

FCC SAR EVALUATION REPORT

**In accordance with the requirements of
FCC 47 CFR Part 2(2.1093), ANSI/IEEE C95.1-1992 and
IEEE Std 1528-2013**

Product Name : Global Hub

Trademark : N/A

Model Name : CSH-0301

Family Model : N/A

Report No. : S18112000402E

FCC ID : 2ARWCCSH-0301

Prepared for

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TEST RESULT CERTIFICATION

Applicant's name: Coolr Group Inc

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Manufacturer's Name: Hatch international limited

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Product description

Product name.....: Global Hub

Trademark: N/A

Model Name: CSH-0301

Family Model.....: N/A

FCC 47 CFR Part 2(2.1093)

ANSI/IEEE C95.1-1992

Standards: IEEE Std 1528-2013

Published RF exposure KDB procedures

This device described above has been tested by Shenzhen NTEK. In accordance with the measurement methods and procedures specified in IEEE Std 1528-2013 and KDB 865664 D01. Testing has shown that this device is capable of compliance with localized specific absorption rate (SAR) specified in FCC 47 CFR Part 2(2.1093) and ANSI/IEEE C95.1-1992. The test results in this report apply only to the tested sample of the stated device/equipment. Other similar device/equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

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Date of Test

Date (s) of performance of tests: Nov. 22, 2018 ~ Nov. 28, 2018

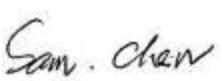
Date of Issue: Dec. 13, 2018

Test Result.....: **Pass**

Prepared By
(Test Engineer)

: 
(Cheng Jiawen)

Approved By
(Lab Manager)

: 
(Sam Chen)

※※ Revision History ※※

REV.	DESCRIPTION	ISSUED DATE	REMARK
Rev.1.0	Initial Test Report Release	Dec. 13, 2018	Cheng Jiawen

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1. General Information

1.1. RF exposure limits

(A).Limits for Occupational/Controlled Exposure (W/kg)

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.4	8.0	20.0

(B).Limits for General Population/Uncontrolled Exposure (W/kg)

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.08	1.6	4.0

NOTE: **Whole-Body SAR** is averaged over the entire body, **partial-body SAR** is averaged over any 1 gram of tissue defined as a tissue volume in the shape of a cube. **SAR for hands, wrists, feet and ankles** is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

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).

General Population/Uncontrolled Environments:

Are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

NOTE

HEAD AND TRUNK LIMIT

1.6 W/kg

APPLIED TO THIS EUT

1.2. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for CSH-0301 are as follows.

Band	Max Reported SAR Value(W/kg)	
	1-g Hotspot (Separation distance of 10mm)	Max Simultaneous Tx
GSM 850	0.501	0.751
GSM 1900	0.333	
WCDMA Band V	0.386	
WCDMA Band II	0.513	
WLAN 2.4G	0.238	

Note: The Max Simultaneous Tx is calculated based on the same configuration and test position. This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg) specified in FCC 47 CFR Part 2(2.1093) and ANSI/IEEE C95.1-1992, and had been tested in accordance with the measurement methods and procedures specified in IEEE Std 1528-2013 & KDB 865664 D01.

1.3. EUT Description

Device Information			
Product Name	Global Hub		
Trademark	N/A		
Model Name	CSH-0301		
Family Model	N/A		
FCC ID	2ARWCCSH-0301		
Device Phase	Identical Prototype		
Exposure Category	General population / Uncontrolled environment		
Antenna	FPCB Antenna		
Battery Information	DC 3.7V, 1500mAh		
Device Operating Configurations			
Supporting Mode(s)	GSM 850/1900, WCDMA Band V/II, WLAN 2.4G, Bluetooth		
Test Modulation	GSM(GMSK), WCDMA(QPSK), WLAN(DSSS/OFDM), Bluetooth(GFSK, $\pi/4$ -DQPSK, 8DPSK)		
Device Class	B		
Operating Frequency Range(s)	Band	Tx (MHz)	Rx (MHz)
	GSM 850	824-849	869-894
	GSM 1900	1850-1910	1930-1990
	WCDMA Band V	824-849	869-894

	WCDMA Band II	1850-1910	1930-1990
	WLAN 2.4G	2412-2462	
	Bluetooth	2402-2480	
GPRS Multislot Class(12)	Max Number of Timeslots in Uplink		4
	Max Number of Timeslots in Downlink		4
	Max Total Timeslot		5
Power Class	4, tested with power level 5(GSM 850)		
	1, tested with power level 0(GSM 1900)		
	3, tested with power control "all 1"(WCDMA Band V)		
	3, tested with power control "all 1"(WCDMA Band II)		
Test Channels (low-mid-high)	128-189-251(GSM 850)		
	512-661-810(GSM 1900)		
	4132-4182-4233(WCDMA Band V)		
	9262-9400-9538(WCDMA Band II)		
	1-3-6-9-11(WLAN 2.4G)		

1.4. Test specification(s)

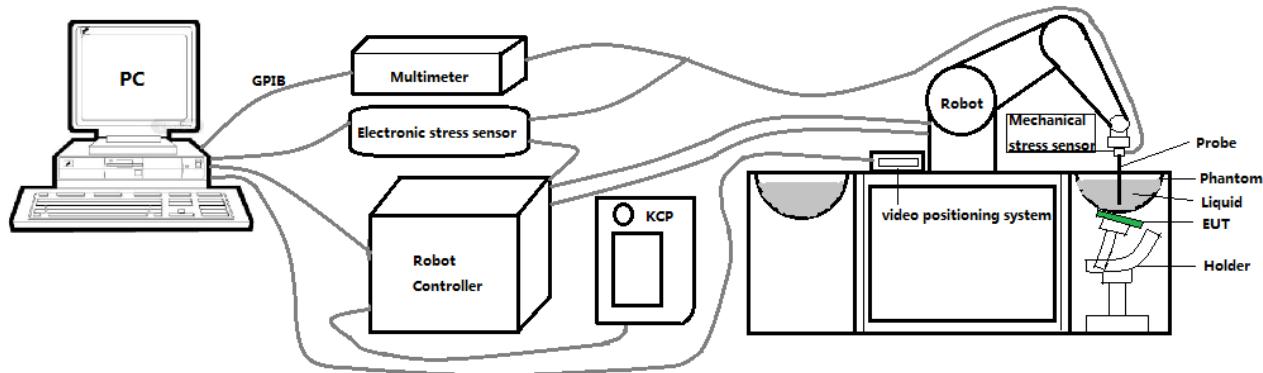
FCC 47 CFR Part 2(2.1093)
ANSI/IEEE C95.1-1992
IEEE Std 1528-2013
KDB 865664 D01 SAR measurement 100 MHz to 6 GHz
KDB 865664 D02 RF Exposure Reporting
KDB 447498 D01 General RF Exposure Guidance
KDB 941225 D01 3G SAR Procedures
KDB 248227 D01 802.11 Wi-Fi SAR
KDB 941225 D06 Hotspot SAR

1.5. Ambient Condition

Ambient temperature	20°C – 24°C
Relative Humidity	30% – 70%

2. SAR Measurement System

2.1. SATIMO SAR Measurement Set-up Diagram



These measurements were performed with the automated near-field scanning system OPENSAR from SATIMO. The system is based on a high precision robot (working range: 901 mm), which positions the probes with a positional repeatability of better than ± 0.03 mm. The SAR measurements were conducted with dosimetric probe (manufactured by SATIMO), designed in the classical triangular configuration and optimized for dosimetric evaluation.

The first step of the field measurement is the evaluation of the voltages induced on the probe by the device under test. Probe diode detectors are nonlinear. Below the diode compression point, the output voltage is proportional to the square of the applied E-field; above the diode compression point, it is linear to the applied E-field. The compression point depends on the diode, and a calibration procedure is necessary for each sensor of the probe.

The Keithley multimeter reads the voltage of each sensor and send these three values to the PC. The corresponding E field value is calculated using the probe calibration factors, which are stored in the working directory. This evaluation includes linearization of the diode characteristics. The field calculation is done separately for each sensor. Each component of the E field is displayed on the "Dipole Area Scan Interface" and the total E field is displayed on the "3D Interface".

2.2. Robot

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



- High precision (repeatability ± 0.03 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

2.3. E-Field Probe

This E-field detection probe is composed of three orthogonal dipoles linked to special Schottky diodes with low detection thresholds. The probe allows the measurement of electric fields in liquids such as the one defined in the IEEE and CENELEC standards.

For the measurements the Specific Dosimetric E-Field Probe SN 08/16 EPGO287 with following specifications is used



- Dynamic range: 0.01-100 W/kg
- Tip Diameter: 2.5 mm
- Distance between probe tip and sensor center: 1 mm
- Distance between sensor center and the inner phantom surface: 2 mm (repeatability better than ± 1 mm).
- Probe linearity: ± 0.08 dB
- Axial isotropy: 0.06 dB
- Hemispherical Isotropy: 0.08 dB
- Calibration range: 650MHz to 5900MHz for head & body simulating liquid.
- Lower detection limit: 7mW/kg

Angle between probe axis (evaluation axis) and surface normal line: less than 30°.

2.3.1. E-Field Probe Calibration

Each probe needs to be calibrated according to a dosimetric assessment procedure with accuracy better than $\pm 10\%$. The spherical isotropy shall be evaluated and within ± 0.25 dB. The sensitivity parameters (Norm X, Norm Y, and Norm Z), the diode compression parameter (DCP) and the conversion factor (Conv F) of the probe are tested. The calibration data can be referred to appendix D of this report.

2.4. SAM phantoms

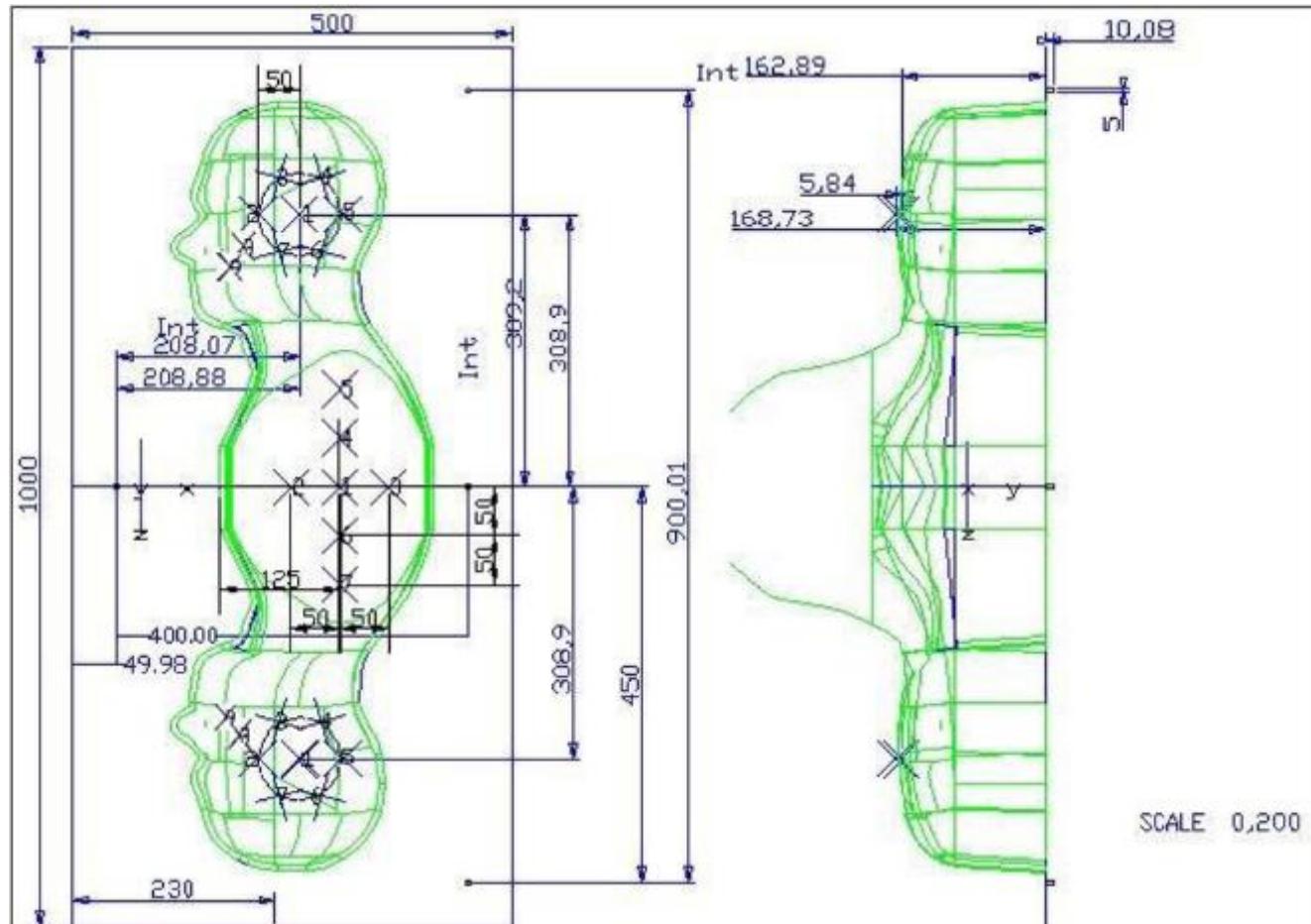
Photo of SAM phantom SN 16/15 SAM119



The SAM phantom is used to measure the SAR relative to people exposed to electro-magnetic field radiated by mobile phones.

2.4.1. Technical Data

Serial Number	Shell thickness	Filling volume	Dimensions	Positioner Material	Permittivity	Loss Tangent
SN 16/15 SAM119	2 mm ± 0.2 mm	27 liters	Length:1000 mm Width:500 mm Height:200 mm	Gelcoat with fiberglass	3.4	0.02

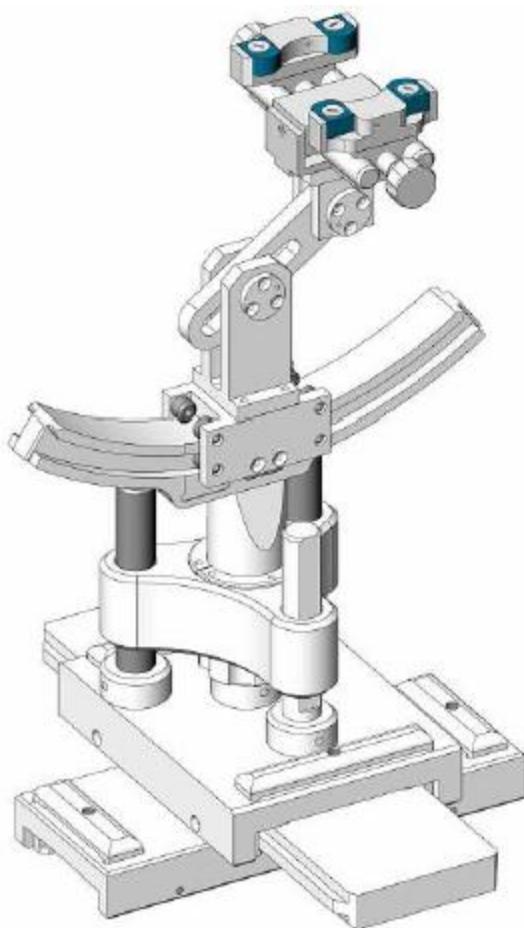


Serial Number	Left Head(mm)		Right Head(mm)		Flat Part(mm)	
SN 16/15 SAM119	2	2.02	2	2.08	1	2.09
	3	2.05	3	2.06	2	2.06
	4	2.07	4	2.07	3	2.08
	5	2.08	5	2.08	4	2.10
	6	2.05	6	2.07	5	2.10
	7	2.05	7	2.05	6	2.07
	8	2.07	8	2.06	7	2.07
	9	2.08	9	2.06	-	-

The test, based on ultrasonic system, allows measuring the thickness with an accuracy of 10 μ m.

2.5. Device Holder

The positioning system allows obtaining cheek and tilting position with a very good accuracy. In compliance with CENELEC, the tilt angle uncertainty is lower than 1 degree.



Serial Number	Holder Material	Permittivity	Loss Tangent
SN 16/15 MSH100	Delrin	3.7	0.005

2.6. Test Equipment List

This table gives a complete overview of the SAR measurement equipment.

Devices used during the test described are marked

	Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
					Last Cal.	Due Date
<input checked="" type="checkbox"/>	MVG	E FIELD PROBE	SSE2	SN 08/16 EPGO287	Sep. 17, 2018	Sep. 16, 2019
<input type="checkbox"/>	MVG	750 MHz Dipole	SID750	SN 03/15 DIP 0G750-355	Apr. 19, 2018	Apr. 18, 2021
<input checked="" type="checkbox"/>	MVG	835 MHz Dipole	SID835	SN 03/15 DIP 0G835-347	Apr. 19, 2018	Apr. 18, 2021
<input type="checkbox"/>	MVG	900 MHz Dipole	SID900	SN 03/15 DIP 0G900-348	Apr. 19, 2018	Apr. 18, 2021
<input type="checkbox"/>	MVG	1800 MHz Dipole	SID1800	SN 03/15 DIP 1G800-349	Apr. 19, 2018	Apr. 18, 2021
<input checked="" type="checkbox"/>	MVG	1900 MHz Dipole	SID1900	SN 03/15 DIP 1G900-350	Apr. 19, 2018	Apr. 18, 2021
<input type="checkbox"/>	MVG	2000 MHz Dipole	SID2000	SN 03/15 DIP 2G000-351	Apr. 19, 2018	Apr. 18, 2021
<input checked="" type="checkbox"/>	MVG	2450 MHz Dipole	SID2450	SN 03/15 DIP 2G450-352	Apr. 19, 2018	Apr. 18, 2021
<input type="checkbox"/>	MVG	2600 MHz Dipole	SID2600	SN 03/15 DIP 2G600-356	Apr. 19, 2018	Apr. 18, 2021
<input type="checkbox"/>	MVG	5000 MHz Dipole	SWG5500	SN 13/14 WGA 33	Apr. 19, 2018	Apr. 18, 2021
<input checked="" type="checkbox"/>	MVG	Liquid measurement Kit	SCLMP	SN 21/15 OCPG 72	NCR	NCR
<input checked="" type="checkbox"/>	MVG	Power Amplifier	N.A	AMPLISAR_28/14_003	NCR	NCR
<input checked="" type="checkbox"/>	KEITHLEY	Millivoltmeter	2000	4072790	NCR	NCR
<input checked="" type="checkbox"/>	R&S	Universal radio communication tester	CMU200	117858	Aug. 05, 2018	Aug. 04, 2019
<input type="checkbox"/>	R&S	Wideband radio communication tester	CMW500	103917	Oct. 08, 2018	Oct. 07, 2019
<input checked="" type="checkbox"/>	HP	Network Analyzer	8753D	3410J01136	Aug. 05, 2018	Aug. 04, 2019
<input checked="" type="checkbox"/>	Agilent	PSG Analog Signal Generator	E8257D	MY51110112	Aug. 05, 2018	Aug. 04, 2019

<input checked="" type="checkbox"/>	Agilent	Power meter	E4419B	MY45102538	Aug. 05, 2018	Aug. 04, 2019
<input checked="" type="checkbox"/>	Agilent	Power sensor	E9301A	MY41495644	Aug. 05, 2018	Aug. 04, 2019
<input checked="" type="checkbox"/>	Agilent	Power sensor	E9301A	US39212148	Aug. 05, 2018	Aug. 04, 2019
<input checked="" type="checkbox"/>	MCLI/USA	Directional Coupler	CB11-20	0D2L51502	Aug. 05, 2018	Aug. 04, 2019

3. SAR Measurement Procedures

The measurement procedures are as follows:

<Conducted power measurement>

- (a) For WWAN power measurement, use base station simulator to configure EUT WWAN transmission in conducted connection with RF cable, at maximum power in each supported wireless interface and frequency band.
- (b) Read the WWAN RF power level from the base station simulator.
- (c) For WLAN/Bluetooth power measurement, use engineering software to configure EUT WLAN/Bluetooth continuously transmission, at maximum RF power in each supported wireless interface and frequency band.
- (d) Connect EUT RF port through RF cable to the power meter, and measure WLAN/Bluetooth output power.

<SAR measurement>

- (a) Use base station simulator to configure EUT WWAN transmission in radiated connection, and engineering software to configure EUT WLAN/Bluetooth continuously transmission, at maximum RF power, in the highest power channel.
- (b) Place the EUT in the positions as Appendix A demonstrates.
- (c) Set scan area, grid size and other setting on the OPENSAR software.
- (d) Measure SAR results for the highest power channel on each testing position.
- (e) Find out the largest SAR result on these testing positions of each band.
- (f) Measure SAR results for other channels in worst SAR testing position if the reported SAR of highest power channel is larger than 0.8 W/kg.

According to the 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

3.1. Power Reference

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

3.2. Area scan & Zoom scan

The area scan is a 2D scan to find the hot spot location on the DUT. The zoom scan is a 3D scan

above the hot spot to calculate the 1g and 10g SAR value.

Measurement of the SAR distribution with a grid of 8 to 16 mm * 8 to 16 mm and a constant distance to the inner surface of the phantom. Since the sensors cannot directly measure at the inner phantom surface, the values between the sensors and the inner phantom surface are extrapolated. With these values the area of the maximum SAR is calculated by an interpolation scheme. Around this point, a cube of 30 * 30 * 30 mm or 32 * 32 * 32 mm is assessed by measuring 5 or 8 * 5 or 8 * 4 or 5 mm. With these data, the peak spatial-average SAR value can be calculated.

From the scanned SAR distribution, identify the position of the maximum SAR value, in addition identify the positions of any local maxima with SAR values within 2 dB of the maximum value that will not be within the zoom scan of other peaks; additional peaks shall be measured only when the primary peak is within 2 dB of the SAR compliance limit (e.g., 1 W/kg for 1,6 W/kg 1 g limit, or 1,26 W/kg for 2 W/kg, 10 g limit).

Area scan & Zoom scan scan parameters extracted from FCC KDB 865664 D01 SAR measurement 100 MHz to 6 GHz.

		≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface		5 ± 1 mm	$\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location		$30^\circ \pm 1^\circ$	$20^\circ \pm 1^\circ$
		≤ 2 GHz: ≤ 15 mm $2 - 3$ GHz: ≤ 12 mm	$3 - 4$ GHz: ≤ 12 mm $4 - 6$ GHz: ≤ 10 mm
Maximum area scan spatial resolution: Δx_{Area} , Δy_{Area}		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 \leq 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: Δx_{Zoom} , Δy_{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: $\Delta z_{\text{Zoom}}(n)$		$3 - 4$ GHz: ≤ 4 mm $4 - 5$ GHz: ≤ 3 mm $5 - 6$ GHz: ≤ 2 mm
	graded grid	$\Delta z_{\text{Zoom}}(1)$: between 1 st two points closest to phantom surface	≤ 4 mm
		$\Delta z_{\text{Zoom}}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{\text{Zoom}}(n-1)$
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: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 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 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.			

3.3. Description of interpolation/extrapolation scheme

The local SAR inside the phantom is measured using small dipole sensing elements inside a probe body. The probe tip must not be in contact with the phantom surface in order to minimise measurements errors, but the highest local SAR will occur at the surface of the phantom.

An extrapolation is used to determinate this highest local SAR values. The extrapolation is based on a fourth-order least-square polynomial fit of measured data. The local SAR value is then extrapolated from the liquid surface with a 1 mm step.

The measurements have to be performed over a limited time (due to the duration of the battery) so the step of measurement is high. It could vary between 5 and 8 mm. To obtain an accurate assessment of the maximum SAR averaged over 10 grams and 1 gram requires a very fine resolution in the three dimensional scanned data array.

3.4. Volumetric Scan

The volumetric scan consists to a full 3D scan over a specific area. This 3D scan is useful for multi Tx SAR measurement. Indeed, it is possible with OpenSAR to add, point by point, several volumetric scan to calculate the SAR value of the combined measurement as it is defined in the standard IEEE1528 and IEC62209.

3.5. Power Drift

All SAR testing is under the EUT installed full charged battery and transmit maximum output power. In OpenSAR 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. The software will calculate the field difference in V/m. If the power drifts more than $\pm 5\%$, the SAR will be retested.

4. System Verification Procedure

4.1. Tissue Verification

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

Ingredients (% of weight)	Head Tissue									
	750	835	900	1800	1900	2000	2450	2600	5200	5800
Frequency Band (MHz)	750	835	900	1800	1900	2000	2450	2600	5200	5800
Water	34.40	34.40	34.40	55.36	55.36	57.87	57.87	57.87	65.53	65.53
NaCl	0.79	0.79	0.79	0.35	0.35	0.16	0.16	0.16	0.00	0.00
1,2-Propanediol	64.81	64.81	64.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Triton X-100	0.00	0.00	0.00	30.45	30.45	19.97	19.97	19.97	24.24	24.24
DGBE	0.00	0.00	0.00	13.84	13.84	22.00	22.00	22.00	10.23	10.23
Ingredients (% of weight)	Body Tissue									
	750	835	900	1800	1900	2000	2450	2600	5200	5800
Frequency Band (MHz)	750	835	900	1800	1900	2000	2450	2600	5200	5800
Water	50.30	50.30	50.30	69.91	69.91	71.88	71.88	71.88	79.54	79.54
NaCl	0.60	0.60	0.60	0.13	0.13	0.16	0.16	0.16	0.00	0.00
1,2-Propanediol	49.10	49.10	49.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Triton X-100	0.00	0.00	0.00	9.99	9.99	19.97	19.97	19.97	11.24	11.24
DGBE	0.00	0.00	0.00	19.97	19.97	7.99	7.99	7.99	9.22	9.22

4.1.1. Tissue Dielectric Parameter Check Results

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine if the dielectric parameter are within the tolerances of the specified target values. The measured conductivity and relative permittivity should be within $\pm 5\%$ of the target values.

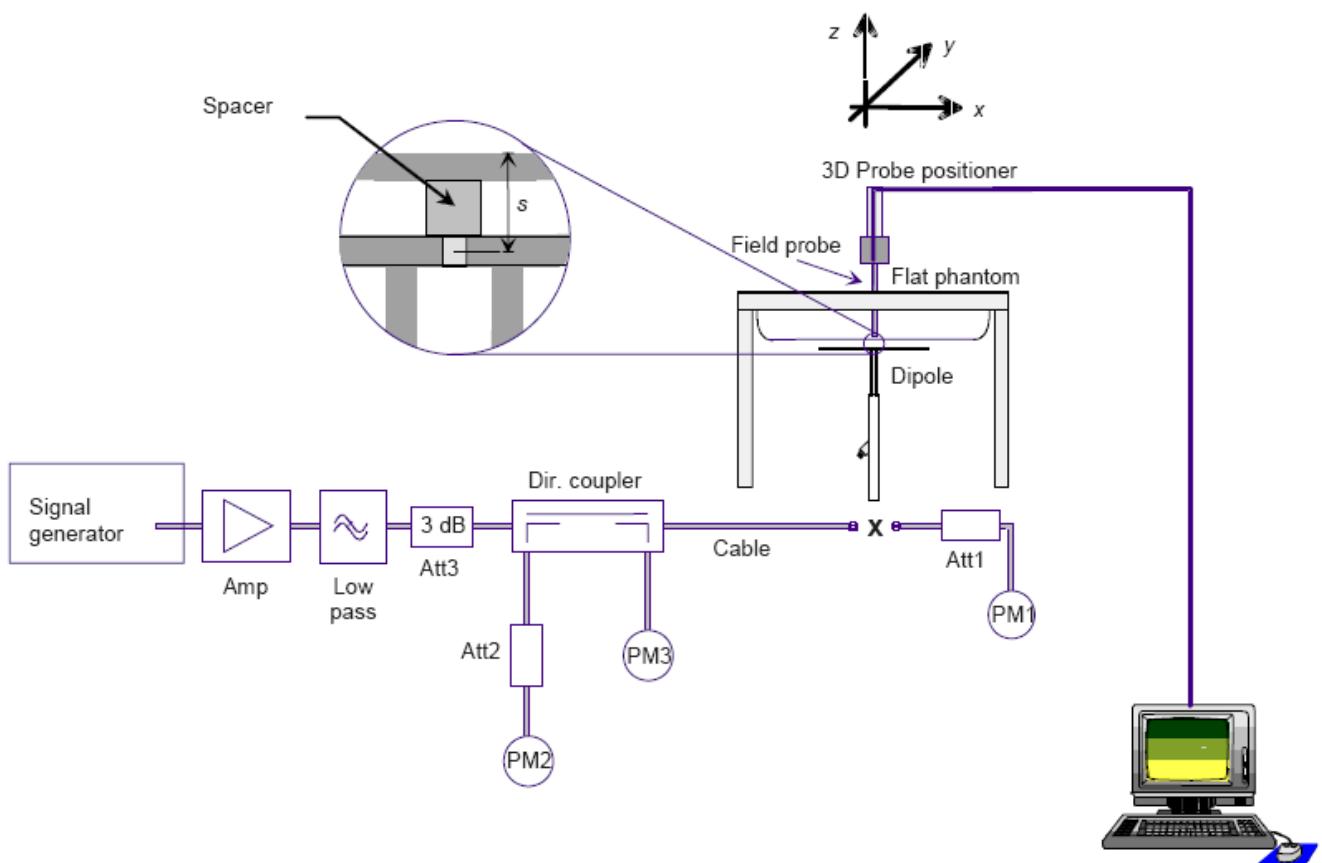
Tissue Type	Measured Frequency (MHz)	Target Tissue		Measured Tissue		Liquid Temp.	Test Date
		ϵ_r ($\pm 5\%$)	σ (S/m) ($\pm 5\%$)	ϵ_r	σ (S/m)		
Body 850	835	55.20 (52.44~57.96)	0.97 (0.92~1.01)	54.86	1.00	21.2 °C	Nov. 26, 2018
Body 1900	1900	53.30 (50.64~55.96)	1.52 (1.44~1.59)	53.16	1.54	21.3 °C	Nov. 22, 2018
Body 2450	2450	52.70 (50.07~55.33)	1.95 (1.85~2.04)	52.69	1.98	21.6 °C	Nov. 28, 2018

NOTE: The dielectric parameters of the tissue-equivalent liquid should be measured under similar ambient conditions and within 2 °C of the conditions expected during the SAR evaluation to satisfy protocol requirements.

4.2. System Verification Procedure

The system verification is performed for verifying the accuracy of the complete measurement system and performance of the software. The dipole is connected to the signal source consisting of signal generator and amplifier via a directional coupler, N-connector cable and adaption to SMA. It is fed with a power of 100mW (below 5GHz) or 100mW (above 5GHz). To adjust this power a power meter is used. The power sensor is connected to the cable before the system verification to measure the power at this point and do adjustments at the signal generator. At the outputs of the directional coupler both return loss as well as forward power are controlled during the system verification to make sure that emitted power at the dipole is kept constant. This can also be checked by the power drift measurement after the test (result on plot).

The system verification is shown as below picture:



4.2.1. System Verification Results

Comparing to the original SAR value provided by SATIMO, the verification data should be within its specification of $\pm 10\%$. Below table shows the target SAR and measured SAR after normalized to 1W input power. The table below indicates the system performance verification can meet the variation criterion and the plots can be referred to Appendix B of this report.

System Verification	Target SAR (1W) ($\pm 10\%$)		Measured SAR (Normalized to 1W)		Liquid Temp.	Test Date
	1-g (W/Kg)	10-g (W/Kg)	1-g (W/Kg)	10-g (W/Kg)		
835MHz Body	9.48 (8.53~10.42)	6.29 (5.66~6.91)	9.53	6.33	21.2 °C	Nov. 26, 2018
1900MHz Body	38.43 (34.59~42.27)	20.34 (18.31~22.37)	40.23	19.85	21.3 °C	Nov. 22, 2018
2450MHz Body	49.32 (44.39~54.25)	22.89 (20.60~25.17)	50.72	22.81	21.6 °C	Nov. 28, 2018

5. SAR Measurement variability and uncertainty

5.1. SAR measurement variability

Per KDB865664 D01 SAR measurement 100 MHz to 6 GHz, SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. The 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 $< 0.80 \text{ W/kg}$; steps 2) through 4) do not apply.
- 2) When the original highest measured SAR is $\geq 0.80 \text{ W/kg}$, 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 $\geq 1.45 \text{ W/kg}$ ($\sim 10\%$ from the 1-g SAR limit).
- 4) Perform a third repeated measurement only if the original, first or second repeated measurement is $\geq 1.5 \text{ W/kg}$ and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20 .

5.2. SAR measurement uncertainty

Per KDB865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is $< 1.5 \text{ W/kg}$, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval. The equivalent ratio (1.5/1.6) is applied to extremity and occupational exposure conditions.

6. RF Exposure Positions

6.1. Wireless Router Devices

Some battery-operated handsets have the capability to transmit and receive user through simultaneous transmission of WLAN simultaneously with a separate licensed transmitter. The FCC has provided guidance in FCC KDB Publication 941225 D06 where SAR test considerations for handsets ($L \times W \geq 9 \text{ cm} \times 5 \text{ cm}$) are based on a composite test separation distance of 10mm from the front, back and edges of the device containing transmitting antennas within 2.5cm of their edges, determined from general mixed use conditions for this type of devices. Since the hotspot SAR results may overlap with the body-worn accessory SAR requirements, the more conservative configurations can be considered, thus excluding some body-worn accessory SAR tests.

When the user enables the personal wireless router functions for the handset, actual operations include simultaneous transmission of both the WLAN transmitter and another licensed transmitter. Both transmitters often do not transmit at the same transmitting frequency and thus cannot be evaluated for SAR under actual use conditions due to the limitations of the SAR assessment probes. Therefore, SAR must be evaluated for each frequency transmission and mode separately and spatially summed with the WLAN transmitter according to FCC KDB Publication 447498 D01 publication procedures. The “Portable Hotspot” feature on the handset was NOT activated during SAR assessments, to ensure the SAR measurements were evaluated for a single transmission frequency RF signal at a time.

7. RF Output Power

7.1. Maximum Tune-up Limit

Band	Mode	The Tune-up Maximum Power (Customer Declared)(dBm)	Range	Measured Maximum Output Power(dBm)
GSM 850	GSM Voice	32±1	31~33	32.53
	GPRS	32±1	31~33	32.50
GSM 1900	GSM Voice	29.5±1	28.5~30.5	30.13
	GPRS	29.5±1	28.5~30.5	30.13
WCDMA Band V	RMC 12.2Kbps	23±1	22~24	23.62
	HSDPA	22±1	21~23	22.64
	HSUPA	22±1	21~23	22.64
WCDMA Band II	RMC 12.2Kbps	22±1	21~23	22.44
	HSDPA	21±1	20~22	21.43
	HSUPA	21±1	20~22	21.43
WLAN 2.4G	802.11b	14.5±1	13.5~15.5	15.3
	802.11g	13.5±1	12.5~14.5	13.4
	802.11n20	13.5±1	12.5~14.5	13.4
	802.11n40	13.5±1	12.5~14.5	14.2
Bluetooth	BR	3±1	2~4	3.85
	EDR	2±1	1~3	2.77
	BLE	2±1	1~3	2.78

7.2. GSM Conducted Power

Band GSM850	Burst-Averaged output Power (dBm)				Frame-Averaged output Power (dBm)			
Tx Channel	Tune-up (dBm)	128	189	251	Tune-up (dBm)	128	189	251
Frequency (MHz)		824.2	836.4	848.8		824.2	836.4	848.8
GSM (GMSK)	33.00	32.47	32.53	32.48	23.97	23.44	23.50	23.45
GPRS(GMSK, 1 TS)	33.00	32.45	32.50	32.49	23.97	23.42	23.47	23.46
GPRS(GMSK, 2 TS)	31.00	29.66	30.00	30.04	24.98	23.64	23.98	24.02
GPRS(GMSK, 3 TS)	29.00	27.27	27.69	27.93	24.74	23.01	23.43	23.67
GPRS(GMSK, 4 TS)	28.00	26.62	26.73	27.08	24.99	23.61	23.72	24.07
Band GSM1900	Burst-Averaged output Power (dBm)				Frame-Averaged output Power (dBm)			
Tx Channel	Tune-up (dBm)	512	661	810	Tune-up (dBm)	512	661	810
Frequency (MHz)		1850.2	1880.0	1909.8		1850.2	1880.0	1909.8
GSM (GMSK)	30.50	30.13	29.79	29.83	21.47	21.10	20.76	20.80
GPRS(GMSK, 1 TS)	30.50	30.13	29.78	29.83	21.47	21.10	20.75	20.80

GPRS(GMSK, 2 TS)	28.50	28.06	28.10	28.11	22.48	22.04	22.08	22.09
GPRS(GMSK, 3 TS)	26.50	25.79	25.93	26.08	22.24	21.53	21.67	21.82
GPRS(GMSK, 4 TS)	25.50	24.73	24.93	25.11	22.49	21.72	21.92	22.10

Note: The frame-averaged power is linearly scaled the maximum burst averaged power over 8 time slots.

The calculated method are shown as below:

Frame-averaged power = Maximum burst averaged power (1 TS) - 9.03 dB

Frame-averaged power = Maximum burst averaged power (2 TS) - 6.02 dB

Frame-averaged power = Maximum burst averaged power (3 TS) - 4.26 dB

Frame-averaged power = Maximum burst averaged power (4 TS) - 3.01 dB

7.3. WCDMA Conducted Power

Band	WCDMA Band V			
Tx Channel	Tune-up	4132	4182	4233
Frequency (MHz)		826.4	836.4	846.6
RMC 12.2Kbps	24.00	23.62	23.54	23.60
HSDPA Subtest-1	23.00	22.62	22.64	22.64
HSDPA Subtest-2	23.00	22.23	22.15	22.14
HSDPA Subtest-3	23.00	22.23	22.16	22.13
HSDPA Subtest-4	23.00	22.16	22.18	22.12
HSUPA Subtest-1	23.00	22.13	22.18	22.16
HSUPA Subtest-2	23.00	22.10	22.16	22.19
HSUPA Subtest-3	23.00	22.18	22.12	22.08
HSUPA Subtest-4	23.00	22.12	22.19	22.05
HSUPA Subtest-5	23.00	22.56	22.62	22.64
Band	WCDMA Band II			
Tx Channel	Tune-up	9262	9400	9538
Frequency (MHz)		1852.4	1880	1907.6
RMC 12.2Kbps	23.00	22.44	22.26	22.40
HSDPA Subtest-1	22.00	21.43	21.23	21.43
HSDPA Subtest-2	22.00	20.94	20.71	20.90
HSDPA Subtest-3	22.00	20.92	20.72	20.87
HSDPA Subtest-4	22.00	20.89	20.70	20.86
HSUPA Subtest-1	22.00	20.89	20.71	20.91
HSUPA Subtest-2	22.00	20.85	20.72	20.88
HSUPA Subtest-3	22.00	20.86	20.68	20.85
HSUPA Subtest-4	22.00	20.92	20.78	20.83
HSUPA Subtest-5	22.00	21.43	21.19	21.36

7.4. WLAN 2.4G Output Power

Mode	Channel	Frequency (MHz)	Tune-up	Output Power (dBm)
802.11b	1	2412	15.5	15.3
	6	2437	15.5	15.2
	11	2462	15.5	15.2
802.11g	1	2412	14.5	13.2
	6	2437	14.5	13.4
	11	2462	14.5	13.3
802.11n 20M	1	2412	14.5	13.2
	6	2437	14.5	13.4
	11	2462	14.5	13.3
802.11n 40M	3	2422	14.5	13.7
	6	2437	14.5	13.5
	9	2452	14.5	14.2

7.5. Bluetooth Output Power

BR+EDR	Output Power (dBm)				
	Channel	Tune-up	Data Rates		
			0CH	39CH	78CH
	1M	4.00	2.71	3.35	3.85
	2M	3.00	1.30	1.73	2.57
	3M	3.00	1.77	2.08	2.77

BLE	Channel	Tune-up	Output Power (dBm)
	0CH	3.00	2.66
	19CH	3.00	2.78
	39CH	3.00	2.13

8. Antenna Location



Left Side

Distance of the Antenna to the EUT surface/edge						
Antennas	Front Side	Back Side	Left Side	Right Side	Top Side	Bottom Side
WWAN Main	≤ 25mm	≤ 25mm	≤ 25mm	≤ 25mm	>25mm	≤ 25mm
WLAN & Bluetooth	≤ 25mm	≤ 25mm	≤ 25mm	>25mm	≤ 25mm	>25mm
Positions for SAR tests						
Antennas	Front Side	Back Side	Left Side	Right Side	Top Side	Bottom Side
WWAN Main	Yes	Yes	Yes	Yes	NO	Yes
WLAN & Bluetooth	Yes	Yes	Yes	NO	Yes	NO

9. Stand-alone SAR test exclusion

Refer to FCC KDB 447498D01, the 1-g SAR and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f_{(\text{GHz})}}]$
 ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where:

- $f_{(\text{GHz})}$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

Mode	P_{max} (dBm)	P_{max} (mW)	Distance (mm)	f (GHz)	Calculation Result	SAR Exclusion threshold	SAR test exclusion
Bluetooth	4.00	2.51	5	2.480	0.79	3.0	Yes

NOTE: Standalone SAR test exclusion for Bluetooth

When standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] * [\sqrt{f_{(\text{GHz})}}/x]$ W/kg for test separation distances ≤ 50 mm, where $x = 7.5$ for 1-g SAR and $x = 18.75$ for 10-g SAR.

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

Mode	Position	P_{max} (dBm)	P_{max} (mW)	Distance (mm)	f (GHz)	x	Estimated SAR (W/Kg)
Bluetooth	Hotspot	4.00	2.51	10	2.480	7.5	0.053

NOTE: Estimated SAR calculation for Bluetooth

10. SAR Results

10.1. SAR measurement results

10.1.1. SAR measurement Result of GSM850

Test Position of Hotspot with 10mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)
			1g	10g				
Front Side	189/836.4	GPRS(GMSK 4TS)	0.374	0.263	-0.66	26.73	28.00	0.501
Back Side	189/836.4	GPRS(GMSK 4TS)	0.368	0.264	-0.86	26.73	28.00	0.493
Left Side	189/836.4	GPRS(GMSK 4TS)	0.124	0.091	-1.42	26.73	28.00	0.166
Right Side	189/836.4	GPRS(GMSK 4TS)	0.177	0.128	0.16	26.73	28.00	0.237
Bottom Side	189/836.4	GPRS(GMSK 4TS)	0.069	0.047	-1.85	26.73	28.00	0.092

NOTE: Hotspot SAR test results of GSM850

10.1.2. SAR measurement Result of GSM1900

Test Position of Hotspot with 10mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)
			1g	10g				
Front Side	661/1880	GPRS(GMSK 4TS)	0.215	0.137	4.99	24.93	25.50	0.245
Back Side	661/1880	GPRS(GMSK 4TS)	0.292	0.189	-3.70	24.93	25.50	0.333
Left Side	661/1880	GPRS(GMSK 4TS)	0.201	0.123	0.21	24.93	25.50	0.229
Right Side	661/1880	GPRS(GMSK 4TS)	0.187	0.101	1.25	24.93	25.50	0.213
Bottom Side	661/1880	GPRS(GMSK 4TS)	0.170	0.089	0.36	24.93	25.50	0.194

NOTE: Hotspot SAR test results of GSM1900

10.1.3. SAR measurement Result of WCDMA Band V

Test Position of Hotspot with 10mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)
			1g	10g				
Front Side	4182/836.4	RMC12.2K	0.347	0.245	0.09	23.54	24.00	0.386
Back Side	4182/836.4	RMC12.2K	0.254	0.189	0.38	23.54	24.00	0.282
Left Side	4182/836.4	RMC12.2K	0.095	0.069	-0.56	23.54	24.00	0.106
Right Side	4182/836.4	RMC12.2K	0.151	0.091	-0.16	23.54	24.00	0.168

Bottom Side	4182/836.4	RMC12.2K	0.054	0.037	-0.66	23.54	24.00	0.060
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NOTE: Hotspot SAR test results of WCDMA Band V

10.1.4. SAR measurement Result of WCDMA Band II

Test Position of Hotspot with 10mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)
			1g	10g				
Front Side	9400/1880	RMC12.2K	0.260	0.164	1.56	22.26	23.00	0.308
Back Side	9400/1880	RMC12.2K	0.433	0.271	-2.60	22.26	23.00	0.513
Left Side	9400/1880	RMC12.2K	0.211	0.121	0.25	22.26	23.00	0.250
Right Side	9400/1880	RMC12.2K	0.243	0.140	1.47	22.26	23.00	0.288
Bottom Side	9400/1880	RMC12.2K	0.197	0.101	-2.87	22.26	23.00	0.234

NOTE: Hotspot SAR test results of WCDMA Band II

10.1.5. SAR measurement Result of WLAN 2.4G

Test Position of Hotspot with 10mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)
			1g	10g				
Front Side	6/2437	802.11 b	0.170	0.105	0.74	15.20	15.50	0.182
Back Side	6/2437	802.11 b	0.222	0.129	-1.28	15.20	15.50	0.238
Left Side	6/2437	802.11 b	0.128	0.087	3.44	15.20	15.50	0.137
Top Side	6/2437	802.11 b	0.123	0.079	-0.71	15.20	15.50	0.132

NOTE: Hotspot SAR test results of WLAN 2.4G

10.2. SAR Summation Scenario

Per KDB 447498 D01, simultaneous transmission SAR is compliant if,

- 1) Scalar SAR summation < 1.6W/kg.
- 2) SPLSR = $(\text{SAR}_1 + \text{SAR}_2)^{1.5} / (\text{min. separation distance, mm})$, and the peak separation distance is determined from the square root of $[(x_1-x_2)^2 + (y_1-y_2)^2 + (z_1-z_2)^2]$, where (x_1, y_1, z_1) and (x_2, y_2, z_2) are the coordinates of the extrapolated peak SAR locations in the zoom scan. If $\text{SPLSR} \leq 0.04$, simultaneously transmission SAR measurement is not necessary.

Test Position		Scaled SAR _{MAX}		$\Sigma 1\text{-g SAR}$ (W/Kg)	SPLSR	Remark
		GSM 850	WLAN 2.4G			
Hotspot	Front Side	0.501	0.182	0.683	N/A	N/A
	Back Side	0.493	0.238	0.731	N/A	N/A
	Left Side	0.166	0.137	0.303	N/A	N/A
	Right Side	0.237	N/A	0.237	N/A	N/A
	Top Side	N/A	0.132	0.132	N/A	N/A
	Bottom Side	0.092	N/A	0.092	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of GSM850 and WLAN 2.4G

Test Position		Scaled SAR _{MAX}		$\Sigma 1\text{-g SAR}$ (W/Kg)	SPLSR	Remark
		GSM 1900	WLAN 2.4G			
Hotspot	Front Side	0.245	0.182	0.427	N/A	N/A
	Back Side	0.333	0.238	0.571	N/A	N/A
	Left Side	0.229	0.137	0.366	N/A	N/A
	Right Side	0.213	N/A	0.213	N/A	N/A
	Top Side	N/A	0.132	0.132	N/A	N/A
	Bottom Side	0.194	N/A	0.194	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of GSM1900 and WLAN 2.4G

Test Position		Scaled SAR _{MAX}		$\Sigma 1\text{-g SAR}$ (W/Kg)	SPLSR	Remark
		WCDMA Band V	WLAN 2.4G			
Hotspot	Front Side	0.386	0.182	0.568	N/A	N/A
	Back Side	0.282	0.238	0.520	N/A	N/A
	Left Side	0.106	0.137	0.243	N/A	N/A
	Right Side	0.168	N/A	0.168	N/A	N/A
	Top Side	N/A	0.132	0.132	N/A	N/A
	Bottom Side	0.060	N/A	0.060	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of WCDMA Band V and WLAN 2.4G

Test Position		Scaled SAR _{MAX}		$\Sigma 1\text{-g SAR}$ (W/Kg)	SPLSR	Remark
		WCDMA	WLAN 2.4G			

		Band II				
Hotspot	Front Side	0.308	0.182	0.490	N/A	N/A
	Back Side	0.513	0.238	0.751	N/A	N/A
	Left Side	0.250	0.137	0.387	N/A	N/A
	Right Side	0.288	N/A	0.288	N/A	N/A
	Top Side	N/A	0.132	0.132	N/A	N/A
	Bottom Side	0.234	N/A	0.234	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of WCDMA Band II and WLAN 2.4G

Test Position		Scaled SAR _{MAX}		Σ 1-g SAR (W/Kg)	SPLSR	Remark
		GSM 850	Bluetooth			
Hotspot	Front Side	0.501	0.053	0.554	N/A	N/A
	Back Side	0.493	0.053	0.546	N/A	N/A
	Left Side	0.166	0.053	0.219	N/A	N/A
	Right Side	0.237	N/A	0.237	N/A	N/A
	Top Side	N/A	0.053	0.053	N/A	N/A
	Bottom Side	0.092	N/A	0.092	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of GSM850 and Bluetooth

Test Position		Scaled SAR _{MAX}		Σ 1-g SAR (W/Kg)	SPLSR	Remark
		GSM 1900	Bluetooth			
Hotspot	Front Side	0.245	0.053	0.298	N/A	N/A
	Back Side	0.333	0.053	0.386	N/A	N/A
	Left Side	0.229	0.053	0.282	N/A	N/A
	Right Side	0.213	N/A	0.213	N/A	N/A
	Top Side	N/A	0.053	0.053	N/A	N/A
	Bottom Side	0.194	N/A	0.194	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of GSM1900 and Bluetooth

Test Position		Scaled SAR _{MAX}		Σ 1-g SAR (W/Kg)	SPLSR	Remark
		WCDMA Band V	Bluetooth			
Hotspot	Front Side	0.386	0.053	0.439	N/A	N/A
	Back Side	0.282	0.053	0.335	N/A	N/A
	Left Side	0.106	0.053	0.158	N/A	N/A
	Right Side	0.168	N/A	0.168	N/A	N/A
	Top Side	N/A	0.053	0.053	N/A	N/A
	Bottom Side	0.060	N/A	0.060	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of WCDMA Band V and Bluetooth

Test Position		Scaled SAR _{MAX}		Σ 1-g SAR (W/Kg)	SPLSR	Remark
		WCDMA	Bluetooth			

		Band II				
Hotspot	Front Side	0.308	0.053	0.361	N/A	N/A
	Back Side	0.513	0.053	0.566	N/A	N/A
	Left Side	0.250	0.053	0.303	N/A	N/A
	Right Side	0.288	N/A	0.288	N/A	N/A
	Top Side	N/A	0.053	0.053	N/A	N/A
	Bottom Side	0.234	N/A	0.234	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of WCDMA Band II and Bluetooth

11. Appendix A. Photo documentation

Refer to appendix Test Setup photo---SAR

12. Appendix B. System Check Plots

Table of contents

MEASUREMENT 1 System Performance Check - SID835 - Body

MEASUREMENT 2 System Performance Check - SID1900 - Body

MEASUREMENT 3 System Performance Check - SID2450 - Body

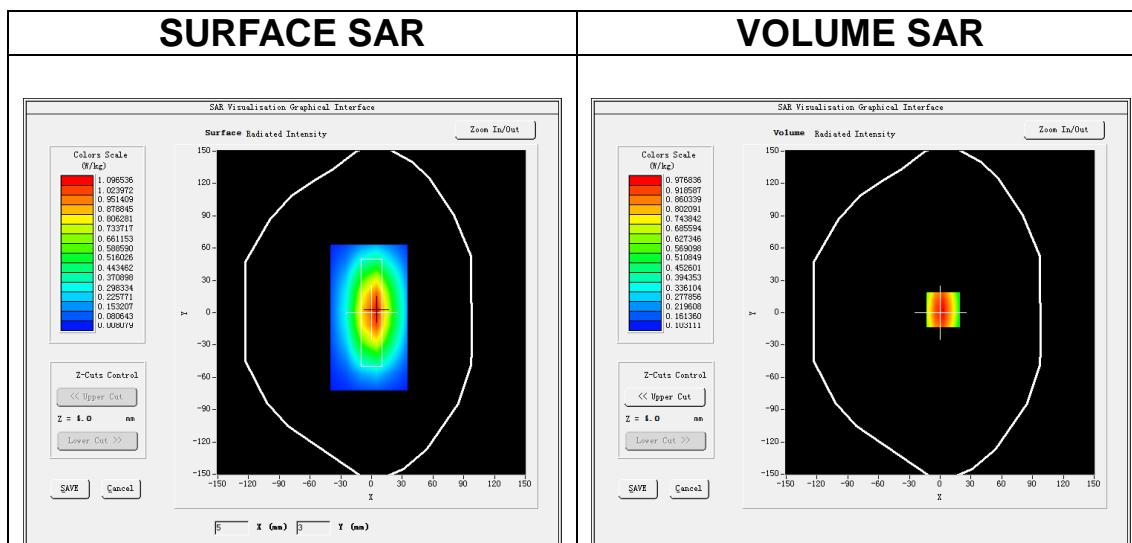
MEASUREMENT 1

A. Experimental conditions.

<u>Area Scan</u>	<u>$dx=15\text{mm}$ $dy=15\text{mm}$, $h= 5.00\text{ mm}$</u>
<u>ZoomScan</u>	<u>$5\times 5\times 7, dx=8\text{mm}$ $dy=8\text{mm}$ $dz=5\text{mm}$</u>
<u>Phantom</u>	<u>Validation plane</u>
<u>Device Position</u>	<u>Dipole</u>
<u>Band</u>	<u>CW835</u>
<u>Channels</u>	<u>Low</u>
<u>Signal</u>	<u>CW (Crest factor: 1.0)</u>

B. SAR Measurement Results

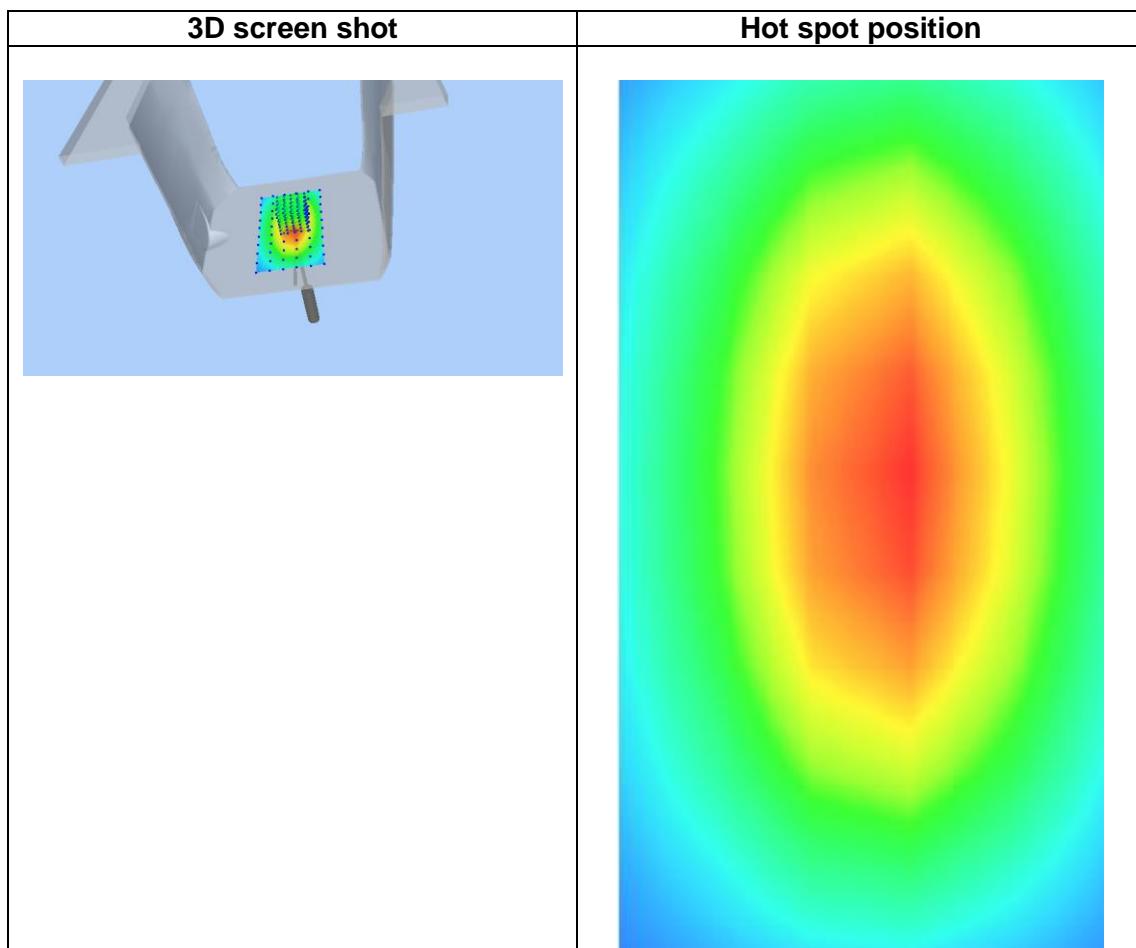
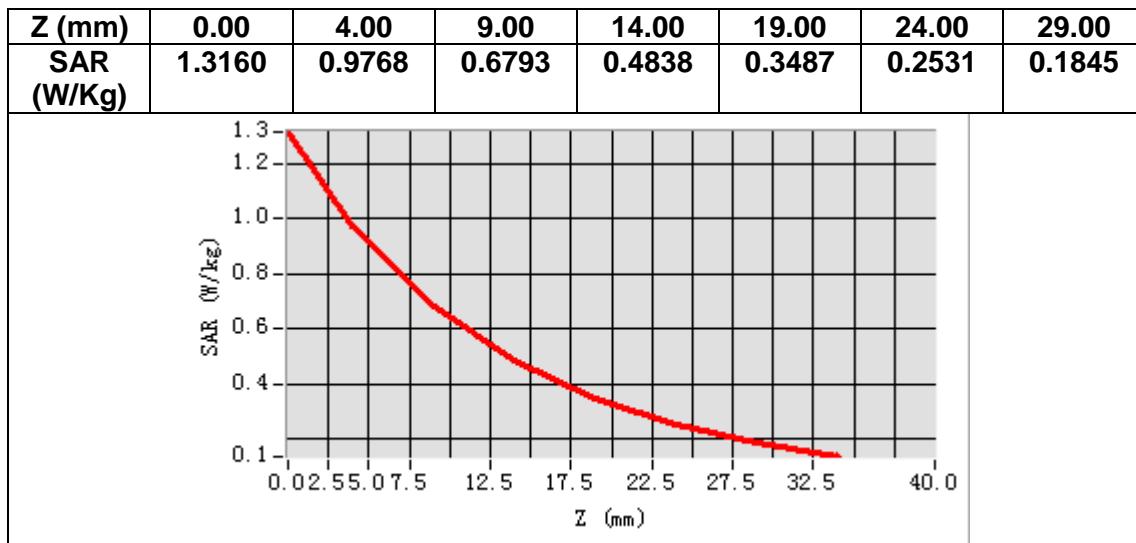
Frequency (MHz)	835.000000
Relative permittivity (real part)	54.862426
Relative permittivity (imaginary part)	21.553465
Conductivity (S/m)	1.002594
Variation (%)	-0.200000



Maximum location: $X=3.00$, $Y=3.00$

SAR Peak: 1.32 W/kg

SAR 10g (W/Kg)	0.632557
SAR 1g (W/Kg)	0.952698



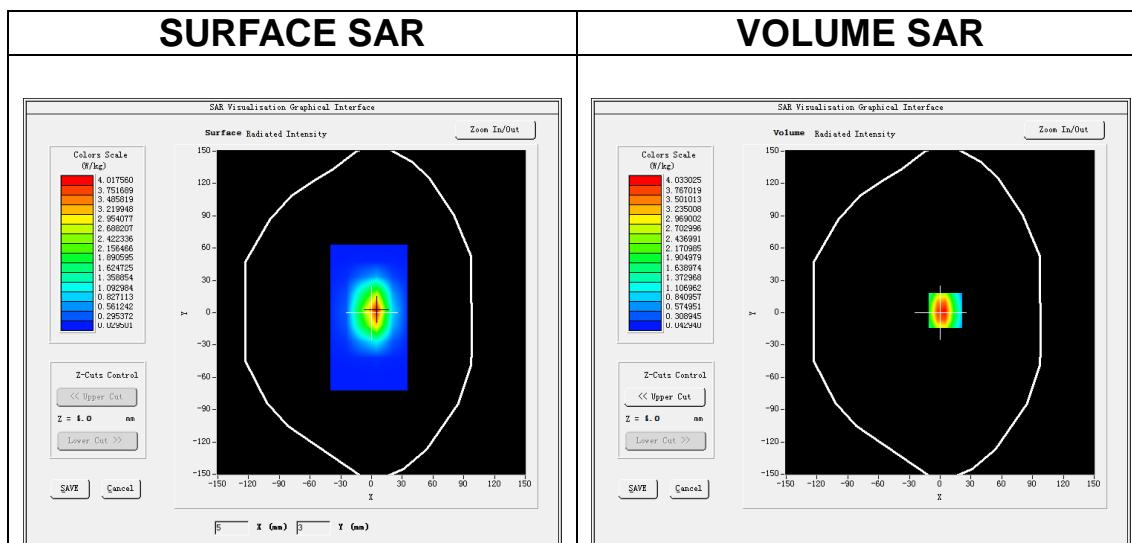
MEASUREMENT 2

A. Experimental conditions.

<u>Area Scan</u>	<u>$dx=15\text{mm}$ $dy=15\text{mm}$, $h= 5.00\text{ mm}$</u>
<u>ZoomScan</u>	<u>$5\times 5\times 7, dx=8\text{mm}$ $dy=8\text{mm}$ $dz=5\text{mm}$</u>
<u>Phantom</u>	<u>Validation plane</u>
<u>Device Position</u>	<u>Dipole</u>
<u>Band</u>	<u>CW1900</u>
<u>Channels</u>	<u>Middle</u>
<u>Signal</u>	<u>CW (Crest factor: 1.0)</u>

B. SAR Measurement Results

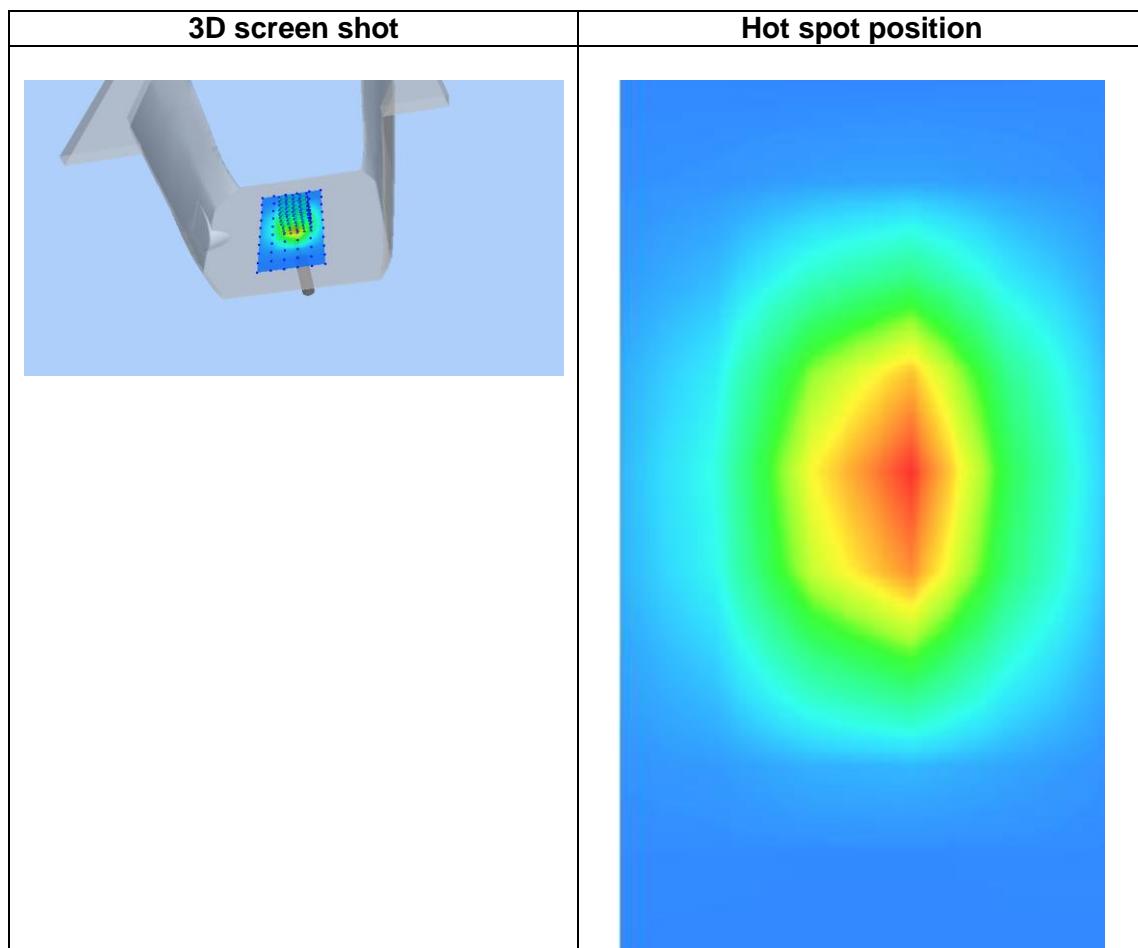
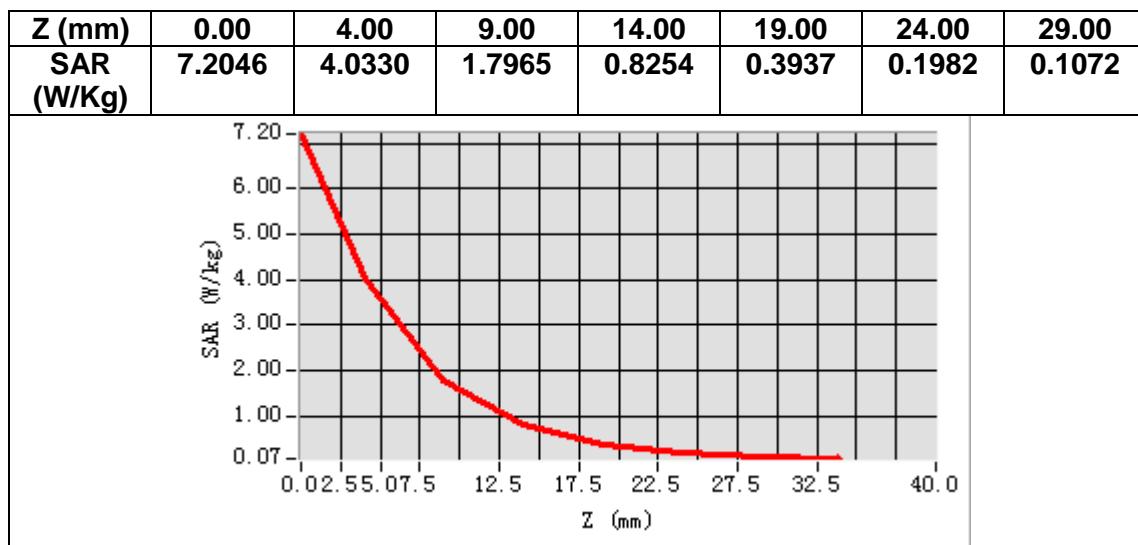
Frequency (MHz)	1900.000000
Relative permittivity (real part)	53.164601
Relative permittivity (imaginary part)	14.622000
Conductivity (S/m)	1.544600
Variation (%)	-0.300000



Maximum location: X=5.00, Y=2.00

SAR Peak: 7.57 W/kg

SAR 10g (W/Kg)	1.984782
SAR 1g (W/Kg)	4.023296



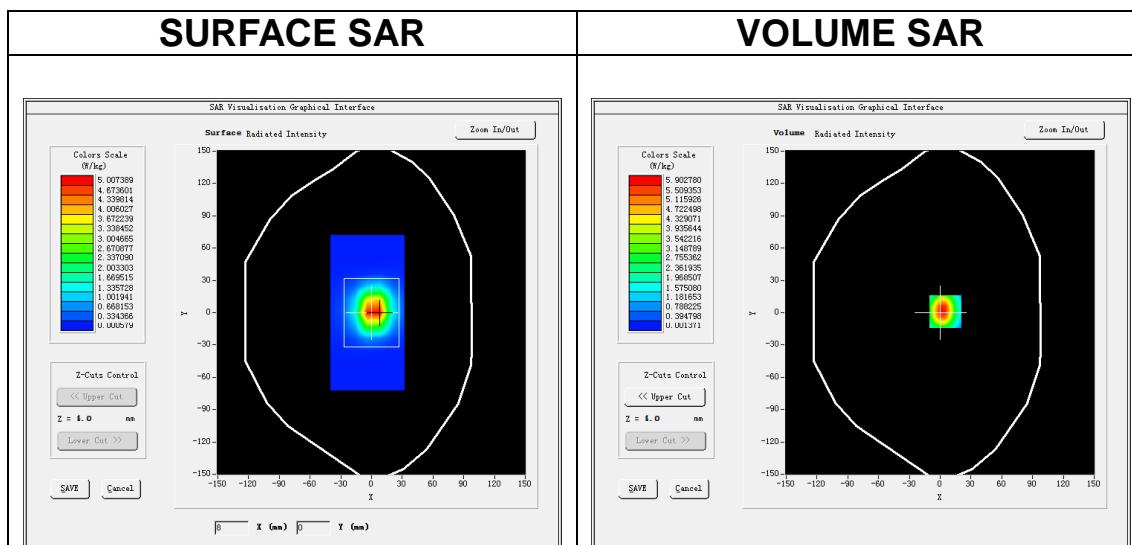
MEASUREMENT 3

A. Experimental conditions.

<u>Area Scan</u>	<u>dx=12mm dy=12mm, h= 5.00 mm</u>
<u>ZoomScan</u>	<u>7x7x7,dx=5mm dy=5mm dz=5mm</u>
<u>Phantom</u>	<u>Validation plane</u>
<u>Device Position</u>	<u>Dipole</u>
<u>Band</u>	<u>CW2450</u>
<u>Channels</u>	<u>Middle</u>
<u>Signal</u>	<u>CW (Crest factor: 1.0)</u>

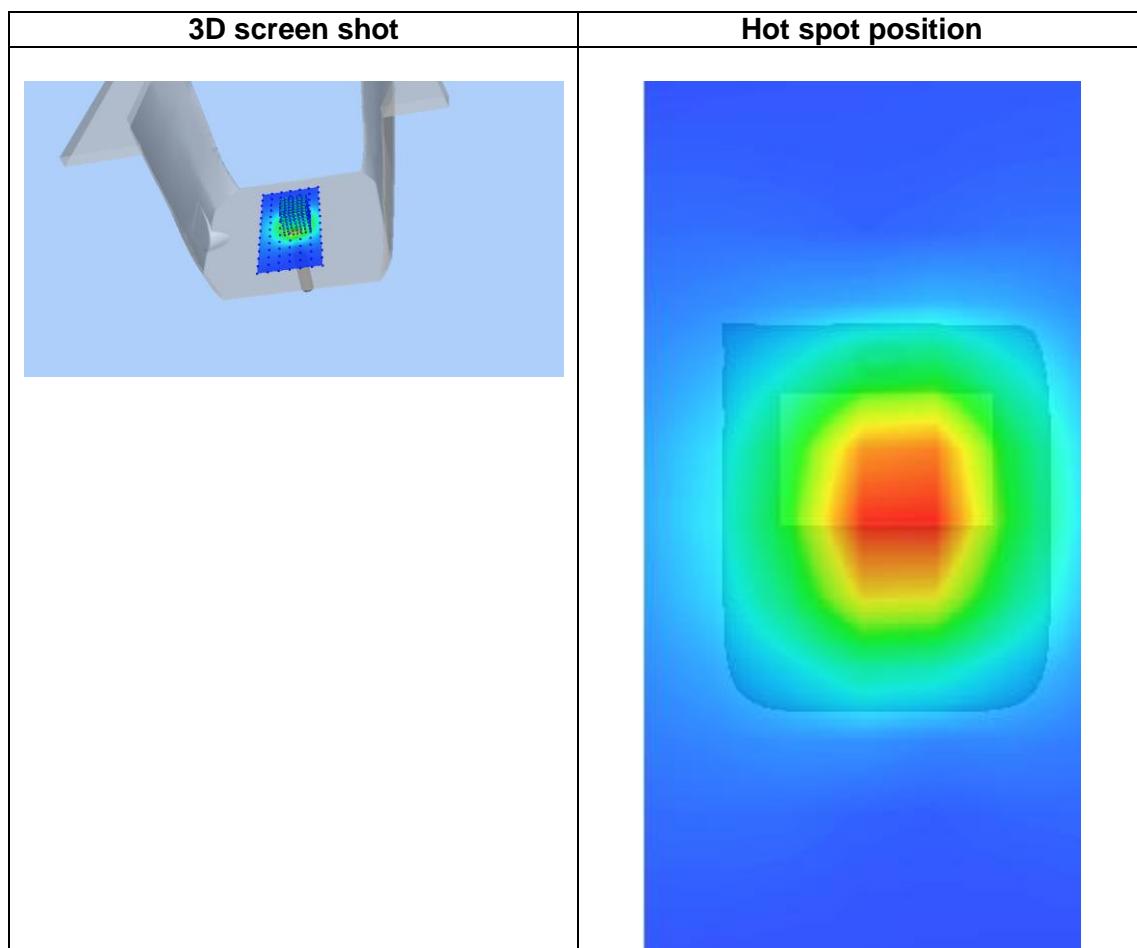
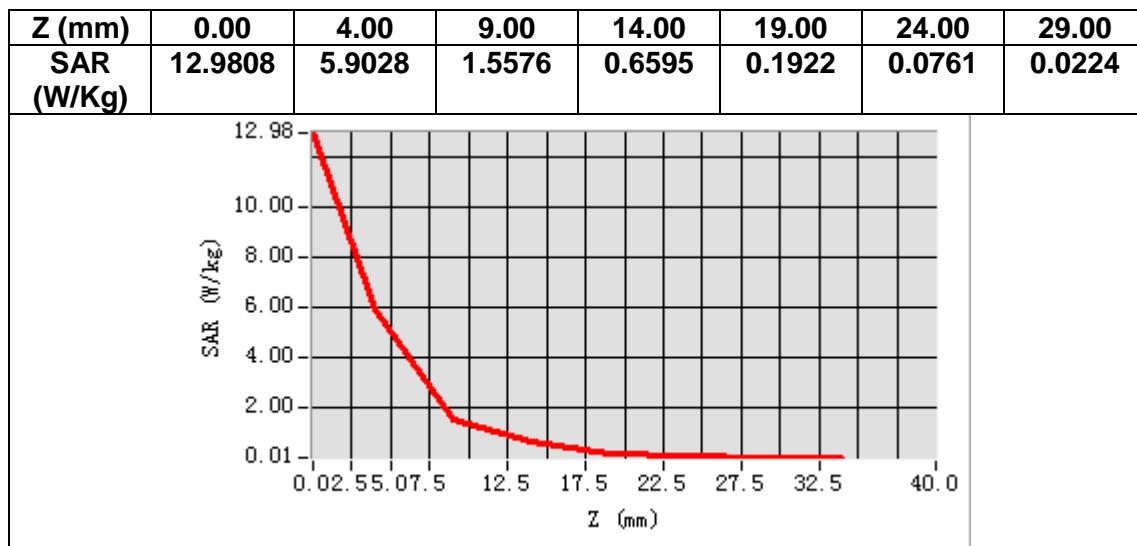
B. SAR Measurement Results

Frequency (MHz)	2450.000000
Relative permittivity (real part)	52.691099
Relative permittivity (imaginary part)	14.579900
Conductivity (S/m)	1.977598
Variation (%)	-0.100000



Maximum location: X=5.00, Y=1.00
SAR Peak: 12.07 W/kg

SAR 10g (W/Kg)	2.281002
SAR 1g (W/Kg)	5.072445



13. Appendix C. Plots of High SAR Measurement

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MEASUREMENT 1 GSM 850

MEASUREMENT 2 GSM 1900

MEASUREMENT 3 WCDMA Band II

MEASUREMENT 4 WCDMA Band V

MEASUREMENT 5 WLAN 2.4G

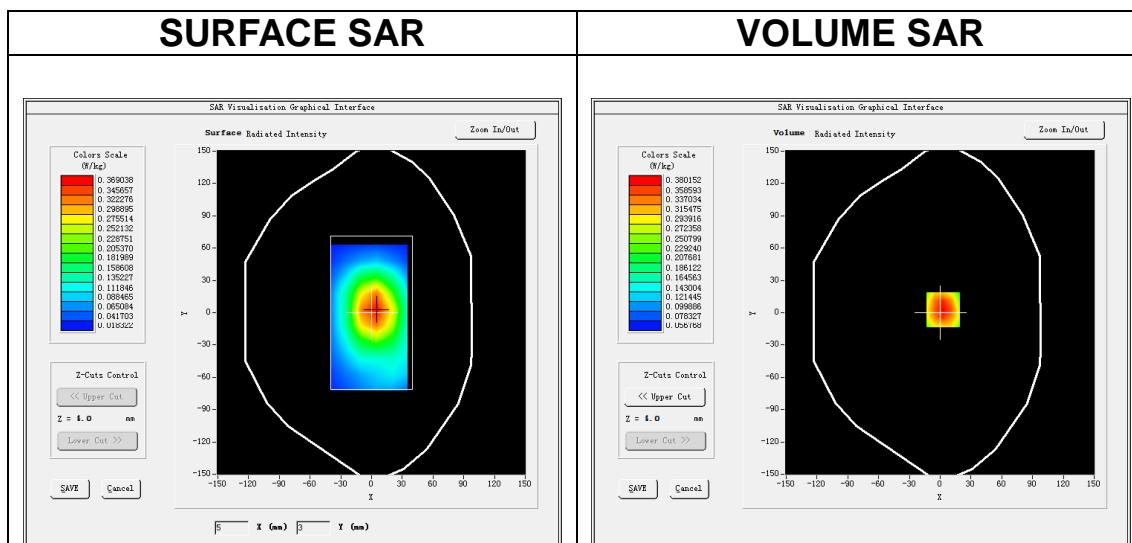
MEASUREMENT 1

A. Experimental conditions.

<u>Area Scan</u>	<u>$dx=15\text{mm}$ $dy=15\text{mm}$, $h= 5.00\text{ mm}$</u>
<u>ZoomScan</u>	<u>$5\times 5\times 7, dx=8\text{mm}$ $dy=8\text{mm}$ $dz=5\text{mm}$</u>
<u>Phantom</u>	<u>Validation plane</u>
<u>Device Position</u>	<u>Body</u>
<u>Band</u>	<u>GSM850</u>
<u>Channels</u>	<u>Middle</u>
<u>Signal</u>	<u>TDMA (Crest factor: 2.0)</u>

B. SAR Measurement Results

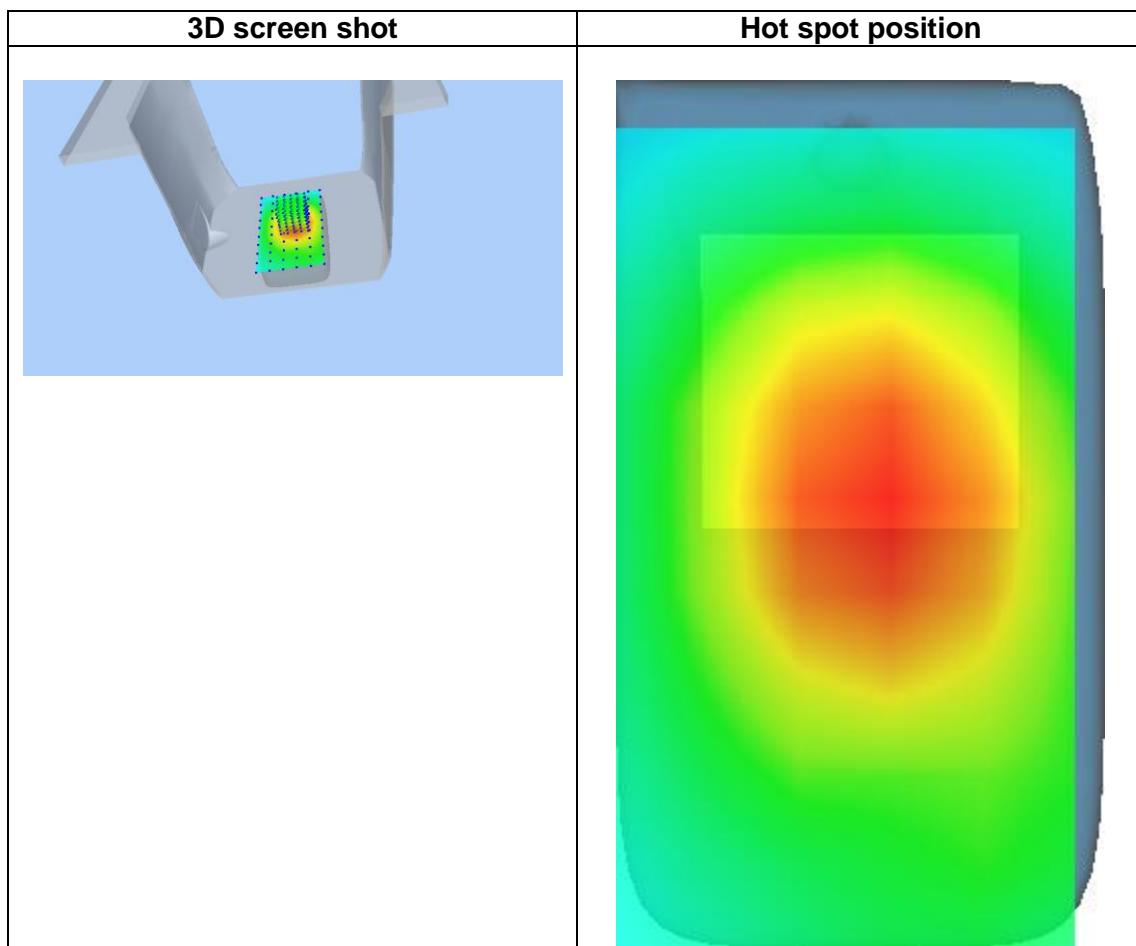
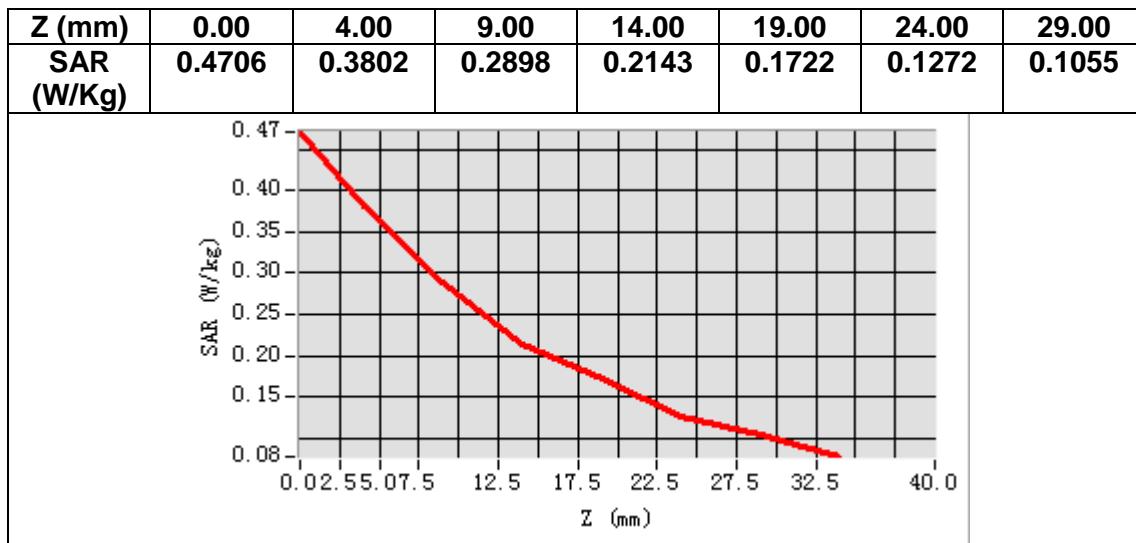
Frequency (MHz)	836.400000
Relative permittivity (real part)	54.869579
Relative permittivity (imaginary part)	21.532740
Conductivity (S/m)	1.000555
Variation (%)	-0.660000



Maximum location: X=3.00, Y=3.00

SAR Peak: 0.49 W/kg

SAR 10g (W/Kg)	0.262872
SAR 1g (W/Kg)	0.373730



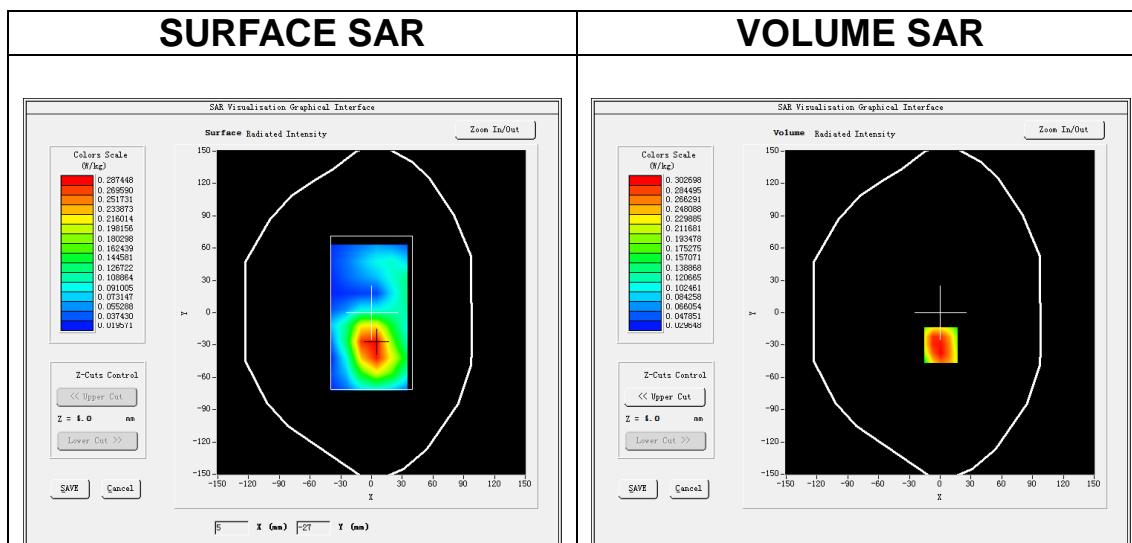
MEASUREMENT 2

A. Experimental conditions.

<u>Area Scan</u>	<u>$dx=15\text{mm}$ $dy=15\text{mm}$, $h= 5.00\text{ mm}$</u>
<u>ZoomScan</u>	<u>$5\times 5\times 7, dx=8\text{mm}$ $dy=8\text{mm}$ $dz=5\text{mm}$</u>
<u>Phantom</u>	<u>Validation plane</u>
<u>Device Position</u>	<u>Body</u>
<u>Band</u>	<u>GSM1900</u>
<u>Channels</u>	<u>Middle</u>
<u>Signal</u>	<u>TDMA (Crest factor: 2.0)</u>

B. SAR Measurement Results

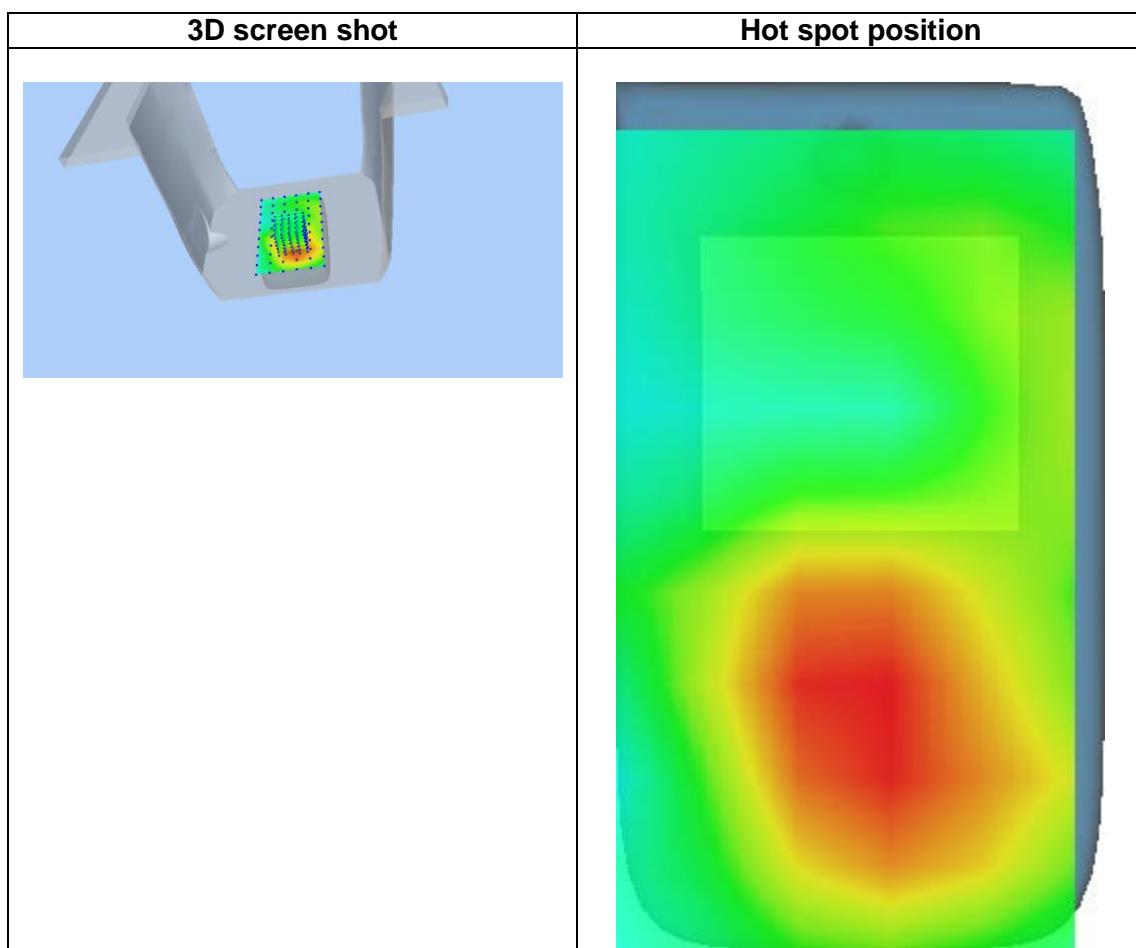
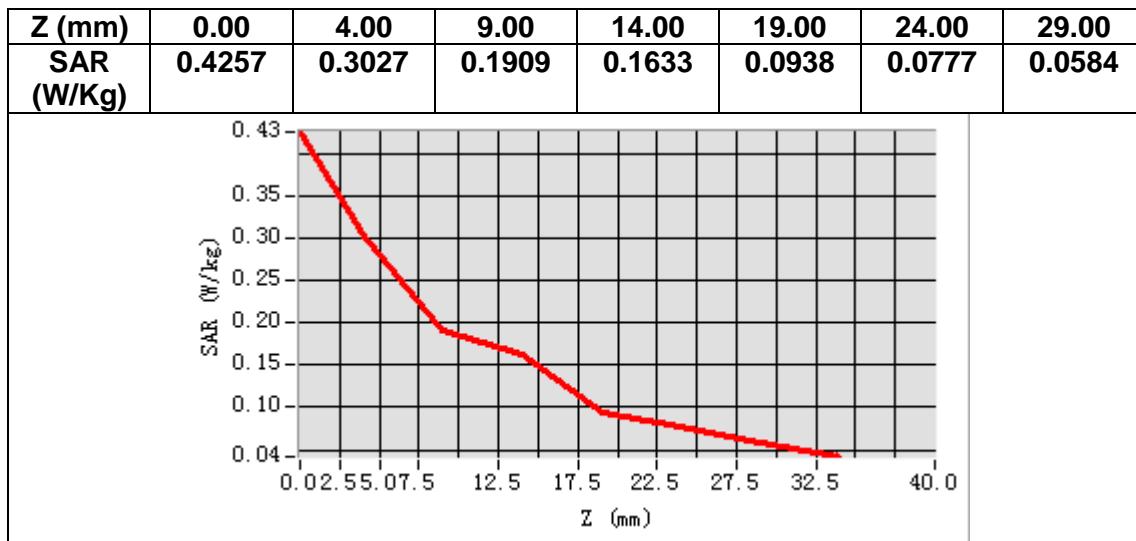
Frequency (MHz)	1880.000000
Relative permittivity (real part)	53.238899
Relative permittivity (imaginary part)	14.707700
Conductivity (S/m)	1.536138
Variation (%)	-3.700000



Maximum location: $X=1.00$, $Y=-30.00$

SAR Peak: 0.43 W/kg

SAR 10g (W/Kg)	0.188962
SAR 1g (W/Kg)	0.291708



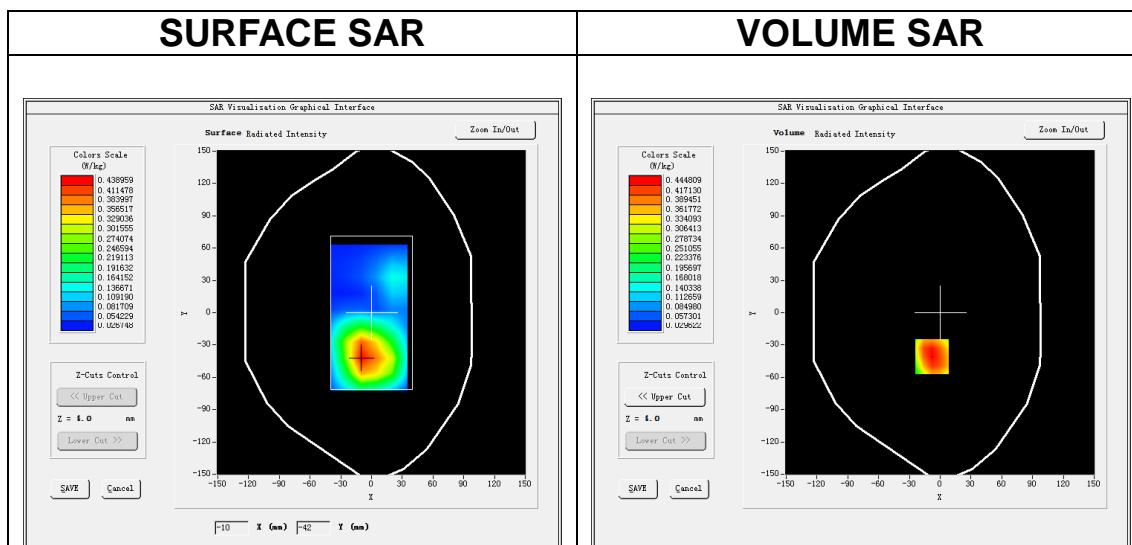
MEASUREMENT 3

A. Experimental conditions.

<u>Area Scan</u>	<u>dx=15mm dy=15mm, h= 5.00 mm</u>
<u>ZoomScan</u>	<u>5x5x7,dx=8mm dy=8mm dz=5mm</u>
<u>Phantom</u>	<u>Validation plane</u>
<u>Device Position</u>	<u>Body</u>
<u>Band</u>	<u>Band2 WCDMA1900</u>
<u>Channels</u>	<u>Middle</u>
<u>Signal</u>	<u>WCDMA (Crest factor: 1.0)</u>

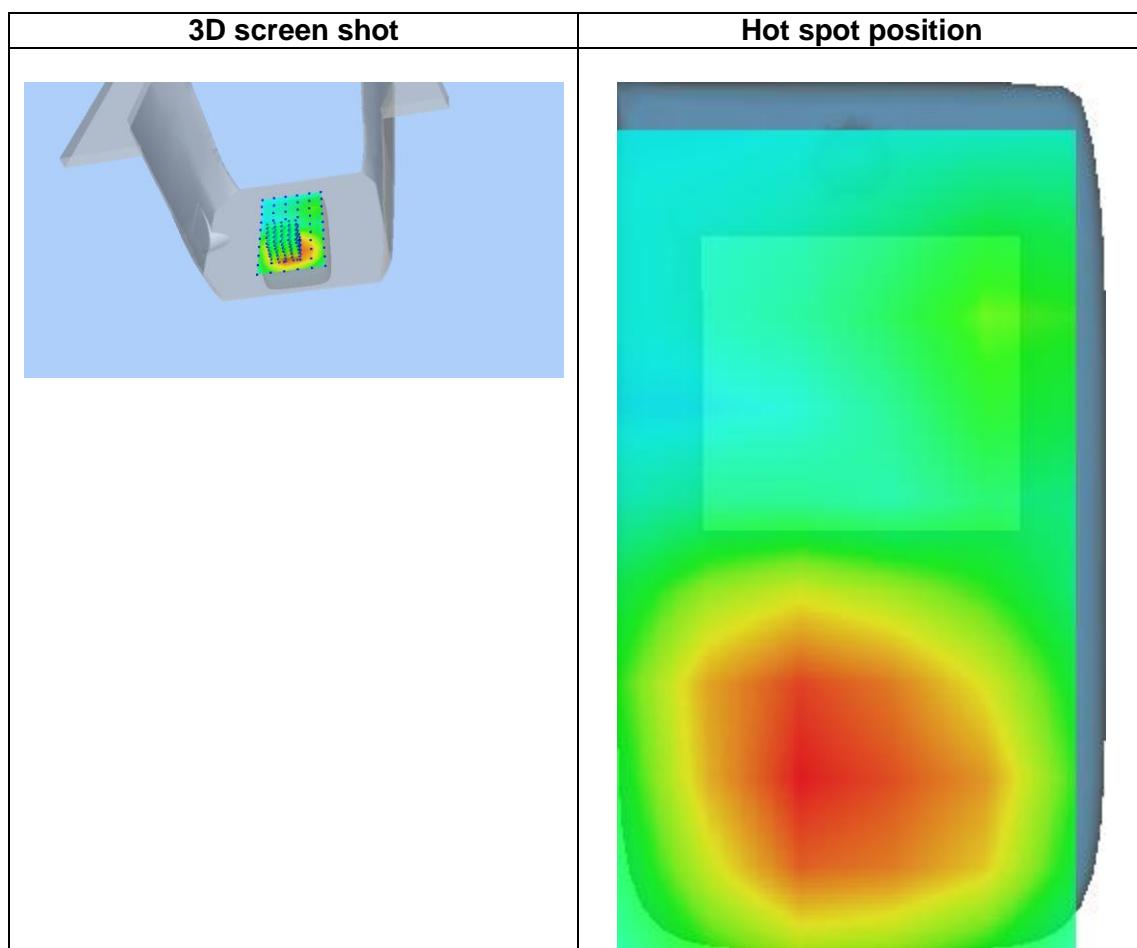
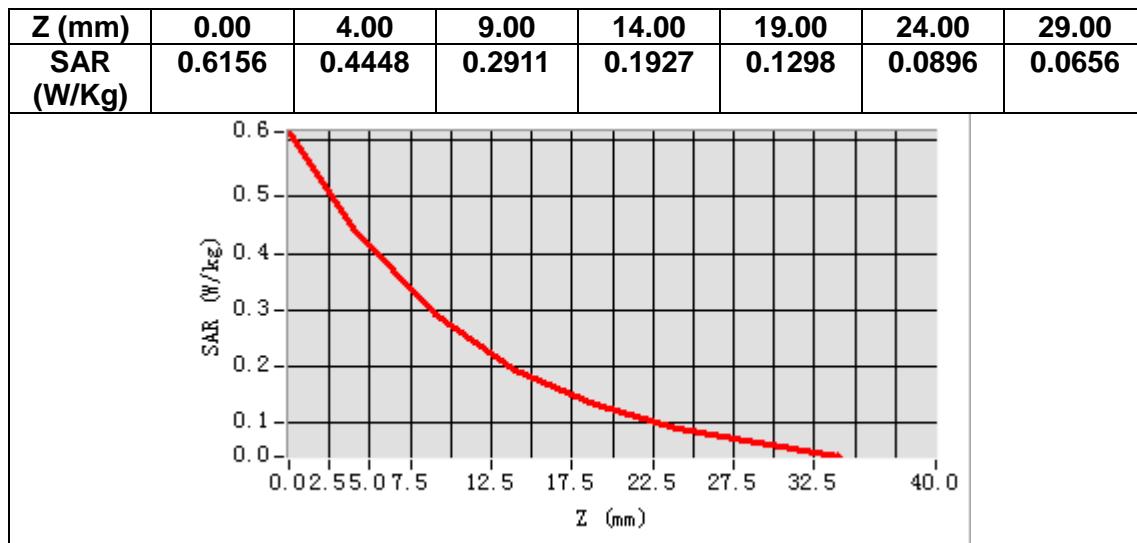
B. SAR Measurement Results

Frequency (MHz)	1880.000000
Relative permittivity (real part)	53.238899
Relative permittivity (imaginary part)	14.707700
Conductivity (S/m)	1.536138
Variation (%)	-2.600000



Maximum location: X=-8.00, Y=-41.00
SAR Peak: 0.64 W/kg

SAR 10g (W/Kg)	0.270971
SAR 1g (W/Kg)	0.432576



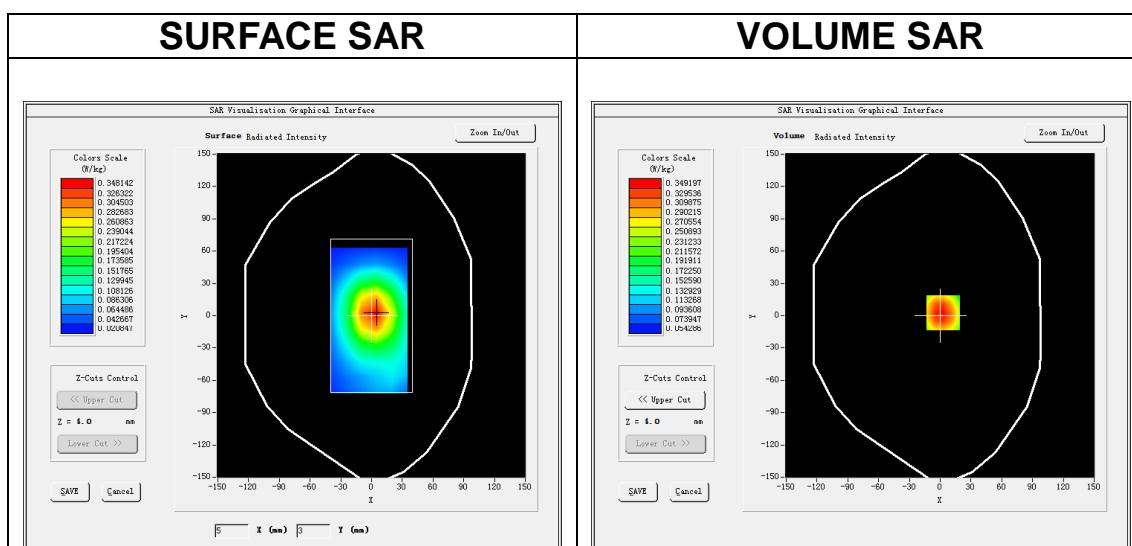
MEASUREMENT 4

A. Experimental conditions.

<u>Area Scan</u>	<u>dx=15mm dy=15mm, h= 5.00 mm</u>
<u>ZoomScan</u>	<u>5x5x7,dx=8mm dy=8mm dz=5mm</u>
<u>Phantom</u>	<u>Validation plane</u>
<u>Device Position</u>	<u>Body</u>
<u>Band</u>	<u>Band5 WCDMA850</u>
<u>Channels</u>	<u>Middle</u>
<u>Signal</u>	<u>WCDMA (Crest factor: 1.0)</u>

B. SAR Measurement Results

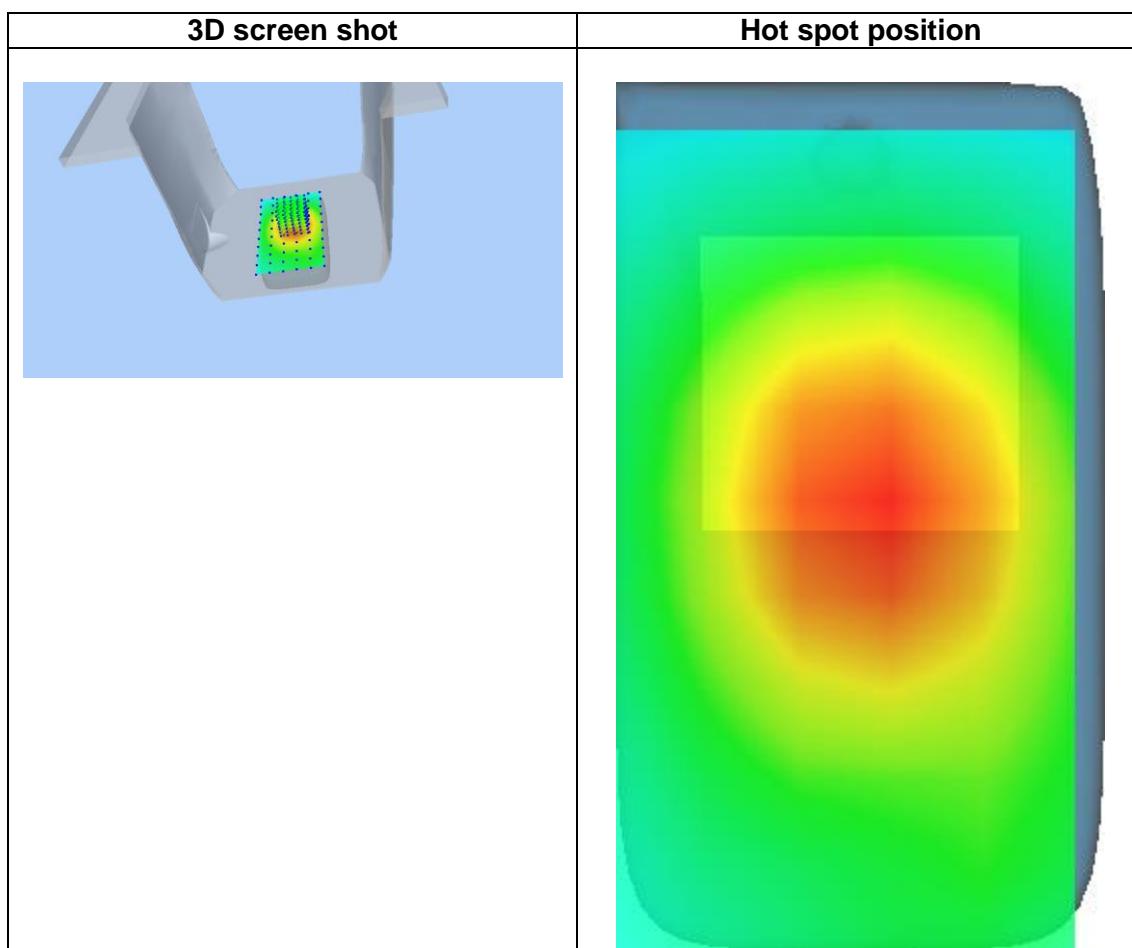
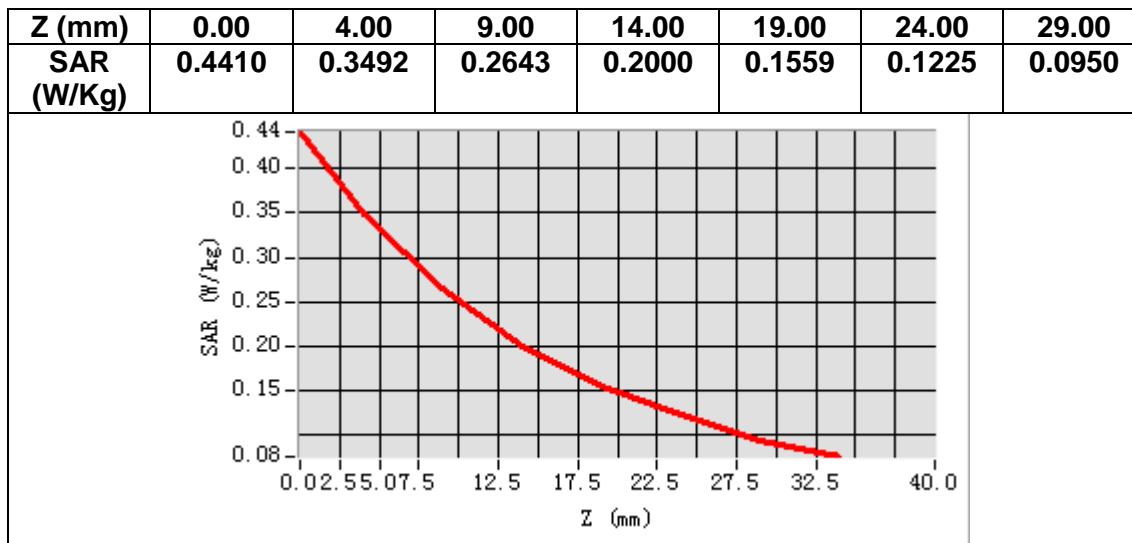
Frequency (MHz)	836.400000
Relative permittivity (real part)	54.869579
Relative permittivity (imaginary part)	21.532740
Conductivity (S/m)	1.000555
Variation (%)	0.090000



Maximum location: X=3.00, Y=3.00

SAR Peak: 0.45 W/kg

SAR 10g (W/Kg)	0.244948
SAR 1g (W/Kg)	0.347419



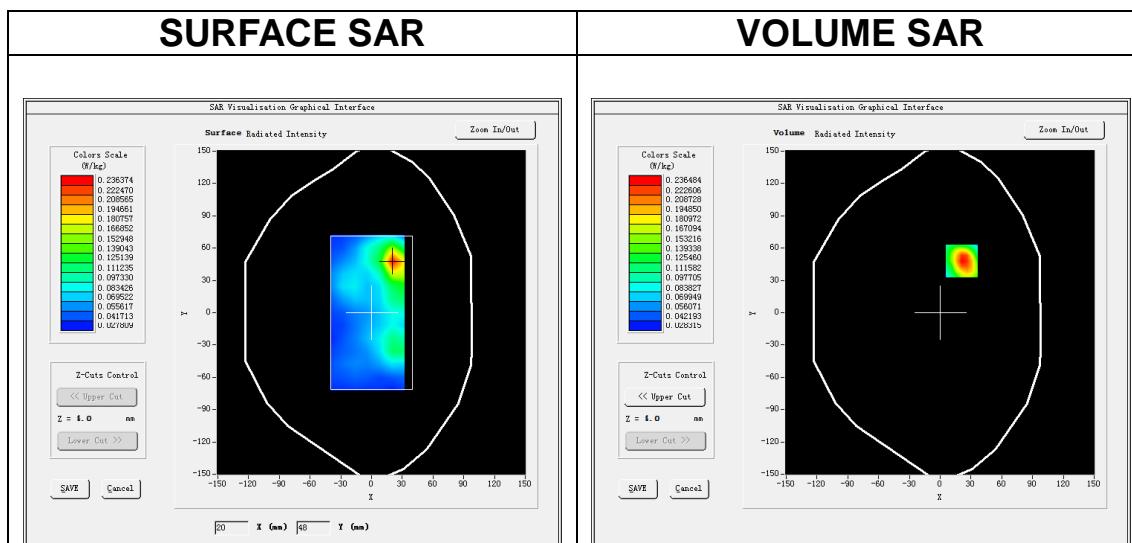
MEASUREMENT 5

A. Experimental conditions.

<u>Area Scan</u>	<u>$dx=12mm$ $dy=12mm$, $h= 5.00$ mm</u>
<u>ZoomScan</u>	<u>$7x7x7, dx=5mm$ $dy=5mm$ $dz=5mm$</u>
<u>Phantom</u>	<u>Validation plane</u>
<u>Device Position</u>	<u>Body</u>
<u>Band</u>	<u>IEEE 802.11b ISM</u>
<u>Channels</u>	<u>Middle</u>
<u>Signal</u>	<u>IEEE802.11b (Crest factor: 1.0)</u>

B. SAR Measurement Results

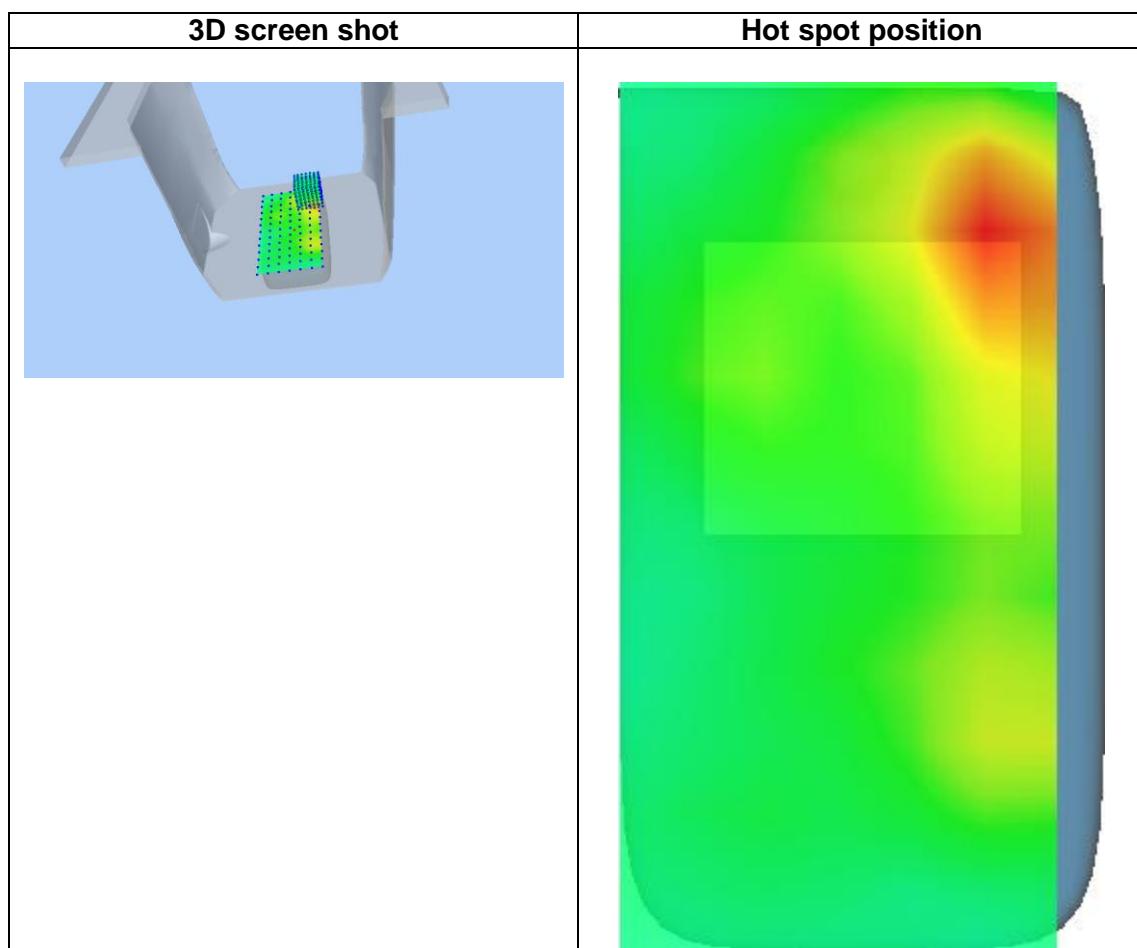
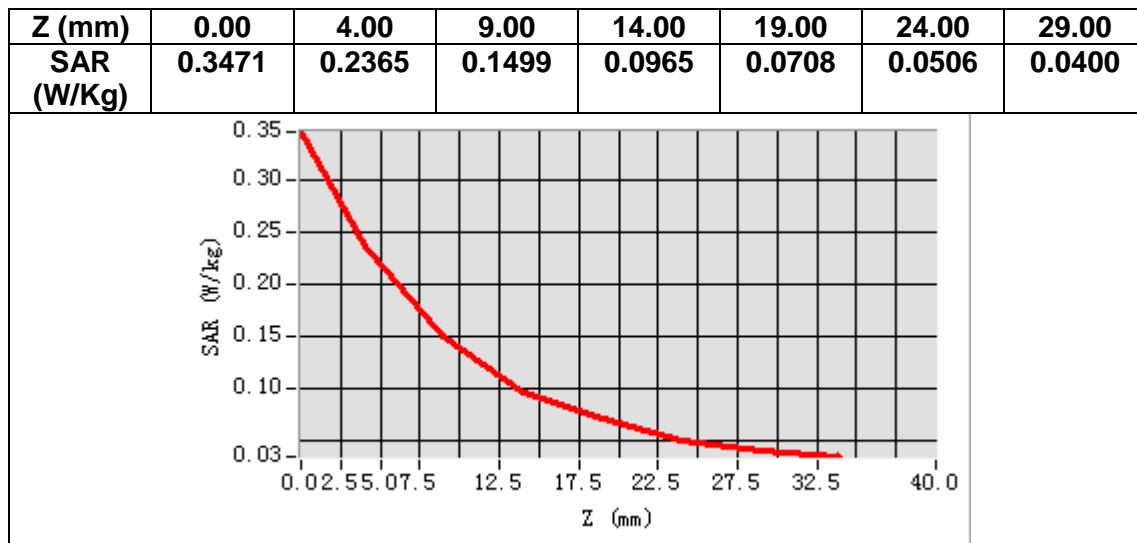
Frequency (MHz)	2437.000000
Relative permittivity (real part)	52.751598
Relative permittivity (imaginary part)	14.535620
Conductivity (S/m)	1.967961
Variation (%)	-1.280000



Maximum location: X=21.00, Y=48.00

SAR Peak: 0.35 W/kg

SAR 10g (W/Kg)	0.128810
SAR 1g (W/Kg)	0.221787



14. Appendix D. Calibration Certificate

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E Field Probe - SN 08/16 EPGO287

835 MHz Dipole - SN 03/15 DIP 0G835-347

1900 MHz Dipole - SN 03/15 DIP 1G900-350

2450 MHz Dipole - SN 03/15 DIP 2G450-352



COMOSAR E-Field Probe Calibration Report

Ref : ACR.260.1.18.SATU.A

**SHENZHEN NTEK TESTING TECHNOLOGY
CO., LTD.**

**BUILDING E, FENDA SCIENCE PARK, SANWEI
COMMUNITY, XIXIANG STREET,
BAO'AN DISTRICT, SHENZHEN GUANGDONG, CHINA
MVG COMOSAR DOSIMETRIC E-FIELD PROBE
SERIAL NO.: SN 08/16 EPGO287**

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



Calibration Date: 09/17/2018

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.



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.260.1.18.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	9/17/2018	
Checked by :	Jérôme LUC	Product Manager	9/17/2018	
Approved by :	Kim RUTKOWSKI	Quality Manager	9/17/2018	Kim RUTKOWSKI

	Customer Name
Distribution :	SHENZHEN NTEK TESTING TECHNOLOGY CO., LTD.

Issue	Date	Modifications
A	9/17/2018	Initial release



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.260.1.18.SATU.A

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.260.1.18.SATU.A

1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	MVG
Model	SSE2
Serial Number	SN 08/16 EPGO287
Product Condition (new / used)	Used
Frequency Range of Probe	0.15 GHz-6GHz
Resistance of Three Dipoles at Connector	Dipole 1: $R1=0.209\text{ M}\Omega$ Dipole 2: $R2=0.196\text{ M}\Omega$ Dipole 3: $R3=0.197\text{ M}\Omega$

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.



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.260.1.18.SATU.A

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%

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

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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 ($\mu\text{V}/(\text{V}/\text{m})^2$)
0.66	0.75	0.58

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
93	93	98

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

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

