EMF Evaluation Report

Date of Report	1/12/2022	**Client's Contact person:**	Rob Hillyard
Number of pages:	18	**Responsible Test engineer:**	Ilari Kinnunen
Testing laboratory:	**Verkotan Oy** Elektroniikkatie 17 90590 Oulu Finland	**Client:**	**This report is issued to** **Kiwa Electrical Compliance** Unit 8, Woodfieldside Business Park Pontllanfraith, Blackwood NP12 2DG, UK **On behalf of** **Sports & Wellbeing Analytics Ltd** 3 New Mill Court Llys Felin Newydd Swansea Enterprise Park Swansea SA7 9FG, UK
Tested device	Protecht Single Charging Case		
Related reports:	-		
Testing has been carried out in accordance with:	**680106 D01 RF Exposure Wireless Charging App v03** Rf exposure considerations for low power consumer wireless power transfer applications		
Documentation:	The test report must always be reproduced in full; reproduction of an excerpt only is subject to written approval of the testing laboratory		
Test Results:	**The EUT complies with the requirements in respect of all parameters subject to the test.** The test results relate only to devices specified in this document		

Date and signatures:

01.12.2022

Miia Nurkkala

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Laboratory Manager

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1. SUMMARY OF EMF TEST REPORT

1.1 Test Details

Equipment under Test (EUT):

Product:	Protecht Single Charging Case
Manufacturer:	Sports & Wellbeing Analytics Ltd
Serial Number:	2622521 / 52AB569AEE
HW / SW ID:	SCC001.1/ V1.0
FCC ID:	2AT9A-SCC001NA
Model:	Protecht Single Charging Case
DUT Number:	22501, 21506
State of the Sample:	Production sample

Testing information:

Testing performed:	10.11.2022 – 15.11.2022
Notes:	-
Document ID:	FCC_EMF_Report_Opro+_ID5842_01122022
Document history/changes:	Initial version
Measurement performed by:	Ilari Kinnunen
FCC Test Firm Designation number:	FI0005

1.2 Maximum Results

1.2.1 KDB 680106 D01

The maximum reported electric field and magnetic field strength values are shown in tables below. The device conforms to the requirements of the standards when the maximum measurement value is less than the MPE limit.

Operation mode	Test	Distance to EUT* [cm]	Frequency [kHz]	MPE Limit	Measured value	Result
Charging	E-field strength	15	150	614 V/m	1.81 V/m	PASS
Charging	H-field strength	15	150	1.63 A/m	0.21 A/m	PASS
Charging	E-field strength	20	150	614 V/m	1.23 V/m	PASS
Charging	H-field strength	20	150	1.63 A/m	0.12 A/m	PASS

*Measured from the center of the probe(s) to the edge of the device

1.2.2 Simultaneous transmission Analysis

Simultaneous transmission analysis of BLE and WPT is done by calculation of total exposure ratio i.e., TER. If TER<1 the product conforms to the requirements of the standards.

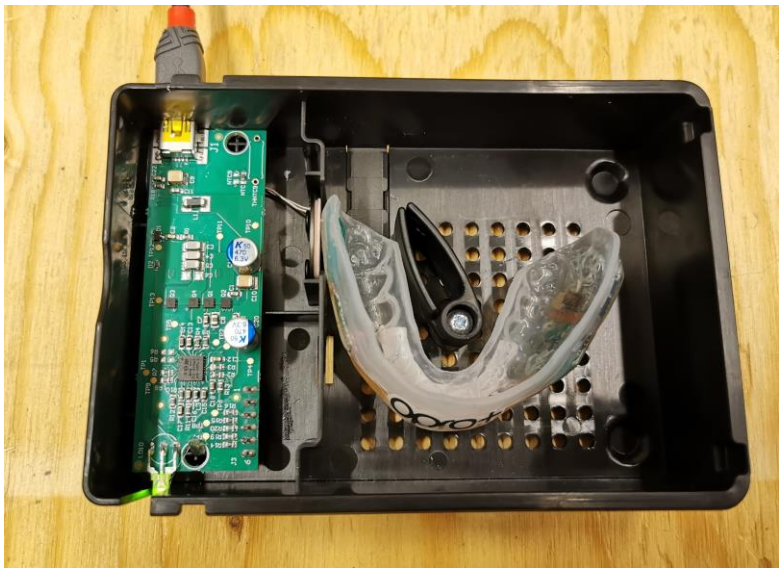
Simultaneous Sources	Summed Components	Distance to EUT* [cm]	TER	Result
WPT + BLE	SAR + E-field strength	15	0.0017	PASS
WPT + BLE	SAR + H-field strength	15	0.0178	PASS

*Measured from the center of the probe(s) to the edge of the device

2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

The DUT is a WPT charging case that is used to charge a mouth guard. Mouth guard also supports Bluetooth Low Energy, and it can be operated simultaneously with WPT. Both WPT and BLE can only be operating while the unit is placed in the charging case. The DUT has a single coil. The charge receiver is mounted in contact with the transmitter.

According to the test report 12406767S-A-R3, for the used BLE module (FCC ID RYYEYSLSN), maximum BLE antenna gain is -3.7 dBi.



Device Category	Mobile
Exposure Environment	Uncontrolled

2.1 Technical data of the DUT

WPT:

Operating Frequency [kHz]	Antenna Type	Maximum Nominal Power [W]
150	Magnetic loop	<15W

BLE:

Bands	Modes of Operation	Transmitter Frequency Range [MHz]
2.4 GHz	Bluetooth Low Energy	2402 – 2480

2.2 Text Exclusions

FCC MPE-based Exemption thresholds in 447498 D04 Interim General RF Exposure Guidance v01 are shown in a table below.

TABLE B.1—THRESHOLDS FOR SINGLE RF SOURCES SUBJECT TO ROUTINE ENVIRONMENTAL EVALUATION

RF Source Frequency			Minimum Distance			Threshold ERP
f_L MHz		f_H MHz	$\lambda_L / 2\pi$		$\lambda_H / 2\pi$	W
0.3	–	1.34	159 m	–	35.6 m	1,920 R^2
1.34	–	30	35.6 m	–	1.6 m	3,450 R^2/f^2
30	–	300	1.6 m	–	159 mm	3.83 R^2
300	–	1,500	159 mm	–	31.8 mm	0.0128 $R^2 f$
1,500	–	100,000	31.8 mm	–	0.5 mm	19.2R^2
Subscripts L and H are low and high; λ is wavelength. From § 1.1307(b)(3)(i)(C), modified by adding Minimum Distance columns.						

2.2.1 Maximum Output Power

From the customer;

Wireless Technology	Maximum conducted Output Power [dBm]	Maximum conducted Output Power [mW]	Antenna Gain* [dBi]	Maximum ERP [dBm]	Maximum ERP [mW]
BLE	4.53	2.84	-3.7	-1.32	0.74

*Antenna gain and maximum conducted power are from test report 12406767S-A-R3, for the used BLE module (FCC ID RYYEYSLSN).

2.2.2 BLE SAR Test Exclusion

According to Table B.1 in 447498 D04 Interim General RF Exposure Guidance v01, FCC MPE-based Exemption threshold can be calculated according to formula:

19.2* R^2 = 19.2 * 0.15^2= 432mW.

where:

Separation distance R (m) = 0.15

The maximum conducted output power of the DUT is 2.84 mW (4.53 dbm) thus it is below the 432mW MPE-Based Exemption threshold.

Calculated BLE SAR:

For simultaneous transmission evaluation the estimated standalone SAR values are calculated according to the following equation 4.

$SARestimated$=0.4$*Pant/Pth$ [w/kg] (Equation 4)

Estimated BT SAR = 0.4*(2.84mW/432mW) = 0.00263W/kg

3. TEST EQUIPMENT

Test Equipment	Model	Serial Number	Calibration Date
E- and H-field meter	Narda EHP-200AC	170WX80310	24.10.2022

3.1 Test setup

3.1.1 KDB 680106 D01

Measurement distance of 15 cm was used when testing the power transfer. The distance is measured from the center of the probe to the edge of the device. The maximum E- & H-field test position was also measured using measurement distance of 20 cm. Testing was done on the wooden table, free of metal objects. Peak E- and H-field, using max hold functionality, was measured from five sides of the DUT. After the maximum E- and H-field test positions were found, 6-minute average was measured for both fields.

Photos of the test setup are shown in Appendix A.

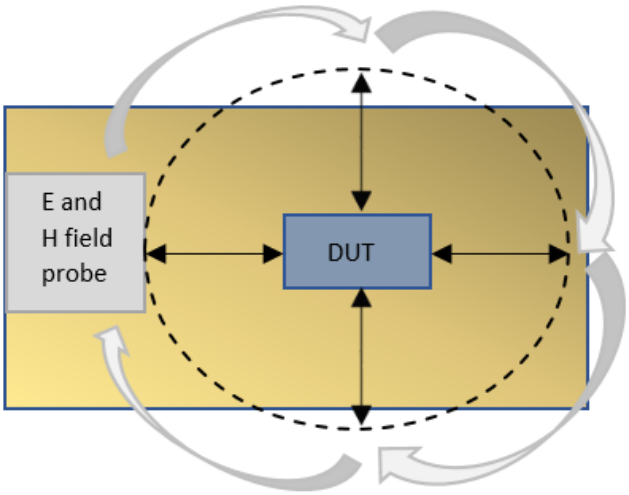


Figure 1 The top view of the test setup.

3.2 Limits

Limits for MPE specified in KDB 680106 D01 (47 CFR § 1.1310, Table 1). The operating frequency for the charger is 150 kHz.

Thus, limits of 614 V/m were used for E-field and 1.63 A/m for H-field.

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

3.3 Measurement uncertainty

Magnetic field 30kHz-30MHz

Quantity	Relative standard uncertainty in (%)	Probability distribution	Sensitivity coefficient	Degrees of freedom	Relative uncertainty contribution
Uncertainty of the calibration of the sensor	3.9	normal	1	infinite	0.039
Uncertainty of the frequency response of the sensor	2.7	rectangular	1	infinite	0.027
Uncertainty of the non-linearity	3.4	rectangular	1	infinite	0.034
Uncertainty of the anisotropy	4.5	rectangular	1	infinite	0.045
Uncertainty of the resolution of the measurement system	1	rectangular	1	infinite	0.01
Uncertainty of the temperature variation	2.3	rectangular	1	infinite	0.023
Uncertainty of the repeatability of the measurements	2	normal	1	4	0.02
Combined standard uncertainty		normal		infinite	0.08
Expanded uncertainty (k=2)					16 %

Electric field 9kHz-27MHz

Quantity	Relative standard uncertainty in (%)	Probability distribution	Sensitivity coefficient	Degrees of freedom	Relative uncertainty contribution
Uncertainty of the calibration of the sensor	3.9	normal	1	infinite	0.039
Uncertainty of the frequency response of the sensor	1.7	rectangular	1	infinite	0.017
Uncertainty of the non-linearity	2.7	rectangular	1	infinite	0.027
Uncertainty of the anisotropy	4.1	rectangular	1	infinite	0.041
Uncertainty of the resolution of the measurement system	1.9	rectangular	1	infinite	0.019
Uncertainty of the temperature variation	2.3	rectangular	1	infinite	0.023
Uncertainty of the repeatability of the measurements	2	normal	1	4	0.02
Combined standard uncertainty		normal		infinite	0.074
Expanded uncertainty (k=2)					14.8 %

4. TEST RESULTS

Test description	Findings
A frequency span from 3 kHz to 30 MHz was scanned to check for spurious.	With the wireless charger, spurious E-field/H-field above -20 dBc were identified. The spurious fields above -20 dBc were summed to the fields generated at the operational frequency.
Occupied Band Width check.	OBW was measured and found to be less than 3 kHz. RBW set to 10 kHz, Span 1.0 MHz.
All sides and front of DUT were scanned.	Maximum emissions were found from the top side of the DUT (Appendix A: Photos of DUT)
E- and H-field measurement was performed with increased monitoring period.	Results in the table below.

4.1 Electric Field Results

Wireless power Charger:

Measurement direction	Separation distance* [cm]	Max Peak E-Field [V/m]**	6 min average E-Field [V/m]**	E-Field Limit [V/m]	Charging load
Front	15	1.77	-	614	Opro+ mouth guard
Left	15	1.61	-		
Right	15	1.25	-		
Top	**15**	**1.84**	**1.81**		
Bottom	15	1.61	-		
Top	**20**	**1.24**	**1.23**		

*measured from the center of the probe(s) to the edge of the device
** E-field of the spurious above -20 dBc was summed to the fields generated at the operational frequency

4.2 Magnetic Field Results

Wireless power charger:

Measurement direction	Separation distance* [cm]	Max Peak H-Field [A/m]	6 min average H-Field [A/m]	H-Field Limit [A/m]	Charging load
Front	15	0.19	-	1.63	Opro+ mouth guard
Left	15	0.08	-		
Right	15	0.14	-		
Top	**15**	**0.21**	**0.21**		
Bottom	15	0.09	-		
Top	**20**	**0.12**	**0.12**		

*measured from the center of the probe(s) to the edge of the device
** E-field of the spurious above -20 dBc was summed to the fields generated at the operational frequency

5. SIMULTANEOUS TRANSMISSION ANALYSIS

WPT and BLE Simultaneous Transmission Analysis is evaluated using the following formula at 15cm separation:

$$TER = \sum_{k=1}^{N_S} \left(\frac{SAR_k}{SAR_{\lim}} \right) + \sum_{k=1}^{N_f} \left(\frac{MPE_{field,\,k}}{MPE_{field,\,\lim}} \right)^2 + \sum_{k=1}^{N_{PD}} \left(\frac{MPE_{PD,\,k}}{MPE_{PD,\,\lim}} \right)$$

BT SAR + WPT E-field @15cm TER	SAR_k = 0.00263W/kg SAR_{lim} = 1.6 W/kg $MPE_{field,\,k}$ = 1.81 V/m $MPE_{field,\,lim}$ = 614 V/m $\frac{0.00263}{1.6} + (\frac{1.81}{614})^2 = 0.0017$
BT SAR + WPT H-field @15cm TER	SAR_k = 0.00263 W/kg SAR_{lim} = 1.6 W/kg $MPE_{field,\,k}$ = 0.21 A/m $MPE_{field,\,lim}$ = 1.63 A/m $\frac{0.00263}{1.6} + (\frac{0.21}{1.63})^2$ =0.0178

APPENDIX A: PHOTOS OF THE DUT

Test setup:

The mouth guard is charged inside the plastic container. The impact of the lid (lid open and closed) to the test results was tested to be negligible.

Test positions:

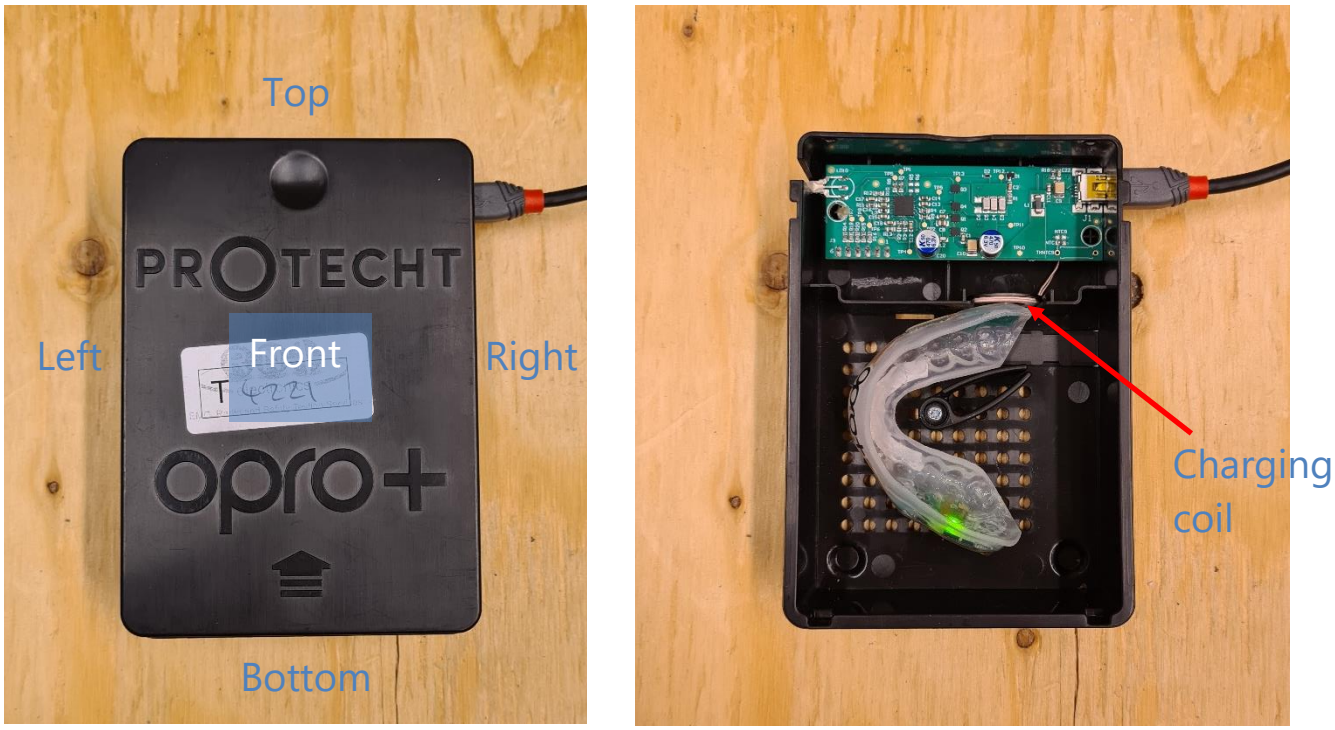


Figure 2 DUT lid closed and open

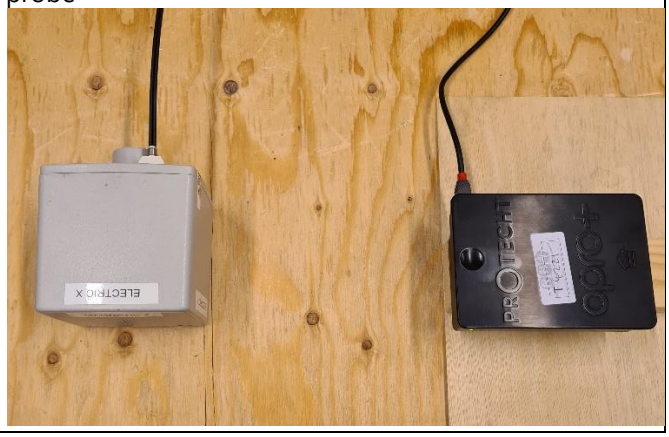
E-field test positions:

Measurement: E-field, Front, 15 cm to the center of the probe

Measurement: E-field, Left, 15 cm to the center of the probe

Measurement: E-field, Right, 15 cm to the center of the probe

Measurement: E-field, Top, 15 cm to the center of the probe

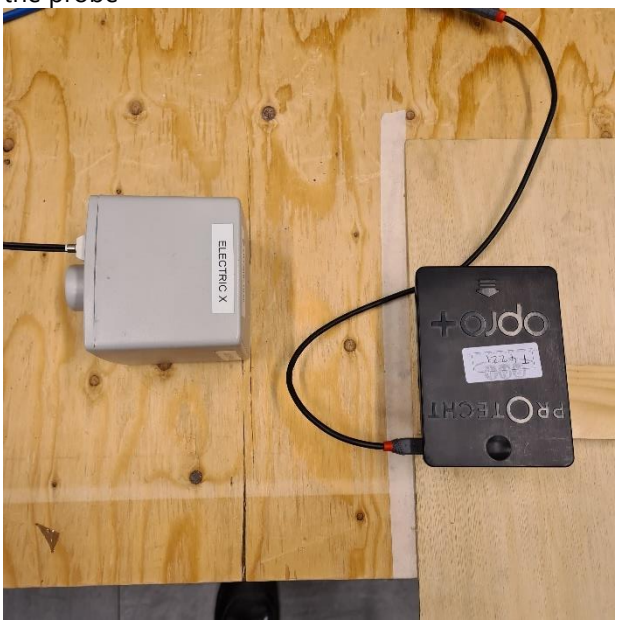
Measurement: E-field, Bottom, 15 cm to the center of the probe	Measurement: E-field, Top, 20 cm to the center of the probe
	

H-field test positions:

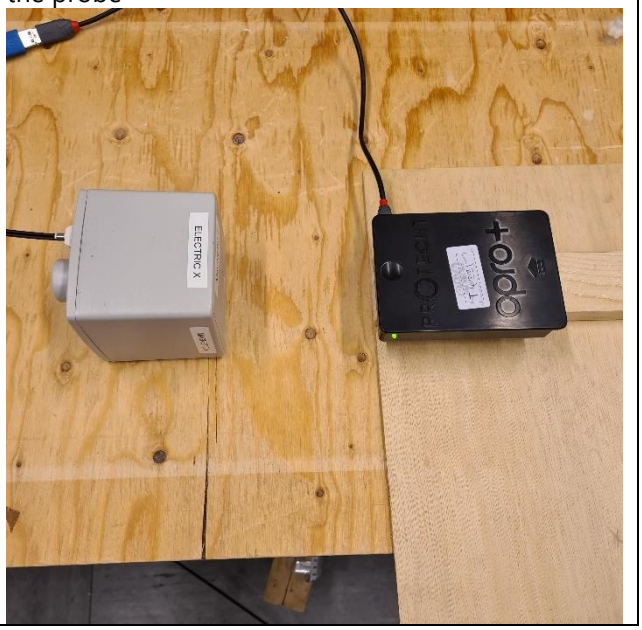
Measurement: H-field, Front, 15 cm to the center of the probe

Measurement: H-field, Left, 15 cm to the center of the probe

Measurement: H-field, Right, 15 cm to the center of the probe



Measurement: H-field, Top, 15 cm to the center of the probe



Measurement: H-field, Bottom, 15 cm to the center of the probe	Measurement: H-field, Top, 20 cm to the center of the probe