



# TEST REPORT

**Report Reference No.**..... : **TRE18070169** R/C.....: 92275

**FCC ID**..... : **2AJGM-BFR5**

**Applicant's name**..... : **PO FUNG ELECTRONIC (HK) INTERNATIOANL GROUP COMPANY**

**Address**..... : 3/F FULOK BLDG 131-133 WING LOK ST SHEUNG WAN Hong Kong

**Manufacturer**..... : PO FUNG ELECTRONIC (HK) INTERNATIOANL GROUP COMPANY

**Address**..... : 3/F FULOK BLDG 131-133 WING LOK ST SHEUNG WAN Hong Kong

**Test item description** ..... : **TWO-WAY RADIO**

**Trade Mark** ..... : BAOFENG

**Model/Type reference**..... : BF-R5

**Listed Model(s)** ..... : -

**Standard** ..... : **FCC 47 CFR Part2.1093**  
**ANSI/IEEE C95.1: 1999**  
**IEEE 1528: 2013**

**Date of receipt of test sample**.....: Jul. 24, 2018

**Date of testing**.....: Jul. 25, 2018 - Jul. 31, 2018

**Date of issue**.....: Aug. 02, 2018

**Result**.....: **PASS**

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**Testing Laboratory Name** ..... : **Shenzhen Huatongwei International Inspection Co., Ltd**

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*The test report merely correspond to the test sample.*

## Contents

<u>1.</u>	<u>Test Standards and Report version</u>	<u>3</u>
1.1.	Test Standards	3
1.2.	Report version	3
<u>2.</u>	<u>Summary</u>	<u>4</u>
2.1.	Client Information	4
2.2.	Product Description	4
2.3.	Test frequency list	5
<u>3.</u>	<u>Test Environment</u>	<u>6</u>
3.1.	Test laboratory	6
3.2.	Test Facility	6
<u>4.</u>	<u>Equipments Used during the Test</u>	<u>7</u>
<u>5.</u>	<u>Measurement Uncertainty</u>	<u>8</u>
<u>6.</u>	<u>SAR Measurements System Configuration</u>	<u>10</u>
6.1.	SAR Measurement Set-up	10
6.2.	DASY5 E-field Probe System	11
6.3.	Phantoms	12
6.4.	Device Holder	12
<u>7.</u>	<u>SAR Test Procedure</u>	<u>13</u>
7.1.	Scanning Procedure	13
7.2.	Data Storage and Evaluation	15
<u>8.</u>	<u>Position of the wireless device in relation to the phantom</u>	<u>17</u>
8.1.	Front-of-face	17
8.2.	Body Position	17
<u>9.</u>	<u>System Verification</u>	<u>18</u>
9.1.	Tissue Dielectric Parameters	18
9.2.	SAR System Verification	19
<u>10.</u>	<u>SAR Exposure Limits</u>	<u>23</u>
<u>11.</u>	<u>Radiated Power Measurement Results</u>	<u>24</u>
<u>12.</u>	<u>Maximum Tune-up Limit</u>	<u>24</u>
<u>13.</u>	<u>SAR Measurement Results</u>	<u>25</u>
<u>14.</u>	<u>SAR Measurement Variability</u>	<u>28</u>
<u>15.</u>	<u>Test Setup Photos</u>	<u>29</u>
<u>16.</u>	<u>External and Internal Photos of the EUT</u>	<u>29</u>

## 1 . Test Standards and Report version

### 1.1. Test Standards

The tests were performed according to following standards:

[FCC 47 Part 2.1093](#): Radiofrequency Radiation Exposure Evaluation:Portable Devices

[IEEE Std C95.1, 1999](#): IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 KHz to 300 GHz.

[IEEE Std 1528™-2013](#): IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.

[KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04](#): SAR Measurement Requirements for 100 MHz to 6 GHz

[KDB 865664 D02 RF Exposure Reporting v01r02](#): RF Exposure Compliance Reporting and Documentation Considerations

[KDB 447498 D01 General RF Exposure Guidance v06](#): Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies

### 1.2. Report version

Revision No.	Date of issue	Description
N/A	2018-08-02	Original

## 2. Summary

### 2.1. Client Information

Applicant:	PO FUNG ELECTRONIC (HK) INTERNATIOANL GROUP COMPANY
Address:	3/F FULOK BLDG 131-133 WING LOK ST SHEUNG WAN Hong Kong
Manufacturer:	PO FUNG ELECTRONIC (HK) INTERNATIOANL GROUP COMPANY
Address:	3/F FULOK BLDG 131-133 WING LOK ST SHEUNG WAN Hong Kong

### 2.2. Product Description

Name of EUT:	TWO-WAY RADIO	
Trade mark:	BAOFENG	
Model/Type reference:	BF-R5	
Listed model(s):	-	
Accessories:	Belt Clip, earphone	
Device Category:	Portable	
RF Exposure Environment:	General Population / Uncontrolled	
Power supply:	DC 3.7V	
<b>Maximum SAR Value</b>		
Separation Distance:	Body:	0mm
	Front-of-face:	25mm
Maximun SAR Value (1g):	Front-of-face:	0.441 W/kg
	Body:	1.051 W/kg
<b>PMR</b>		
Operation Frequency Range:	462.5625MHz~ 462.7125MHz 467.5625MHz~ 467.7125MHz 462.5500MHz~ 462.7250MHz	
Rated Output Power:	0.5W(27.00dBm)	
Modulation Type:	FM(Analog)	
Channel Separation:	Analog:12.5kHz	
Antenna type:	Integral	
<i>Remark:</i> The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power		

### 2.3. Test frequency list

When the frequency channels required for SAR testing are not specified in the published RF exposure KDB procedures, the following should be applied to determine the number of required test channels. The test channels should be evenly spread across the transmission frequency band of each wireless mode:

$$N_c = 2 * \text{roundup} [10 * (f_{\text{high}} - f_{\text{low}}) / f_c] + 1$$

$f_c$ : is the centre frequency of the band in hertz;

$f_{\text{high}}$ : is the highest frequency in the band in hertz;

$f_{\text{low}}$ : is the lowest frequency in the band in hertz;

$N_c$ : is the number of channels;

$f$ : is the width of the transmit frequency band in hertz.

ModulationType	Channel Separation	Test Channel	Test Frequency (MHz)
			TX
Analog	12.5kHz	CH4	462.6375
		CH11	467.6375
		CH19	462.6500

### **3. Test Environment**

#### **3.1. Test laboratory**

Laboratory: Shenzhen Huatongwei International Inspection Co., Ltd.

Address: 1/F, Bldg 3, Hongfa Hi-tech Industrial Park, Genyu Road, Tianliao, Gongming, Shenzhen, China

#### **3.2. Test Facility**

##### **CNAS-Lab Code: L1225**

Shenzhen Huatongwei International Inspection Co., Ltd. has been assessed and proved to be in compliance with CNAS-CL01 Accreditation Criteria for Testing and Calibration Laboratories (identical to ISO/IEC 17025: 2005 General Requirements) for the Competence of Testing and Calibration Laboratories.

##### **A2LA-Lab Cert. No.: 3902.01**

Shenzhen Huatongwei International Inspection Co., Ltd. EMC Laboratory has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

##### **FCC-Registration No.: 762235**

Shenzhen Huatongwei International Inspection Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the FCC (Federal Communications Commission). The acceptance letter from the FCC is maintained in our files. Registration 762235.

##### **IC-Registration No.: 5377B-1**

Two 3m Alternate Test Site of Shenzhen Huatongwei International Inspection Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for the performance of radiated measurements with Registration No. 5377B-1.

##### **ACA**

Shenzhen Huatongwei International Inspection Co., Ltd. EMC Laboratory can also perform testing for the Australian C-Tick mark as a result of our A2LA accreditation.

#### 4. Equipments Used during the Test

Test Equipment	Manufacturer	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
Data Acquisition Electronics DAEx	SPEAG	DAE4	1549	2018/04/25	2019/04/24
E-field Probe	SPEAG	EX3DV4	7494	2018/02/26	2019/02/25
System Validation Dipole	SPEAG	D450V3	1102	2018/02/23	2021/02/22
Dielectric Assessment Kit	SPEAG	DAK-3.5	1267	2018/03/01	2019/02/28
Network analyzer	Agilent	N9923A	MY51491493	2017/09/05	2018/09/04
Universal Radio Communication Tester	ROHDE & SCHWARZ	CMU200	112012	2017/11/11	2018/11/10
Signal Generator	ROHDE & SCHWARZ	SMB100A	175248	2017/09/02	2018/09/01
Power meter	Agilent	N1914A	MY52090010	2018/03/22	2019/03/21
Power sensor	Agilent	E9304A	MY52140008	2018/03/22	2019/03/21
Power sensor	Agilent	E9301H	MY54470001	2018/03/22	2019/03/21
Power Amplifier	Mini-Circuits	ZHL-42W	QA1202003	2017/11/27	2018/11/26
Dual Directional Coupler	Agilent	778D	MY48220612	2018/03/22	2019/03/21

Note:

The DAE ,Probe and Dipole calibration reference to the Appendix A and Appendix B.

## 5. Measurement Uncertainty

Measurement Uncertainty										
No.	Error Description	Type	Uncertainty Value	Probably Distribution	Div.	(Ci) 1g	(Ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)	Degree of freedom
Measurement System										
1	Probe calibration	B	6.0%	N	1	1	1	6.0%	6.0%	∞
2	Axial isotropy	B	4.70%	R	$\sqrt{3}$	0.7	0.7	1.90%	1.90%	∞
3	Hemispherical isotropy	B	9.60%	R	$\sqrt{3}$	0.7	0.7	3.90%	3.90%	∞
4	Boundary Effects	B	1.00%	R	$\sqrt{3}$	1	1	0.60%	0.60%	∞
5	Probe Linearity	B	4.70%	R	$\sqrt{3}$	1	1	2.70%	2.70%	∞
6	Detection limit	B	1.00%	R	$\sqrt{3}$	1	1	0.60%	0.60%	∞
7	RF ambient conditions-noise	B	0.00%	R	$\sqrt{3}$	1	1	0.00%	0.00%	∞
8	RF ambient conditions-reflection	B	0.00%	R	$\sqrt{3}$	1	1	0.00%	0.00%	∞
9	Response time	B	0.80%	R	$\sqrt{3}$	1	1	0.50%	0.50%	∞
10	Integration time	B	5.00%	R	$\sqrt{3}$	1	1	2.90%	2.90%	∞
11	RF ambient	B	3.00%	R	$\sqrt{3}$	1	1	1.70%	1.70%	∞
12	Probe positioned mech. restrictions	B	0.40%	R	$\sqrt{3}$	1	1	0.20%	0.20%	∞
13	Probe positioning with respect to phantom shell	B	2.90%	R	$\sqrt{3}$	1	1	1.70%	1.70%	∞
14	Max.SAR evaluation	B	3.90%	R	$\sqrt{3}$	1	1	2.30%	2.30%	∞
Test Sample Related										
15	Test sample positioning	A	1.86%	N	1	1	1	1.86%	1.86%	∞
16	Device holder uncertainty	A	1.70%	N	1	1	1	1.70%	1.70%	∞
17	Drift of output power	B	5.00%	R	$\sqrt{3}$	1	1	2.90%	2.90%	∞
Phantom and Set-up										
18	Phantom uncertainty	B	4.00%	R	$\sqrt{3}$	1	1	2.30%	2.30%	∞
19	Liquid conductivity (target)	B	5.00%	R	$\sqrt{3}$	0.64	0.43	1.80%	1.20%	∞
20	Liquid conductivity (meas.)	A	0.50%	N	1	0.64	0.43	0.32%	0.26%	∞
21	Liquid permittivity (target)	B	5.00%	R	$\sqrt{3}$	0.64	0.43	1.80%	1.20%	∞
22	Liquid permittivity (meas.)	A	0.16%	N	1	0.64	0.43	0.10%	0.07%	∞
Combined standard uncertainty		$u_c = \sqrt{\sum_{i=1}^{22} c_i^2 u_i^2}$		/	/	/	/	9.79%	9.67%	∞
Expanded uncertainty (confidence interval of 95 %)		$u_e = 2u_c$		R	K=2	/	/	19.57%	19.34%	∞



System Check Uncertainty										
No.	Error Description	Type	Uncertainty Value	Probably Distribution	Div.	(Ci) 1g	(Ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)	Degree of freedom
Measurement System										
1	Probe calibration	B	6.0%	N	1	1	1	6.0%	6.0%	∞
2	Axial isotropy	B	4.70%	R	$\sqrt{3}$	0.7	0.7	1.90%	1.90%	∞
3	Hemispherical isotropy	B	9.60%	R	$\sqrt{3}$	0.7	0.7	3.90%	3.90%	∞
4	Boundary Effects	B	1.00%	R	$\sqrt{3}$	1	1	0.60%	0.60%	∞
5	Probe Linearity	B	4.70%	R	$\sqrt{3}$	1	1	2.70%	2.70%	∞
6	Detection limit	B	1.00%	R	$\sqrt{3}$	1	1	0.60%	0.60%	∞
7	RF ambient conditions-noise	B	0.00%	R	$\sqrt{3}$	1	1	0.00%	0.00%	∞
8	RF ambient conditions-reflection	B	0.00%	R	$\sqrt{3}$	1	1	0.00%	0.00%	∞
9	Response time	B	0.80%	R	$\sqrt{3}$	1	1	0.50%	0.50%	∞
10	Integration time	B	5.00%	R	$\sqrt{3}$	1	1	2.90%	2.90%	∞
11	RF ambient	B	3.00%	R	$\sqrt{3}$	1	1	1.70%	1.70%	∞
12	Probe positioned mech. restrictions	B	0.40%	R	$\sqrt{3}$	1	1	0.20%	0.20%	∞
13	Probe positioning with respect to phantom shell	B	2.90%	R	$\sqrt{3}$	1	1	1.70%	1.70%	∞
14	Max.SAR evaluation	B	3.90%	R	$\sqrt{3}$	1	1	2.30%	2.30%	∞
System validation source-dipole										
15	Deviation of experimental dipole from numerical dipole	A	1.58%	N	1	1	1	1.58%	1.58%	∞
16	Dipole axis to liquid distance	A	1.35%	N	1	1	1	1.35%	1.35%	∞
17	Input power and SAR drift	B	4.00%	R	$\sqrt{3}$	1	1	2.30%	2.30%	∞
Phantom and Set-up										
18	Phantom uncertainty	B	4.00%	R	$\sqrt{3}$	1	1	2.30%	2.30%	∞
20	Liquid conductivity (meas.)	A	0.50%	N	1	0.64	0.43	0.32%	0.26%	∞
22	Liquid cpermittivity (meas.)	A	0.16%	N	1	0.64	0.43	0.10%	0.07%	∞
Combined standard uncertainty		$u_c = \sqrt{\sum_{i=1}^{22} c_i^2 u_i^2}$		/	/	/	/	8.80%	8.79%	∞
Expanded uncertainty (confidence interval of 95 %)		$u_e = 2u_c$		R	K=2	/	/	17.59%	17.58%	∞

## 6. SAR Measurements System Configuration

### 6.1. SAR Measurement Set-up

The DASY5 system for performing compliance tests consists of the following items:

A standard high precision 6-axis robot (Stäubli RX family) with controller and software. An arm extension for accommodating the data acquisition electronics (DAE).

A dosimetric probe, i.e. an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.

A data acquisition electronic (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.

A unit to operate the optical surface detector which is connected to the EOC.

The Electro-Optical Coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the DASY5 measurement server.

The DASY5 measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. A computer operating Windows 2003.

DASY5 software and SEMCAD data evaluation software.

Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.

The generic twin phantom enabling the testing of left-hand and right-hand usage.

The device holder for handheld Mobile Phones.

Tissue simulating liquid mixed according to the given recipes.

System validation dipoles allowing to validate the proper functioning of the system.



## 6.2. DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe EX3DV4 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.

### ● Probe Specification

Construction Symmetrical design with triangular core  
 Interleaved sensors  
 Built-in shielding against static charges  
 PEEK enclosure material (resistant to organic solvents, e.g., DGBE)

Calibration ISO/IEC 17025 calibration service available.

Frequency 10 MHz to 10 GHz;  
 Linearity:  $\pm 0.2$  dB (30 MHz to 10 GHz)

Directivity  $\pm 0.1$  dB in TSL (rotation around probe axis)  
 $\pm 0.3$  dB in TSL (rotation normal to probe axis)

Dynamic Range 10  $\mu$ W/g to > 100 mW/g;  
 Linearity:  $\pm 0.2$  dB

Dimensions Overall length: 337 mm (Tip: 20 mm)  
 Tip diameter: 2.5 mm (Body: 12 mm)  
 Distance from probe tip to dipole centers: 2.0 mm

Application General dosimetry up to 10 GHz  
 Dosimetry in strong gradient fields  
 Compliance tests of Mobile Phones

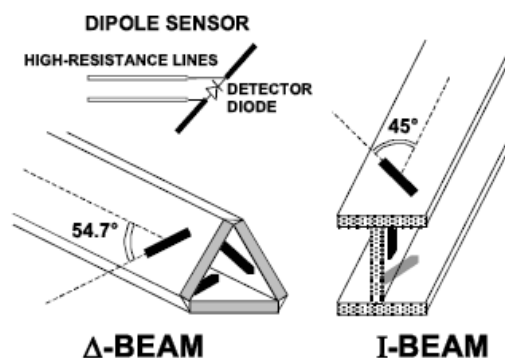
Compatibility DASY3, DASY4, DASY52 SAR and higher, EASY4/MRI



### ● Isotropic E-Field Probe

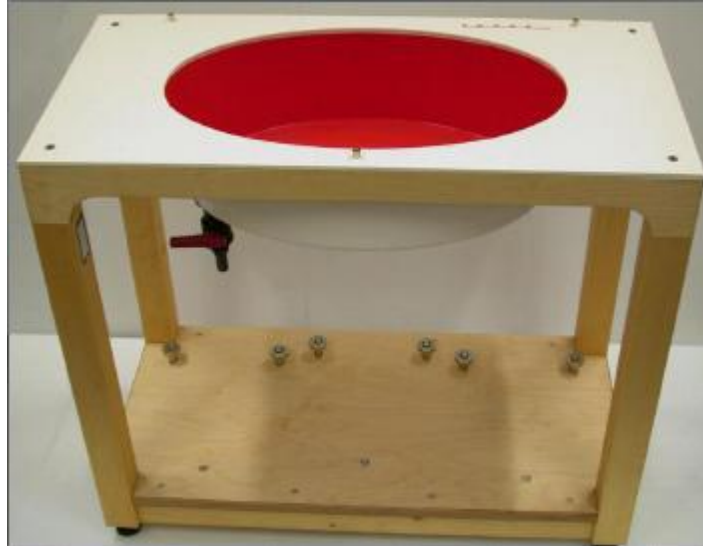
The isotropic E-Field probe has been fully calibrated and assessed for isotropicity, and boundary effect within a controlled environment. Depending on the frequency for which the probe is calibrated the method utilized for calibration will change.

The E-Field probe utilizes a triangular sensor arrangement as detailed in the diagram below:



### 6.3. Phantoms

Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue-simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.



ELI4 Phantom

### 6.4. Device Holder

The device was placed in the device holder (illustrated below) that is supplied by SPEAG as an integral part of the DASY system.

The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.



Device holder supplied by SPEAG

## 7. SAR Test Procedure

### 7.1. Scanning Procedure

The DASY5 installation includes predefined files with recommended procedures for measurements and validation. They are read-only document files and destined as fully defined but unmeasured masks. All test positions (head or body-worn) are tested with the same configuration of test steps differing only in the grid definition for the different test positions.

The “reference” and “drift” measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the DUT’s output power and should vary max.  $\pm 5\%$ .

The “surface check” measurement tests the optical surface detection system of the DASY5 system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above  $\pm 0.1\text{mm}$ ). To prevent wrong results tests are only executed when the liquid is free of air bubbles. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe (It does not depend on the surface reflectivity or the probe angle to the surface within  $\pm 30^\circ$ .)

#### Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values before running a detailed measurement around the hot spot. Before starting the area scan a grid spacing of 15 mm x 15 mm is set. During the scan the distance of the probe to the phantom remains unchanged. After finishing area scan, the field maxima within a range of 2 dB will be ascertained.

#### Zoom Scan

After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1g or 10g) using a 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the “Not a knot” condition (in x, y, and z directions). The volume was then integrated with the trapezoidal algorithm.

#### Spatial Peak Detection

The procedure for spatial peak SAR evaluation has been implemented and can determine values of masses of 1g and 10g, as well as for user-specific masses. The DASY5 system allows evaluations that combine measured data and robot positions, such as:

- maximum search
- extrapolation
- boundary correction
- peak search for averaged SAR

During a maximum search, global and local maxima searches are automatically performed in 2-D after each Area Scan measurement with at least 6 measurement points. It is based on the evaluation of the local SAR gradient calculated by the Quadratic Shepard’s method. The algorithm will find the global maximum and all local maxima within -2 dB of the global maxima for all SAR distributions.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. Several measurements at different distances are necessary for the extrapolation. Extrapolation routines require at least 10 measurement points in 3-D space.

They are used in the Zoom Scan to obtain SAR values between the lowest measurement points and the inner phantom surface. The routine uses the modified Quadratic Shepard’s method for extrapolation.

A Z-axis scan measures the total SAR value at the x-and y-position of the maximum SAR value found during the cube scan. The probe is moved away in z-direction from the bottom of the SAM phantom in 5mm steps.

**Table 1: Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v04**

		≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface		5 mm ± 1 mm	$\frac{1}{2} \cdot \delta \cdot \ln(2)$ mm ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location		30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: $\Delta x_{Area}$ , $\Delta y_{Area}$		≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
		When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	
Maximum zoom scan spatial resolution: $\Delta x_{Zoom}$ , $\Delta y_{Zoom}$		≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$	≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$ : between 1 <sup>st</sup> two points closest to phantom surface	≤ 4 mm  3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$ : between subsequent points	≤ 1.5 · $\Delta z_{Zoom}(n-1)$ mm
Minimum zoom scan volume	x, y, z	≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm
Note: $\delta$ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see IEEE Std 1528-2013 for details. * When zoom scan is required and the <i>reported</i> SAR from the <i>area scan based 1-g SAR estimation</i> procedures of KDB Publication 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.			

## 7.2. Data Storage and Evaluation

### Data Storage

The DASY5 software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension ".DA4". The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [mW/g], [mW/cm<sup>2</sup>], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

### Data Evaluation

The SEMCAD software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe parameters:	Sensitivity:	Normi, ai0, ai1, ai2
	Conversion factor:	ConvFi
	Diode compression point:	Dcpi
Device parameters:	Frequency:	f
	Crest factor:	cf
Media parameters:	Conductivity:	σ
	Density:	ρ

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY5 components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

Vi:	compensated signal of channel ( i = x, y, z )
Ui:	input signal of channel ( i = x, y, z )
cf:	crest factor of exciting field (DASY parameter)
dcp <sub>i</sub> :	diode compression point (DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

$$E - \text{fieldprobes} : \quad E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

$$H - \text{fieldprobes} : \quad H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f}$$

Vi:	compensated signal of channel ( i = x, y, z )
Norm <sub>i</sub> :	sensor sensitivity of channel ( i = x, y, z ), [mV/(V/m) <sup>2</sup> ] for E-field Probes
ConvF:	sensitivity enhancement in solution
aij:	sensor sensitivity factors for H-field probes
f:	carrier frequency [GHz]
E <sub>i</sub> :	electric field strength of channel i in V/m
H <sub>i</sub> :	magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1'000}$$

SAR: local specific absorption rate in mW/g  
Etot: total field strength in V/m  
 $\sigma$ : conductivity in [mho/m] or [Siemens/m]  
 $\rho$ : equivalent tissue density in g/cm<sup>3</sup>

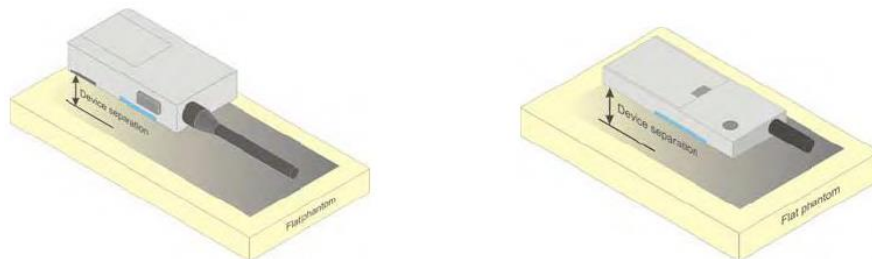
Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.



## 8. Position of the wireless device in relation to the phantom

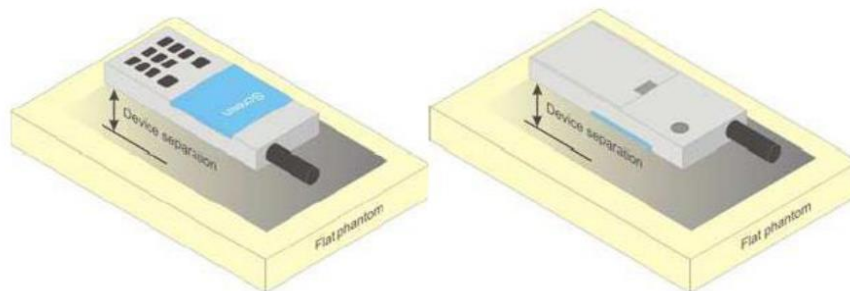
### 8.1. Front-of-face

A typical example of a front-of-face device is a two-way radio that is held at a distance from the face of the user when transmitting. In these cases the device under test shall be positioned at the distance to the phantom surface that corresponds to the intended use as specified by the manufacturer in the user instructions. If the intended use is not specified, a separation distance of 25 mm between the phantom surface and the device shall be used.



### 8.2. Body Position

A typical example of a body-worn device is a mobile phone, wireless enabled PDA or other battery operated wireless device with the ability to transmit while mounted on a person's body using a carry accessory approved by the wireless device manufacturer.



## 9. System Verification

### 9.1. Tissue Dielectric Parameters

It's satisfying the latest tissue dielectric parameters requirements proposed by the KDB865664 D01.

Targets for tissue simulating liquid

Tissue dielectric parameters for head and body				
Target Frequency	Head		Body	
(MHz)	$\epsilon_r$	$\sigma$ (s/m)	$\epsilon_r$	$\sigma$ (s/m)
450	43.50	0.87	56.70	0.94

#### CheckResult:

Dielectric performance of Head tissue simulating liquid									
Frequency (MHz)	$\epsilon_r$		$\sigma$ (s/m)		Delta ( $\epsilon_r$ )	Delta ( $\sigma$ )	Limit	Temp (°C)	Date
	Target	Measured	Target	Measured					
450	43.50	44.49	0.87	0.86	2.28%	-1.26%	±5%	22	2018-07-25

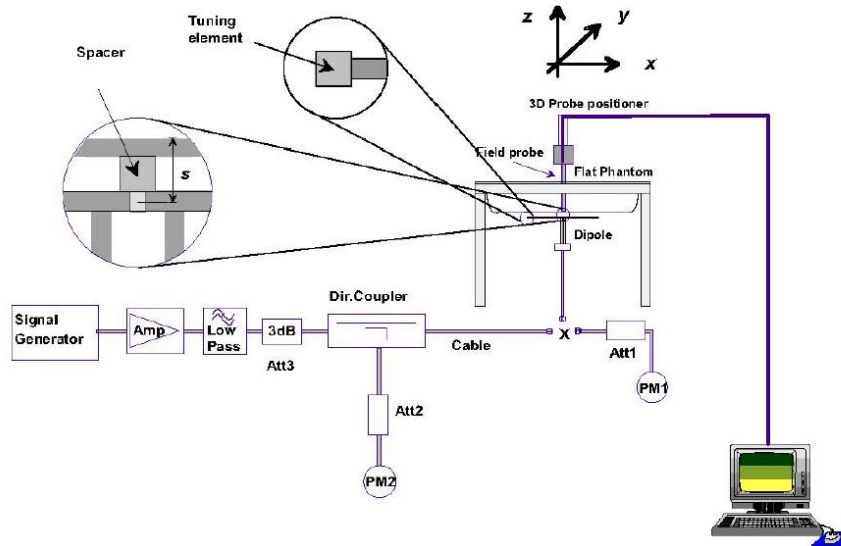
Dielectric performance of Body tissue simulating liquid									
Frequency (MHz)	$\epsilon_r$		$\sigma$ (s/m)		Delta ( $\epsilon_r$ )	Delta ( $\sigma$ )	Limit	Temp (°C)	Date
	Target	Measured	Target	Measured					
450	56.70	56.11	0.94	0.96	-1.05%	2.23%	±5%	22	2018-07-26

### 9.2. SAR System Verification

The purpose of the system check is to verify that the system operates within its specifications at the device test frequency. The system check is simple check of repeatability to make sure that the system works correctly at the time of the compliance test;

System check results have to be equal or near the values determined during dipole calibration with the relevant liquids and test system ( $\pm 10\%$ ).

System check is performed regularly on all frequency bands where tests are performed with the DASY5 system.



System Performance Check Setup



Photo of Dipole Setup

**Check Result:**

Head											
Frequency (MHz)	1g SAR			10g SAR			Delta (1g)	Delta (10g)	Limit	Temp (°C)	Date
	Target 1W	Normalize to 1W	Measured 250mW	Target 1W	Normalize to 1W	Measured 250mW					
450	4.48	4.64	1.16	3.00	3.09	0.77	3.57%	3.07%	±10%	22	2018-07-25

Body											
Frequency (MHz)	1g SAR			10g SAR			Delta (1g)	Delta (10g)	Limit	Temp (°C)	Date
	Target 1W	Normalize to 1W	Measured 250mW	Target 1W	Normalize to 1W	Measured 250mW					
450	4.47	4.88	1.22	3.01	3.30	0.83	9.17%	9.77%	±10%	22	2018-07-26

Note:

1. the graph results see follow.

## Plots of System Performance Check

### SystemPerformanceCheck-Head 450MHz

DUT: Dipole 450 MHz; Type: D450V3; Serial: 1102

Date: 2018-07-25

Communication System: UID 0, A-CW (0); Frequency: 450 MHz

Medium parameters used:  $f = 450$  MHz;  $\sigma = 0.859$  S/m;  $\epsilon_r = 44.492$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

#### DASY Configuration:

- Probe: EX3DV4 - SN7494; ConvF(11.7, 11.7, 11.7); Calibrated: 2/26/2018;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection),  $z = 1.0, 31.0$
- Electronics: DAE4 Sn1549; Calibrated: 4/25/2018
- Phantom: ELI V8.0 ; Type: QD OVA 004 AA ; Serial: 2078
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

**Head/d=15mm, Pin=250mW/Area Scan (81x81x1):** Interpolated grid:  $dx=1.500$  mm,  $dy=1.500$  mm

Maximum value of SAR (interpolated) = 1.60 W/kg

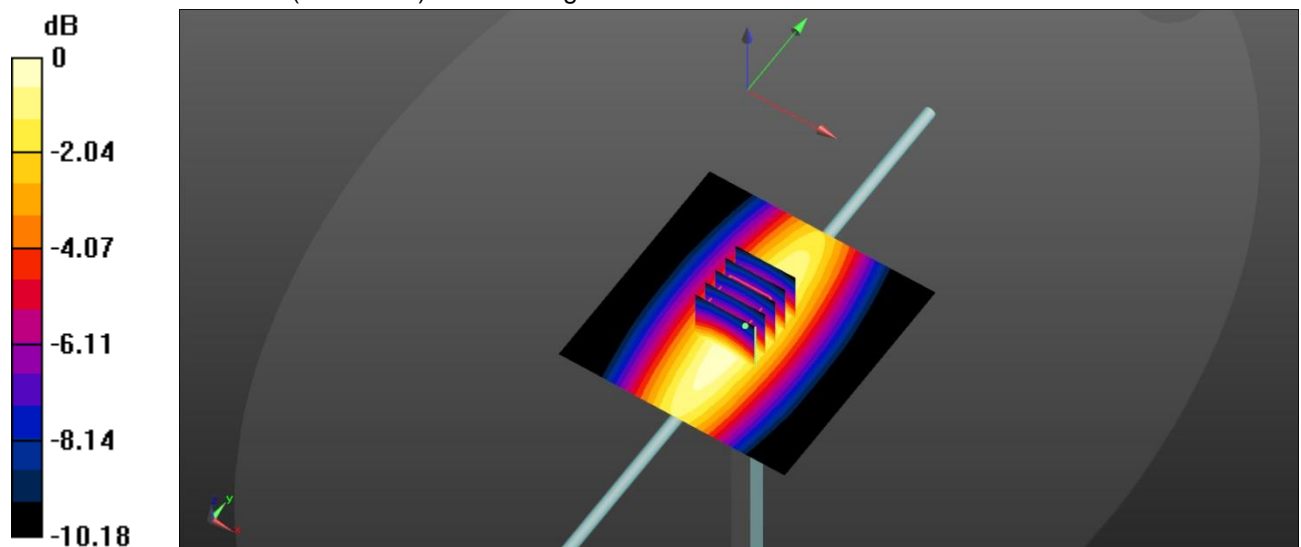
**Head/d=15mm, Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8$ mm,  $dy=8$ mm,  $dz=5$ mm

Reference Value = 44.31 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 1.85 W/kg

**SAR(1 g) = 1.16 W/kg; SAR(10 g) = 0.773 W/kg**

Maximum value of SAR (measured) = 1.58 W/kg



0 dB = 1.58 W/kg = 1.99 dBW/kg

**SystemPerformanceCheck-Body 450MHz**

DUT: Dipole 450 MHz; Type: D450V3; Serial: 1102

Date: 2018-07-26

Communication System: UID 0, A-CW (0); Frequency: 450 MHz

Medium parameters used:  $f = 450 \text{ MHz}$ ;  $\sigma = 0.961 \text{ S/m}$ ;  $\epsilon_r = 56.106$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

**DASY Configuration:**

- Probe: EX3DV4 - SN7494; ConvF(11.87, 11.87, 11.87); Calibrated: 2/26/2018;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection),  $z = 1.0, 31.0$
- Electronics: DAE4 Sn1549; Calibrated: 4/25/2018
- Phantom: ELI V8.0 ; Type: QD OVA 004 AA ; Serial: 2078
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

**Head/d=15mm, Pin=250mW/Area Scan (51x121x1):** Interpolated grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$

Maximum value of SAR (interpolated) = 1.67 W/kg

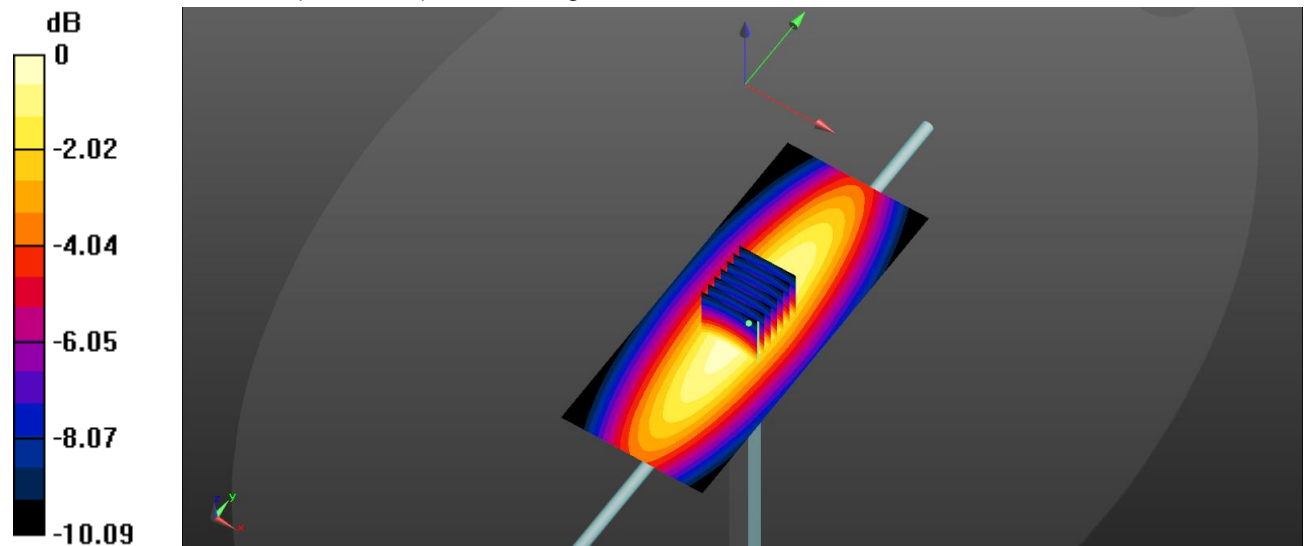
**Head/d=15mm, Pin=250mW /Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 42.66 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 2.03 W/kg

**SAR(1 g) = 1.22 W/kg; SAR(10 g) = 0.826 W/kg**

Maximum value of SAR (measured) = 1.72 W/kg



0 dB = 1.72 W/kg = 2.36 dBW/kg

## 10. SAR Exposure Limits

Type Exposure	Limit (W/kg)	
	General Population / Uncontrolled Exposure Environment	Occupational / Controlled Exposure Environment
Spatial Average SAR (whole body)	0.08	0.4
Spatial Peak SAR (1g cube tissue for head and trunk)	1.6	8.0
Spatial Peak SAR (10g for limb)	4.0	20.0

Population/Uncontrolled Environments: are defined as locations where there is the exposure of individual who have no knowledge or control of their exposure.

Occupational/Controlled Environments: are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure (i.e. as a result of employment or occupation).

## 11. Radiated Power Measurement Results

PMR				
Mode	Channel Separation	Frequency		Radiated power (dBm)
		Channel	MHz	
Analog	12.5KHz	CH4	462.6375	25.67
		CH11	467.6375	24.48
		CH19	462.6500	25.75

## 12. Maximum Tune-up Limit

This device operates using the following maximum output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB publication 447498 D01

PMR			
Mode	Channel Separation	Operation Frequency Range (MHz)	Maximum tune up power (dBm)
Analog	12.5 KHz	462.5625MHz~462.7125MHz	26.00
		467.5625MHz~467.7125MHz	25.00
		462.5500MHz~462.7250MHz	26.00



### 13. SAR Measurement Results

Front-of-face											
Mode	Channel Separation	Frequency		Conducted Power (dBm)	Tune up limit (dBm)	Tune up scaling factor	Power Drift(dB )	Measured SAR(1g)	Report SAR(1g)	50% Duty factor SAR	Test Plot
		CH	MHz					(W/kg)	(W/kg)	(W/kg)	
Analog	12.5KHz	CH4	462.6375	25.67	26.00	1.04	-0.13	0.847	0.881	<b>0.441</b>	AF
		CH11	467.6375	24.48	25.00	1.05	-0.20	0.621	0.652	0.326	-
		CH19	462.6500	25.75	26.00	1.06	-0.15	0.709	0.752	0.376	-

Body-worn (Rear)											
Mode	Channel Separation	Frequency		Conducted Power (dBm)	Tune up limit (dBm)	Tune up scaling factor	Power Drift(dB)	Measured SAR(1g)	Report SAR(1g)	50% Duty factor SAR	Test Plot
		CH	MHz					(W/kg)	(W/kg)	(W/kg)	
Analog	12.5KHz	CH4	462.6375	25.67	26.00	1.04	-0.16	2.020	2.101	<b>1.051</b>	AB
		CH11	467.6375	24.48	25.00	1.05	-0.13	1.360	1.428	0.714	-
		CH19	462.6500	25.75	26.00	1.06	-0.15	1.750	1.855	0.928	-

Note:

1. The value with blue color is the maximum SAR Value of each test band.
2. Batteries are fully charged at the beginning of the SAR measurements
3. The Body-worn SAR evaluation was performed with the Leather Case body-worn accessory attached to the DUT and touching the outer surface of the planar phantom

### SAR Test Data Plots

Test Position: Front-of-face

Test Plot: AF

Date: 2018-07-25

Communication System: UID 0, A-CW (0); Frequency: 462.637 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 462.637$  MHz;  $\sigma = 0.87$  S/m;  $\epsilon_r = 44.258$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

#### DASY5 Configuration:

- Probe: EX3DV4 - SN7494; ConvF(11.7, 11.7, 11.7) @ 462.637 MHz; Calibrated: 2/26/2018
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1549; Calibrated: 4/25/2018
- Phantom: ELI V8.0 ; Type: QD OVA 004 AA ; Serial: 2078
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

**Front-of-face/Procedure/Area Scan (61x111x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.993 W/kg

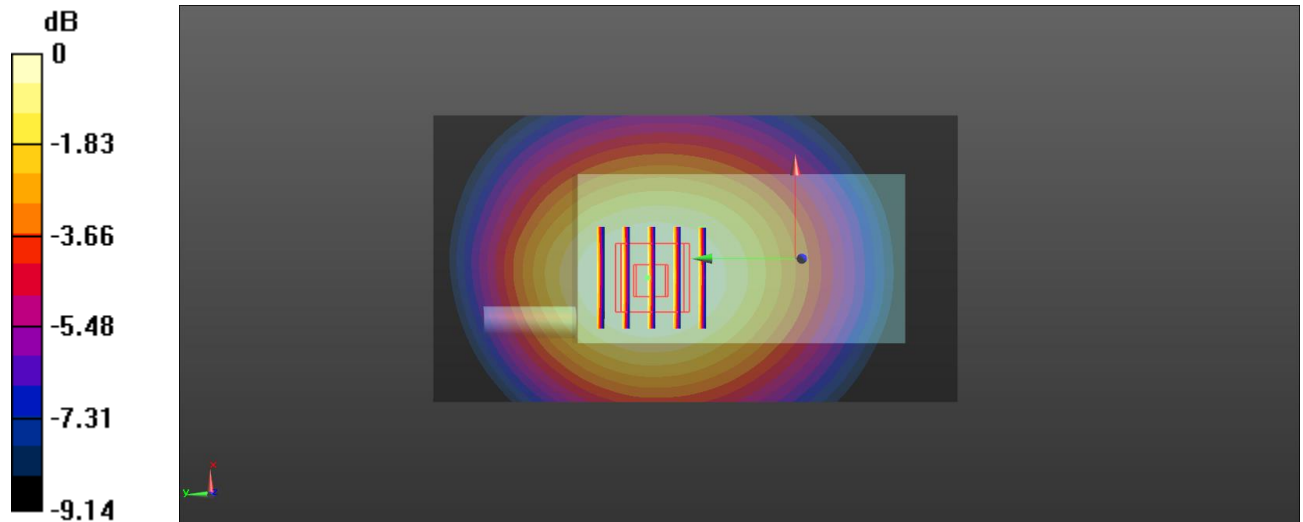
**Front-of-face/Procedure/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 29.51 V/m; Power Drift = -0.13 dB

Peak SAR (extrapolated) = 1.14 W/kg

**SAR(1 g) = 0.847 W/kg; SAR(10 g) = 0.610 W/kg**

Maximum value of SAR (measured) = 0.896 W/kg



0 dB = 0.896 W/kg = -0.48 dBW/kg

Test Position: Body-worn

Test Plot: AB

Date: 2018-07-26

Communication System: UID 0, A-CW (0); Frequency: 462.637 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated):  $f = 462.637 \text{ MHz}$ ;  $\sigma = 0.973 \text{ S/m}$ ;  $\epsilon_r = 55.63$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

**DASY5 Configuration:**

- Probe: EX3DV4 - SN7494; ConvF(11.87, 11.87, 11.87) @ 462.637 MHz; Calibrated: 2/26/2018
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1549; Calibrated: 4/25/2018
- Phantom: ELI V8.0 ; Type: QD OVA 004 AA ; Serial: 2078
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

**Body Worn/Procedure/Area Scan (61x111x1):** Interpolated grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$

Info: [Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (interpolated) = 2.45 W/kg

**Body Worn/Procedure/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

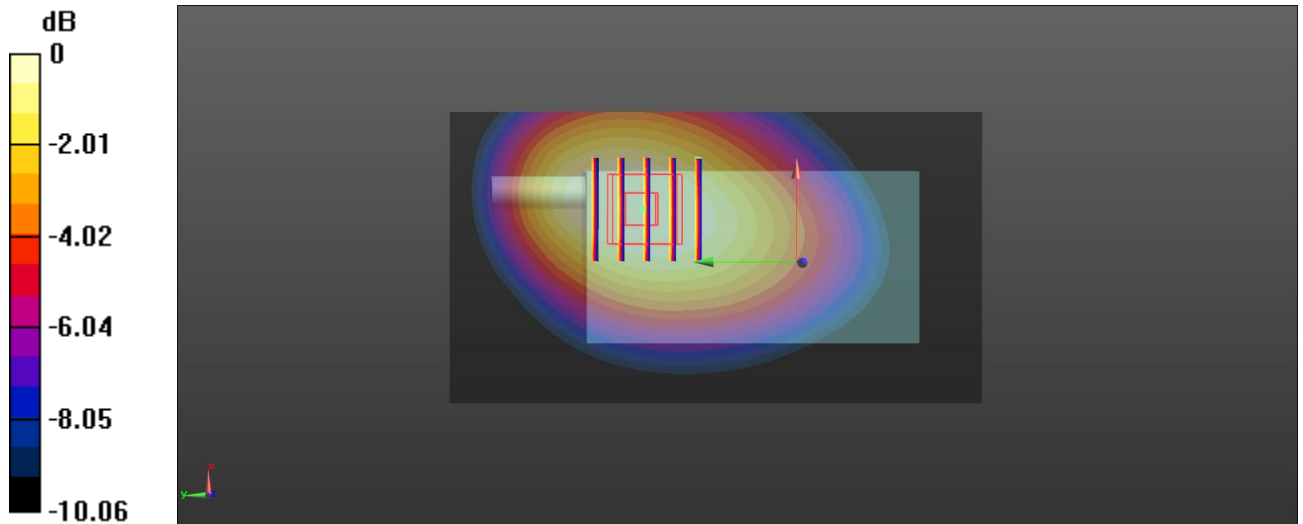
Reference Value = 39.20 V/m; Power Drift = -0.16 dB

Peak SAR (extrapolated) = 2.85 W/kg

**SAR(1 g) = 2.02 W/kg; SAR(10 g) = 1.4 W/kg**

Info: [Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 2.16 W/kg



0 dB = 2.16 W/kg = 3.34 dBW/kg

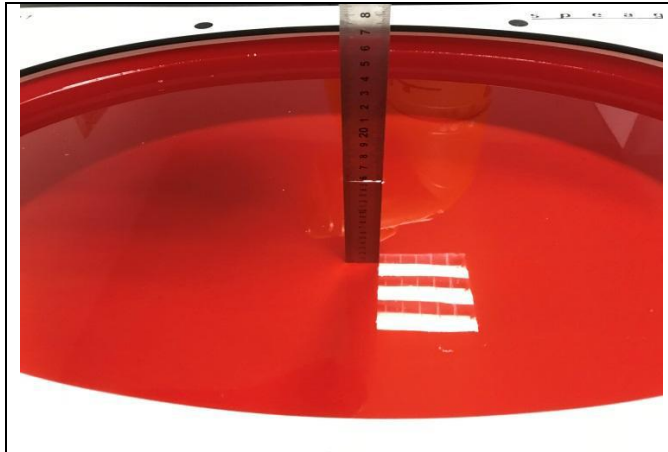
## 14. SAR Measurement Variability

In accordance with published RF Exposure KDB 865664 D01 SAR measurement 100 MHz to 6 GHz. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

- 1) Repeated measurement is not required when the original highest measured SAR is  $<0.8$  or  $2$  W/kg (1-g or 10-g respectively); steps 2) through 4) do not apply.
- 2) When the original highest measured SAR is  $\geq 0.8$  or  $2$  W/kg (1-g or 10-g respectively), repeat that measurement once.
- 3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is  $> 1.20$  or when the original or repeated measurement is  $\geq 1.45$  or  $3.6$  W/kg (~ 10% from the 1-g or 10-g respective SAR limit).
- 4) Perform a third repeated measurement only if the original, first, or second repeated measurement is  $\geq 1.5$  or  $3.75$  W/kg (1-g or 10-g respectively) and the ratio of largest to smallest SAR for the original, first and second repeated measurements is  $> 1.20$ .

Mode	Test Position	Frequency		Highest Measured SAR (W/kg)	First Repeated		Second Repeated	
		CH	MHz		Measured SAR(W/kg)	Largest to Smallest SAR Ratio	Measured SAR(W/kg)	Largest to Smallest SAR Ratio
Analog (12.5KHz)	Rear	CH4	462.6375	2.02	2.00	1.01	N/A	N/A

### 15. Test Setup Photos



Liquid depth in the ELI Phantom(450MHz)



Front-of-face(25mm)



Body-worn (0mm)

### 16. External and Internal Photos of the EUT

. Please refer to the test report No. TRE1807016801

-----End of Report-----