Test report

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Human exposure test report

170269-AU01+W03

HEINE Optotechnik GmbH & Co. KG
Wireless Power Transmission System
iC2 Charger

EMV TESTHAUS

EMV **TESTHAUS** GmbH

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

Table of contents

List of pictures

List of tables

1 Test regulations

Standard	*Title*
RSS-102 Issue 5 March 2015	Spectrum Management and Telecommunications Radio Standards Specification Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus (All Frequency Bands)
SPR-002 Issue 1 September 2016	Spectrum Management and Telecommunications Supplementary Procedure Supplementary Procedure for Assessing Compliance with RSS-102 Nerve Stimulation Exposure Limits
Safety Code 6 (2015)	Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz
IEEE C95.3-2002 (R2008) Approved December 11, 2002 Reaffirmed June 12, 2008	IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to Such Fields, 100 kHz–300 GHz
KDB 680106 D01 May 31, 2013 (published by the Federal Communications Commission FCC)	RF Exposure Considerations for Low Power Consumer Wireless Power Transfer Applications

2 Summary of test results

Standard	*Result*	*Remark*
RSS-102 Issue 5 *for transmitters operating between 3 kHz and 10 MHz*	Passed	---
KDB 680106 D01 *RF Exposure Considerations for Low Power Consumer Wireless Power Transfer Applications*	Passed	Requirements for devices designed for typical desktop applications

Straubing, March 27, 2018

Andreas Menacher
Test engineer
EMV **TESTHAUS** GmbH

Christian Kiermeier
Head of EMC department
EMV **TESTHAUS** GmbH

3 Equipment under test (EUT)

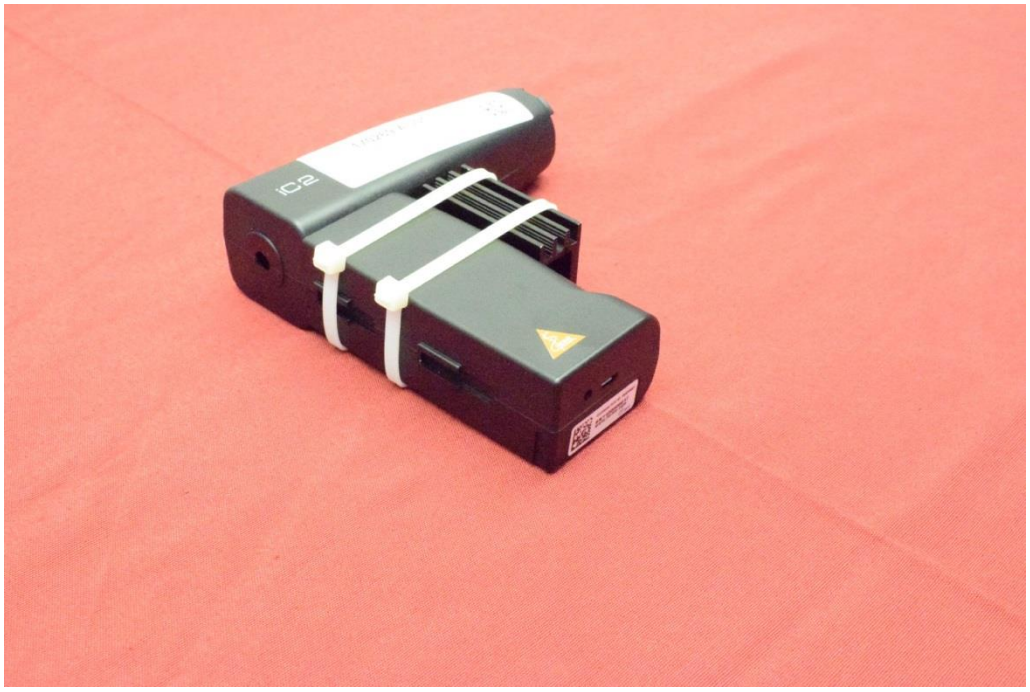
Product type:	Wireless Power Transmission System
Model Name:	iC2 Charger
Applicant:	HEINE Optotechnik GmbH & Co. KG
Manufacturer:	HEINE Optotechnik GmbH & Co. KG
Serial number:	1100000029
FCC ID:	2AOTS-HE-IC2CHARGER
IC certification number:	23552-IC2CHARGER
Application frequency band:	n/a
Frequency range:	137 kHz – 176 kHz
Operating frequency:	137 kHz – 176 kHz
Number of RF-channels:	1
Modulation:	ASK
Antenna types:	PCB antenna ☐ detachable ☒ not detachable
Power supply:	AC supply nominal: 230 V minimum: 100 V maximum: 240 V
Temperature range:	0 °C to +35°C
Type of device:	☐ Body-supported device ☐ Body-worn (or body-mount) radio ☐ Limb-Worn device ☒ other
Separation distance:	☒ ≤ 20 cm ☐ > 20 cm
Evaluated against exposure limits:	☒ General public use ☐ Controlled use
Duty cycle used in evaluation:	100 %

4 Photographs of EUT

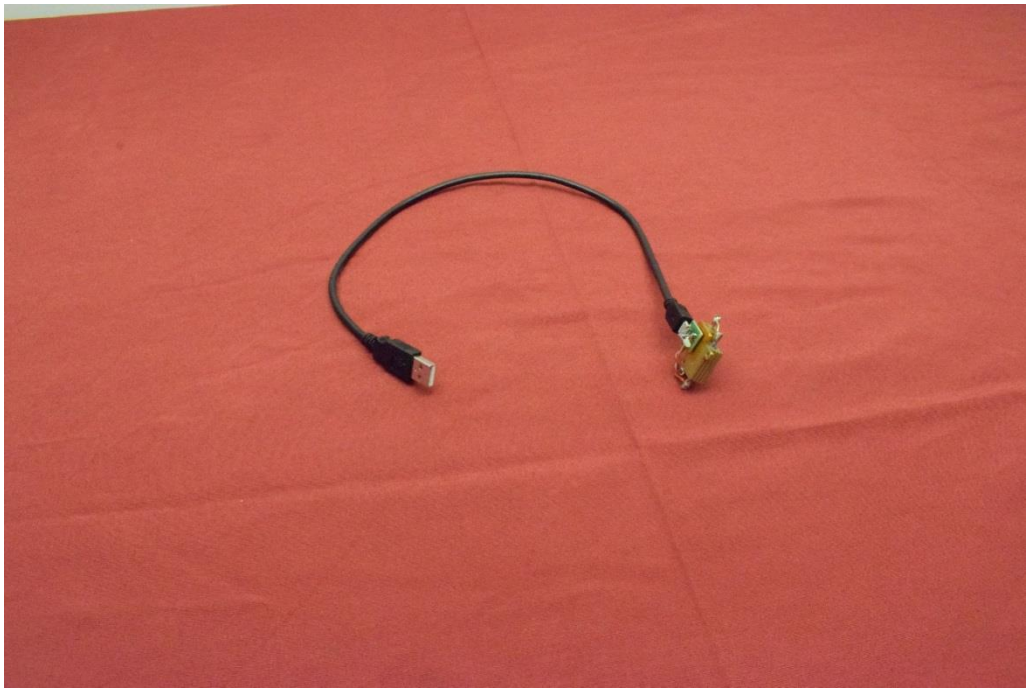
Picture 1: Front view of EUT

Picture 2: Rear view of EUT

Picture 3: Front view of power receiver dummy



Picture 4: Rear view of power receiver dummy



Picture 5: Power receiver USB

5 Test configuration and mode of operation

5.1 Test configuration

Device	*Type designation*	*Serial or inventory no.*	*Manufacturer*
Wireless Power Transmission Systemr	iC2 Charger	1100000029	HEINE OPTOTECHNIK GmbH & Co. KG
Power Receiver Dummy	iC2	11000000017	HEINE OPTOTECHNIK GmbH & Co. KG
Power Receiver USB	---	---	HEINE OPTOTECHNIK GmbH & Co. KG
AC power source (120 V / 60 Hz)	Chroma 616062	E00633	Chroma

Table 1: Devices used for testing

5.2 Mode of operation

The EUT is a Wireless Power Transmission System operating in the frequency range 130 kHz to 175 kHz.

The Measurements were performed in standby and charging mode.

6 Test results

6.1 RF exposure of non-simultaneous transmission

Reference(s): RSS-102
KDB 680106 D01

Test procedure(s): SPR-002
IEEE C95.3

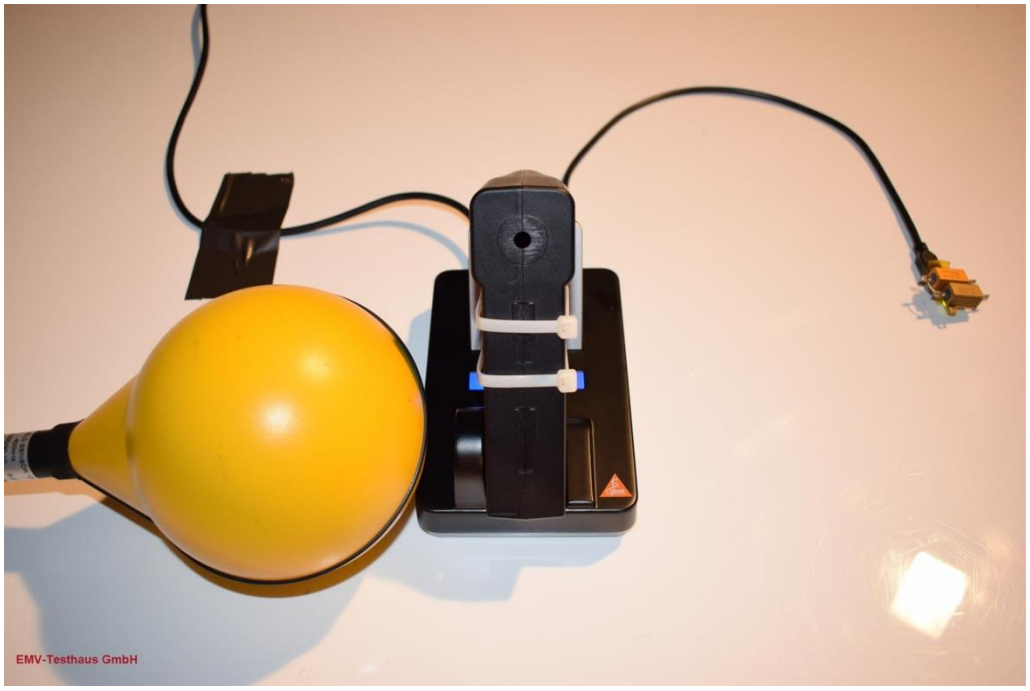
Performed by:	Andreas Menacher	Date of test:	November 17, 2017
Climatic conditions:	Ambient temperature 23 °C	Relative humidity 45.5 %	Barometric pressure 98.0 kPa
Result[1]:	☒ Test passed	☐ Test not passed	

6.1.1 Test equipment

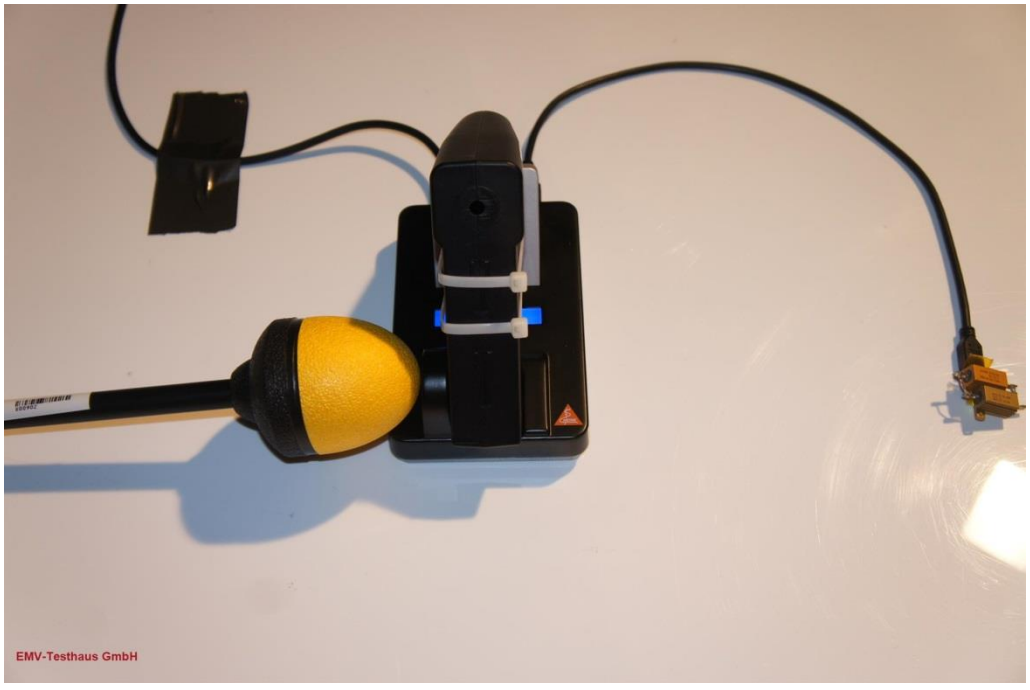
	Type	*Designation*	*Manufacturer*	*Inventory no.*
☒	Exposure level tester with magnetic field probe 100 cm^2	ELT-400 with BN 2300/90.10	Narda Safety Test Solutions GmbH	E00276
☒	Broadband field meter	NBM-550	Narda Safety Test Solutions GmbH	E00900
☐	Magnetic field probe	HF3061	Narda Safety Test Solutions GmbH	E00901
☒	Electric field probe	EF0691	Narda Safety Test Solutions GmbH	E00902

[1] For information about measurement uncertainties see page 21

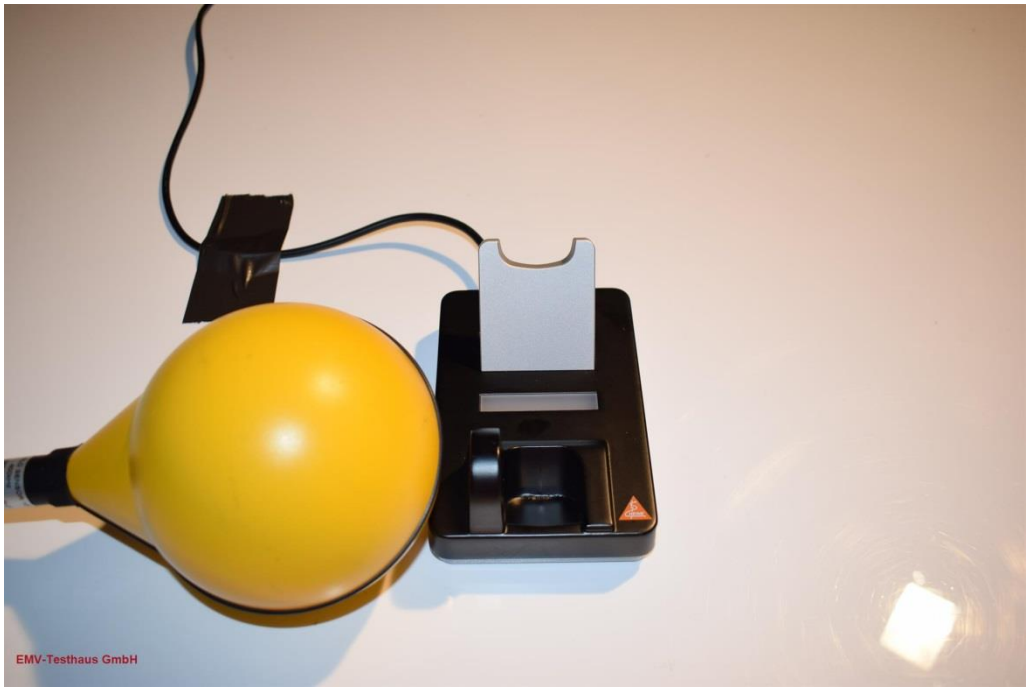
6.1.2 Test setup



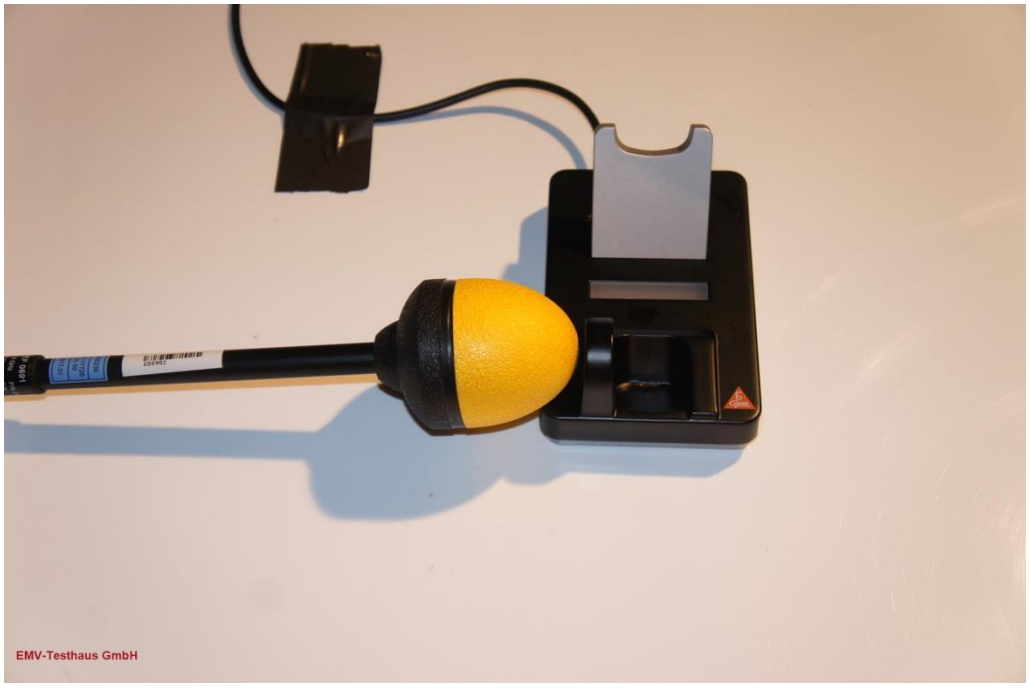
Picture 6: Setup of magnetic filed test for charging mode



Picture 7: Setup of electric field test for charging mode



Picture 8: Setup of magnetic filed test for standby mode



Picture 9: Setup of electric field test for standby mode

6.1.3 Limits

6.1.3.1 Limits according to RSS-102

According to section 2.5.1 of RSS-102, transmitters operating between 3 kHz and 10 MHz, meeting the exemption from routine SAR evaluation, shall demonstrate compliance to the instantaneous limits in section 4 of RSS-102. Therefore, these limits apply irrespective of the separation distance between the user or bystanders and the device.

The exposure limits in section 4 of RSS-102 are adopted from Health Canada's Safety Code 6. According to section 2.1 of Safety Code 6, limits for internal electric field strength are intended to prevent the occurrence of nerve stimulation (NS). At frequencies between 3 kHz and 10 MHz, basic restrictions for internal electric field strength in excitable tissues as shown in table 1 of Safety Code 6 (i.e. table 2 of RSS-102) shall not be exceeded. For conditions where the determination of internal electric field strength is not possible or practical (e.g. by measurement or modelling), external unperturbed field strength assessment shall be carried out and the reference levels outlined in section 2.2 of Safety Code 6 shall be respected.

For transmitters operating between 3 kHz and 10 MHz, the requirements of table 4 and table 6 in section 4 of RSS-102 can be found in table 3 and table 4 of Safety Code 6, section 2.2:

Electric Field Strength Reference Levels				
Frequency Range (MHz)	*Reference Level Basis*	*Reference Level (E_{RL}), (V/m, RMS)*		*Reference Period (minutes)*
		Uncontrolled Environment	*Controlled Environment*	
0.003 – 10	NS	83	170	Instantaneous*
1.1 – 1.29	SAR	$87 / f^{0.5}$	---	6**
1.29 – 10	SAR	$87 / f^{0.5}$	$193 / f^{0.5}$	6**
Note: Frequency, f, is in MHz.				

Table 2: Electric field strength reference levels (see table 3 of Safety Code 6)

Magnetic Field Strength Reference Levels				
Frequency Range (MHz)	*Reference Level Basis*	*Reference Level (H_{RL}), (A/m, RMS)*		*Reference Period (minutes)*
		Uncontrolled Environment	*Controlled Environment*	
0.003 – 10	NS	90	180	Instantaneous*
0.1 – 10	SAR	$0.73 / f$	$1.6 / f$	6**
Note: Frequency, f, is in MHz.				

Table 3: Magnetic field strength reference levels (see table 4 of Safety Code 6)

Notes:

1 * At no point in time shall the RMS values for electric- and magnetic-fields exceed the reference levels with an instantaneous reference period in table 2 and table 3. In the case of RF fields with amplitude modulation, the RMS value during the maximum of the modulation envelope shall be compared to the reference level.
2 ** For exposures shorter than the reference period, field strengths may exceed the reference levels, provided that the time average of the squared value of the electric or magnetic field strength over any time period equal to the reference period shall not exceed E_{RL}^2 or H_{RL}^2, respectively. For exposures longer than the reference period, including indefinite exposures, the time average of the squared value of the electric or magnetic field strength over any time period equal to the reference period shall not exceed E_{RL}^2 or H_{RL}^2, respectively.
3 Where external electric (at all applicable frequencies) or magnetic (at frequencies at or above 100 kHz) field strengths are spatially non-uniform, comparison to the reference levels shall be made after spatially averaging the field strengths over the vertical extent of the human body. Where comparison is to be made to the reference levels based on NS in table 2 and table 3, spatial averaging is with respect to the sample values of the field strengths. Where comparison is to be made to the reference levels based on SAR in table 2 and table 3, spatial averaging is with respect to the square of the sample values of the field strengths.
4 Where external magnetic field strengths are spatially non-uniform and are below 100 kHz, the spatial peak magnetic field strength over the vertical extent of the human body shall be compared to the reference levels in table 3 (i.e. magnetic field strengths shall not be spatially-averaged at frequencies below 100 kHz).
5 For simultaneous exposure to multiple frequencies and where comparison is to be made to the reference level based on NS, each of the field strength frequency component amplitudes shall be divided by the corresponding field strength reference level for that frequency, and the sum of all these ratios shall not exceed unity. This may be expressed as $\Sigma (Ei/E_{RL}) \leq 1$ for electric field strength or $\Sigma (Hi/H_{RL}) \leq 1$ for magnetic field strength.
6 For simultaneous exposure to multiple frequencies and where comparison is to be made to the reference level based on SAR, each of the squares of the field strength frequency component amplitudes shall be divided by the square of the corresponding field strength reference level for that frequency, and the sum of all these ratios shall not exceed unity. This may be expressed as $\Sigma (Ei/E_{RL})^2 \leq 1$ for electric field strength or $\Sigma (Hi/H_{RL})^2 \leq 1$ for magnetic field strength.
7 For localized exposure of the limbs, the reference levels for magnetic field strength may be exceeded provided that the basic restrictions in table 1 of Safety Code 6 are respected within the limbs.

6.1.3.2 Limits according to KDB 680106 D01

According to section 3, paragraph 3) of KDB 680106 D01, for devices designed for typical desktop applications, such a wireless charging pads, RF exposure evaluation should be conducted assuming a user separation distance of 10 cm. E and H field strength measurements or numerical modeling may be used to demonstrate compliance. Measurements should be made from all sides and the top of the primary/client pair, with the 10 cm measured from the center of the probe(s) to the edge of the device. Emissions between 100 kHz to 300 kHz should be assessed versus the limits at 300 kHz in table 1 of 47 CFR Part 1, §1.1310 (see table 4): 614 V/m and 1.63 A/m

Frequency range (MHz)	*Electric field strength (V/m)*	*Magnetic field strength (A/m)*	*Power density (mW/cm^2)*	*Averaging time (minutes)*
(A) Limits for Occupational/Controlled Exposure				
0.3 - 3.0	614	1.63	*100	6
3.0 - 30	1842/f	4.89/f	*$900/f^2$	6
30 - 300	61.4	0.163	1.0	6
300 - 1,500			f/300	6
1,500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3 - 1.34	614	1.63	*100	30
1.34 - 30	824/f	2.19/f	*$180/f^2$	30
30 - 300	27.5	0.073	0.2	30
300 - 1,500			f/1500	30
1,500 - 100,000			1.0	30
f = frequency in MHz * = Plane-wave equivalent power density				

Table 4: Limits for Maximum Permissible Exposure (MPE) to RF electromagnetic fields

6.1.4 Test procedure

The RF exposure test is performed by the direct measurement method using a Broadband probe as described in clause 6.6.1.1 of the supplementary procedure SPR-002.

To find the worst case emissions, the field probe is moved over all sides of the EUT at the separation distance as noted in table 6 while observing the display of the field meter. At the worst case position, the final value is measured and recorded.

According to section 3.2 of RSS-102, RF exposure evaluation of devices shall be made in accordance with the latest version of IEEE C95.3. Definition 3.95 in clause 3 of IEEE C95.3 specifies the separation distance applied to the measurement of electric and magnetic fields as the “distance between a source and the nearest point on the probe sensing elements”.

According to section 3 of KDB 680106 D01, the test distance is measured from the center of the probe(s) to the edge of the device. To determine the test distance, the separation distance stated for testing according to RSS-102 has to be increased by half of the diameter of the probe(s) used. As long as this test distance is equal to or less than the required test distance of 10 cm, the values measured according to RSS-102 may be used to show compliance with the RF exposure requirements of KDB 680106 D01.

Table 5 shows the relationship between the test distance according to KDB 680106 D01 and the separation distance according to RSS-102 as a function of the probe diameter.

Field probe	*Field type*	*Used with*	*Diameter*	*Separation distance (RSS-102)*	*Test distance (KDB 680106 D01)*
100 cm^2	Magnetic field	ELT-400	125 mm	D	D + 6.1 cm
HF3061	Magnetic field	NBM-550	120 mm	D	D + 6.0 cm
EF0691	Electric field	NBM-550	66 mm	D	D + 3.3 cm

Table 5: Test distance versus separation distance

6.1.5 Test results

6.1.5.1 Test results according to RSS-102

For the test result, the maximum field strength value of all probe positions is recorded and used to proof compliance. As the device is intended for general public use, the limits for uncontrolled environment apply.

Electric field strength at a separation distance of 0 cm						
Reference level frequency range	*Reference level basis*	*Frequency*	*Operation mode*	*Measured value*	*Limit*	*Result*
3 kHz - 10 MHz	NS	175 kHz	Standby	2.13 V/m	83 V/m	Passed
3 kHz - 10 MHz	NS	137 kHz – 176 kHz	Charging	9.29 V/m	83 V/m	Passed
Magnetic field strength at a separation distance of 0 cm						
Reference level frequency range	*Reference level basis*	*Frequency*	*Operation mode*	*Measured value*	*Limit*	*Result*
3 kHz - 10 MHz	NS	175 kHz	Standby	0.658 A/m	90 A/m	Passed
3 kHz - 10 MHz	NS	137 kHz – 176 kHz	Charging	1.017 A/m	90 A/m	Passed
100 kHz - 10 MHz	SAR	175 kHz	Standby	0.658 A/m	4.171 A/m	Passed
100 kHz - 10 MHz	SAR	137 kHz – 176 kHz	Charging	1.017 A/m	4.171 A/m	Passed

Table 6: RF exposure test results according to RSS-102

Note: Calculation of the SAR based limits:
No SAR based limit for E_{RL} as requirement starts from 1.1 MHz;
H_{RL}(130 kHz) = 0.73 / 0.130 = 5.615 A/m;
H_{RL}(175 kHz) = 0.73 / 0.175 = 4.171 A/m;
For the frequency range 130 kHz to 175 kHz, the worst case limit is H_{RL}(175 kHz).

For the test result, the maximum field strength value without any averaging and recorded at all probe positions is used to proof compliance. As the device is intended for general public use, the limits for uncontrolled environment apply.

6.1.5.2 Test results according to KDB 680106 D01

Table 5 shows the relationship between the test distance according to KDB 680106 D01 and the separation distance according to RSS-102. As long as the test distance is equal to or less than the required test distance of 10 cm, the measured values as listed in table 6 may be used to show compliance with the RF exposure requirements of KDB 680106 D01.

Electric field strength at a test distance of 3.3 cm					
Reference level frequency range	*Frequency*	*Operation mode*	*Measured value*	*Limit*	*Result*
100 kHz - 300 kHz	175 kHz	Standby	2.13 V/m	614 V/m	Passed
100 kHz - 300 kHz	137 kHz – 176 kHz	Charging	9.29 V/m	614 V/m	Passed
Magnetic field strength at a test distance of 6.1 cm					
Reference level frequency range	*Frequency*	*Operation mode*	*Measured value*	*Limit*	*Result*
100 kHz - 300 kHz	175 kHz	Standby	0.658 A/m	1.63 A/m	Passed
100 kHz - 300 kHz	137 kHz – 176 kHz	Charging	1.017 A/m	1.63 A/m	Passed

Table 7: RF exposure test results according to KDB 680106 D01

6.2 Multiple transmitters capable of simultaneous transmission

For wireless power transmission systems, in charging mode the operating frequency depends on the battery charge condition. Therefore, the operating frequency may vary between 130 kHz and 175 kHz. In standby mode, the operating frequency remains at about 175 kHz.
Therefore, simultaneous transmission does not apply.

7 Measurement uncertainty

The relative uncertainty is defined as the expanded uncertainty using a confidence interval of 95 % (k = 2). For evaluation of compliance, the measured value is compared directly to the applicable limit without any reduction.

Test	*Equipment used*	*Expanded uncertainty*	*k*
Magnetic field (H and B) 1 Hz – 400 kHz	ELT-400 with BN 2300/90.10	-28.07 % +28.07%	2
Electric field (E) 100 kHz to 6 GHz	NBM-550 with EF0691	-27.75 % +31.11 %	2

Table 8: Measurement uncertainties

8 Equipment calibration status

Description	**Modell number(s)**	**Serial number(s)**	**Inventory number(s)**	**Last calibration**	**Next calibration**
Exposure level tester with magnetic field probe 100 cm^2	ELT-400 with BN 2300/90.10	B-0087 B-0102	E00276	2017-05	2019-05
Broadband field meter with magnetic field probe	NBM-550 with HF3061	H-0015 D-0595	E00900 E00901	2017-01	2019-01
Broadband field meter with electric field probe	NBM-550 with EF0691	H-0015 H-0318	E00900 E00902	2017-01	2019-01

Table 9: Equipment calibration status

9 Revision history

Revision	*Date*	*Issued by*	*Description of modifications*
0	2018-03-27	Andreas Menacher	First edition