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1. Summary of Maximum SAR Value

| Equipment Class | Mode | Highest Reported Head SAR _{1g} (W/kg) | Highest Reported Body-worn SAR _{1g} (1.0 cm Gap) (W/kg) | Highest Reported Hotspot SAR _{1g} (1.0 cm Gap) (W/kg) |
|---------------------------------------|-----------|--|--|--|
| PCE | GSM850 | 0.69 | 0.25 | 0.25 |
| | GSM1900 | 0.71 | 0.27 | 0.27 |
| | WCDMA II | 0.78 | 0.37 | 0.37 |
| | WCDMA V | 0.56 | 0.22 | 0.22 |
| DTS | 2.4G WLAN | N/A | N/A | N/A |
| DSS | Bluetooth | N/A | N/A | N/A |
| Highest Simultaneous Transmission SAR | | Head (W/kg) | Body-worn (W/kg) | Hotspot (W/kg) |
| PCE + DTS | | 1.15 | 0.56 | 0.56 |
| PCE + DSS | | N/A | 0.44 | N/A |

Note:

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

2. Description of Equipment Under Test

| | |
|--|---|
| EUT Type | Mobile phone |
| FCC ID | 2AJDZSTELLAX |
| Brand Name | N/A |
| Model Name | Stella X |
| IMEI Code | 352472091878418/ 352472091878426 |
| HW Version | H01_M_V2.0 |
| SW Version | G_TOUCH_Stella_X_V02_20180518 |
| Tx Frequency Bands (Unit: MHz) | GSM850 : 824.2 ~ 848.8 GSM1900 : 1850.2 ~ 1909.8 WCDMA Band II : 1852.4 ~ 1907.6 WCDMA Band V : 826.4 ~ 846.6 WLAN : 2412 ~ 2462 Bluetooth : 2402 ~ 2480 |
| Uplink Modulations | GSM & GPRS : GMSK WCDMA : QPSK 802.11b : DSSS 802.11g/n : OFDM Bluetooth : GFSK, $\pi/4$ -DQPSK, 8-DPSK, LE |
| Maximum Tune-up Conducted Power (Unit: dBm) | GSM850 : 33.0 GSM1900 : 31.0 WCDMA Band II : 22.0 WCDMA Band V : 22.0 WLAN 2.4G : 9.5 Bluetooth : 5.0 |
| Antenna Type | WLAN: PIFA Antenna WWAN: PIFA Antenna |
| EUT Stage | Production Unit |

Note:

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

List of Accessory:

| | | |
|----------------|---------------------|-----------------|
| Battery | Brand Name | N/A |
| | Model Name | Stella X |
| | Power Rating | 3.7Vdc, 2200mAh |
| | Type | Li-ion |

3. SAR Measurement System

3.1 Definition of Specific Absorption Rate (SAR)

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

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

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

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

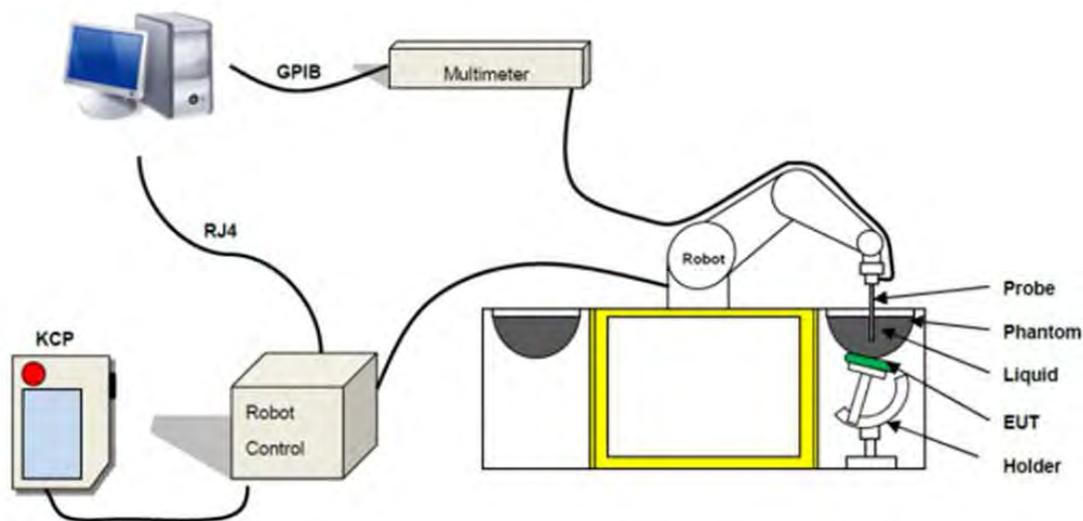
SAR measurement can be related to the electrical field in the tissue by

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

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

3.2 COMOSAR System

3.2.1 Measurement System Diagram



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

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

3.2.2 Robot

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

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



Fig-3.2 KUKA KR5

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3.2.3 E-Field Probes

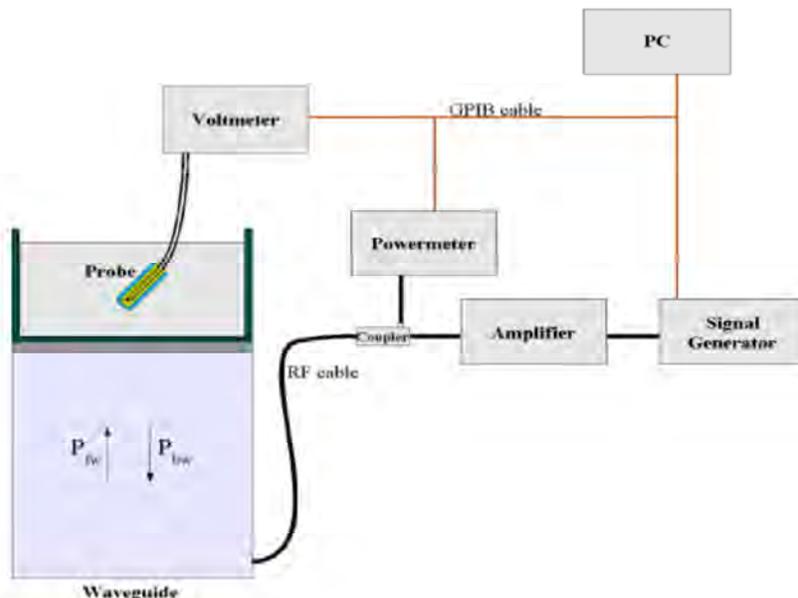
The SAR measurement is conducted with the dosimetric probe. The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency.



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

E-Field Probe Calibration Process

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



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

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

Where :

- P_{fw} = Forward Power
- P_{bw} = Backward Power
- a and b = Waveguide Dimensions
- l = Skin Depth

Keithley configuration

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

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

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

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

The linearized output voltage V_{lin}(N) is obtained from the displayed output voltage V(N) using

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

Where the DCP is the dipole compression point in mV

3.2.4 Phantoms

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

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

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| | | |
|------------------------|---|---|
| Model | Elliptic Phantom |  |
| Construction | Elliptic Phantom for compliance testing of handheld and body-mounted wireless devices. Elliptic Phantom is fully compatible with the IEC/EN 62209-2 standard and all known tissue simulating liquids. Elliptic Phantom has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching reference points. | |
| Material | The material is resistant to Glycol and offers high rigidity composite material based on fiberglass). | |
| Shell Thickness | 2.0 ± 0.2 mm (bottom plate) | |
| Dimensions | Length: 600 mm Width: 400 mm Height: 200 mm | |
| Filling Volume | approx. 25 liters | |

3.2.5 Device Holder

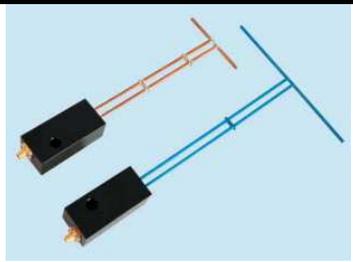
The positioning system is made of an extremely stable material, which ensures easy handling and reproducible positioning. It also allows correct positioning of the dipoles referenced by the IEEE, ANSI and IEC.

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

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

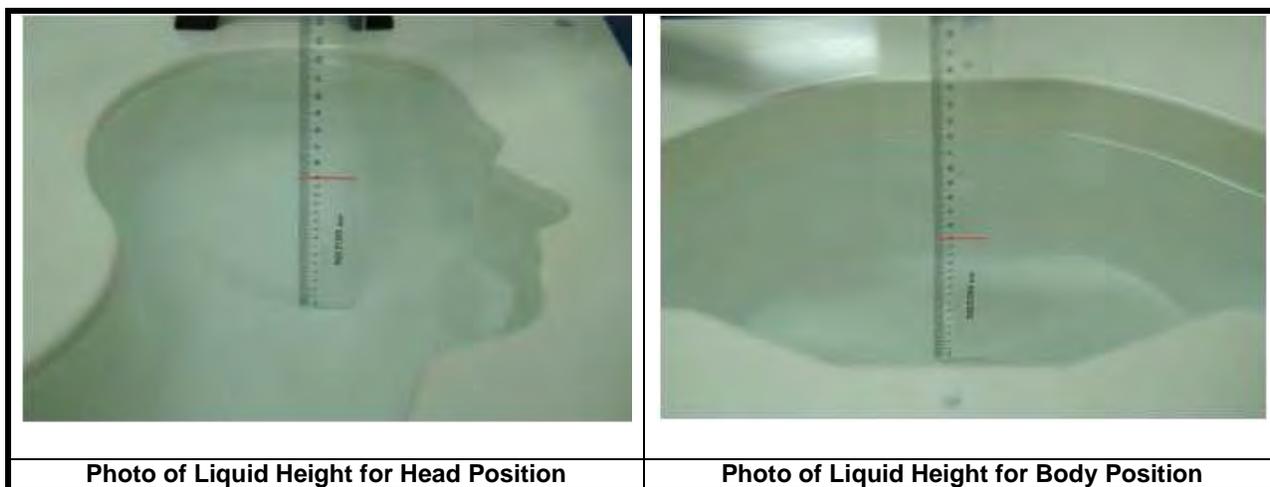
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3.2.6 System Validation Dipoles

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

3.2.7 Tissue Simulating Liquids

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



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

Table-3.1 Targets of Tissue Simulating Liquid

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

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The following table gives the recipes for tissue simulating liquids.

Table-3.2 Recipes of Tissue Simulating Liquid

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

3.3 SAR System Verification

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

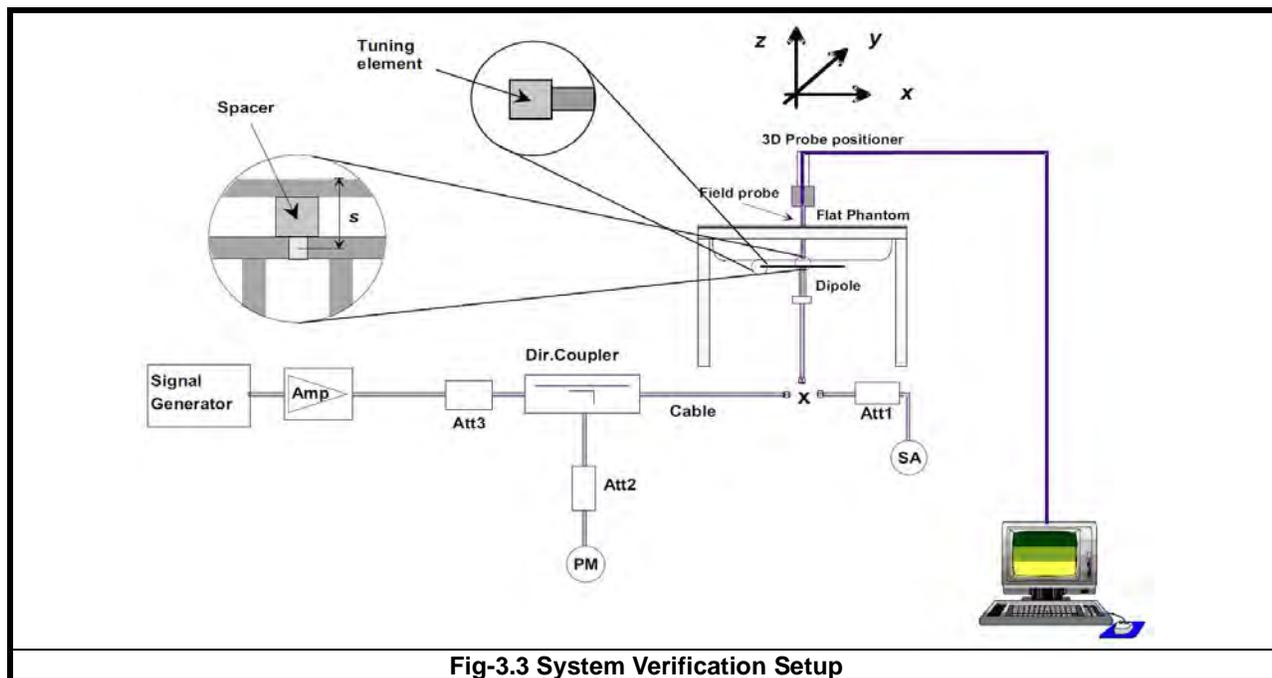


Fig-3.3 System Verification Setup

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

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

3.4 SAR Measurement Procedure

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

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

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

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

3.4.1 Area & Zoom Scan Procedure

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

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

Note:

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

3.4.2 Volume Scan Procedure

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

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3.4.3 Power Drift Monitoring

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

3.4.4 Spatial Peak SAR Evaluation

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

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

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

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

3.4.5 SAR Averaged Methods

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

4. SAR Measurement Evaluation

4.1 EUT Configuration and Setting

<Connections between EUT and System Simulator>

For WWAN SAR testing, the EUT was linked and controlled by base station emulator (Agilent E5515C is used for GSM/WCDMA, and Anritsu MT8820C is used for LTE). Communication between the EUT and the emulator was established by air link. The distance between the EUT and the communicating antenna of the emulator is larger than 50 cm and the output power radiated from the emulator antenna is at least 30 dB smaller than the output power of EUT. The EUT was set from the emulator to radiate maximum output power during SAR testing.

<Considerations Related to GSM / GPRS for Setup and Testing>

The maximum multi-slot capability supported by this device is as below.

1. This EUT is class B device
2. This EUT supports GPRS multi-slot class 12 (max. uplink: 4, max. downlink: 4, total timeslots: 5)

For GSM850 frequency band, the power control level is set to 5 for GSM mode and GPRS (GMSK: CS1). For GSM1900 frequency band, the power control level is set to 0 for GSM mode and GPRS (GMSK: CS1).

SAR test reduction for GPRS modes is determined by the source-based time-averaged output power specified for production units, including tune-up tolerance. The data mode with highest specified time-averaged output power should be tested for SAR compliance in the applicable exposure conditions. For modes with the same specified maximum output power and tolerance, the higher number time-slot configuration should be tested.

<Considerations Related to WCDMA for Setup and Testing>

WCDMA Handsets Head SAR

SAR for next to the ear head exposure is measured using a 12.2 kbps RMC with TPC bits configured to all "1's". The 3G SAR test reduction procedure is applied to AMR configurations with 12.2 kbps RMC as the primary mode.

WCDMA Handsets Body-worn SAR

SAR for body-worn configurations is measured using a 12.2 kbps RMC with TPC bits configured to all "1's". The 3G SAR test reduction procedure is applied to other spreading codes and multiple DPDCH_n configurations supported by the handset with 12.2 kbps RMC as the primary mode.

Handsets with Release 5 HSDPA

The 3G SAR test reduction procedure is applied to HSDPA body-worn configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for HSDPA using the HSDPA body SAR procedures in the "Release 5 HSDPA Data Devices", for the highest reported SAR body-worn exposure configuration in 12.2 kbps RMC. Handsets with both HSDPA and HSUPA are tested according to Release 6 HSPA test procedures.

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Handsets with Release 6 HSUPA

The 3G SAR test reduction procedure is applied to HSPA (HSUPA/HSDPA with RMC) body-worn configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for HSPA using the HSPA body SAR procedures in the “Release 6 HSPA Data Devices”, for the highest reported body-worn exposure SAR configuration in 12.2 kbps RMC. When VOIP is applicable for next to the ear head exposure in HSPA, the 3G SAR test reduction procedure is applied to HSPA with 12.2 kbps RMC as the primary mode; otherwise, the same HSPA configuration used for body-worn measurements is tested for next to the ear head exposure.

Release 5 HSDPA Data Devices

The 3G SAR test reduction procedure is applied to body SAR with 12.2 kbps RMC as the primary mode. Otherwise, body SAR for HSDPA is measured using an FRC with H-Set 1 in Sub-test 1 and a 12.2 kbps RMC configured in Test Loop Mode 1, for the highest reported SAR configuration in 12.2 kbps RMC without HSDPA. HSDPA is configured according to the applicable UE category of a test device. The number of HS-DSCH / HS-PDSCHs, HARQ processes, minimum inter-TTI interval, transport block sizes and RV coding sequence are defined by the H-set. To maintain a consistent test configuration and stable transmission conditions, QPSK is used in the H-set for SAR testing. HS-DPCCH should be configured with a CQI feedback cycle of 4 ms and a CQI repetition factor of 2 to maintain a constant rate of active CQI slots. DPCCH and DPDCH gain factors (β_c , β_d), and HS-DPCCH power offset parameters (Δ_{ACK} , Δ_{NACK} , Δ_{CQI}) are set according to values indicated in below. The CQI value is determined by the UE category, transport block size, number of HS-PDSCHs and modulation used in the H-set.

| Sub-test | β_c | β_d | β_d (SF) | β_c / β_d | $\beta_{hs}^{(1)}$ | CM (dB) ⁽²⁾ | MPR |
|----------|------------------------|------------------------|-------------------|------------------------|--------------------|------------------------|-----|
| 1 | 2 / 15 | 15 / 15 | 64 | 2 / 15 | 4 / 15 | 0.0 | 0 |
| 2 | 12 / 15 ⁽³⁾ | 15 / 15 ⁽³⁾ | 64 | 12 / 15 ⁽³⁾ | 24 / 15 | 1.0 | 0 |
| 3 | 15 / 15 | 8 / 15 | 64 | 15 / 8 | 30 / 15 | 1.5 | 0.5 |
| 4 | 15 / 15 | 4 / 15 | 64 | 15 / 4 | 30 / 15 | 1.5 | 0.5 |

Note 1: Δ_{ACK} , Δ_{NACK} and $\Delta_{CQI} = 8 \Leftrightarrow A_{hs} = \beta_{hs} / \beta_c = 30 / 15 \Leftrightarrow \beta_{hs} = 30 / 15 * \beta_c$.
 Note 2: CM = 1 for $\beta_c / \beta_d = 12 / 15$, $\beta_{hs} / \beta_c = 24 / 15$.
 Note 3: For subtest 2 the β_c / β_d ratio of 12 / 15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 11 / 15$ and $\beta_d = 15 / 15$.

Release 6 HSUPA Data Devices

The 3G SAR test reduction procedure is applied to body SAR with 12.2 kbps RMC as the primary mode. Otherwise, body SAR for HSPA is measured with E-DCH Sub-test 5, using H-Set 1 and QPSK for FRC and a 12.2 kbps RMC configured in Test Loop Mode 1 and power control algorithm 2, according to the highest reported body SAR configuration in 12.2 kbps RMC without HSPA. When VOIP applies to head exposure, the 3G SAR test reduction procedure is applied with 12.2 kbps RMC as the primary mode. Otherwise, the same HSPA configuration used for body SAR measurements are applied to head exposure testing. Due to inner loop power control requirements in HSPA, a communication test set is required for output power and SAR tests. The 12.2 kbps RMC, FRC H-set 1 and E-DCH configurations for HSPA are configured according to the β values indicated in below.

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| Sub-test | β_c | β_d | β_d (SF) | β_c / β_d | $\beta_{hs}^{(1)}$ | β_{ec} | β_{ed} | β_{ed} (SF) | β_{ed} (codes) | CM ⁽²⁾ (dB) | MPR (dB) | AG ⁽⁴⁾ Index | E-TFCI |
|----------|------------------------|------------------------|-------------------|------------------------|--------------------|--------------|--|----------------------|-------------------------|---------------------------|-------------|----------------------------|--------|
| 1 | 11 / 15 ⁽³⁾ | 15 / 15 ⁽³⁾ | 64 | 11 / 15 ⁽³⁾ | 22 / 15 | 209 / 225 | 1039 / 225 | 4 | 1 | 1.0 | 0.0 | 20 | 75 |
| 2 | 6 / 15 | 15 / 15 | 64 | 6 / 15 | 12 / 15 | 12 / 15 | 94 / 75 | 4 | 1 | 3.0 | 2.0 | 12 | 67 |
| 3 | 15 / 15 | 9 / 15 | 64 | 15 / 9 | 30 / 15 | 30 / 15 | $\beta_{ed1}: 47/15$ $\beta_{ed2}: 47/15$ | 4 | 2 | 2.0 | 1.0 | 15 | 92 |
| 4 | 2 / 15 | 15 / 15 | 64 | 2 / 15 | 4 / 15 | 2 / 15 | 56 / 75 | 4 | 1 | 3.0 | 2.0 | 17 | 71 |
| 5 | 15 / 15 ⁽⁴⁾ | 15 / 15 ⁽⁴⁾ | 64 | 15 / 15 ⁽⁴⁾ | 30 / 15 | 24 / 15 | 134 / 15 | 4 | 1 | 1.0 | 0.0 | 21 | 81 |

Note 1: $\Delta_{ACK}, \Delta_{NACK}$ and $\Delta_{OOI} = 8 \Leftrightarrow A_{hs} = \beta_{hs} / \beta_c = 30 / 15 \Leftrightarrow \beta_{hs} = 30 / 15 * \beta_c$.

Note 2: CM = 1 for $\beta_c / \beta_d = 12 / 15, \beta_{hs} / \beta_c = 24 / 15$. For all other combinations of DPDCH, DPCCH, HS-DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference.

Note 3: For subtest 1 the β_c / β_d ratio of 11 / 15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 10 / 15$ and $\beta_d = 15 / 15$.

Note 4: For subtest 5 the β_c / β_d ratio of 15 / 15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 14 / 15$ and $\beta_d = 15 / 15$.

Note 5: Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Table 5.1g.

Note 6: β_{ed} cannot be set directly; it is set by Absolute Grant Value.

4.2 EUT Testing Position

According to KDB 648474 D04, handsets are tested for SAR compliance in head, body-worn accessory and other use configurations described in the following subsections.

4.2.1 Head Exposure Conditions

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

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

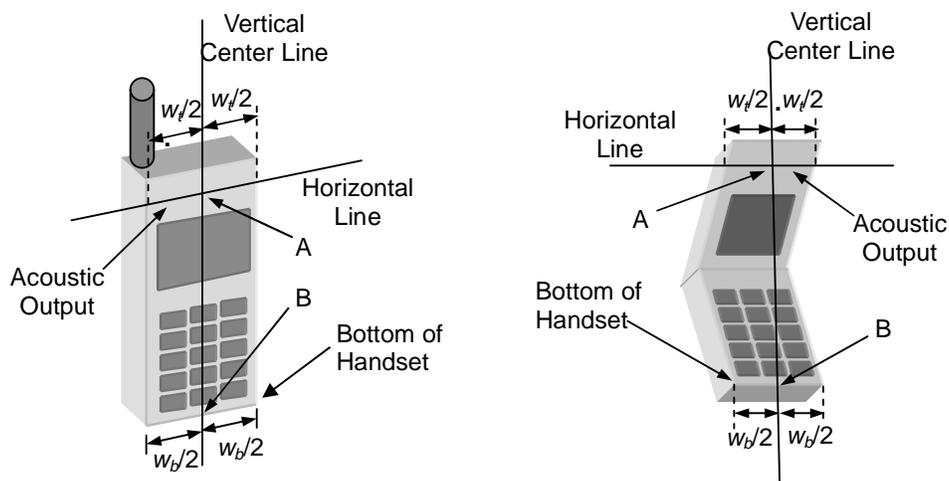


Fig-4.1 Illustration for Handset Vertical and Horizontal Reference Lines

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2. Cheek Position

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

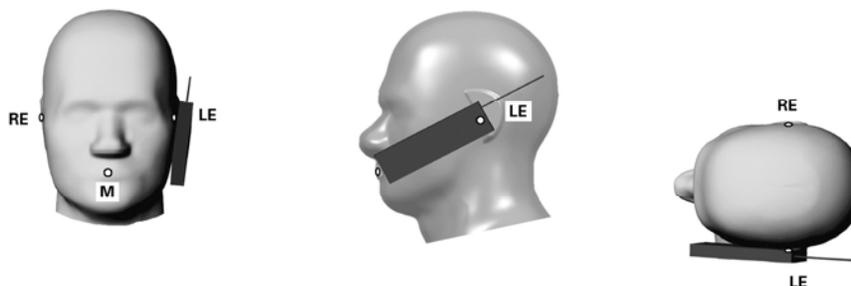


Fig-4.2 Illustration for Cheek Position

3. Tilted Position

- (a) To position the device in the “cheek” position described above.
- (b) While maintaining the device the reference plane described above and pivoting against the ear, moves it outward away from the mouth by an angle of 15 degrees or until contact with the ear is lost (see Fig-4.3).

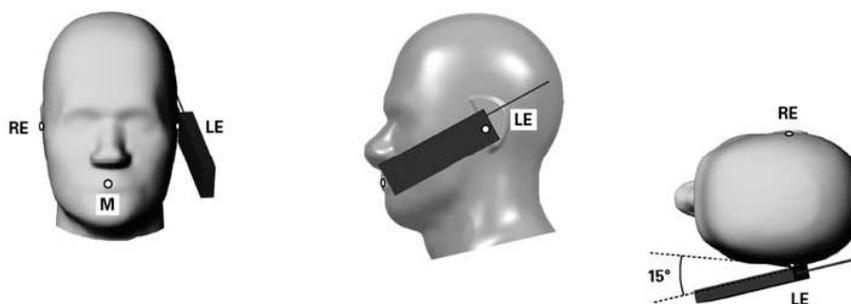


Fig-4.3 Illustration for Tilted Position

4.2.2 Body-worn Accessory Exposure Conditions

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 KDB 447498 are 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 the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is $> 1.2 \text{ W/kg}$, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

Body-worn accessories that do not contain metallic or conductive components may be tested according to worst-case exposure configurations, typically according to the smallest test separation distance required for the group of body-worn accessories with similar operating and exposure characteristics. All body-worn accessories containing metallic components are tested in conjunction with the host device.

Body-worn accessory SAR compliance is based on a single minimum test separation distance for all wireless and operating modes applicable to each body-worn accessory used by the host, and according to the relevant voice and/or data mode transmissions and operations. If a body-worn accessory supports voice only operations in its normal and expected use conditions, testing of data mode for body-worn compliance is not required.

A conservative minimum test separation distance for supporting off-the-shelf body-worn accessories that may be acquired by users of consumer handsets is used to test for body-worn accessory SAR compliance. This distance is determined by the handset manufacturer, according to the requirements of Supplement C 01-01. Devices that are designed to operate on the body of users using lanyards and straps, or without requiring additional body-worn accessories, will be tested using a conservative minimum test separation distance $\leq 5 \text{ mm}$ to support compliance.

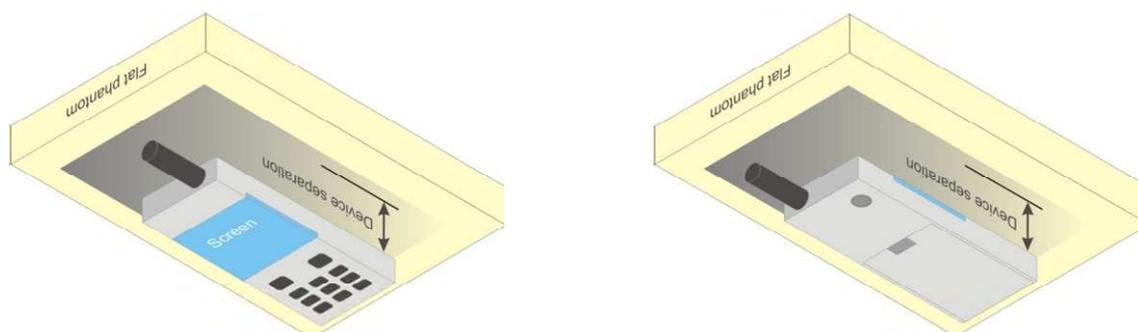
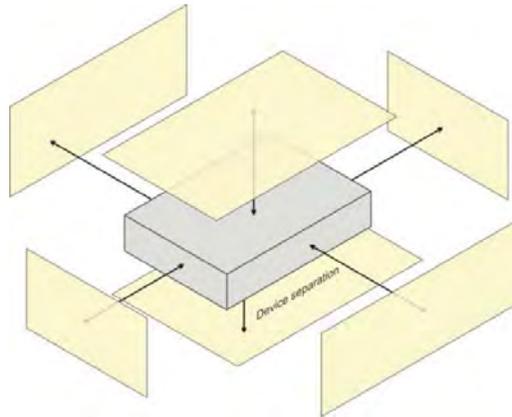


Fig-4.4 Illustration for Body Worn Position

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4.2.3 Hotspot Mode Exposure Conditions

For handsets that support hotspot mode operations, with wireless router capabilities and various web browsing functions, the relevant hand and body exposure conditions are tested according to the hotspot SAR procedures in KDB 941225 D06. A test separation distance of 10 mm is required between the phantom and all surfaces and edges with a transmitting antenna located within 25 mm from that surface or edge. When the form factor of a handset is smaller than 9 cm x 5 cm, a test separation distance of 5 mm (instead of 10 mm) is required for testing hotspot mode. When the separation distance required for body-worn accessory testing is larger than or equal to that tested for hotspot mode, in the same wireless mode and for the same surface of the phone, the hotspot mode SAR data may be used to support body-worn accessory SAR compliance for that particular configuration (surface).



Based on the antenna location shown on appendix D of this report, the SAR testing required for hotspot mode is listed as below.

| Antenna | Front Face | Rear Face | Left Side | Right Side | Top Side | Bottom Side |
|-----------|------------|-----------|-----------|------------|----------|-------------|
| WWAN | √ | √ | √ | | √ | |
| WLAN / BT | √ | √ | | √ | √ | |

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4.2.4 SAR Test Exclusion Evaluations

According to KDB 447498 D01, the SAR test exclusion condition is based on source-based time-averaged maximum conducted output power, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions. The SAR exclusion threshold is determined by the following.

| Mode | Max. Tune-up Power (dBm) | Max. Tune-up Power (mW) | Head | | | Body-Worn | | | Hotspot | | |
|-----------|--------------------------|-------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| | | | Ant. to Surface (mm) | Power Threshold (mW) | Require SAR Testing? | Ant. to Surface (mm) | Power Threshold (mW) | Require SAR Testing? | Ant. to Surface (mm) | Power Threshold (mW) | Require SAR Testing? |
| WLAN 2.4G | 9.5 | 8.91 | 5 | 2.8 | No | 10 | 1.4 | No | 10 | 1.4 | No |
| BT | 5.0 | 3.16 | - | - | - | 10 | 0.5 | No | - | - | - |

4.2.5 Simultaneous Transmission Possibilities

The simultaneous transmission possibilities for this device are listed as below.

| Simultaneous TX Combination | Capable Transmit Configurations | Head (Voice / VoIP) | Body-worn (Voice / VoIP) | Hotspot (Data) |
|-----------------------------|---------------------------------------|---------------------|--------------------------|----------------|
| 1 | GSM850 (Voice / Data) + WLAN (Data) | Yes | Yes | Yes |
| 2 | GSM1900 (Voice / Data) + WLAN (Data) | Yes | Yes | Yes |
| 3 | WCDMA II (Voice / Data) + WLAN (Data) | Yes | Yes | Yes |
| 4 | WCDMA V (Voice / Data) + WLAN (Data) | Yes | Yes | Yes |
| 5 | GSM850 (Voice / Data) + BT (Data) | No | Yes | No |
| 6 | GSM1900 (Voice / Data) + BT (Data) | No | Yes | No |
| 7 | WCDMA II (Voice / Data) + BT (Data) | No | Yes | No |
| 8 | WCDMA V (Voice / Data) + BT (Data) | No | Yes | No |

Note :

1. The WLAN and Bluetooth cannot transmit simultaneously, so there is no co-location test requirement for WLAN and Bluetooth.

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4.3 Tissue Verification

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

| Test Date | Tissue Type | Frequency (MHz) | Liquid Temp. (°C) | Measured Conductivity (σ) | Measured Permittivity (ϵ_r) | Target Conductivity (σ) | Target Permittivity (ϵ_r) | Conductivity Deviation (%) | Permittivity Deviation (%) |
|---------------|-------------|-----------------|-------------------|------------------------------------|--|----------------------------------|--------------------------------------|----------------------------|----------------------------|
| Apr. 24, 2018 | HL850 | 835 | 21.5 | 0.91 | 42.30 | 0.90 | 41.50 | 1.11 | 1.93 |
| Apr. 25, 2018 | HL1900 | 1900 | 21.3 | 1.41 | 40.86 | 1.40 | 40.00 | 0.71 | 2.15 |
| Apr. 24, 2018 | BL850 | 835 | 21.5 | 0.95 | 56.40 | 0.97 | 55.20 | -2.06 | 2.17 |
| Apr. 25, 2018 | BL1900 | 1900 | 21.3 | 1.54 | 55.12 | 1.52 | 53.30 | 1.32 | 3.41 |

Note:

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

4.4 System Validation

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

| Test Date | Probe S/N | Calibration Point | Measured Conductivity (σ) | Measured Permittivity (ϵ_r) | Validation for CW | | | Validation for Modulation | | | |
|---------------|------------------|-------------------|------------------------------------|--|-------------------|-----------------|----------------|---------------------------|-------------|------|-----|
| | | | | | Sensitivity Range | Probe Linearity | Probe Isotropy | Modulation Type | Duty Factor | PAR | |
| Apr. 24, 2018 | SN 27/15 EPGO262 | Head | 835 | 0.91 | 42.30 | Pass | Pass | Pass | GMSK | Pass | N/A |
| Apr. 25, 2018 | SN 27/15 EPGO262 | Head | 1900 | 1.41 | 40.86 | Pass | Pass | Pass | GMSK | Pass | N/A |
| Apr. 24, 2018 | SN 27/15 EPGO262 | Body | 835 | 0.95 | 56.40 | Pass | Pass | Pass | GMSK | Pass | N/A |
| Apr. 25, 2018 | SN 27/15 EPGO262 | Body | 1900 | 1.54 | 55.12 | Pass | Pass | Pass | GMSK | Pass | N/A |

4.5 System Verification

The measuring result for system verification is tabulated as below.

| Test Date | Mode | Frequency (MHz) | 1W Target SAR-1g (W/kg) | Measured SAR-1g (W/kg) | Normalized to 1W SAR-1g (W/kg) | Deviation (%) | Dipole S/N | Probe S/N |
|---------------|------|-----------------|-------------------------|------------------------|--------------------------------|---------------|------------------|------------------|
| Apr. 24, 2018 | Head | 835 | 9.64 | 0.98 | 9.78 | 1.45 | SN 18/11 DIPG150 | SN 27/15 EPGO262 |
| Apr. 25, 2018 | Head | 1900 | 39.88 | 3.78 | 37.83 | -5.14 | SN 18/11 DIPG153 | SN 27/15 EPGO262 |
| Apr. 24, 2018 | Body | 835 | 9.96 | 0.96 | 9.64 | -3.21 | SN 18/11 DIPG150 | SN 27/15 EPGO262 |
| Apr. 25, 2018 | Body | 1900 | 40.38 | 4.16 | 41.61 | 3.05 | SN 18/11 DIPG153 | SN 27/15 EPGO262 |

Note:

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

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4.6 Maximum Output Power

4.6.1 Maximum Conducted Power

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

| Mode | GSM850 | GSM1900 |
|-----------------------|--------|---------|
| GSM (GMSK, 1Tx-slot) | 33.0 | 31.0 |
| GPRS (GMSK, 1Tx-slot) | 33.0 | 30.0 |
| GPRS (GMSK, 2Tx-slot) | 33.0 | 29.0 |
| GPRS (GMSK, 3Tx-slot) | 32.0 | 28.0 |
| GPRS (GMSK, 4Tx-slot) | 31.0 | 27.0 |

| Mode | WCDMA Band II | WCDMA Band V |
|-----------|---------------|--------------|
| RMC 12.2K | 22.0 | 22.0 |
| HSDPA | 22.0 | 22.0 |
| HSUPA | 22.0 | 22.0 |

| Mode | 2.4G WLAN |
|--------------|-----------|
| 802.11b | 9.5 |
| 802.11g | 9.0 |
| 802.11n HT20 | 9.0 |
| 802.11n HT40 | 9.0 |

| Mode | 2.4G Bluetooth |
|----------------|----------------|
| GFSK | 5.0 |
| $\pi/4$ -DQPSK | 4.5 |
| 8-DPSK | 4.5 |
| LE | 4.5 |

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4.6.2 Measured Conducted Power Result

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

| Band | GSM850 | | | GSM1900 | | |
|--|--------|-------|--------------|--------------|--------|--------------|
| Channel | 128 | 189 | 251 | 512 | 661 | 810 |
| Frequency (MHz) | 824.2 | 836.4 | 848.8 | 1850.2 | 1880.0 | 1909.8 |
| Maximum Burst-Averaged Output Power | | | | | | |
| GSM (GMSK, 1Tx-slot) | 32.31 | 32.19 | 32.25 | 29.30 | 29.31 | 29.44 |
| GPRS (GMSK, 1Tx-slot) | 32.18 | 32.25 | 32.33 | 29.31 | 29.33 | 29.36 |
| GPRS (GMSK, 2Tx-slot) | 32.00 | 32.01 | 32.10 | 28.50 | 28.49 | 28.66 |
| GPRS (GMSK, 3Tx-slot) | 31.01 | 31.06 | 31.09 | 27.46 | 27.41 | 27.50 |
| GPRS (GMSK, 4Tx-slot) | 30.09 | 30.13 | 30.20 | 26.50 | 26.42 | 26.33 |
| Maximum Frame-Averaged Output Power | | | | | | |
| GSM (GMSK, 1Tx-slot) | 23.31 | 23.19 | 23.25 | 20.30 | 20.31 | 20.44 |
| GPRS (GMSK, 1Tx-slot) | 23.18 | 23.25 | 23.33 | 20.31 | 20.33 | 20.36 |
| GPRS (GMSK, 2Tx-slot) | 26.00 | 26.01 | 26.10 | 22.50 | 22.49 | 22.66 |
| GPRS (GMSK, 3Tx-slot) | 26.75 | 26.80 | 26.83 | 23.20 | 23.15 | 23.24 |
| GPRS (GMSK, 4Tx-slot) | 27.09 | 27.13 | 27.20 | 23.50 | 23.42 | 23.33 |

Note:

- SAR testing was performed on the maximum frame-averaged power mode.
- The frame-averaged power is linearly proportion to the slot number configured and it is linearly scaled the maximum burst-averaged power based on time slots. The calculated method is shown as below:

$$\text{Frame-averaged power} = 10 \times \log (\text{Burst-averaged power mW} \times \text{Slot used} / 8)$$

| Band | WCDMA Band II | | | WCDMA Band V | | | 3GPP MPR (dB) |
|-----------------|---------------|--------|--------------|--------------|-------|--------------|---------------|
| Channel | 9262 | 9400 | 9538 | 4132 | 4182 | 4233 | |
| Frequency (MHz) | 1852.4 | 1880.0 | 1907.6 | 826.4 | 836.4 | 846.6 | |
| RMC 12.2K | 21.33 | 21.23 | 21.63 | 21.43 | 21.33 | 21.46 | - |
| HSDPA Subtest-1 | 21.28 | 21.18 | 21.58 | 21.38 | 21.28 | 21.41 | 0 |
| HSDPA Subtest-2 | 21.23 | 21.13 | 21.53 | 21.33 | 21.23 | 21.36 | 0 |
| HSDPA Subtest-3 | 21.15 | 21.05 | 21.45 | 21.25 | 21.15 | 21.28 | 0.5 |
| HSDPA Subtest-4 | 21.12 | 21.02 | 21.42 | 21.22 | 21.12 | 21.25 | 0.5 |
| HSUPA Subtest-1 | 21.25 | 21.15 | 21.55 | 21.35 | 21.25 | 21.38 | 0 |
| HSUPA Subtest-2 | 20.39 | 20.29 | 20.69 | 20.49 | 20.39 | 20.52 | 2 |
| HSUPA Subtest-3 | 21.16 | 21.06 | 21.46 | 21.26 | 21.16 | 21.29 | 1 |
| HSUPA Subtest-4 | 20.34 | 20.24 | 20.64 | 20.44 | 20.34 | 20.47 | 2 |
| HSUPA Subtest-5 | 21.32 | 21.22 | 21.62 | 21.42 | 21.32 | 21.45 | 0 |

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<WLAN 2.4G>

| Mode | 802.11b | | |
|---------------------------|----------------|----------|-----------|
| Channel / Frequency (MHz) | 1 (2412) | 6 (2437) | 11 (2462) |
| Average Power | 8.50 | 8.92 | 8.83 |
| Mode | 802.11g | | |
| Channel / Frequency (MHz) | 1 (2412) | 6 (2437) | 11 (2462) |
| Average Power | 8.33 | 8.22 | 8.53 |
| Mode | 802.11n (HT20) | | |
| Channel / Frequency (MHz) | 1 (2412) | 6 (2437) | 11 (2462) |
| Average Power | 8.16 | 8.27 | 8.77 |
| Mode | 802.11n (HT40) | | |
| Channel / Frequency (MHz) | 3 (2422) | 6 (2437) | 9 (2452) |
| Average Power | 8.19 | 8.65 | 8.04 |

<Bluetooth>

| Mode | Bluetooth GFSK | | |
|---------------------------|--------------------------|-----------|-----------|
| Channel / Frequency (MHz) | 0 (2402) | 39 (2441) | 78 (2480) |
| Average Power | 3.40 | 3.97 | 4.39 |
| Mode | Bluetooth $\pi/4$ -DQPSK | | |
| Channel / Frequency (MHz) | 0 (2402) | 39 (2441) | 78 (2480) |
| Average Power | 3.27 | 3.88 | 4.28 |
| Mode | Bluetooth 8-DPSK | | |
| Channel / Frequency (MHz) | 0 (2402) | 39 (2441) | 78 (2480) |
| Average Power | 3.21 | 3.81 | 4.23 |
| Mode | Bluetooth LE | | |
| Channel / Frequency (MHz) | 0 (2402) | 19 (2440) | 39 (2480) |
| Average Power | 3.29 | 3.88 | 4.32 |

4.7 SAR Testing Results

4.7.1 SAR Test Reduction Considerations

<KDB 447498 D01, General RF Exposure Guidance>

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

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

<KDB 941225 D01, 3G SAR Measurement Procedures>

The mode tested for SAR is referred to as the primary mode. The equivalent modes considered for SAR test reduction are denoted as secondary modes. Both primary and secondary modes must be in the same frequency band. When the maximum output power and tune-up tolerance specified for production units in a secondary mode is $\leq 1/4$ dB higher than the primary mode or when the highest reported SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of secondary to primary mode and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for the secondary mode.

<KDB 248227 D01, SAR Guidance for Wi-Fi Transmitters>

- (1) For handsets operating next to ear, hotspot mode or mini-tablet configurations, the initial test position procedures were applied. The test position with the highest extrapolated peak SAR will be used as the initial test position. When the reported SAR of initial test position is ≤ 0.4 W/kg, SAR testing for remaining test positions is not required. Otherwise, SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR result is ≤ 0.8 W/kg or all test positions are measured.
- (2) For WLAN 2.4 GHz, the highest measured maximum output power channel for DSSS was selected for SAR measurement. When the reported SAR is ≤ 0.8 W/kg, no further SAR testing is required. Otherwise, SAR is evaluated at the next highest measured output power channel. When any reported SAR is > 1.2 W/kg, SAR is required for the third channel. For OFDM modes (802.11g/n), SAR is not required when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and it is ≤ 1.2 W/kg.

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4.7.2 SAR Results for Head Exposure Condition

| Plot No. | Band | Mode | Test Position | Ch. | Max. Tune-up Power (dBm) | Measured Conducted Power (dBm) | Scaling Factor | Power Drift (dB) | Measured SAR-1g (W/kg) | Scaled SAR-1g (W/kg) |
|----------|----------|----------|---------------|------|--------------------------|--------------------------------|----------------|------------------|------------------------|----------------------|
| 1# | GSM850 | GPRS12 | Right Cheek | 251 | 31.0 | 30.20 | 1.20 | -4.76 | 0.57 | 0.69 |
| | GSM850 | GPRS12 | Right Tilted | 251 | 31.0 | 30.20 | 1.20 | 1.63 | 0.539 | 0.65 |
| | GSM850 | GPRS12 | Left Cheek | 251 | 31.0 | 30.20 | 1.20 | 0.95 | 0.333 | 0.40 |
| | GSM850 | GPRS12 | Left Tilted | 251 | 31.0 | 30.20 | 1.20 | 3.33 | 0.326 | 0.39 |
| 2# | GSM1900 | GPRS12 | Right Cheek | 512 | 27.0 | 26.50 | 1.12 | -1.31 | 0.632 | 0.71 |
| | GSM1900 | GPRS12 | Right Tilted | 512 | 27.0 | 26.50 | 1.12 | -3.98 | 0.491 | 0.55 |
| | GSM1900 | GPRS12 | Left Cheek | 512 | 27.0 | 26.50 | 1.12 | -2.02 | 0.291 | 0.33 |
| | GSM1900 | GPRS12 | Left Tilted | 512 | 27.0 | 26.50 | 1.12 | -1.46 | 0.263 | 0.30 |
| 3# | WCDMA II | RMC12.2K | Right Cheek | 9538 | 22.0 | 21.63 | 1.09 | -4.2 | 0.72 | 0.78 |
| | WCDMA II | RMC12.2K | Right Tilted | 9538 | 22.0 | 21.63 | 1.09 | 3.28 | 0.632 | 0.69 |
| | WCDMA II | RMC12.2K | Left Cheek | 9538 | 22.0 | 21.63 | 1.09 | -2.42 | 0.376 | 0.41 |
| | WCDMA II | RMC12.2K | Left Tilted | 9538 | 22.0 | 21.63 | 1.09 | -2.61 | 0.348 | 0.38 |
| 4# | WCDMA V | RMC12.2K | Right Cheek | 4233 | 22.0 | 21.46 | 1.13 | -1.45 | 0.494 | 0.56 |
| | WCDMA V | RMC12.2K | Right Tilted | 4233 | 22.0 | 21.46 | 1.13 | 0.06 | 0.435 | 0.49 |
| | WCDMA V | RMC12.2K | Left Cheek | 4233 | 22.0 | 21.46 | 1.13 | -1.25 | 0.401 | 0.45 |
| | WCDMA V | RMC12.2K | Left Tilted | 4233 | 22.0 | 21.46 | 1.13 | -0.39 | 0.327 | 0.37 |

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4.7.3 SAR Results for Body-worn Exposure Condition (Separation Distance is 1.0 cm Gap)

| Plot No. | Band | Mode | Test Position | Ch. | Max. Tune-up Power (dBm) | Measured Conducted Power (dBm) | Scaling Factor | Power Drift (dB) | Measured SAR-1g (W/kg) | Scaled SAR-1g (W/kg) |
|----------|----------|----------|---------------|------|--------------------------|--------------------------------|----------------|------------------|------------------------|----------------------|
| | GSM850 | GPRS12 | Front Face | 251 | 31.0 | 30.20 | 1.20 | -0.59 | 0.151 | 0.18 |
| 6# | GSM850 | GPRS12 | Rear Face | 251 | 31.0 | 30.20 | 1.20 | 1.72 | 0.207 | 0.25 |
| | GSM1900 | GPRS12 | Front Face | 512 | 27.0 | 26.50 | 1.12 | 0 | 0.096 | 0.11 |
| 7# | GSM1900 | GPRS12 | Rear Face | 512 | 27.0 | 26.50 | 1.12 | -2.65 | 0.237 | 0.27 |
| | WCDMA II | RMC12.2K | Front Face | 9538 | 22.0 | 21.63 | 1.09 | -2.74 | 0.135 | 0.15 |
| 8# | WCDMA II | RMC12.2K | Rear Face | 9538 | 22.0 | 21.63 | 1.09 | 3.53 | 0.344 | 0.37 |
| | WCDMA V | RMC12.2K | Front Face | 4233 | 22.0 | 21.46 | 1.13 | 0.19 | 0.146 | 0.17 |
| 9# | WCDMA V | RMC12.2K | Rear Face | 4233 | 22.0 | 21.46 | 1.13 | -0.26 | 0.197 | 0.22 |

4.7.4 SAR Results for Hotspot Exposure Condition (Separation Distance is 1.0 cm Gap)

| Plot No. | Band | Mode | Test Position | Ch. | Max. Tune-up Power (dBm) | Measured Conducted Power (dBm) | Scaling Factor | Power Drift (dB) | Measured SAR-1g (W/kg) | Scaled SAR-1g (W/kg) |
|----------|----------|----------|---------------|------|--------------------------|--------------------------------|----------------|------------------|------------------------|----------------------|
| | GSM850 | GPRS12 | Front Face | 251 | 31.0 | 30.20 | 1.20 | -0.59 | 0.151 | 0.18 |
| 6# | GSM850 | GPRS12 | Rear Face | 251 | 31.0 | 30.20 | 1.20 | 1.72 | 0.207 | 0.25 |
| | GSM850 | GPRS12 | Left Side | 251 | 31.0 | 30.20 | 1.20 | -1.71 | 0.103 | 0.12 |
| | GSM850 | GPRS12 | Top Side | 251 | 31.0 | 30.20 | 1.20 | 1.01 | 0.057 | 0.07 |
| | GSM1900 | GPRS12 | Front Face | 512 | 27.0 | 26.50 | 1.12 | 0 | 0.096 | 0.11 |
| 7# | GSM1900 | GPRS12 | Rear Face | 512 | 27.0 | 26.50 | 1.12 | -2.65 | 0.237 | 0.27 |
| | GSM1900 | GPRS12 | Left Side | 512 | 27.0 | 26.50 | 1.12 | -1.1 | 0.161 | 0.18 |
| | GSM1900 | GPRS12 | Top Side | 512 | 27.0 | 26.50 | 1.12 | 0 | 0.112 | 0.13 |
| | WCDMA II | RMC12.2K | Front Face | 9538 | 22.0 | 21.63 | 1.09 | -2.74 | 0.135 | 0.15 |
| 8# | WCDMA II | RMC12.2K | Rear Face | 9538 | 22.0 | 21.63 | 1.09 | 3.53 | 0.344 | 0.37 |
| | WCDMA II | RMC12.2K | Left Side | 9538 | 22.0 | 21.63 | 1.09 | -0.52 | 0.163 | 0.18 |
| | WCDMA II | RMC12.2K | Top Side | 9538 | 22.0 | 21.63 | 1.09 | -1.38 | 0.185 | 0.20 |
| | WCDMA V | RMC12.2K | Front Face | 4233 | 22.0 | 21.46 | 1.13 | 0.19 | 0.146 | 0.17 |
| 9# | WCDMA V | RMC12.2K | Rear Face | 4233 | 22.0 | 21.46 | 1.13 | -0.26 | 0.197 | 0.22 |
| | WCDMA V | RMC12.2K | Left Side | 4233 | 22.0 | 21.46 | 1.13 | 2.58 | 0.109 | 0.12 |
| | WCDMA V | RMC12.2K | Top Side | 4233 | 22.0 | 21.46 | 1.13 | 0.01 | 0.049 | 0.06 |

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4.7.5 SAR Measurement Variability

According to KDB 865664 D01, SAR measurement variability was assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. Alternatively, if the highest measured SAR for both head and body tissue-equivalent media are ≤ 1.45 W/kg and the ratio of these highest SAR values, i.e., largest divided by smallest value, is ≤ 1.10 , the highest SAR configuration for either head or body tissue-equivalent medium may be used to perform the repeated measurement. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

Since all the measured SAR are less than 0.8 W/kg, the repeated measurement is not required.

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4.7.6 Simultaneous Multi-band Transmission Evaluation

<Estimated SAR Calculation>

According to KDB 447498 D01, when standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR was estimated according to following formula to result in substantially conservative SAR values of ≤ 0.4 W/kg to determine simultaneous transmission SAR test exclusion.

$$\text{Estimated SAR} = \frac{\text{Max. Tune up Power}_{(mW)}}{\text{Min. Test Separation Distance}_{(mm)}} \times \frac{\sqrt{f_{(GHz)}}}{7.5}$$

If the minimum test separation distance is < 5 mm, a distance of 5 mm is used for estimated SAR calculation. When the test separation distance is > 50 mm, the 0.4 W/kg is used for SAR-1g.

| Mode / Band | Frequency (GHz) | Max. Tune-up Power (dBm) | Test Position | Separation Distance (mm) | Estimated SAR (W/kg) |
|-------------|-----------------|--------------------------|---------------|--------------------------|----------------------|
| WLAN (DTS) | 2.462 | 9.5 | Head | 5 | 0.37 |
| WLAN (DTS) | 2.462 | 9.5 | Body-worn | 10 | 0.19 |
| WLAN (DTS) | 2.462 | 9.5 | Hotspot | 10 | 0.19 |
| BT (DSS) | 2.48 | 5.0 | Body | 10 | 0.07 |

Note:

1. The separation distance is determined from the outer housing of the tablet to the user.
2. When standalone SAR testing is not required, an estimated SAR can be applied to determine simultaneous transmission SAR test exclusion.

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<SAR Summation Analysis>

Simultaneous transmission SAR test exclusion is determined for each operating configuration and exposure condition according to the reported standalone SAR of each applicable simultaneous transmitting antenna. When the sum of SAR_{1g} of all simultaneously transmitting antennas in an operating mode and exposure condition combination is within the SAR limit (SAR_{1g} 1.6 W/kg), the simultaneous transmission SAR is not required. When the sum of SAR_{1g} is greater than the SAR limit (SAR_{1g} 1.6 W/kg), SAR test exclusion is determined by the SPLSR.

| No. | Conditions (SAR1 + SAR2) | Exposure Condition | Test Position | Max. SAR1 | Max. SAR2 | SAR Summation | SPLSR Analysis |
|-----|--------------------------|--------------------|---------------|-----------|-----------|---------------|---------------------------|
| 1 | GSM850 + WLAN (DTS) | Head | Right Cheek | 0.69 | 0.37 | 1.06 | ∑ SAR < 1.6, Not required |
| | | | Right Tilted | 0.65 | 0.37 | 1.02 | ∑ SAR < 1.6, Not required |
| | | | Left Cheek | 0.40 | 0.37 | 0.77 | ∑ SAR < 1.6, Not required |
| | | | Left Tilted | 0.39 | 0.37 | 0.76 | ∑ SAR < 1.6, Not required |
| | | Body-Worn | Front Face | 0.18 | 0.19 | 0.37 | ∑ SAR < 1.6, Not required |
| | | | Rear Face | 0.25 | 0.19 | 0.44 | ∑ SAR < 1.6, Not required |
| | | Hotspot | Front Face | 0.18 | 0.19 | 0.37 | ∑ SAR < 1.6, Not required |
| | | | Rear Face | 0.25 | 0.19 | 0.44 | ∑ SAR < 1.6, Not required |
| | | | Left Side | 0.12 | 0.00 | 0.12 | ∑ SAR < 1.6, Not required |
| | | | Right Side | 0.00 | 0.19 | 0.00 | ∑ SAR < 1.6, Not required |
| | | | Top Side | 0.07 | 0.19 | 0.26 | ∑ SAR < 1.6, Not required |
| | | | Bottom Side | 0.00 | 0.00 | 0.00 | ∑ SAR < 1.6, Not required |
| 2 | GSM850 + BT (DSS) | Body-Worn | Front Face | 0.18 | 0.07 | 0.25 | ∑ SAR < 1.6, Not required |
| | | | Rear Face | 0.25 | 0.07 | 0.32 | ∑ SAR < 1.6, Not required |

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| No. | Conditions (SAR1 + SAR2) | Exposure Condition | Test Position | Max. SAR1 | Max. SAR2 | SAR Summation | SPLSR Analysis |
|-----|--------------------------|--------------------|---------------|-----------|-----------|---------------|----------------------------------|
| 3 | GSM1900 + WLAN (DTS) | Head | Right Cheek | 0.71 | 0.37 | 1.08 | Σ SAR < 1.6, Not required |
| | | | Right Tilted | 0.55 | 0.37 | 0.92 | Σ SAR < 1.6, Not required |
| | | | Left Cheek | 0.33 | 0.37 | 0.70 | Σ SAR < 1.6, Not required |
| | | | Left Tilted | 0.30 | 0.37 | 0.67 | Σ SAR < 1.6, Not required |
| | | Body-Worn | Front Face | 0.11 | 0.19 | 0.30 | Σ SAR < 1.6, Not required |
| | | | Rear Face | 0.27 | 0.19 | 0.46 | Σ SAR < 1.6, Not required |
| | | Hotspot | Front Face | 0.11 | 0.19 | 0.30 | Σ SAR < 1.6, Not required |
| | | | Rear Face | 0.27 | 0.19 | 0.46 | Σ SAR < 1.6, Not required |
| | | | Left Side | 0.18 | 0.00 | 0.18 | Σ SAR < 1.6, Not required |
| | | | Right Side | 0.00 | 0.19 | 0.00 | Σ SAR < 1.6, Not required |
| | | | Top Side | 0.13 | 0.19 | 0.32 | Σ SAR < 1.6, Not required |
| | | | Bottom Side | 0.00 | 0.00 | 0.00 | Σ SAR < 1.6, Not required |
| 4 | GSM1900 + BT (DSS) | Body-Worn | Front Face | 0.11 | 0.07 | 0.18 | Σ SAR < 1.6, Not required |
| | | | Rear Face | 0.27 | 0.07 | 0.34 | Σ SAR < 1.6, Not required |

| No. | Conditions (SAR1 + SAR2) | Exposure Condition | Test Position | Max. SAR1 | Max. SAR2 | SAR Summation | SPLSR Analysis |
|-----|--------------------------|--------------------|---------------|-----------|-----------|---------------|----------------------------------|
| 5 | WCDMA B2 + WLAN (DTS) | Head | Right Cheek | 0.78 | 0.37 | 1.15 | Σ SAR < 1.6, Not required |
| | | | Right Tilted | 0.69 | 0.37 | 1.06 | Σ SAR < 1.6, Not required |
| | | | Left Cheek | 0.41 | 0.37 | 0.78 | Σ SAR < 1.6, Not required |
| | | | Left Tilted | 0.38 | 0.37 | 0.75 | Σ SAR < 1.6, Not required |
| | | Body-Worn | Front Face | 0.15 | 0.19 | 0.34 | Σ SAR < 1.6, Not required |
| | | | Rear Face | 0.37 | 0.19 | 0.56 | Σ SAR < 1.6, Not required |
| | | Hotspot | Front Face | 0.15 | 0.19 | 0.34 | Σ SAR < 1.6, Not required |
| | | | Rear Face | 0.37 | 0.19 | 0.56 | Σ SAR < 1.6, Not required |
| | | | Left Side | 0.18 | 0.00 | 0.18 | Σ SAR < 1.6, Not required |
| | | | Right Side | 0.00 | 0.19 | 0.00 | Σ SAR < 1.6, Not required |
| | | | Top Side | 0.20 | 0.19 | 0.39 | Σ SAR < 1.6, Not required |
| | | | Bottom Side | 0.00 | 0.00 | 0.00 | Σ SAR < 1.6, Not required |
| 6 | WCDMA B2 + BT (DSS) | Body-Worn | Front Face | 0.15 | 0.07 | 0.22 | Σ SAR < 1.6, Not required |
| | | | Rear Face | 0.37 | 0.07 | 0.44 | Σ SAR < 1.6, Not required |

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| No. | Conditions (SAR1 + SAR2) | Exposure Condition | Test Position | Max. SAR1 | Max. SAR2 | SAR Summation | SPLSR Analysis |
|-----|-----------------------------|-----------------------|------------------|--------------|--------------|------------------|-------------------------------------|
| 7 | WCDMA B5 + WLAN (DTS) | Head | Right Cheek | 0.56 | 0.37 | 0.93 | Σ SAR < 1.6, Not required |
| | | | Right Tilted | 0.49 | 0.37 | 0.86 | Σ SAR < 1.6, Not required |
| | | | Left Cheek | 0.45 | 0.37 | 0.82 | Σ SAR < 1.6, Not required |
| | | | Left Tilted | 0.37 | 0.37 | 0.74 | Σ SAR < 1.6, Not required |
| | | Body-Worn | Front Face | 0.17 | 0.19 | 0.36 | Σ SAR < 1.6, Not required |
| | | | Rear Face | 0.22 | 0.19 | 0.41 | Σ SAR < 1.6, Not required |
| | | Hotspot | Front Face | 0.17 | 0.19 | 0.36 | Σ SAR < 1.6, Not required |
| | | | Rear Face | 0.22 | 0.19 | 0.41 | Σ SAR < 1.6, Not required |
| | | | Left Side | 0.12 | 0.00 | 0.12 | Σ SAR < 1.6, Not required |
| | | | Right Side | 0.00 | 0.19 | 0.00 | Σ SAR < 1.6, Not required |
| | | | Top Side | 0.06 | 0.19 | 0.25 | Σ SAR < 1.6, Not required |
| | | | Bottom Side | 0.00 | 0.00 | 0.00 | Σ SAR < 1.6, Not required |
| 8 | WCDMA B5 + BT (DSS) | Body-Worn | Front Face | 0.17 | 0.07 | 0.24 | Σ SAR < 1.6, Not required |
| | | | Rear Face | 0.22 | 0.07 | 0.29 | Σ SAR < 1.6, Not required |

Test Engineer : Wiky Zhang

5. Calibration of Test Equipment

| Equipment | Manufacturer | Model | SN | Cal. Date | Cal. Interval |
|---------------------------------|--------------|--------------------|-------------------|---------------|---------------|
| System Validation Dipole | SATIMO | SID835 | SN 18/11 DIPC 150 | Jun. 08, 2017 | 1 Year |
| System Validation Dipole | SATIMO | SID1900 | SN 18/11 DIPG 153 | Jun. 08, 2017 | 1 Year |
| E-Field Probe | MVG | SSE2 | SN 27/15 EPGO262 | Sep. 20, 2016 | 2 Years |
| MultiMeter | Keithley | Multimate 2000 | 1331865 | Jun. 21, 2017 | 1 Year |
| Radio Communication Analyzer | ANRITSU | MT8820C | 6201300717 | Jul. 24, 2017 | 1 Year |
| Wireless Communication Test Set | Agilent | E5515C | MY50260600 | Jun. 28, 2017 | 1 Year |
| ENA Series Network Analyzer | Agilent | E5071C | MY46214638 | Jul. 24, 2017 | 1 Year |
| Spectrum Analyzer | KEYSIGHT | N9010A | MY54510355 | Jun. 27, 2017 | 1Year |
| MXG Analog Signal Generator | KEYSIGHT | N5183A | MY50143024 | Mar. 01, 2018 | 1 Year |
| Power Meter | Agilent | N1914A | MY52180044 | Aug. 12, 2016 | 2 Years |
| Power Sensor | Agilent | E9304A H18 | MY52050011 | Jan. 04, 2018 | 1 Year |
| Power Meter | Agilent | ML2495A | 1506002 | Mar. 01, 2018 | 1 Year |
| Power Sensor | Agilent | MA2411B | 1339353 | Mar. 01, 2018 | 1 Year |
| Temp. & Humi. Recorder | CLOCK | HTC-1 | 157248 | Jul. 26, 2017 | 1 Year |
| Electronic Thermometer | YONGFA | YF-160A | 120100323 | Sep. 22, 2017 | 1 Year |
| Coupler | Woken | 0110A056020-1 0 | COM27RW1A3 | Sep. 20, 2017 | 1 Year |

6. Measurement Uncertainty

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

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7. Information on the Testing Laboratories

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

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

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Web Site: www.bureauveritas.com

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

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Appendix A. SAR Plots of System Verification

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

System Verification Plots

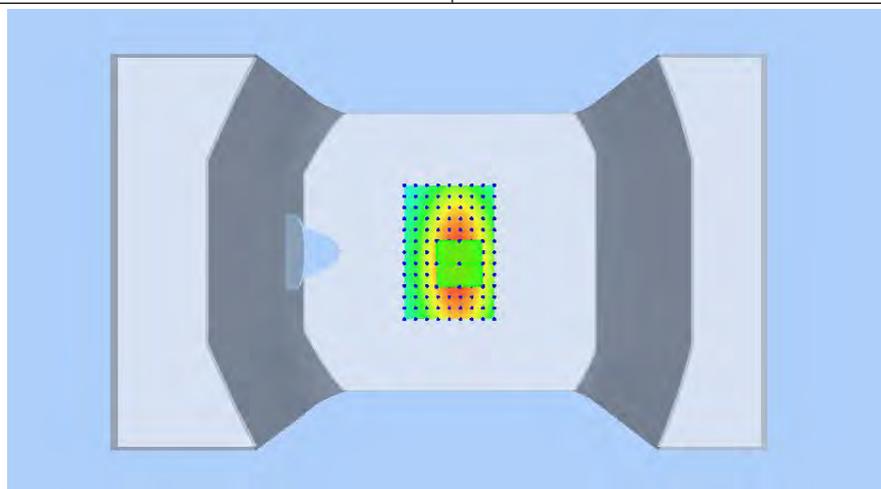
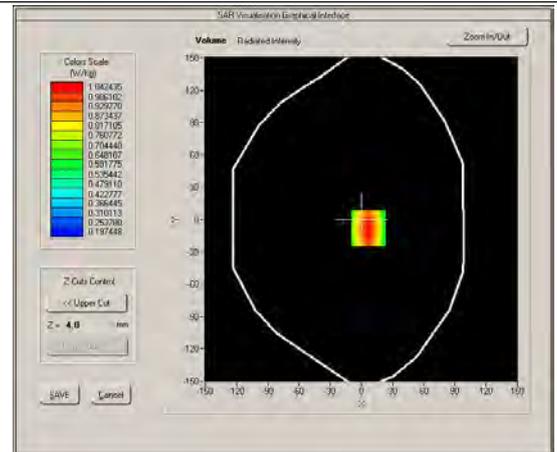
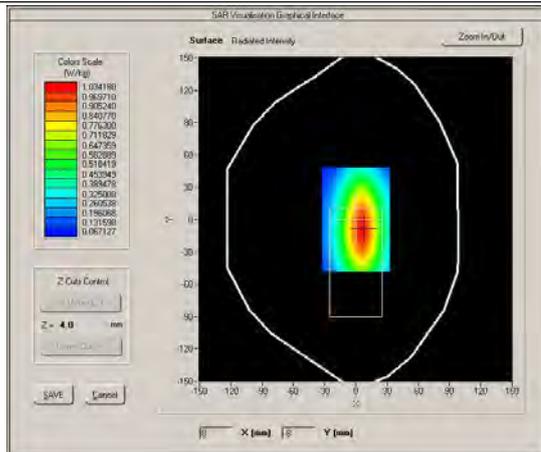
Product Description: Dipole

Model: SID835

Test Date: Apr 24, 2018

Ambient Temperature: 22.7°C; Liquid Temperature: 21.5°C

| | |
|-----------------------------------|----------------------------|
| Medium(liquid type) | HL835 |
| Frequency (MHz) | 835.000000 |
| Relative permittivity (real part) | 42.3 |
| Conductivity (S/m) | 0.91 |
| Input power | 100mW |
| E-Field Probe | SN 27/15 EPGO262 |
| Crest factor | 1.0 |
| Conversion Factor | 1.74 |
| Sensor-surface | 4mm |
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Variation (%) | 0.350000 |
| SAR 10g (W/Kg) | 0.656432 |
| SAR 1g (W/Kg) | 0.978034 |



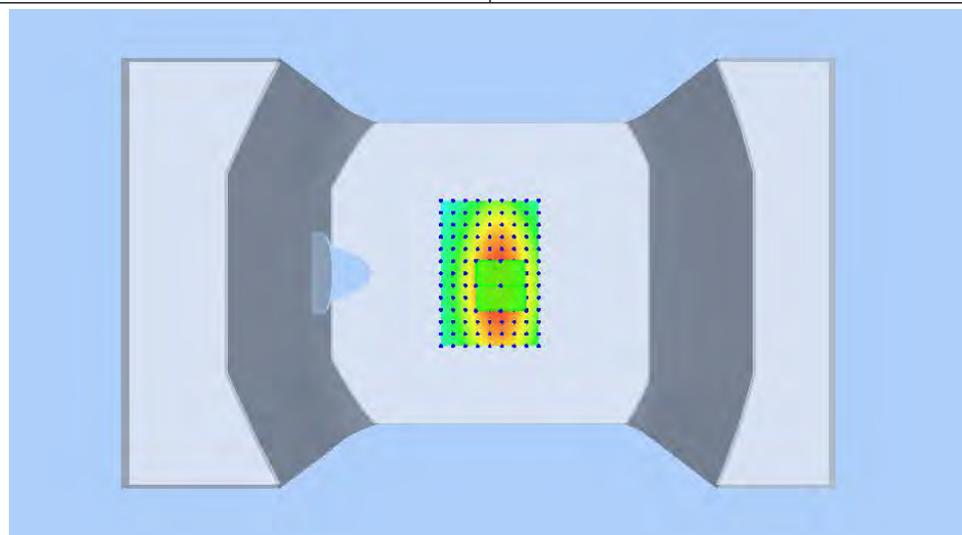
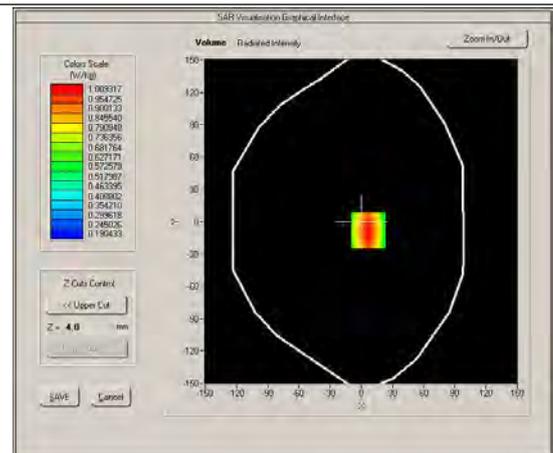
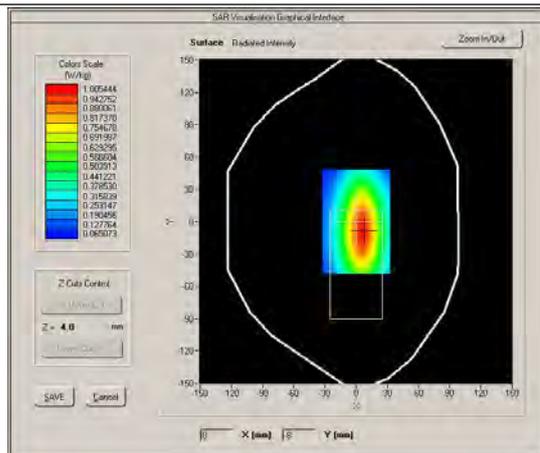
Product Description: Dipole

Model: SID835

Test Date: Apr 24, 2018

Ambient Temperature: 22.7°C; Liquid Temperature: 21.5°C

| | |
|-----------------------------------|-----------------------------|
| Medium(liquid type) | BL835 |
| Frequency (MHz) | 835.000000 |
| Relative permittivity (real part) | 56.40 |
| Conductivity (S/m) | 0.95 |
| Input power | 100mW |
| E-Field Probe | SN 27/15 EPGO262 |
| Crest factor | 1.0 |
| Conversion Factor | 1.81 |
| Sensor-surface | 4mm |
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | 5x5x7, dx=8mm dy=8mm dz=5mm |
| Variation (%) | -0.350000 |
| SAR 10g (W/Kg) | 0.642167 |
| SAR 1g (W/Kg) | 0.964154 |



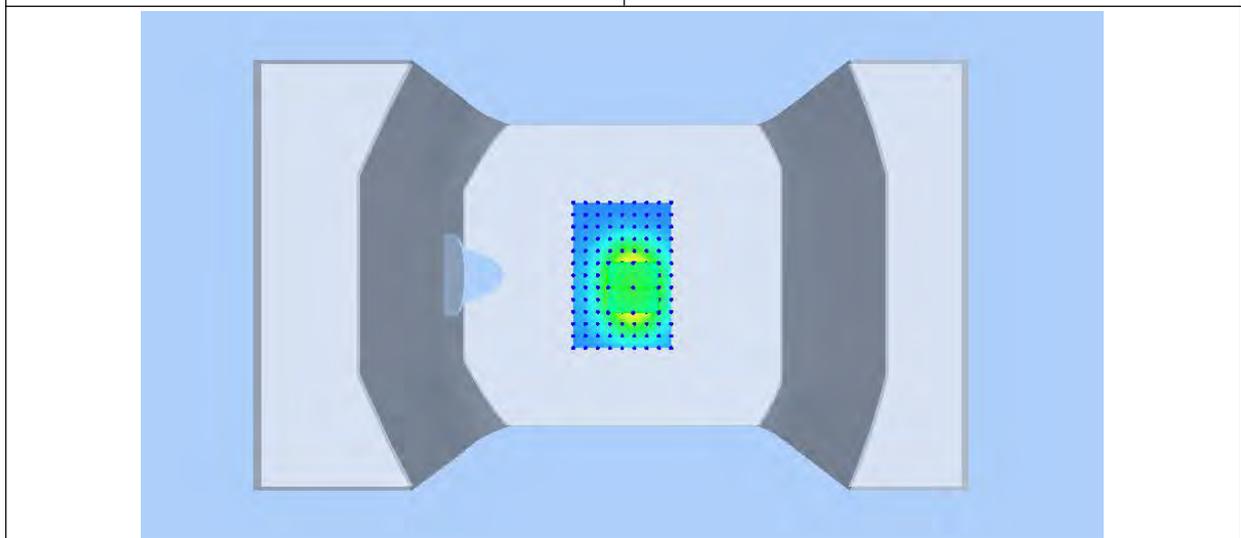
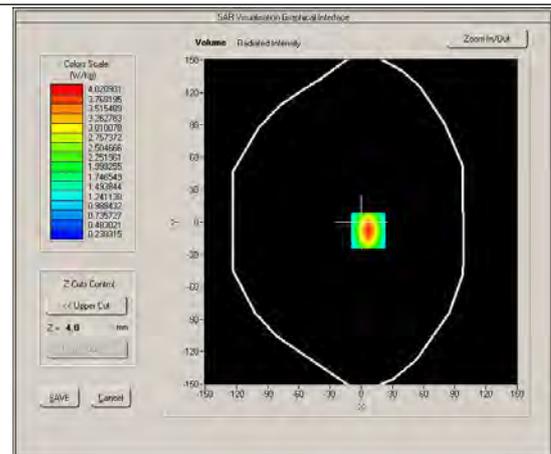
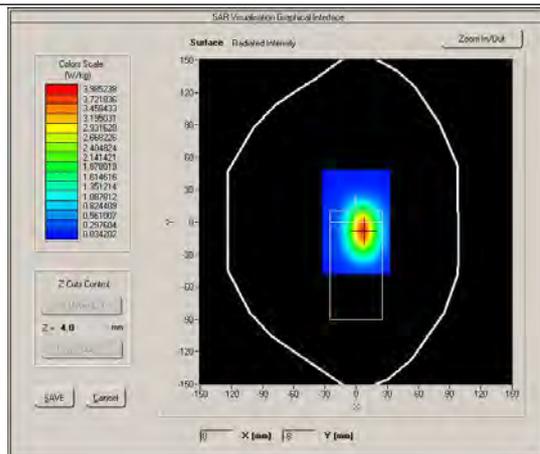
Product Description: Dipole

Model: SID1900

Test Date: Apr 25, 2018

Ambient Temperature: 22.5°C; Liquid Temperature: 21.3°C

| | |
|-----------------------------------|----------------------------|
| Medium(liquid type) | HL1900 |
| Frequency (MHz) | 1900.000 |
| Relative permittivity (real part) | 40.86 |
| Conductivity (S/m) | 1.41 |
| Input power | 100mW |
| E-Field Probe | SN 27/15 EPGO262 |
| Crest factor | 1.0 |
| Conversion Factor | 2.01 |
| Sensor-Surface | 4mm |
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Variation (%) | -1.710000 |
| SAR 10g (W/Kg) | 1.984642 |
| SAR 1g (W/Kg) | 3.783156 |



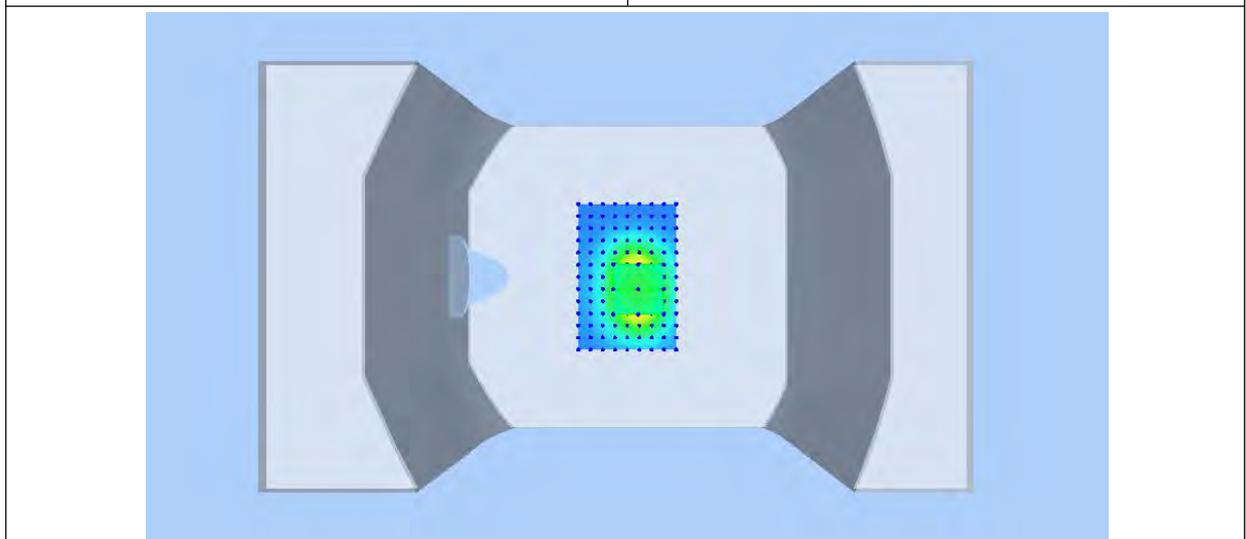
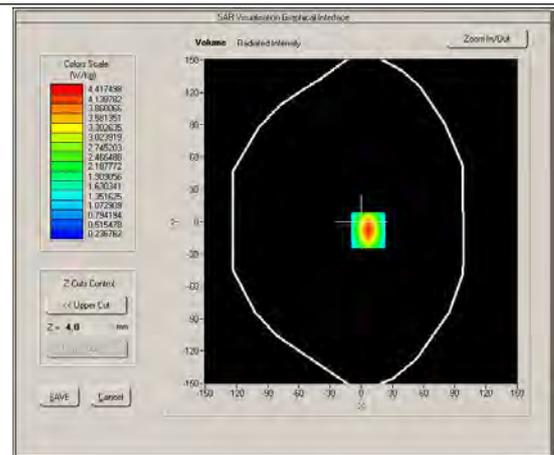
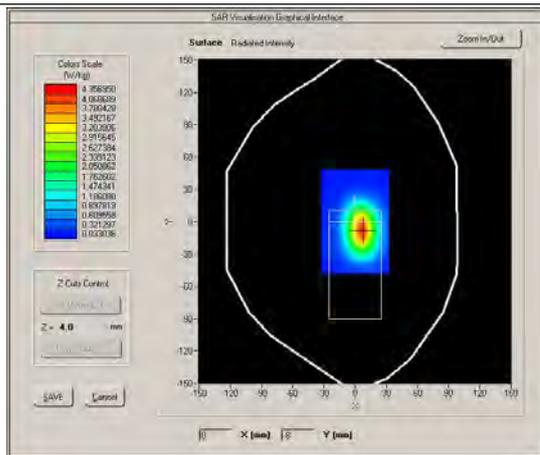
Product Description: Dipole

Model: SID1900

Test Date: Apr 25, 2018

Ambient Temperature: 22.5°C; Liquid Temperature: 21.3°C

| | |
|-----------------------------------|----------------------------|
| Medium(liquid type) | BL1900 |
| Frequency (MHz) | 1900.000 |
| Relative permittivity (real part) | 55.12 |
| Conductivity (S/m) | 1.54 |
| Input power | 100mW |
| E-Field Probe | SN 27/15 EPGO262 |
| Crest factor | 1.0 |
| Conversion Factor | 2.05 |
| Sensor-Surface | 4mm |
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Variation (%) | -1.670000 |
| SAR 10g (W/Kg) | 2.144192 |
| SAR 1g (W/Kg) | 4.161274 |



Appendix B. SAR Plots of SAR Measurement

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

Maximum SAR measurement Plots

1# GSM850_GPRS 12_Right Cheek_Ch251

DUT:180420W002

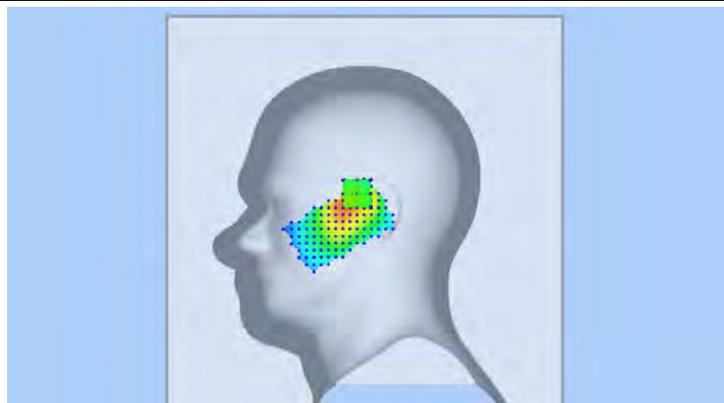
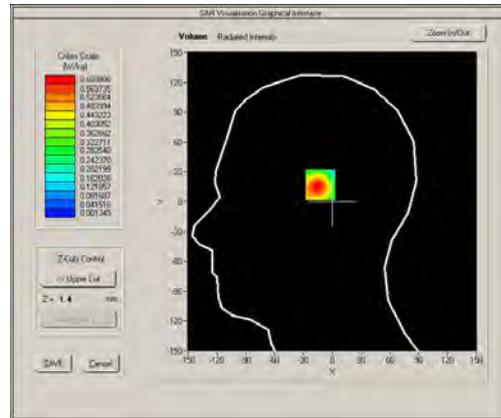
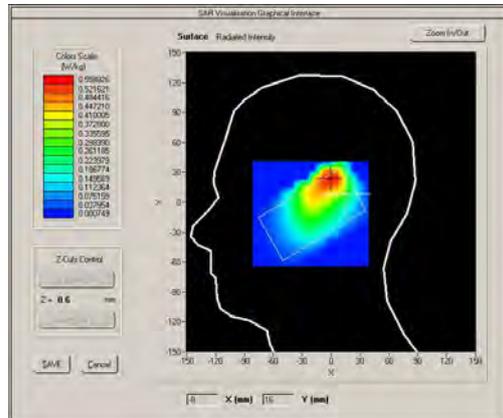
Test Date: Apr 24, 2018

Ambient Temperature: 22.7°C; Liquid Temperature: 21.5°C

| | |
|-----------------------------------|----------------------------|
| Medium(liquid type) | HL835 |
| Frequency (MHz) | 848.8 |
| Relative permittivity (real part) | 42.3 |
| Conductivity (S/m) | 0.91 |
| E-Field Probe | SN 27/15 EPGO262 |
| Crest factor | 2.0 |
| Conversion Factor | 1.74 |
| Sensor-Surface | 4mm |
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Variation (%) | -4.760000 |
| SAR 10g (W/Kg) | 0.318733 |
| SAR 1g (W/Kg) | 0.570045 |

SURFACE SAR

VOLUME SAR



2# GSM1900_GPRS12_Right Cheek_Ch512

DUT:180420W002

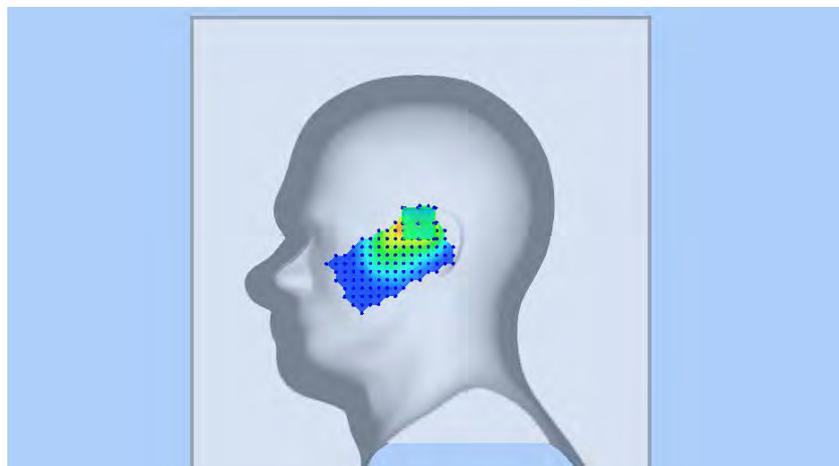
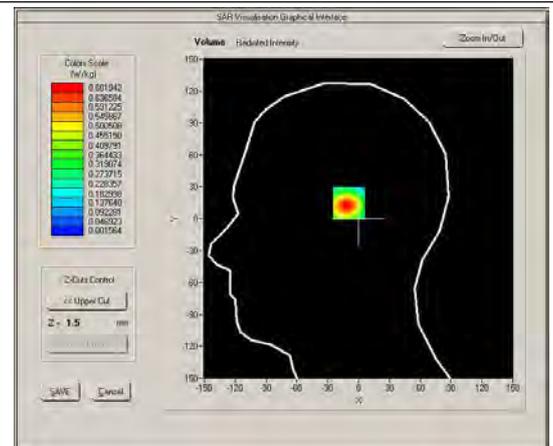
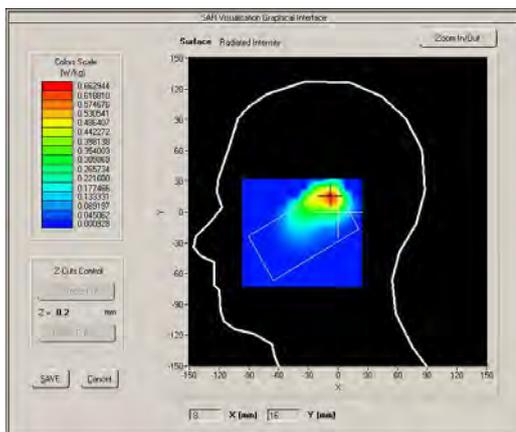
Test Date: Apr 25, 2018

Ambient Temperature: 22.5°C; Liquid Temperature: 21.3°C

| | |
|-----------------------------------|----------------------------|
| Medium(liquid type) | HL1900 |
| Frequency (MHz) | 1850.2 |
| Relative permittivity (real part) | 40.86 |
| Conductivity (S/m) | 1.41 |
| E-Field Probe | SN 27/15 EPGO262 |
| Crest factor | 2.0 |
| Conversion Factor | 2.01 |
| Sensor-Surface | 4mm |
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Variation (%) | -1.310000 |
| SAR 10g (W/Kg) | 0.305124 |
| SAR 1g (W/Kg) | 0.631552 |

SURFACE SAR

VOLUME SAR



3# WCDMA Band II _ RMC12.2K _ Right Cheek _ Ch9538

DUT:180420W002

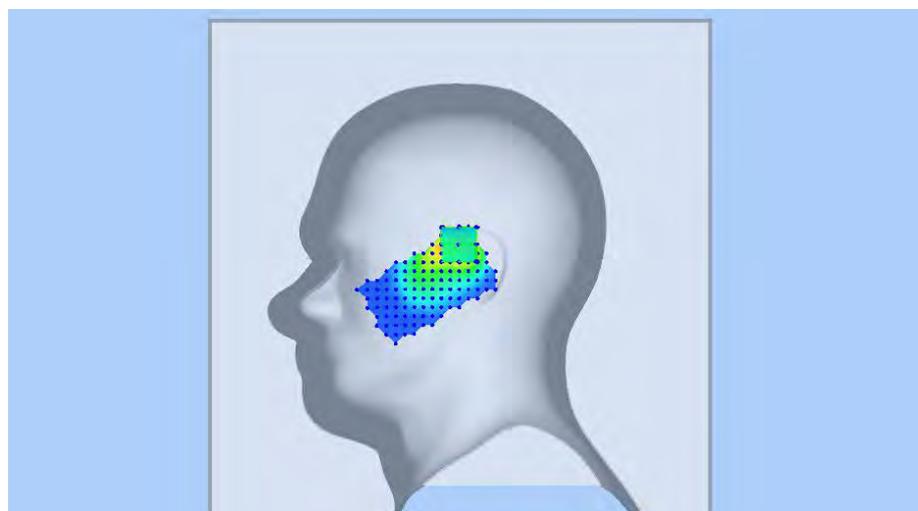
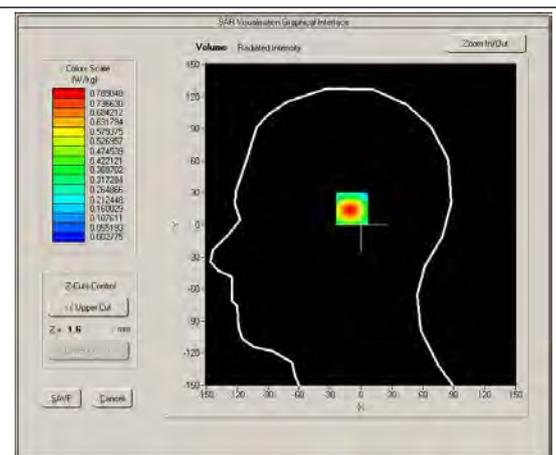
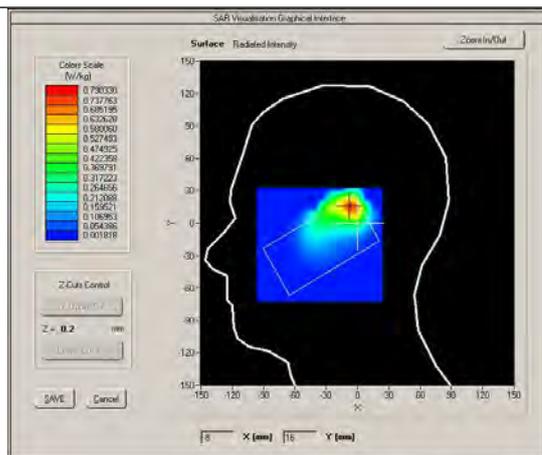
Test Date: Apr 25, 2018

Ambient Temperature: 22.5°C; Liquid Temperature: 21.3°C

| | |
|-----------------------------------|----------------------------|
| Medium(Liquid type) | HL1900 |
| Frequency (MHz) | 1907.6 |
| Relative permittivity (real part) | 40.86 |
| Conductivity (S/m) | 1.41 |
| E-Field Probe | SN 27/15 EPGO262 |
| Crest factor | 1.0 |
| Conversion Factor | 2.01 |
| Sensor-Surface | 4mm |
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Variation (%) | -4.200000 |
| SAR 10g (W/Kg) | 0.341372 |
| SAR 1g (W/Kg) | 0.720305 |

SURFACE SAR

VOLUME SAR



4# WCDMA Band V _ RMC12.2K _ Right Cheek _ Ch4233

DUT:180420W002

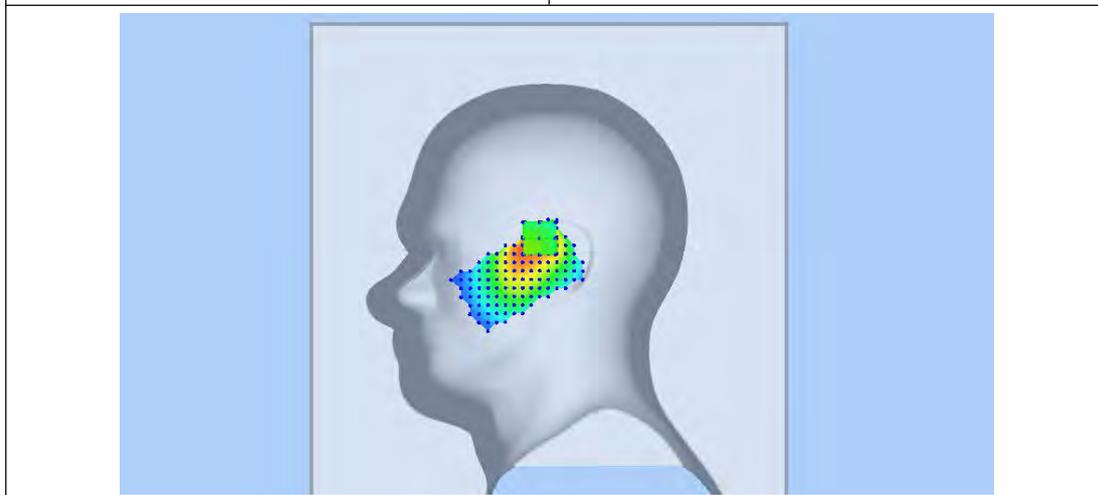
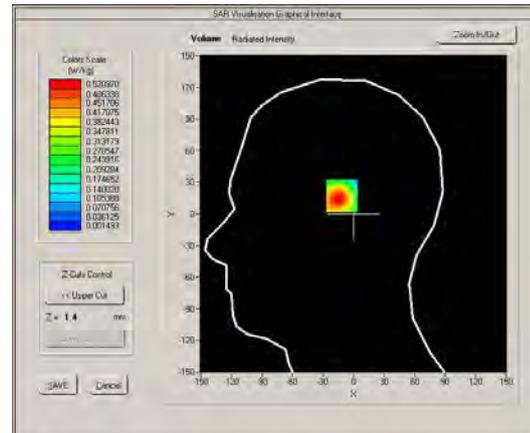
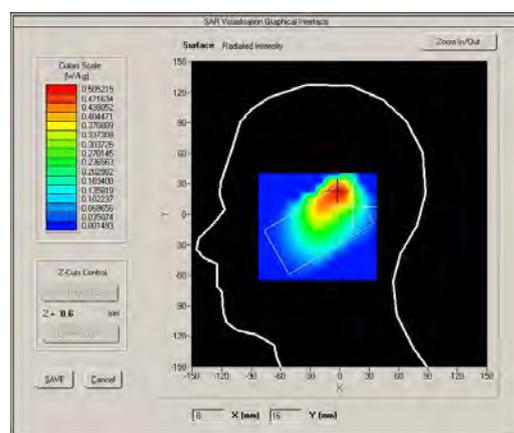
Test Date: Apr 24, 2018

Ambient Temperature: 22.7°C; Liquid Temperature: 21.5°C

| | |
|-----------------------------------|----------------------------|
| Medium(liquid type) | HL835 |
| Frequency (MHz) | 846.6 |
| Relative permittivity (real part) | 42.3 |
| Conductivity (S/m) | 0.91 |
| E-Field Probe | SN 27/15 EPGO262 |
| Crest factor | 1.0 |
| Conversion Factor | 1.74 |
| Sensor-Surface | 4mm |
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Variation (%) | -1.450000 |
| SAR 10g (W/Kg) | 0.272461 |
| SAR 1g (W/Kg) | 0.493577 |

SURFACE SAR

VOLUME SAR



6# GSM850_GPRS12_Rear Face_1.0cm_Ch251

DUT:180420W002

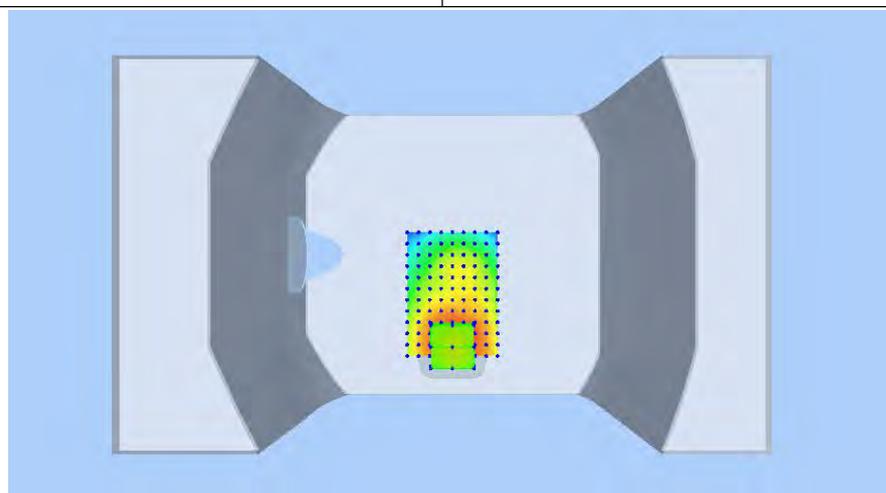
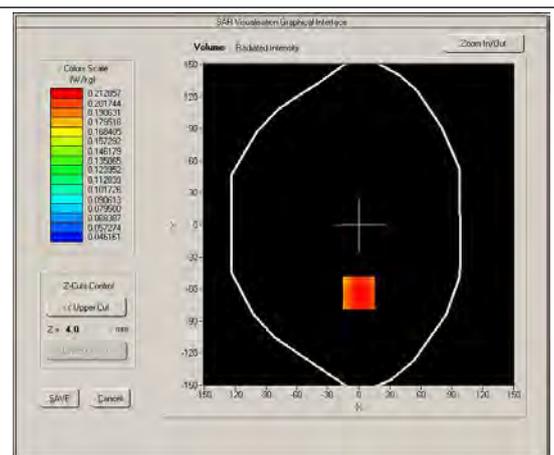
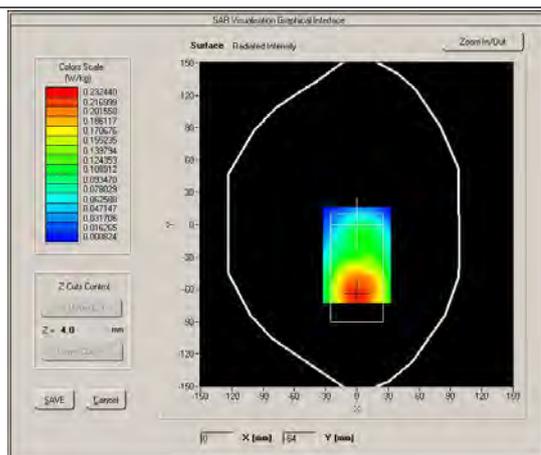
Test Date: Apr 24, 2018

Ambient Temperature: 22.7°C; Liquid Temperature: 21.5°C

| | |
|-----------------------------------|----------------------------|
| Medium(liquid type) | BL835 |
| Frequency (MHz) | 848.8 |
| Relative permittivity (real part) | 56.40 |
| Conductivity (S/m) | 0.95 |
| E-Field Probe | SN 27/15 EPGO262 |
| Crest factor | 2.0 |
| Conversion Factor | 1.81 |
| Sensor-Surface | 4mm |
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Variation (%) | 1.720000 |
| SAR 10g (W/Kg) | 0.148829 |
| SAR 1g (W/Kg) | 0.207160 |

SURFACE SAR

VOLUME SAR



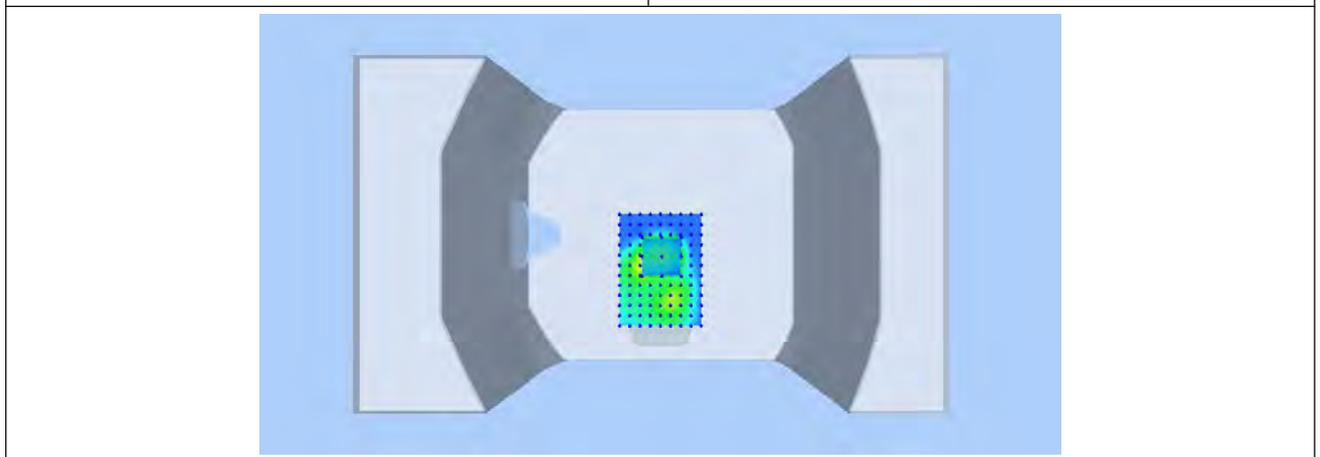
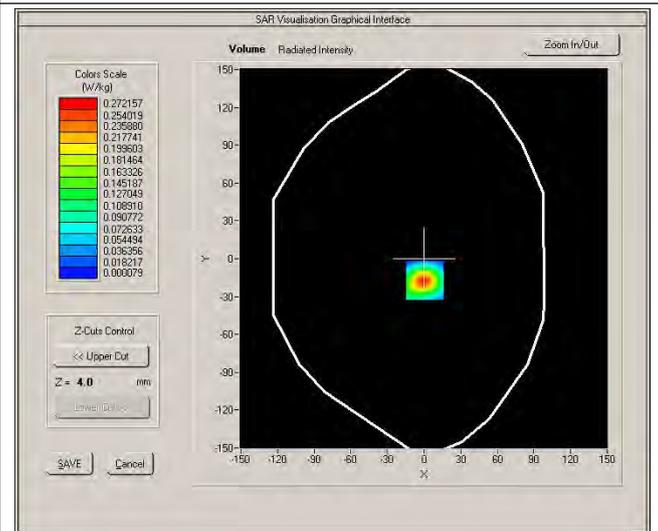
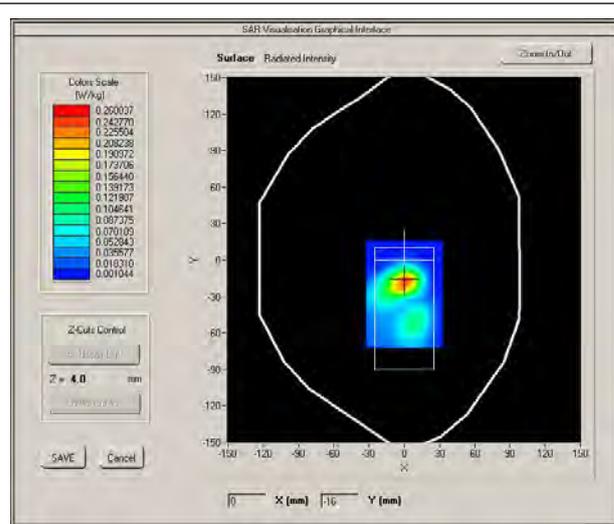
7# GSM1900_GPRS12_Rear Face_1.0cm_Ch512

DUT:180420W002

Test Date: Apr 25, 2018

Ambient Temperature: 22.5°C; Liquid Temperature: 21.3°C

| | |
|-----------------------------------|----------------------------|
| Medium(liquid type) | BL1900 |
| Frequency (MHz) | 1850.2 |
| Relative permittivity (real part) | 55.12 |
| Conductivity (S/m) | 1.54 |
| E-Field Probe | SN 27/15 EPGO262 |
| Crest factor | 2.0 |
| Conversion Factor | 2.05 |
| Sensor-Surface | 4mm |
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Variation (%) | -2.650000 |
| SAR 10g (W/Kg) | 0.096468 |
| SAR 1g (W/Kg) | 0.237258 |
| SURFACE SAR | VOLUME SAR |



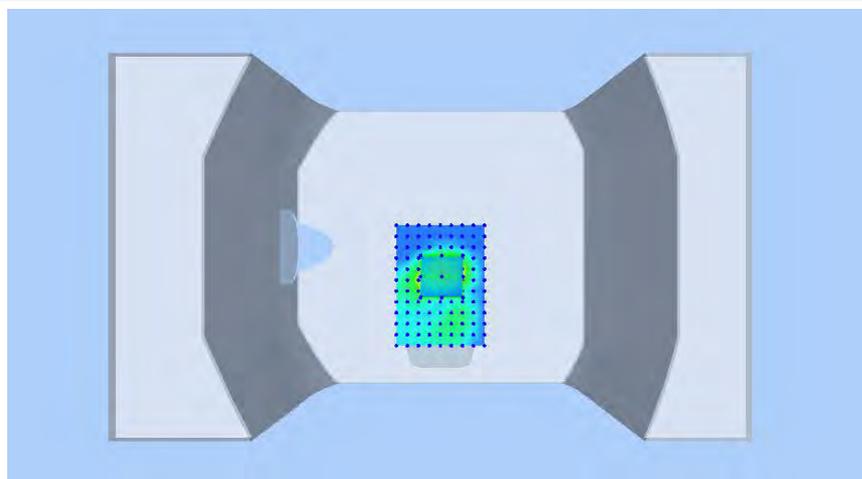
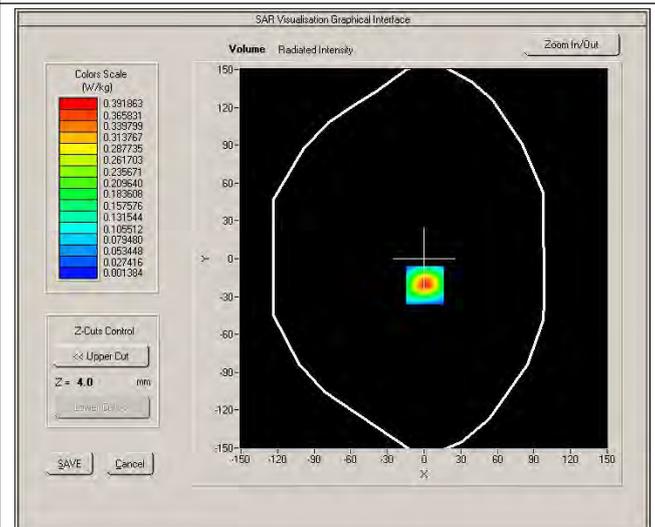
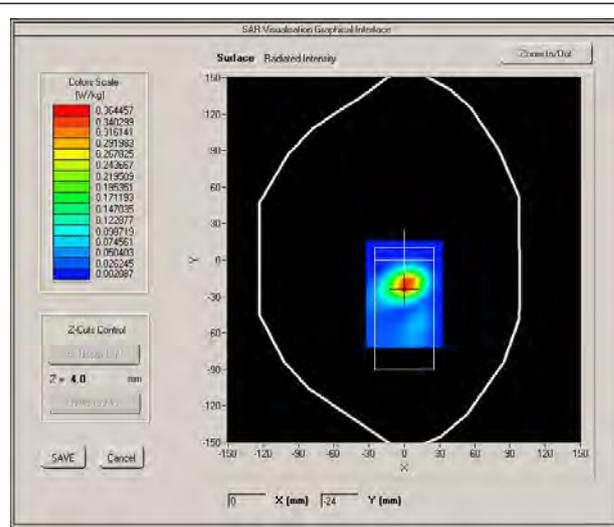
8# WCDMA Band II_RMC12.2K_Rear Face_1.0cm_Ch9538

DUT:180420W002

Test Date: Apr 25, 2018

Ambient Temperature: 22.5°C; Liquid Temperature: 21.3°C

| | |
|-----------------------------------|----------------------------|
| Medium(liquid type) | BL1900 |
| Frequency (MHz) | 1907.6 |
| Relative permittivity (real part) | 55.12 |
| Conductivity (S/m) | 1.54 |
| E-Field Probe | SN 27/15 EPGO262 |
| Crest factor | 1.0 |
| Conversion Factor | 2.05 |
| Sensor-Surface | 4mm |
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Variation (%) | 3.530000 |
| SAR 10g (W/Kg) | 0.140282 |
| SAR 1g (W/Kg) | 0.343585 |
| SURFACE SAR | VOLUME SAR |



9# WCDMA Band V_RMC12.2K_Rear Face_1.0cm_Ch4233

DUT:180420W002

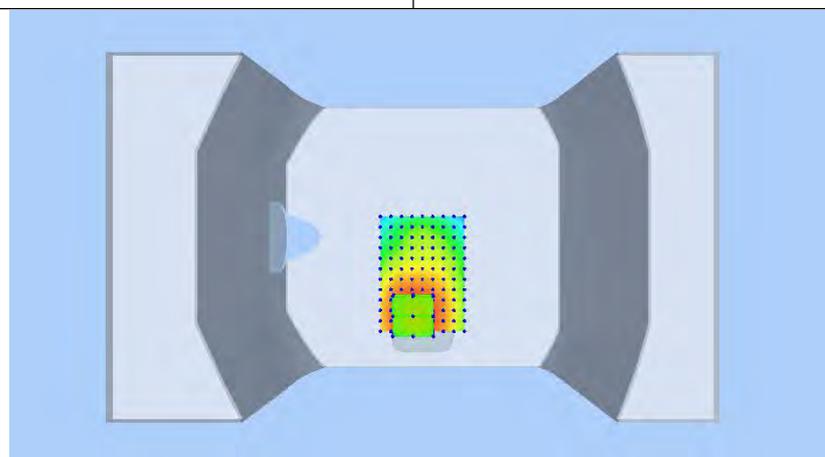
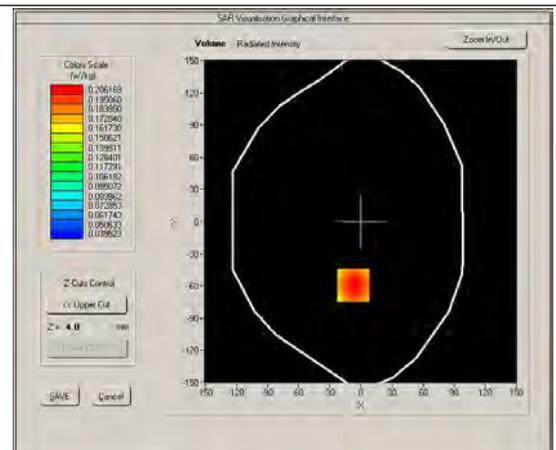
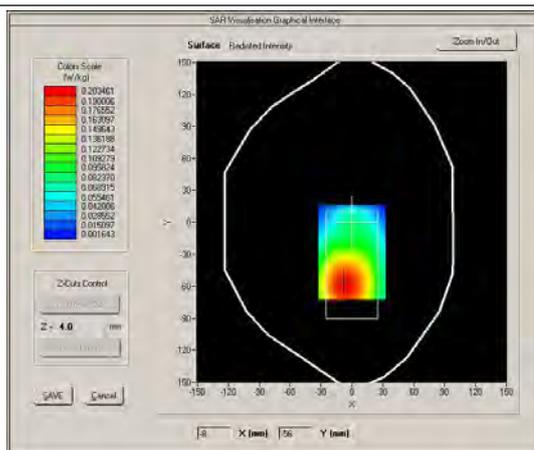
Test Date: Apr 24, 2018

Ambient Temperature: 22.7°C; Liquid Temperature: 21.5°C

| | |
|-----------------------------------|----------------------------|
| Medium(liquid type) | BL835 |
| Frequency (MHz) | 846.6 |
| Relative permittivity (real part) | 56.40 |
| Conductivity (S/m) | 0.95 |
| E-Field Probe | SN 27/15 EPGO262 |
| Crest factor | 1.0 |
| Conversion Factor | 1.81 |
| Sensor-Surface | 4mm |
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Variation (%) | -0.260000 |
| SAR 10g (W/Kg) | 0.134888 |
| SAR 1g (W/Kg) | 0.196699 |

SURFACE SAR

VOLUME SAR



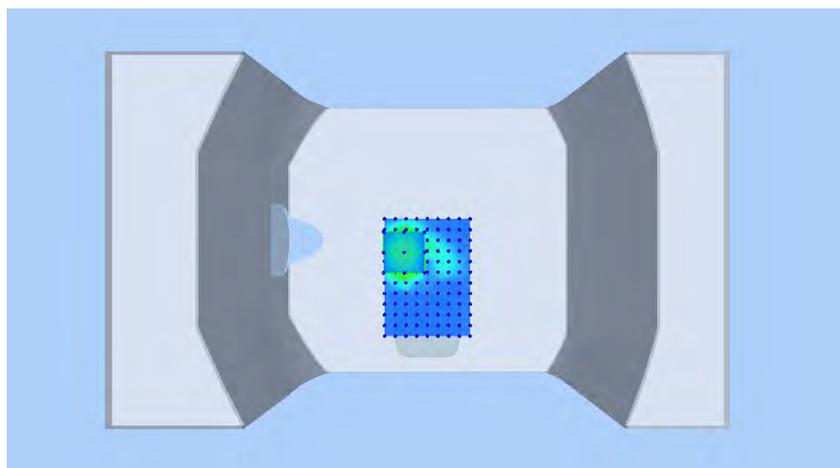
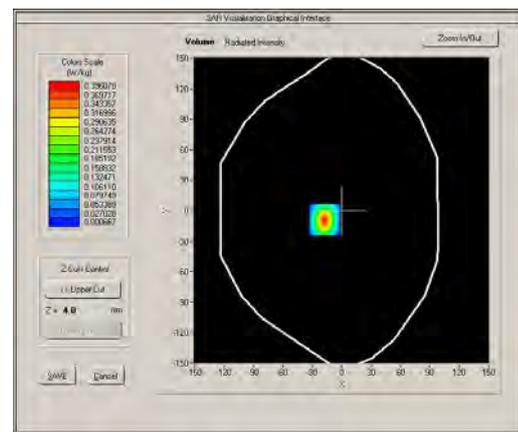
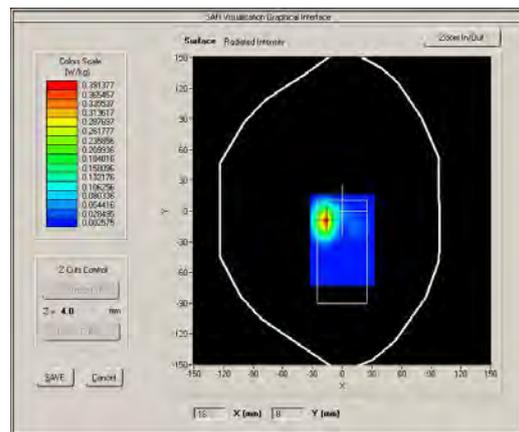
10# 802.11b_Rear Face_1cm_Ch 6

DUT:180420W002

Test Date: Apr 26, 2018

Ambient Temperature: 22.3°C; Liquid Temperature: 21.0°C

| | |
|-----------------------------------|----------------------------|
| Medium(liquid type) | BL_2450 |
| Frequency (MHz) | 2437 |
| Relative permittivity (real part) | 54.2 |
| Conductivity (S/m) | 1.93 |
| Crest factor | 1.0 |
| E-Field Probe | SN 27/15 EPGO262 |
| Conversion Factor | 2.12 |
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | 5x5x7,dx=5mm dy=5mm dz=4mm |
| Variation (%) | -1.780000 |
| SAR 10g (W/Kg) | 0.133856 |
| SAR 1g (W/Kg) | 0.340192 |





FCC SAR Test Report

Appendix C. Calibration Certificate for Probe and Dipole

The MVG calibration certificates are shown as follows.



COMOSAR E-Field Probe Calibration Report

Ref : ACR.264.3.16.SATU.A

**SIEMIC TESTING AND CERTIFICATION
SERVICES**

**ZONE A,FLOOR 1,BUILDING 2,WAN YE LONG
TECHNOLOGY PARK,SOUTH SIDE OF ZHOUSHI ROAD,
SHIYAN STREET,BAO'AN DISTRICT, SHENZHEN 518108 ,
GUANGDONG , P.R.C.**

**MVG COMOSAR DOSIMETRIC E-FIELD PROBE
SERIAL NO.: SN 27/15 EPGO262**

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



Calibration Date: 09/20/2016

Summary:

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



| | <i>Name</i> | <i>Function</i> | <i>Date</i> | <i>Signature</i> |
|----------------------|---------------|-----------------|-------------|----------------------|
| <i>Prepared by :</i> | Jérôme LUC | Product Manager | 9/20/2016 | <i>JS</i> |
| <i>Checked by :</i> | Jérôme LUC | Product Manager | 9/20/2016 | <i>JS</i> |
| <i>Approved by :</i> | Kim RUTKOWSKI | Quality Manager | 9/20/2016 | <i>Kim Rutkowski</i> |

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

| <i>Issue</i> | <i>Date</i> | <i>Modifications</i> |
|--------------|-------------|----------------------|
| A | 9/20/2016 | Initial release |
| | | |
| | | |
| | | |



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1 DEVICE UNDER TEST

| Device Under Test | |
|--|---|
| Device Type | COMOSAR DOSIMETRIC E FIELD PROBE |
| Manufacturer | MVG |
| Model | SSE2 |
| Serial Number | SN 27/15 EPGO262 |
| Product Condition (new / used) | Used |
| Frequency Range of Probe | 0.7 GHz-6GHz |
| Resistance of Three Dipoles at Connector | Dipole 1: R1=0.221 MΩ Dipole 2: R2=0.199 MΩ Dipole 3: R3=0.199 MΩ |

A yearly calibration interval is recommended.

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

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



Figure 1 – MVG COMOSAR Dosimetric E field Dipole

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

3 MEASUREMENT METHOD

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

3.1 LINEARITY

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



3.2 SENSITIVITY

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

3.3 LOWER DETECTION LIMIT

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

3.4 ISOTROPY

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

3.5 BOUNDARY EFFECT

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

4 MEASUREMENT UNCERTAINTY

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

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



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

5 CALIBRATION MEASUREMENT RESULTS

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

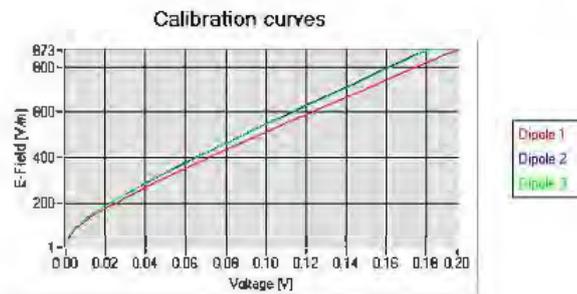
5.1 SENSITIVITY IN AIR

| Normx dipole 1 ($\mu\text{V}/(\text{V}/\text{m}^2)$) | Normy dipole 2 ($\mu\text{V}/(\text{V}/\text{m}^2)$) | Normz dipole 3 ($\mu\text{V}/(\text{V}/\text{m}^2)$) |
|--|--|--|
| 0.80 | 0.71 | 0.72 |

| DCP dipole 1 (mV) | DCP dipole 2 (mV) | DCP dipole 3 (mV) |
|-------------------|-------------------|-------------------|
| 92 | 90 | 91 |

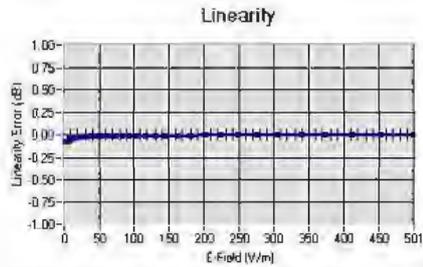
Calibration curves $e_i=f(V)$ ($i=1,2,3$) allow to obtain H-field value using the formula:

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





5.2 LINEARITY



Linearity $\pm 1.69\%$ ($\pm 0.07\text{dB}$)

5.3 SENSITIVITY IN LIQUID

| Liquid | Frequency (MHz +/- 100MHz) | Permittivity | Epsilon (S/m) | ConvF |
|--------|----------------------------|--------------|---------------|-------|
| HL750 | 750 | 40.03 | 0.93 | 1.57 |
| BL750 | 750 | 56.83 | 1.00 | 1.62 |
| HL850 | 835 | 42.19 | 0.90 | 1.74 |
| BL850 | 835 | 54.67 | 1.01 | 1.81 |
| HL900 | 900 | 42.08 | 1.01 | 1.67 |
| BL900 | 900 | 55.25 | 1.08 | 1.73 |
| HL1800 | 1800 | 41.68 | 1.46 | 1.81 |
| BL1800 | 1800 | 53.86 | 1.46 | 1.87 |
| HL1900 | 1900 | 38.45 | 1.45 | 2.01 |
| BL1900 | 1900 | 53.32 | 1.56 | 2.05 |
| HL2000 | 2000 | 38.26 | 1.38 | 1.86 |
| BL2000 | 2000 | 52.70 | 1.51 | 1.91 |
| HL2450 | 2450 | 37.50 | 1.80 | 2.04 |
| BL2450 | 2450 | 53.22 | 1.89 | 2.12 |
| HL2600 | 2600 | 39.80 | 1.99 | 2.05 |
| BL2600 | 2600 | 52.52 | 2.23 | 2.12 |
| HL3500 | 3500 | 38.21 | 2.98 | 2.02 |
| BL3500 | 3500 | 52.95 | 3.43 | 2.08 |
| HL5200 | 5200 | 35.64 | 4.67 | 1.51 |
| BL5200 | 5200 | 48.64 | 5.51 | 1.55 |
| HL5400 | 5400 | 36.44 | 4.87 | 1.56 |
| BL5400 | 5400 | 46.52 | 5.77 | 1.61 |
| HL5600 | 5600 | 36.66 | 5.17 | 1.55 |
| BL5600 | 5600 | 46.79 | 5.77 | 1.60 |
| HL5800 | 5800 | 35.31 | 5.31 | 1.44 |
| BL5800 | 5800 | 47.04 | 6.10 | 1.48 |

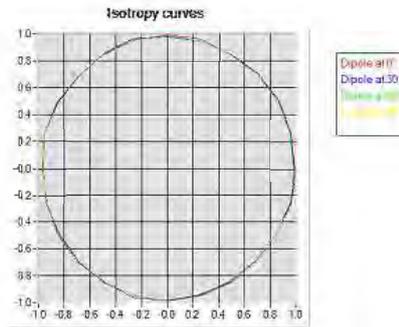
LOWER DETECTION LIMIT: 7mW/kg



5.4 ISOTROPY

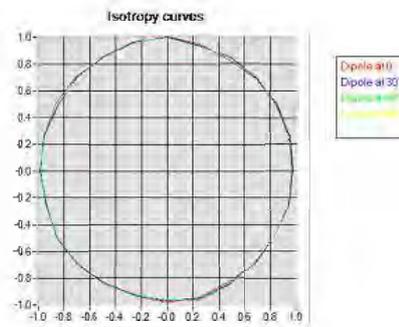
HL900 MHz

- Axial isotropy: 0.04 dB
- Hemispherical isotropy: 0.05 dB



HL1800 MHz

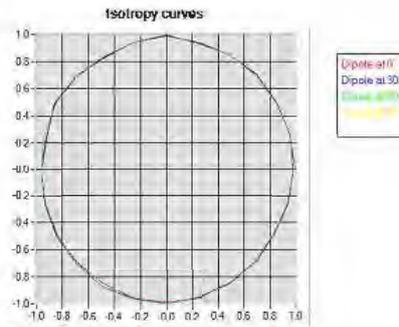
- Axial isotropy: 0.04 dB
- Hemispherical isotropy: 0.06 dB





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 | 10/2015 | 10/2016 |
| Multimeter | Keithley 2000 | 1188656 | 12/2013 | 12/2016 |
| Signal Generator | Agilent E4438C | MY49070581 | 12/2013 | 12/2016 |
| Amplifier | Aethercomm | SN 046 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter | HP E4418A | US38261498 | 12/2013 | 12/2016 |
| Power Sensor | HP ECP-E26A | US37181460 | 12/2013 | 12/2016 |
| 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.165.2.17.SATU.A

SIEMIC TESTING AND CERTIFICATION SERVICES

ZONE A,FLOOR 1,BUILDING 2,WAN YE LONG
TECHNOLOGY PARK,SOUTH SIDE OF ZHOUSHI ROAD,
SHIYAN STREET,BAO'AN DISTRICT, SHENZHEN 518108 ,
GUANGDONG , P.R.C.

MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 835 MHZ

SERIAL NO.: SN 18/11 DIP150

Calibrated at MVG US

2105 Barrett Park Dr. - Kennesaw, GA 30144



Calibration Date: 06/8/2017

Summary:

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



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

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

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



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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 835 MHz REFERENCE DIPOLE |
| Manufacturer | MVG |
| Model | SID835 |
| Serial Number | SN 18/11 DIPC150 |
| 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.

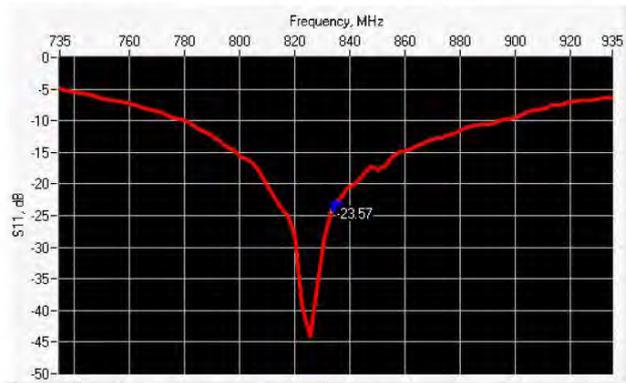
| Scan Volume | Expanded Uncertainty |
|-------------|----------------------|
| 1 g | 20.3 % |



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

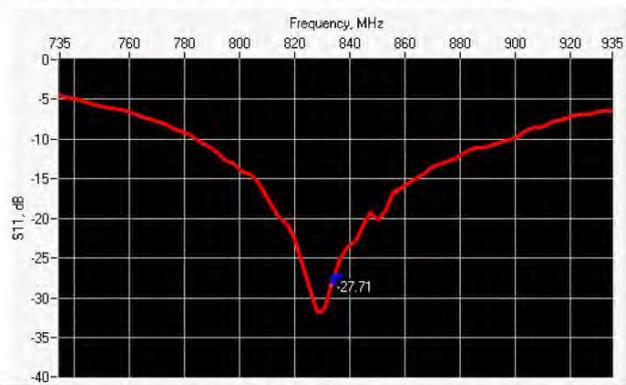
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|-----------------|------------------|------------------|-----------------|
| 835 | -23.57 | -20 | 57.0 Ω + 1.2 jΩ |

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|-----------------|------------------|------------------|-----------------|
| 835 | -27.71 | -20 | 52.9 Ω + 3.1 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 %. | PASS | 89.8 ±1 %. | PASS | 3.6 ±1 %. | PASS |
| 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 % | | 0.89 ±5 % | |
| 835 | 41.5 ±5 % | PASS | 0.90 ±5 % | PASS |
| 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 % | |

Page: 7/11

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| | | | | |
|------|-----------|--|-----------|--|
| 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 % | |

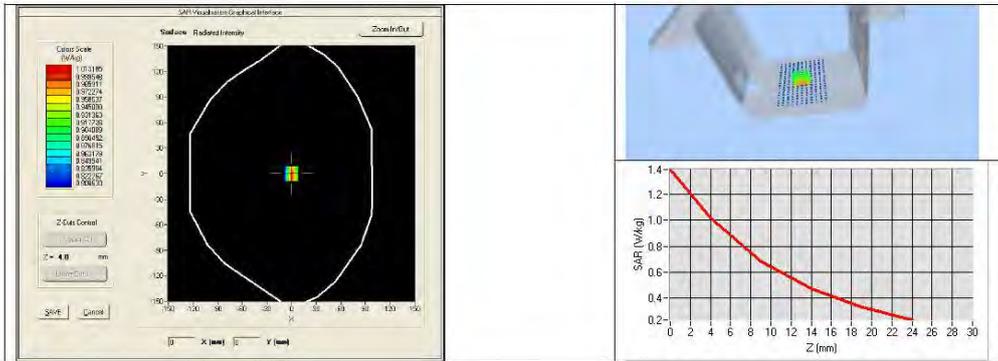
7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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 : 0.90 |
| 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 | 835 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 | 9.64 (0.96) | 6.22 | 6.20 (0.62) |
| 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 % | | 0.96 ±5 % | |
| 835 | 55.2 ±5 % | PASS | 0.97 ±5 % | PASS |
| 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 % | |

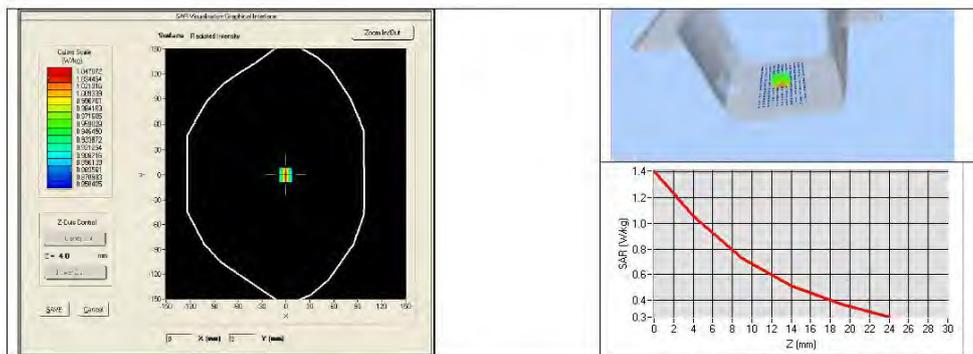


| | | | | |
|------|------------|--|------------|--|
| 2300 | 52.9 ±5 % | | 1.81 ±5 % | |
| 2450 | 52.7 ±5 % | | 1.95 ±5 % | |
| 2600 | 52.5 ±5 % | | 2.16 ±5 % | |
| 3000 | 52.0 ±5 % | | 2.73 ±5 % | |
| 3500 | 51.3 ±5 % | | 3.31 ±5 % | |
| 3700 | 51.0 ±5 % | | 3.55 ±5 % | |
| 5200 | 49.0 ±10 % | | 5.30 ±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' : 57.5 sigma : 0.96 |
| 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 | 835 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 |
| 835 | 9.96 (1.00) | 6.53 (0.65) |





8 LIST OF EQUIPMENT

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



SAR Reference Dipole Calibration Report

Ref : ACR.165.5.17.SATU.A

SIEMIC TESTING AND CERTIFICATION SERVICES

ZONE A,FLOOR 1,BUILDING 2,WAN YE LONG
TECHNOLOGY PARK,SOUTH SIDE OF ZHOUSHI ROAD,
SHIYAN STREET,BAO'AN DISTRICT, SHENZHEN 518108 ,
GUANGDONG , P.R.C.

MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 1900 MHZ
SERIAL NO.: SN 18/11 DIPG153

Calibrated at MVG US

2105 Barrett Park Dr. - Kennesaw, GA 30144



Calibration Date: 06/8/2017

Summary:

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



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

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

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



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8 List of Equipment 11



1 INTRODUCTION

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

2 DEVICE UNDER TEST

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

A yearly calibration interval is recommended.

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

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



Figure 1 – MVG COMOSAR Validation Dipole



4 MEASUREMENT METHOD

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

4.1 RETURN LOSS REQUIREMENTS

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

4.2 MECHANICAL REQUIREMENTS

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

5 MEASUREMENT UNCERTAINTY

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

5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

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

5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

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

5.3 VALIDATION MEASUREMENT

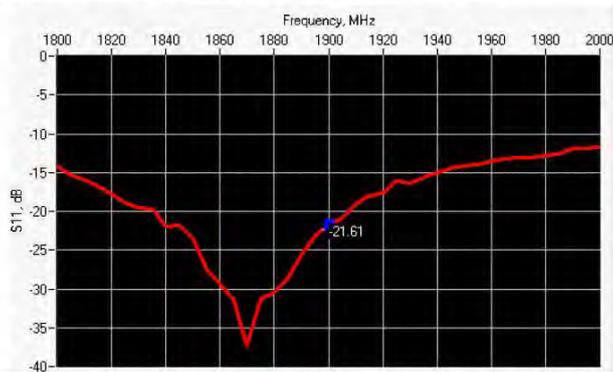
The guidelines outlined in the IEEE 1528, FCC KDBs, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

| Scan Volume | Expanded Uncertainty |
|-------------|----------------------|
| 1 g | 20.3 % |

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

6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



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

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



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

6.3 MECHANICAL DIMENSIONS

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



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

7 VALIDATION MEASUREMENT

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

7.1 HEAD LIQUID MEASUREMENT

| Frequency MHz | Relative permittivity (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

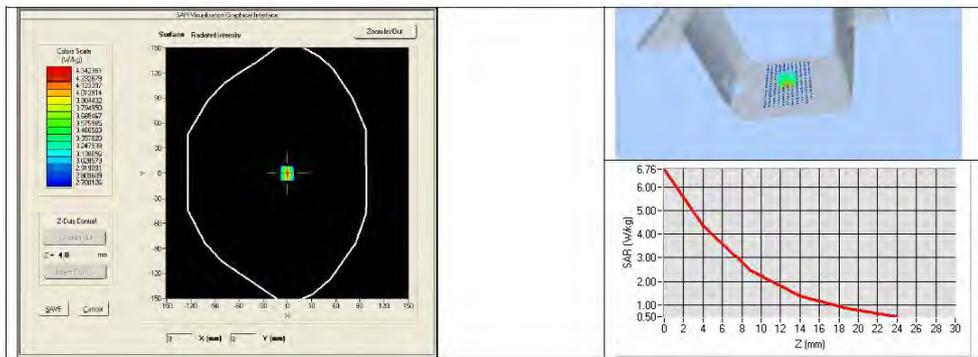
The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is 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 | 39.88 (3.99) | 20.5 | 20.52 (2.05) |
| 1950 | 40.5 | | 20.9 | |
| 2000 | 41.1 | | 21.1 | |
| 2100 | 43.6 | | 21.9 | |
| 2300 | 48.7 | | 23.3 | |
| 2450 | 52.4 | | 24 | |
| 2600 | 55.3 | | 24.6 | |
| 3000 | 63.8 | | 25.7 | |
| 3500 | 67.1 | | 25 | |
| 3700 | 67.4 | | 24.2 | |



7.3 BODY LIQUID MEASUREMENT

| Frequency MHz | Relative permittivity (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 % | PASS | 1.52 ±5 % | PASS |
| 2000 | 53.3 ±5 % | | 1.52 ±5 % | |
| 2100 | 53.2 ±5 % | | 1.62 ±5 % | |

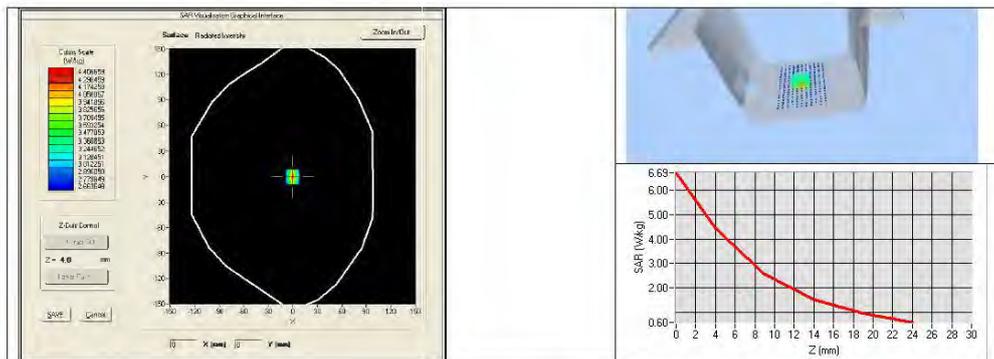


| | | | | |
|------|------------|--|------------|--|
| 2300 | 52.9 ±5 % | | 1.81 ±5 % | |
| 2450 | 52.7 ±5 % | | 1.95 ±5 % | |
| 2600 | 52.5 ±5 % | | 2.16 ±5 % | |
| 3000 | 52.0 ±5 % | | 2.73 ±5 % | |
| 3500 | 51.3 ±5 % | | 3.31 ±5 % | |
| 3700 | 51.0 ±5 % | | 3.55 ±5 % | |
| 5200 | 49.0 ±10 % | | 5.30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

7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

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

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





8 LIST OF EQUIPMENT

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



Appendix D. Photographs of EUT and Setup