DEKRA Testing and Certification, S.A.U.
Parque Tecnológico de Andalucía,
c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España

Assessment report No:

NIE: 54099RAN.002

Assessment report
RF EXPOSURE TEST REPORT ACCORDING TO
FCC 47 CFR Part 2.1091
ISED RSS -102 Issue 5:2015

Identification of item tested.....:	Wireless charger
Trademark .....:	Delphi
Model and /or type reference .....:	Volvo
Other identification of the product .....:	FCC ID: L2C0073TR IC: 3432A-0073TR
Final HW version .....:	35052528
Final SW version .....:	A
Features.....:	Wireless Charging (Qi Standard) and NFC.
Manufacturer.....:	DELPHI ELECTRONIC & SAFETY 2451 Lincoln RD Kokomo IN 46901, USA
Test method requested, standard.....:	FCC 47 CFR Part 2.1091 Radiofrequency radiation exposure evaluation: mobile devices. ISED RSS-102 Issue 5 (2015-03) – Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
Summary .....:	IN COMPLIANCE
Approved by (name / position & signature) .....:	Miguel Lacave Antennas Lab Manager  MIGUEL LACAVE GARCÍA 2018.02.06 11:39:13 +01'00'
Date of issue .....:	2018-02-05
Report template No.....:	FAN24_01

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Competences and guarantees

In order to assure the traceability to other national and international laboratories, DEKRA has a calibration and maintenance program for its measurement equipment.

DEKRA guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA at the time of performance of the test.

DEKRA is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document.

General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA and the Accreditation Bodies.

Uncertainty

Uncertainty (factor k=2) was calculated according to the DEKRA internal document PODT000.

Usage of samples

Samples under test have been selected by: the Client.

Sample **S/01** is composed of the following elements:

Control Nº	Description	Model	Serial number	Reception date
52723/06	Wireless Charger	Volvo	S170103000016	2017-04-05
52723/11	Plastic Separator	---	----	2017-04-05
52723/20	PCB (Qi Receiver)	---	---	2017-04-05

Test sample description

The test sample consists of a Wireless Charger for the Cell Phone.

Identification of the client

DELPHI ELECTRONIC & SAFETY

2451 Lincoln RD Kokomo IN 46901, USA

Testing period

Nerve Stimulation tests were performed on 2017-12-22 and finished during the same day.

WPT evaluation test were performed on 2018-01-30 and finished on 2018-01-31.

The tests have been performed at DEKRA Testing and Certification, S.A.U.

Environmental conditions

The following limits were not exceeded during the tests:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 30 % Max. = 60 %

Used instrumentation

		Last Cal. date	Cal. due date
1.	Narda ELT-400 Exposure Level Tester	2017/10	2019/10
2.	Lumiloop GMBH LSProbe 1.2	2017/09	2019/09

Assessment summary

Radiofrequency radiation exposure limits			
FCC 47 CFR § 2.1091 & ISED RSS -102 Issue 5:2015			
Frequency (MHz)	**Technology**	**Band**	**VERDICT (Pass/Fail)**
0.110	Wireless Charging System (Qi)	LF Band	Pass
13.56	NFC	ISM	Pass

Appendix A – FCC RF Exposure

FCC RF Exposure evaluation for mobile devices

Devices operating in standalone mobile device exposure conditions may contain a single transmitter or multiple transmitters that do not transmit simultaneously. A minimum test separation distance ≥ 20 cm is required between the antenna and radiating structures of the device and nearby persons to apply mobile device exposure limits. The distance must be at least 20 cm and fully supported by the operating and installation configurations of the transmitter and its antenna(s), according to the source-based time-averaged maximum power requirements of § 2.1091(d)(2). In cases where cable losses or other attenuations are applied to determine compliance, the most conservative operating configurations and exposure conditions must be evaluated. The minimum test separation distance required for a device to comply with mobile device exposure conditions must be clearly identified in the installation and operating instructions, for all installation and exposure conditions, to enable users and installers to comply with RF exposure requirements. For mobile devices that have the potential to operate in portable device exposure conditions, similar to the configurations described in § 2.1091(d)(4), a KDB inquiry is required to determine the SAR test requirements for demonstrating compliance.

When a device qualifies for the categorical exclusion provision of § 2.1091(c), the minimum test separation distance may be estimated, when applicable, by simple calculations according to plane-wave equivalent conditions, to ensure the transmitter and its antenna(s) can operate in manners that meet or exceed the estimated distance. The source-based time-averaged maximum radiated power, according to the maximum antenna gain, must be applied to calculate the field strength and power density required to establish the minimum test separation distance. When the estimated test separation distance becomes overly conservative and does not support compliance, MPE measurement or computational modeling may be used to determine the required minimum separation distance.

According to §1.1310 Radiofrequency radiation exposure limits, paragraph (e), the limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields are:

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

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

FCC Evaluation

The device under evaluation consists of a single slot dock battery charger, which also has NFC feature. During its normal use, the distance between the radiating parts of the device and the user will be greater than 20 cm.

1. WPT Evaluation Results

According to 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 Section 1.1310: 614 V/m and 1.63 A/m.

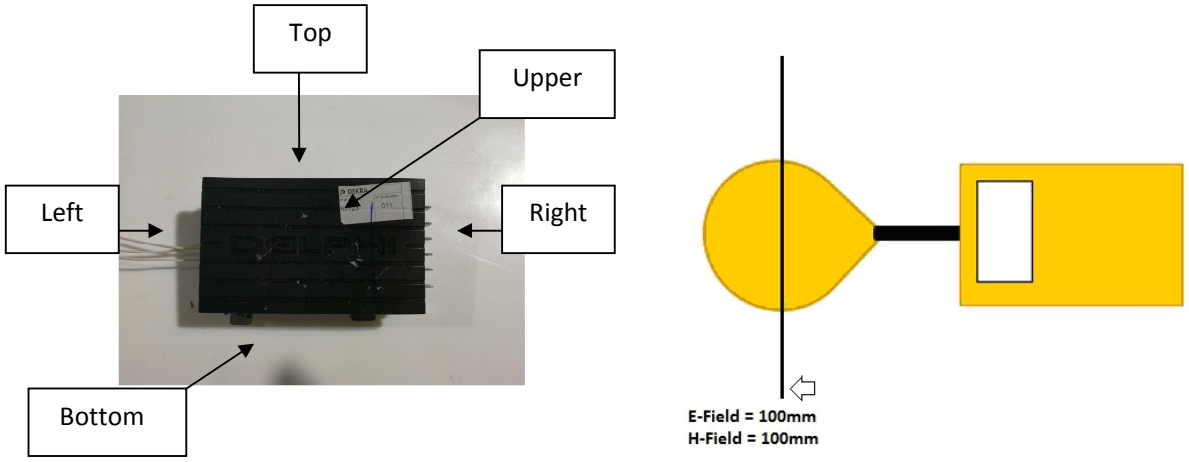


Figure 1: Measurement Setup

Measurements were performed using the equipment listed in the "Used Instrumentation" paragraph of this document and and a PCB - Qi receiver provided by the manufacturer, to set the maximum output load rate. Measurements were performed at 1%, 50% and 99% battery charging output power loads. The measured values are listed in the following tables:

Frequency (KHz)	Battery charging output level	H-Field measurements [A/m]					Max [A/m]	Limit [A/m]	% Limit	Verdict
		Top	Bottom	Left	Right	Upper				
110	99%	0.88	0.88	0.80	0.84	1.01	1.01	1.630	62.00	Pass
	50%	0.87	0.85	0.80	0.82	0.88	0.88	1.630	54.19	Pass
	1%	0.88	0.84	0.78	0.86	0.94	0.94	1.630	57.61	Pass

Table 1: H-field measurement values

Frequency (KHz)	Battery charging output level	E-Field measurements [V/m]					Max [V/m]	Limit [V/m]	% Limit	Verdict
		Top	Bottom	Left	Right	Upper				
110	99%	7.38	7.40	7.28	8.11	8.80	9.72	614.0	1.43	Pass
	50%	7.26	7.21	7.16	7.73	8.03	8.03	614.0	1.31	Pass
	1%	7.09	7.16	7.11	7.60	7.99	7.99	614.0	1.30	Pass

Table 2: E-field measurements values

2. NFC Evaluation Results

As stated into DEKRA Testing and Certification, S.A.U. test report 523723RRF.003 the maximum measured field strength for the operating frequency is:

Frequency (MHz)	Maximum H-field strength (dBµA/m) measured at 10 m
13.56	-23.90

Table 3: Measurement Results

Using Field Strength Approach formula (linear terms), this value corresponds to an output power of 0.000154 mW

$E.I.R.P = P_t \times G_t = (Exd)^2/30$

Where:
P_t = transmitter output power in watts
G_t = numeric gain of the transmitting antenna (unitless)
E = electric field strength in V/m, --- $10^{((dB\mu V/m)/20)}/10^6$.
For measuring equipment calibrated in dBµV/m, the reading should be reduced by 51.5 dB to be converted to dBµA/m, therefore E = H + 51.5 dB.
d = measurement distance in meters (m) = 10m

So $P_t = (Exd)^2/(30xG_t)$
H Field strength = -23.90 dBµA/m = 27.6 dBµV/m @ 10m
Antenna gain =0.0 dBi, so numeric gain = 1.0
Therefore
$P_t = \{[10^{(27.6/20)}/10^6 x10]^2/(30x1.0)\}x1000$ mW = 0.0000019 mW = -57.17 dBm

The maximum output power for the 13.56 MHz transmission mode of the device is -57.17 dBm.

In order to perform the assessment, the following equations have been used for the calculations; these equations are accurate in the far-field of an antenna but will over-predict power density in the near field, where they could be used for making a "worst case" or conservative prediction:

Power density: $S[mW/cm^2] = \frac{P_{E.I.R.P.}[mW]}{4\Pi R[cm]^2}$

Minimum compliance distance: $R_{\min}[cm] = \sqrt{\frac{P_{E.I.R.P.}[mW]}{4\Pi S[mW/cm^2]}}$

Where:
S = power density
$P_{E.I.R.P.}$ = Equivalent isotropically radiated power
R = distance to the center of radiation of the antenna (evaluation distance)
$R_{\min}$ = distance to the center of radiation of the antenna

NFC Trasmission:

Minimum use distance (cm):	20
Worst Case Frequency (MHz):	13.56
Maximum E.I.R.P (dBm):	-57.17
Maximum E.I.R.P (mW):	0.000002
Power density reference level (mW/cm^2):	0.2

Power density at minimum use distance:

Power density (mW/cm^2):	0.0000000004
Verdict:	PASS

The power density level for this transmission mode is below general population exposure power density limit.

Minimum compliance distance for this technology:

Minimum compliance distance to meet reference level (cm):	0.0009
Verdict:	PASS

The minimum use distance is greater than general population exposure minimum compliance distance.

3. Multiple frequencies assessment

When multiple sources are introduced into an environment, it becomes necessary to address the sources interdependently, since each source will contribute some percentage of the maximum exposure toward the total exposure at a fixed location. The sum of the ratios of the exposure from each source to the corresponding maximum exposure for the frequency of each source must be evaluated.

The exposure complies with the maximum permissible exposure if the sum of the ratios is less than unity:

$$\sum_{i=1}^{n} \frac{S_i}{MPE_i} < 1$$

Where
S_i is the contribution of each source;
MPE_i is the basic restriction of each source.

The device under test is able to transmit simultaneously using WPT and NFC technologies, therefore the multiple frequencies calculation will be as follow:

Magnetic field calculation:

$$\frac{1.01}{1.63} + \frac{0.0000000004}{0.2} = \quad 0.62 < 1 \text{ Limit}$$

Electric field calculation:

$$\frac{9.72}{614} + \frac{0.0000000004}{0.2} = \quad 0.016 < 1 \text{ Limit}$$

Appendix B – ISED RF Exposure

ISED RF Exposure evaluation for mobile devices

According to RSS-102 Issue 5, Paragraph "4. Exposure Limits", Industry of Canada has adopted the RF field strength limits stablished in Healths Canada's RF exposure guideline, Safety code 6:

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142\,f^{0.3417}$	$0.008335\,f^{0.3417}$	$0.02619f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158\,f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

ISED Evaluation Results for Mobile Exposure

The device under evaluation consists of a single slot dock battery charger, which also has NFC feature. During its normal use, the distance between the radiating parts of the device and the user will be greater than 20 cm.

1. WPT Evaluation Results

According to RSS-216- Issue 2, RF exposure shall be evaluated with the client devices charged/powered by the source device at maximum output power. Additionally, all transmitters, including those not used for wireless power transfer, must be active simultaneously and at maximum power. For WPT devices designed for desktop applications (e.g. wireless charging pads), RF exposure shall be evaluated at 10 cm away from all sides and from the top of the WPT device / system. The 10 cm shall be as measured from the probe centre to the WPT device / system edge.

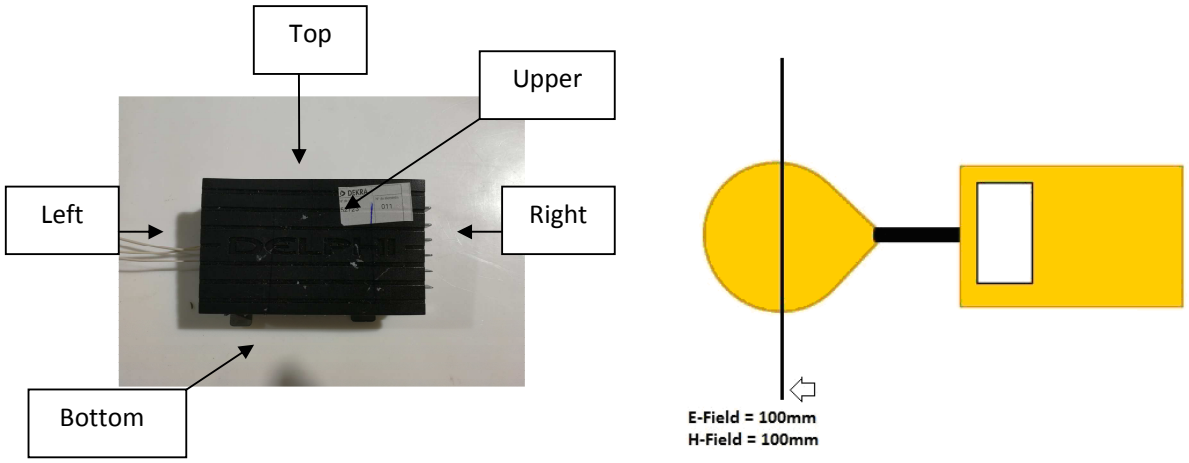


Figure 1: MPE Measurement Setup

Measurements were performed using the equipment listed in the "Used Instrumentation" paragraph of this document and and a PCB - Qi receiver provided by the manufacturer, to set the maximum output load rate. The measured values are listed in the following tables:

Frequency (KHz)	Battery charging output level	H-Field measurements [A/m]					Max [A/m]	Limit [A/m]	% Limit	Verdict
		Top	Bottom	Left	Right	Upper				
110	99%	0.88	0.88	0.80	0.84	1.01	1.01	7.3	13.84	Pass
	50%	0.87	0.85	0.80	0.82	0.88	0.88	7.3	12.10	Pass
	1%	0.88	0.84	0.78	0.86	0.94	0.94	7.3	12.86	Pass

Table 4: H-field measurement values

2. NFC Evaluation Results

As stated into DEKRA Testing and Certification, S.A.U. test report 523723RRF.003 the maximum measured field strength for the operating frequency is:

Frequency (MHz)	Maximum H-field strength (dBµA/m) measured at 10 m
13.56	-23.90

Table 5: Measurement Results

Using Field Strength Approach formula (linear terms), this value corresponds to an output power of 0.000154 mW

$E.I.R.P = P_t \times G_t = (Exd)^2/30$

Where:
P_t = transmitter output power in watts
G_t = numeric gain of the transmitting antenna (unitless)
E = electric field strength in V/m, --- $10^{((dB\mu V/m)/20)}/10^6$.
For measuring equipment calibrated in dBµV/m, the reading should be reduced by 51.5 dB to be converted to dBµA/m, therefore E = H + 51.5 dB.
d = measurement distance in meters (m) = 10m

So $P_t = (Exd)^2/(30xG_t)$
H Field strength = -23.90 dBµA/m = 27.6 dBµV/m @ 10m
Antenna gain =0.0 dBi, so numeric gain = 1.0
Therefore
P_t= {$[10^{(27.6/20)}/10^6 x10]^2/(30x1.0)$}x1000 mW = 0.0000019 mW = -57.17 dBm

The maximum output power for the 13.56 MHz transmission mode of the device is -57.17 dBm.

In order to perform the assessment, the following equations have been used for the calculations; these equations are accurate in the far-field of an antenna but will over-predict power density in the near field, where they could be used for making a "worst case" or conservative prediction:

Power density: $S[W/m^2] = \frac{P_{E.I.R.P.}[W]}{4\Pi R[m]^2}$

Minimum compliance distance: $R_{\min}[m] = \sqrt{\frac{P_{E.I.R.P.}[W]}{4\Pi S[W/m^2]}}$

Where:
S = power density
$P_{E.I.R.P.}$ = Equivalent isotropically radiated power
R = distance to the center of radiation of the antenna (evaluation distance)
$R_{\min}$ = distance to the center of radiation of the antenna

NFC Trasmission:

Minimum use distance (m):	0.2
Worst Case Frequency (MHz):	13.56
Maximum EIRP (dBm):	-57.17
Maximum EIRP (mW):	0.000002
General public - Power density limit (W/m^2):	2.0

Power density at minimum use distance:

Power density (W/m^2):	0.0000000004
Verdict for general public:	PASS

The power density level for this transmission mode is below general public power density limit.

Minimum compliance distance for this technology:

Minimum compliance distance for general public (m):	0.000874
Verdict for general public:	PASS

The minimum use distance is greater than general public minimum compliance distance.

3. Multiple frequencies assessment

When multiple sources are introduced into an environment, it becomes necessary to address the sources interdependently, since each source will contribute some percentage of the maximum exposure toward the total exposure at a fixed location. The sum of the ratios of the exposure from each source to the corresponding maximum exposure for the frequency of each source must be evaluated.

The exposure complies with the maximum permissible exposure if the sum of the ratios is less than unity:

$$\sum_{i=1}^{n} \frac{S_i}{MPE_i} < 1$$

Where
S_i is the contribution of each source;
MPE_i is the basic restriction of each source.

The device under test is able to transmit simultaneously using WPT and NFC technologies, therefore the multiple frequencies calculation will be as follow:

$$\frac{1.01}{7.3} + \frac{0.0000000004}{2} = \quad 0.14 < 1 \text{ Limit}$$

ISED Nerve Stimulation Evaluation Results

According to RSS-102 Issue 5, Nerve Stimulation exposure limits shall be evaluated for transmission into the frequency range from 0.003 to 10 MHz. Supplementary Procedure SPR-002, Issue 1, for Radio Standards Specification RSS-102 sets out the general test methods to be followed when carrying out an assessment to the nerve stimulation exposure requirements of RSS-102.

According to Supplementary Procedure SPR-002, "Annex E – E.1.1. Passively Used Table-Top Devices", measurements have been performed installing the device at the edge of a 80 cm tall and non-metallic constructed table, placing the measurement probe at the compliance distance away from the edge of the table. A compliance distance of 10 cm from the probe edge to the WPT device/sytem edge has been used for the measurements.

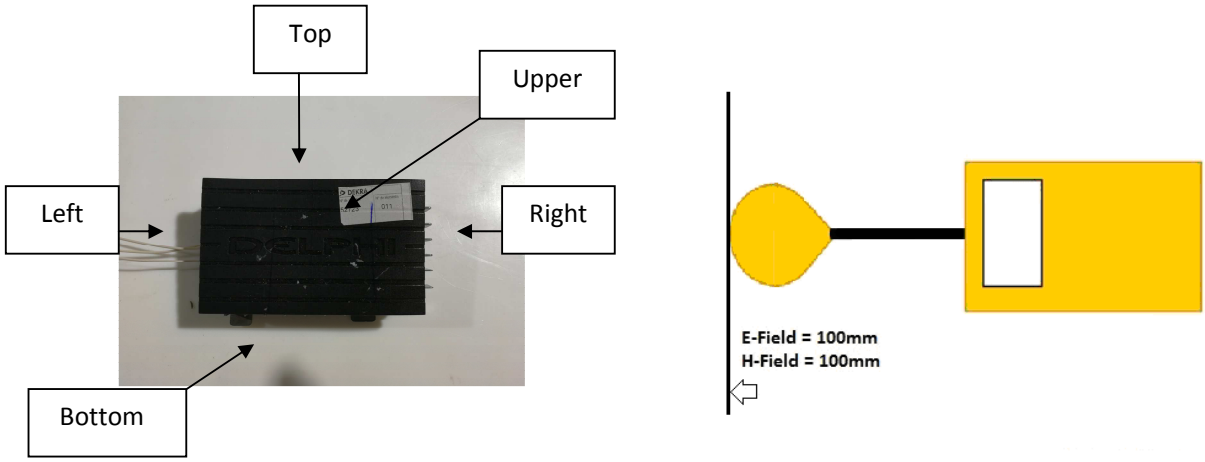


Figure 2: Nerve Stimulation Measurement Setup

Measurements were performed using the equipment listed in the "Used Instrumentation" paragraph of this document, following the measurement method shown in paragraph 6.6.1.1 of "Supplementary Procedure for Assessing Compliance with RSS-102 Nerve Stimulation Exposure Limits SPR-002". Measured values for each configuration are listed in the following table:

Frequency (KHz)	Battery charging mode	H-Field measurements [A/m]					Max [A/m]	Limit [A/m]	% Limit	Verdict
		Top	Bottom	Left	Right	Upper				
110	Max output load	5.76	6.04	6.31	5.76	6.29	6.31	90.0	7.01	Pass

Table 5: H-field measurement values and ISED limit for Nerve Stimulation

Frequency (KHz)	Battery charging mode	E-Field measurements [V/m]					Max [V/m]	Limit [V/m]	% Limit	Verdict
		Top	Bottom	Left	Right	Upper				
110	Max output load	33.03	28.17	36.82	25.03	38.80	38.80	83.0	46.75	Pass

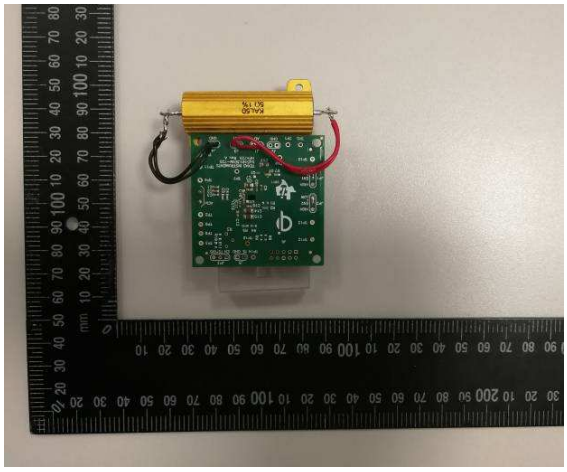
Table 6: E-field measurements values and ISED limit for Nerve Stimulation

All H-Field and E-Field values are in compliance to values shown into "Table 4: RF Field Strength Limits for Devices Used by the General Public" for the frequency range used by the device.

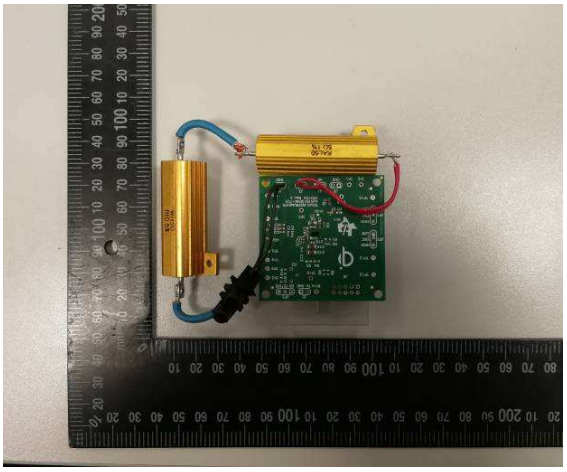
Appendix C – Photographs

- **Equipment view**

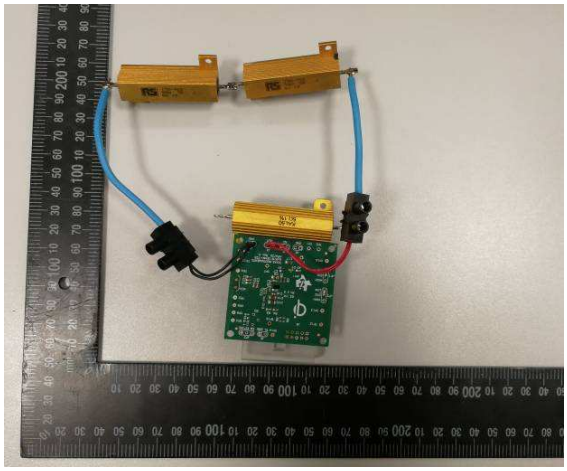
- **PCB Qi Receiver views**



Max Output Load



99% Load



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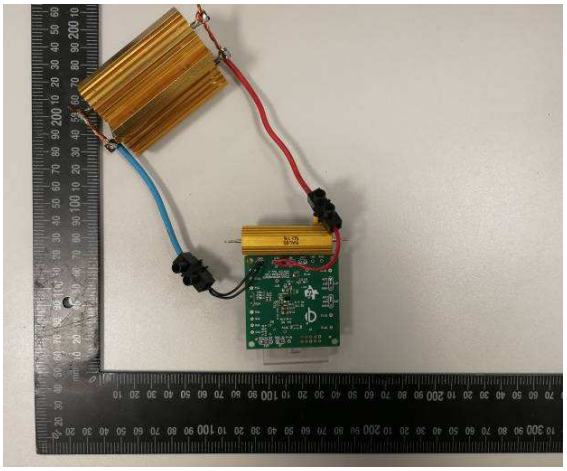
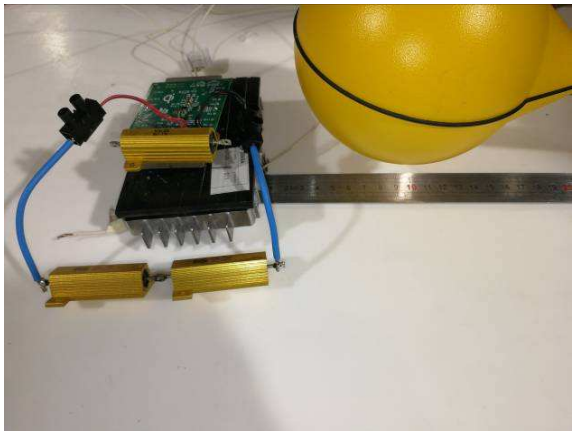
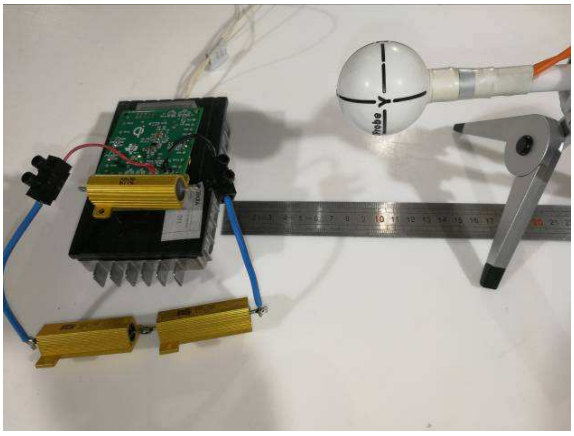


1% Load

- **Mobile Exposure measurement setup views**

Top

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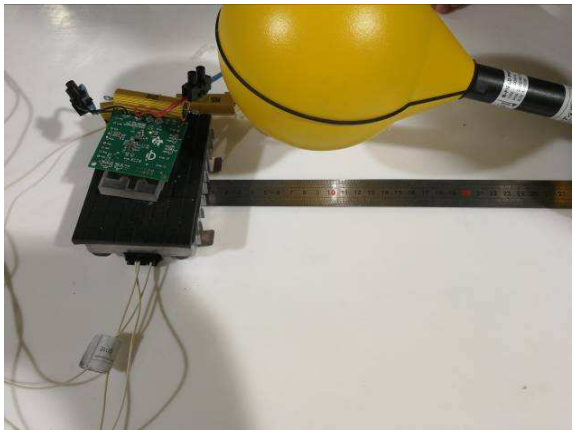
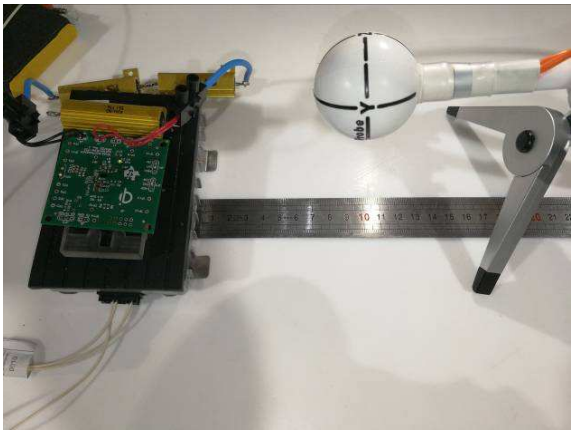
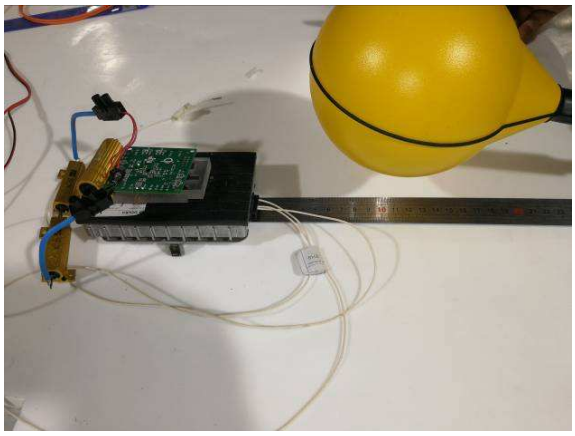
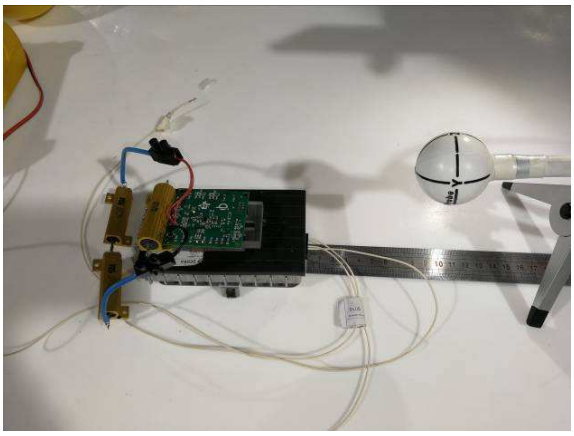
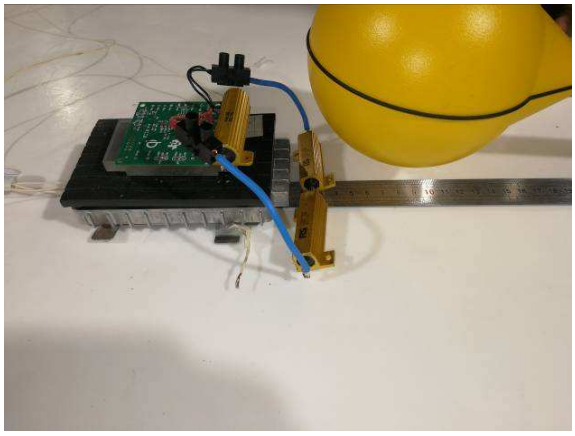
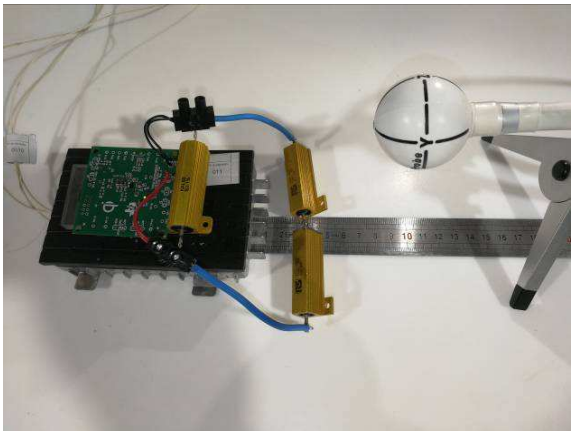



Left

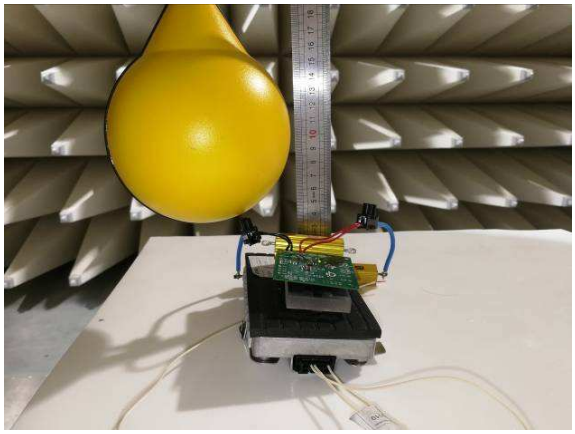



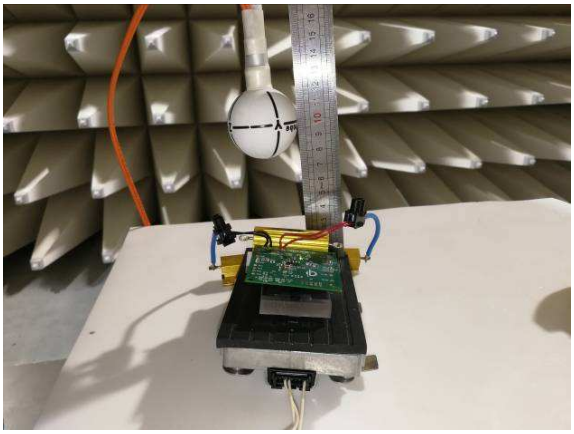
Right





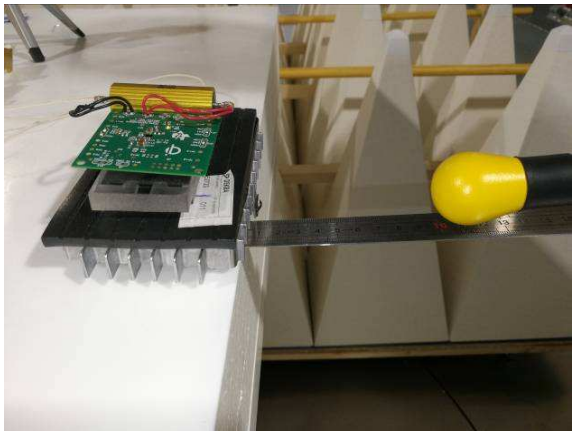
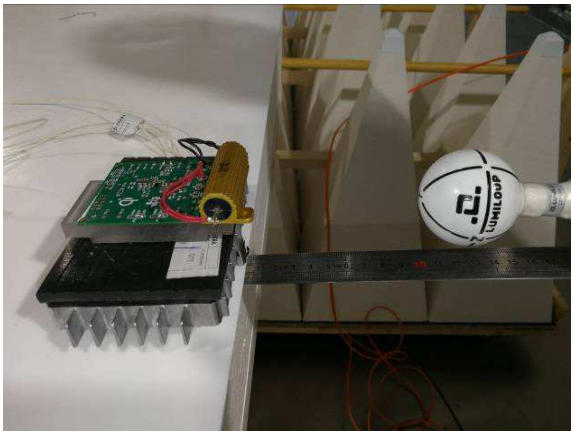
Upper





- **Nerve stimulation measurement setup.**

Top

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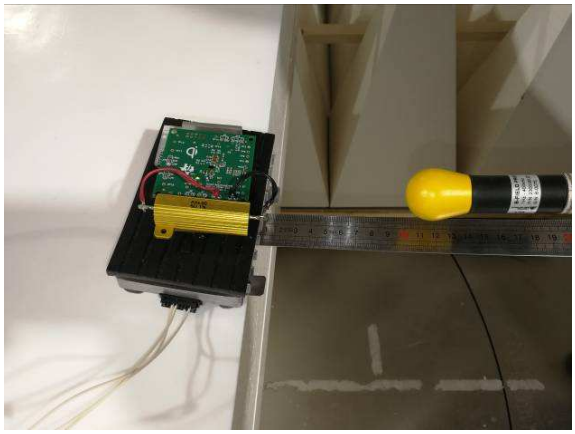
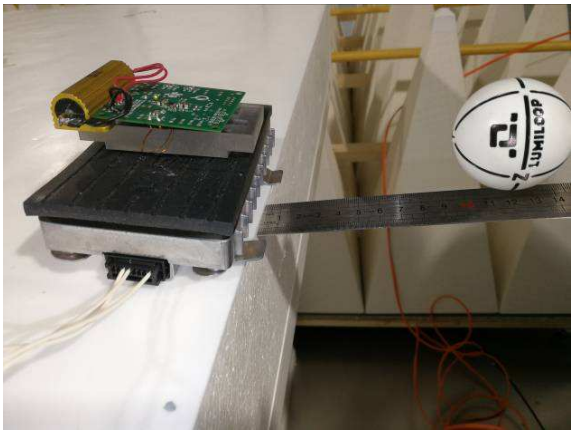

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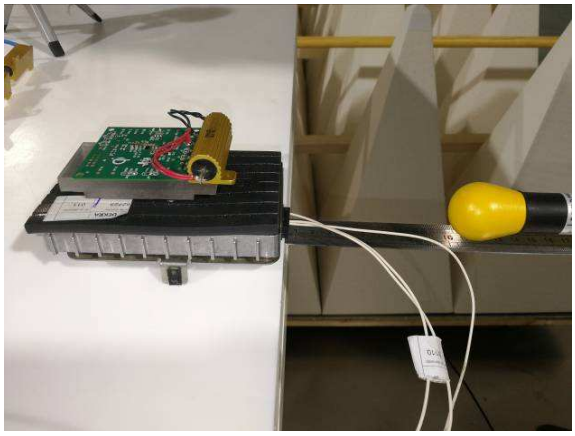
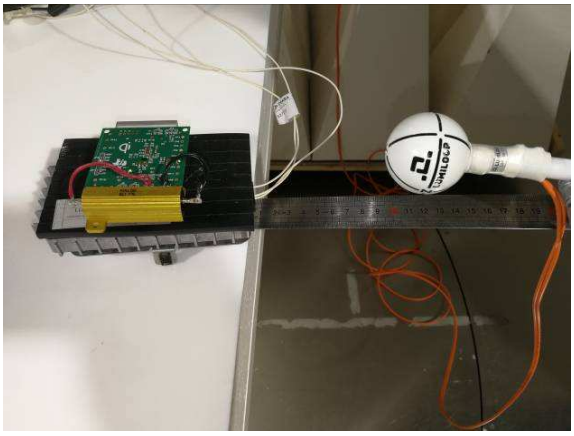

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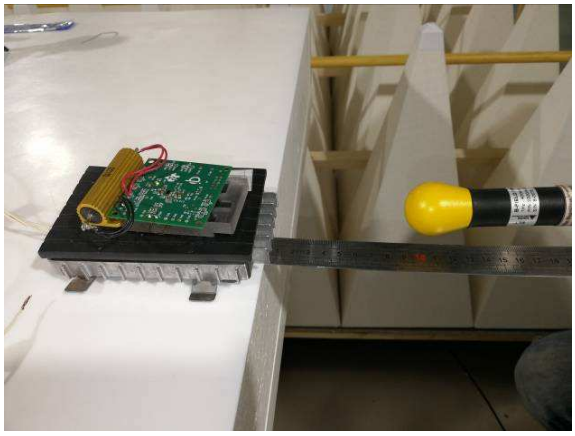

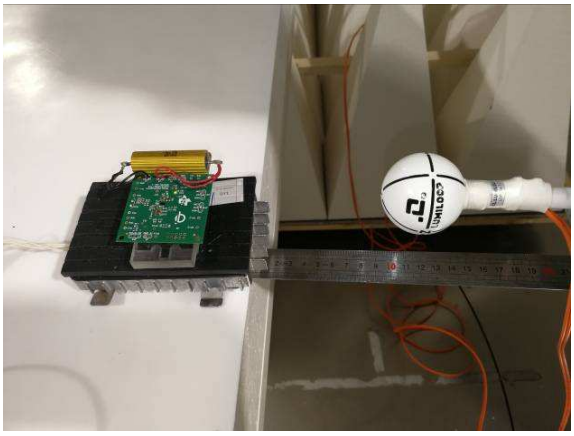

Upper