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： Handheld Device

Trademark： N/A

Model Name： GT50VH2

Serial Model： N/A

Report No.： SER180628704001E

FCC ID： 2ACC5-GT50VH2

Prepared for

AMobile Intelligent Corp.

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TEST RESULT CERTIFICATION

Applicant's name ....:	AMobile Intelligent Corp.
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Manufacturer's Name...........:	AMobile Intelligent Corp.
Address..................................:	8F.-1, No.700, Zhongzheng Rd., Zhonghe Dist New Taipei City, 235 Taiwan

Product description

Product name..........................:	Handheld Device
Trademark ....:	N/A
Model and/or type reference .:	GT50VH2
Serial Model ....:	N/A
Standards ....:	FCC 47 CFR Part 2(2.1093) ANSI/IEEE C95.1-1992 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 ....:	Aug. 07, 2018 ~ Aug. 14, 2018
Date of Issue ....:	Aug. 28, 2018
Test Result ....:	**Pass**

Prepared By (Test Engineer) : Cheng Jiawen

(Cheng Jiawen)

Approved By (Lab Manager) : Sam. Chen

(Sam Chen)

※ ※ Revision History ※ ※

REV.	DESCRIPTION	ISSUED DATE	REMARK
Rev.1.0	Initial Test Report Release	Aug. 28, 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 GT50VH2 are as follows.

Band	Max Reported SAR Value(W/kg)			
	1-g Head	1-g Body-Worn (Separation distance of 10mm)	1-g Hotspot (Separation distance of 10mm)	Max Simultaneous Tx
LTE Band XIII	0.081	0.170	0.170	1.532
LTE Band IV	0.067	0.247	0.247	
LTE Band II	0.101	1.138	1.138	
WLAN 2.4G	0.030	0.395	0.395	

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	Handheld Device		
Trade Name	N/A		
Model Name	GT50VH2		
Serial Model	N/A		
FCC ID	2ACC5-GT50VH2		
Device Phase	Identical Prototype		
Exposure Category	General population / Uncontrolled environment		
Antenna	FPCB Antenna		
Battery Information	DC 3.8V, 5200mAh		
Device Operating Configurations			
Supporting Mode(s)	LTE Band XIII/IV/II, WLAN 2.4G, Bluetooth		
Test Modulation	LTE(QPSK/16QAM), WLAN(DSSS/OFDM), Bluetooth(GFSK, π/4-DQPSK, 8DPSK)		
Device Class	B		
Operating Frequency Range(s)	Band	Tx (MHz)	Rx (MHz)
	LTE Band XIII	777-787	746-756
	LTE Band IV	1710-1755	2110-2155
	LTE Band II	1850-1910	1930-1990

	WLAN 2.4G	2412-2462
	Bluetooth	2402-2480
Power Class	3, tested with power control all Max.(LTE Band XIII)	
	3, tested with power control all Max.(LTE Band IV)	
	3, tested with power control all Max.(LTE Band II)	
Test Channels (low-mid-high)	23205-23230-23255 (LTE Band XIII BW=5MHz)	
	23230(LTE Band XIII BW=10MHz)	
	19957-20175-20393(LTE Band IV BW=1.4MHz)	
	19965-20175-20385(LTE Band IV BW=3MHz)	
	19975-20175-20375(LTE Band IV BW=5MHz)	
	20000-20175-20350(LTE Band IV BW=10MHz)	
	20025-20175-20325(LTE Band IV BW=15MHz)	
	20050-20175-20300(LTE Band IV BW=20MHz)	
	18607-18900-19193(LTE Band II BW=1.4MHz)	
	18615-18900-19185(LTE Band II BW=3MHz)	
	18625-18900-19175(LTE Band II BW=5MHz)	
	18650-18900-19150(LTE Band II BW=10MHz)	
	18675-18900-19125(LTE Band II BW=15MHz)	
	18700-18900-19100(LTE Band II BW=20MHz)	
	1-3-6-9-11(WLAN 2.4G)	

1.4. Test specification(s)

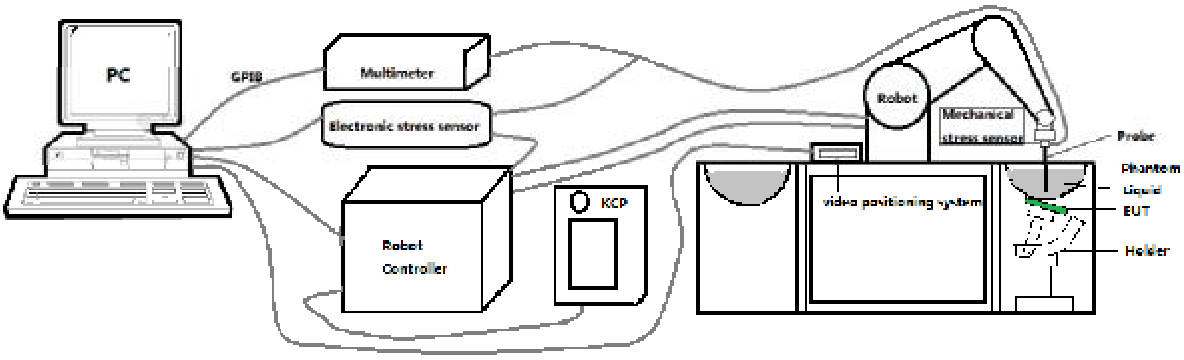
FCC 47 CFR Part 2(2.1093)
ANSI/IEEE C95.1-1992
IEEE Std 1528-2013
KDB 865664 D01 SAR measurement 100 MHz to 6 GHz
KDB 865664 D02 RF Exposure Reporting
KDB 447498 D01 General RF Exposure Guidance
KDB 248227 D01 802.11 Wi-Fi SAR
KDB 941225 D05 SAR for LTE Devices
KDB 941225 D06 Hotspot SAR

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: <0.25 dB
- Hemispherical Isotropy: <0.50 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 ±10%. The spherical isotropy shall be evaluated and within ±0.25dB. 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.

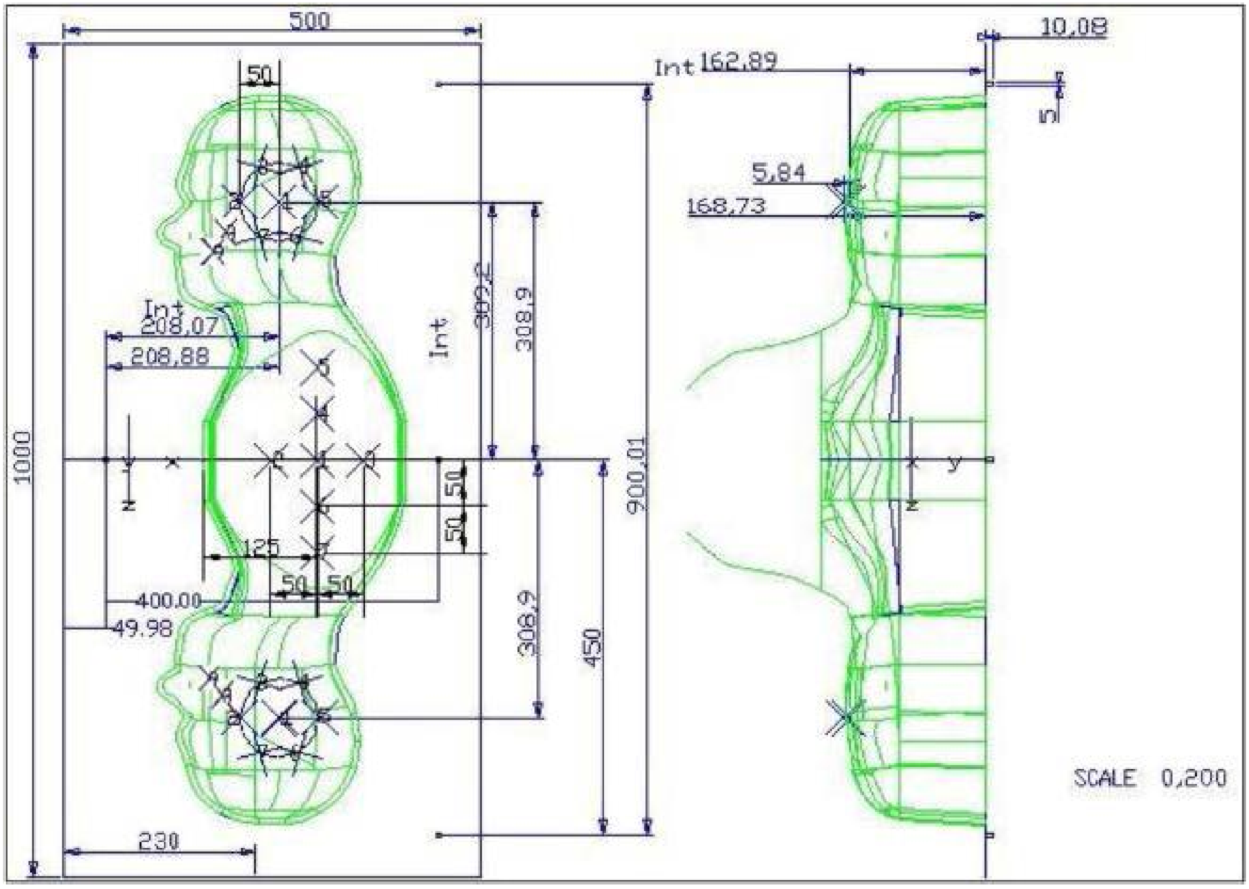
2.4. SAM phantoms

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	Positionner 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

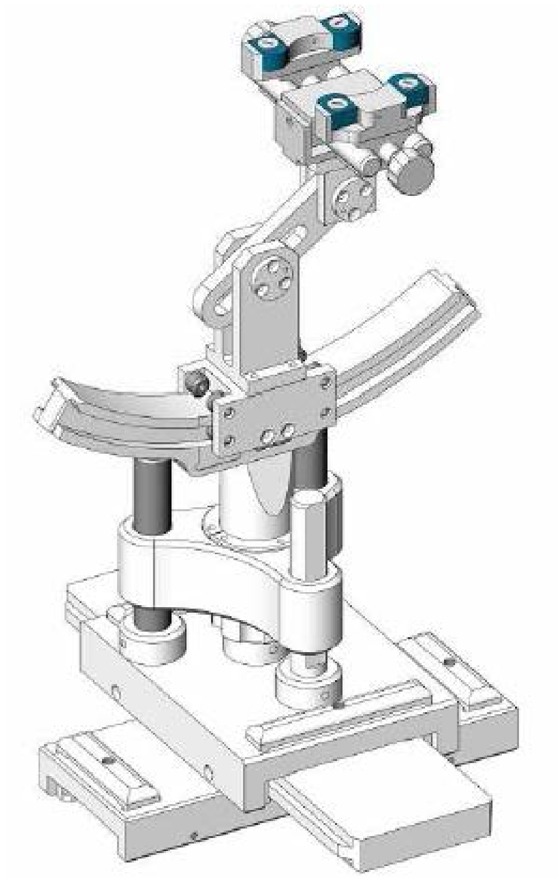


Serial Number	Left Head		Right Head		Flat Part	
SN 16/15 SAM119	2	2.02	2	2.08	1	2.09
	3	2.05	3	2.06	2	2.06
	4	2.07	4	2.07	3	2.08
	5	2.08	5	2.08	4	2.10
	6	2.05	6	2.07	5	2.10
	7	2.05	7	2.05	6	2.07
	8	2.07	8	2.06	7	2.07
	9	2.08	9	2.06	-	-

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

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
☒	MVG	E FIELD PROBE	SSE2	SN 08/16 EPGO287	Sep. 18, 2017	Sep. 17, 2018
☒	MVG	750 MHz Dipole	SID750	SN 03/15 DIP 0G750-355	Apr. 19, 2018	Apr. 18, 2021
☐	MVG	835 MHz Dipole	SID835	SN 03/15 DIP 0G835-347	Apr. 19, 2018	Apr. 18, 2021
☐	MVG	900 MHz Dipole	SID900	SN 03/15 DIP 0G900-348	Apr. 19, 2018	Apr. 18, 2021
☒	MVG	1800 MHz Dipole	SID1800	SN 03/15 DIP 1G800-349	Apr. 19, 2018	Apr. 18, 2021
☒	MVG	1900 MHz Dipole	SID1900	SN 03/15 DIP 1G900-350	Apr. 19, 2018	Apr. 18, 2021
☐	MVG	2000 MHz Dipole	SID2000	SN 03/15 DIP 2G000-351	Apr. 19, 2018	Apr. 18, 2021
☒	MVG	2450 MHz Dipole	SID2450	SN 03/15 DIP 2G450-352	Apr. 19, 2018	Apr. 18, 2021
☐	MVG	2600 MHz Dipole	SID2600	SN 03/15 DIP 2G600-356	Apr. 19, 2018	Apr. 18, 2021
☐	MVG	5000 MHz Dipole	SWG5500	SN 13/14 WGA 33	Apr. 19, 2018	Apr. 18, 2021
☒	MVG	Liquid measurement Kit	SCLMP	SN 21/15 OCPG 72	NCR	NCR
☒	MVG	Power Amplifier	N.A	AMPLISAR_28/14_003	NCR	NCR
☒	KEITHLEY	Millivoltmeter	2000	4072790	NCR	NCR
☐	R&S	Universal radio communication tester	CMU200	117858	Aug. 05, 2018	Aug. 04, 2019
☒	R&S	Wideband radio communication tester	CMW500	103917	Oct. 26, 2017	Oct. 25, 2018
☒	HP	Network Analyzer	8753D	3410J01136	Aug. 05, 2018	Aug. 04, 2019
☒	Agilent	PSG Analog Signal Generator	E8257D	MY51110112	Aug. 05, 2018	Aug. 04, 2019

☒	Agilent	Power meter	E4419B	MY45102538	Aug. 05, 2018	Aug. 04, 2019
☒	Agilent	Power sensor	E9301A	MY41495644	Aug. 05, 2018	Aug. 04, 2019
☒	Agilent	Power sensor	E9301A	US39212148	Aug. 05, 2018	Aug. 04, 2019
☒	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	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location			30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}			≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
			When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	
Maximum zoom scan spatial resolution: 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: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	≤ 1.5·$\Delta z_{Zoom}(n-1)$	
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 *reported* SAR from the *area scan based 1-g SAR estimation* 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 using 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 form 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 define in the standard IEEE1528 and IEC62209.

3.5. Power Drift

All SAR testing is under the EUT install 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 ±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									
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									
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 of the dielectric parameter are within the tolerances of the specified target values. The measured conductivity and relative permittivity should be within ±5% of the target values.

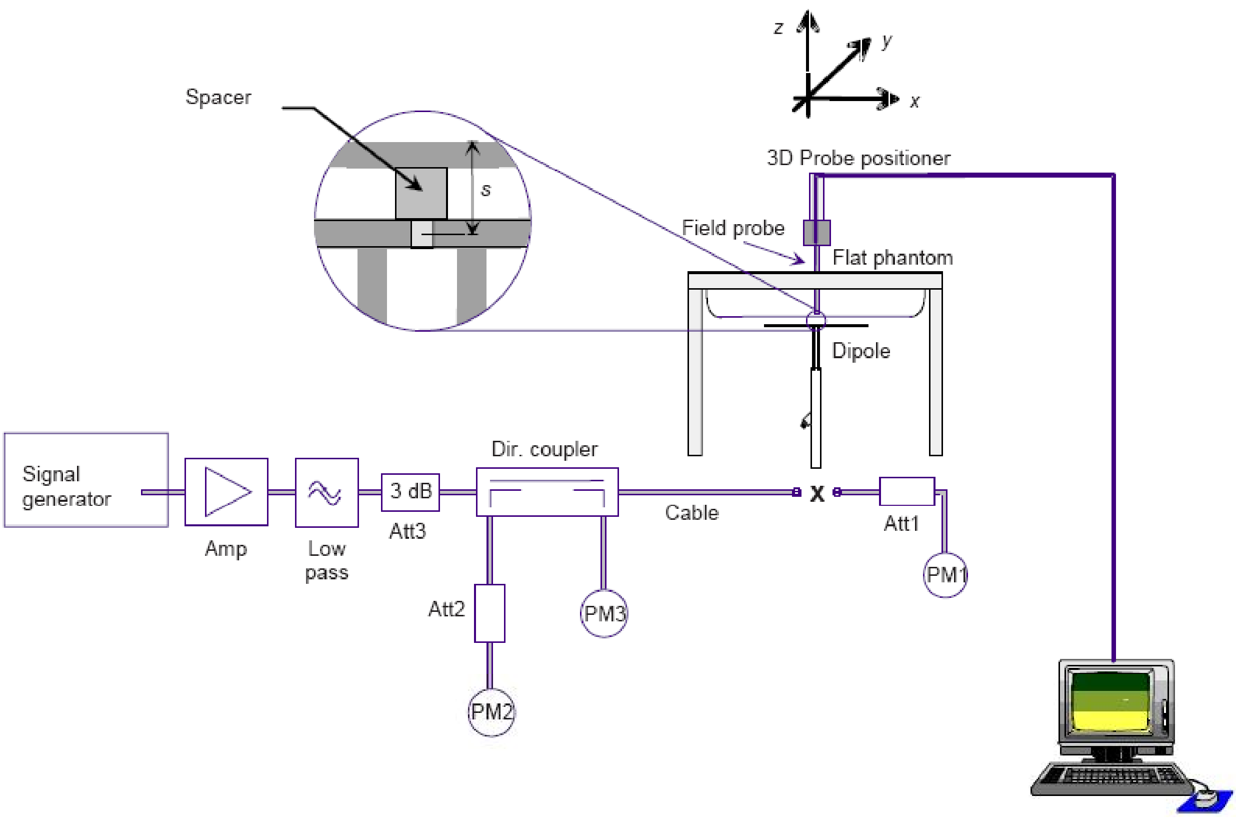
Tissue Type	Measured Frequency (MHz)	Target Tissue		Measured Tissue		Liquid Temp.	Test Date
		εr (±5%)	σ (S/m) (±5%)	εr	σ (S/m)		
Head 750	750	41.90 (39.81~43.99)	0.89 (0.85~0.93)	41.59	0.91	21.8 °C	Aug. 13, 2018
Body 750	750	55.50 (52.73~58.27)	0.96 (0.91~1.01)	55.58	0.97	21.5 °C	Aug. 13, 2018
Head 1800	1800	40.00 (38.00~42.00)	1.40 (1.33~1.47)	39.91	1.40	22.0 °C	Aug. 07, 2018
Body 1800	1800	53.30 (50.64~55.96)	1.52 (1.44~1.59)	53.98	1.51	21.9 °C	Aug. 07, 2018
Head 1900	1900	40.00 (38.00~42.00)	1.40 (1.33~1.47)	39.49	1.43	21.5 °C	Aug. 14, 2018
Body 1900	1900	53.30 (50.64~55.96)	1.52 (1.44~1.59)	53.50	1.54	21.4 °C	Aug. 14, 2018
Head 2450	2450	39.20 (37.24~41.16)	1.80 (1.71~1.89)	38.92	1.84	21.7 °C	Aug. 09, 2018
Body 2450	2450	52.70 (50.07~55.33)	1.95 (1.85~2.04)	52.54	1.97	21.4 °C	Aug. 09, 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 ±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) (±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)		
750MHz Head	8.49 (7.64~9.34)	5.55 (4.99~6.11)	8.55	5.69	21.8 °C	Aug. 13, 2018
750MHz Body	8.55 (7.69~9.41)	5.75 (5.17~6.33)	8.39	5.59	21.5 °C	Aug. 13, 2018
1800MHz Head	38.40 (34.56~42.24)	20.10 (18.09~22.11)	38.48	20.11	22.0 °C	Aug. 07, 2018
1800MHz Body	37.04 (33.34~40.74)	20.26 (18.23~22.29)	38.38	20.03	21.9 °C	Aug. 07, 2018
1900MHz Head	39.70 (35.73~43.67)	20.50 (18.45~22.55)	41.89	21.73	21.5 °C	Aug. 14, 2018
1900MHz Body	38.43 (34.59~42.27)	20.34 (18.31~22.37)	41.94	21.68	21.4 °C	Aug. 14, 2018
2450MHz Head	52.40 (47.16~57.64)	24.00 (21.60~26.40)	53.40	24.62	21.7 °C	Aug. 09, 2018
2450MHz Body	49.32 (44.39~54.25)	22.89 (20.60~25.17)	51.79	22.93	21.4 °C	Aug. 09, 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 W/kg; steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 0.80 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 ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥1.5 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 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. Ear and handset reference point

Figure 6.1.1 shows the front, back, and side views of the SAM phantom. The center-of-mouth reference point is labeled “M”, the left ear reference point (ERP) is marked “LE”, and the right ERP is marked “RE”.

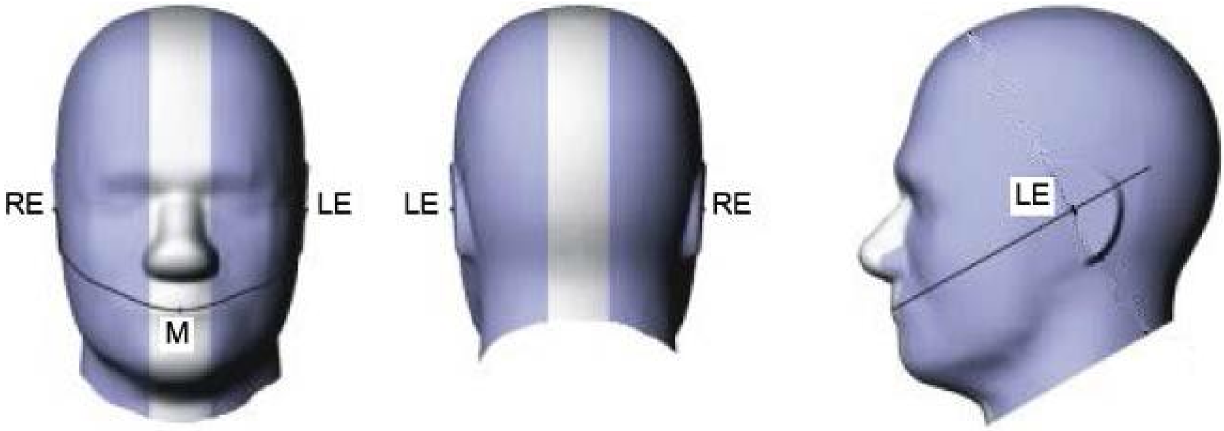


Fig 6.1.1 Front, back, and side views of SAM phantom

6.2. Definition of the cheek position

1. Define two imaginary lines on the handset, the vertical centerline and the horizontal line. 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 (point A in Figure 6.2.1 and Figure 6.2.2), and the midpoint of the width w_b of the bottom of the handset (point B). The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output (see Figure 6.2.1). 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 (see Figure 6.2.2), especially for clamshell handsets, handsets with flip covers, and other irregularly-shaped handsets.
2. Position the handset close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 6.2.3), such that the plane defined by the vertical centerline and the horizontal line of the handset is approximately parallel to the sagittal plane of the phantom.
3. Translate the handset towards the phantom along the line passing through RE and LE until handset point A touches the pinna at the ERP
4. While maintaining the handset in this plane, rotate it around the LE-RE line until the vertical centerline is in the plane normal to the plane containing B-M and N-F lines, i.e., the Reference Plane.
5. Rotate the handset around the vertical centerline until the handset (horizontal line) is parallel to the N-F line.

6. While maintaining the vertical centerline in the Reference Plane, keeping point A on the line passing through RE and LE, and maintaining the handset contact with the pinna, rotate the handset about the N-F line until any point on the handset is in contact with a phantom point below the pinna on the cheek. See Figure 6.2.3. The actual rotation angles should be documented in the test report.

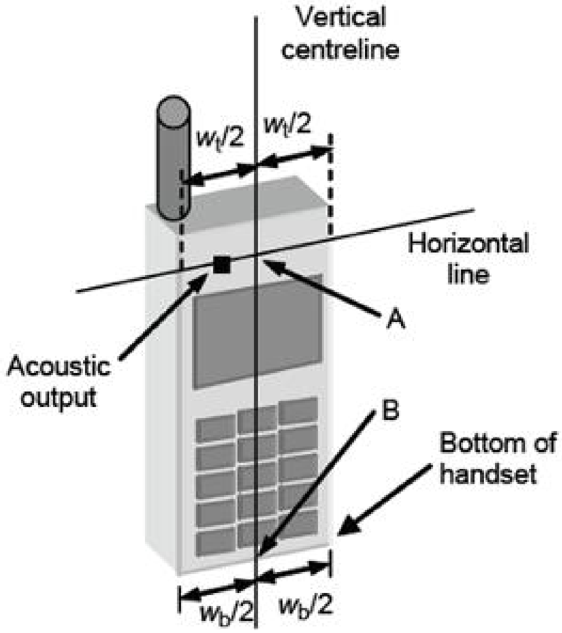


Fig 6.2.1 Handset vertical and horizontal reference lines—“fixed case

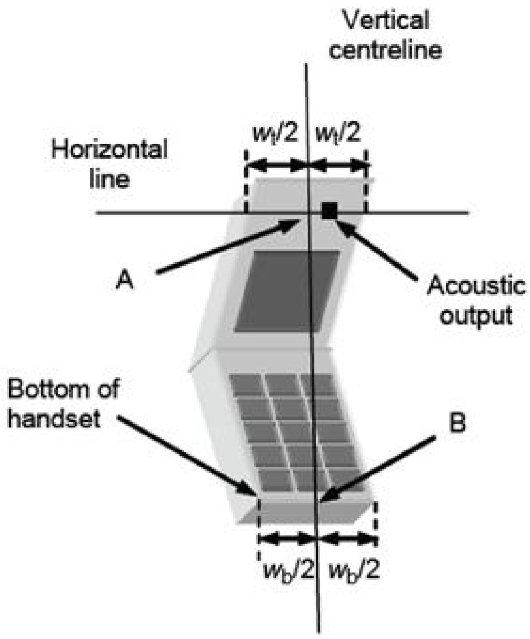


Fig 6.2.2 Handset vertical and horizontal reference lines—“clam-shell case”

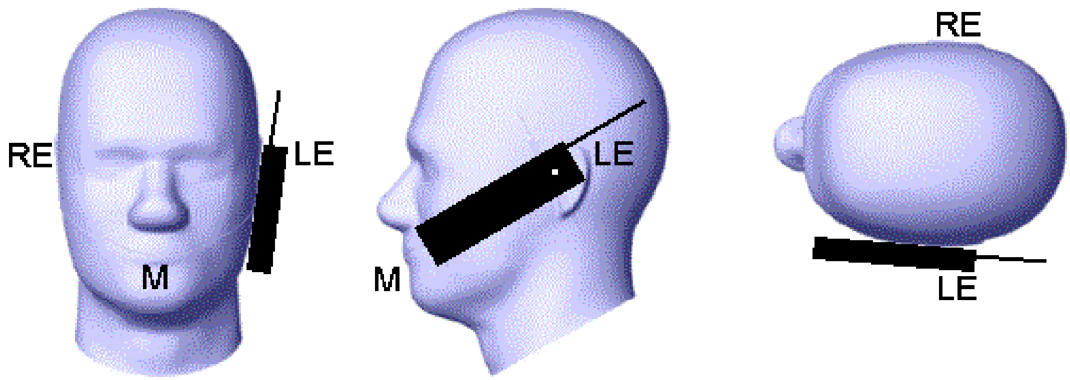


Fig 6.2.3 cheek or touch position. The reference points for the right ear (RE), left ear (LE), and mouth (M), which establish the Reference Plane for handset positioning, are indicated.

6.3. Definition of the tilt position

1. While maintaining the orientation of the handset, retract the handset parallel to the reference plane far enough away from the phantom to enable a rotation of the device by 15 degree.
2. Rotate the Handset around the horizontal line by 15 degree (see Figure 6.3.1).
3. While maintaining the orientation of the handset, move the handset towards the phantom on a line passing through RE and LE until any part of the handset touches the ear. The tilt position is obtained when the contact is on the pinna. If the contact is at any location other than the pinna, e.g., the antenna with the back of the phantom head, the angle of the handset shall be reduced. In this case, the tilt position is obtained if any part of the handset is in contact with the pinna as well as a second part of the handset is in contact with the phantom, e.g., the antenna with the back of the head.

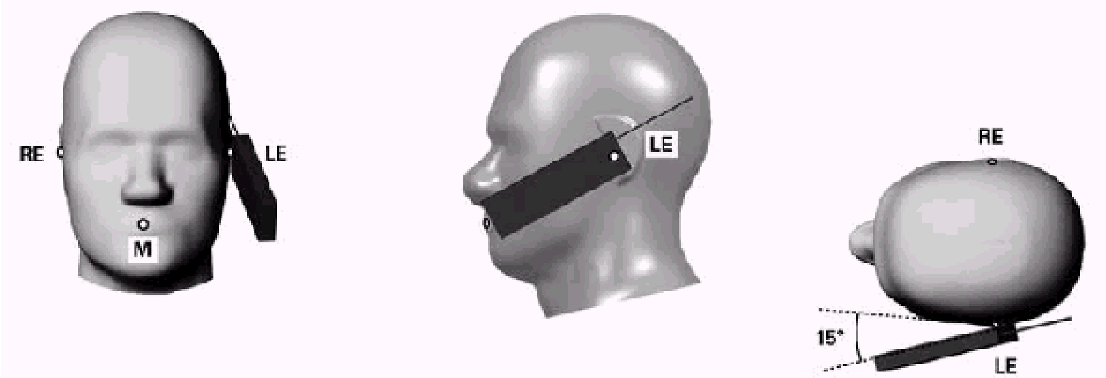


Figure 6.3.1 – Tilt position of the wireless device on the left side of SAM

6.4. Body Worn Accessory

1. Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration (see Figure 6.4.1). Per KDB 648474 D04, body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in FCC KDB 447498 D01 should be used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode, when applicable. When the reported SAR for body-worn accessory, measured without a headset connected to the handset is < 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a handset attached to the handset.
2. Accessories for body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest

spacing to the body. Then multiple accessories that contain metallic components are test with the device with each accessory. If multiple accessories share an identical metallic component (i.e. the same metallic belt-chip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.

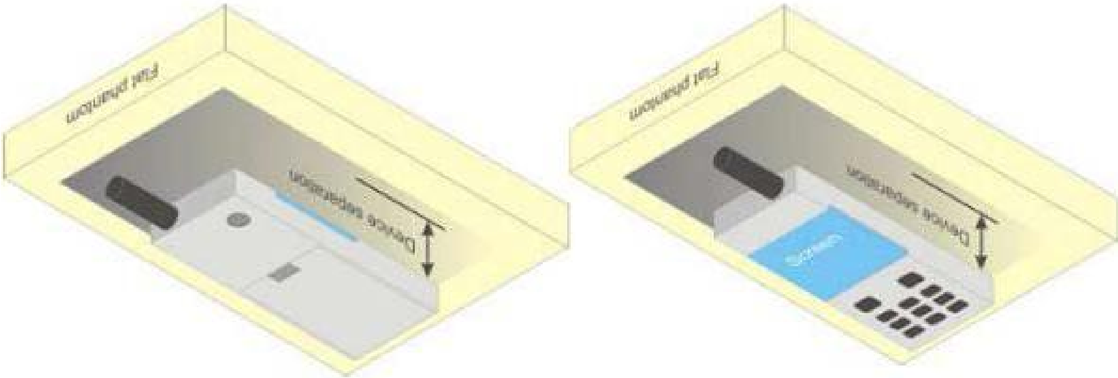


Figure 6.4.1 – Test positions for body-worn devices

6.5. 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 x W ≥ 9 cm x 5 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 form 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)
LTE Band XIII	QPSK	23±1	22~24	24.00
	16QAM	23±1	22~24	23.60
LTE Band IV	QPSK	23±1	22~24	24.00
	16QAM	23±1	22~24	23.84
LTE Band II	QPSK	23±1	22~24	24.00
	16QAM	23±1	22~24	23.99
WLAN 2.4G	802.11b	16±1	15~17	16.8
	802.11g	16±1	15~17	16.3
	802.11n20	16±1	15~17	16.3
	802.11n40	15±1	14~16	15.8
Bluetooth	BR+EDR	4.5±1	3.5~5.5	5.41
	BLE	4.5±1	3.5~5.5	5.32

7.2. LTE Conducted Power

Band	Band Width	Modulation	RB Configuration		Tune-up	Channel/Frequency(MHz)		
			RB Size	RB Offset		23205/779.5	23230/782	23255/784.5
LTE Band XIII	5MHz	QPSK	1	0	24.00	23.85	23.94	24.00
			1	12	24.00	23.99	23.98	23.94
			1	24	24.00	23.98	23.81	23.79
			12	0	24.00	23.28	23.27	23.40
			12	6	24.00	23.09	23.18	23.25
			12	11	24.00	23.30	23.22	23.23
			25	0	24.00	23.39	23.26	23.25
		16QAM	1	0	24.00	23.10	23.07	23.36
			1	12	24.00	23.12	23.07	23.30
			1	24	24.00	23.08	22.92	23.19
			12	0	23.00	22.27	22.47	22.28
			12	6	23.00	22.39	22.38	22.26
			12	11	23.00	22.48	22.32	22.27
			25	0	23.00	22.40	22.41	22.25

Band	Band Width	Modulation	RB Configuration		Tune-up	Channel/Frequency(MHz)
			RB Size	RB Offset		23230/782
LTE Band XIII	10MHz	QPSK	1	0	24.00	23.79
			1	24	24.00	23.86
			1	49	24.00	23.44
			25	0	24.00	23.37
			25	12	24.00	23.34
			25	24	24.00	23.34
			50	0	24.00	23.44
		16QAM	1	0	24.00	23.59
			1	24	24.00	23.60
			1	49	24.00	23.15
			25	0	23.00	22.41
			25	12	23.00	22.41
			25	24	23.00	22.39
			50	0	23.00	22.41

Band	Band Width	Modulation	RB Configuration		Tune-up	Channel/Frequency(MHz)		
			RB Size	RB Offset		19957/1710.7	20175/1732.5	20393/1754.3
LTE Band IV	1.4MHz	QPSK	1	0	24.00	23.27	23.36	23.69
			1	2	24.00	23.21	23.37	23.76
			1	5	24.00	23.26	23.39	23.68
			3	0	24.00	23.43	23.41	23.75
			3	1	24.00	23.33	23.41	23.72
			3	2	24.00	23.39	23.45	23.72
			6	0	23.00	22.73	22.68	22.85
		16QAM	1	0	23.00	22.89	22.83	22.95
			1	2	23.00	22.90	22.74	22.95
			1	5	23.00	22.84	22.87	22.91
			3	0	23.00	22.88	22.75	22.94
			3	1	23.00	22.81	22.73	22.92
			3	2	23.00	22.89	22.72	22.93
			6	0	22.00	21.79	21.76	21.98

Band	Band Width	Modulation	RB Configuration		Tune-up	Channel/Frequency(MHz)		
			RB Size	RB Offset		19965/1711.5	20175/1732.5	20385/1753.5
LTE Band IV	3MHz	QPSK	1	0	24.00	23.51	23.49	23.72
			1	7	24.00	23.48	23.39	23.65
			1	14	24.00	23.45	23.35	23.63
			8	0	23.00	22.69	22.80	22.95
			8	4	23.00	22.65	22.75	22.80
			8	7	23.00	22.74	22.74	22.89
			15	0	23.00	22.74	22.63	22.94
		16QAM	1	0	24.00	23.28	22.80	23.18
			1	7	24.00	23.23	22.69	23.10
			1	14	24.00	23.06	22.75	23.12
			8	0	23.00	22.05	21.93	22.00
			8	4	23.00	22.06	21.95	22.11
			8	7	23.00	21.98	21.92	22.05
			15	0	22.00	21.85	21.85	21.92

Band	Band Width	Modulation	RB Configuration		Tune-up	Channel/Frequency(MHz)		
			RB Size	RB Offset		19975/1712.5	20175/1732.5	20375/1752.5
LTE Band IV	5MHz	QPSK	1	0	24.00	23.75	23.50	23.83
			1	12	24.00	23.53	23.43	23.70
			1	24	24.00	23.54	23.38	23.68
			12	0	23.00	22.75	22.79	22.91
			12	6	23.00	22.69	22.70	22.95
			12	11	23.00	22.68	22.68	22.88
			25	0	23.00	22.75	22.74	22.87
		16QAM	1	0	24.00	22.75	22.86	23.13
			1	12	24.00	22.55	22.72	23.07
			1	24	24.00	22.53	22.72	22.99
			12	0	23.00	21.89	21.80	22.16
			12	6	23.00	21.85	22.79	22.15
			12	11	23.00	21.82	21.79	22.11
			25	0	23.00	21.80	21.81	22.03

Band	Band Width	Modulation	RB Configuration		Tune-up	Channel/Frequency(MHz)		
			RB Size	RB Offset		20000/1715	20175/1732.5	20350/1750
LTE Band IV	10MHz	QPSK	1	0	24.00	23.89	23.76	23.91
			1	24	24.00	23.31	23.40	23.60
			1	49	24.00	23.42	23.50	23.71
			25	0	23.00	22.87	22.85	22.98
			25	12	23.00	22.68	22.75	22.89
			25	24	23.00	22.66	22.76	22.89
			50	0	23.00	22.78	22.78	22.97
		16QAM	1	0	24.00	23.58	23.13	23.39
			1	24	24.00	23.14	22.69	23.05
			1	49	24.00	23.18	22.87	23.15
			25	0	23.00	22.03	21.97	22.12
			25	12	23.00	21.95	21.89	22.05
			25	24	23.00	21.80	21.87	21.99
			50	0	23.00	21.81	21.87	22.00

Band	Band Width	Modulation	RB Configuration RB Size	RB Offset	Tune-up	Channel/Frequency(MHz) 20025/1717.5	20175/1732.5	20325/1747.5
LTE Band IV	15MHz	QPSK	1	0	24.00	23.80	23.83	23.94
			1	37	24.00	23.37	23.42	23.61
			1	74	24.00	23.49	23.60	23.71
			36	0	24.00	23.05	22.91	23.11
			36	18	24.00	22.77	22.89	22.98
			36	37	24.00	22.75	22.78	22.95
			75	0	23.00	22.88	22.84	22.96
		16QAM	1	0	24.00	23.84	23.61	23.59
			1	37	24.00	23.10	23.02	23.09
			1	74	24.00	23.22	23.13	23.17
			36	0	23.00	22.02	22.02	22.17
			36	18	23.00	21.92	21.89	22.05
			36	37	23.00	21.79	21.82	21.91
			75	0	23.00	21.89	21.88	22.03

Band	Band Width	Modulation	RB Configuration RB Size	RB Offset	Tune-up	Channel/Frequency(MHz) 20050/1720	20175/1732.5	20300/1745
LTE Band IV	20MHz	QPSK	1	0	24.00	23.98	24.00	23.99
			1	49	24.00	23.28	23.30	23.49
			1	99	24.00	23.24	23.43	23.71
			50	0	24.00	22.93	22.98	22.97
			50	24	24.00	22.90	22.89	22.95
			50	49	24.00	22.59	22.70	22.84
			100	0	24.00	22.77	22.78	22.97
		16QAM	1	0	24.00	23.44	23.72	23.53
			1	49	24.00	22.74	23.02	22.88
			1	99	24.00	22.68	23.17	23.07
			50	0	23.00	22.04	22.03	22.13
			50	24	23.00	22.01	21.92	22.12
			50	49	23.00	21.62	21.76	21.88
			100	0	22.00	21.86	21.91	21.98

Band	Band Width	Modulation	RB Configuration		Tune-up	Channel/Frequency(MHz)		
			RB Size	RB Offset		18607/1850.7	18900/1880	19193/1909.3
LTE Band II	1.4MHz	QPSK	1	0	24.00	23.11	23.73	23.87
			1	2	24.00	23.98	23.75	23.78
			1	5	24.00	23.95	23.71	23.68
			3	0	24.00	23.88	23.70	23.82
			3	1	24.00	23.89	23.71	23.75
			3	2	24.00	23.84	23.71	23.74
			6	0	23.00	22.90	22.99	22.95
		16QAM	1	0	24.00	23.29	23.22	23.29
			1	2	24.00	23.18	22.98	23.23
			1	5	24.00	23.18	23.20	23.22
			3	0	24.00	23.19	23.11	23.19
			3	1	24.00	23.20	23.11	23.15
			3	2	24.00	23.27	23.05	23.11
			6	0	23.00	22.21	22.13	22.22
Band	Band Width	Modulation	RB Configuration		Tune-up	Channel/Frequency(MHz)		
			RB Size	RB Offset		18615/1851.5	18900/1880	19185/1908.5
LTE Band II	3MHz	QPSK	1	0	24.00	23.80	23.57	23.99
			1	7	24.00	23.69	23.45	23.79
			1	14	24.00	23.40	23.51	23.68
			8	0	24.00	23.09	23.02	23.23
			8	4	24.00	23.56	23.05	23.21
			8	7	24.00	22.99	23.05	23.09
			15	0	24.00	22.94	23.00	22.90
		16QAM	1	0	24.00	23.54	23.25	23.71
			1	7	24.00	23.40	23.20	23.62
			1	14	24.00	23.33	23.18	23.43
			8	0	23.00	22.38	22.23	22.55
			8	4	23.00	22.31	22.25	22.45
			8	7	23.00	22.30	22.22	22.40
			15	0	23.00	22.12	22.15	22.28

Band	Band Width	Modulation	RB Configuration		Tune-up	Channel/Frequency(MHz)		
			RB Size	RB Offset		18625/1852.5	18900/1880	19175/1907.5
LTE Band II	5MHz	QPSK	1	0	24.00	23.86	23.45	23.99
			1	12	24.00	23.53	23.40	23.73
			1	24	24.00	23.43	23.44	23.48
			12	0	24.00	23.11	23.10	23.38
			12	6	24.00	23.15	23.10	23.25
			12	11	24.00	22.99	23.05	23.13
			25	0	24.00	23.09	23.03	23.23
		16QAM	1	0	24.00	23.00	23.18	23.66
			1	12	24.00	22.79	23.11	23.43
			1	24	24.00	22.74	23.17	23.25
			12	0	23.00	22.22	22.20	22.57
			12	6	23.00	22.15	22.21	22.35
			12	11	23.00	22.10	22.15	22.39
			25	0	23.00	22.15	22.15	22.38

Band	Band Width	Modulation	RB Configuration		Tune-up	Channel/Frequency(MHz)		
			RB Size	RB Offset		18650/1855	18900/1880	19150/1905
LTE Band II	10MHz	QPSK	1	0	24.00	23.73	23.83	23.97
			1	24	24.00	23.38	23.53	23.74
			1	49	24.00	23.24	23.64	23.61
			25	0	24.00	23.16	23.18	23.59
			25	12	24.00	22.12	23.11	23.45
			25	24	24.00	22.91	23.11	23.25
			50	0	24.00	23.06	23.16	23.41
		16QAM	1	0	24.00	23.78	23.39	23.99
			1	24	24.00	23.37	22.97	23.49
			1	49	24.00	23.27	23.29	23.38
			25	0	23.00	22.27	22.28	22.68
			25	12	23.00	22.15	22.25	22.41
			25	24	23.00	22.10	22.23	22.35
			50	0	23.00	22.11	22.30	22.49

Band	Band Width	Modulation	RB Configuration		Tune-up	Channel/Frequency(MHz)		
			RB Size	RB Offset		18675/1857.5	18900/1880	19125/1902.5
LTE Band II	15MHz	QPSK	1	0	24.00	23.80	24.00	23.98
			1	37	24.00	23.37	23.51	23.73
			1	74	24.00	23.45	23.73	23.62
			36	0	24.00	23.47	23.32	23.73
			36	18	24.00	23.15	23.22	23.31
			36	37	24.00	23.12	23.17	23.34
			75	0	24.00	23.23	23.22	23.61
		16QAM	1	0	24.00	23.86	23.95	23.94
			1	37	24.00	23.44	23.35	23.49
			1	74	24.00	23.54	23.66	23.37
			36	0	23.00	22.44	22.34	22.84
			36	18	23.00	22.35	22.31	22.40
			36	37	23.00	22.19	22.22	22.40
			75	0	23.00	22.12	22.27	22.65

Band	Band Width	Modulation	RB Configuration		Tune-up	Channel/Frequency(MHz)		
			RB Size	RB Offset		18700/1860	18900/1880	19100/1900
LTE Band II	20MHz	QPSK	1	0	24.00	23.99	23.94	23.98
			1	49	24.00	23.31	23.36	23.66
			1	99	24.00	23.30	23.50	23.27
			50	0	24.00	23.55	23.69	23.67
			50	24	24.00	23.45	23.25	23.41
			50	49	24.00	22.95	23.15	23.20
			100	0	24.00	23.13	23.34	23.50
		16QAM	1	0	24.00	23.89	23.98	23.98
			1	49	24.00	23.05	23.52	23.55
			1	99	24.00	23.03	23.63	23.05
			50	0	23.00	22.51	22.47	22.70
			50	24	23.00	22.37	22.41	22.40
			50	49	23.00	22.06	22.25	22.24
			100	0	23.00	22.24	22.36	22.48

7.3. WLAN & Bluetooth Output Power

7.3.1. Output Power Results Of WLAN

The output power of WLAN is as following:

Mode	Channel	Frequency (MHz)	Tune-up	Output Power (dBm)
802.11b	1	2412	17.0	16.5
	6	2437	17.0	16.8
	11	2462	17.0	16.2
802.11g	1	2412	17.0	15.4
	6	2437	17.0	16.3
	11	2462	17.0	15.9
802.11n 20M	1	2412	17.0	15.4
	6	2437	17.0	16.3
	11	2462	17.0	16.1
802.11n 40M	3	2422	16.0	15.3
	6	2437	16.0	15.8
	9	2452	16.0	15.6

7.3.2. Output Power Results Of Bluetooth

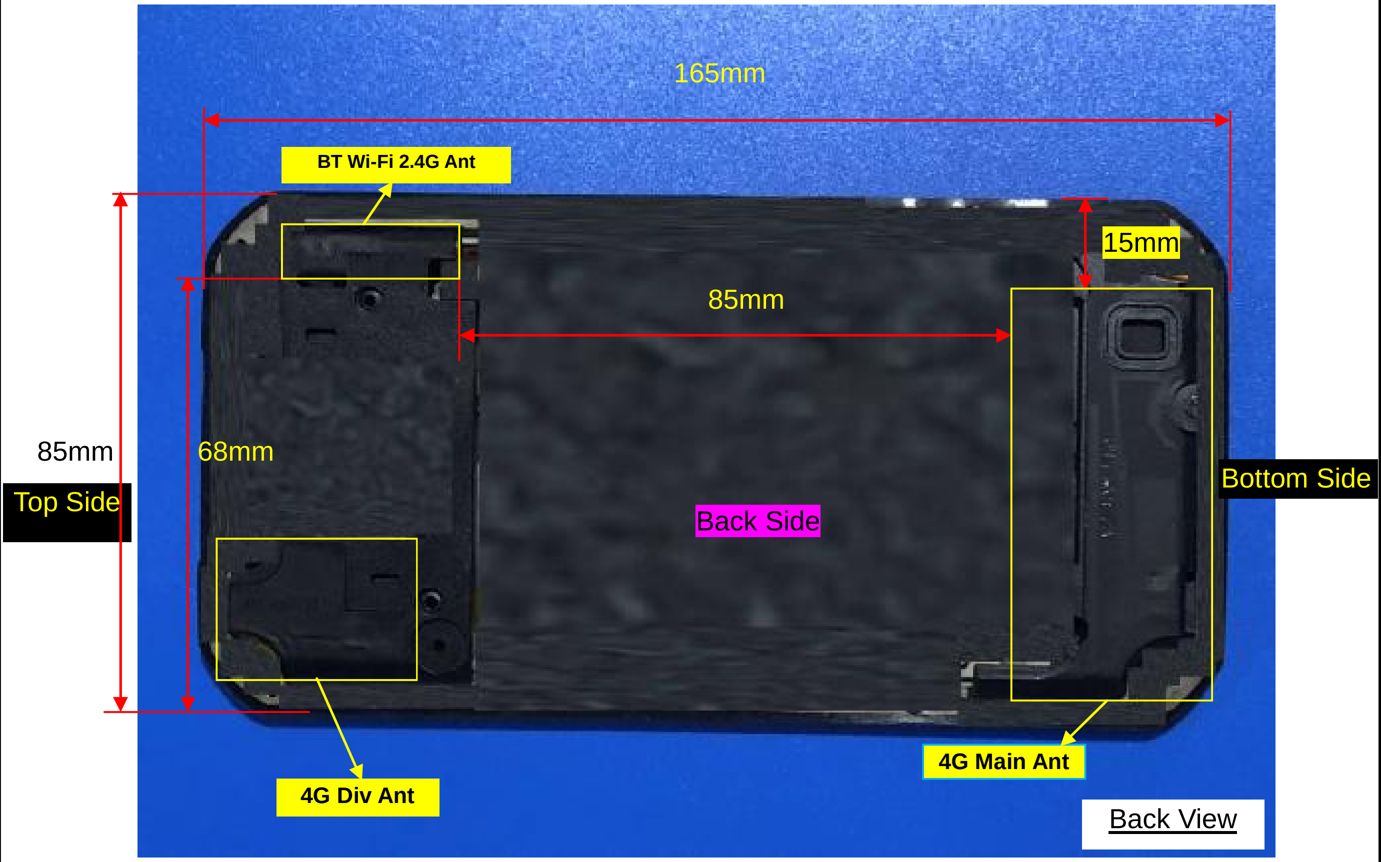
The output power of Bluetooth is as following:

BR+EDR	Output Power (dBm)				
	Channel	Tune-up	Data Rates		
			0CH	39CH	78CH
	1M	5.50	4.15	5.41	4.17
	2M	5.00	3.22	4.49	3.34
	3M	5.00	3.64	4.89	3.72

BLE	Channel	Tune-up	Output Power (dBm)
	0CH	5.50	3.68
	19CH	5.50	5.32
	39CH	5.50	4.03

8. Antenna Location

Left Side



Right 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:

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

- $f_{(GHZ)}$ 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	5.5	3.55	5	2.480	1.12	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:

[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] * [$\sqrt{f_{(GHZ)}}/x$] W/kg for test separation distances ≤ 50mm, 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	Head	5.5	3.55	5	2.480	7.5	0.149
Bluetooth	Body	5.5	3.55	10	2.480	7.5	0.075
Bluetooth	Hotspot	5.5	3.55	10	2.480	7.5	0.075

NOTE: Estimated SAR calculation for Bluetooth

10. SAR Results

10.1. SAR measurement results

10.1.1. SAR measurement Result of LTE Band XIII

Test Position of Head	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				
1RB								
Left Cheek	23230/782	10M QPSK(1,24)	0.078	0.062	3.09	23.86	24.00	0.081
Left Tilt 15 Degree	23230/782	10M QPSK(1,24)	0.037	0.020	-1.16	23.86	24.00	0.038
Right Cheek	23230/782	10M QPSK(1,24)	0.065	0.030	0.87	23.86	24.00	0.067
Right Tilt 15 Degree	23230/782	10M QPSK(1,24)	0.028	0.016	2.31	23.86	24.00	0.029
50%RB								
Left Cheek	23230/782	10M QPSK(25,0)	0.065	0.051	3.05	23.37	24.00	0.075
Left Tilt 15 Degree	23230/782	10M QPSK(25,0)	0.031	0.018	-1.13	23.37	24.00	0.036
Right Cheek	23230/782	10M QPSK(25,0)	0.049	0.025	3.25	23.37	24.00	0.057
Right Tilt 15 Degree	23230/782	10M QPSK(25,0)	0.024	0.015	-2.21	23.37	24.00	0.028

NOTE: Head SAR test results of LTE Band XIII

Test Position of Body-Worn 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				
1RB								
Front Side	23230/782	10M QPSK(1,24)	0.061	0.040	-1.13	23.86	24.00	0.063
Back Side	23230/782	10M	0.165	0.103	3.45	23.86	24.00	0.170

		QPSK(1,24)						
50%RB								
Front Side	23230/782	10M QPSK(25,0)	0.050	0.031	-1.28	23.37	24.00	0.058
Back Side	23230/782	10M QPSK(25,0)	0.131	0.061	-1.13	23.37	24.00	0.151

NOTE: Body-Worn SAR test results of LTE Band XIII

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				
1RB								
Front Side	23230/782	10M QPSK(1,24)	0.061	0.040	-1.13	23.86	24.00	0.063
Back Side	23230/782	10M QPSK(1,24)	0.165	0.103	3.45	23.86	24.00	0.170
Left Side	23230/782	10M QPSK(1,24)	0.030	0.018	0.58	23.86	24.00	0.031
Right Side	23230/782	10M QPSK(1,24)	0.032	0.022	0.21	23.86	24.00	0.033
Bottom Side	23230/782	10M QPSK(1,24)	0.059	0.031	-1.13	23.86	24.00	0.061
50%RB								
Front Side	23230/782	10M QPSK(25,0)	0.050	0.031	-1.28	23.37	24.00	0.058
Back Side	23230/782	10M QPSK(25,0)	0.131	0.061	-1.13	23.37	24.00	0.151
Left Side	23230/782	10M QPSK(25,0)	0.028	0.018	-2.31	23.37	24.00	0.032
Right Side	23230/782	10M QPSK(25,0)	0.030	0.018	2.24	23.37	24.00	0.035
Bottom Side	23230/782	10M QPSK(25,0)	0.050	0.030	0.76	23.37	24.00	0.058

NOTE: Hotspot SAR test results of LTE Band XIII

10.1.2. SAR measurement Result of LTE Band IV

Test Position of Head	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				
1RB								
Left Cheek	20175/1732.5	20M QPSK(1,0)	0.059	0.041	2.83	24.00	24.00	0.059
Left Tilt 15 Degree	20175/1732.5	20M QPSK(1,0)	0.028	0.020	-1.15	24.00	24.00	0.028
Right Cheek	20175/1732.5	20M QPSK(1,0)	0.040	0.027	0.59	24.00	24.00	0.040
Right Tilt 15 Degree	20175/1732.5	20M QPSK(1,0)	0.020	0.011	0.02	24.00	24.00	0.020
50%RB								
Left Cheek	20175/1732.5	20M QPSK(50,0)	0.053	0.036	4.52	22.98	24.00	0.067
Left Tilt 15 Degree	20175/1732.5	20M QPSK(50,0)	0.025	0.018	-1.64	22.98	24.00	0.032
Right Cheek	20175/1732.5	20M QPSK(50,0)	0.035	0.022	-2.21	22.98	24.00	0.044
Right Tilt 15 Degree	20175/1732.5	20M QPSK(50,0)	0.021	0.015	0.86	22.98	24.00	0.027

NOTE: Head SAR test results of LTE Band IV

Test Position of Body-Worn 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				
1RB								
Front Side	20175/1732.5	20M QPSK(1,0)	0.104	0.059	-1.13	24.00	24.00	0.104
Back Side	20175/1732.5	20M QPSK(1,0)	0.241	0.145	-1.87	24.00	24.00	0.241
50%RB								
Front Side	20175/1732.	20M QPSK(50,0)	0.089	0.055	-2.23	22.98	24.00	0.113

	5							
Back Side	20175/1732.5	20M QPSK(50,0)	0.195	0.112	2.38	22.98	24.00	0.247

NOTE: Body-Worn SAR test results of LTE Band IV

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				
1RB								
Front Side	20175/1732.5	20M QPSK(1,0)	0.104	0.059	-1.13	24.00	24.00	0.104
Back Side	20175/1732.5	20M QPSK(1,0)	0.241	0.145	-1.87	24.00	24.00	0.241
Left Side	20175/1732.5	20M QPSK(1,0)	0.038	0.025	0.25	24.00	24.00	0.038
Right Side	20175/1732.5	20M QPSK(1,0)	0.049	0.029	2.21	24.00	24.00	0.049
Bottom Side	20175/1732.5	20M QPSK(1,0)	0.067	0.042	-1.13	24.00	24.00	0.067
50%RB								
Front Side	20175/1732.5	20M QPSK(50,0)	0.089	0.055	-2.23	22.98	24.00	0.113
Back Side	20175/1732.5	20M QPSK(50,0)	0.195	0.112	2.38	22.98	24.00	0.247
Left Side	20175/1732.5	20M QPSK(50,0)	0.030	0.021	0.65	22.98	24.00	0.038
Right Side	20175/1732.5	20M QPSK(50,0)	0.042	0.025	-2.06	22.98	24.00	0.053
Bottom Side	20175/1732.5	20M QPSK(50,0)	0.051	0.037	0.08	22.98	24.00	0.065

NOTE: Hotspot SAR test results of LTE Band IV

10.1.3. SAR measurement Result of LTE Band II

Test Position of Head	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				
1RB								
Left Cheek	18900/1880	20M QPSK(1,0)	0.100	0.064	0.96	23.94	24.00	0.101
Left Tilt 15 Degree	18900/1880	20M QPSK(1,0)	0.039	0.020	-2.13	23.94	24.00	0.040
Right Cheek	18900/1880	20M QPSK(1,0)	0.070	0.043	0.08	23.94	24.00	0.071
Right Tilt 15 Degree	18900/1880	20M QPSK(1,0)	0.032	0.021	0.14	23.94	24.00	0.032
50%RB								
Left Cheek	18900/1880	20M QPSK(50,0)	0.089	0.051	-2.21	23.69	24.00	0.096
Left Tilt 15 Degree	18900/1880	20M QPSK(50,0)	0.034	0.022	0.17	23.69	24.00	0.037
Right Cheek	18900/1880	20M QPSK(50,0)	0.061	0.038	-1.16	23.69	24.00	0.066
Right Tilt 15 Degree	18900/1880	20M QPSK(50,0)	0.030	0.017	0.58	23.69	24.00	0.032

NOTE: Head SAR test results of LTE Band II

Test Position of Body-Worn 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				
1RB								
Front Side	18900/1880	20M QPSK(1,0)	0.120	0.073	-0.58	23.94	24.00	0.122
Back Side	18900/1880	20M QPSK(1,0)	1.122	0.636	1.01	23.94	24.00	1.138
Back Side - Repeated	18900/1880	20M QPSK(1,0)	1.107	0.622	-1.20	23.94	24.00	1.122
Back Side	18700/1860	20M QPSK(1,0)	0.730	0.378	-2.18	23.99	24.00	0.732
Back Side	19100/1900	20M QPSK(1,0)	1.105	0.573	-0.87	23.98	24.00	1.110

50%RB								
Front Side	18900/1880	20M QPSK(50,0)	0.091	0.050	-1.12	23.69	24.00	0.098
Back Side	18900/1880	20M QPSK(50,0)	0.735	0.407	-1.10	23.69	24.00	0.789
100%RB								
Back Side	18900/1880	20M QPSK(100,0)	0.614	0.377	-1.15	23.34	24.00	0.715

NOTE: Body-Worn SAR test results of LTE 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				
1RB								
Front Side	18900/1880	20M QPSK(1,0)	0.120	0.073	-0.58	23.94	24.00	0.122
Back Side	18900/1880	20M QPSK(1,0)	1.122	0.636	1.01	23.94	24.00	1.138
Back Side - Repeated	18900/1880	20M QPSK(1,0)	1.107	0.622	-1.20	23.94	24.00	1.122
Left Side	18900/1880	20M QPSK(1,0)	0.138	0.079	-2.11	23.94	24.00	0.140
Right Side	18900/1880	20M QPSK(1,0)	0.267	0.157	2.69	23.94	24.00	0.271
Bottom Side	18900/1880	20M QPSK(1,0)	0.531	0.317	0.07	23.94	24.00	0.538
Back Side	18700/1860	20M QPSK(1,0)	0.730	0.378	-2.18	23.99	24.00	0.732
Back Side	19100/1900	20M QPSK(1,0)	1.105	0.573	-0.87	23.98	24.00	1.110
50%RB								
Front Side	18900/1880	20M QPSK(50,0)	0.091	0.050	-1.12	23.69	24.00	0.098
Back Side	18900/1880	20M QPSK(50,0)	0.735	0.407	-1.10	23.69	24.00	0.789
Left Side	18900/1880	20M QPSK(50,0)	0.095	0.045	0.01	23.69	24.00	0.102
Right Side	18900/1880	20M QPSK(50,0)	0.201	0.114	0.84	23.69	24.00	0.216
Bottom Side	18900/1880	20M QPSK(50,0)	0.337	0.208	-1.68	23.69	24.00	0.362
100%RB								
Back Side	18900/1880	20M QPSK(100,0)	0.614	0.377	-1.15	23.34	24.00	0.715

NOTE: Hotspot SAR test results of LTE Band II

10.1.4. SAR measurement Result of WLAN 2.4G

Test Position of Head	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				
Left Cheek	6/2437	802.11 b	0.029	0.019	4.23	16.80	17.00	0.030
Left Tilt 15 Degree	6/2437	802.11 b	0.021	0.014	-1.10	16.80	17.00	0.022
Right Cheek	6/2437	802.11 b	0.024	0.017	2.84	16.80	17.00	0.025
Right Tilt 15 Degree	6/2437	802.11 b	0.017	0.010	-2.31	16.80	17.00	0.018

NOTE: Head SAR test results of WLAN 2.4G

Test Position of Body-Worn 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	0.064	0.038	3.32	16.80	17.00	0.067
Back Side	6/2437	802.11 b	0.377	0.204	-2.05	16.80	17.00	0.395

NOTE: Body-Worn SAR test results 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	0.064	0.038	3.32	16.80	17.00	0.067
Back Side	6/2437	802.11 b	0.377	0.204	-2.05	16.80	17.00	0.395
Left Side	6/2437	802.11 b	0.041	0.025	-1.10	16.80	17.00	0.043
Top Side	6/2437	802.11 b	0.057	0.032	0.58	16.80	17.00	0.060

NOTE: Hotspot SAR test results of WLAN 2.4G

10.2. Simultaneous Transmission Possibilities

The Simultaneous Transmission Possibilities of this device are as below:

No.	Configuration	Head	Body	Hotspot	Note
1	LTE(data) + WLAN 2.4GHz(data)	Yes	Yes	Yes	2.4GHz Hotspot
2	LTE(data) + Bluetooth(data)	Yes	Yes	Yes	Bluetooth Tethering

NOTE:

1) This device supported VoIP in LTE (e.g. 3rd party VoIP).

2) This device WLAN 2.4GHz supports Hotspot operation.

3) WLAN 2.4GHz and Bluetooth share the same antenna, and cannot transmit simultaneously.

4) EUT will choose each LTE according to the network signal condition; therefore, they will not operate simultaneously at any moment.

5) The Scaled SAR Simultaneous Tx is calculated based on the same configuration and test position.

10.3. SAR Summation Scenario

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

1) Scalar SAR summation < 1.6W/kg.

2) SPLSR = $(SAR_1 + SAR_2)^{1.5}$ / (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 SPLSR ≤ 0.04, simultaneously transmission SAR measurement is not necessary.

Test Position		Scaled SAR_{MAX}		Σ1-g SAR (W/Kg)	SPLSR	Remark
		LTE Band XIII	WLAN 2.4G			
Head	Left Cheek	0.081	0.030	0.111	N/A	N/A
	Left Tilt 15 Degree	0.038	0.022	0.060	N/A	N/A
	Right Cheek	0.067	0.025	0.092	N/A	N/A
	Right Tilt 15 Degree	0.029	0.018	0.047	N/A	N/A
Body-Worn	Front Side	0.063	0.067	0.130	N/A	N/A
	Back Side	0.170	0.395	0.565	N/A	N/A
Hotspot	Front Side	0.063	0.067	0.130	N/A	N/A
	Back Side	0.170	0.395	0.565	N/A	N/A
	Left Side	0.032	0.043	0.075	N/A	N/A
	Right Side	0.035	N/A	0.035	N/A	N/A
	Top Side	N/A	0.060	0.060	N/A	N/A
	Bottom Side	0.061	N/A	0.061	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of LTE Band XIII and WLAN 2.4G.

Test Position		Scaled SAR_{MAX}		Σ1-g SAR (W/Kg)	SPLSR	Remark
		LTE Band IV	WLAN 2.4G			
Head	Left Cheek	0.067	0.030	0.097	N/A	N/A
	Left Tilt 15 Degree	0.032	0.022	0.054	N/A	N/A
	Right Cheek	0.044	0.025	0.069	N/A	N/A
	Right Tilt 15 Degree	0.027	0.018	0.044	N/A	N/A
Body-Worn	Front Side	0.113	0.067	0.180	N/A	N/A
	Back Side	0.247	0.395	0.641	N/A	N/A
Hotspot	Front Side	0.113	0.067	0.180	N/A	N/A
	Back Side	0.247	0.395	0.641	N/A	N/A
	Left Side	0.038	0.043	0.081	N/A	N/A
	Right Side	0.053	N/A	0.053	N/A	N/A
	Top Side	N/A	0.060	0.060	N/A	N/A

	Bottom Side	0.067	N/A	0.067	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of LTE Band IV and WLAN 2.4G.

Test Position		Scaled SAR_{MAX}		Σ1-g SAR (W/Kg)	SPLSR	Remark
		LTE Band II	WLAN 2.4G			
Head	Left Cheek	0.101	0.030	0.132	N/A	N/A
	Left Tilt 15 Degree	0.040	0.022	0.062	N/A	N/A
	Right Cheek	0.071	0.025	0.096	N/A	N/A
	Right Tilt 15 Degree	0.032	0.018	0.050	N/A	N/A
Body-Worn	Front Side	0.122	0.067	0.189	N/A	N/A
	Back Side	1.138	0.395	1.532	N/A	N/A
Hotspot	Front Side	0.122	0.067	0.189	N/A	N/A
	Back Side	1.138	0.395	1.532	N/A	N/A
	Left Side	0.140	0.043	0.183	N/A	N/A
	Right Side	0.271	N/A	0.271	N/A	N/A
	Top Side	N/A	0.060	0.060	N/A	N/A
	Bottom Side	0.538	N/A	0.538	N/A	N/A

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

Test Position		Scaled SAR_{MAX}		Σ1-g SAR (W/Kg)	SPLSR	Remark
		LTE Band XIII	Bluetooth			
Head	Left Cheek	0.081	0.149	0.230	N/A	N/A
	Left Tilt 15 Degree	0.038	0.149	0.187	N/A	N/A
	Right Cheek	0.067	0.149	0.216	N/A	N/A
	Right Tilt 15 Degree	0.029	0.149	0.178	N/A	N/A
Body-Worn	Front Side	0.063	0.075	0.137	N/A	N/A
	Back Side	0.170	0.075	0.245	N/A	N/A
Hotspot	Front Side	0.063	0.075	0.137	N/A	N/A
	Back Side	0.170	0.075	0.245	N/A	N/A
	Left Side	0.032	0.075	0.107	N/A	N/A
	Right Side	0.035	N/A	0.035	N/A	N/A
	Top Side	N/A	0.075	0.075	N/A	N/A
	Bottom Side	0.061	N/A	0.061	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of LTE Band XIII and Bluetooth

Test Position		Scaled SAR_{MAX} LTE Band IV	Scaled SAR_{MAX} Bluetooth	Σ1-g SAR (W/Kg)	SPLSR	Remark
Head	Left Cheek	0.067	0.149	0.216	N/A	N/A
	Left Tilt 15 Degree	0.032	0.149	0.181	N/A	N/A
	Right Cheek	0.044	0.149	0.193	N/A	N/A
	Right Tilt 15 Degree	0.027	0.149	0.176	N/A	N/A
Body-Worn	Front Side	0.113	0.075	0.187	N/A	N/A
	Back Side	0.247	0.075	0.321	N/A	N/A
Hotspot	Front Side	0.113	0.075	0.187	N/A	N/A
	Back Side	0.247	0.075	0.321	N/A	N/A
	Left Side	0.038	0.075	0.112	N/A	N/A
	Right Side	0.053	N/A	0.053	N/A	N/A
	Top Side	N/A	0.075	0.075	N/A	N/A
	Bottom Side	0.067	N/A	0.067	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of LTE Band IV and Bluetooth

Test Position		Scaled SAR_{MAX} LTE Band II	Scaled SAR_{MAX} Bluetooth	Σ1-g SAR (W/Kg)	SPLSR	Remark
Head	Left Cheek	0.101	0.149	0.250	N/A	N/A
	Left Tilt 15 Degree	0.040	0.149	0.189	N/A	N/A
	Right Cheek	0.071	0.149	0.220	N/A	N/A
	Right Tilt 15 Degree	0.032	0.149	0.181	N/A	N/A
Body-Worn	Front Side	0.122	0.075	0.197	N/A	N/A
	Back Side	1.138	0.075	1.212	N/A	N/A
Hotspot	Front Side	0.122	0.075	0.197	N/A	N/A
	Back Side	1.138	0.075	1.212	N/A	N/A
	Left Side	0.140	0.075	0.214	N/A	N/A
	Right Side	0.271	N/A	0.271	N/A	N/A
	Top Side	N/A	0.075	0.075	N/A	N/A
	Bottom Side	0.538	N/A	0.538	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of LTE 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

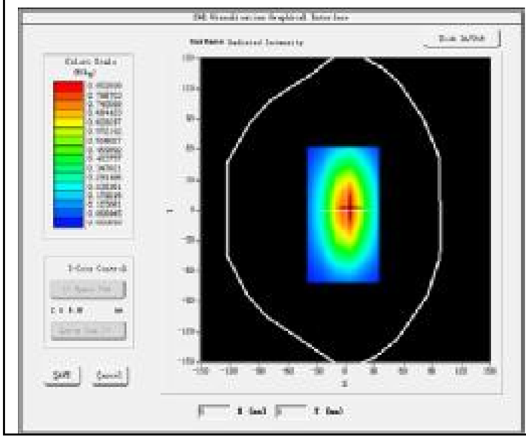
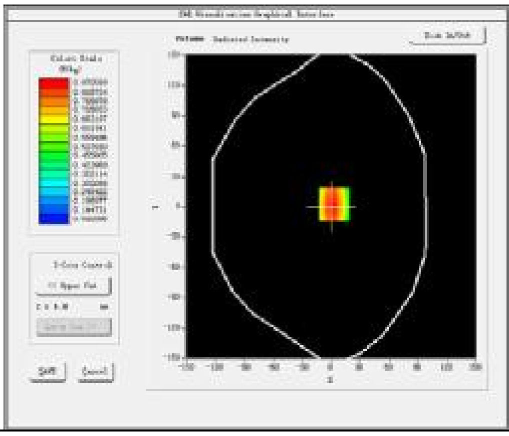
MEASUREMENT 1

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=15mm dy=15mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Dipole
Band	CW750
Channels	Middle
Signal	CW (Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	750.000000
Relative permittivity (real part)	41.589426
Relative permittivity (imaginary part)	21.939779
Conductivity (S/m)	0.906594
Variation (%)	-0.710000

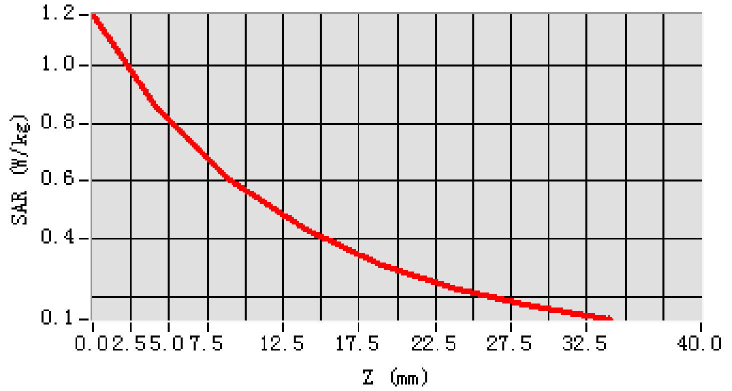
SURFACE SAR	VOLUME SAR
	

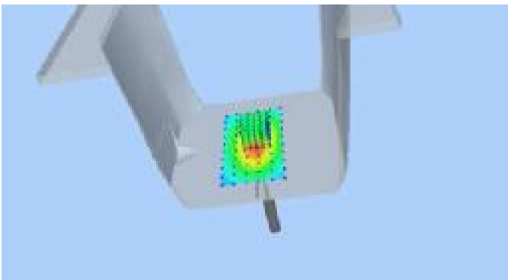
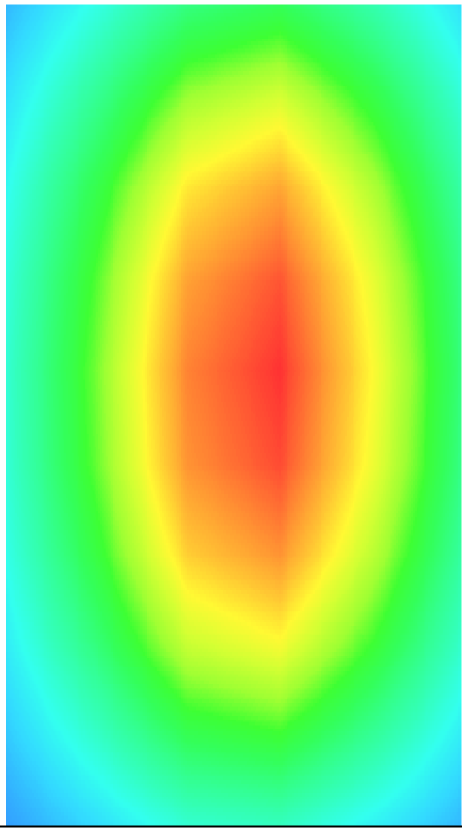
Maximum location: X=3.00, Y=2.00

SAR Peak: 1.18 W/kg

SAR 10g (W/Kg)	0.569036
SAR 1g (W/Kg)	0.855279

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	1.1757	0.8706	0.6043	0.4328	0.3111	0.2271	0.1651



3D screen shot	Hot spot position
	

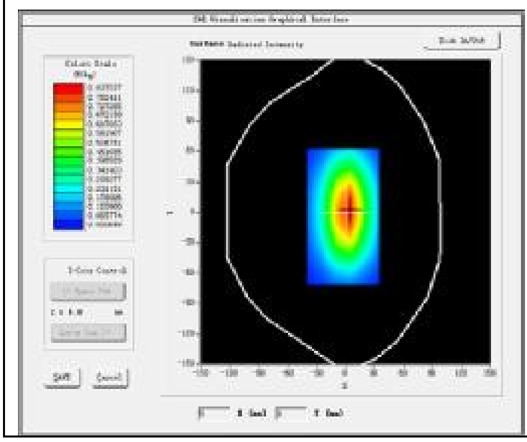
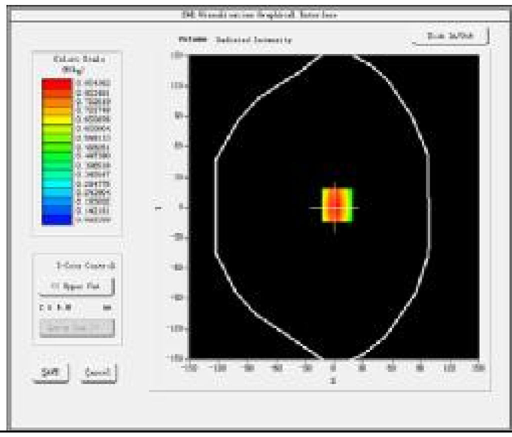
MEASUREMENT 2

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=15mm dy=15mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Dipole
Band	CW750
Channels	Middle
Signal	CW (Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	750.000000
Relative permittivity (real part)	55.579426
Relative permittivity (imaginary part)	23.375000
Conductivity (S/m)	0.966594
Variation (%)	-0.610000

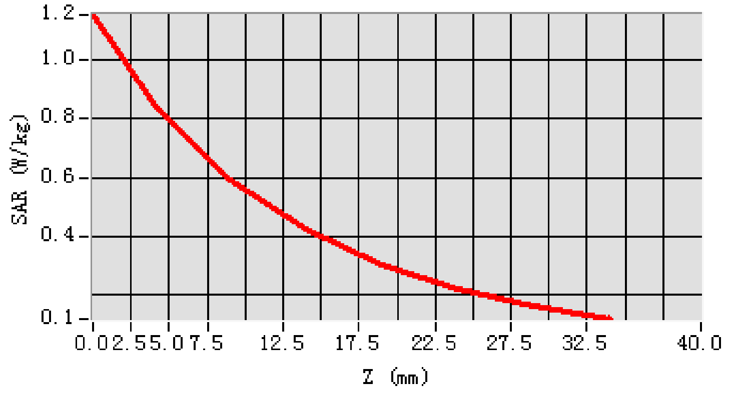
SURFACE SAR	VOLUME SAR
	

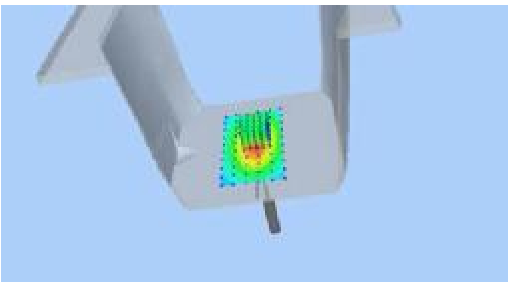
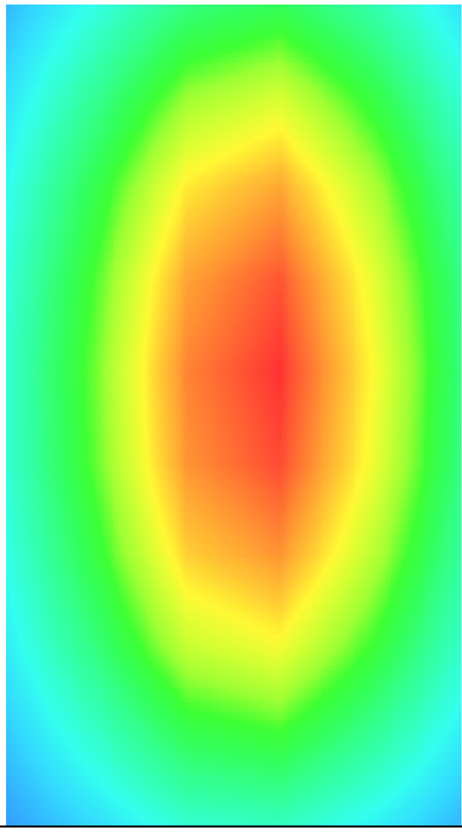
Maximum location: X=3.00, Y=2.00

SAR Peak: 1.16 W/kg

SAR 10g (W/Kg)	0.558532
SAR 1g (W/Kg)	0.839217

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	1.1532	0.8544	0.5935	0.4241	0.3055	0.2233	0.1623



3D screen shot	Hot spot position
	

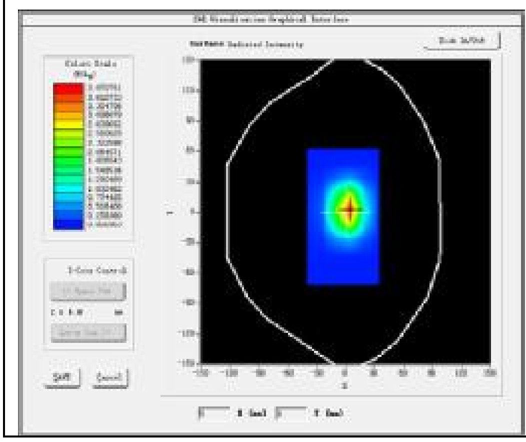
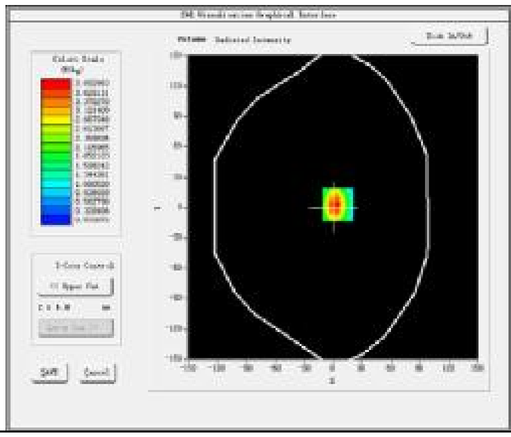
MEASUREMENT 3

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=15mm dy=15mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Dipole
Band	CW1800
Channels	Middle
Signal	CW (Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	1800.000000
Relative permittivity (real part)	39.905899
Relative permittivity (imaginary part)	14.002042
Conductivity (S/m)	1.401587
Variation (%)	-0.380000

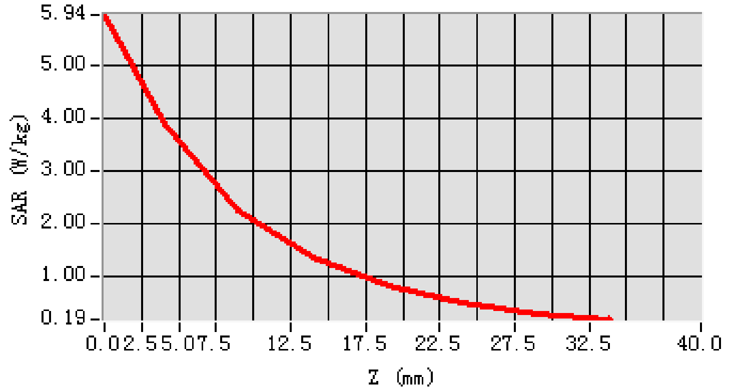
SURFACE SAR	VOLUME SAR
	

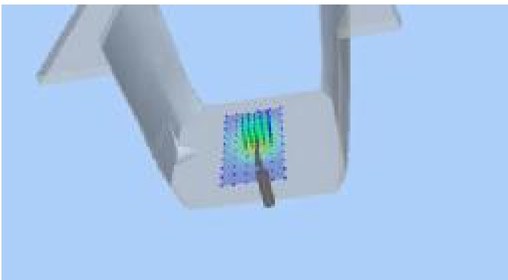
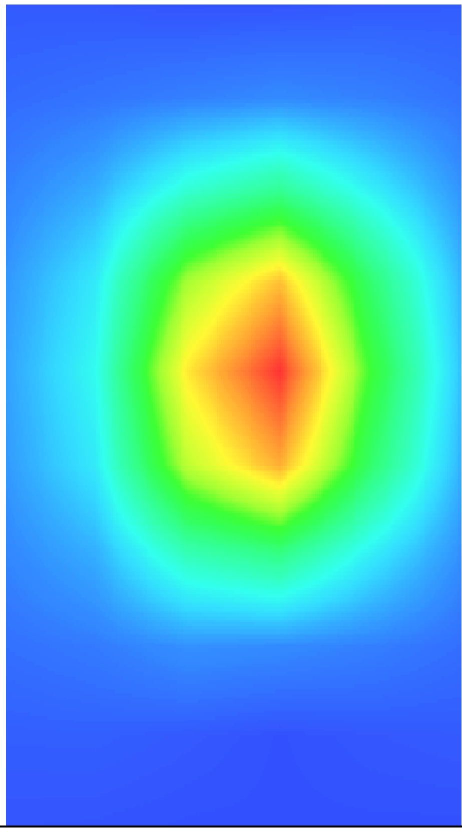
Maximum location: X=5.00, Y=3.00

SAR Peak: 6.17 W/kg

SAR 10g (W/Kg)	2.010726
SAR 1g (W/Kg)	3.848393

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	5.9426	3.8830	2.2478	1.3541	0.8138	0.4975	0.3052



3D screen shot	Hot spot position
	

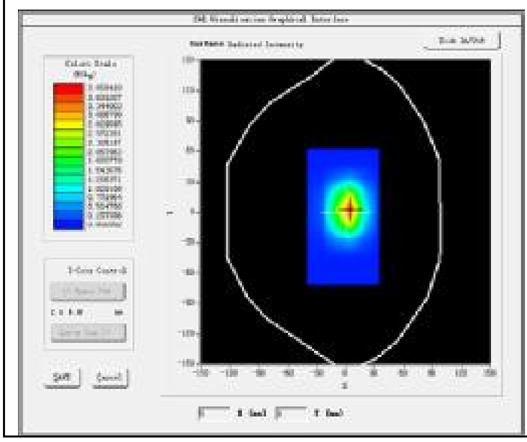
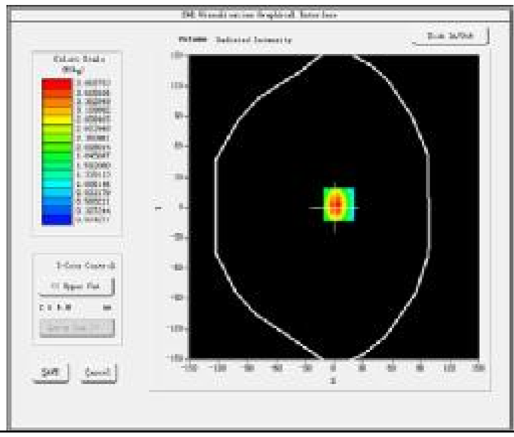
MEASUREMENT 4

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=15mm dy=15mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Dipole
Band	CW1800
Channels	Middle
Signal	CW (Crest factor: 1.0)

B. SAR Measurement Results

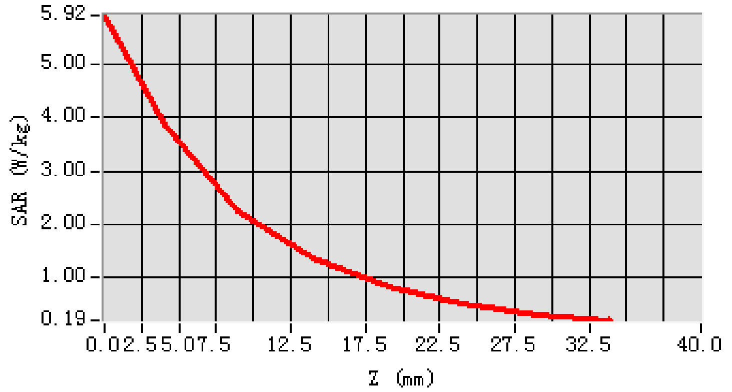
Frequency (MHz)	1800.000000
Relative permittivity (real part)	53.975899
Relative permittivity (imaginary part)	15.147470
Conductivity (S/m)	1.505587
Variation (%)	-0.190000

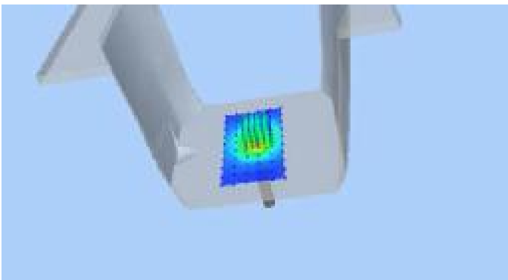
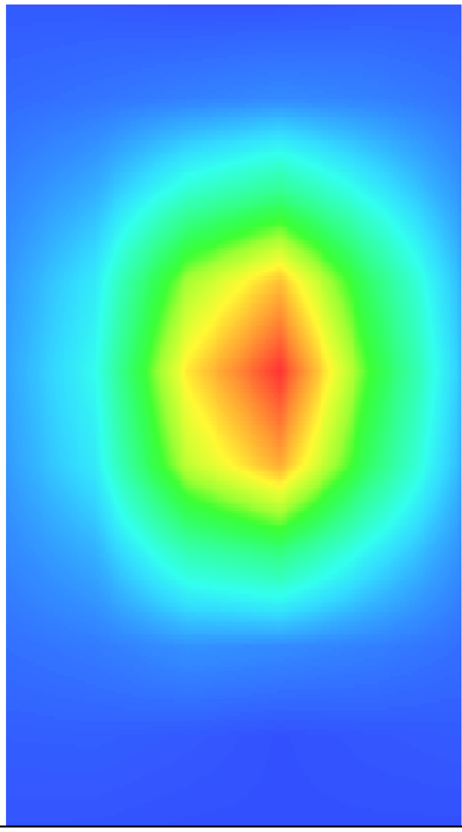
SURFACE SAR	VOLUME SAR
	

Maximum location: X=5.00, Y=3.00
SAR Peak: 6.16 W/kg

SAR 10g (W/Kg)	2.003281
SAR 1g (W/Kg)	3.838010

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	5.9236	3.8688	2.2379	1.3467	0.8084	0.4941	0.3025



3D screen shot	Hot spot position
	

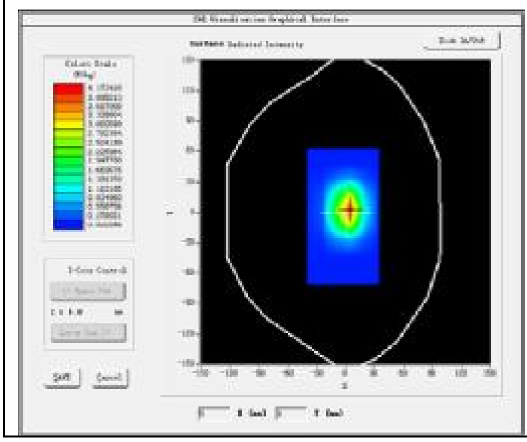
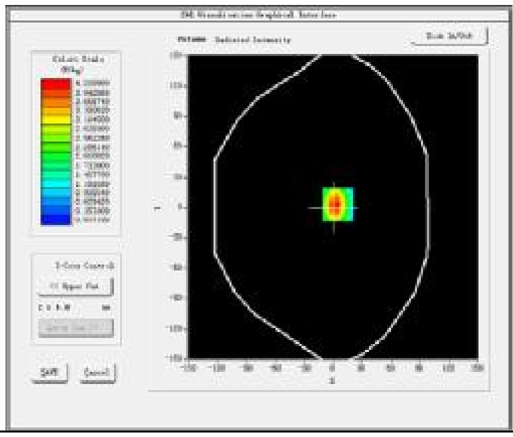
MEASUREMENT 5

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=15mm dy=15mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Dipole
Band	CW1900
Channels	Middle
Signal	CW (Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	1900.000000
Relative permittivity (real part)	39.485899
Relative permittivity (imaginary part)	13.590900
Conductivity (S/m)	1.425587
Variation (%)	1.410000

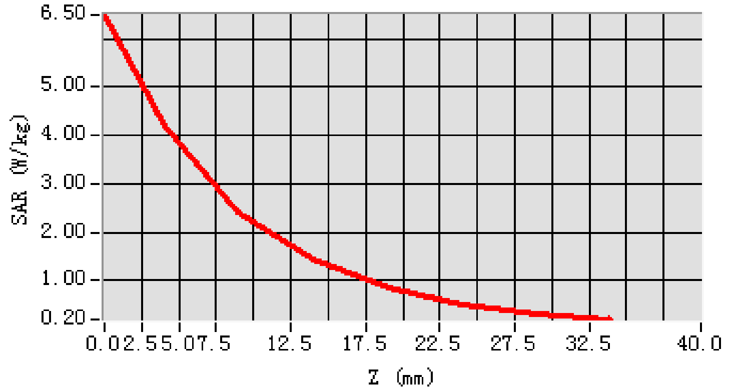
SURFACE SAR	VOLUME SAR
	

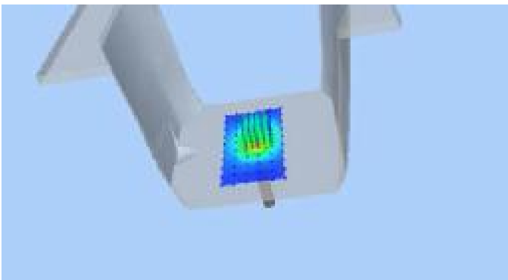
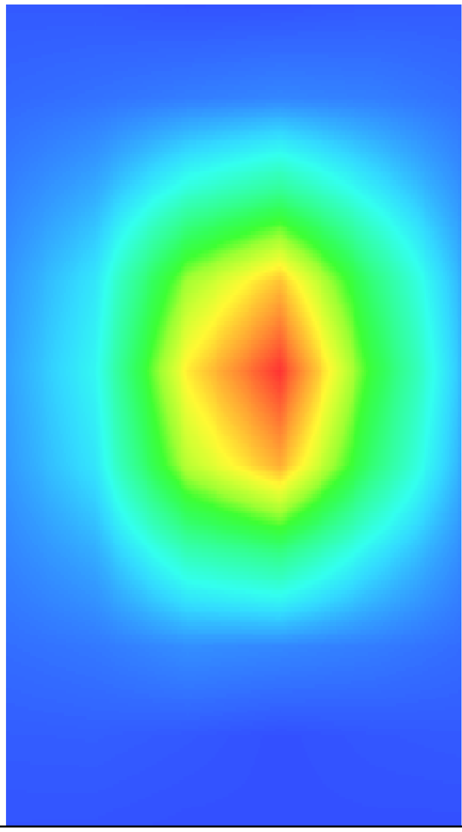
Maximum location: X=5.00, Y=3.00

SAR Peak: 6.76 W/kg

SAR 10g (W/Kg)	2.173139
SAR 1g (W/Kg)	4.188765

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	6.4952	4.2190	2.4222	1.4497	0.8664	0.5254	0.3199



3D screen shot	Hot spot position
	

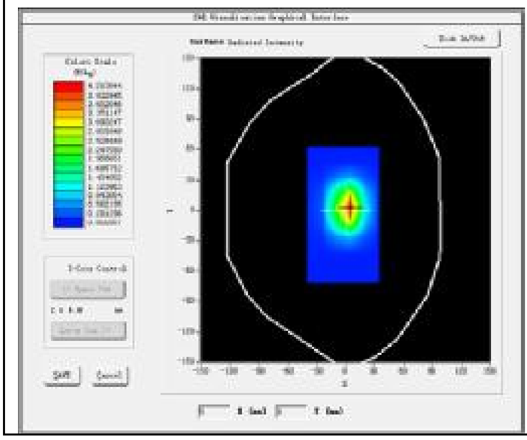
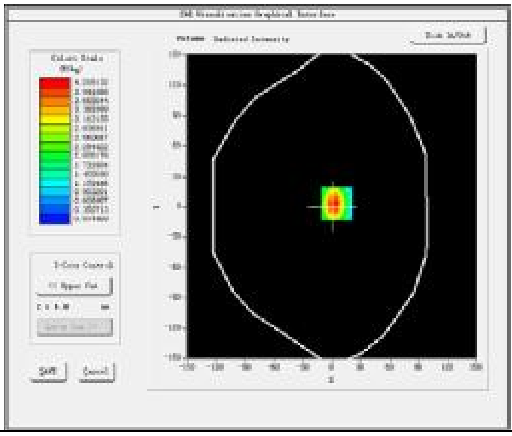
MEASUREMENT 6

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=15mm dy=15mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Dipole
Band	CW1900
Channels	Middle
Signal	CW (Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	1900.000000
Relative permittivity (real part)	53.495899
Relative permittivity (imaginary part)	14.563560
Conductivity (S/m)	1.535587
Variation (%)	-0.410000

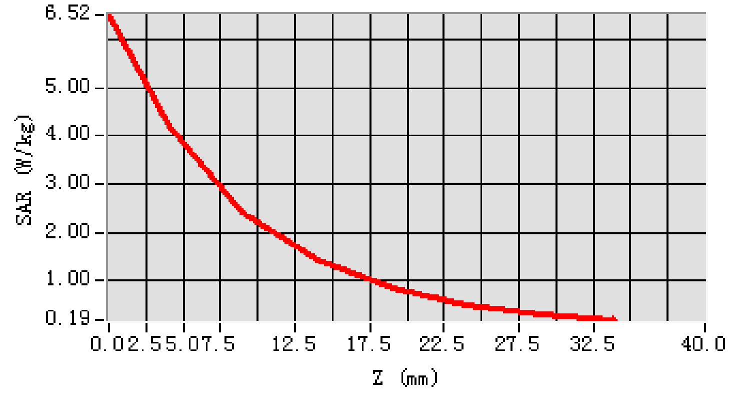
SURFACE SAR	VOLUME SAR
	

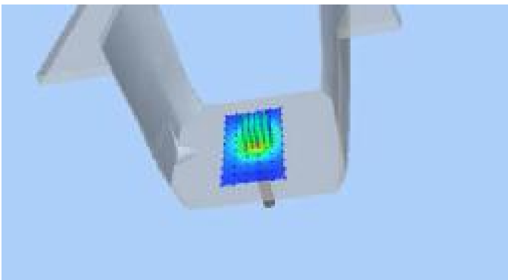
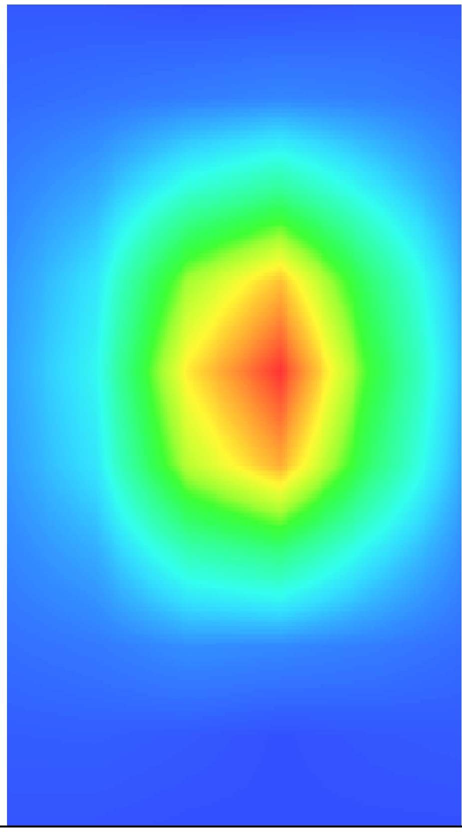
Maximum location: X=5.00, Y=3.00

SAR Peak: 6.79 W/kg

SAR 10g (W/Kg)	2.167814
SAR 1g (W/Kg)	4.194172

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	6.5171	4.2181	2.4087	1.4319	0.8520	0.5137	0.3110



3D screen shot	Hot spot position
	

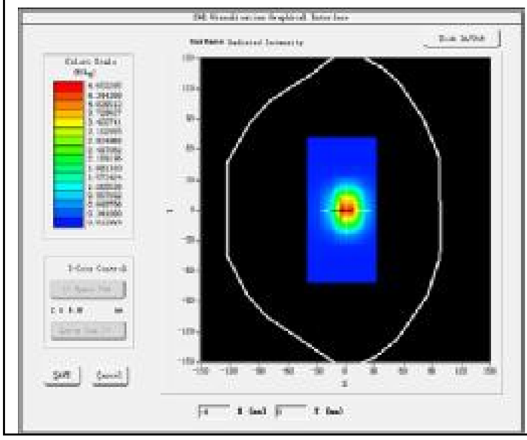
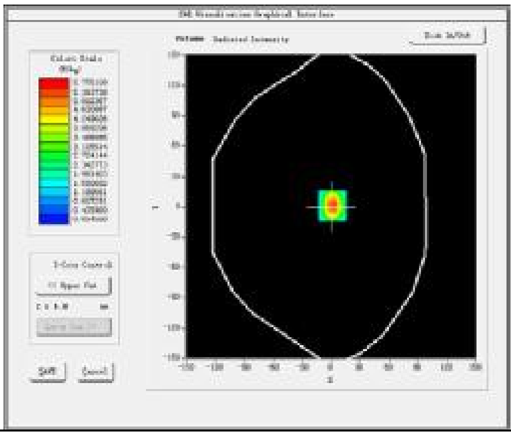
MEASUREMENT 7

A. Experimental conditions.

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

B. SAR Measurement Results

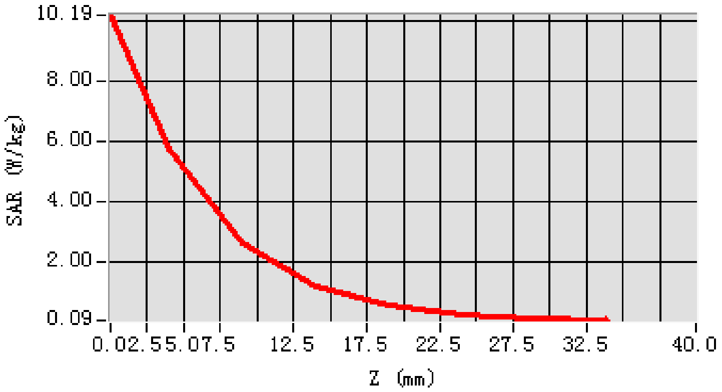
Frequency (MHz)	2450.000000
Relative permittivity (real part)	38.924097
Relative permittivity (imaginary part)	13.529100
Conductivity (S/m)	1.836738
Variation (%)	-0.050000

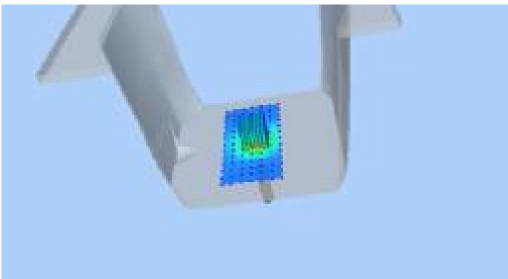
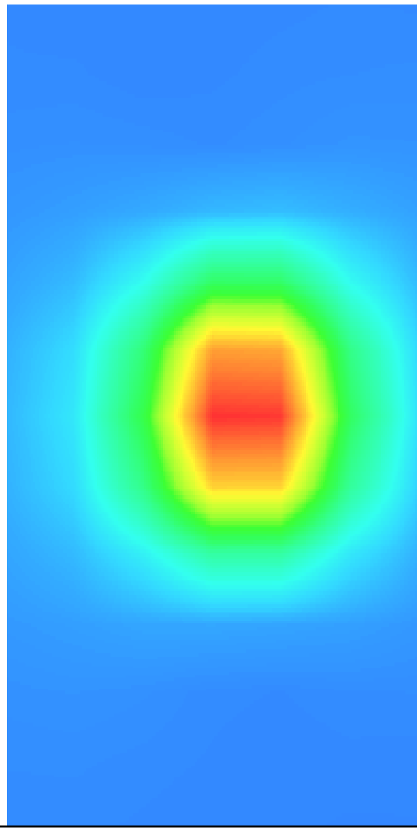
SURFACE SAR	VOLUME SAR
	

Maximum location: X=1.00, Y=1.00
SAR Peak: 10.08 W/kg

SAR 10g (W/Kg)	2.462453
SAR 1g (W/Kg)	5.339995

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	10.1922	5.7751	2.6280	1.2137	0.5848	0.2917	0.1545



3D screen shot	Hot spot position
	

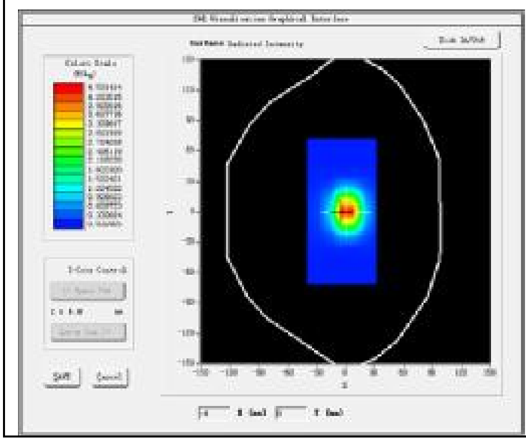
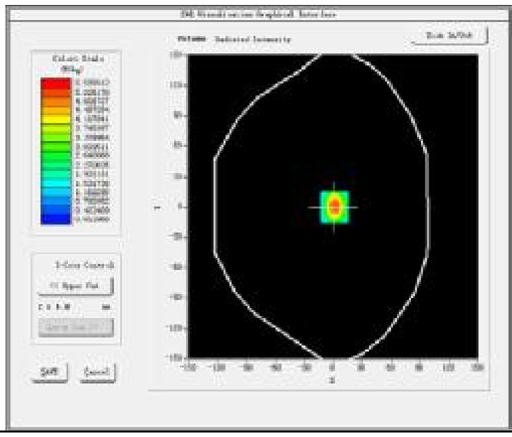
MEASUREMENT 8

A. Experimental conditions.

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

B. SAR Measurement Results

Frequency (MHz)	2450.000000
Relative permittivity (real part)	52.544097
Relative permittivity (imaginary part)	14.451220
Conductivity (S/m)	1.966738
Variation (%)	-0.060000

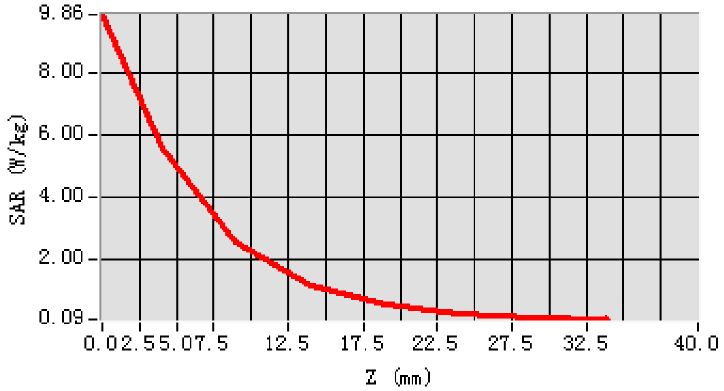
SURFACE SAR	VOLUME SAR
	

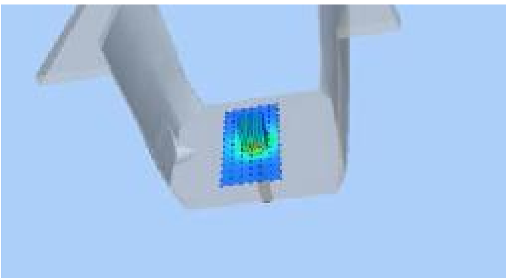
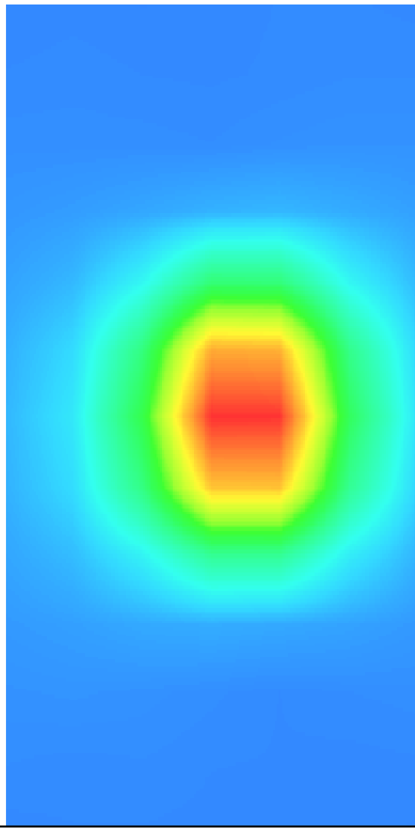
Maximum location: X=1.00, Y=0.00

SAR Peak: 9.78 W/kg

SAR 10g (W/Kg)	2.293258
SAR 1g (W/Kg)	5.179459

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	9.8570	5.5956	2.5548	1.1800	0.5696	0.2849	0.1508



3D screen shot	Hot spot position
	

13. Appendix C. Plots of High SAR Measurement

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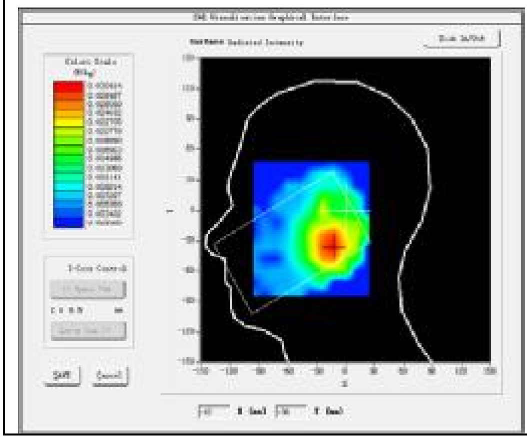
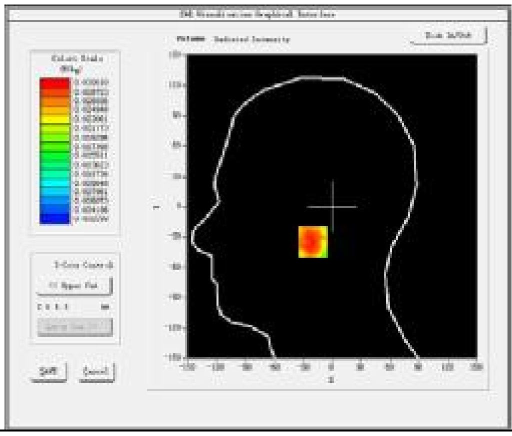
MEASUREMENT 1

A. Experimental conditions.

Area Scan	dx=12mm dy=12mm, h= 5.00 mm
ZoomScan	7x7x7,dx=5mm dy=5mm dz=5mm,Complete/ndx=12mm dy=12mm, h= 5.00 mm
Phantom	Left head
Device Position	Cheek
Band	IEEE 802.11b ISM
Channels	Middle
Signal	IEEE802.11b (Crest factor: 1.0)

B. SAR Measurement Results

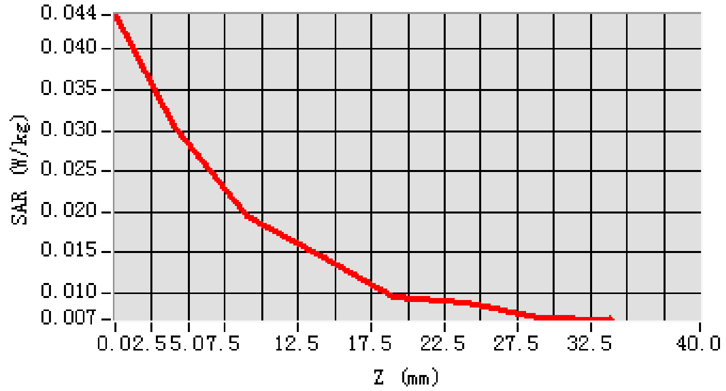
Frequency (MHz)	2437.000000
Relative permittivity (real part)	39.091999
Relative permittivity (imaginary part)	13.461900
Conductivity (S/m)	1.822592
Variation (%)	4.230000

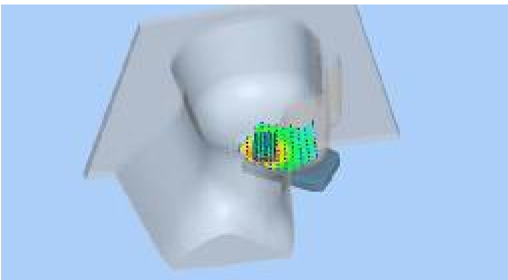
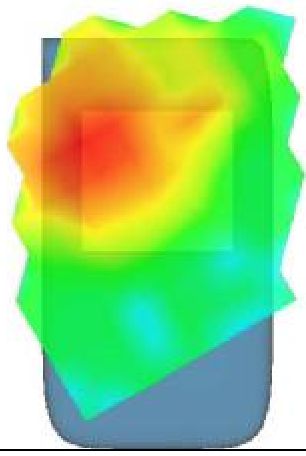
SURFACE SAR	VOLUME SAR
	

Maximum location: X=-14.00, Y=-35.00
SAR Peak: 0.05 W/kg

SAR 10g (W/Kg)	0.019425
SAR 1g (W/Kg)	0.029135

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.0443	0.0306	0.0194	0.0147	0.0096	0.0088	0.0070



3D screen shot	Hot spot position
	

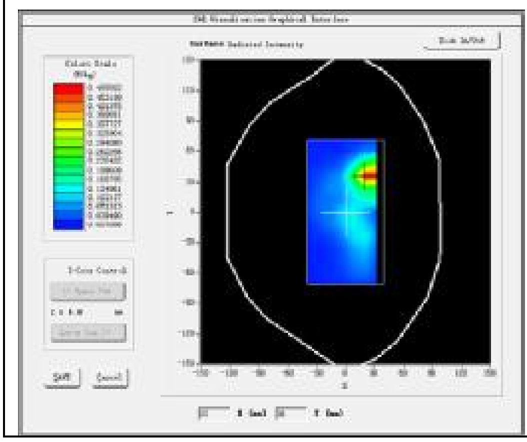
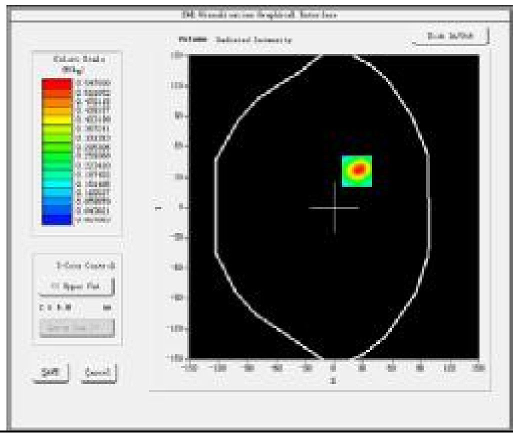
MEASUREMENT 2

A. Experimental conditions.

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

B. SAR Measurement Results

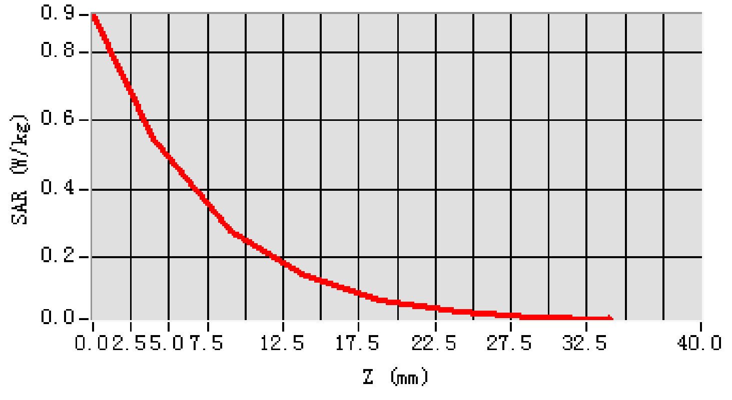
Frequency (MHz)	2437.000000
Relative permittivity (real part)	52.599300
Relative permittivity (imaginary part)	14.403320
Conductivity (S/m)	1.950049
Variation (%)	-2.050000

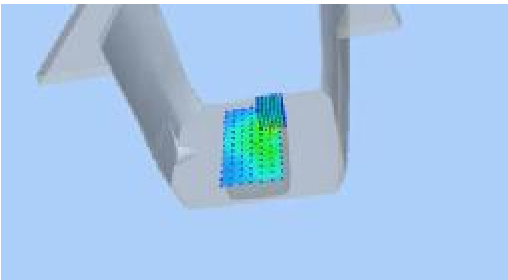
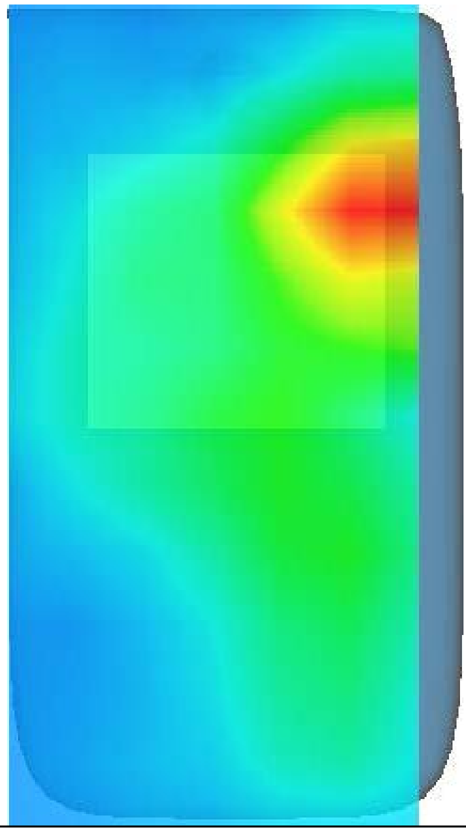
SURFACE SAR	VOLUME SAR
	

Maximum location: X=24.00, Y=36.00
SAR Peak: 0.94 W/kg

SAR 10g (W/Kg)	0.204396
SAR 1g (W/Kg)	0.377095

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.9127	0.5470	0.2728	0.1420	0.0702	0.0389	0.0218



3D screen shot	Hot spot position
	

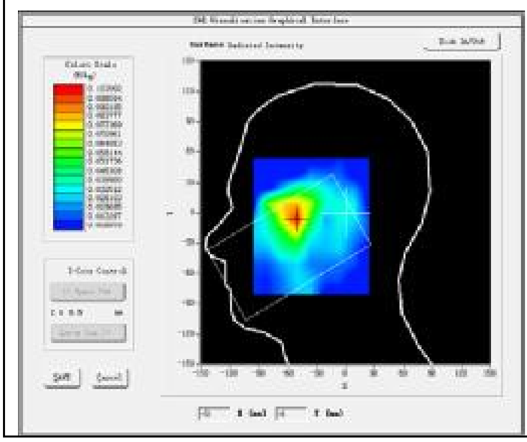
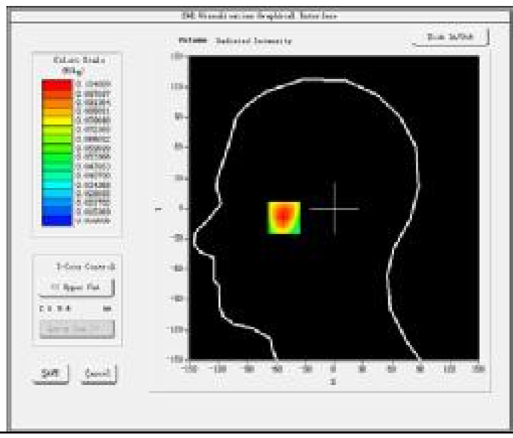
MEASUREMENT 3

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=15mm dy=15mm, h= 5.00 mm
Phantom	Left head
Device Position	Cheek
Band	LTE band 2
Channels	Middle
Signal	LTE (Crest factor: 1.0)

B. SAR Measurement Results

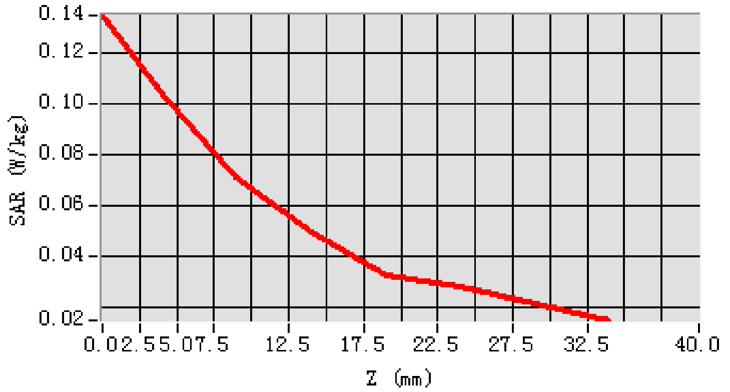
Frequency (MHz)	1880.000000
Relative permittivity (real part)	39.567951
Relative permittivity (imaginary part)	13.623750
Conductivity (S/m)	1.422547
Variation (%)	0.960000

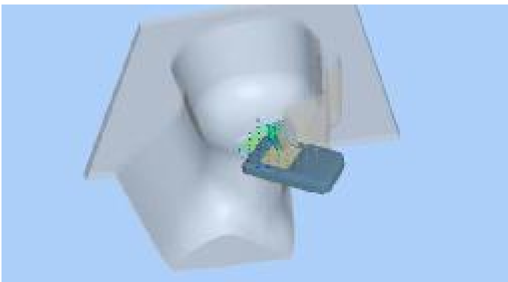
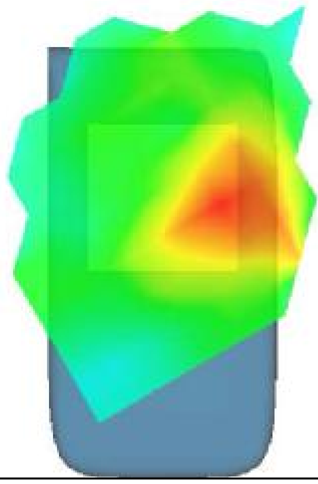
SURFACE SAR	VOLUME SAR
	

Maximum location: X=-52.00, Y=-6.00
SAR Peak: 0.14 W/kg

SAR 10g (W/Kg)	0.063762
SAR 1g (W/Kg)	0.099643

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.1351	0.1040	0.0714	0.0499	0.0326	0.0280	0.0214



3D screen shot	Hot spot position
	

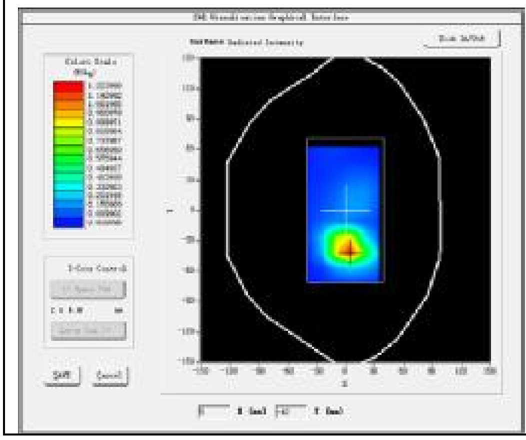
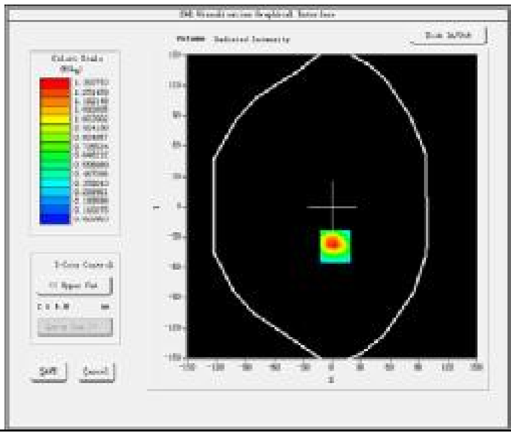
MEASUREMENT 4

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=15mm dy=15mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body
Band	LTE band 2
Channels	Middle
Signal	LTE (Crest factor: 1.0)

B. SAR Measurement Results

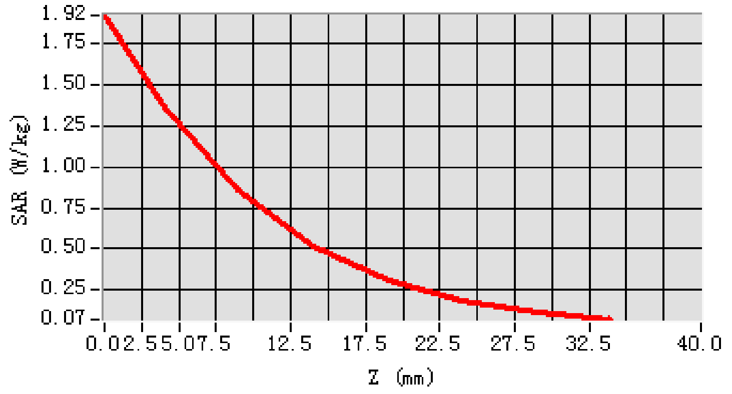
Frequency (MHz)	1880.000000
Relative permittivity (real part)	53.581738
Relative permittivity (imaginary part)	14.660210
Conductivity (S/m)	1.530770
Variation (%)	1.010000

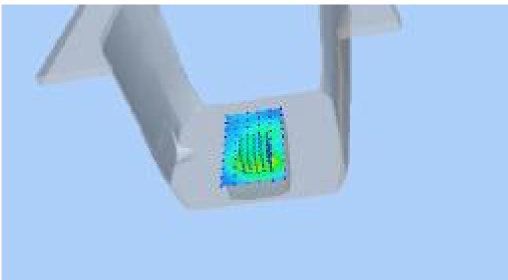
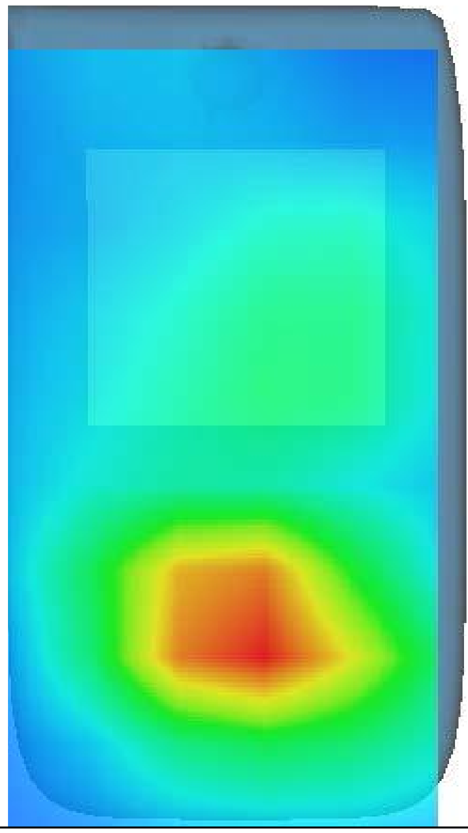
SURFACE SAR	VOLUME SAR
	

Maximum location: X=3.00, Y=-39.00
SAR Peak: 2.13 W/kg

SAR 10g (W/Kg)	0.636028
SAR 1g (W/Kg)	1.121555

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	1.9189	1.3608	0.8603	0.5168	0.3157	0.1882	0.1173



3D screen shot	Hot spot position
	

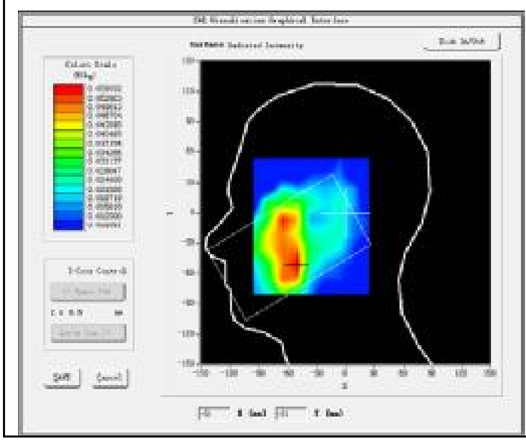
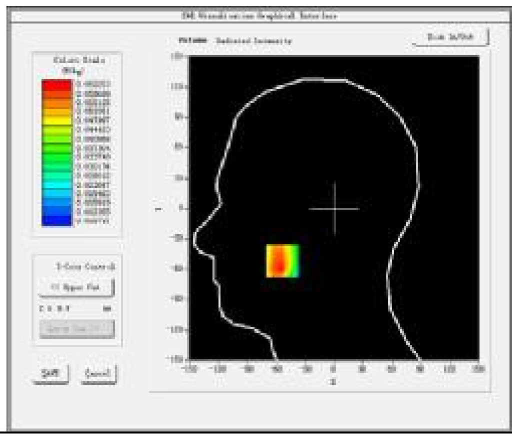
MEASUREMENT 5

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=15mm dy=15mm, h= 5.00 mm
Phantom	Left head
Device Position	Cheek
Band	LTE band 4
Channels	Middle
Signal	LTE (Crest factor: 1.0)

B. SAR Measurement Results

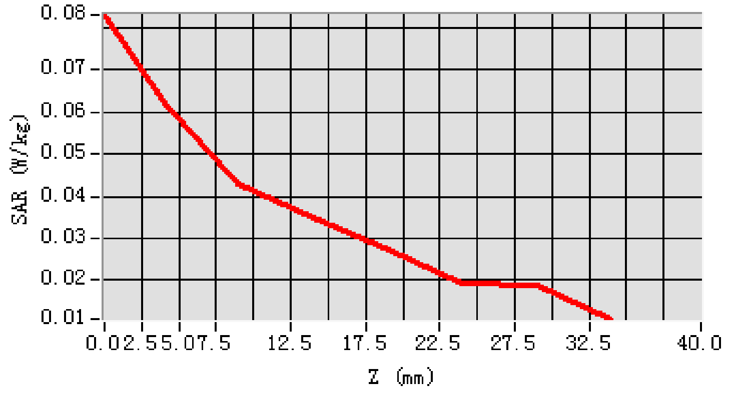
Frequency (MHz)	1732.500000
Relative permittivity (real part)	40.377289
Relative permittivity (imaginary part)	13.939192
Conductivity (S/m)	1.341647
Variation (%)	2.830000

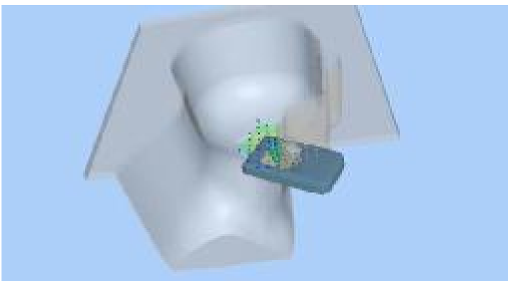
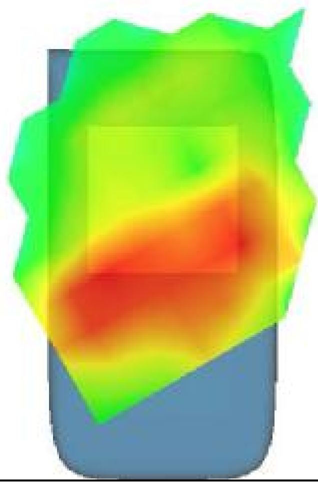
SURFACE SAR	VOLUME SAR
	

Maximum location: X=-54.00, Y=-52.00
SAR Peak: 0.08 W/kg

SAR 10g (W/Kg)	0.041172
SAR 1g (W/Kg)	0.058524

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.0831	0.0623	0.0431	0.0347	0.0274	0.0195	0.0187



3D screen shot	Hot spot position
	

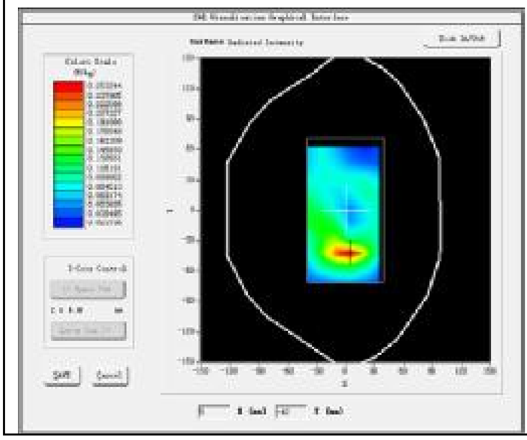
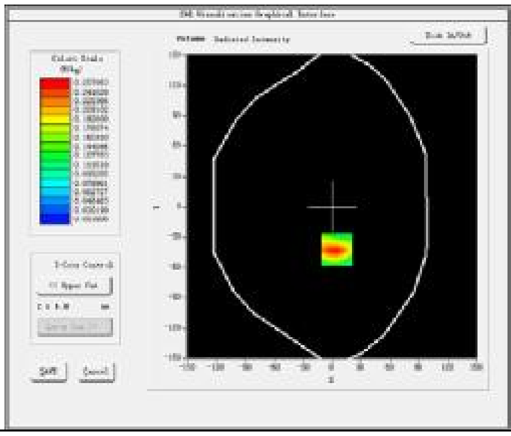
MEASUREMENT 6

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=15mm dy=15mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body
Band	LTE band 4
Channels	Middle
Signal	LTE (Crest factor: 1.0)

B. SAR Measurement Results

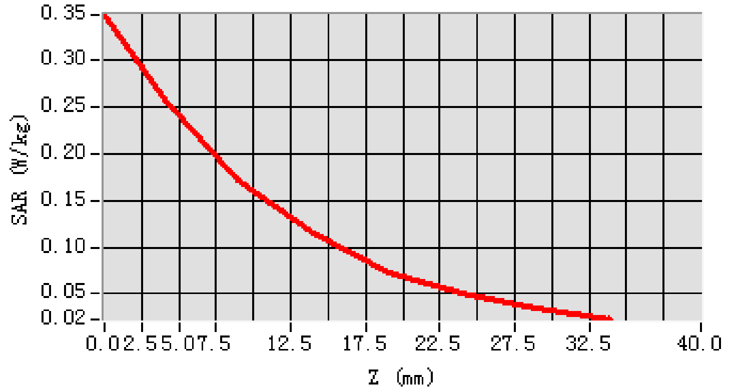
Frequency (MHz)	1732.500000
Relative permittivity (real part)	54.369366
Relative permittivity (imaginary part)	15.174220
Conductivity (S/m)	1.460519
Variation (%)	-1.870000

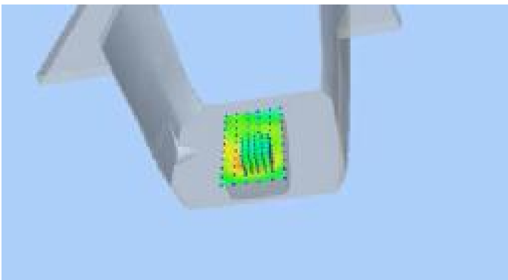
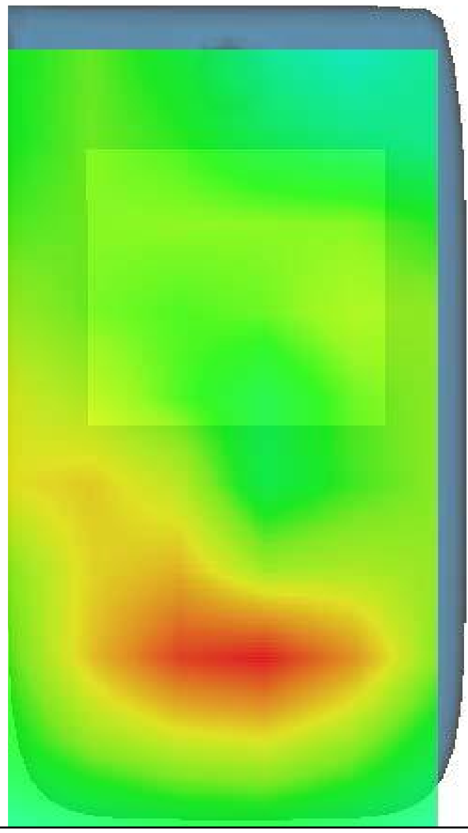
SURFACE SAR	VOLUME SAR
	

Maximum location: X=5.00, Y=-43.00
SAR Peak: 0.36 W/kg

SAR 10g (W/Kg)	0.144785
SAR 1g (W/Kg)	0.240915

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.3481	0.2579	0.1715	0.1148	0.0726	0.0504	0.0348



3D screen shot	Hot spot position
	

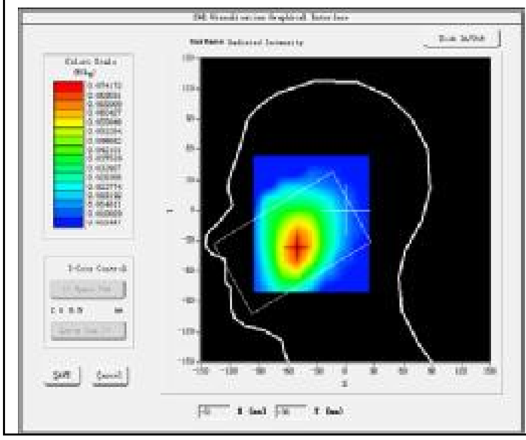
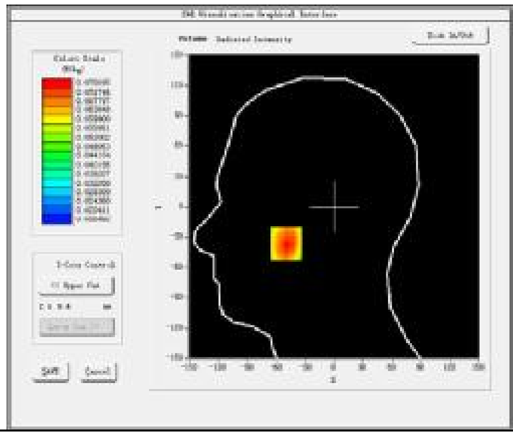
MEASUREMENT 7

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=15mm dy=15mm, h= 5.00 mm
Phantom	Left head
Device Position	Cheek
Band	LTE band 13
Channels	Middle
Signal	LTE (Crest factor: 1.0)

B. SAR Measurement Results

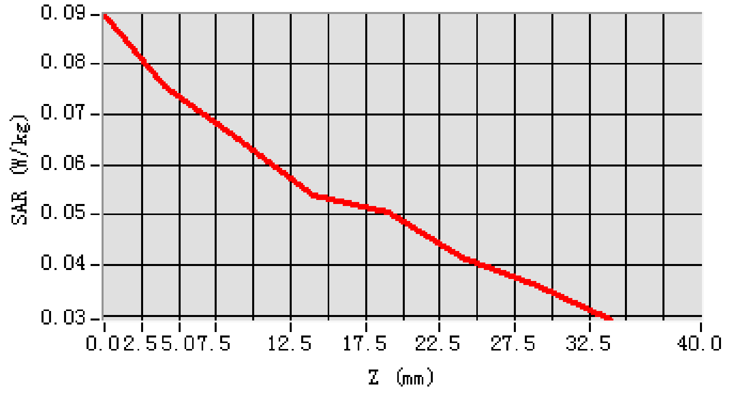
Frequency (MHz)	782.000000
Relative permittivity (real part)	41.147911
Relative permittivity (imaginary part)	22.100979
Conductivity (S/m)	0.959551
Variation (%)	3.090000

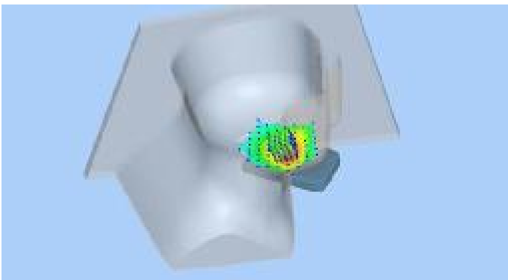
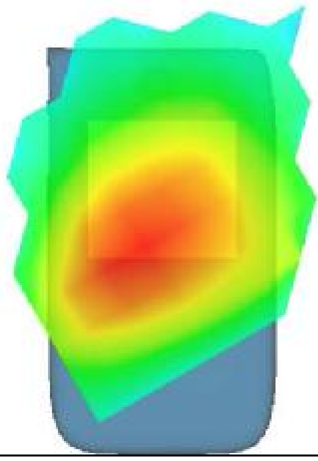
SURFACE SAR	VOLUME SAR
	

Maximum location: X=-50.00, Y=-37.00
SAR Peak: 0.09 W/kg

SAR 10g (W/Kg)	0.061572
SAR 1g (W/Kg)	0.078012

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.0897	0.0757	0.0650	0.0540	0.0506	0.0418	0.0359



3D screen shot	Hot spot position
	

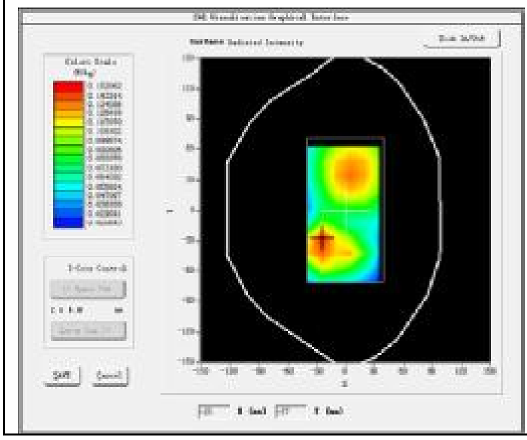
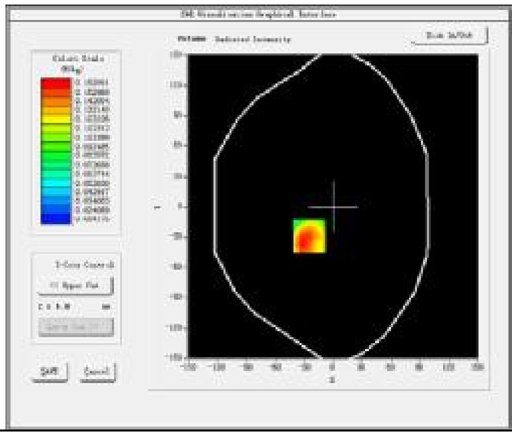
MEASUREMENT 8

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=15mm dy=15mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body
Band	LTE band 13
Channels	Middle
Signal	LTE (Crest factor: 1.0)

B. SAR Measurement Results

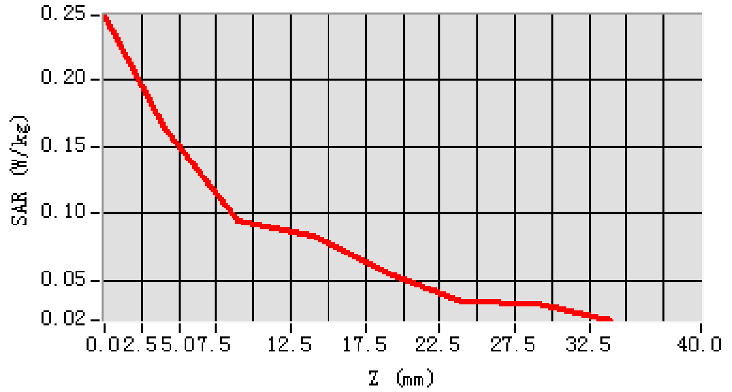
Frequency (MHz)	782.000000
Relative permittivity (real part)	55.205761
Relative permittivity (imaginary part)	23.279301
Conductivity (S/m)	1.010710
Variation (%)	3.450000

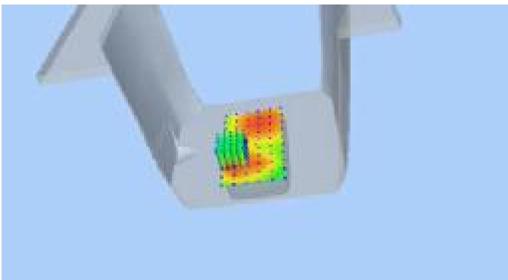
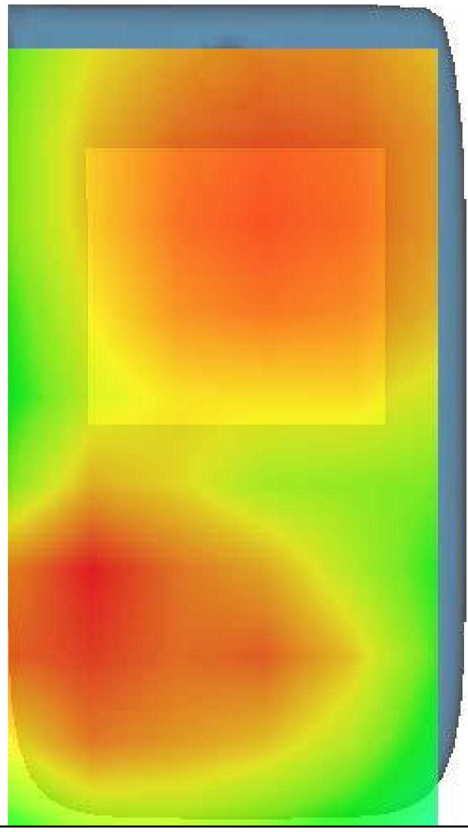
SURFACE SAR	VOLUME SAR
	

Maximum location: X=-25.00, Y=-29.00
SAR Peak: 0.24 W/kg

SAR 10g (W/Kg)	0.103009
SAR 1g (W/Kg)	0.164644

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.2475	0.1629	0.0954	0.0842	0.0558	0.0341	0.0338



3D screen shot	Hot spot position
	

14. Appendix D. Calibration Certificate

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E Field Probe - SN 08/16 EPGO287
750 MHz Dipole - SN 03/15 DIP 0G750-355
1800 MHz Dipole - SN 03/15 DIP 1G800-349
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.261.2.17.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: 09/18/2017

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.

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme LUC	Product Manager	9/18/2017	
Checked by :	Jérôme LUC	Product Manager	9/18/2017	
Approved by :	Kim RUTKOWSKI	Quality Manager	9/18/2017	Kim Rutkowski

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

Issue	*Date*	*Modifications*
A	9/18/2017	Initial release

TABLE OF CONTENTS

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	0.4 GHz-6GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.208 MΩ Dipole 2: R2=0.196 MΩ Dipole 3: R3=0.196 MΩ

A yearly calibration interval is recommended.

2 PRODUCT DESCRIPTION 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.

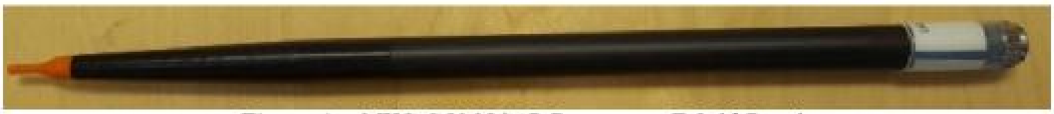


Figure 1 – *MVG COMOSAR Dosimetric E field Dipole*

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

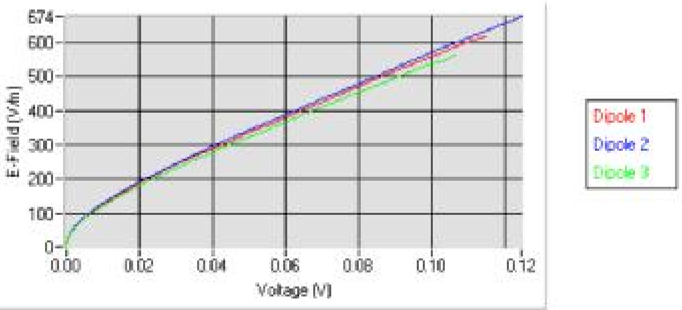
Normx dipole 1 (µV/(V/m)²)	Normy dipole 2 (µV/(V/m)²)	Normz dipole 3 (µV/(V/m)²)
0.69	0.78	0.61

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
92	90	96

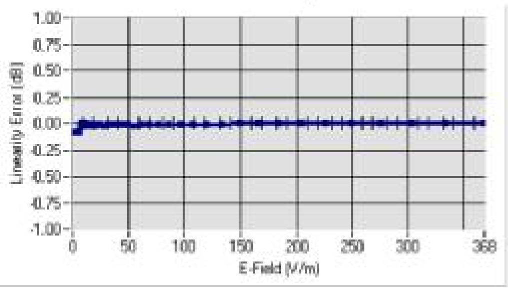
Calibration curves ei=f(V) (i=1,2,3) allow to obtain H-field value using the formula:

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

Calibration curves



5.2 LINEARITY



Linearity:I+/-1.86% (+/-0.08dB)

5.3 SENSITIVITY IN LIQUID

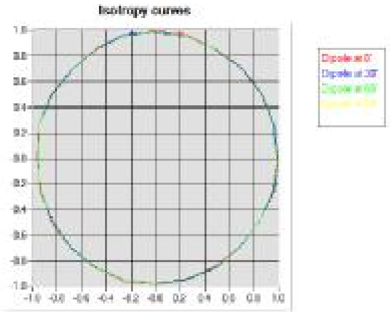
Liquid	Frequency (MHz +/- 100MHz)	Permittivity	Epsilon (S/m)	ConvF
HL750	750	42.09	0.91	1.44
BL750	750	55.69	0.95	1.49
HL850	835	42.71	0.89	1.48
BL850	835	57.52	1.03	1.53
HL900	900	41.94	0.93	1.50
BL900	900	52.87	1.09	1.54
HL1800	1800	40.62	1.39	1.75
BL1800	1800	53.22	1.47	1.79
HL1900	1900	41.22	1.37	2.00
BL1900	1900	50.99	1.52	2.07
HL2000	2000	40.39	1.36	1.93
BL2000	2000	54.39	1.54	1.99
HL2450	2450	40.46	1.87	2.18
BL2450	2450	54.62	1.95	2.27
HL2600	2600	38.46	2.01	2.15
BL2600	2600	51.98	2.16	2.19
HL5200	5200	35.14	4.74	2.37
BL5200	5200	49.01	5.27	2.46
HL5400	5400	34.52	4.77	2.33
BL5400	5400	49.67	5.45	2.41
HL5600	5600	37.08	5.03	2.47
BL5600	5600	47.57	5.69	2.54
HL5800	5800	34.64	5.19	2.51
BL5800	5800	49.82	5.94	2.57

LOWER DETECTION LIMIT: 7mW/kg

5.4 ISOTROPY

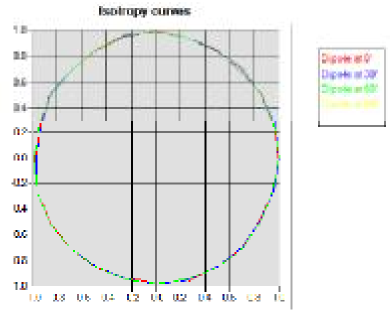
HL900 MHz

- Axial isotropy: 0.05 dB
- Hemispherical isotropy: 0.06 dB



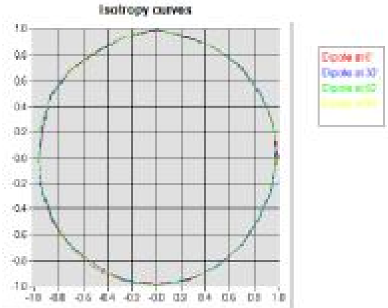
HL1800 MHz

- Axial isotropy: 0.05 dB
- Hemispherical isotropy: 0.08 dB



HL5600 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	10/2016	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.
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	10/2015	10/2017

SAR Reference Dipole Calibration Report

Ref : ACR.109.1.18.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 REFERENCE DIPOLE
FREQUENCY: 750 MHZ
SERIAL NO.: SN 03/15 DIP 0G750-355

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

Calibration Date: 04/19/2018

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.

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme LUC	Product Manager	4/19/2018	
Checked by :	Jérôme LUC	Product Manager	4/19/2018	
Approved by :	Kim RUTKOWSKI	Quality Manager	4/19/2018	

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

Issue	*Date*	*Modifications*
A	4/19/2018	Initial release

TABLE OF CONTENTS

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 750 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SID750
Serial Number	SN 03/15 DIP 0G750-355
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

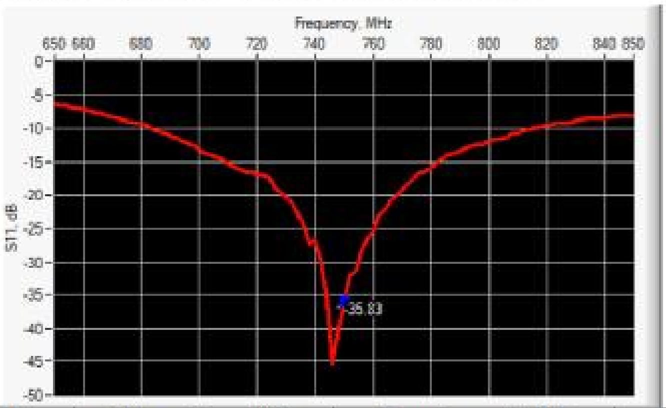
The guidelines outlined in the IEEE 1528, FCC KDBs, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

Scan Volume	Expanded Uncertainty
1 g	20.3 %

10 g	20.1 %

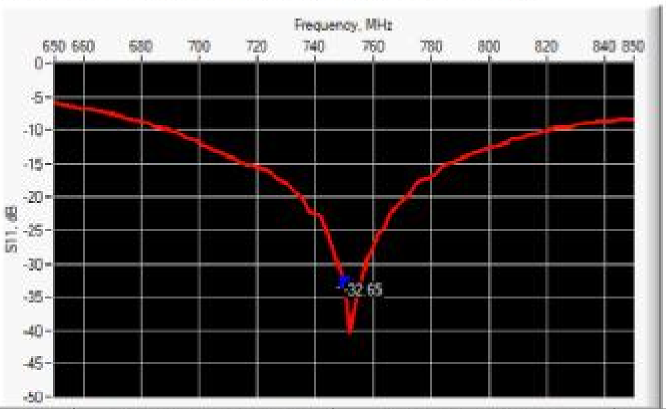
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
750	-35.83	-20	51.3 Ω - 1.2 jΩ

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
750	-32.65	-20	50.8 Ω + 2.3 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 %.	PASS	100.0 ±1 %.	PASS	6.35 ±1 %.	PASS
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 %.		39.5 ±1 %.		3.6 ±1 %.	
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 (ε_r')		Conductivity (σ) S/m	
	required	measured	required	measured
300	45.3 ±5 %		0.87 ±5 %	
450	43.5 ±5 %		0.87 ±5 %	
750	41.9 ±5 %	PASS	0.89 ±5 %	PASS
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 %		1.40 ±5 %	
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 %	

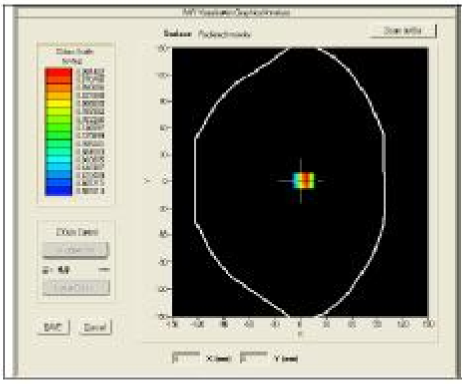
7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

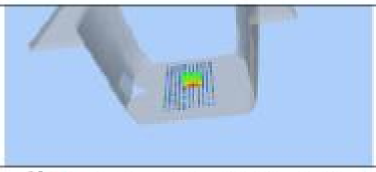
The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is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

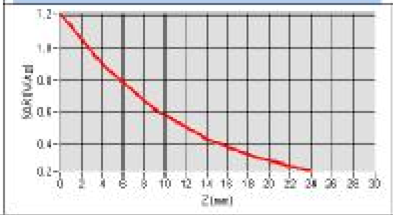
Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: eps' : 40.0 sigma : 0.93
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	750 MHz
Input power	20 dBm
Liquid Temperature	21 °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	8.56 (0.86)	5.55	5.61 (0.56)
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		20.5	
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

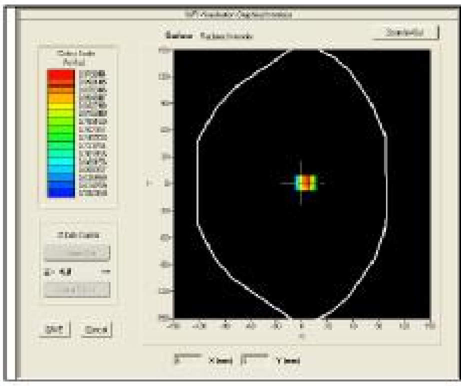
Frequency MHz	Relative permittivity (ε_r')		Conductivity (σ) S/m	
	required	measured	required	measured
150	61.9 ±5 %		0.80 ±5 %	
300	58.2 ±5 %		0.92 ±5 %	
450	56.7 ±5 %		0.94 ±5 %	
750	55.5 ±5 %	PASS	0.96 ±5 %	PASS
835	55.2 ±5 %		0.97 ±5 %	
900	55.0 ±5 %		1.05 ±5 %	
915	55.0 ±5 %		1.06 ±5 %	
1450	54.0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

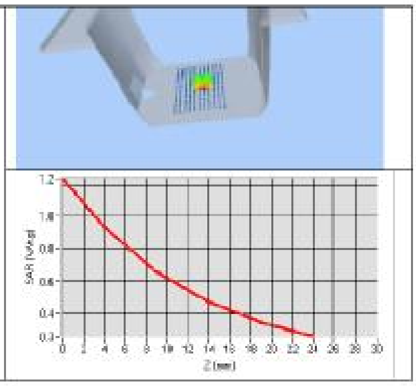
2300	52.9 ±5 %		1.81 ±5 %	
2450	52.7 ±5 %		1.95 ±5 %	
2600	52.5 ±5 %		2.16 ±5 %	
3000	52.0 ±5 %		2.73 ±5 %	
3500	51.3 ±5 %		3.31 ±5 %	
3700	51.0 ±5 %		3.55 ±5 %	
5200	49.0 ±10 %		5.30 ±10 %	
5300	48.9 ±10 %		5.42 ±10 %	
5400	48.7 ±10 %		5.53 ±10 %	
5500	48.6 ±10 %		5.65 ±10 %	
5600	48.5 ±10 %		5.77 ±10 %	
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' : 56.8 sigma : 1.00
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	750 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
750	8.85 (0.89)	5.91 (0.59)





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	10/2017	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.
Temperature and Humidity Sensor	Control Company	150798832	11/2017	11/2020

SAR Reference Dipole Calibration Report

Ref : ACR.109.4.18.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 REFERENCE DIPOLE

FREQUENCY: 1800 MHZ

SERIAL NO.: SN 03/15 DIP 1G800-349

Calibrated at MVG US

2105 Barrett Park Dr. - Kennesaw, GA 30144

Calibration Date: 04/19/2018

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.

SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.109.4.18.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	4/19/2018	
Checked by :	Jérôme LUC	Product Manager	4/19/2018	
Approved by :	Kim RUTKOWSKI	Quality Manager	4/19/2018	Kim Rutkowski

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

Issue	Date	Modifications
A	4/19/2018	Initial release

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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 1800 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model Serial Number	SID1800 SN 03/15 DIP 1G800-349
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

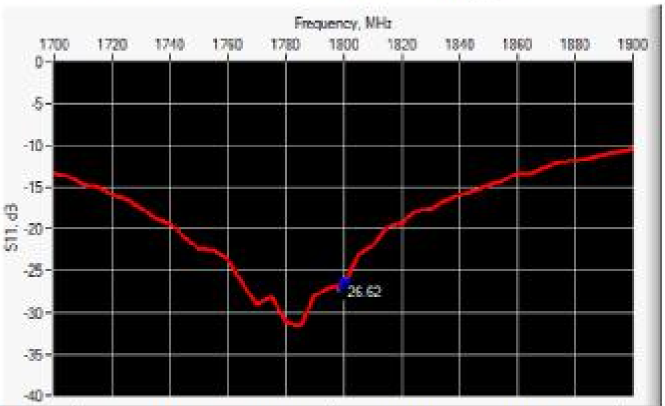
The guidelines outlined in the IEEE 1528, FCC KDBs, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

Scan Volume	Expanded Uncertainty
1 g	20.3 %

10 g	20.1 %

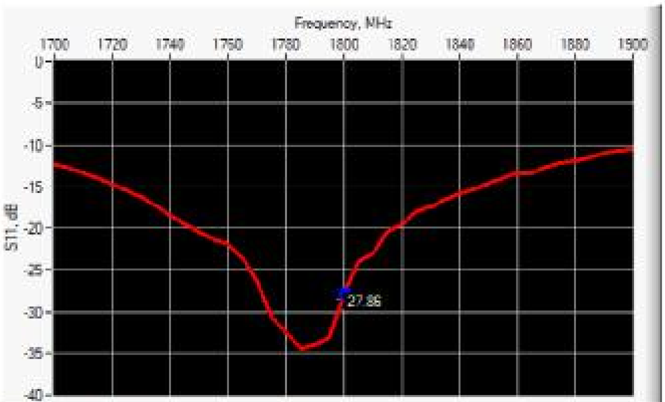
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1800	-26.62	-20	47.3 Ω + 3.6 jΩ

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1800	-27.86	-20	46.2 Ω - 0.9 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 %.	PASS	41.7 ±1 %.	PASS	3.6 ±1 %.	PASS
1900	68.0 ±1 %.		39.5 ±1 %.		3.6 ±1 %.	
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 (ε_r')		Conductivity (σ) 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 %	PASS	1.40 ±5 %	PASS
1900	40.0 ±5 %		1.40 ±5 %	
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.

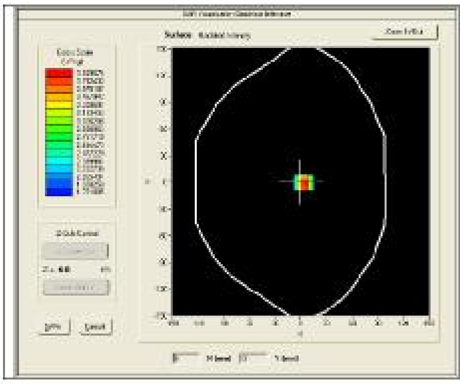
Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: eps' : 41.7 sigma : 1.46
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	1800 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

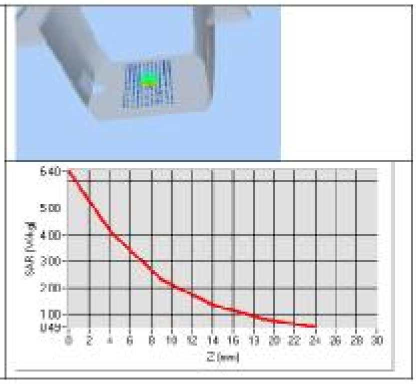
Frequency MHz	1 g SAR (W/kg/W)		10 g SAR (W/kg/W)	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49		5.55	
835	9.56		6.22	
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4	38.11 (3.81)	20.1	20.05 (2.00)

SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.109.4.18.SATU.A

1900	39.7		20.5	
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

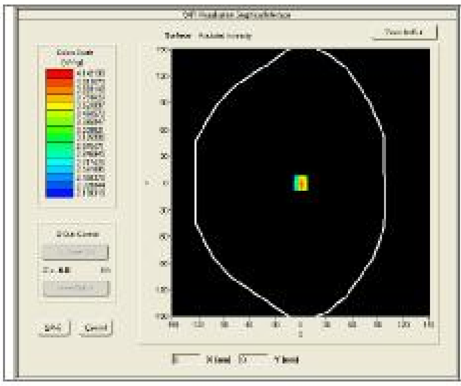
Frequency MHz	Relative permittivity (ε$_r$')		Conductivity (σ) S/m	
	required	measured	required	measured
150	61.9 ±5 %		0.80 ±5 %	
300	58.2 ±5 %		0.92 ±5 %	
450	56.7 ±5 %		0.94 ±5 %	
750	55.5 ±5 %		0.96 ±5 %	
835	55.2 ±5 %		0.97 ±5 %	
900	55.0 ±5 %		1.05 ±5 %	
915	55.0 ±5 %		1.06 ±5 %	
1450	54.0 ±5 %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

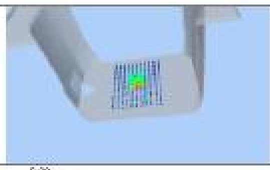
2300	52.9 ±5 %		1.81 ±5 %	
2450	52.7 ±5 %		1.95 ±5 %	
2600	52.5 ±5 %		2.16 ±5 %	
3000	52.0 ±5 %		2.73 ±5 %	
3500	51.3 ±5 %		3.31 ±5 %	
3700	51.0 ±5 %		3.55 ±5 %	
5200	49.0 ±10 %		5.30 ±10 %	
5300	48.9 ±10 %		5.42 ±10 %	
5400	48.7 ±10 %		5.53 ±10 %	
5500	48.6 ±10 %		5.65 ±10 %	
5600	48.5 ±10 %		5.77 ±10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

7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

Software	OPENSAR V4
Phantom Probe	SN 20/09 SAM71 SN 18/11 EPG122
Liquid	Body Liquid Values: eps' : 53.9 sigma : 1.46
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	1800 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
1800	38.13 (3.81)	20.65 (2.06)





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	10/2017	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.
Temperature and Humidity Sensor	Control Company	150798832	11/2017	11/2020

SAR Reference Dipole Calibration Report

Ref : ACR.109.5.18.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 REFERENCE DIPOLE
FREQUENCY: 1900 MHZ
SERIAL NO.: SN 03/15 DIP 1G900-350

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

ACCREDITED
Calibration CERT #2446.02

Calibration Date: 04/19/2018

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.

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme LUC	Product Manager	4/19/2018	
Checked by :	Jérôme LUC	Product Manager	4/19/2018	
Approved by :	Kim RUTKOWSKI	Quality Manager	4/19/2018	Kim Rutkowski

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

Issue	*Date*	*Modifications*
A	4/19/2018	Initial release

TABLE OF CONTENTS

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 03/15 DIP 1G900-350
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

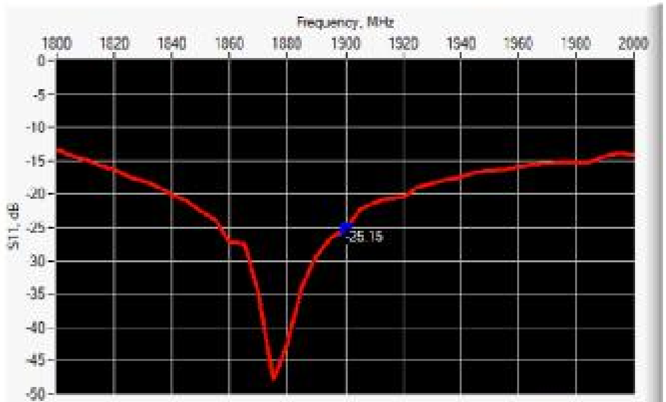
The guidelines outlined in the IEEE 1528, FCC KDBs, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

Scan Volume	Expanded Uncertainty
1 g	20.3 %

10 g	20.1 %

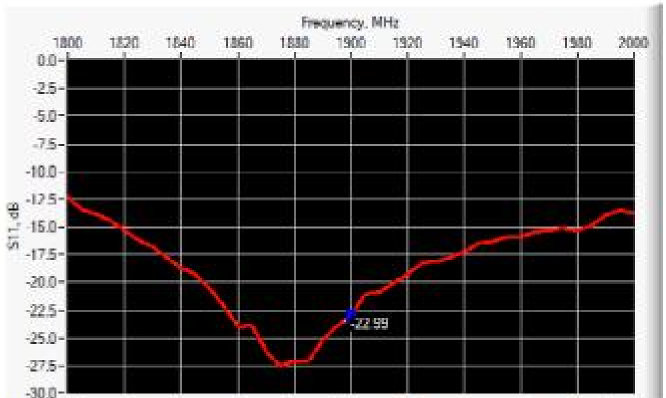
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1900	-25.15	-20	52.6 Ω + 5.1 jΩ

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1900	-22.99	-20	47.6 Ω + 6.5 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 (ε_r')		Conductivity (σ) 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 %	

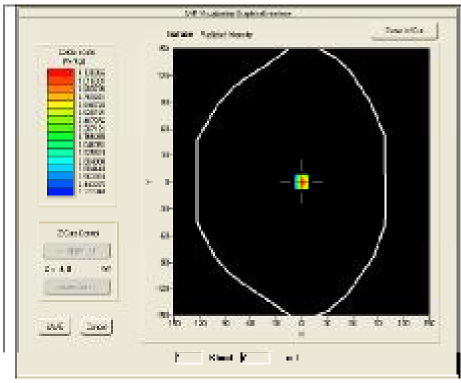
7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

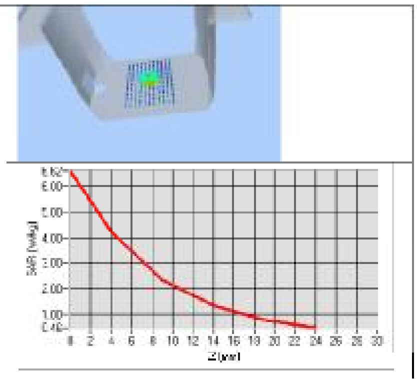
The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is 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	38.92 (3.89)	20.5	20.09 (2.01)
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 (ε′)		Conductivity (σ) 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 %	

SAR REFERENCE DIPOLE CALIBRATION REPORT

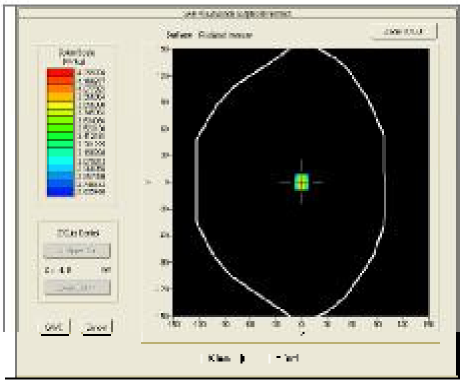
Ref: ACR.109.5.18.SATU.A

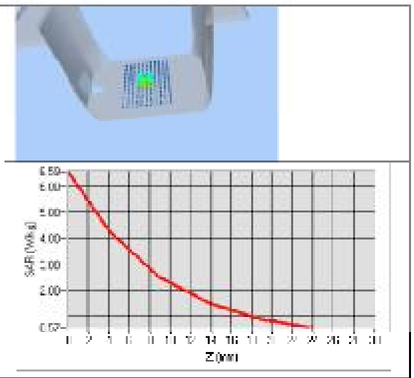
2300	52.9 ±5 %	1.81 ±5 %
2450	52.7 ±5 %	1.95 ±5 %
2600	52.5 ±5 %	2.16 ±5 %
3000	52.0 ±5 %	2.73 ±5 %
3500	51.3 ±5 %	3.31 ±5 %
3700	51.0 ±5 %	3.55 ±5 %
5200	49.0 ±10 %	5.30 ±10 %
5300	48.9 ±10 %	5.42 ±10 %
5400	48.7 ±10 %	5.53 ±10 %
5500	48.6 ±10 %	5.65 ±10 %
5600	48.5 ±10 %	5.77 ±10 %
5800	48.2 ±10 %	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	39.02 (3.90)	20.57 (2.06)





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SAR REFERENCE DIPOLE CALIBRATION REPORT Ref: ACR.109.5.18.SATU.A

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	10/2017	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.
Temperature and Humidity Sensor	Control Company	150798832	11/2017	11/2020

SAR Reference Dipole Calibration Report

Ref : ACR.109.7.18.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 REFERENCE DIPOLE
FREQUENCY: 2450 MHZ
SERIAL NO.: SN 03/15 DIP 2G450-352

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

Calibration Date: 04/19/2018

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.

SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.109.7.18.SATU.A

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme LUC	Product Manager	4/19/2018	
Checked by :	Jérôme LUC	Product Manager	4/19/2018	
Approved by :	Kim RUTKOWSKI	Quality Manager	4/19/2018	Kim Rutkowski

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

Issue	*Date*	*Modifications*
A	4/19/2018	Initial release

TABLE OF CONTENTS

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 2450 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model Serial Number	SID2450 SN 03/15 DIP 2G450-352
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

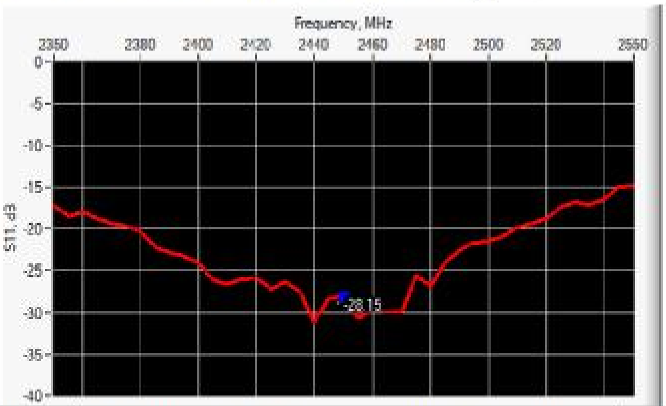
The guidelines outlined in the IEEE 1528, FCC KDBs, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

Scan Volume	Expanded Uncertainty
1 g	20.3 %

10 g	20.1 %

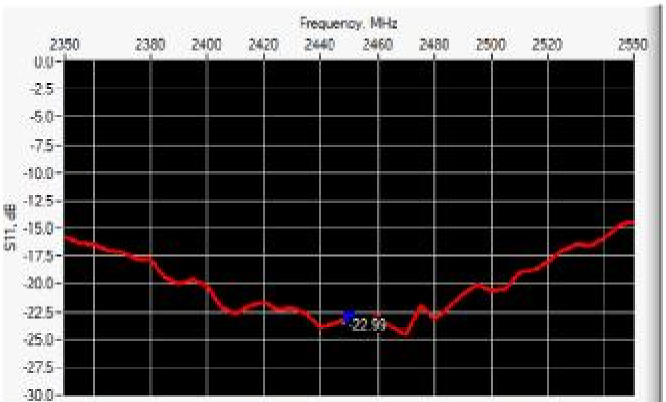
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
2450	-28.15	-20	53.9 Ω + 0.3 jΩ

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
2450	-22.99	-20	57.6 Ω - 0.8 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 %.		39.5 ±1 %.		3.6 ±1 %.	
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 %.	PASS	30.4 ±1 %.	PASS	3.6 ±1 %.	PASS
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 (ε_r')		Conductivity (σ) 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 %		1.40 ±5 %	
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 %	PASS	1.80 ±5 %	PASS
2600	39.0 ±5 %		1.96 ±5 %	
3000	38.5 ±5 %		2.40 ±5 %	
3500	37.9 ±5 %		2.91 ±5 %	

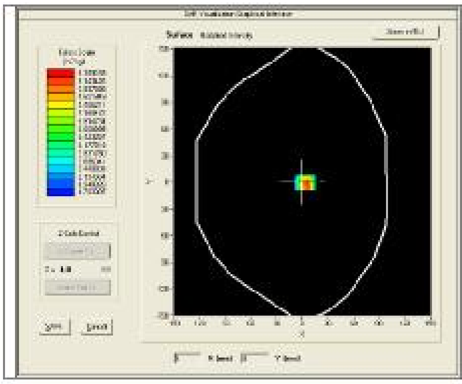
7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

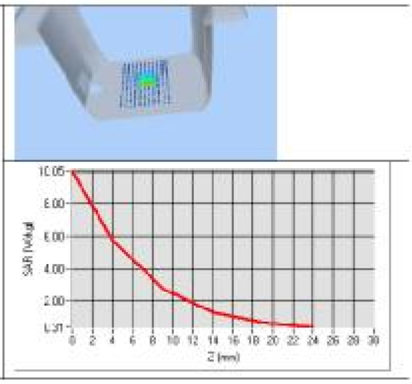
The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is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

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: eps' : 37.5 sigma : 1.80
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=5mm/dy=5mm/dz=5mm
Frequency	2450 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		20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4	53.75 (5.38)	24	24.12 (2.41)
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 (ε_r')		Conductivity (σ) 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 %		1.52 ±5 %	
2000	53.3 ±5 %		1.52 ±5 %	
2100	53.2 ±5 %		1.62 ±5 %	

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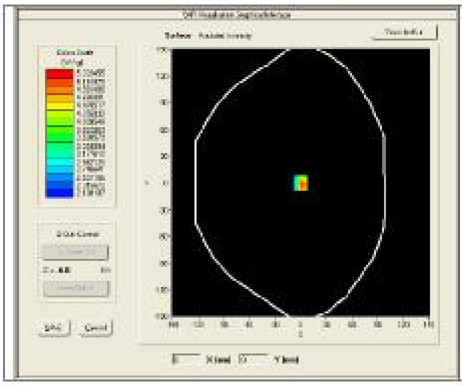
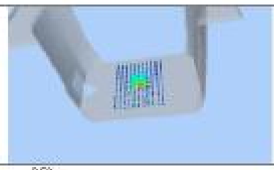
2300	52.9 ±5 %		1.81 ±5 %	
2450	52.7 ±5 %	PASS	1.95 ±5 %	PASS
2600	52.5 ±5 %		2.16 ±5 %	
3000	52.0 ±5 %		2.73 ±5 %	
3500	51.3 ±5 %		3.31 ±5 %	
3700	51.0 ±5 %		3.55 ±5 %	
5200	49.0 ±10 %		5.30 ±10 %	
5300	48.9 ±10 %		5.42 ±10 %	
5400	48.7 ±10 %		5.53 ±10 %	
5500	48.6 ±10 %		5.65 ±10 %	
5600	48.5 ±10 %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

7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

Software	OPENSAR V4
Phantom Probe	SN 20/09 SAM71 SN 18/11 EPG122
Liquid	Body Liquid Values: eps' : 53.2 sigma : 1.89
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=5mm/dy=5mm/dz=5mm
Frequency	2450 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
2450	52.90 (5.29)	24.09 (2.41)





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	10/2017	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.
Temperature and Humidity Sensor	Control Company	150798832	11/2017	11/2020

END