

# FCC SAR Test Report

Report No. : SA180808W001  
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 Address : 606, GODOWHADONG, KYUNGGI TECHONO PARK, 1271-11, SA-DONG, ANSAN-SI, KYUNGGI-DO  
 Product : Wireless Headset  
 FCC ID : WF2DW-800H  
 Brand : Freemate  
 Model No. : DW-800H  
 Standards : FCC 47 CFR Part 2 (2.1093) / IEEE C95.1:1992 / IEEE 1528:2013  
 KDB 865664 D01 v01r04 / KDB 865664 D02 v01r02 / KDB 447498 D01 v06  
 Sample Received Date : Aug. 08, 2018  
 Date of Testing : Aug. 10, 2018

**CERTIFICATION:** The above equipment have been tested by **BV 7LAYERS COMMUNICATIONS TECHNOLOGY (SHENZHEN) CO. LTD.**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample’s SAR characteristics under the conditions specified in this report. It should not be reproduced except in full, without the written approval of our laboratory. The client should not use it to claim product certification, approval, or endorsement by A2LA or any government agencies.

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## Table of Contents

Release Control Record .....	3
<b>1. Summary of Maximum SAR Value .....</b>	<b>4</b>
<b>2. Description of Equipment Under Test .....</b>	<b>5</b>
<b>3. SAR Measurement System .....</b>	<b>6</b>
3.1 Definition of Specific Absorption Rate (SAR) .....	6
3.2 COMOSAR System.....	6
3.2.1 Measurement System Diagram .....	6
3.2.2 Robot.....	7
3.2.3 E-Field Probes .....	8
3.2.4 Phantoms .....	9
3.2.5 Device Holder.....	10
3.2.6 System Validation Dipoles.....	11
3.2.7 Tissue Simulating Liquids.....	11
3.3 SAR System Verification .....	14
3.4 SAR Measurement Procedure .....	15
3.4.1 Area & Zoom Scan Procedure .....	15
3.4.2 Volume Scan Procedure.....	15
3.4.3 Power Drift Monitoring.....	16
3.4.4 Spatial Peak SAR Evaluation .....	16
3.4.5 SAR Averaged Methods.....	16
<b>4. SAR Measurement Evaluation .....</b>	<b>17</b>
4.1 EUT Configuration and Setting.....	17
4.2 EUT Testing Position .....	17
4.2.1 Head Exposure Conditions.....	17
4.2.2 Simultaneous Transmission Possibilities.....	18
4.3 Tissue Verification .....	19
4.4 System Validation.....	19
4.5 System Verification.....	19
4.6 Maximum Output Power.....	20
4.6.1 Maximum Conducted Power .....	20
4.6.2 Measured Conducted Power Result.....	20
4.7 SAR Testing Results .....	21
4.7.1 SAR Test Reduction Considerations .....	21
4.7.2 SAR Results for Head Exposure Condition .....	21
4.7.3 Simultaneous Multi-band Transmission Evaluation .....	21
<b>5. Calibration of Test Equipment.....</b>	<b>22</b>
<b>6. Measurement Uncertainty.....</b>	<b>23</b>
<b>7. Information on the Testing Laboratories.....</b>	<b>24</b>
<b>Appendix A. SAR Plots of System Verification</b>	
<b>Appendix B. SAR Plots of SAR Measurement</b>	
<b>Appendix C. Calibration Certificate for Probe and Dipole</b>	
<b>Appendix D. Photographs of EUT and Setup</b>	



### Release Control Record

Report No.	Reason for Change	Date Issued
SA180808W001	Initial release	Sep. 10, 2018

## FCC SAR Test Report

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### 1. Summary of Maximum SAR Value

Equipment Class	Mode	Highest Reported Head SAR <sub>1g</sub> (W/kg)
DECT	DECT	0.04

**Note:**

1. The SAR limit (**Head: SAR<sub>1g</sub> 1.6 W/kg**) for general population / uncontrolled exposure is specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992

## 2. Description of Equipment Under Test

<b>EUT Type</b>	Wireless Headset
<b>FCC ID</b>	WF2DW-800H
<b>Brand Name</b>	Freemate
<b>Model Name</b>	DW-800H
<b>Serial Model Name</b>	DW-800, X500, X500H, DW-800M, X500M
<b>HW Version</b>	Rev0.1
<b>SW Version</b>	Ver1.0
<b>Tx Frequency Bands (Unit: MHz)</b>	DECT : 1921.536 ~ 1928.448
<b>Uplink Modulations</b>	DECT : GFSK
<b>Maximum Tune-up Conducted Power (Unit: dBm)</b>	DECT : 17.0
<b>Antenna Type</b>	Fixed Internal Antenna
<b>EUT Stage</b>	Identical Prototype

**Note:**

1. The above EUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.

**List of Accessory:**

<b>Battery</b>	<b>Power Rating</b>	3.7Vdc, 370mAh, 1.369Wh
	<b>Type</b>	Li-ion

### **3. SAR Measurement System**

#### **3.1 Definition of Specific Absorption Rate (SAR)**

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person’s awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (ρ). The equation description is as below:

$$SAR = \frac{d}{dt} \left( \frac{dW}{dm} \right) = \frac{d}{dt} \left( \frac{dW}{\rho dv} \right)$$

SAR is expressed in units of Watts per kilogram (W/kg)

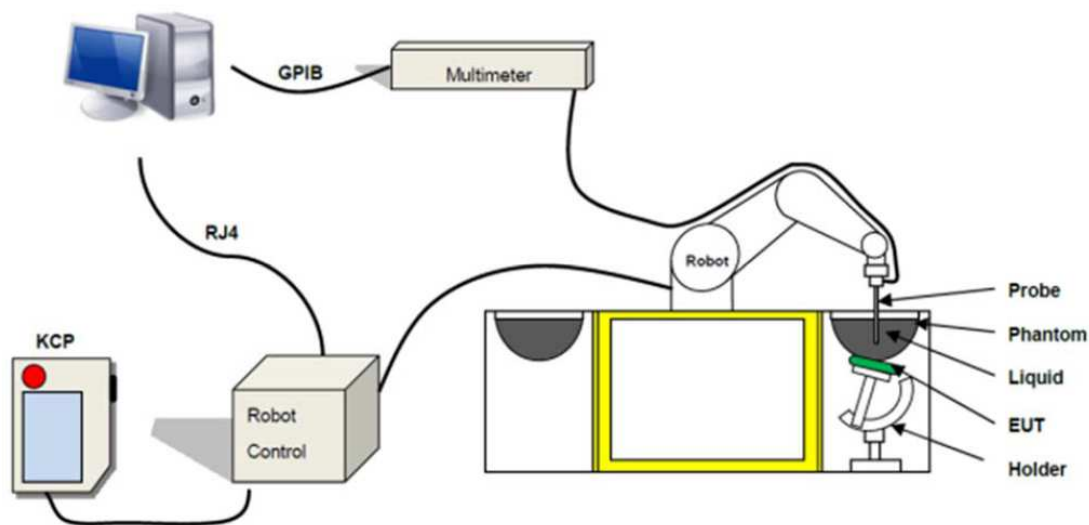
SAR measurement can be related to the electrical field in the tissue by

$$SAR = \frac{\sigma |E|^2}{\rho}$$

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength.

#### **3.2 COMOSAR System**

##### **3.2.1 Measurement System Diagram**



These measurements were performed with the automated near-field scanning system COMOSAR from SATIMO. The system is based on a high precision robot (working range: 850 mm), which positions the probes with a positional repeatability of better than ± 0.02 mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit.

## FCC SAR Test Report

The SAR measurements were conducted with dosimetric probe (manufactured by SATIMO), designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure described in SAR standard with accuracy of better than  $\pm 10\%$ . The spherical isotropy was evaluated with the procedure described in SAR standard and found to be better than  $\pm 0.25$  dB. The phantom used was the SAM Phantom as described in FCC supplement C, IEEE P1528.

### 3.2.2 Robot

The COMOSAR system uses the high precision robots from KUKA. For the 6-axis controller system, the robot controller version (KUKA-KRC2sr) from KUKA is used. The KUKA robot series have many features that are important for our application:

- High precision (repeatability  $\pm 0.02$  mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)



Fig-3.2 KUKA KR5

# FCC SAR Test Report

### 3.2.3 E-Field Probes

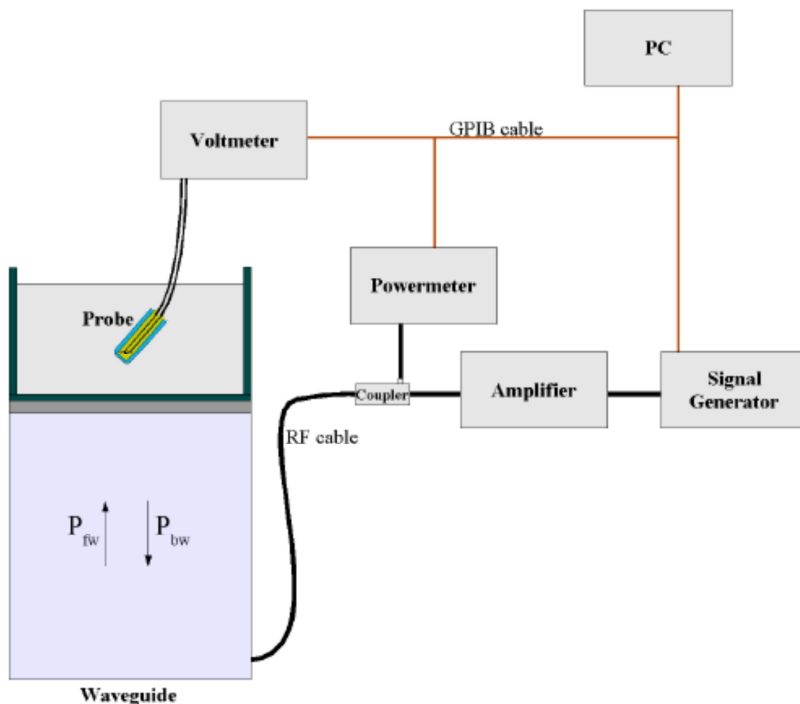
The SAR measurement is conducted with the dosimetric probe. The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency.



<b>Device Type</b>	COMOSAR DOSIMETRIC E FIELD PROBE
<b>Model</b>	SSE2
<b>Frequency</b>	100 MHz to 6 GHz
<b>Directivity</b>	±0.25 dB in brain tissue (rotation around probe axis) ±0.5 dB in brain tissue (rotation normal probe axis)
<b>Dynamic Range</b>	0.001W/kg to > 100W/kg
<b>Probe Linearity</b>	± 0.25 dB
<b>Dimensions</b>	Overall length: 330 mm Tip diameter: 2.5 mm Distance from probe tip to dipole centers: <1.5 mm

### E-Field Probe Calibration Process

Probe calibration is realized, in compliance with EN/IEC 62209-1/-2 and IEEE 1528 std, with CALISAR, SATIMO proprietary calibration system. The calibration is performed with the technique using reference waveguide.





## FCC SAR Test Report

$$SAR = \frac{4(P_{fw} - P_{bw})}{ab\sigma} \cos^2 \left( \pi \frac{y}{a} \right) e^{-(2\pi/\sigma)z}$$

Where :

- P<sub>fw</sub> = Forward Power
- P<sub>bw</sub> = Backward Power
- a and b = Waveguide Dimensions
- l = Skin Depth

Keithley configuration

Rate=Medium; Filter=ON; RDGS=10; FILTER TYPE=MOVING AVERAGE; RANGE AUTO

After each calibration, a SAR measurement performed on a validation dipole and compared with a NPL calibrated probe, to verify it.

The Calibration factors, CF(N), for the 3 sensors corresponding to dipole 1, dipole 2 and dipole 3 are:

$$CF(N) = SAR(N) / V_{lin}(N) \quad (N=1,2,3)$$


The linearized output voltage V<sub>lin</sub>(N) is obtained from the displayed output voltage V(N) using

$$V_{lin}(N) = V(N) * (1 + V(N) / DCP(N)) \quad N=1,2,3$$


Where the DCP is the dipole compression point in mV

### 3.2.4 Phantoms

The phantom developed by SATIMO is produced in accordance with the specified in the standards. It has been designed to fit the COMOSAR phantom tables and is delivered with a plastic cover to prevent liquid evaporation.


<b>Model</b>	SAM Phantom	
<b>Construction</b>	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching reference points with the robot.	
<b>Material</b>	The material is resistant to Glycol and offers high rigidity composite material based on fiberglass).	
<b>Shell Thickness</b>	2 ± 0.2 mm (6 ± 0.2 mm at ear point)	
<b>Dimensions</b>	Length: 1000 mm Width: 500 mm Height: 200 mm	
<b>Filling Volume</b>	approx. 27 liters	


## FCC SAR Test Report

<b>Model</b>	Elliptic Phantom	
<b>Construction</b>	Elliptic Phantom for compliance testing of handheld and body-mounted wireless devices. Elliptic Phantom is fully compatible with the IEC/EN 62209-2 standard and all known tissue simulating liquids. Elliptic Phantom 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 reference points.	
<b>Material</b>	The material is resistant to Glycol and offers high rigidity composite material based on fiberglass).	
<b>Shell Thickness</b>	2.0 ± 0.2 mm (bottom plate)	
<b>Dimensions</b>	Length: 600 mm Width: 400 mm Height: 200 mm	
<b>Filling Volume</b>	approx. 25 liters	

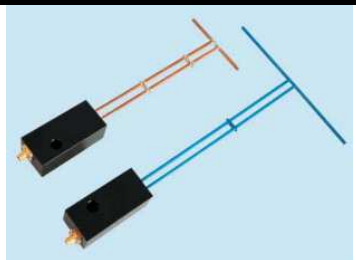
### 3.2.5 Device Holder

The positioning system is made of an extremely stable material, which ensures easy handling and reproducible positioning. It also allows correct positioning of the dipoles referenced by the IEEE, ANSI and IEC.

<b>Model</b>	Handset Positioning System	
<b>Material properties</b>	The positioning system is made of PETP. This material offers a low permittivity of 3.2 and low loss, with a loss tangent of 0.005 to minimize the influence of the DUT on measurement results.	
<b>Mechanical properties</b>	The positioning system developed by SATIMO allows a positioning resolution better than 1 mm. The system is fixed on a bottom rail "x axis" so that the positioning system can be quickly moved from the right to the left part of the phantom. In addition, it can be moved on a perpendicular "y axis" and the height can be adapted. The system is also composed of three rotation points for accurate positioning of the device's acoustical output.	
<b>Accuracy and precision</b>	A curved rail on the top part allows the fast switch from the cheek to the tilt position. The required 15° angle for the tilt position can be easily checked thanks to a printed scale on the curved rail with a tolerance of ± 1°	

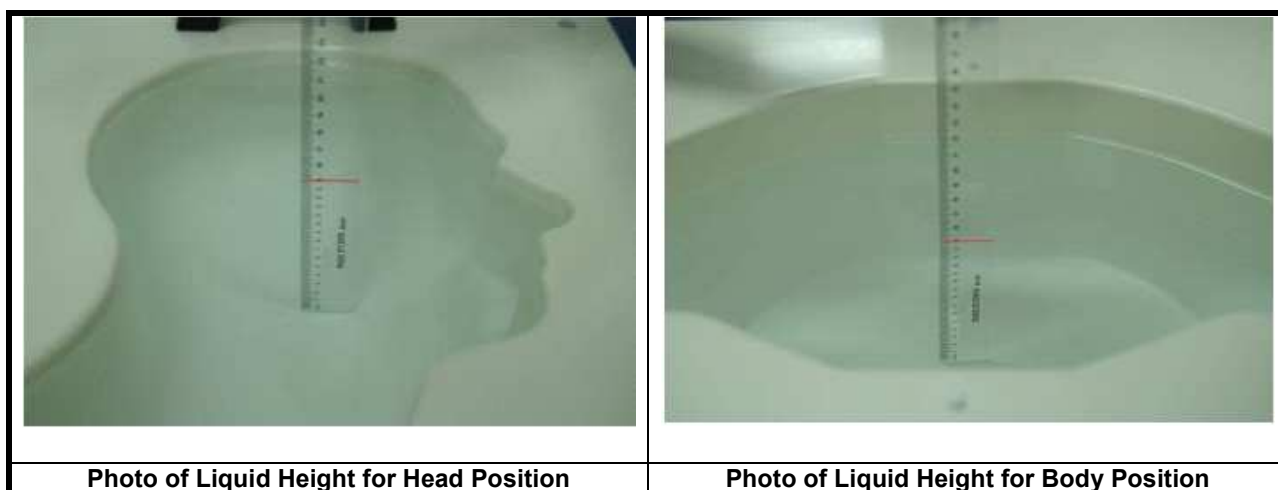
<b>Model</b>	Device Positioning System	
<b>Material properties</b>	The positioning system is made of PETP. This material offers a low permittivity of 3.2 and low loss, with a loss tangent of 0.005 to minimize the influence of the DUT on measurement results.	
<b>Mechanical properties</b>	2 rows of rail to cover easily the surface of the phantom. The fixing plate is perfectly adapted to larger devices, such as a PC which can be positioned in all configurations.	
<b>Accuracy and precision</b>	Graduated scale available on each axis. The DUT is fixed with a specific adaptable grip.	

### 3.2.6 System Validation Dipoles

<b>Model</b>	D-Serial	
<b>Construction</b>	Symmetrical dipole with $\lambda/4$ ablaun. Enables measurement of feed point impedance with NWA. Matched for use near flat phantoms filled with tissue simulating solutions.	
<b>Frequency</b>	300 MHz to 6000 MHz	
<b>Return Loss</b>	> 20 dB	
<b>Adaptation</b>	S11 < -20 dB in specified validation Position	

### 3.2.7 Tissue Simulating Liquids

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5% are listed in Table-3.1.



The dielectric properties of the head tissue simulating liquids are defined in IEEE 1528, and KDB 865664 D01 Appendix A. For the body tissue simulating liquids, the dielectric properties are defined in KDB 865664 D01 Appendix A. The dielectric properties of the tissue simulating liquids were verified prior to the SAR evaluation using a dielectric assessment kit and a network analyzer.

**Table-3.1 Targets of Tissue Simulating Liquid**

Frequency (MHz)	Target Permittivity	Range of $\pm 5\%$	Target Conductivity	Range of $\pm 5\%$
<b>For Head</b>				
750	41.9	39.8 ~ 44.0	0.89	0.85 ~ 0.93
835	41.5	39.4 ~ 43.6	0.90	0.86 ~ 0.95
900	41.5	39.4 ~ 43.6	0.97	0.92 ~ 1.02
1450	40.5	38.5 ~ 42.5	1.20	1.14 ~ 1.26
1640	40.3	38.3 ~ 42.3	1.29	1.23 ~ 1.35
1750	40.1	38.1 ~ 42.1	1.37	1.30 ~ 1.44
1800	40.0	38.0 ~ 42.0	1.40	1.33 ~ 1.47
1900	40.0	38.0 ~ 42.0	1.40	1.33 ~ 1.47
2000	40.0	38.0 ~ 42.0	1.40	1.33 ~ 1.47
2300	39.5	37.5 ~ 41.5	1.67	1.59 ~ 1.75
2450	39.2	37.2 ~ 41.2	1.80	1.71 ~ 1.89
2600	39.0	37.1 ~ 41.0	1.96	1.86 ~ 2.06
3500	37.9	36.0 ~ 39.8	2.91	2.76 ~ 3.06
5200	36.0	34.2 ~ 37.8	4.66	4.43 ~ 4.89
5300	35.9	34.1 ~ 37.7	4.76	4.52 ~ 5.00
5500	35.6	33.8 ~ 37.4	4.96	4.71 ~ 5.21
5600	35.5	33.7 ~ 37.3	5.07	4.82 ~ 5.32
5800	35.3	33.5 ~ 37.1	5.27	5.01 ~ 5.53
<b>For Body</b>				
750	55.5	52.7 ~ 58.3	0.96	0.91 ~ 1.01
835	55.2	52.4 ~ 58.0	0.97	0.92 ~ 1.02
900	55.0	52.3 ~ 57.8	1.05	1.00 ~ 1.10
1450	54.0	51.3 ~ 56.7	1.30	1.24 ~ 1.37
1640	53.8	51.1 ~ 56.5	1.40	1.33 ~ 1.47
1750	53.4	50.7 ~ 56.1	1.49	1.42 ~ 1.56
1800	53.3	50.6 ~ 56.0	1.52	1.44 ~ 1.60
1900	53.3	50.6 ~ 56.0	1.52	1.44 ~ 1.60
2000	53.3	50.6 ~ 56.0	1.52	1.44 ~ 1.60
2300	52.9	50.3 ~ 55.5	1.81	1.72 ~ 1.90
2450	52.7	50.1 ~ 55.3	1.95	1.85 ~ 2.05
2600	52.5	49.9 ~ 55.1	2.16	2.05 ~ 2.27
3500	51.3	48.7 ~ 53.9	3.31	3.14 ~ 3.48
5200	49.0	46.6 ~ 51.5	5.30	5.04 ~ 5.57
5300	48.9	46.5 ~ 51.3	5.42	5.15 ~ 5.69
5500	48.6	46.2 ~ 51.0	5.65	5.37 ~ 5.93
5600	48.5	46.1 ~ 50.9	5.77	5.48 ~ 6.06
5800	48.2	45.8 ~ 50.6	6.00	5.70 ~ 6.30

## FCC SAR Test Report

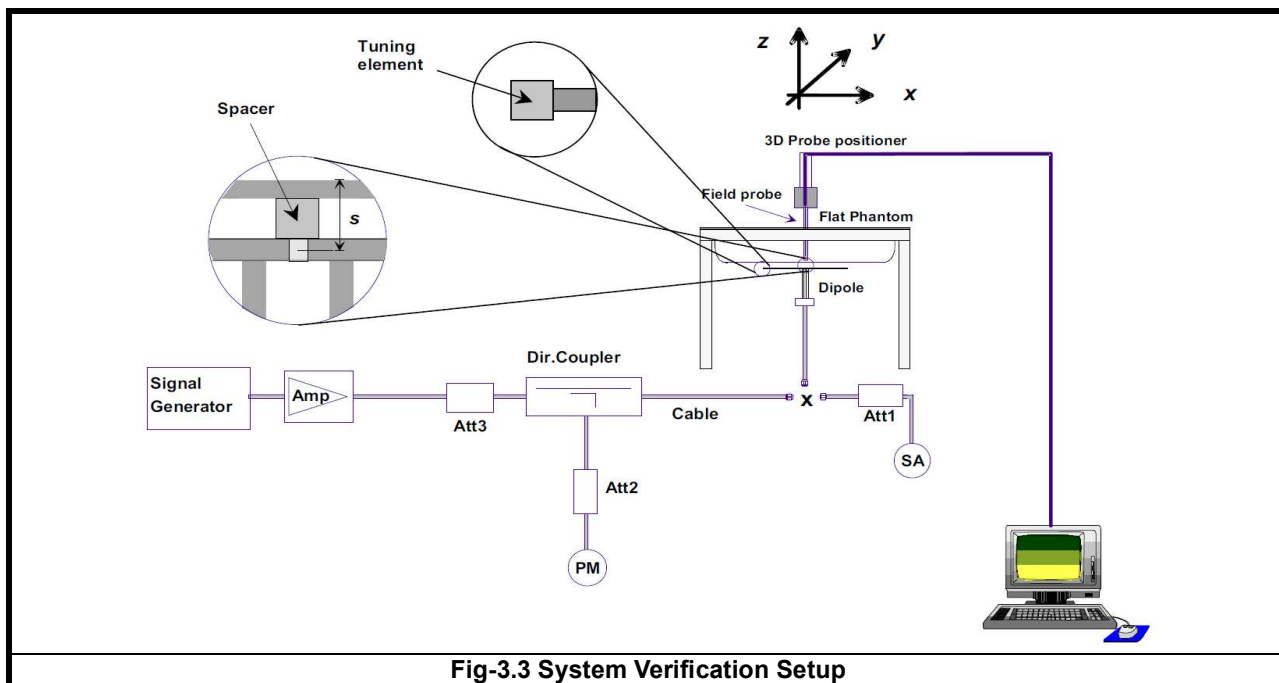
The following table gives the recipes for tissue simulating liquids.

**Table-3.2 Recipes of Tissue Simulating Liquid**

Tissue Type	Bactericide	DGBE	HEC	NaCl	Sucrose	Triton X-100	Water	Diethylene Glycol Mono-hexylether
H750	0.2	-	0.2	1.5	56.0	-	42.1	-
H835	0.2	-	0.2	1.5	57.0	-	41.1	-
H900	0.2	-	0.2	1.4	58.0	-	40.2	-
H1450	-	43.3	-	0.6	-	-	56.1	-
H1640	-	45.8	-	0.5	-	-	53.7	-
H1750	-	47.0	-	0.4	-	-	52.6	-
H1800	-	44.5	-	0.3	-	-	55.2	-
H1900	-	44.5	-	0.2	-	-	55.3	-
H2000	-	44.5	-	0.1	-	-	55.4	-
H2300	-	44.9	-	0.1	-	-	55.0	-
H2450	-	45.0	-	0.1	-	-	54.9	-
H2600	-	45.1	-	0.1	-	-	54.8	-
H3500	-	8.0	-	0.2	-	20.0	71.8	-
H5G	-	-	-	-	-	17.2	65.5	17.3
B750	0.2	-	0.2	0.8	48.8	-	50.0	-
B835	0.2	-	0.2	0.9	48.5	-	50.2	-
B900	0.2	-	0.2	0.9	48.2	-	50.5	-
B1450	-	34.0	-	0.3	-	-	65.7	-
B1640	-	32.5	-	0.3	-	-	67.2	-
B1750	-	31.0	-	0.2	-	-	68.8	-
B1800	-	29.5	-	0.4	-	-	70.1	-
B1900	-	29.5	-	0.3	-	-	70.2	-
B2000	-	30.0	-	0.2	-	-	69.8	-
B2300	-	31.0	-	0.1	-	-	68.9	-
B2450	-	31.4	-	0.1	-	-	68.5	-
B2600	-	31.8	-	0.1	-	-	68.1	-
B3500	-	28.8	-	0.1	-	-	71.1	-
B5G	-	-	-	-	-	10.7	78.6	10.7

### **3.3 SAR System Verification**

The system check verifies that the system operates within its specifications. It is performed daily or before every SAR measurement. The system check uses normal SAR measurements in the flat section of the phantom with a matched dipole at a specified distance. The system verification setup is shown as below.



**Fig-3.3 System Verification Setup**

The validation dipole is placed beneath the flat phantom with the specific spacer in place. The distance spacer is touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The spectrum analyzer measures the forward power at the location of the system check dipole connector. The signal generator is adjusted for the desired forward power at the dipole connector and the power meter is read at that level. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at power meter.

After system check testing, the SAR result will be normalized to 1W forward input power and compared with the reference SAR value derived from validation dipole certificate report. The deviation of system check should be within 10 %.

### 3.4 SAR Measurement Procedure

According to the SAR test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

- (a) Power reference measurement
- (b) Area scan
- (c) Zoom scan
- (d) Power drift measurement

The SAR measurement procedures for each of test conditions are as follows:

- (a) Make EUT to transmit maximum output power
- (b) Measure conducted output power through RF cable
- (c) Place the EUT in the specific position of phantom
- (d) Perform SAR testing steps on the COMOSAR system
- (e) Record the SAR value

#### 3.4.1 Area & Zoom Scan Procedure

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g. According to KDB 865664 D01, the resolution for Area and Zoom scan is specified in the table below.

Items	<= 2 GHz	2-3 GHz	3-4 GHz	4-5 GHz	5-6 GHz
Area Scan ( $\Delta x, \Delta y$ )	<= 15 mm	<= 12 mm	<= 12 mm	<= 10 mm	<= 10 mm
Zoom Scan ( $\Delta x, \Delta y$ )	<= 8 mm	<= 5 mm	<= 5 mm	<= 4 mm	<= 4 mm
Zoom Scan ( $\Delta z$ )	<= 5 mm	<= 5 mm	<= 4 mm	<= 3 mm	<= 2 mm
Zoom Scan Volume	>= 30 mm	>= 30 mm	>= 28 mm	>= 25 mm	>= 22 mm

**Note:**

When zoom scan is required and report SAR is <= 1.4 W/kg, the zoom scan resolution of  $\Delta x / \Delta y$  (2-3GHz: <= 8 mm, 3-4GHz: <= 7 mm, 4-6GHz: <= 5 mm) may be applied.

#### 3.4.2 Volume Scan Procedure

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software can combine and subsequently superpose these measurement data to calculating the multiband SAR.

## FCC SAR Test Report

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### 3.4.3 Power Drift Monitoring

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In COMOSAR measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. If the power drift more than 5%, the SAR will be retested.

### 3.4.4 Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1g and 10g, as well as for user-specific masses. The OPENSAR software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

The base for the evaluation is a "cube" measurement. The measured volume must include the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.

The entire evaluation of the spatial peak values is performed within the post-processing engine. The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

- (a) Extraction of the measured data (grid and values) from the Zoom Scan
- (b) Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
- (c) Generation of a high-resolution mesh within the measured volume
- (d) Interpolation of all measured values from the measurement grid to the high-resolution grid
- (e) Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
- (f) Calculation of the averaged SAR within masses of 1g and 10g

### 3.4.5 SAR Averaged Methods

In COMOSAR System, the interpolation and extrapolation are both based on the modified Quadratic Shepard's method. The interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation.



## 4. SAR Measurement Evaluation

### 4.1 EUT Configuration and Setting

#### <Connections between EUT and System Simulator>

For WWAN SAR testing, the EUT was linked and controlled by base station emulator . Communication between the EUT and the emulator was established by air link. The distance between the EUT and the communicating antenna of the emulator is larger than 50 cm and the output power radiated from the emulator antenna is at least 30 dB smaller than the output power of EUT. The EUT was set from the emulator to radiate maximum output power during SAR testing.

### 4.2 EUT Testing Position

#### 4.2.1 Head Exposure Conditions

Head exposure is limited to next to the ear voice mode operations. Head SAR compliance is tested according to the test positions defined in IEEE Std 1528-2013 using the SAM phantom illustrated as below.

1. Define two imaginary lines on the handset
  - (a) The vertical centerline passes through two points on the front side of the handset - the midpoint of the width  $w_t$  of the handset at the level of the acoustic output, and the midpoint of the width  $w_b$  of the bottom of the handset.
  - (b) The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output. The horizontal line is also tangential to the face of the handset at point A.
  - (c) The two lines intersect at point A. Note that for many handsets, point A coincides with the center of the acoustic output; however, the acoustic output may be located elsewhere on the horizontal line. Also note that the vertical centerline is not necessarily parallel to the front face of the handset, especially for clamshell handsets, handsets with flip covers, and other irregularly shaped handsets.

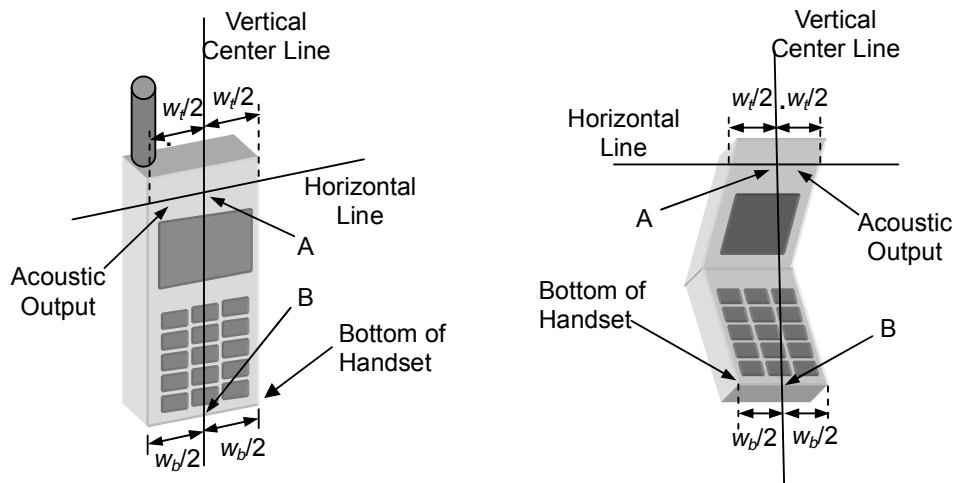


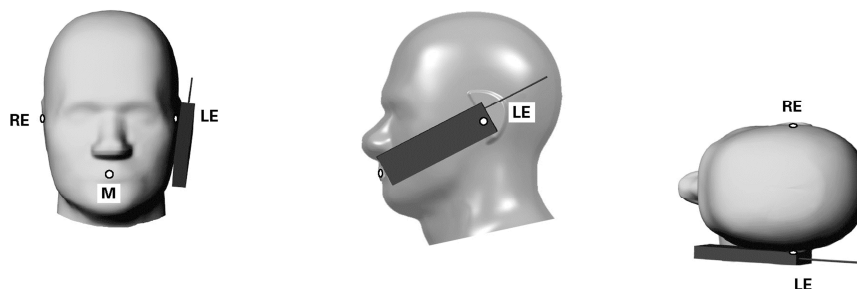
Fig-4.1 Illustration for Handset Vertical and Horizontal Reference Lines

## FCC SAR Test Report

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### 2. Cheek Position

- (a) To position the device with the vertical center line of the body of the device and the horizontal line crossing the center piece in a plane parallel to the sagittal plane of the phantom. While maintaining the device in this plane, align the vertical center line with the reference plane containing the three ear and mouth reference point (M: Mouth, RE: Right Ear, and LE: Left Ear) and align the center of the ear piece with the line RE-LE.
- (b) To move the device towards the phantom with the ear piece aligned with the line LE-RE until the phone touched the ear. While maintaining the device in the reference plane and maintaining the phone contact with the ear, move the bottom of the phone until any point on the front side is in contact with the cheek of the phantom or until contact with the ear is lost (see Fig-4.2).



**Fig-4.2 Illustration for Cheek Position**

### 4.2.2 Simultaneous Transmission Possibilities

The simultaneous transmission possibilities for this device are not available.

# FCC SAR Test Report

## 4.3 Tissue Verification

The measuring results for tissue simulating liquid are shown as below.

Test Date	Tissue Type	Frequency (MHz)	Liquid Temp. (°C)	Measured Conductivity ( $\sigma$ )	Measured Permittivity ( $\epsilon_r$ )	Target Conductivity ( $\sigma$ )	Target Permittivity ( $\epsilon_r$ )	Conductivity Deviation (%)	Permittivity Deviation (%)
Aug. 10, 2018	Head	HL1900	21.8	1.420	41.250	1.40	40.00	1.43	3.13

**Note:**

1. The dielectric properties of the tissue simulating liquid must be measured within 24 hours before the SAR testing and within  $\pm 5\%$  of the target values. Liquid temperature during the SAR testing must be within  $\pm 2$  °C.
2. Since the maximum deviation of dielectric properties of the tissue simulating liquid is within 5%, SAR correction is evaluated in the measurement uncertainty shown on section 6 of this report.

## 4.4 System Validation

The SAR measurement system was validated according to procedures in KDB 865664 D01. The validation status in tabulated summary is as below.

Test Date	Probe S/N	Calibration Point	Measured Conductivity ( $\sigma$ )	Measured Permittivity ( $\epsilon_r$ )	Validation for CW			Validation for Modulation		
					Sensitivity Range	Probe Linearity	Probe Isotropy	Modulation Type	Duty Factor	PAR
Aug. 10, 2018	SN 27/15 EPGO262	Head   1900	1.420	41.250	Pass	Pass	Pass	GMSK	Pass	N/A

## 4.5 System Verification

The measuring result for system verification is tabulated as below.

Test Date	Mode	Frequency (MHz)	1W Target SAR-1g (W/kg)	Measured SAR-1g (W/kg)	Normalized to 1W SAR-1g (W/kg)	Deviation (%)	Dipole S/N	Probe S/N
Aug. 10, 2018	Head	1900	39.88	3.78	37.83	-5.14	SN 18/11 DIPG153	SN 27/15 EPGO262

**Note:**

Comparing to the reference SAR value provided by MVG, the validation data should be within its specification of 10 %. The result indicates the system check can meet the variation criterion and the plots can be referred to Appendix A of this report.

# FCC SAR Test Report

## 4.6 Maximum Output Power

### 4.6.1 Maximum Conducted Power

The maximum conducted average power (Unit: dBm) including tune-up tolerance is shown as below.

Mode	DECT
DECT (GFSK)	17.0

### 4.6.2 Measured Conducted Power Result

The measuring conducted average power (Unit: dBm) is shown as below.

Band Channel	DECT		
	0	2	4
Frequency (MHz)	1928.448	1924.992	1921.536
<b>Maximum Burst-Averaged Output Power</b>			
DECT (GFSK)	16.00	16.48	16.17

**Note:**

1. SAR testing was performed on the maximum averaged power mode.

**4.7 SAR Testing Results**

**4.7.1 SAR Test Reduction Considerations**

**<KDB 447498 D01, General RF Exposure Guidance>**

Testing of other required channels within the operating mode of a frequency band is not required when the reported SAR for the mid-band or highest output power channel is:

- (1)  $\leq 0.8$  W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is  $\leq 100$  MHz
- (2)  $\leq 0.6$  W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
- (3)  $\leq 0.4$  W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is  $\geq 200$  MHz

**4.7.2 SAR Results for Head Exposure Condition**

Plot No.	Band	Mode	Test Position	Ch.	Max. Tune-up Power (dBm)	Measured Conducted Power (dBm)	Power Drift (dB)	Measured SAR-1g (W/kg)	Scaling Factor	Scaled SAR-1g (W/kg)
1#	DECT	Voice	Right Cheek	2	17.0	16.48	1.19	0.034	1.13	<b>0.04</b>
	DECT	Voice	Left Cheek	2	17.0	16.48	0.21	0.031	1.13	0.03

**4.7.3 Simultaneous Multi-band Transmission Evaluation**

There is no simultaneous transmission condition for this device.

Test Engineer : Wiky Zhang

## 5. Calibration of Test Equipment

Equipment	Manufacturer	Model	SN	Cal. Date	Cal. Interval
System Validation Dipole	SATIMO	SID1900	SN 18/11 DIPG 153	Jun. 08, 2017	2 Years
E-Field Probe	MVG	SSE2	SN 27/15 EPGO262	Jun. 07, 2018	1 Year
MultiMeter	Keithley	Multimate 2000	1331865	Jun. 21, 2018	1 Year
Radio Communication Analyzer	ANRITSU	MT8820C	6201300717	Jul. 24, 2018	1 Year
Digital Radiocommunication Tester	R&S	CMD60	840677/012	Sep. 14, 2017	1 Year
ENA Series Network Analyzer	Agilent	E5071C	MY46214638	Jul. 24, 2018	1 Year
Spectrum Analyzer	KEYSIGHT	N9010A	MY54510355	Jun. 27, 2018	1Year
MXG Analog Signal Generator	KEYSIGHT	N5183A	MY50143024	Mar. 01, 2018	1 Year
Power Meter	Agilent	N1914A	MY52180044	Aug. 12, 2016	2 Years
Power Sensor	Agilent	E9304A H18	MY52050011	Jan. 04, 2018	1 Year
Power Meter	Agilent	ML2495A	1506002	Mar. 01, 2018	1 Year
Power Sensor	Agilent	MA2411B	1339353	Mar. 01, 2018	1 Year
Temp. & Humi. Recorder	CLOCK	HTC-1	157248	Jul. 26, 2018	1 Year
Electronic Thermometer	YONGFA	YF-160A	120100323	Sep. 22, 2017	1 Year
Coupler	Woken	0110A056020 -10	COM27RW1A 3	Sep. 20, 2017	1 Year

## 6. Measurement Uncertainty

Source of Uncertainty	Tolerance (± %)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (1g)	Standard Uncertainty (10g)	Vi Veff
<b>Measurement System</b>								
Probe Calibration	6.0	N	1	1	1	6.0	6.0	∞
Axial Isotropy	5.9	R	1.732	0.7	0.7	2.4	2.4	∞
Hemispherical Isotropy	12.2	R	1.732	0.7	0.7	4.9	4.9	∞
Boundary Effects	1.0	R	1.732	1	1	0.6	0.6	∞
Linearity	5.9	R	1.732	1	1	3.4	3.4	∞
System Detection Limits	1.0	R	1.732	1	1	0.6	0.6	∞
Readout Electronics	1.0	N	1	1	1	1.0	1.0	∞
Response Time	0.0	R	1.732	1	1	0.0	0.0	∞
Integration Time	2.6	R	1.732	1	1	1.5	1.5	∞
RF Ambient Noise	3.0	R	1.732	1	1	1.7	1.7	∞
RF Ambient Reflections	3.0	R	1.732	1	1	1.7	1.7	∞
Probe Positioner	1.4	R	1.732	1	1	0.8	0.8	∞
Probe Positioning	1.4	R	1.732	1	1	0.8	0.8	∞
Max. SAR Eval.	2.3	R	1.732	1	1	1.3	1.3	∞
<b>Test Sample Related</b>								
Device Positioning	2.3	N	1	1	1	2.3	2.3	35
Device Holder	2.7	N	1	1	1	2.7	2.7	12
Power Drift	5.0	R	1.732	1	1	2.9	2.9	∞
Power Scaling	0.0	R	1.732	1	1	0.0	0.0	∞
<b>Phantom and Setup</b>								
Phantom Uncertainty	4.0	R	1.732	1	1	2.3	2.3	∞
SAR correction	1.2	R	1.732	1	0.84	0.7	0.6	∞
Liquid Conductivity (target)	5.0	R	1.732	0.78	0.71	2.3	2.0	∞
Liquid Conductivity (mea.)	4.1	R	1.732	0.78	0.71	1.8	1.7	∞
Temp. unc. - Conductivity	3.4	R	1.732	0.78	0.71	1.5	1.4	∞
Liquid Permittivity (target)	5.0	R	1.732	0.23	0.26	0.7	0.8	∞
Liquid Permittivity (mea.)	5.0	R	1.732	0.23	0.26	0.7	0.8	∞
Temp. unc. - Permittivity	0.83	R	1.732	0.23	0.26	0.1	0.1	∞
<b>Combined Standard Uncertainty (K = 1)</b>						± 11.4 %	± 11.3 %	2923
<b>Expanded Uncertainty (K = 2)</b>						± 22.7 %	± 22.6 %	

## FCC SAR Test Report

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### **7. Information on the Testing Laboratories**

We, BV 7LAYERS COMMUNICATIONS TECHNOLOGY (SHENZHEN) CO. LTD., were founded in 2015 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

Add: No. B102, Dazhu Chuangxin Mansion, North of Beihuan Avenue, North Area, Hi-Tech Industry Park, Nanshan District, Shenzhen, Guangdong, China

Tel: 86-755-8869-6566

Fax: 86-755-8869-6577

**Email:** [customerservice.dg@cn.bureauveritas.com](mailto:customerservice.dg@cn.bureauveritas.com)

**Web Site:** [www.bureauveritas.com](http://www.bureauveritas.com)

The road map of all our labs can be found in our web site also.

---END---



## **Appendix A. SAR Plots of System Verification**

The plots for system verification with largest deviation for each SAR system combination are shown as follows.

# System Verification Plot

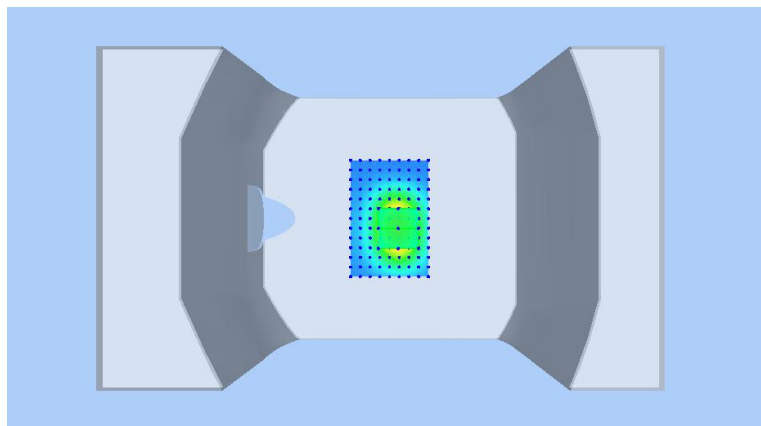
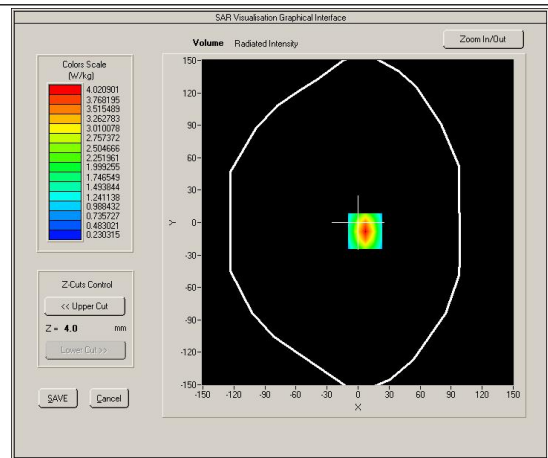
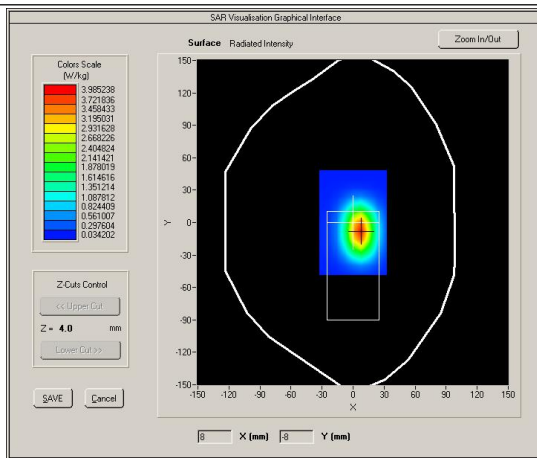
Product Description: Dipole

Model: SID1900

Test Date: Aug 10, 2018

Ambient Temperature: 22.5°C; Liquid Temperature: 21.8°C

Medium(liquid type)	HL1900
Frequency (MHz)	1900.000
Relative permittivity (real part)	41.25
Conductivity (S/m)	1.42
Input power	100mW
E-Field Probe	SN 27/15 EPGO262
Crest factor	1.0
Conversion Factor	2.14
Sensor-Surface	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-2.210000
SAR 10g (W/Kg)	1.984678
SAR 1g (W/Kg)	3.783263



## **Appendix B. SAR Plots of SAR Measurement**

The SAR plots for highest measured SAR in each exposure configuration, wireless mode and frequency band combination, and measured SAR > 1.5 W/kg are shown as follows.

# Maximum SAR measurement Plots

1# DECT\_Voice\_Right Cheek\_Ch2

DUT:180808W001

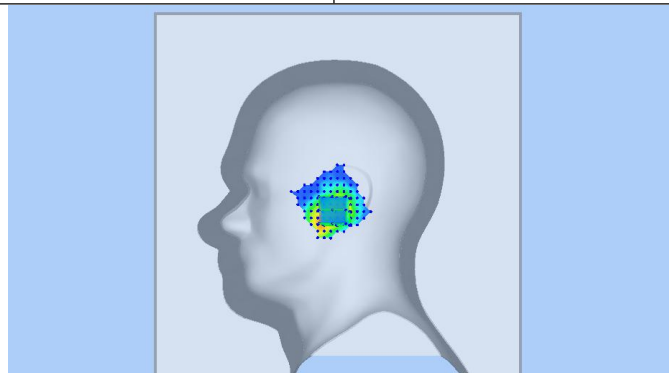
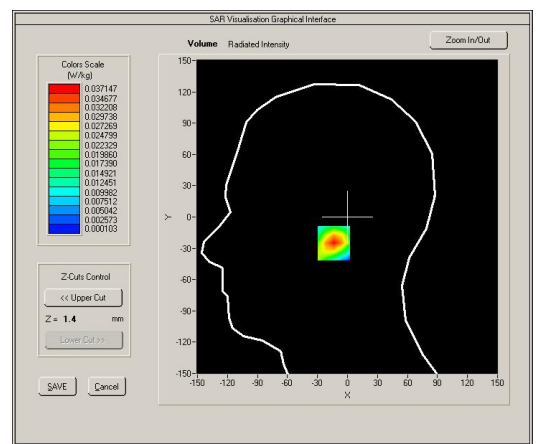
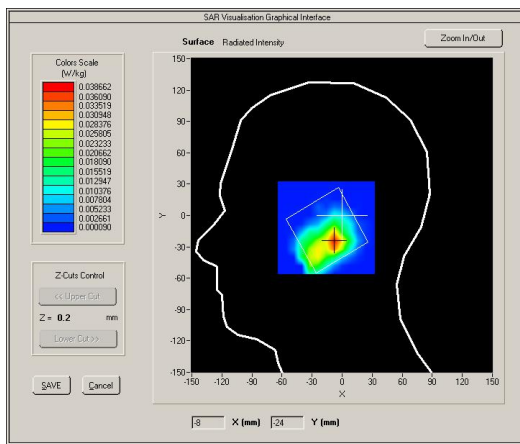
Test Date: Aug 10, 2018

Ambient Temperature: 22.5°C; Liquid Temperature: 21.8°C

Medium(liquid type)	HL1900
Frequency (MHz)	1924.992
Relative permittivity (real part)	41.25
Conductivity (S/m)	1.42
E-Field Probe	SN 27/15 EPGO262
Crest factor	12.0
Conversion Factor	2.14
Sensor-Surface	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	1.190000
SAR 10g (W/Kg)	0.015767
SAR 1g (W/Kg)	0.034028

## SURFACE SAR

## VOLUME SAR





**Appendix C. Calibration Certificate for Probe and Dipole**

The MVG calibration certificates are shown as follows.



**COMOSAR E-Field Probe Calibration Report**

Ref : ACR.158.1.18.SATU.A

**BV 7LAYERS COMMUNICATIONS  
TECHNOLOGY (SHENZHEN) CO. LTD  
NO.B102, DAZU CHUANGXIN MANSION,NORTH OF  
BEIHUAN AVENUE,NORTH AREA,  
HI-TECH INDUSTRIAL PARK,NANSHAN  
DISTRICT,SHENZHEN, CHINA  
MVG COMOSAR DOSIMETRIC E-FIELD PROBE  
SERIAL NO.: SN 27/15 EPGO262**

**Calibrated at MVG US  
2105 Barrett Park Dr. - Kennesaw, GA 30144**



**Calibration Date: 06/07/2018**

*Summary:*

This document presents the method and results from an accredited COMOSAR Dosimetric E-Field Probe calibration performed in MVG USA using the CALISAR / CALIBAIR test bench, for use with a COMOSAR system only. All calibration results are traceable to national metrology institutions.



	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme LUC	Product Manager	6/7/2018	<i>JS</i>
<i>Checked by :</i>	Jérôme LUC	Product Manager	6/7/2018	<i>JS</i>
<i>Approved by :</i>	Kim RUTKOWSKI	Quality Manager	6/7/2018	<i>Kim Rutkowski</i>

	<i>Customer Name</i>
<i>Distribution :</i>	BV 7Layers Communications Technology (Shenzhen) Co. Ltd

<i>Issue</i>	<i>Date</i>	<i>Modifications</i>
A	6/7/2018	Initial release



TABLE OF CONTENTS

1 Device Under Test ..... 4

2 Product Description ..... 4

    2.1 General Information ..... 4

3 Measurement Method ..... 4

    3.1 Linearity ..... 4

    3.2 Sensitivity ..... 5

    3.3 Lower Detection Limit ..... 5

    3.4 Isotropy ..... 5

    3.5 Boundary Effect ..... 5

4 Measurement Uncertainty ..... 5

5 Calibration Measurement Results ..... 6

    5.1 Sensitivity in air ..... 6

    5.2 Linearity ..... 7

    5.3 Sensitivity in liquid ..... 7

    5.4 Isotropy ..... 8

6 List of Equipment ..... 10



**1 DEVICE UNDER TEST**

Device Under Test	
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	MVG
Model	SSE2
Serial Number	SN 27/15 EPGO262
Product Condition (new / used)	Used
Frequency Range of Probe	0.7 GHz-6GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.222 MΩ Dipole 2: R2=0.200 MΩ Dipole 3: R3=0.200 MΩ

A yearly calibration interval is recommended.

**2 PRODUCT DESCRIPTION**

**2.1 GENERAL INFORMATION**

MVG's COMOSAR E field Probes are built in accordance to the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards.



Figure 1 – MVG COMOSAR Dosimetric E field Dipole

Probe Length	330 mm
Length of Individual Dipoles	2 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	2.5 mm
Distance between dipoles / probe extremity	1 mm

**3 MEASUREMENT METHOD**

The IEEE 1528, OET 65 Bulletin C, CENELEC EN50361 and CEI/IEC 62209 standards provide recommended practices for the probe calibrations, including the performance characteristics of interest and methods by which to assess their affect. All calibrations / measurements performed meet the fore mentioned standards.

**3.1 LINEARITY**

The evaluation of the linearity was done in free space using the waveguide, performing a power sweep to cover the SAR range 0.01W/kg to 100W/kg.



### 3.2 SENSITIVITY

The sensitivity factors of the three dipoles were determined using a two step calibration method (air and tissue simulating liquid) using waveguides as outlined in the standards.

### 3.3 LOWER DETECTION LIMIT

The lower detection limit was assessed using the same measurement set up as used for the linearity measurement. The required lower detection limit is 10 mW/kg.

### 3.4 ISOTROPY

The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole with the dipole mounted under the flat phantom in the test configuration suggested for system validations and checks. The probe was rotated along its main axis from 0 - 360 degrees in 15 degree steps. The hemispherical isotropy is determined by inserting the probe in a thin plastic box filled with tissue-equivalent liquid, with the plastic box illuminated with the fields from a half wave dipole. The dipole is rotated about its axis (0°–180°) in 15° increments. At each step the probe is rotated about its axis (0°–360°).

### 3.5 BOUNDARY EFFECT

The boundary effect is defined as the deviation between the SAR measured data and the expected exponential decay in the liquid when the probe is oriented normal to the interface. To evaluate this effect, the liquid filled flat phantom is exposed to fields from either a reference dipole or waveguide. With the probe normal to the phantom surface, the peak spatial average SAR is measured and compared to the analytical value at the surface.

## 4 MEASUREMENT UNCERTAINTY

The guidelines outlined in the IEEE 1528, OET 65 Bulletin C, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty associated with an E-field probe calibration using the waveguide technique. All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of  $k=2$ , traceable to the Internationally Accepted Guides to Measurement Uncertainty.

Uncertainty analysis of the probe calibration in waveguide					
ERROR SOURCES	Uncertainty value (%)	Probability Distribution	Divisor	ci	Standard Uncertainty (%)
Incident or forward power	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Reflected power	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Liquid conductivity	5.00%	Rectangular	$\sqrt{3}$	1	2.887%
Liquid permittivity	4.00%	Rectangular	$\sqrt{3}$	1	2.309%
Field homogeneity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Field probe positioning	5.00%	Rectangular	$\sqrt{3}$	1	2.887%



Field probe linearity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Combined standard uncertainty					5.831%
Expanded uncertainty 95 % confidence level k = 2					12.0%

5 CALIBRATION MEASUREMENT RESULTS

Calibration Parameters	
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

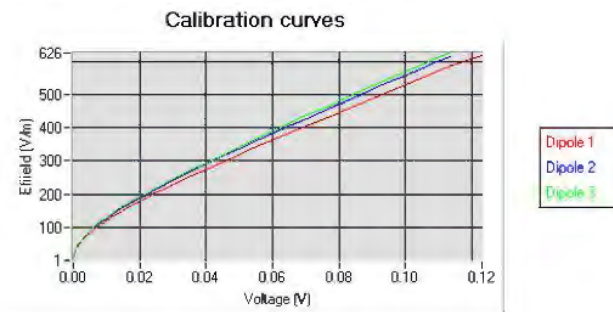
5.1 SENSITIVITY IN AIR

Normx dipole 1 ( $\mu\text{V}/(\text{V}/\text{m})^2$ )	Normy dipole 2 ( $\mu\text{V}/(\text{V}/\text{m})^2$ )	Normz dipole 3 ( $\mu\text{V}/(\text{V}/\text{m})^2$ )
0.76	0.67	0.67

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
90	93	91

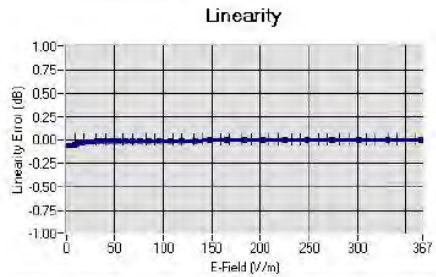
Calibration curves  $e_i=f(V)$  ( $i=1,2,3$ ) allow to obtain H-field value using the formula:

$$E = \sqrt{E_1^2 + E_2^2 + E_3^2}$$





5.2 LINEARITY



Linearity:  $\pm 1.39\%$  ( $\pm 0.06\text{dB}$ )

5.3 SENSITIVITY IN LIQUID

Liquid	Frequency (MHz +/- 100MHz)	Permittivity	Epsilon (S/m)	ConvF
HL750	750	40.03	0.93	1.71
BL750	750	56.83	1.00	1.76
HL850	835	42.19	0.90	1.79
BL850	835	54.67	1.01	1.86
HL900	900	42.08	1.01	1.84
HL1450	1450	40.64	1.18	1.87
BL1450	1450	53.01	1.33	1.93
HL1750	1750	41.01	1.45	1.88
BL1750	1750	53.50	1.50	1.95
HL1900	1900	38.45	1.45	2.14
BL1900	1900	53.32	1.56	2.20
HL2000	2000	38.26	1.38	2.02
HL2300	2300	39.44	1.62	2.24
BL2300	2300	54.52	1.77	2.32
HL2450	2450	37.50	1.80	2.25
BL2450	2450	53.22	1.89	2.31
HL2600	2600	39.80	1.99	2.16
BL2600	2600	52.52	2.23	2.21
HL5200	5250	35.85	4.74	1.70
BL5200	5250	48.01	5.40	1.76
HL5600	5600	36.66	5.17	1.69
BL5600	5600	46.79	5.77	1.75
HL5800	5800	35.31	5.31	1.71
BL5800	5800	47.04	6.10	1.74

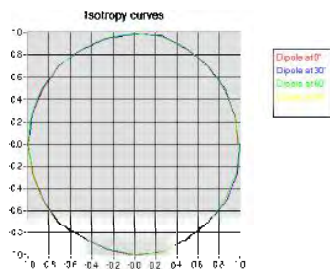
LOWER DETECTION LIMIT: 9mW/kg



5.4 ISOTROPY

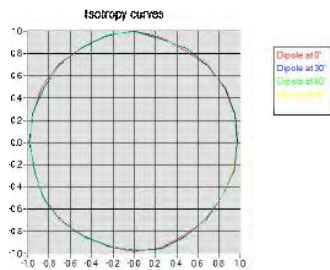
**HL 900 MHz**

- Axial isotropy: 0.04 dB
- Hemispherical isotropy: 0.07 dB



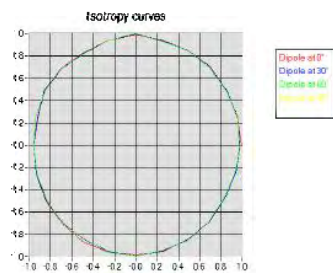
**HL 1800 MHz**

- Axial isotropy: 0.06 dB
- Hemispherical isotropy: 0.08 dB



**HL 5600 MHz**

- Axial isotropy: 0.06 dB
- Hemispherical isotropy: 0.08 dB





## 6 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
Flat Phantom	MVG	SN-20/09-SAM71	Validated. No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2016	02/2019
Reference Probe	MVG	EP 94 SN 37/08	10/2017	10/2018
Multimeter	Keithley 2000	1188656	01/2017	01/2020
Signal Generator	Agilent E4438C	MY49070581	01/2017	01/2020
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	01/2017	01/2020
Power Sensor	HP ECP-E26A	US37181460	01/2017	01/2020
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Waveguide	Mega Industries	069Y7-158-13-712	Validated. No cal required.	Validated. No cal required.
Waveguide Transition	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Waveguide Termination	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Control Company	150798832	11/2017	11/2020



## SAR Reference Dipole Calibration Report

Ref : ACR.165.5.17.SATU.A

### SIEMIC TESTING AND CERTIFICATION SERVICES

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#### MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 1900 MHZ

SERIAL NO.: SN 18/11 DIPG153

Calibrated at MVG US

2105 Barrett Park Dr. - Kennesaw, GA 30144



Calibration Date: 06/8/2017

#### *Summary:*

This document presents the method and results from an accredited SAR reference dipole calibration performed in MVG USA using the COMOSAR test bench. All calibration results are traceable to national metrology institutions.





	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme LUC	Product Manager	6/14/2017	<i>JS</i>
<i>Checked by :</i>	Jérôme LUC	Product Manager	6/14/2017	<i>JS</i>
<i>Approved by :</i>	Kim RUTKOWSKI	Quality Manager	6/14/2017	<i>Kim Rutkowski</i>

	<i>Customer Name</i>
<i>Distribution :</i>	SIEMIC Testing and Certification Services

<i>Issue</i>	<i>Date</i>	<i>Modifications</i>
A	6/14/2017	Initial release



TABLE OF CONTENTS

1 Introduction ..... 4

2 Device Under Test ..... 4

3 Product Description ..... 4

    3.1 General Information ..... 4

4 Measurement Method ..... 5

    4.1 Return Loss Requirements ..... 5

    4.2 Mechanical Requirements ..... 5

5 Measurement Uncertainty ..... 5

    5.1 Return Loss ..... 5

    5.2 Dimension Measurement ..... 5

    5.3 Validation Measurement ..... 5

6 Calibration Measurement Results ..... 6

    6.1 Return Loss and Impedance In Head Liquid ..... 6

    6.2 Return Loss and Impedance In Body Liquid ..... 6

    6.3 Mechanical Dimensions ..... 6

7 Validation measurement ..... 7

    7.1 Head Liquid Measurement ..... 7

    7.2 SAR Measurement Result With Head Liquid ..... 8

    7.3 Body Liquid Measurement ..... 9

    7.4 SAR Measurement Result With Body Liquid ..... 10

8 List of Equipment ..... 11

## 1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, FCC KDBs and CEI/IEC 62209 standards for reference dipoles used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

## 2 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR 1900 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SID1900
Serial Number	SN 18/11 DIPG153
Product Condition (new / used)	Used

A yearly calibration interval is recommended.

## 3 PRODUCT DESCRIPTION

### 3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, FCC KDBs and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.



Figure 1 – MVG COMOSAR Validation Dipole



#### 4 MEASUREMENT METHOD

The IEEE 1528, FCC KDBs and CEI/IEC 62209 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standards.

##### 4.1 RETURN LOSS REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a return loss of -20 dB or better. The return loss measurement shall be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards.

##### 4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness.

#### 5 MEASUREMENT UNCERTAINTY

All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

##### 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

Frequency band	Expanded Uncertainty on Return Loss
400-6000MHz	0.1 dB

##### 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

Length (mm)	Expanded Uncertainty on Length
3 - 300	0.05 mm

##### 5.3 VALIDATION MEASUREMENT

The guidelines outlined in the IEEE 1528, FCC KDBs, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

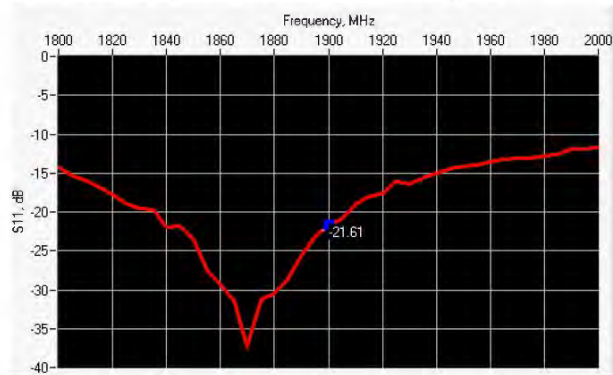
Scan Volume	Expanded Uncertainty
1 g	20.3 %



10 g	20.1 %
------	--------

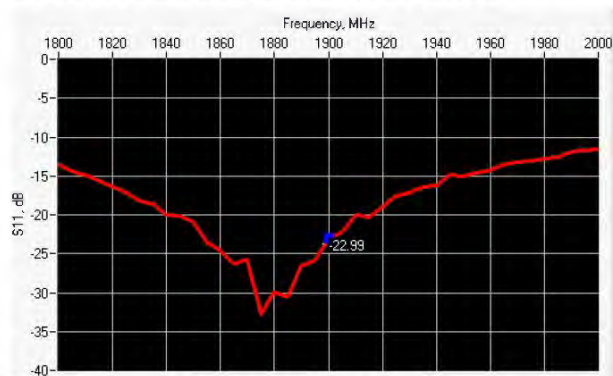
## 6 CALIBRATION MEASUREMENT RESULTS

### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1900	-21.61	-20	52.8 Ω + 8.1 jΩ

### 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1900	-22.99	-20	47.9 Ω + 6.6 jΩ

### 6.3 MECHANICAL DIMENSIONS

Frequency MHz	L mm		h mm		d mm	
	required	measured	required	measured	required	measured
300	420.0 ±1 %		250.0 ±1 %		6.35 ±1 %	



450	290.0 ±1 %.		166.7 ±1 %.		6.35 ±1 %.	
750	176.0 ±1 %.		100.0 ±1 %.		6.35 ±1 %.	
835	161.0 ±1 %.		89.8 ±1 %.		3.6 ±1 %.	
900	149.0 ±1 %.		83.3 ±1 %.		3.6 ±1 %.	
1450	89.1 ±1 %.		51.7 ±1 %.		3.6 ±1 %.	
1500	80.5 ±1 %.		50.0 ±1 %.		3.6 ±1 %.	
1640	79.0 ±1 %.		45.7 ±1 %.		3.6 ±1 %.	
1750	75.2 ±1 %.		42.9 ±1 %.		3.6 ±1 %.	
1800	72.0 ±1 %.		41.7 ±1 %.		3.6 ±1 %.	
1900	68.0 ±1 %.	PASS	39.5 ±1 %.	PASS	3.6 ±1 %.	PASS
1950	66.3 ±1 %.		38.5 ±1 %.		3.6 ±1 %.	
2000	64.5 ±1 %.		37.5 ±1 %.		3.6 ±1 %.	
2100	61.0 ±1 %.		35.7 ±1 %.		3.6 ±1 %.	
2300	55.5 ±1 %.		32.6 ±1 %.		3.6 ±1 %.	
2450	51.5 ±1 %.		30.4 ±1 %.		3.6 ±1 %.	
2600	48.5 ±1 %.		28.8 ±1 %.		3.6 ±1 %.	
3000	41.5 ±1 %.		25.0 ±1 %.		3.6 ±1 %.	
3500	37.0 ±1 %.		26.4 ±1 %.		3.6 ±1 %.	
3700	34.7 ±1 %.		26.4 ±1 %.		3.6 ±1 %.	

**7 VALIDATION MEASUREMENT**

The IEEE Std. 1528, FCC KDBs and CEI/IEC 62209 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. Per the standards, the dipole shall be positioned below the bottom of the phantom, with the dipole length centered and parallel to the longest dimension of the flat phantom, with the top surface of the dipole at the described distance from the bottom surface of the phantom.

**7.1 HEAD LIQUID MEASUREMENT**

Frequency MHz	Relative permittivity ( $\epsilon_r'$ )		Conductivity ( $\sigma$ ) S/m	
	required	measured	required	measured
300	45.3 ±5 %		0.87 ±5 %	
450	43.5 ±5 %		0.87 ±5 %	
750	41.9 ±5 %		0.89 ±5 %	
835	41.5 ±5 %		0.90 ±5 %	
900	41.5 ±5 %		0.97 ±5 %	
1450	40.5 ±5 %		1.20 ±5 %	
1500	40.4 ±5 %		1.23 ±5 %	
1640	40.2 ±5 %		1.31 ±5 %	
1750	40.1 ±5 %		1.37 ±5 %	



1800	40.0 ±5 %		1.40 ±5 %	
1900	40.0 ±5 %	PASS	1.40 ±5 %	PASS
1950	40.0 ±5 %		1.40 ±5 %	
2000	40.0 ±5 %		1.40 ±5 %	
2100	39.8 ±5 %		1.49 ±5 %	
2300	39.5 ±5 %		1.67 ±5 %	
2450	39.2 ±5 %		1.80 ±5 %	
2600	39.0 ±5 %		1.96 ±5 %	
3000	38.5 ±5 %		2.40 ±5 %	
3500	37.9 ±5 %		2.91 ±5 %	

7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

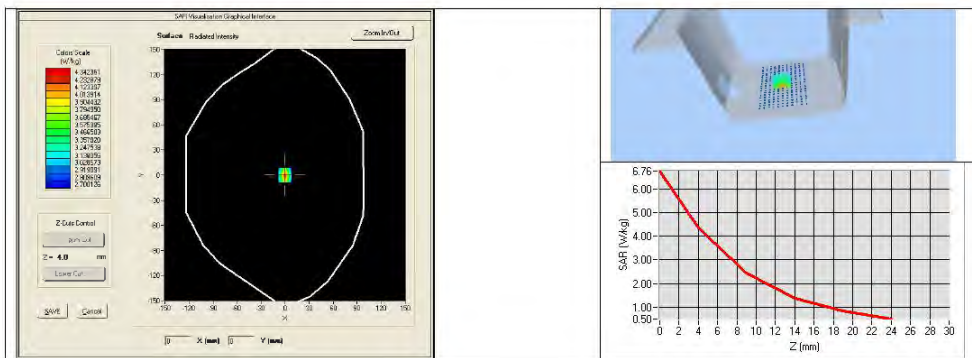
The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: eps' : 38.5 sigma : 1.45
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	1900 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR (W/kg/W)	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49		5.55	
835	9.56		6.22	
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4		20.1	



1900	39.7	39.88 (3.99)	20.5	20.52 (2.05)
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4		24	
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	
3700	67.4		24.2	



7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity ( $\epsilon_r'$ )		Conductivity ( $\sigma$ ) S/m	
	required	measured	required	measured
150	61.9 ±5 %		0.80 ±5 %	
300	58.2 ±5 %		0.92 ±5 %	
450	56.7 ±5 %		0.94 ±5 %	
750	55.5 ±5 %		0.96 ±5 %	
835	55.2 ±5 %		0.97 ±5 %	
900	55.0 ±5 %		1.05 ±5 %	
915	55.0 ±5 %		1.06 ±5 %	
1450	54.0 ±5 %		1.30 ±5 %	
1610	53.8 ±5 %		1.40 ±5 %	
1800	53.3 ±5 %		1.52 ±5 %	
1900	53.3 ±5 %	PASS	1.52 ±5 %	PASS
2000	53.3 ±5 %		1.52 ±5 %	
2100	53.2 ±5 %		1.62 ±5 %	

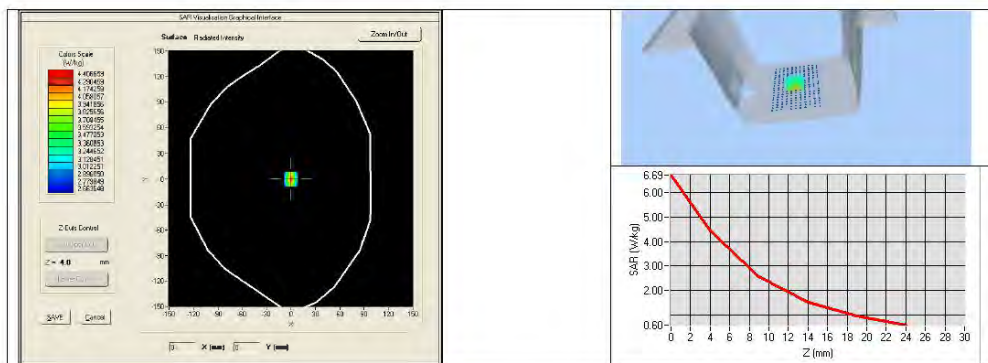


2300	52.9 ±5 %		1.81 ±5 %	
2450	52.7 ±5 %		1.95 ±5 %	
2600	52.5 ±5 %		2.16 ±5 %	
3000	52.0 ±5 %		2.73 ±5 %	
3500	51.3 ±5 %		3.31 ±5 %	
3700	51.0 ±5 %		3.55 ±5 %	
5200	49.0 ±10 %		5.30 ±10 %	
5300	48.9 ±10 %		5.42 ±10 %	
5400	48.7 ±10 %		5.53 ±10 %	
5500	48.6 ±10 %		5.65 ±10 %	
5600	48.5 ±10 %		5.77 ±10 %	
5800	48.2 ±10 %		6.00 ±10 %	

#### 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values: eps' : 53.3 sigma : 1.56
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	1900 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
1900	40.38 (4.04)	20.98 (2.10)



Page: 10/11

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## 8 LIST OF EQUIPMENT

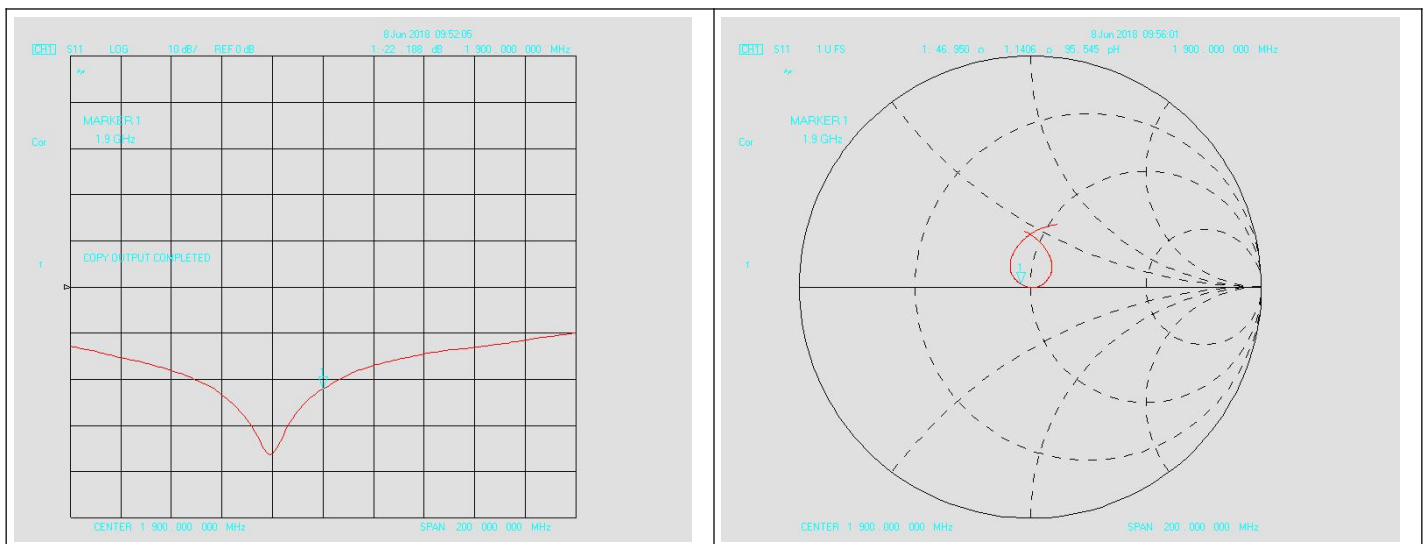
Equipment Summary Sheet				
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
SAM Phantom	MVG	SN-20/09-SAM71	Validated. No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2016	02/2019
Calipers	Carrera	CALIPER-01	01/2017	01/2020
Reference Probe	MVG	EPG122 SN 18/11	10/2016	10/2017
Multimeter	Keithley 2000	1188656	01/2017	01/2020
Signal Generator	Agilent E4438C	MY49070581	01/2017	01/2020
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	01/2017	01/2020
Power Sensor	HP ECP-E26A	US37181460	01/2017	01/2020
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Temperature and Humidity Sensor	Control Company	150798832	10/2015	10/2017

## SATIMO Calibration Certificate-Extended Dipole Calibrations

According to KDB865664 D01, Dipoles must be recalibrated at least once every three years; however, immediate re-calibration is required for following conditions. The test laboratory must ensure that the required supporting information and documentation have been included in the SAR report to qualify for extended 3-year calibration interval.

- 1) When the most recent return-loss, measured at least annually, deviates by more than 20% from the previous measurement (i.e. 0.2 of the dB value) or not meeting the required -20 dB return-loss specification
- 2) When the most recent measurement of the real or imaginary parts of the impedance, measured at least annually, deviates by more than 5Ω from the previous measurement

### Dipole Verification plot: SID 1900 SN 18/11 DIPG153 1900MHz for Head:



The measuring results are shown as below.

Tissue Type	Frequency (MHz)	Return- Loss (dB)	Real Impedance (Ω)	Targeted Return- Loss (dB)	Targeted Real Impedance (Ω)	Deviation Return- Loss (dB)	Deviation Real Impedance (Ω)	Date
HL1900	1900	-21.819	46.950	-21.610	50.00	-0.209	-3.05	Jun. 08, 2018

According to up table, the return loss is <-20dB, deviates by less than 20% from the previous measurement; the real Impedance are all within 5 Ω compared to the required Impedance.



**Appendix D. Photographs of EUT and Setup**