Test report

Customer:

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RF test report

170269-AU01+W02

HEINE Optotechnik GmbH & Co. KG

Wireless Power Transmission System

iC2 Charger

Deutsche Akkreditierungsstelle D-PL-12155-01-00

EMV **TESTHAUS** GmbH

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Accreditation:

Test Firm Type “accredited”: Valid until 2019-05-06
MRA US-EU, FCC designation number: DE0010
BNetzA-CAB-02/21-02/04 Valid until 2018-11-27

Industry Canada test site numbers with registration expiry date:
3472A-1, expiring 2018-11-09
3472A-2, expiring 2018-11-12

Location of Testing:

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Germany

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

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1 Summary of test results

47 CFR part and section	*Test*	*Equivalent IC standard(s)*	*Page*	*Result*	*Note(s)*
15.205	Restricted bands of operation	RSS-216, section 6.2.3 / RSS-Gen, section 8.10	26	Passed	1
15.207	AC power line conducted emissions 9 kHz to 30 MHz	RSS-216, section 6.2.2.1 / ICES-001	33	Passed	2
15.209	Radiated emissions	RSS-216, section 6.2.2.2 / ICES-001			
	9 kHz to 30 MHz		41	Passed	3
	30 MHz to 1 GHz		49	Passed	
	1 GHz to 10th harmonic		---	Not applicable	4
15.215	Emission bandwidth	---		Recorded	5
---	Occupied bandwidth	RSS-Gen, section 6.6		Recorded	

Notes (for information about EUT see clause 3):

1 Restricted band according to §15.205 close to operating frequency range is 90 kHz to 110 kHz which is identical to the requirements of section 8.10 in RSS-Gen.

2 According to §15.207, conducted emission limits are defined for the frequency range 150 kHz to 30 MHz. However, according to section 6.2.2.1 of RSS-216, the mains terminals disturbance voltage limits for induction cooking (group 2) equipment defined for the frequency range 9 kHz to 30 MHz apply, as set out in the CISPR 11 standard referenced in ICES-001.

3 Alternate 60 cm loop test method used as set out in the CISPR 11 standard referenced in ICES-001. According to section 6.2.2.2 of RSS-216, it is acceptable to use this method referring to the limits for commercial / industrial and large residential induction cooking appliances even if the WPT device is small and for residential use.

4 As the intentional radiator of the WPT system operates below 10 GHz and the tenth harmonic of the highest fundamental frequency is lower than 1 GHz (see 47 CFR Part 15, section 15.33(a)(1)), this measurement needs to be applied only if the digital part of the WPT device generates or uses internal frequencies higher than 108 MHz (see 47 CFR Part 15 section 15.33(b)(1)). RSS-216 specifies limits from 9 kHz to 1 GHz, only.

5 Required for intentional radiators operating under the alternative provisions to the general emission limits, only.

Straubing, March 2, 2018

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Test engineer
EMV **TESTHAUS** GmbH

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2 Referenced publications

In this report, any reference to publications without stating the issue date explicitly refers to the versions as listed below.

Publication	*Title*
47 CFR Part 2:2017-10	Code of Federal Regulations Part 2 (Frequency allocation and radio treaty matters; General rules and regulations) of the Federal Communication Commission (FCC)
47 CFR Part 15:2017-10	Code of Federal Regulations Part 15 (Radio Frequency Devices) of the Federal Communication Commission (FCC)
ANSI C63.10:2013-06	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
FCC KDB 680106 D01 May 31, 2013	RF Exposure Considerations for Low Power Consumer Wireless Power Transfer Applications
FCC KDB 174176 D01 June 3, 2015	AC power-line conducted emissions Frequently Asked Questions
RSS-216 Issue 2, January 2016	Spectrum Management and Telecommunications Radio Standards Specification Wireless Power Transfer Devices
RSS-Gen Issue 4, November 2014	Spectrum Management and Telecommunications Radio Standards Specification General Requirements and Information for the Certification of Radiocommunication Equimpment
ICES-001 Issue 4, January 2016, Updated November 2014	Spectrum Management and Telecommunications Interference-Causing Equipment Standard Industrial, Scientific and Medical (ISM) Radio Frequency Generators
CAN/CSA-CEI/IEC CISPR 11:04	Industrial, Scientific and Medical (ISM) Radio-Frequency Equipment - Electromagnetic Disturbance Characteristics - Limits and Methods of Measurement
CISPR 11:2003-03 Edition 4.0	Industrial, scientific and medical (ISM) radio-frequency equipment - Electromagnetic disturbance characteristics - Limits and methods of measurement

Notes:

1 Although not listed explicitly in the Annex to Accreditation Certificate D-PL-12155-01-00, testing according to RSS-216 Issue 2, January 2016, is regarded as to be covered by the scope of accreditation because for all tests performed, this standard refers to ICES-001 and/or RSS-Gen (see clause 1), which both are listed in the Annex to Accreditation Certificate D-PL-12155-01-00.

2 CAN/CSA-CEI/IEC CISPR 11:04 is an adoption of the fourth edition of CISPR 11, i.e. CISP 11:2003-03.

3 Equipment under test (EUT)

All Information in this clause is declared by customer.

3.1 General information

Product type:	Wireless Power Transmission System		
Model name:	Power transmitter: (WPT source device)	iC2 Charger	
	Power receiver: (WPT client device)	iC2	
Serial number(s):	Power transmitter:	1100000029	
	Power receiver:	1100000005	
Manufacturer:	Heine Optotechnik GmbH & Co. KG		
Version:	Power transmitter:	Hardware:	HW01_5102100_Rev04
		Software:	No SW-Version
	Power receiver:	Hardware:	HW01_51020_Rev07
		Software:	1.0.4
Short description:	EUT is a Wireless power transmission (WPT) system that has a range of operating frequencies from 137 kHz to 176 kHz.		
Additional modifications:	None		
Power supply:	AC supply		
	Nominal voltage:	230 V	
	Minimum voltage:	100 V	
	Maximum voltage:	240 V	
Temperature range:	0 ℃ to +35 ℃ (Customized)		

3.2 Radio specifications

Application(s):	Wireless Power Transfer (WPT)	
Range of operating frequencies:	137 kHz to 176 kHz	
Frequency stability during charging:	☐ Fixed frequency ☒ Frequency depending on charge of battery	
Secondary frequency[1]:	☐ yes	☒ no
Power transfer management[1]:	☒ yes	☐ no
Modulation:	ASK	
Device type(s) [1]:	☒ WPT source device: Power transmitter (base station), with additional communication capability to control the charge function, in conjunction with the receiving part ☒ WPT client device: Power receiver, which supplies the received energy to a mobile device and performs a control/supervision function for the mobile device status and charge operation. Both parts in combination are able to transmit and receive data in addition to the power transmission mode e.g. to control the mobile device status and to optimize the power transmission mode	
WPT source type[1]:	☐ Type 1 (ISM) ☐ Type 2 (Category II) ☒ Type 3 (Category I)	
Power transfer zone(s) [1]:	☒ Single fixed power transfer zone, single client ☐ Multiple fixed power transfer zones, single client ☐ Multiple non-fixed power transfer zones, single client ☐ Multiple power transfer zones, multiple clients	
EUT setup for[1]:	☒ WPT system (source and client(s) together) ☐ WPT source (marketed independently) ☐ WPT client (marketed independently)	
Antenna:	Type:	Power transmitter: TDK WT303012-12F2-ID Power receiver: TDK WR303050-15F5-G
	Size:	Power transmitter: 30 mm Ø Power receiver: 30.0 mm x 29.6 mm
	Style:	☒ integral ☐ dedicated
	Connector:	☐ external ☐ internal ☐ temporary ☒ none

[1] Classification according to RSS-216.

4 Photo documentation

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

5 Test configuration and mode of operation

5.1 Test configuration

EUT			
Device	*Type designation*	*Serial or inventory no.*	*Manufacturer*
Power transmitter	iC2 Charger	1100000029	HEINE OPTOTECHNIK GmbH & Co. KG
Peripheral devices			
Device	*Type designation*	*Serial or inventory no.*	*Manufacturer*
USB power resistive load (3.9 Ω and 2.7 Ω in series between plus and minus)	---	---	HEINE OPTOTECHNIK GmbH & Co. KG
Power receiver	iC2	1100000005	HEINE OPTOTECHNIK GmbH & Co. KG
Power receiver dummy	iC2	---	HEINE OPTOTECHNIK GmbH & Co. KG
Support devices			
Device	*Type designation*	*Serial or inventory no.*	*Manufacturer*
AC power source	616062	E00633	Chroma

Table 1: Devices used for testing

Note: The power receiver is used for determining the operating frequency range when charging. For testing at a single frequency, the power receiver dummy is selected. This dummy device is equipped with the same power receiver part as the original power receiver device, but the battery is disconnected and a special load mounted outside the cabinet is used instead. This enables testing the EUT operating in charging mode at a single and stable frequency.

Port	*Classification (see note 1)*	*Cable type*	*Outdoor cable*	*Cable length*		*Note*
				used	*maximum*	
AC input of power supply of power transmitter	AC power	---	☐	N/A	N/A	
DC input of power transmitter	DC power	Unshielded	☐	1.70 m	1.70 m	2
USB port of power transmitter	DC power	Shielded	☐	0.5 m	2.00 m	3

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

Notes:
1 Ports of EUT are classified as “AC power”, “DC power”, “DC power connected to dedicated AC/DC power supply”, “Signal/control” or “Wired network”.
2 Fixed connection of power supply to power transmitter.
3 USB port of power transmitter is intended to be used for charging additional peripheral devices. Therefore, a resistive load is connected to simulate appropriate power consumption.

5.2 Mode of operation

5.2.1 Separation distance

For EUTs that are capable of wireless power transfer over a non-zero separation distance between the source and the client devices, testing at zero separation only is not sufficient.

☒ EUT is not capable of wireless power transfer over a non-zero separation distance: Testing at zero separation is performed.
☐ EUT is capable of wireless power transfer over a non-zero separation distance. According to section 6.1.5 of RSS-216, there are two possible approaches:
  ☐ Preliminary exploratory measurements are performed by varying the orientation of the WPT client(s) and its (their) separation distance(s) from the wireless power transfer zone of the WPT source, for finding the configuration that generates the highest levels of emissions. The final compliance measurement is performed on the worst-case EUT configuration. This procedure is used for all EUT emissions.
  ☐ EUT is tested in the following two configurations:
    - With zero separation between the source and client device(s);
    - With maximum separation between the source and client device(s).

[2] As specified by customer.

5.2.2 Orientation

The EUT is tested in its typical setup configuration, as per the manufacturer's instructions in the user manual. If the device can be operated in various orientations (e.g. tabletop and wall-mount), it is tested in each orientation in which it is intended to be used.

☒ EUT has one position of use which is selected for testing.
☐ EUT is tested in three orthogonal orientations.

For photos of EUT positions see annex A.

5.2.3 Operational modes

In table 3 the operational modes of the WPT system are listed.

Operational mode	*Set-up*	*Function of WPT source*	*Function of WPT client*	*Tests performed*
Standby mode: WPT source in standby or idle mode	WPT source only	Transmitter	Not applicable	• Restricted bands of operation • AC power line conducted emissions • Radiated emissions
Charging mode 1: energy transmission with communication	WPT system alignment with WPT source and standard WPT client	TX and RX	TX and RX	• Restricted bands of operation
Charging mode 2: energy transmission with communication on fixed frequency	WPT system alignment with WPT source and power receiver dummy	TX and RX	TX and RX	• Restricted bands of operation • AC power line conducted emissions • Radiated emissions

Table 3: Operational modes of WPT system

6 Test procedures

6.1 General specifications

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

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

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

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

6.2 AC power-line 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 and clause 5.1 of CISPR 11 from 9 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*
9 kHz ≤ f < 150 kHz	200 Hz	≤ 100 Hz	Peak, Average	Quasi-peak, Average	Quasi-peak, Average
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).

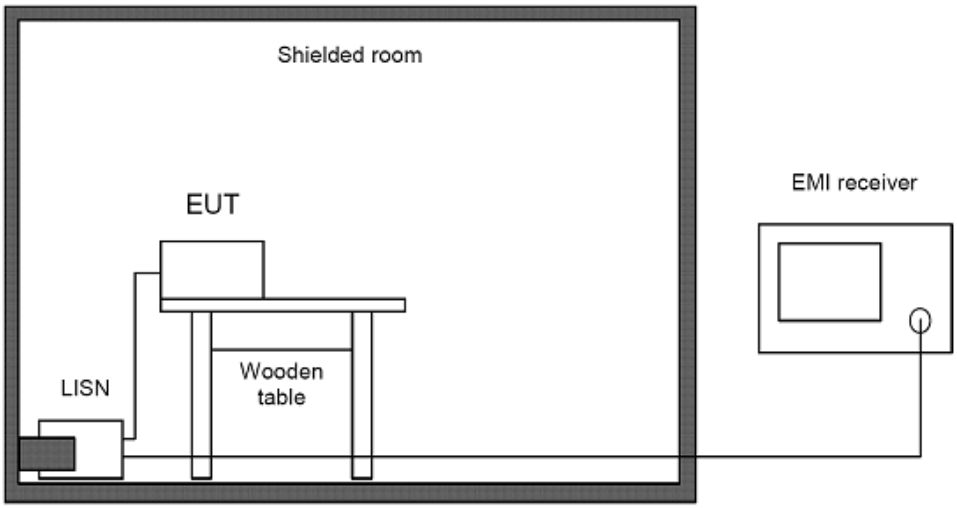

Figure 1: Setup for AC power-line conducted emissions test from 9 kHz to 30 MHz

6.3 Radiated emissions below 30 MHz

Radiated emissions below 30 MHz are measured according to clause 6.4 of ANSI C63.10 and clause 5.2 of CISPR 11 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.

6.3.1 Extrapolation according to ANSI C63.10

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

6.3.2 Test method according to RSS-216

According to section 6.2.2.2 of RSS-216, 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 using the van Veen loop antenna system. However, it is acceptable to use the alternate 60 cm loop test method, as set out in the CISPR 11 standard referenced in ICES 001.

As the limits for commercial / industrial and large residential devices defined for a test distance of 3 meters shall apply even if the WPT device is small and for residential use, extrapolation is not required for magnetic field tests performed according to CISPR 11.

6.3.3 Measuring radiated emissions below 30 MHz

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

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 th e 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.

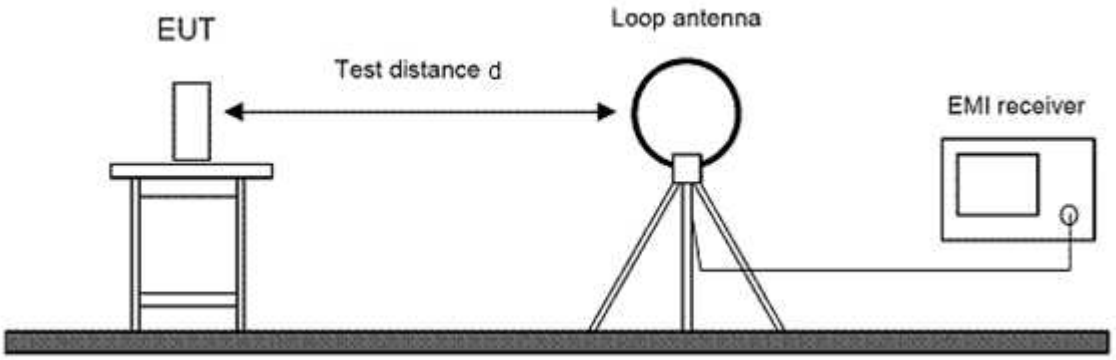

Figure 2: Setup for radiated emissions test below 30 MHz

6.4 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 and clause 5.2 of CISPR 11 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

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.

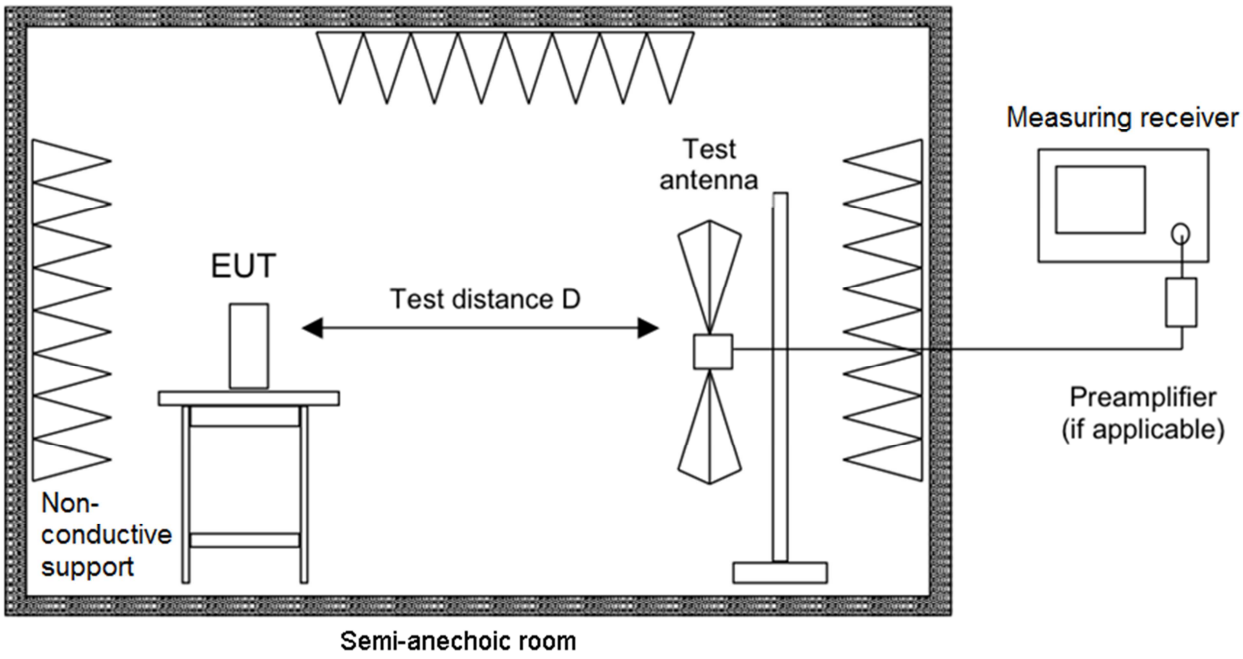

Figure 3: Setup for radiated emissions test from 30 MHz to 1 GHz

6.5 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.

6.5.1 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.

6.5.2 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.

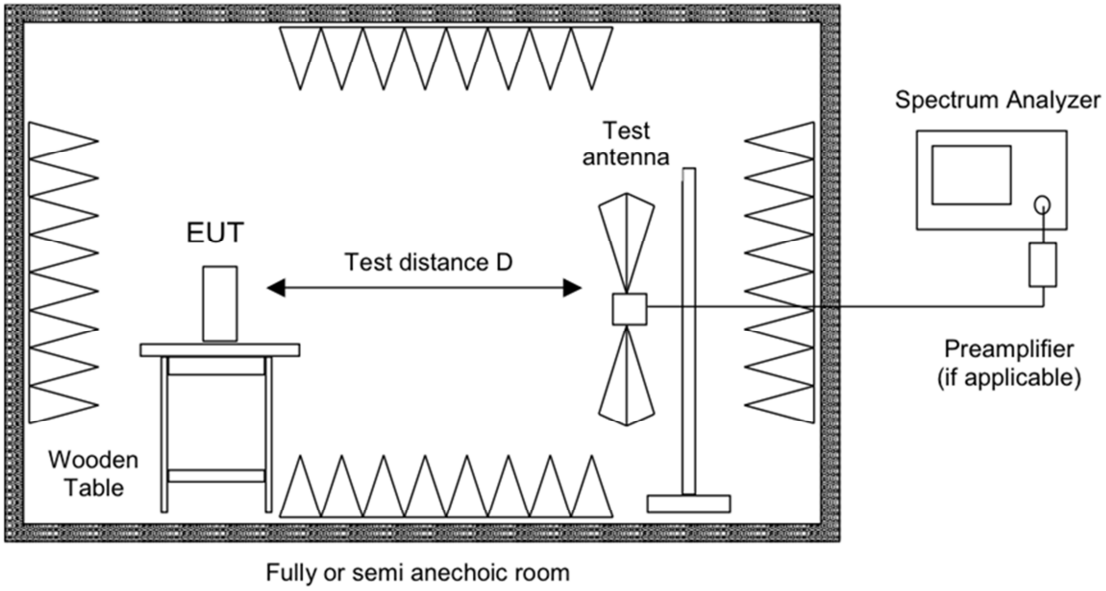

Figure 4: Setup for radiated emissions test above 1 GHz

7 Test results

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

7.1 Restricted bands of operation

Section(s) in 47 CFR Part 15:	Requirement:	15.205
	Reference(s):	ANSI C63.10, clause 6.4
Section(s) in RSS-216:	Requirement:	6.2.3
	Reference(s):	RSS-Gen, section 8.10

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

7.1.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☒	Compact Diagnostic Chamber (CDC)	VK041.0174	Albatross Projects	E00026
☐	Open area test site (OATS)	---	EMV **TESTHAUS**	E00354
☐	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☒	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☐	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Field probe	RF-R 400-1	Langer EMV-Technik	E00270
☒	Loop antenna	HFH2-Z2	Rohde & Schwarz	E00060
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☐	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☒	Cable set CDC	RF cable(s)	Huber + Suhner AME HF-Technik AME HF-Technik Stabo	E00446 E00920 E00921 E01215
☐	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☒	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[3] For information about measurement uncertainties see page 73.

7.1.2 Limits

The field strength of any emissions including spurious emissions falling into restricted bands as specified in section 15.205(a) of 47 CFR Part 15 and section 8.10 of RSS-Gen, shall not exceed the general radiated emission limits as specified in section 15.209 of 47 CFR Part 15 and section 8.10 of RSS-Gen. In addition, only spurious emissions are permitted in any of the restricted bands.

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

Table 10: Limits for emissions in restricted bands

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 10 using the recalculation factor as described in clause 6.3.1.

7.1.3 Test procedure

Emissions in the restricted bands of operation are measured using the test procedure as described in clause 6.3.

7.1.4 Test results

7.1.4.1 Test results for standby mode

Performed by:	Andreas Menacher	Date of test:	November 20, 2017
Climatic conditions:	Ambient temperature 20.0 ℃	Relative humidity 41.0 %	Barometric pressure 98.2 kPa
Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
Antenna alignment:	☒ in parallel	☐ in line	☐ angle ….. °
EUT position:	☒ Position 1	☐ Position 2	☐ Position 3

Frequency range	*Step size*	*IF Bandwidth*	*Detector*		*Measurement Time*		*Preamplifier*
			Prescan	*Final scan*	*Prescan*	*Final scan*	
9 kHz – 150 kHz	50 Hz	200 Hz	QP, PK, CAV	QP, PK, AV	2 s	1 s	Off
150 kHz – 30 MHz	2.25 kHz	9 kHz	QP, PK, CAV	QP, PK, AV	2 s	1 s	Off

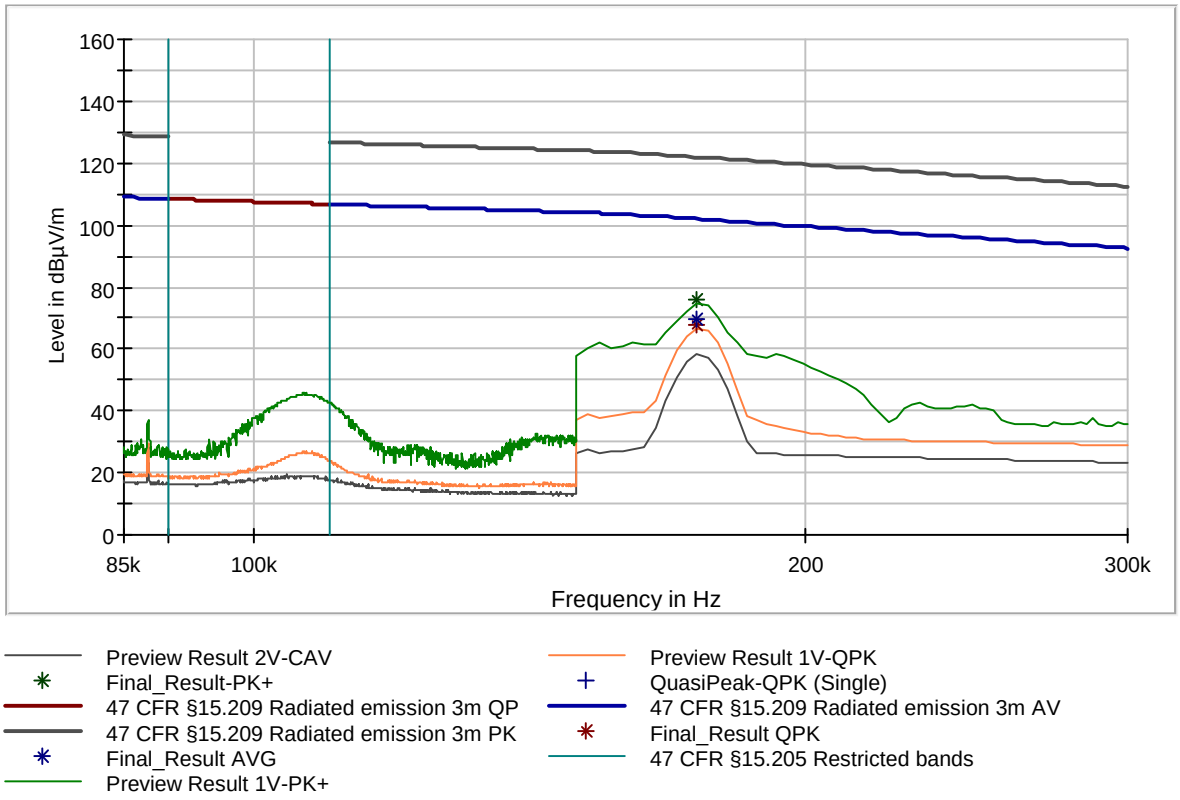

Figure 5: Chart of restricted bands of operation test for standby mode

Frequency (MHz)	*De-tector*	*Measured field strength* (dBµV/m)	*Distance referred to limit* (m)	*Re-calculation factor* (dB)	*Calcu-lated field strength* (dBµV/m)	*Limit* (dBµV/m)	*Margin* (dB)	*Meas. Time* (ms)	*Band-width* (kHz)	*Azi-muth* (deg)	*Corr.* (dB)
0.17475	AV	69.56	300	79.19	-9.63	22.76	32.39	100.0	9.000	249.0	20.0
0.17475	PK	75.84	300	79.19	-3.35	42.76	46.11	100.0	9.000	249.0	20.0

Table 11: Results of restricted bands of operation test for standby mode

Note: The emission within the restricted band from 90 kHz to 110 kHz is a spurious emission for which the quasi-peak limit applies. In standby mode, no power receiver is present, i.e. there is no communication.

7.1.4.2 Test results for charging mode 1

Performed by:	Andreas Menacher	Date of test:	November 23, 2017
Climatic conditions:	Ambient temperature 22.0℃	Relative humidity 34.5 %	Barometric pressure 98.6 kPa
Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
Antenna alignment:	☒ in parallel	☐ in line	☐ angle ….. °
EUT position:	☒ Position 1	☐ Position 2	☐ Position 3

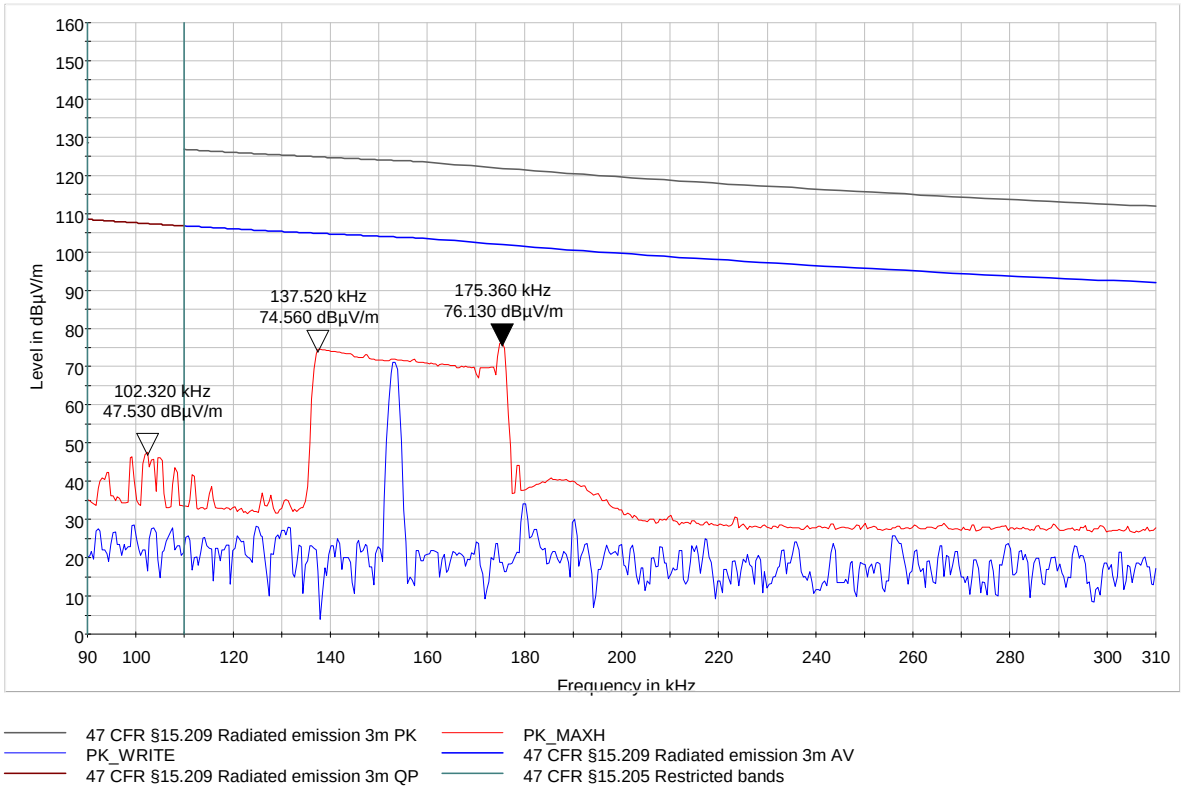

Figure 6: Chart of restricted bands of operation test for charging mode 1

Note: Figure 6 shows the spectrum of emission when charging an empty WPT client over 6 hours. The EUT starts charging at the lowest frequency. With battery getting charged, the frequency increases. When battery is fully charged, the frequency stays at approximately the same value as in standby mode without WPT client.
The test is performed with EMI test receiver in spectrum analyzer mode with trace mode set to “maxhold”.
The emission within the restricted band from 90 kHz to 110 kHz is a spurious emission caused by standby mode for which the quasi-peak limit applies (see figure 5).

7.1.4.3 Test results for charging mode 2

Performed by:	Andreas Menacher	Date of test:	November 20, 2017
Climatic conditions:	Ambient temperature 20.0 ℃	Relative humidity 41.0 %	Barometric pressure 98.2 kPa
Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
Antenna alignment:	☒ in parallel	☐ in line	☐ angle ….. °
EUT position:	☒ Position 1	☐ Position 2	☐ Position 3

Frequency range	*Step size*	*IF Bandwidth*	*Detector*		*Measurement Time*		*Preamplifier*
			Prescan	*Final scan*	*Prescan*	*Final scan*	
9 kHz – 150 kHz	50 Hz	200 Hz	QP, PK, CAV	QP, PK, AV	2 s	1 s	Off
150 kHz – 30 MHz	2.25 kHz	9 kHz	QP, PK, CAV	QP, PK, AV	2 s	1 s	Off

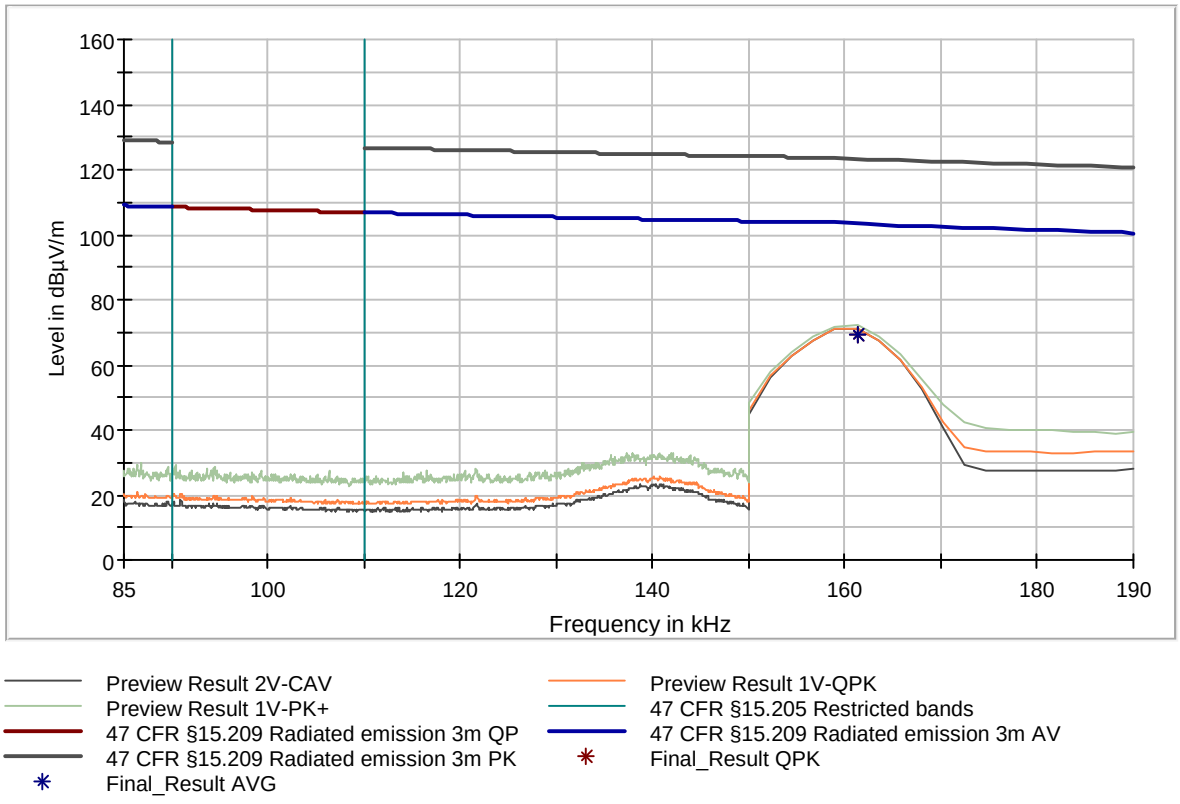

Figure 7: Chart of restricted bands of operation test for charging mode 2

Frequency (MHz)	*De-tector*	*Measured field strength* (dBµV/m)	*Distance referred to limit* (m)	*Re-calculation factor* (dB)	*Calcu-lated field strength* (dBµV/m)	*Limit* (dBµV/m)	*Margin* (dB)	*Meas. Time* (ms)	*Band-width* (kHz)	*Azi-muth* (deg)	*Corr.* (dB)
0.161250	AV	69.47	300	79.89	-10.42	23.45	33.87	100.0	9.000	99.0	20.0
0.161250	PK	70.06	300	79.89	-9.83	43.45	53.28	100.0	9.000	99.0	20.0

Table 12: Results of restricted bands of operation test for charging mode 2

7.2 AC power line conducted emissions

Section(s) in 47 CFR Part 15:	Requirement:	15.207
	Reference(s):	ANSI C63.10, clause 6.2
Section(s) in RSS-216:	Requirement:	6.2.2.1
	Reference(s):	ICES-001 CISPR 11, clause 5.1

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

7.2.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☒	Shielded room	P92007	Siemens Matsushita	E00107
☒	EMI test receiver	ESCS 30	Rohde & Schwarz	E00003
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☐	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☐	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☒	Artificial mains network	ESH2-Z5	Rohde & Schwarz	E00004
☐	Artificial mains network	ESH2-Z5	Rohde & Schwarz	E00005
☐	Artificial mains network	ENV216	Rohde & Schwarz	E00892
☐	Attenuator (10 dB)	50FHB-010-10	JFW Industries	E00471
☐	Cable set (shielded room) no. 1	RF cable(s)	Huber + Suhner	E00741 E00804
☐	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☒	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[4] For information about measurement uncertainties see page 73.

7.2.2 Limits

As specified in section 15.207 of 47 CFR Part 15, 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 13.

Frequency	*Conducted limit*	
	Quasi-peak	*Average*
[MHz]	*[dBµV]*	*[dBµV]*
0.15 – 0.5	66 – 56	56 – 46
0.5 – 5	56	46
5 – 30	60	50

Table 13: Limits for AC power-line conducted emissions according to §15.207

According to section 6.2.2.1 of RSS-216, the mains terminals disturbance voltage limits for induction cooking (group 2) equipment defined for the frequency range 9 kHz to 30 MHz apply, as set out in the CISPR 11 standard referenced in ICES-001 and listed in table 14.

Frequency	*Conducted limit*	
	Quasi-peak	*Average*
[MHz]	*[dBµV]*	*[dBµV]*
0.009 – 0.05	110	---
0.05 – 0.1485	90 – 80	---
0.1485 – 0.5	66 – 56	56 – 46
0.5 – 5	56	46
5 – 30	60	50

Table 14: Limits for AC power-line conducted emissions according to CISPR 11

Therefore, the AC power line conducted emissions test is performed in the frequency range 9 kHz to 30 MHz using the limits according to CISPR 11, as this is the worst-case requirement.

7.2.3 Test procedure

AC power line conducted emissions are measured using the test procedure as described in clause 6.2.

7.2.4 Test results

7.2.4.1 Test results for standby mode

Performed by:	Andreas Menacher	Date of test:	March 2, 2018
Climatic conditions:	Ambient temperature 21.0 °C	Relative humidity 31.0 %	Barometric pressure 95.9 kPa

Frequency range	*Step size*	*IF Bandwidth*	*Detector*		*Measurement Time*		*Preamplifier*
			Prescan	*Final scan*	*Prescan*	*Final scan*	
9 kHz – 150 kHz	100 Hz	200 Hz	PK, AV	QP, AV	100 ms	1 s	Off
150 kHz – 30 MHz	4 kHz	9 kHz	PK, AV	QP, AV	10 ms	1 s	Off

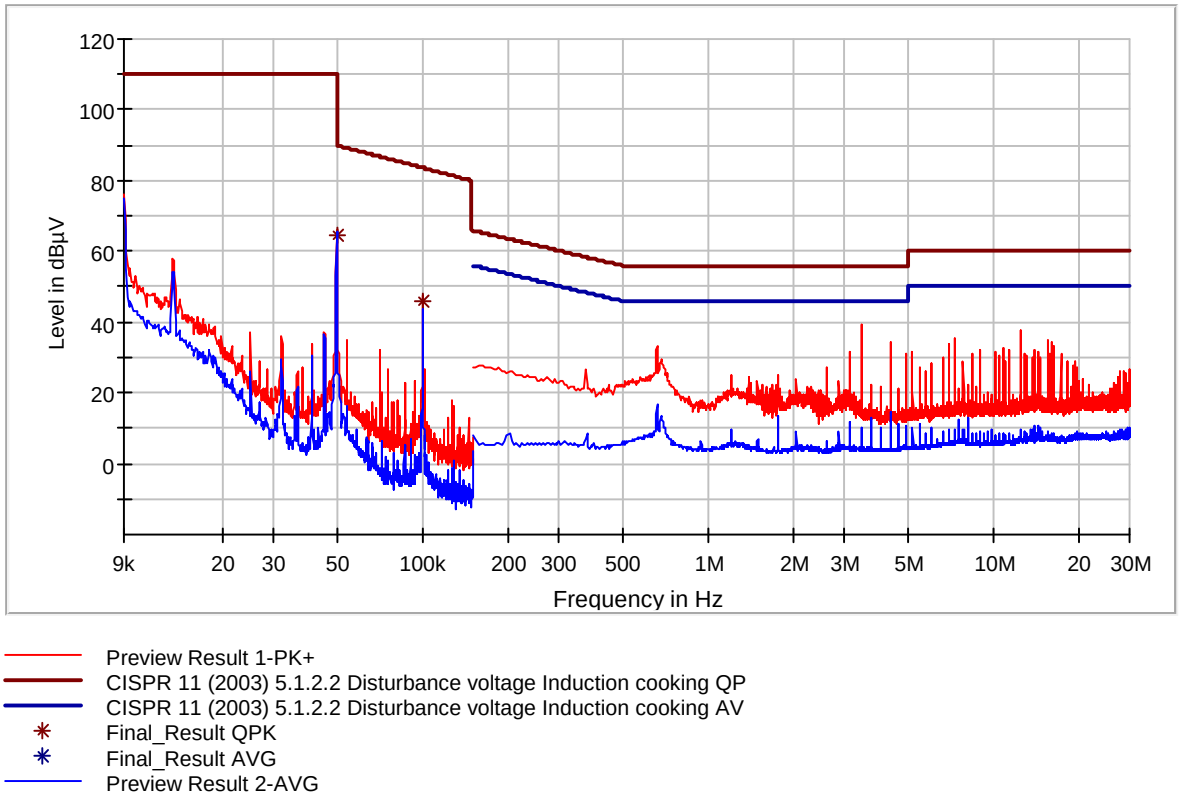

Figure 8: Chart of AC power-line conducted emissions test on live wire L1 for standby mode

Frequency (MHz)	*Detector*	*Voltage (dBµV)*	*Limit (dBµV)*	*Margin (dB)*	*Meas. time (ms)*	*Bandwidth (kHz)*	*Line*	*PE*	*Corr. (dB)*
0.050000	QP	61.57	90.00	28.43	1000.0	0.200	L1	GND	10.1
0.100000	QP	46.13	83.63	37.50	1000.0	0.200	L1	GND	10.1

Table 15: Results of AC power-line conducted emissions test on live wire L1 for standby mode

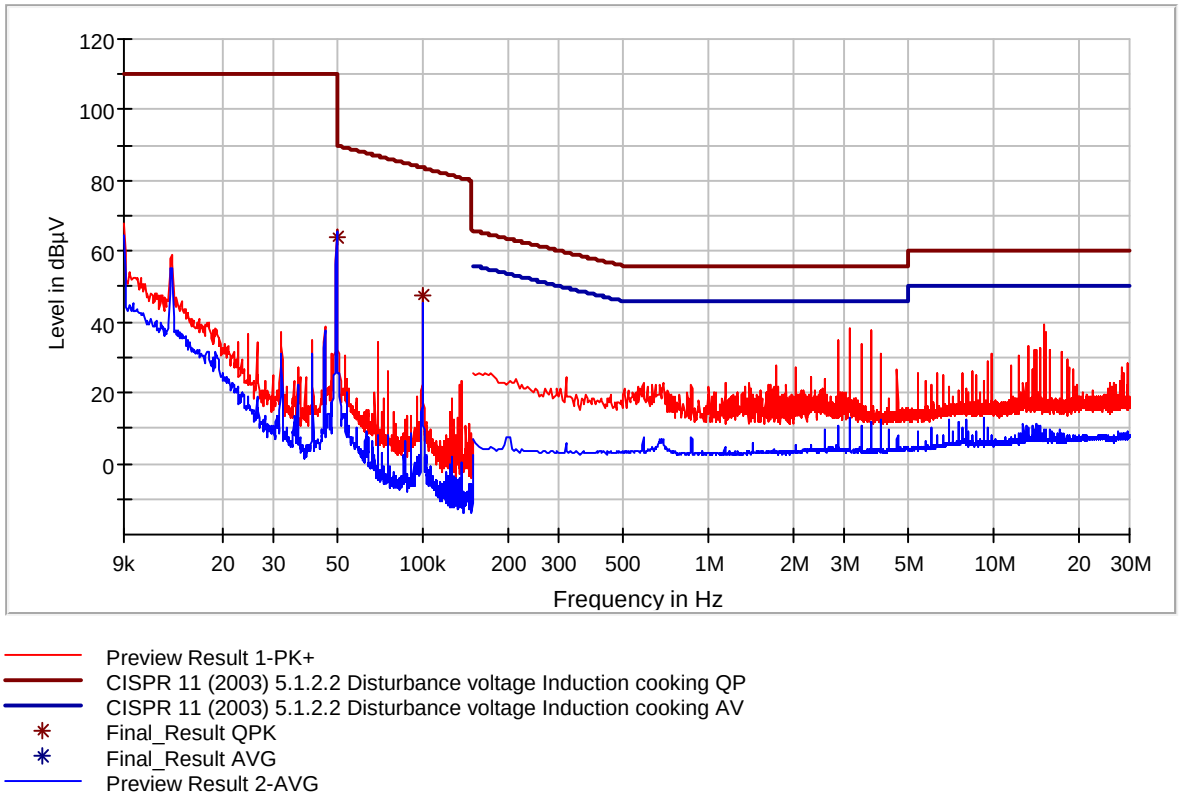

Figure 9: Chart of AC power-line conducted emissions test on neutral wire N for standby mode

Frequency (MHz)	*Detector*	*Voltage (dBµV)*	*Limit (dBµV)*	*Margin (dB)*	*Meas. time (ms)*	*Bandwidth (kHz)*	*Line*	*PE*	*Corr. (dB)*
0.050000	QP	63.87	90.00	26.13	1000.0	0.200	N	GND	10.1
0.100000	QP	47.41	83.63	36.22	1000.0	0.200	N	GND	10.1

Table 16: Results of AC power-line conducted emissions test on neutral wire N for standby mode

7.2.4.2 Test results for charging mode 2

Performed by:	Andreas Menacher	Date of test:	March 2, 2018
Climatic conditions:	Ambient temperature 21.0 ℃	Relative humidity 31.0 %	Barometric pressure 95.9 kPa

Frequency range	*Step size*	*IF Bandwidth*	*Detector*		*Measurement Time*		*Preamplifier*
			Prescan	*Final scan*	*Prescan*	*Final scan*	
9 kHz – 150 kHz	100 Hz	200 Hz	PK, AV	QP, AV	100 ms	1 s	Off
150 kHz – 30 MHz	4 kHz	9 kHz	PK, AV	QP, AV	10 ms	1 s	Off

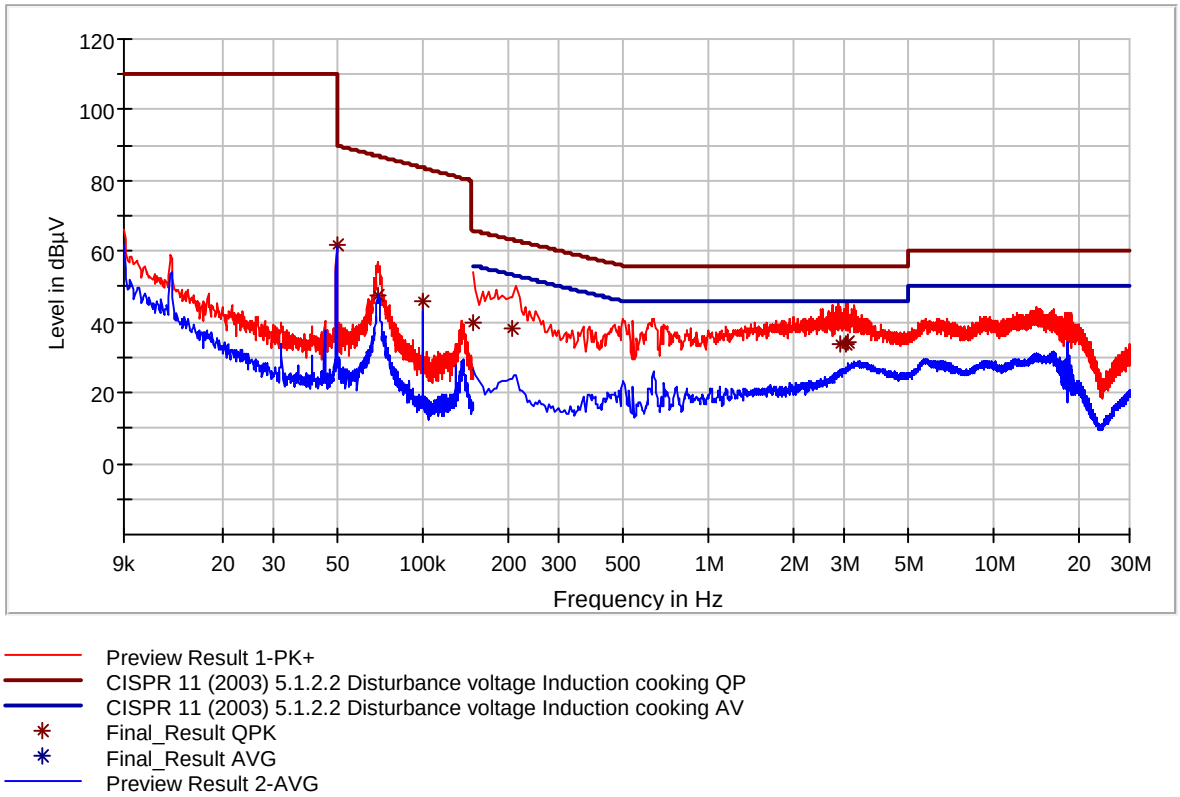

Figure 10: Chart of AC power-line conducted emissions test on live wire L1 for charging mode 2

Frequency (MHz)	*Detector*	*Voltage (dBµV)*	*Limit (dBµV)*	*Margin (dB)*	*Meas. time (ms)*	*Bandwidth (kHz)*	*Line*	*PE*	*Corr. (dB)*
0.050000	QP	61.73	90.00	28.27	1000.0	0.200	L1	GND	10.1
0.069900	QP	47.33	86.92	39.59	1000.0	0.200	L1	GND	10.1
0.100000	QP	46.03	83.63	37.60	1000.0	0.200	L1	GND	10.1
0.150000	QP	39.76	65.92	26.16	1000.0	9.000	L1	GND	10.1
0.205000	QP	38.14	63.34	25.20	1000.0	9.000	L1	GND	10.1
2.897000	QP	33.86	56.00	22.14	1000.0	9.000	L1	GND	10.5
3.061000	QP	33.59	56.00	22.41	1000.0	9.000	L1	GND	10.5
3.081000	QP	34.11	56.00	21.89	1000.0	9.000	L1	GND	10.5

Table 17: Results of AC power-line conducted emissions test on live wire L1 for charging mode 2

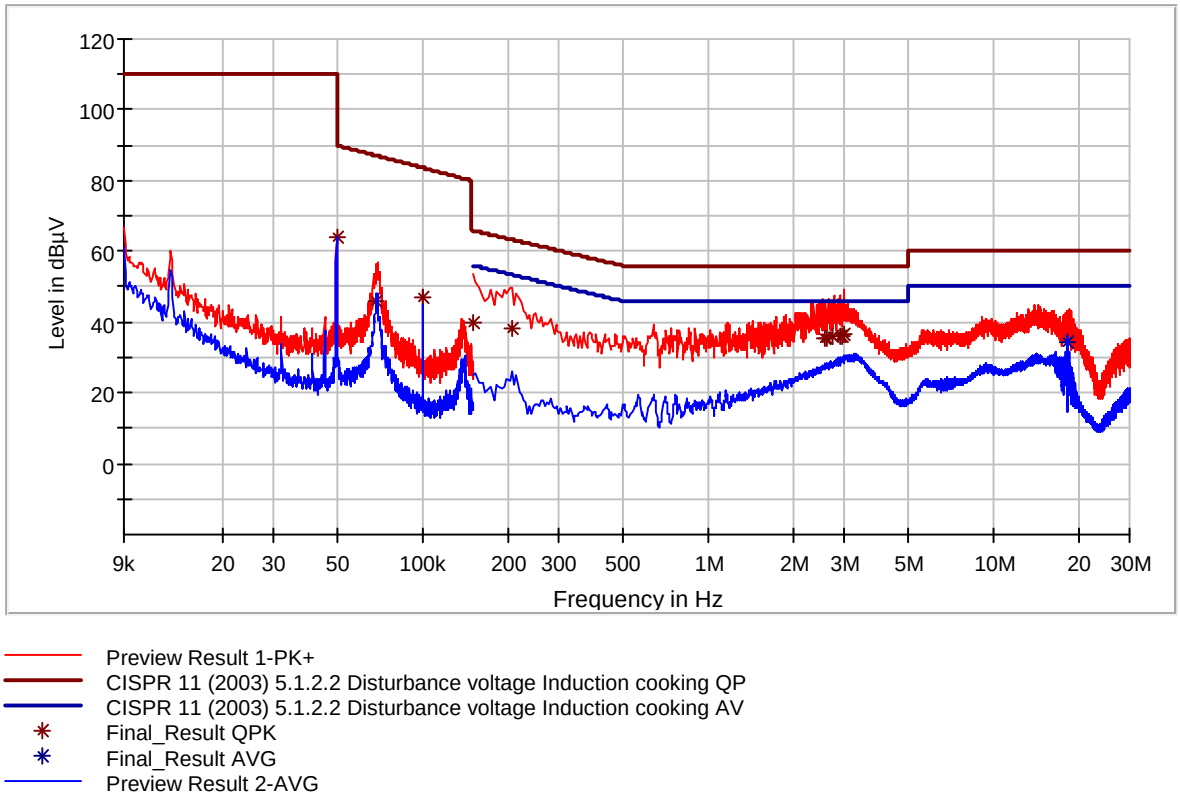

Figure 11: Chart of AC power-line conducted emissions test on neutral wire N for charging mode 2

Frequency (MHz)	*Detector*	*Voltage (dBµV)*	*Limit (dBµV)*	*Margin (dB)*	*Meas. time (ms)*	*Bandwidth (kHz)*	*Line*	*PE*	*Corr. (dB)*
0.050000	QP	64.05	90.00	25.95	1000.0	0.200	N	GND	10.1
0.069400	QP	46.09	86.99	40.90	1000.0	0.200	N	GND	10.1
0.100000	QP	47.23	83.63	36.40	1000.0	0.200	N	GND	10.1
0.150000	QP	39.96	65.92	25.96	1000.0	9.000	N	GND	10.1
0.205000	QP	37.93	63.34	25.41	1000.0	9.000	N	GND	10.1
2.577000	QP	35.56	56.00	20.44	1000.0	9.000	N	GND	10.4
2.613000	QP	35.52	56.00	20.48	1000.0	9.000	N	GND	10.4
2.737000	QP	35.81	56.00	20.19	1000.0	9.000	N	GND	10.4
2.889000	QP	36.17	56.00	19.83	1000.0	9.000	N	GND	10.5
2.949000	QP	36.11	56.00	19.89	1000.0	9.000	N	GND	10.5
2.985000	QP	36.55	56.00	19.45	1000.0	9.000	N	GND	10.5
18.165000	AV	34.23	50.00	15.77	1000.0	9.000	N	GND	12.0

Table 18: Results of AC power-line conducted emissions test on neutral wire N for charging mode 2

7.3 Radiated emissions

7.3.1 Radiated emissions below 30 MHz

Section(s) in 47 CFR Part 15:	Requirement:	15.209
	Reference(s):	ANSI C63.10, clause 6.4
Section(s) in RSS-216:	Requirement:	6.2.2.2
	Reference(s):	ICES-001 CISPR 11, clause 5.2

Result[5]: ☒ Test passed ☐ Test not passed

7.3.1.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☒	Compact Diagnostic Chamber (CDC)	VK041.0174	Albatross Projects	E00026
☐	Open area test site (OATS)	---	EMV **TESTHAUS**	E00354
☐	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☒	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☐	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Field probe	RF-R 400-1	Langer EMV-Technik	E00270
☒	Loop antenna	HFH2-Z2	Rohde & Schwarz	E00060
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☐	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☒	Cable set CDC	RF cable(s)	Huber + Suhner AME HF-Technik AME HF-Technik Stabo	E00446 E00920 E00921 E01215
☐	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☒	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[5] For information about measurement uncertainties see page 73.

7.3.1.2 Limits

As specified in section 15.209 of 47 CFR Part 15, the emissions from an intentional radiator shall not exceed the field strength levels specified in table 19:

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 19: General radiated emission limits 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 19 using the recalculation factor as described in clause 6.3.1.

According to section 6.2.2.2 of RSS-216, it is acceptable to use the alternate 60 cm loop test method referring to the limits for commercial / industrial and large residential induction cooking appliances even if the WPT device is small and for residential use. Therefore, the magnetic field strength limits for induction cooking (group 2) equipment defined for the frequency range 9 kHz to 30 MHz apply, as set out in the CISPR 11 standard referenced in ICES-001 and listed in table 20:

Frequency range *[MHz]*	*Limit in 3 m distance* *Quasi-peak* *[dBµA/m]*
0.009 – 0.070	69
0.070 – 0.1485	Decreasing linearly with logarithm of frequency from 69 to 39
0.1485 – 4.0	Decreasing linearly with logarithm of frequency from 39 to 3
4.0 – 30	3

Table 20: Magnetic field strength limits according to CISPR 11

7.3.1.3 Test procedure

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

7.3.1.4 Test results

7.3.1.4.1 Test results for standby mode

Performed by:	Andreas Menacher	Date of test:	November 20, 2017
Climatic conditions:	Ambient temperature 20.0 ℃	Relative humidity 41.0 %	Barometric pressure 98.2 kPa
Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
Antenna alignment:	☒ in parallel	☐ in line	☐ angle ….. °
EUT position:	☒ Position 1	☐ Position 2	☐ Position 3

Frequency range	*Step size*	*IF Bandwidth*	*Detector*		*Measurement Time*		*Preamplifier*
			Prescan	*Final scan*	*Prescan*	*Final scan*	
9 kHz – 150 kHz	50 Hz	200 Hz	QP, PK, CAV	QP, PK, AV	2 s	1 s	Off
150 kHz – 30 MHz	2.25 kHz	9 kHz	QP, PK, CAV	QP, PK, AV	2 s	1 s	Off

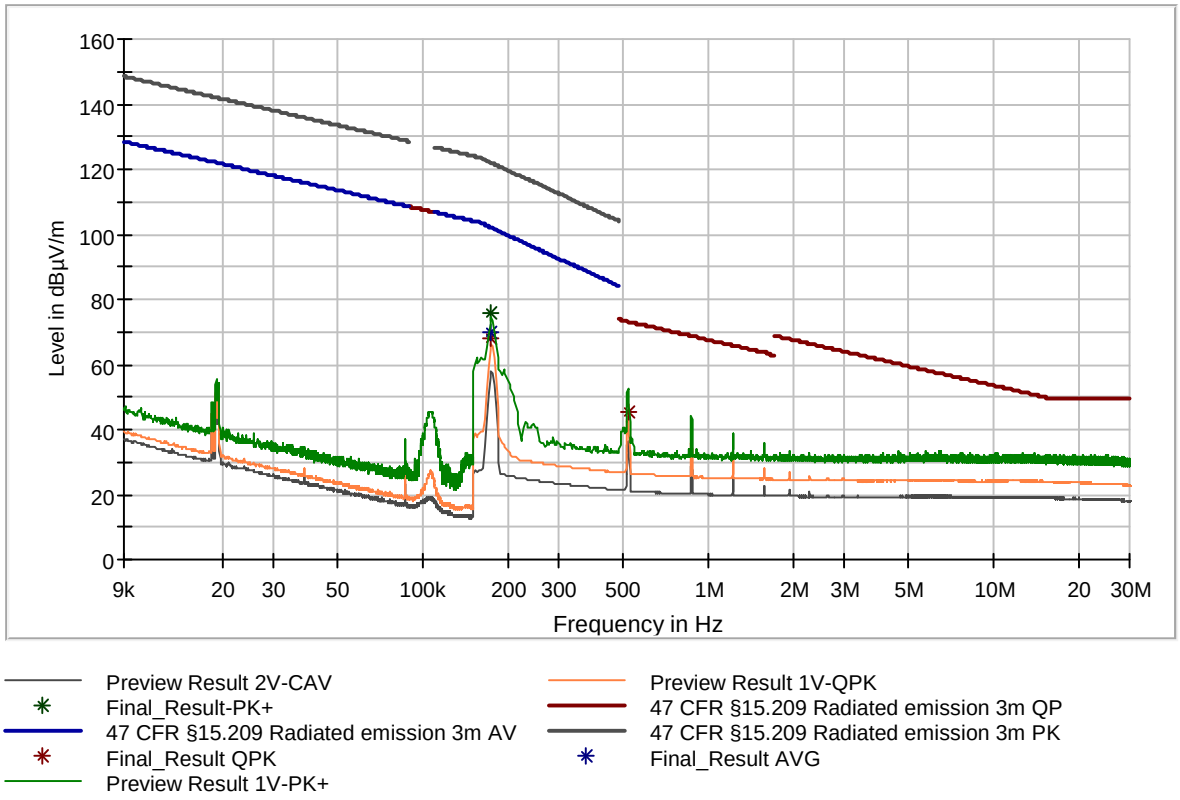

Figure 12: Chart of radiated emissions test below 30 MHz according to §15.209 for standby mode

Frequency (MHz)	*De-tector*	*Measured field strength (dBµV/m)*	*Distance referred to limit (m)*	*Re-calculation factor (dB)*	*Calcu-lated field strength (dBµV/m)*	*Limit (dBµV/m)*	*Margin (dB)*	*Meas. Time (ms)*	*Band-width (kHz)*	*Azi-muth (deg)*	*Corr. (dB)*
0.17475	AV	69.56	300	79.19	-9.63	22.76	32.39	100	9.000	249.0	20.0
0.17475	PK	75.84	300	79.19	-3.35	42.76	46.11	100	9.000	249.0	20.0
0.52575	QP	45.38	30	40.00	5.38	33.19	27.81	1000	9.000	242.0	20.0

Table 21: Results of radiated emissions test below 30 MHz according to §15.209 for standby mode

Note: The emission within the restricted band from 90 kHz to 110 kHz is a spurious emission for which the quasi-peak limit applies. In standby mode, no power receiver is present, i.e. there is no communication.

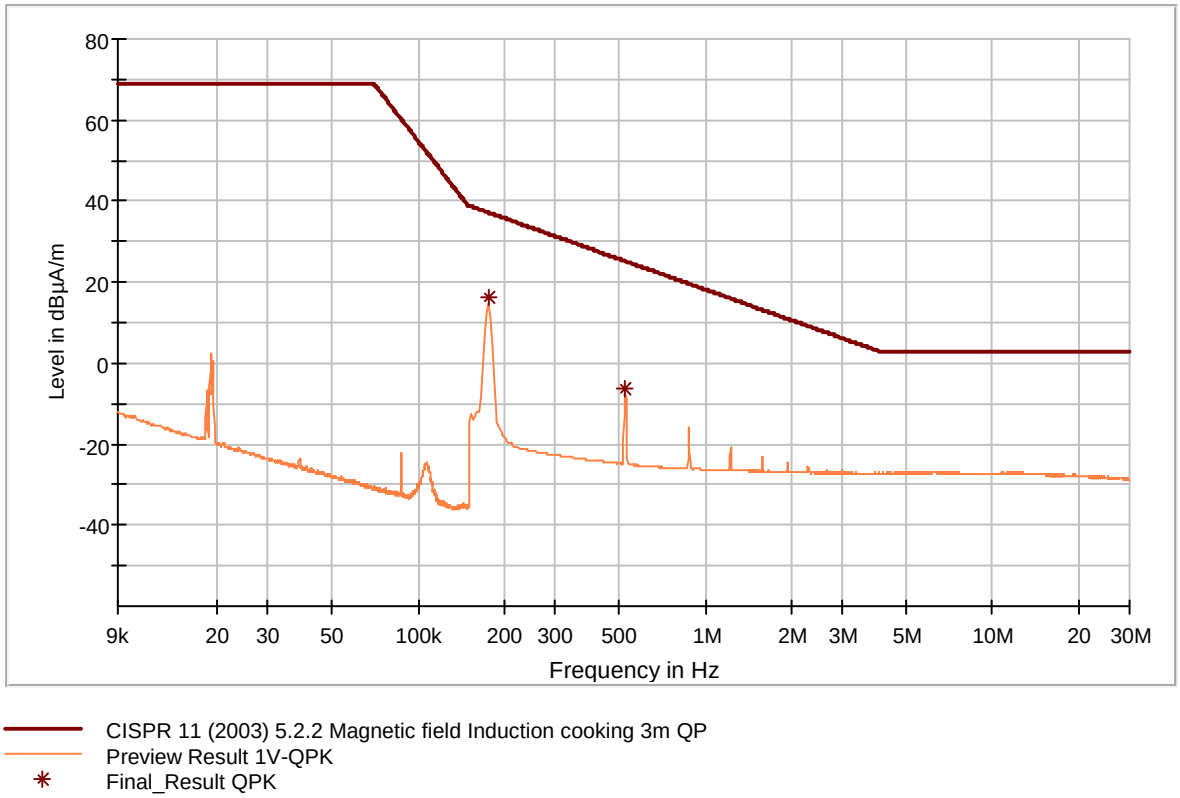

Figure 13: Chart of radiated emissions test below 30 MHz according to CISPR 11 for standby mode

Frequency *(MHz)*	*Detector*	*Magnetic field strength* *(dBµA/m)*	*Limit* *(dBµA/m)*	*Margin* *(dB)*	*Meas. Time* *(ms)*	*Bandwidth* *(kHz)*	*Azimuth* *(deg)*	*Corr.* *(dB)*
0.17475	QP	16.24	37.22	20.98	1000.0	9.000	249.0	-31.5
0.52575	QP	-6.15	25.18	31.33	1000.0	9.000	242.0	-31.5

Table 22: Results of radiated emissions test below 30 MHz according to CISPR 11 for standby mode

7.3.1.4.2 Test results for charging mode 2

Performed by:	Andreas Menacher	Date of test:	November 20, 2017
Climatic conditions:	Ambient temperature 20.0 ℃	Relative humidity 41.0 %	Barometric pressure 98.2 kPa
Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
Antenna alignment:	☒ in parallel	☐ in line	☐ angle ….. °
EUT position:	☒ Position 1	☐ Position 2	☐ Position 3

Frequency range	*Step size*	*IF Bandwidth*	*Detector*		*Measurement Time*		*Preamplifier*
			Prescan	*Final scan*	*Prescan*	*Final scan*	
9 kHz – 150 kHz	50 Hz	200 Hz	QP, PK, CAV	QP, PK, AV	2 s	1 s	Off
150 kHz – 30 MHz	2.25 kHz	9 kHz	QP, PK, CAV	QP, PK, AV	2 s	1 s	Off

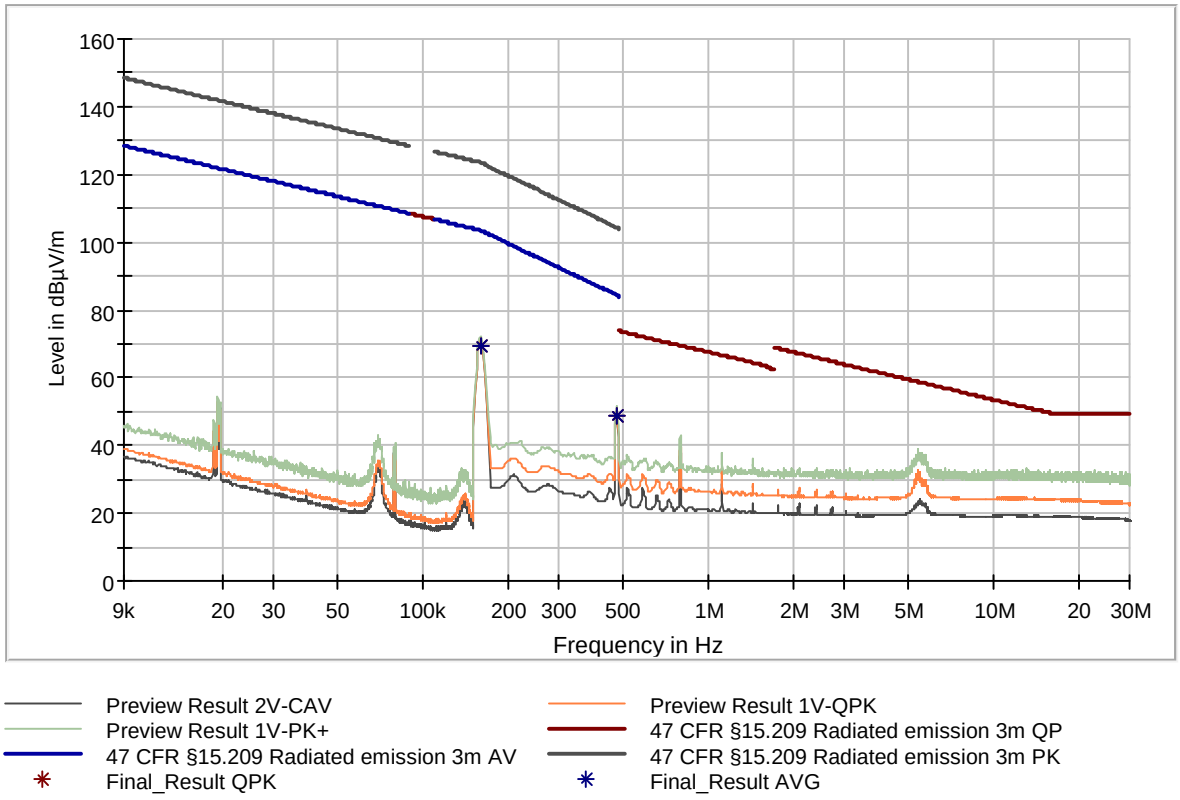

Figure 14: Chart of radiated emissions test below 30 MHz according to §15.209 for charging mode 2

Frequency (MHz)	*De-tector*	*Measured field strength (dBµV/m)*	*Distance referred to limit (m)*	*Re-calculation factor (dB)*	*Calcu-lated field strength (dBµV/m)*	*Limit (dBµV/m)*	*Margin (dB)*	*Meas. Time (ms)*	*Band-width (kHz)*	*Azi-muth (deg)*	*Corr. (dB)*
0.161250	AV	69.47	300	79.89	-10.42	23.45	33.87	100.0	9.000	99.0	20.0
0.161250	PK	70.06	300	79.89	-9.83	43.45	53.28	100.0	9.000	99.0	20.0
0.480750	AV	48.86	300	70.40	-21.54	13.97	35.50	100.0	9.000	93.0	20.0
0.480750	PK	51.35	300	70.40	-19.05	33.97	53.01	100.0	9.000	93.0	20.0

Table 23: Results of radiated emissions test below 30 MHz according to §15.209 for charging mode 2

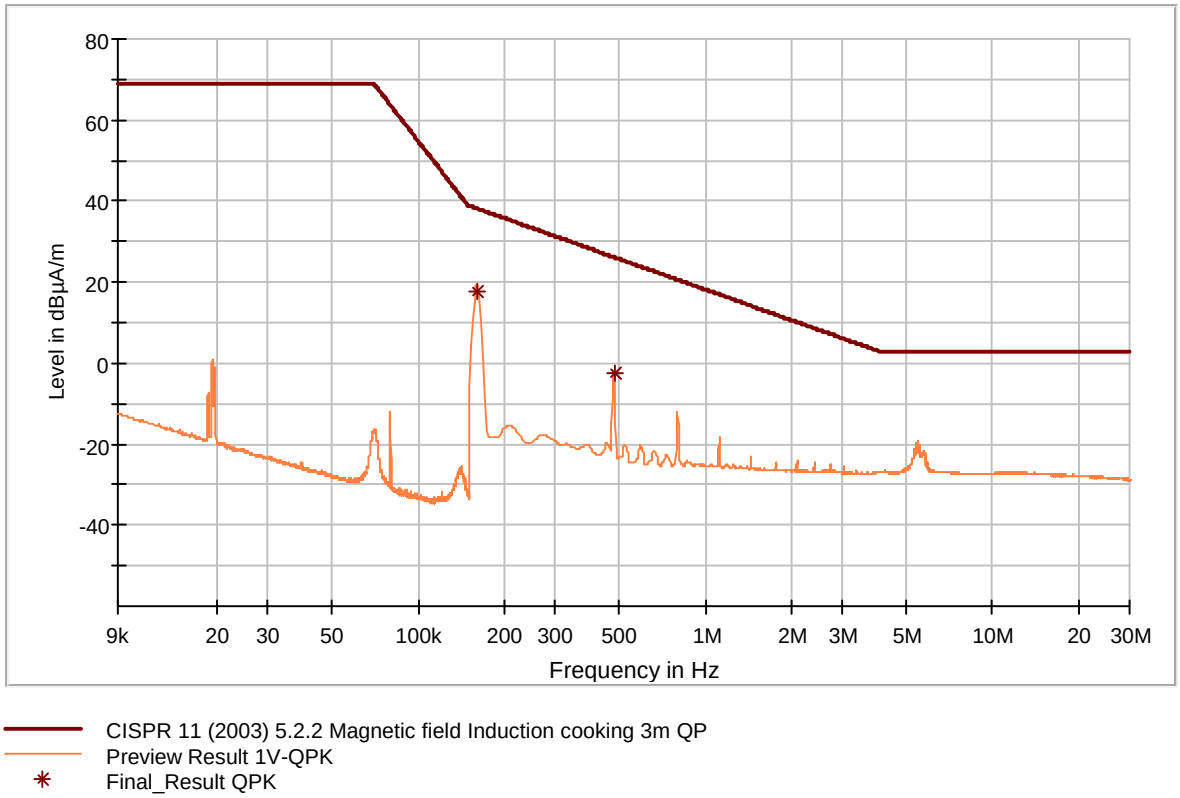

Figure 15: Chart of radiated emissions test below 30 MHz according to CISPR 11 for charging mode 2

Frequency (MHz)	*Detector*	*Magnetic field strength (dBµA/m)*	*Limit (dBµA/m)*	*Margin (dB)*	*Meas. Time (ms)*	*Bandwidth (kHz)*	*Azimuth (deg)*	*Corr. (dB)*
0.16125	QP	17.84	38.10	20.26	1000.0	9.000	99.0	-31.5
0.48075	QP	-2.50	26.16	28.66	1000.0	9.000	93.0	-31.5

Table 24: Results of radiated emissions test below 30 MHz according to CISPR 11 for charging mode 2

7.3.2 Radiated emissions from 30 MHz to 1 GHz

Section(s) in 47 CFR Part 15:	Requirement:	15.209
	Reference(s):	ANSI C63.10, clause 6.5
Section(s) in RSS-216:	Requirement:	6.2.2.2
	Reference(s):	ICES-001 CISPR 11, clause 5.2

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

7.3.2.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☐	Compact Diagnostic Chamber (CDC)	VK041.0174	Albatross Projects	E00026
☐	Open area test site (OATS)	---	EMV **TESTHAUS**	E00354
☒	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☒	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☐	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Field probe	RF-R 400-1	Langer EMV-Technik	E00270
☐	Loop antenna	HFH2-Z2	Rohde & Schwarz	E00060
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☒	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☒	Cable set SAC	RF cable(s)	Huber + Suhner	E00755 E01033 E01034
☒	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[6] For information about measurement uncertainties see page 73.

7.3.2.2 Limits

As specified in section 15.209 of 47 CFR Part 15, the emissions from an intentional radiator shall not exceed the field strength levels specified in table 25:

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 according to §15.209

According to section 6.2.2.2 of RSS-216, the electric field radiated emissions shall comply with the Class B limits for group 2 equipment, as set out in the CISPR 11 standard referenced in ICES-001 and listed in table 26:

Frequency range *[MHz]*	*Quasi-peak level of electric field strength in 10 m distance* *[dBµV/m]*	*Quasi-peak level of electric field strength in 3 m distance* *[dBµV/m]*
30 – 80.872	30	40
80.872 – 81.848	50	60
81.848 – 134.786	30	40
134.786 – 136.414	50	60
136.414 – 230	30	40
230 – 1000	37	47

Table 26: Electric field strength limits according to CISPR 11

Note: According to clause 5.2.2, class B devices may be tested at distances between 3 m and 10 m. Calculation of limits for 3 m using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements) gives slightly higher limits, but to be consistent with later versions of CISPR 11, the values for 3 m distance as listed in table 26 are selected.

7.3.2.3 Test procedure

Radiated emissions from 30 MHz to 1 GHz are measured using the test procedure as described in clause 6.4.

7.3.2.4 Test results

7.3.2.4.1 Test results for standby mode

Performed by:	Andreas Menacher	Date of test:	December 1, 2017
Climatic conditions:	Ambient temperature 22.6 ℃	Relative humidity 35.3 %	Barometric pressure 97.4 kPa
Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
Antenna alignment:	☒ in parallel	☐ in line	☐ angle ….. °
EUT position:	☒ Position 1	☐ Position 2	☐ Position 3

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

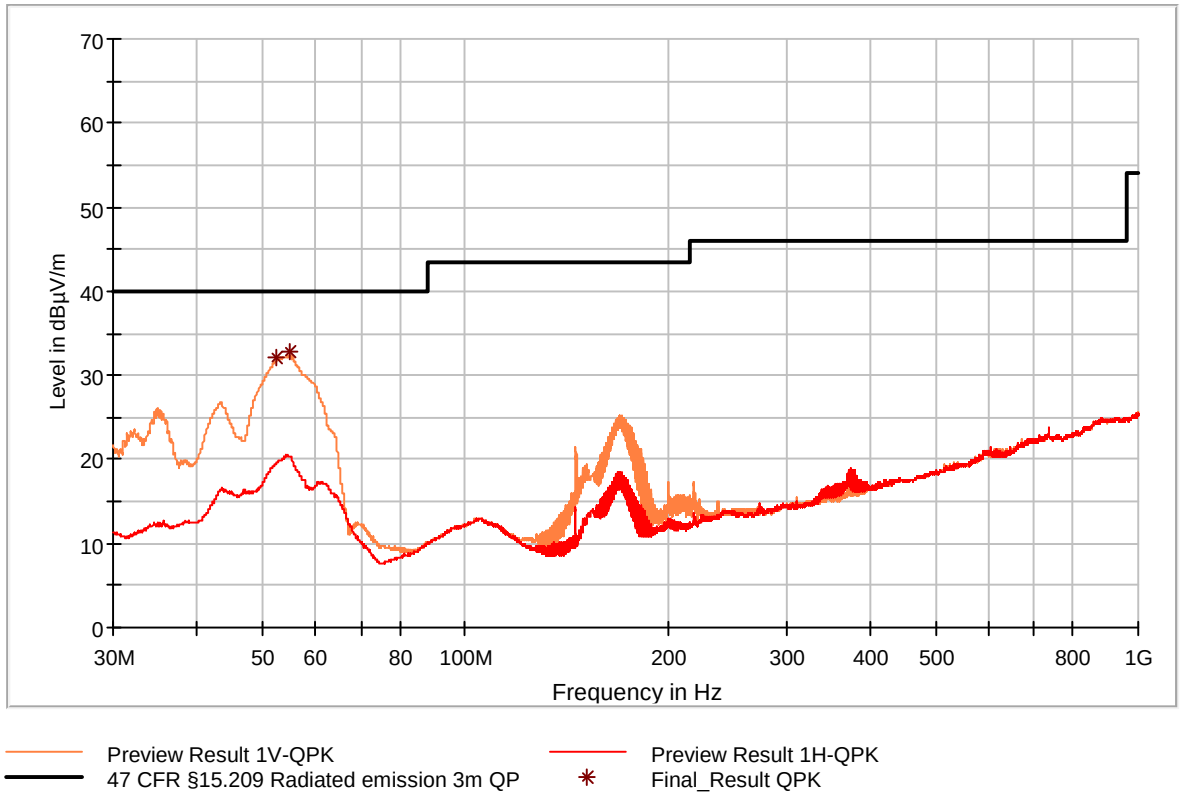

Figure 16: Chart of radiated emissions test 30 MHz to 1 GHz according to §15.209 for standby mode

Frequency (MHz)	*Detector*	*Electric field strength (dBµV/m)*	*Limit (dBµV/m)*	*Margin (dB)*	*Meas. Time (ms)*	*Band-width (kHz)*	*Height (cm)*	*Pol*	*Azimuth (deg)*	*Corr. (dB)*
52.560000	QP	32.00	40.00	8.00	1000.0	120.000	100.0	V	352.0	14.9
54.840000	QP	32.79	40.00	7.21	1000.0	120.000	100.0	V	352.0	14.7

Table 27: Results of radiated emissions test 30 MHz to 1 GHz according to §15.209 for standby mode

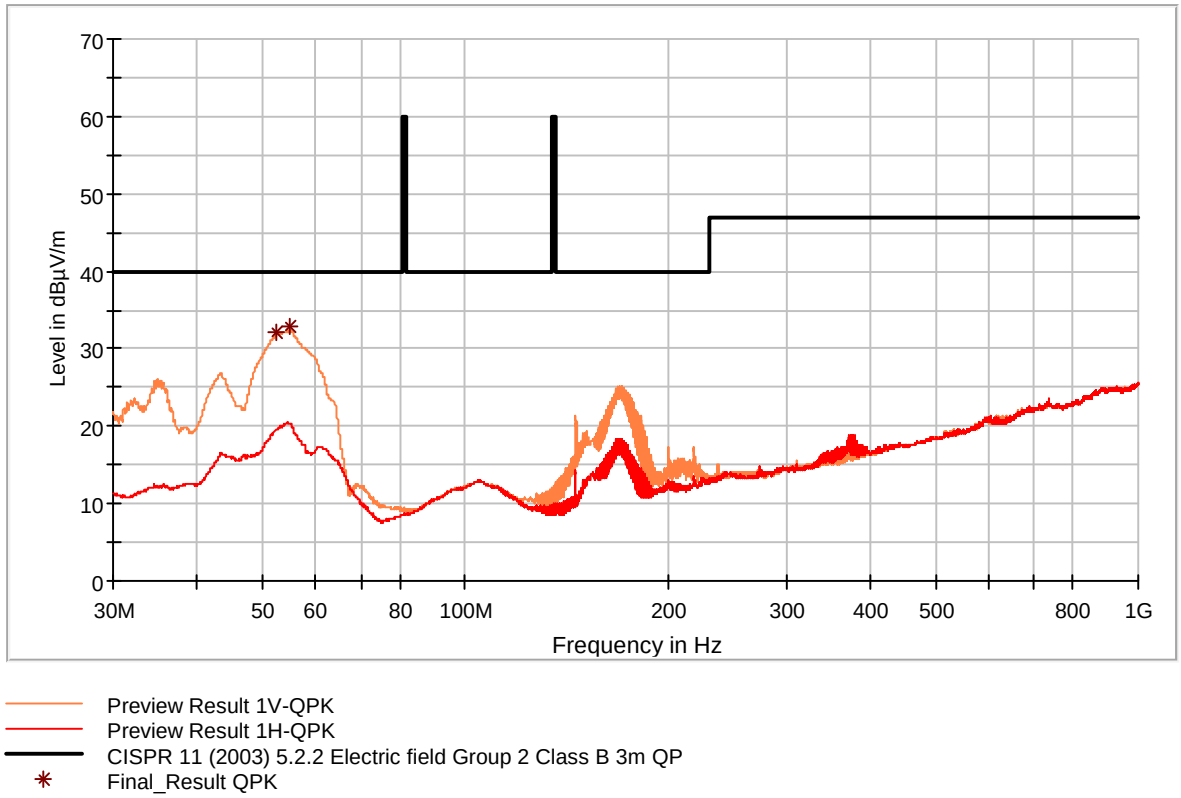

Figure 17: Chart of radiated emissions test 30 MHz to 1 GHz according to CISPR 11 for standby mode

Frequency (MHz)	*Detector*	*Electric field strength (dBµV/m)*	*Limit (dBµV/m)*	*Margin (dB)*	*Meas. Time (ms)*	*Band-width (kHz)*	*Height (cm)*	*Pol*	*Azimuth (deg)*	*Corr. (dB)*
52.560000	QP	32.00	40.00	8.00	1000.0	120.000	100.0	V	352.0	14.9
54.840000	QP	32.79	40.00	7.21	1000.0	120.000	100.0	V	352.0	14.7

Table 28: Results of radiated emissions test 30 MHz to 1 GHz according to CISPR 11 for standby mode

7.3.2.4.2 Test results for charging mode 2

Performed by:	Andreas Menacher	Date of test:	December 1, 2017
Climatic conditions:	Ambient temperature 22.6 ℃	Relative humidity 35.3 %	Barometric pressure 97.4 kPa
Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
Antenna alignment:	☒ in parallel	☐ in line	☐ angle ….. °
EUT position:	☒ Position 1	☐ Position 2	☐ Position 3

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

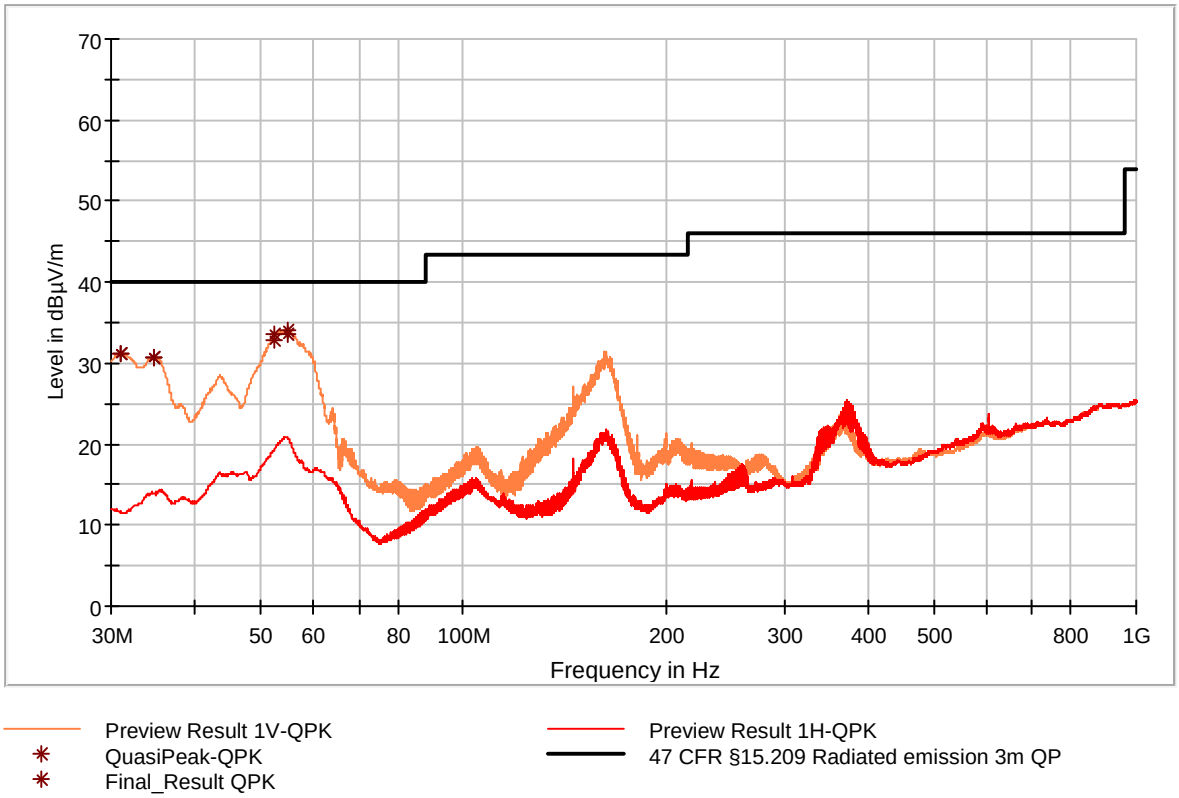

Figure 18: Chart of radiated emissions test 30 MHz to 1 GHz according to §15.209 for charging mode 2

Frequency (MHz)	*Detector*	*Electric field strength (dBµV/m)*	*Limit (dBµV/m)*	*Margin (dB)*	*Meas. Time (ms)*	*Band-width (kHz)*	*Height (cm)*	*Pol*	*Azimuth (deg)*	*Corr. (dB)*
31.110000	QP	31.23	40.00	8.77	1000.0	120.000	100.0	V	22.0	11.1
34.800000	QP	30.78	40.00	9.22	1000.0	120.000	100.0	V	31.0	12.1
52.560000	QP	32.89	40.00	7.11	1000.0	120.000	100.0	V	0.0	14.9
55.020000	QP	33.61	40.00	6.39	1000.0	120.000	100.0	V	1.0	14.7

Table 29: Results of radiated emissions test 30 MHz to 1 GHz according to §15.209 for charging mode 2

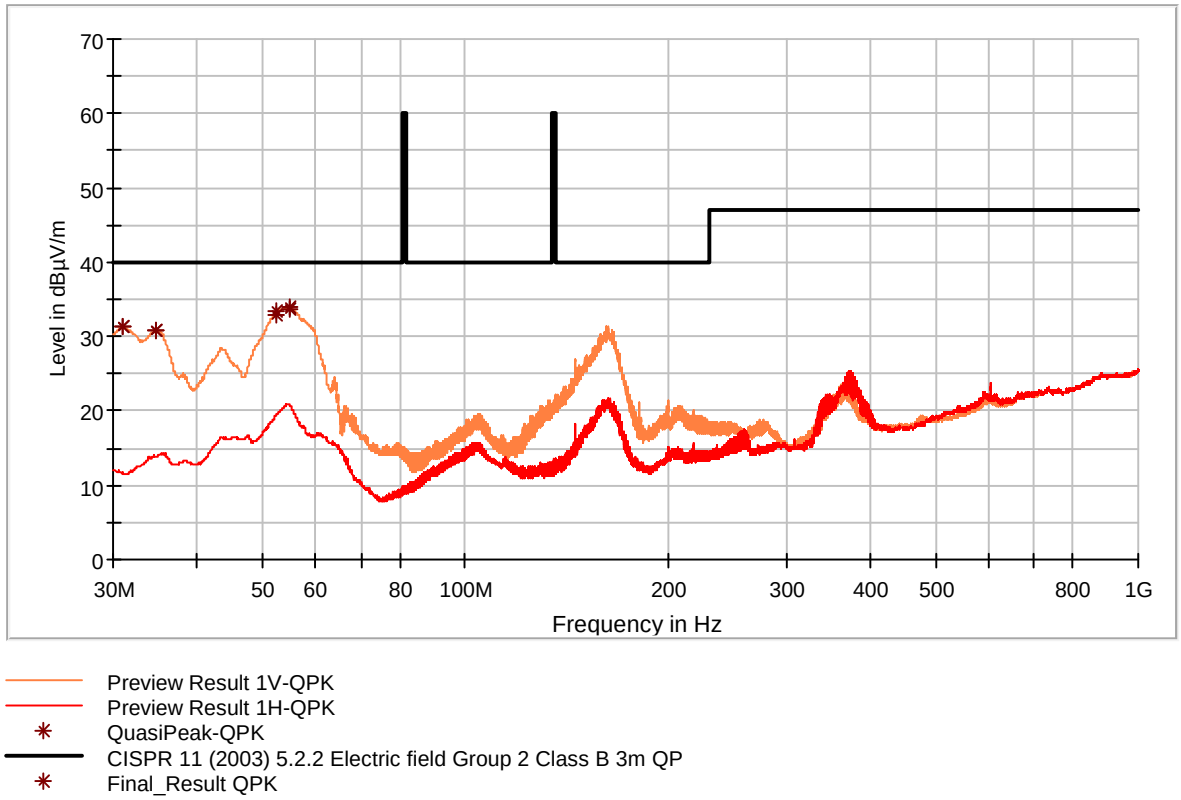

Figure 19: Chart of radiated emissions test below 30 MHz according to CISPR 11 for charging mode 2

Frequency (MHz)	*Detector*	*Electric field strength (dBµV/m)*	*Limit (dBµV/m)*	*Margin (dB)*	*Meas. Time (ms)*	*Band-width (kHz)*	*Height (cm)*	*Pol*	*Azimuth (deg)*	*Corr. (dB)*
31.110000	QP	31.23	40.00	8.77	1000.0	120.000	100.0	V	22.0	11.1
34.800000	QP	30.78	40.00	9.22	1000.0	120.000	100.0	V	31.0	12.1
52.560000	QP	32.89	40.00	7.11	1000.0	120.000	100.0	V	0.0	14.9
55.020000	QP	33.61	40.00	6.39	1000.0	120.000	100.0	V	1.0	14.7

Table 30: Results of radiated emissions test 30 MHz to 1 GHz according to CISPR 11 for charging mode 2

7.4 Bandwidth tests

Section(s) in 47 CFR Part 15:	Requirement:	15.215(c)
	Reference(s):	ANSI C63.10, clause 6.9.2
Section(s) in RSS-216:	Requirement:	5
	Reference(s):	RSS-Gen, section 6.6

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

7.4.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☒	Compact Diagnostic Chamber (CDC)	VK041.0174	Albatross Projects	E00026
☐	Open area test site (OATS)	---	EMV **TESTHAUS**	E00354
☐	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☒	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☐	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Field probe	RF-R 400-1	Langer EMV-Technik	E00270
☒	Loop antenna	HFH2-Z2	Rohde & Schwarz	E00060
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☐	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☒	Cable set CDC	RF cable(s)	Huber + Suhner AME HF-Technik AME HF-Technik Stabo	E00446 E00920 E00921 E01215
☐	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[7] For information about measurement uncertainties see page 73.

7.4.2 Limits

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of 47 CFR Part 15, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. However, as WPT systems are certified with reference to the general radiated emission limits as specified in §15.209, no limit for the 20 dB bandwidth applies.

The occupied bandwidth is recorded according to section 6.6 of RSS-Gen with no limit applied, as there is no occupied bandwidth limit stated in RSS-216.

7.4.3 Test procedure

Emissions in the restricted bands of operation are measured using the test procedure as described in clause 6.3.

7.4.3.1 Test procedure for 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 reference value is

☐ the level of the unmodulated carrier, or

☒ the highest level of the spectral envelope of the modulated signal.

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.

7.4.3.2 Test procedure for 99 % occupied bandwidth

According to section 6.6 of RSS-Gen, the occupied bandwidth (OBW) is defined as the 99 % emission bandwidth. The span of the analyzer is set to capture all products of the modulation process, including the emission skirts.
The resolution bandwidth is in the range of 1 % to 5 % of the occupied bandwidth and the video bandwidth is approximately three times the resolution bandwidth. There is no video averaging applied.

A peak, or peak hold, may be used in place of the sampling detector if the device is not transmitting continuously. This may produce 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.

7.4.4 Test results

7.4.4.1 Test results for standby mode

Performed by:	Andreas Menacher	Date of test:	November 20, 2017
Climatic conditions:	Ambient temperature 20.0 ℃	Relative humidity 41.0 %	Barometric pressure 98.2 kPa
Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
Antenna alignment:	☒ in parallel	☐ in line	☐ angle ….. °
EUT position:	☒ Position 1	☐ Position 2	☐ Position 3

Bandwidth test	*Value* *kHz*	*Center frequency* *kHz*	*Lowest frequency* *kHz*	*Highest frequency* *kHz*	*Application band* *kHz*	*Result*
20 dB bandwidth	1.503	175.267	174.514	176.017	---	Recorded
Occupied bandwidth (99 %)	56.168	175.267	141.358	197.526	---	Recorded

Table 31: Results of bandwidth tests for standby mode

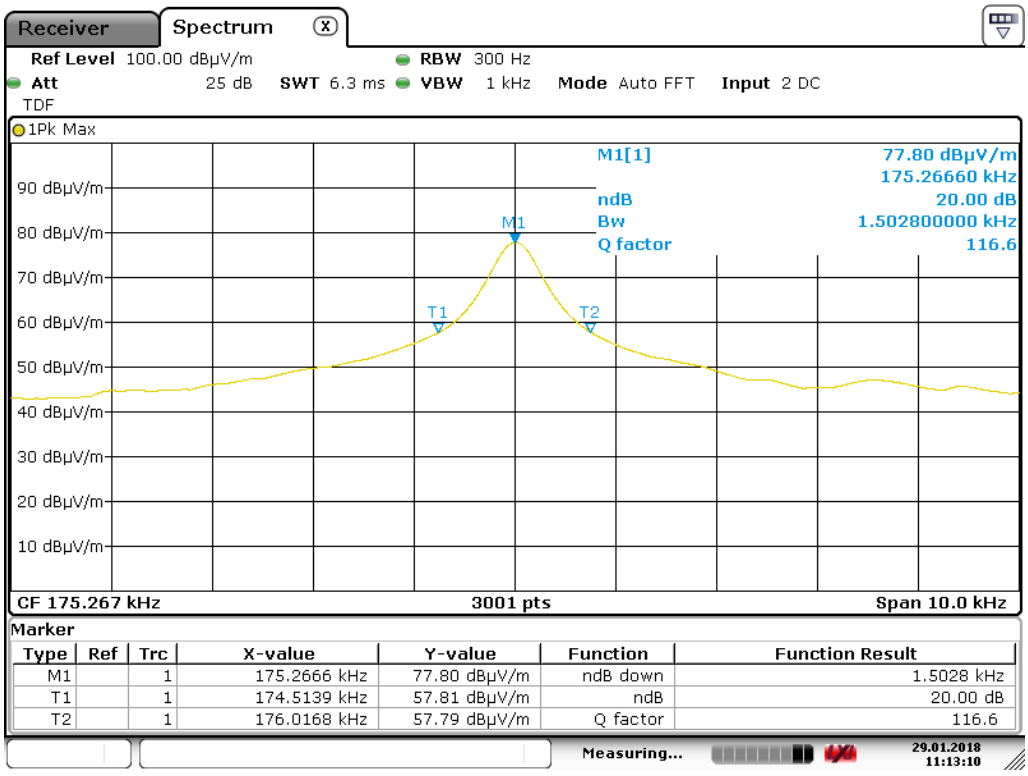

Figure 20: Chart of 20 dB bandwidth of the emission test for standby mode

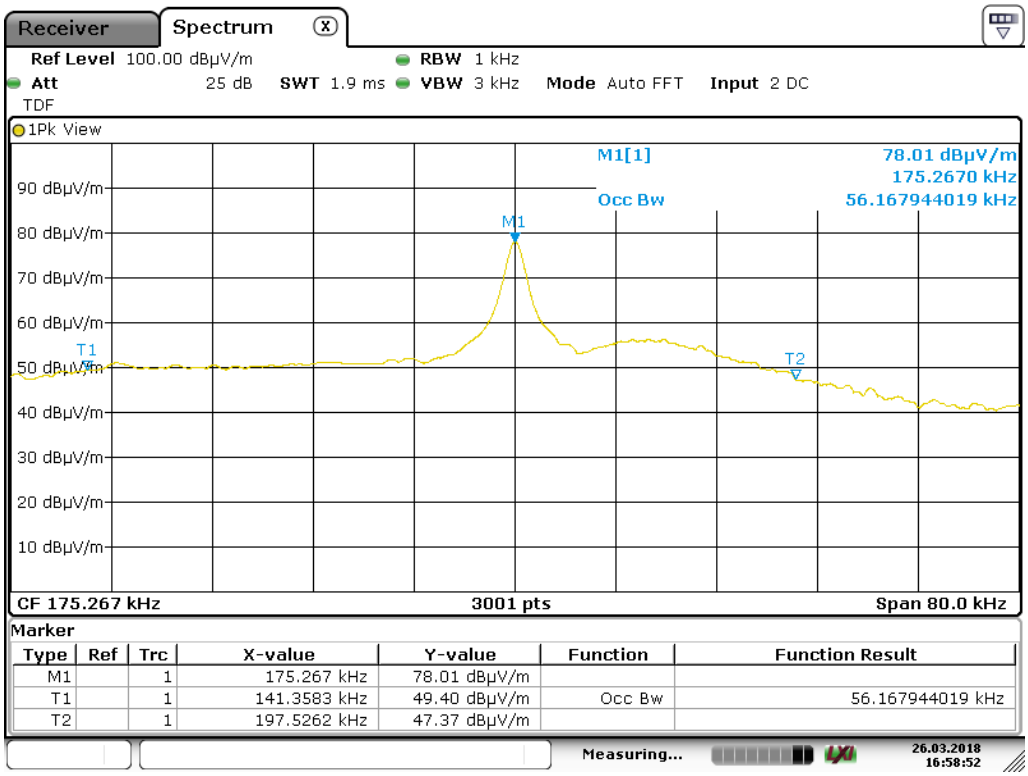

Figure 21: Chart of occupied bandwidth (99 %) test for standby mode

7.4.4.2 Test results for charging mode 2

Performed by:	Andreas Menacher	Date of test:	November 20, 2017
Climatic conditions:	Ambient temperature 20.0 ℃	Relative humidity 41.0 %	Barometric pressure 98.2 kPa
Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
Antenna alignment:	☒ in parallel	☐ in line	☐ angle ….. °
EUT position:	☒ Position 1	☐ Position 2	☐ Position 3

Bandwidth test	*Value* *kHz*	*Center frequency* *kHz*	*Lowest frequency* *kHz*	*Highest frequency* *kHz*	*Application band* *kHz*	*Result*
20 dB bandwidth	0.790	159.823	159.429	160.219	---	Recorded
Occupied bandwidth (99 %)	68.804	160.978	128.349	197.153	---	Recorded

Table 32: Results of bandwidth tests for charging mode 2

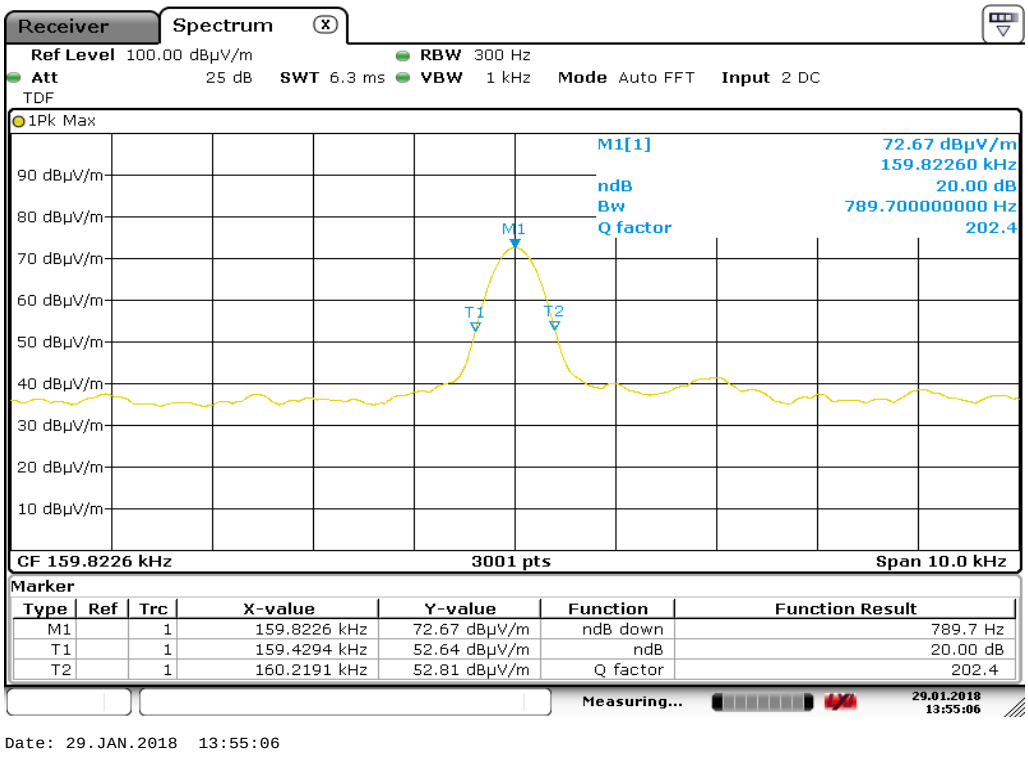

Figure 22: Chart of 20 dB bandwidth of the emission test for charging mode 2

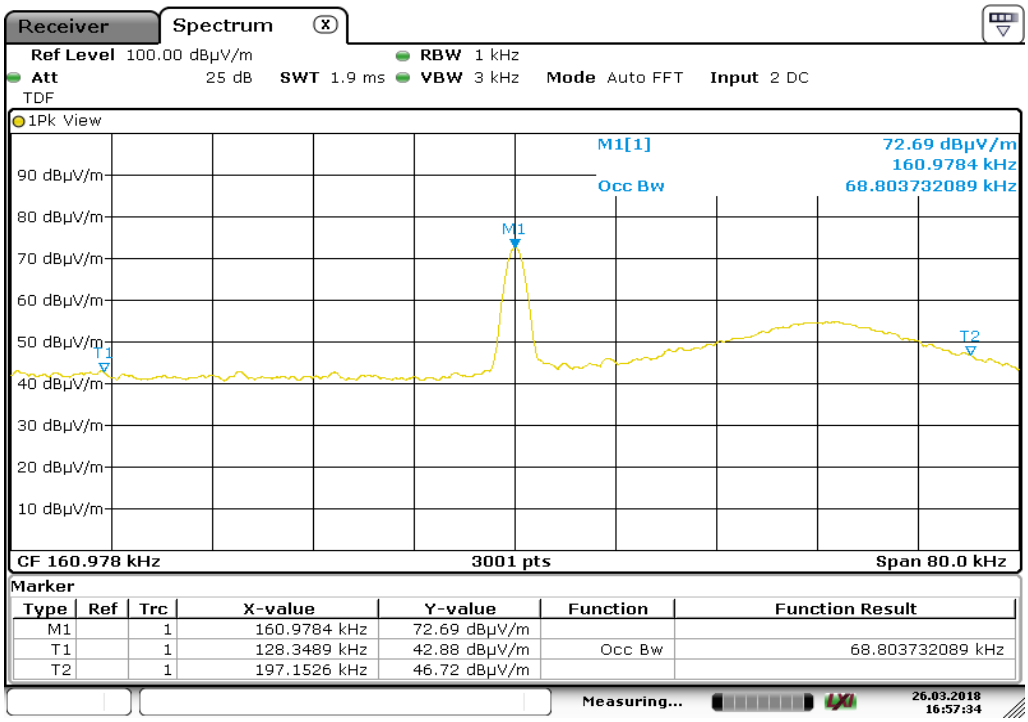

Figure 23: Chart of occupied bandwidth (99 %) test for charging mode 2

8 Equipment calibration status

Description	*Modell number*	*Serial number*	*Inventory number(s)*	*Last calibration*	*Next calibration*
EMI test receiver	ESR7	101059	E00739	2016-02	2018-02
EMI test receiver	ESCS30	825442/0002	E00003	2016-04	2018-04
Attenuator (10 dB)	50FHB-010-10	---	E00471	2017-02	2019-02
Artficial mains network (AMN)	ESH2-Z5	881362/037	E00004	2016-10	2018-10
Loop antenna	HFH2-Z2	871398/0050	E00060	2016-09	2018-09
TRILOG broadband antenna (SAC)	VULB 9162	9162-041	E00643	2015-11	2018-11
Shielded room	P92007	B 83117 C 1109 T 211	E00107	N/A	
Compact diagnostic chamber (CDC)	VK041.0174	D62128-A502-A69-2-0006	E00026	N/A	
Semi-anechoic chamber (SAC)	SAC3	C62128-A520-A643-x-0006	E00716	See notes 1 and 2	
Cable set shielded room	RG 223/U	---	E00741	2017-02	2019-02
	RG 223/U	---	E00804	2017-02	2019-02
Cable set CDC	RG214/U	---	E00446	2018-01	2020-01
	LMR400	1718020006	E00920	2018-01	2020-01
	RG214 Hiflex	171802007	E00921	2018-01	2020-01
	LCF12-50J	---	E01215	2018-01	2020-01
Cable set SAC	SF104EA/11PC35/11PC35/10000MM	501347/4EA	E00755	2017-12	2019-12
	SF104E/11PC35/11PC35/2000MM	507410/4E	E01033	2017-12	2019-12
	SF104E/11PC35/11PC35/2000MM	507411/4E	E01034	2017-09	2019-09

Note 1: Industry Canada (test sites number 3472A-1 and 3472A-2): 2018-11
Note 2: Expiration date of test firm accreditation for OATS and SAC:
FCC test firm type “accredited”: 2019-05

9 Measurement uncertainties

Description	*Uncertainty*	*k=*
AC power line conducted emissions (with AMN) 9 kHz to 150 kHz 150 kHz to 30 MHz	 ±3.8 dB ±3.4 dB	2
Radiated emissions in semi-anechoic chamber or open area test site 9 kHz to 30 MHz 30 MHz to 300 MHz 300MHz to 1 GHz	 ± 4.8 dB ± 5.4 dB ± 4.7 dB	2
Radiated emissions in semi-anechoic chamber with RF absorbing material on the floor or fully anechoic room 1 GHz to 18 GHz	 ± 4.5 dB	2

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

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

10 Revision history

Revision	*Date*	*Issued by*	*Description of modifications*
0	2018-03-02	Andreas Menacher	First edition