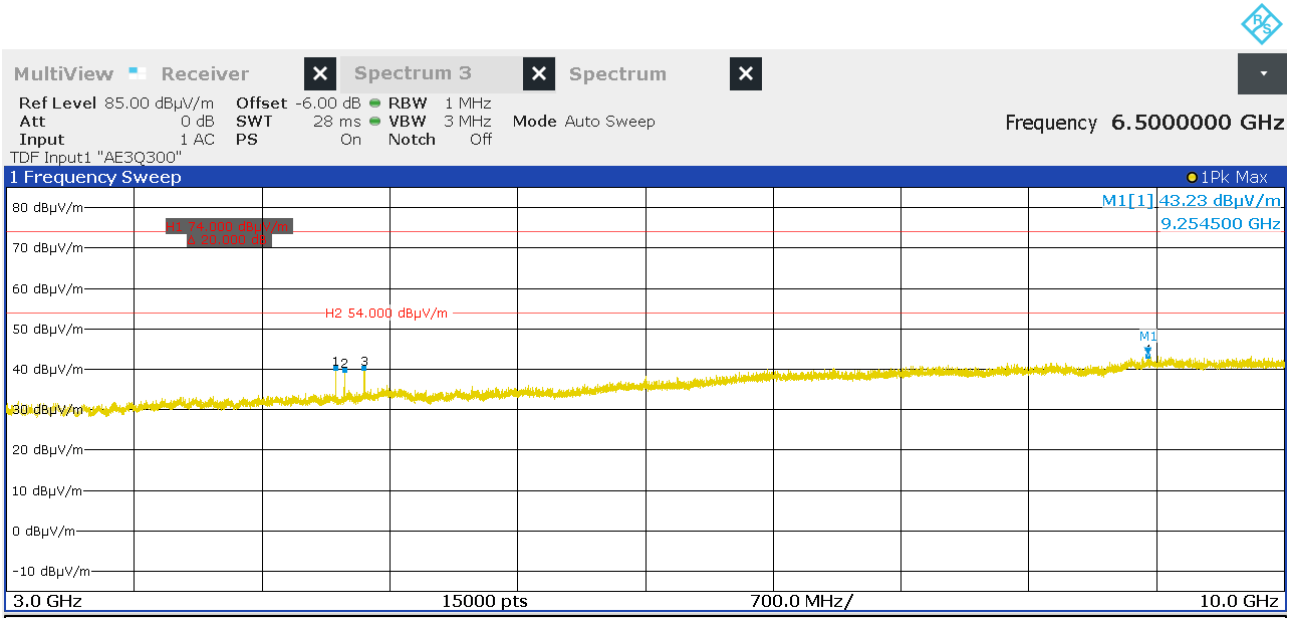

Figure 22: Chart of radiated emissions pre-measurement from 3 GHz to 10 GHz, EUT position Z, antenna polarization vertical with peak detector

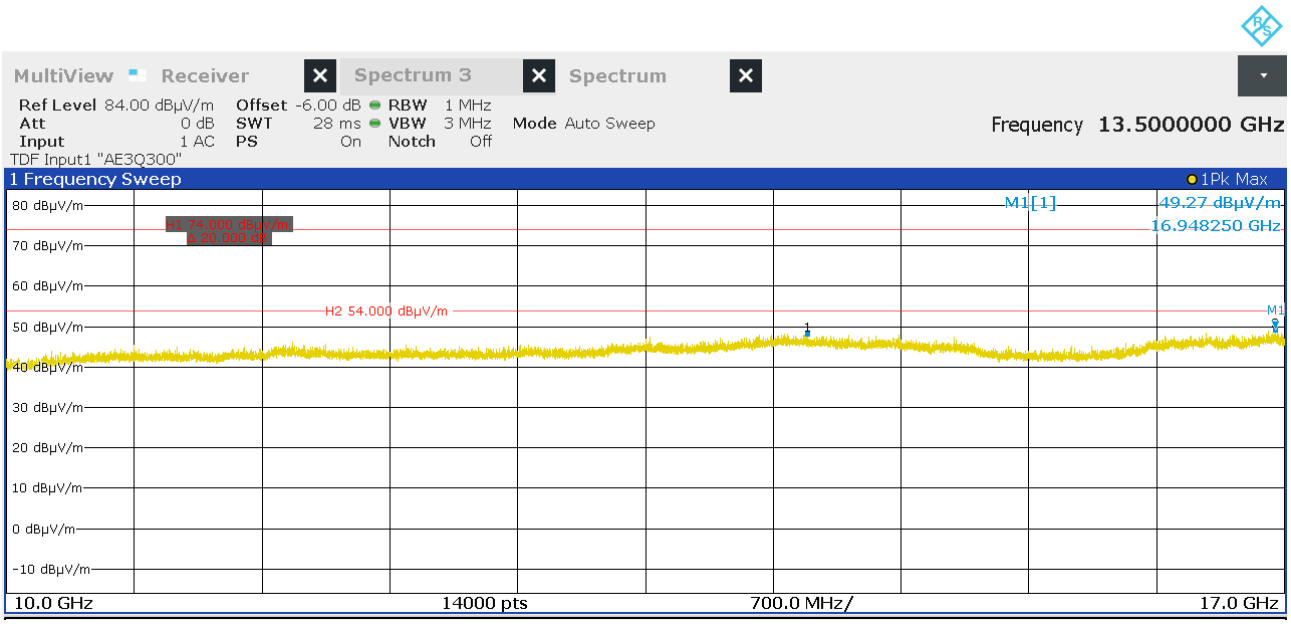

Figure 23: Chart of radiated emissions pre-measurement from 10 GHz to 17 GHz, EUT position Z, antenna polarization vertical with peak detector

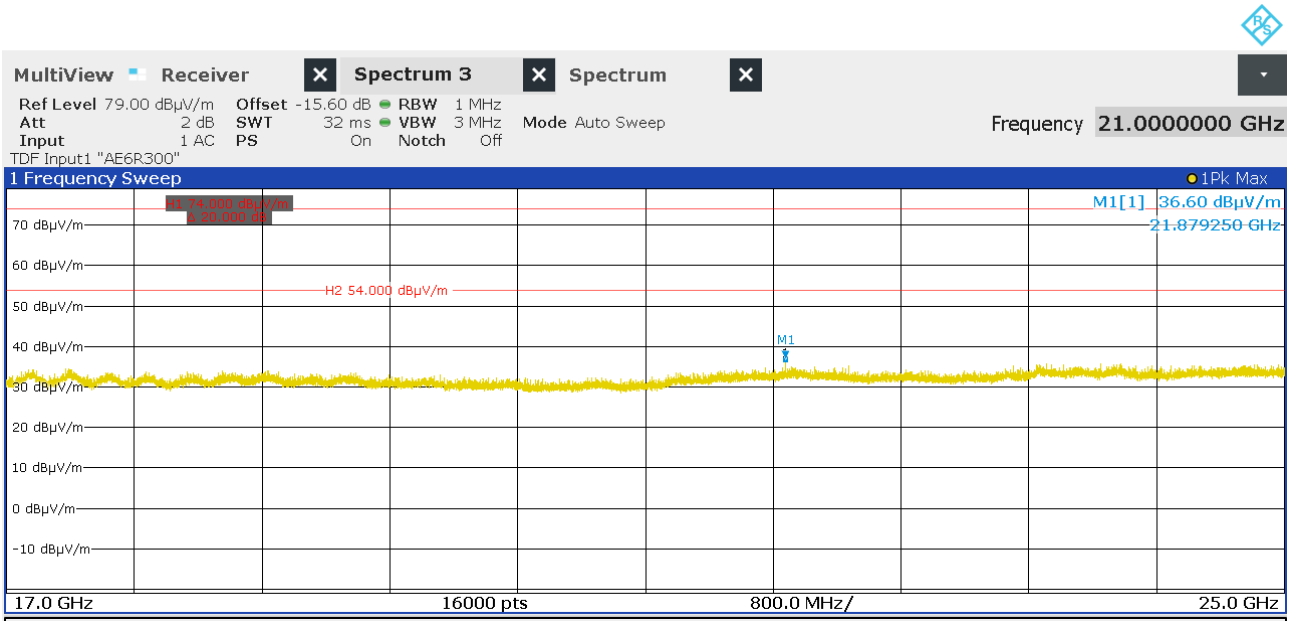

Figure 24: Chart of exploratory radiated emissions measurement from 17 GHz to 25 GHz with peak detector

Frequency (MHz)	*EUT Pos.*	*Field strength (dBµV/m) at 3 m*	*Detec-tor*	*Limit (dBµV/m) at 3 m*	*Margin (dB)*	*Height (cm)*	*Pol.*	*Azimuth (deg)*
2483.830	Z	47.3	Pk	74.0	26.7	150	V	318
4804.370	Z	40.3	Pk	74.0	33.7	168	V	6
4851.500	Z	39.8	Pk	74.0	34.2	168	V	6
4960.230	Z	40.3	Pk	74.0	33.7	168	V	6

Table 31: Results of radiated emissions test from 1 GHz to 25 GHz

8 Equipment calibration status

Description	*Modell number*	*Serial number*	*Inventory number(s)*	*Last calibration*	*Next calibration*
EMI test receiver	ESW44	101538	E00895	2022-08	2024-08
EMI test receiver	ESU26	100026	W00002	2022-06	2024-06
EMI test receiver	ESR7	101059	E00739	2022-08	2024-08
Preamplifier (1 GHz – 18 GHz)	BBV 9718 B	00032	W01325	2022-09	2023-10
Preamplifier (18 GHz – 40 GHz)	BBV 9721	43	W01350	2022-11	2023-11
Preamplifier (1 GHz - 18 GHz)	ALS05749	001	W01007	2023-03	2024-03
Loop antenna	HFH2-Z2	871398/0050	E00060	2021-10	2023-10
LISN	ESH2-Z5	881362/037	E00004	Note 1	
LISN	ESH2-Z5	893406/009	E00005	2021-10	2023-10
Field probe	RF-R 400-1	02-2030	E00270	Note 2	
TRILOG broadband antenna (SAC3)	VULB 9162	9162-041	E00643	2021-03	2024-03
Horn antenna	BBHA 9120D	9120D-592	W00053	2022-09	2025-09
Horn antenna	BBHA 9170	9170-332	W00055	2022-08	2023-08
Shielded room	P92007	B 83117 C 1109 T 211	E00107	N/A	
Compact diagnostic chamber (CDC)	VK041.0174	D62128-A502-A69-2-0006	E00026	N/A	
Semi-anechoic chamber (SAC) with floor absorbers	FS-SAC	---	E00100	2021-03	2024-03
Semi-anechoic chamber (SAC)	SAC3	C62128-A520-A643-x-0006	E00716	2021-03	2024-03
Cable set CDC	RG214/U	---	E00446	2023-01	2024-07
	LCF12-50J	---	E01215	2023-01	2024-07
	LMR400	1718020006	E00920	2023-01	2024-07
	RG214 Hiflex	171802007	E00921	2023-01	2024-07
Cable set anechoic chamber	262-0942-1500	005	E00435	2022-04	2023-10
	SF104EA/2x11PC35-42/5m	11144/4EA	E00307	2023-01	2024-07
	262-0942-1500	003	E00433	2022-04	2023-10
Cable set of semi-anechoic chamber SAC3	SF104EA/11PC35/11PC35/10000MM	501347/4EA	E00755	2023-01	2024-07
	SF104E/11PC35/11PC35/2000MM	507410/4E	E01035	2023-01	2024-07
	SF104E/11PC35/11PC35/2000MM	507411/4E	E01034	2023-01	2024-07

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

9 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.

10 Revision history

Revision	*Date*	*Issued by*	*Description of modifications*
0	2023-06-22	Konrad Graßl	First edition

Template: RF_Colocation_15.225_15.209_15.247_RSS-210_RSS-247