# SAR TEST REPORT

For

Fujian Newland Auto-ID Tech Co.,Ltd.

Portable Data Collector

Model No.:NLS-MT65

| | | |
|---|---|---|
| Prepared for | : | Fujian Newland Auto-ID Tech Co.,Ltd. |
| Address | : | Newland Science & Technology Park, No.1 Rujiang West Rd,Mawei,Fuzhou, P.R.China |

| | | |
|---|---|---|
| Prepared by | : | Shenzhen LCS Compliance Testing Laboratory Ltd. |
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| | | |
|---|---|---|
| Date of receipt of test sample | : | September 01, 2015 |
| Number of tested samples | : | 1 |
| Serial number | : | Prototype |
| Date of Test | : | September 01, 2015 - September 16, 2015 |
| Date of Report | : | September 16, 2015 |

## SAR TEST REPORT

| | |
|---|---|
| **Report Reference No.................:** | **LCS1508191116E** |
| Date Of Issue...............................: | September 16, 2015 |
| **Testing Laboratory Name ........:** | **Shenzhen LCS Compliance Testing Laboratory Ltd.** |
| Address........................................: | 1/F., Xingyuan Industrial Park, Tongda Road, Bao'an Avenue, Bao'an District, Shenzhen, Guangdong, China |
| Testing Location/ Procedure .......: | Full application of Harmonised standards ■<br>Partial application of Harmonised standards □<br>Other standard testing method □ |
| **Applicant's Name......................:** | **Fujian Newland Auto-ID Tech Co.,Ltd.** |
| Address........................................: | Newland Science & Technology Park, No.1 Rujiang West Rd,Mawei,Fuzhou, P.R.China |
| **Test Specification:** | |
| Scaled SAR Max. Values is ........: | 0.361 W/Kg (1g) for Body, 0.340 W/Kg (1g) for Head. |
| TestStandard................................: | ANSI/IEEE C95.1:2005/ANSI/IEEE C95.3 :2002<br>IEEE1528 :2013/47CFR § 2.1093 |
| Test Report Form No. .................: | LCSEMC-1.0 |
| TRF Originator............................: | Shenzhen LCS Compliance Testing Laboratory Ltd. |



| | |
|---|---|
| **Test Item Description................:** | **Portable Data Collector** |
| Trade Mark.................................: | Newland |
| Model/Type Reference................: | NLS-MT65 |
| Ratings ........................................: | DC 3.7V by battery(3700mAh)<br>Adapter parameters: Input: AC 100~240V, 50/60Hz 0.35A<br>Output: DC 5V/2A |
| **Result .........................................:** | **Positive** |

| **Compiled by:** | **Supervised by:** | **Approved by:** |
|---|---|---|
| Dick Su/ File administrators | Glin Lu/ Technique principal | Gavin Liang/ Manager |

# SAR -- TEST REPORT

| | |
|---|---|
| **Test Report No. : LCS1508191116E** | September 16, 2015<br>Date of issue |

| | | |
|---|---|---|
| Type / Model......................... | : | NLS-MT65 |
| EUT...................................... | : | Portable Data Collector |
| **Applicant.............................** | **:** | **Fujian Newland Auto-ID Tech Co.,Ltd.** |
| Address................................. | : | Newland Science & Technology Park, No.1 Rujiang West Rd,Mawei,Fuzhou, P.R.China |
| Telephone............................. | : | 0591-83979235 |
| Fax........................................ | : | 0591-83979250 |
| **Manufacturer.......................** | **:** | **Fujian Newland Auto-ID Tech Co.,Ltd.** |
| Address................................. | : | Newland Science & Technology Park, No.1 Rujiang West Rd,Mawei,Fuzhou, P.R.China |
| Telephone............................. | : | 0591-83979235 |
| Fax........................................ | : | 0591-83979250 |
| **Factory.................................** | **:** | **Fujian Newland Auto-ID Tech Co.,Ltd.** |
| Address................................. | : | Newland Science & Technology Park, No.1 Rujiang West Rd,Mawei,Fuzhou, P.R.China |
| Telephone............................. | : | 0591-83979235 |
| Fax........................................ | : | 0591-83979250 |

| **Test Result** | **Positive** |
|---|---|

The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

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# 1.TEST STANDARDS AND TEST DESCRIPTION

## 1.1. Test Standards

The tests were performed according to following standards:

ANSI/IEEE C95.1: 2005:IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fileds,3 kHz to 300 GHz.
ANSI/IEEE C95.3: 2002:IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to SuchFields,100 kHz—300 GHz.
IEEE1528:2013:Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate.
KDB447498 D01v05r02:General RF Exposure Guidance.
KDB865664 D01v01r03:SAR measurement 100MHz to 6GHz.
KDB865664 D02v01r01:SAR Report.
KDB690783 D01v01r03:SAR lisitings on Grants.
KDB648474 D04:SAR Handsets Multi Xmiter and Ant v01
FCC Part 2:2012: frequency alloca-tions and radio treaty mat-ters; general rules and reg-ulations

## 1.2. Test Description

The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power .
And Test device is identical prototype.

## 1.3. Product Description

| | |
|---|---|
| Product Name: | Portable Data Collector |
| Trade Mark: | Newland |
| Model/Type reference: | NLS-MT65 |
| Listed Model(s): | NLS-MT65 |
| Hardware Version | V1.0 |
| Software Version: | V1.0 |
| Power supply: | DC 3.7V by battery(3700mAh)<br>Adapter parameters: Input: AC 100~240V, 50/60Hz 0.35A<br>Output: DC 5V/2A |
| 2G | |
| Operation Band: | GSM850, PCS1900 |
| Supported type: | GSM/GPRS |
| Power Class: | GSM850:Power Class 5<br>DCS1900:Power Class 0 |
| Modulation Type: | GMSK for GSM/GPRS |
| GSM Release Version | R99 |
| GPRS Multislot Class | 12 |
| EGPRS Multislot Class | 12 |

## 1.4. Summary SAR Results

Table 1:Max. SAR Measured(1g)

| Exposure Configuration | Technolohy Band | Highest Measured SAR 1g(W/Kg) |
|---|---|---|
| Head | GSM850 | **0.336** |
| | PCS1900 | **0.033** |
| Body-worn | GSM850 | **0.351** |
| | PCS1900 | **0.143** |

The SAR values found for the Mobile Phone are below the maximum recommended levels of 1.6W/Kg as averaged over any 1g tissue accordintg to the ANSI C95.1-1999.
For body worn operation,this devices has been tested and meets FCC RF exposure guidelines when used with any accessory that conrtains no metal and which provides a minimum separation distance of 0mm between this devices and the body of the user.User of other accessories may not ensure compliance with FCC RF exposure guidelines.
The EUT battery must be fully charged and checked periodically during the test to ascertain iniform power output

## 1.5. EUT operation mode

The EUT has been tested under typical operating condition and The Transmitter was operated in the normal operating mode. The TX frequency was fixed which was for the purpose of the measurements.

## 1.6. EUT configuration

**The following peripheral devices and interface cables were connected during the measurement:**

● - supplied by the manufacturer

○ - supplied by the lab

| | | | |
|---|---|---|---|
| ○ | Power Cable | Length (m) : | / |
| | | Shield : | / |
| | | Detachable : | / |
| ○ | Multimeter | Manufacturer : | / |
| | | Model No. : | / |

# 2.TEST ENVIRONMENT

## 2.1. Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

Site Description

EMC Lab. : CNAS Registration Number. is L4595.
FCC Registration Number. is 899208.
Industry Canada Registration Number. is 9642A-1.
VCCI Registration Number. is C-4260 and R-3804.
ESMD Registration Number. is ARCB0108.
UL Registration Number. is 100571-492.
TUV SUD Registration Number. is SCN1081.
TUV RH Registration Number. is UA 50296516-001

## 2.2. Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

| | |
|---|---|
| Temperature: | 18-25 ° C |
| | |
| Humidity: | 40-65 % |
| | |
| Atmospheric pressure: | 950-1050mbar |

## 2.3. SAR Limits

FCC Limit (1g Tissue)

| EXPOSURE LIMITS | SAR (W/kg) | |
|---|---|---|
| | (General Population / Uncontrolled Exposure Environment) | (Occupational / Controlled Exposure Environment) |
| Spatial Average(averaged over the whole body) | 0.08 | 0.4 |
| Spatial Peak(averaged over any 1 g of tissue) | 1.6 | 8.0 |
| Spatial Peak(hands/wrists/ feet/anklesaveraged over 10 g) | 4.0 | 20.0 |

Population/Uncontrolled Environments are defined as locations where there is the exposure of individual who have no knowledge or control of their exposure.
Occupational/Controlled Environments are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure (i.e. as a result of employment or occupation).

## 2.4. Equipments Used during the Test

| Test Equipment | Manufacturer | Type/Model | Serial Number | Calibration | |
|---|---|---|---|---|---|
| | | | | Calibration Date | Calibration Due |
| PC | Lenovo | G5005 | MY42081102 | N/A | N/A |
| Signal Generator | Angilent | E4438C | MY42081396 | 09/25/2014 | 09/24/2015 |
| Multimeter | Keithley | MiltiMeter 2000 | 4059164 | 10/01/2014 | 09/30/2015 |
| S-parameter Network Analyzer | Agilent | 8753ES | US38432944 | 09/25/2014 | 09/24/2015 |
| Wireless Communication Test Set | R & S | CMU200 | 105988 | 06/18/2015 | 06/17/2016 |
| Power Meter | R&S | NRVS | 100444 | 06/18/2015 | 06/17/2016 |
| Power Meter | R&S | NRVS | 100469 | 06/18/2015 | 06/17/2016 |
| Power Sensor | R&S | NRV-Z51 | 100458 | 06/18/2015 | 06/17/2016 |
| Power Sensor | R&S | NRV-Z32 | 100657 | 06/18/2015 | 06/17/2016 |
| E-Field PROBE | SATIMO | SSE5 | SN 17/14 EP220 | 10/01/2014 | 09/30/2015 |
| E-Field PROBE | SATIMO | SSE5 | SN 17/14 EP221 | 09/01/2014 | 08/31/2015 |
| DIPOLE 835 | SATIMO | SID 835 | SN 07/14 DIP 0G835-303 | 10/01/2014 | 09/30/2015 |
| DIPOLE 900 | SATIMO | SID 900 | SN 07/14 DIP 0G900-300 | 10/01/2014 | 09/30/2015 |
| DIPOLE 1900 | SATIMO | SID 1900 | SN 30/14 DIP 1G900-333 | 09/01/2014 | 08/31/2015 |
| DIPOLE 2450 | SATIMO | SID 2450 | SN 07/14 DIP 2G450-306 | 10/01/2014 | 09/30/2015 |
| COMOSAR OPEN Coaxial Probe | SATIMO | OCPG 68 | SN 40/14 OCPG68 | 10/01/2014 | 09/30/2015 |
| Communication Antenna | SATIMO | ANTA57 | SN 39/14 ANTA57 | 10/01/2014 | 09/30/2015 |
| Mobile Phone POSITIONING DEVICE | SATIMO | MSH98 | SN 40/14 MSH98 | N/A | N/A |
| DUMMY PROBE | SATIMO | DP60 | SN 03/14 DP60 | N/A | N/A |
| SAM PHANTOM | SATIMO | SAM117 | SN 40/14 SAM117 | N/A | N/A |
| Simulated Tissue 900 MHzBody and Head | SATIMO | SAM-9-H | SN 21/14 HLD438 | Each Time | N/A |
| Simulated Tissue 1900 MHz For Head | SATIMO | SAM-18-H | SN 21/14 HLF439 | Each Time | N/A |
| Simulated Tissue 2450 MHz Body and Head | SATIMO | SAM-24-H | SN 21/14 HLJ445 | Each Time | N/A |
| PHANTOM TABLE | SATIMO | TABP98 | SN 40/14 TABP98 | N/A | N/A |
| 6 AXIS ROBOT | KUKA | KR6-R900 | 501217 | N/A | N/A |
| High Power Solid State Amplifier (80MHz~1000MHz) | Instruments for Industry | CMC150 | M631-0627 | 09/25/2014 | 09/24/2015 |
| Medium Power Solid State Amplifier (0.8~4.2GHz) | Instruments for Industry | S41-25 | M629-0539 | 09/25/2014 | 09/24/2015 |
| Wave Tube Amplifier 48 GHz at 20Watt | Hughes Aircraft Company | 1277H02F000 | 102 | 09/25/2014 | 09/24/2015 |

# 3.SAR MEASUREMENTS SYSTEM CONFIGURATION

## 3.1. SARMeasurement Set-up

The OPENSAR system for performing compliance tests consist of the following items:

A standard high precision 6-axis robot (KUKA) with controller and software.

KUKA Control Panel (KCP)

A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with a Video Positioning System(VPS).

The stress sensor is composed with mechanical and electronic when the electronic part detects a change on the electro-mechanical switch,It sends an “Emergency signal” to the robot controller that to stop robot’s moves

A computer operating Windows XP.

OPENSAR software

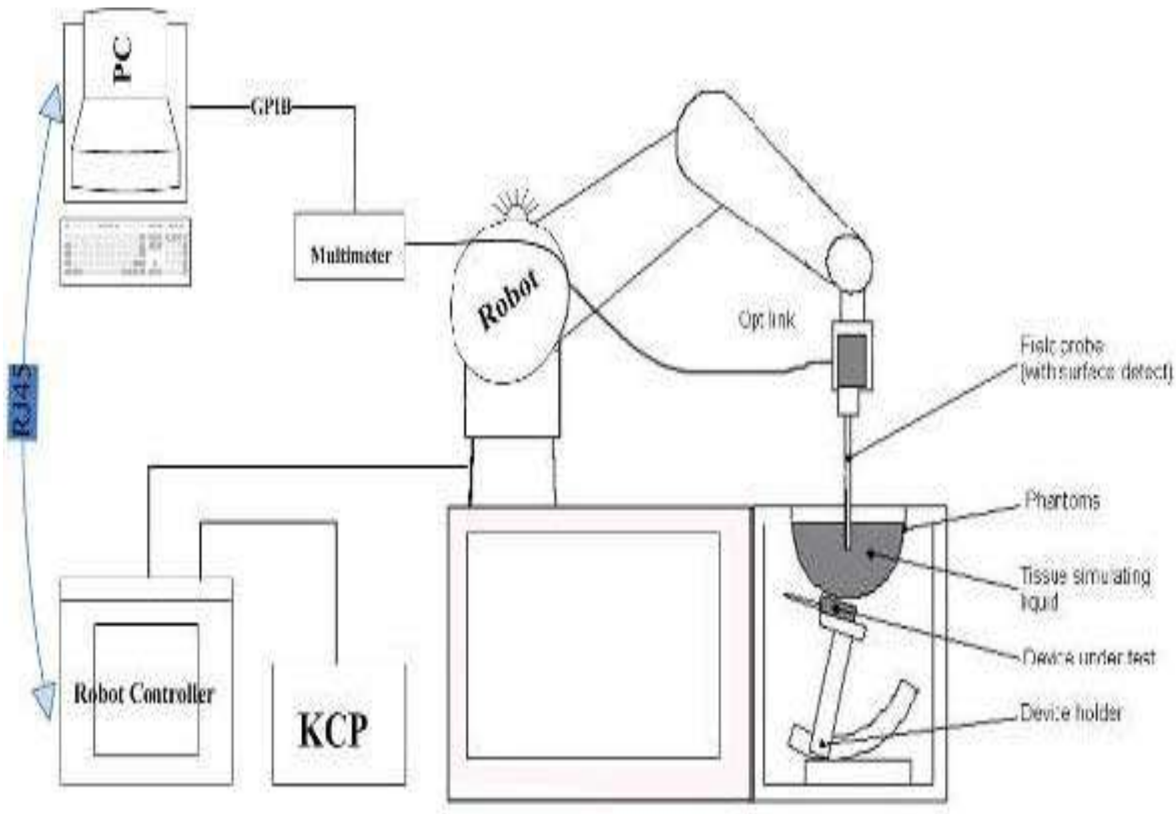
Remote control with teaches pendant and additional circuitry for robot safety such as warning lamps, etc.

The SAM phantom enabling testing left-hand right-hand and body usage.

The Position device for handheld EUT

Tissue simulating liquid mixed according to the given recipes .

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



## 3.2. OPENSAR E-field Probe System

The SAR measurements were conducted with the dosimetric probe EP220 (manufactured by SATIMO), designed in the classical triangular configuration and optimized for dosimetric evaluation.

Probe Specification

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

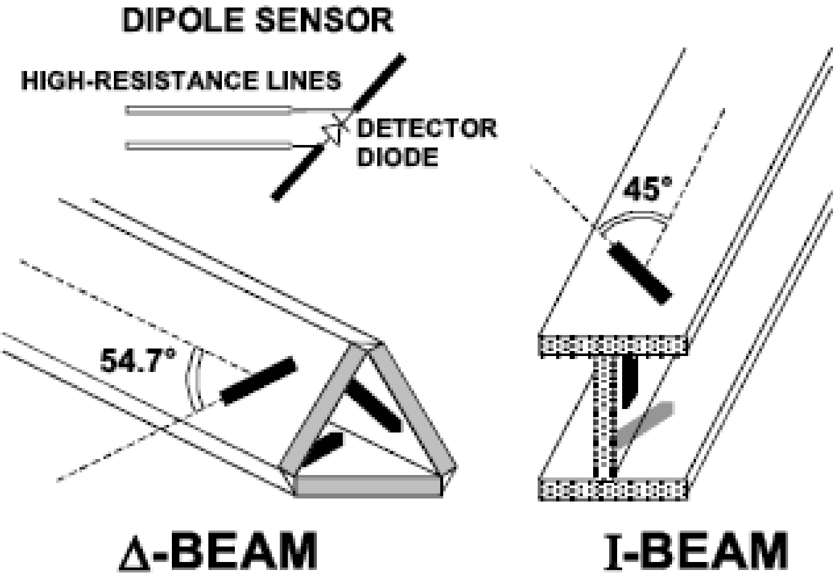
CalibrationISO/IEC 17025 calibration service available.

| | |
|---|---|
| Frequency | 700 MHz to 3 GHz;<br>Linearity:0.25dB(700 MHz to 3GHz) |
| Directivity | 0.25 dB in HSL (rotation around probe axis)<br>0.5 dB in tissue material (rotation normal to probe axis) |
| Dynamic Range | 0.01W/kg to > 100 W/kg;<br>Linearity: 0.25 dB |
| Dimensions | Overall length: 330 mm (Tip: 16mm)<br>Tip diameter: 5 mm (Body: 8 mm)<br>Distance from probe tip to sensor centers: 2.5 mm |
| Application | General dosimetry up to 3 GHz<br>Dosimetry in strong gradient fields<br>Compliance tests of Mobile Phones |

Isotropic E-Field Probe

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

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



## 3.3. Phantoms

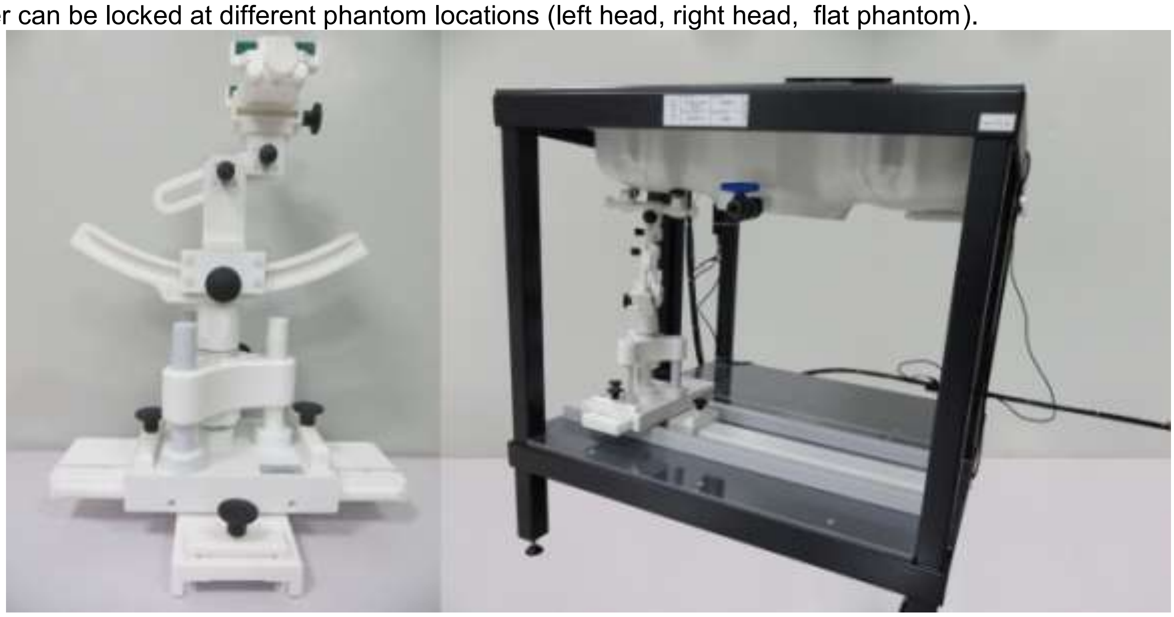
The SAM Phantom SAM117 is constructed of a fiberglass shell ntegrated in a wooden table. The shape of the shell is in compliance with the specification set in IEEE P1528 and CENELEC EN62209-1 , EN62209-2:2010.The phantom enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents the evaporation of the liquid. Reference markings on the Phantom allow the complete setup of allpredefined phantom positions and measurement grids by manually teaching three points in the robo

System checking was performed using the flat section, whilst Head SAR tests used the left and right head profile sections. Body SAR testing also used the flat section between the head profiles.

SAM Twin Phantom

## 3.4. Device Holder

In combination with the Generic Twin PhantomSAM117, the Mounting Device enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation points is the ear opening. The devices can be easily, accurately, and repeatedly positioned according to the FCC and CENELEC specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).



Device holder supplied by SATIMO

## 3.5. Scanning Procedure

**The procedure for assessing the peak spatial-average SAR value consists of the following steps**

Power Reference Measurement
The referenceand drift jobs are useful jobs for monitoring the power drift of the device under test in the batch process. Both jobs measure the field at a specified reference position, at a selectable distance from the phantom surface. The reference position can be either the selected section's grid reference point or a user point in this section. The reference job projects the selected point onto the phantom surface, orients the probe perpendicularly to the surface, and approaches the surface using the selected detection method.

Area Scan
The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a finer measurement around the hot spot.Thesophisticated interpolation routines implemented in OPENSAR software can find the maximum locations even in relatively coarse grids. The scan area is defined by an editable grid. This grid is anchored at the grid reference point of the selected section in the phantom. When the area scan's property sheet is brought-up, grid was at to 15 mm by 15 mm and can be edited by a user.

Zoom Scan
Zoom scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default zoom scan measures 7 x 7 x 7 points within a cube whose base faces are centered around the maximum found in a preceding area scan job within the same procedure. If the preceding Area Scan job indicates more then one maximum, the number of Zoom Scans has to be enlarged accordingly (The default number inserted is 1).

Power Drift measurement
The drift job measures the field at the same location as the most recent reference job within the same procedure, and with the same settings. The drift measurement gives the field difference in dB from the reading conducted within the last reference measurement. Several drift measurements are possible for one reference measurement. This allows a user to monitor the power drift of the device under test within a batch process. In the properties of the Drift job, the user can specify a limit for the drift and have OPENSAR software stop the measurements if this limit is exceeded.

## 3.6. Data Storage and Evaluation

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

The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [mW/g], [mW/cm²], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

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

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

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

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

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

With Vi = compensated signal of channel i ( i = x, y, z )
Ui = input signal of channel i ( i = x, y, z )
cf = crest factor of exciting field
dcpi = diode compression point

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

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

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

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

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

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

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

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

with SAR = local specific absorption rate in mW/g
Etot = total field strength in V/m
σ = conductivity in [mho/m] or [Siemens/m]
ρ = equivalent tissue density in g/cm3

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

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

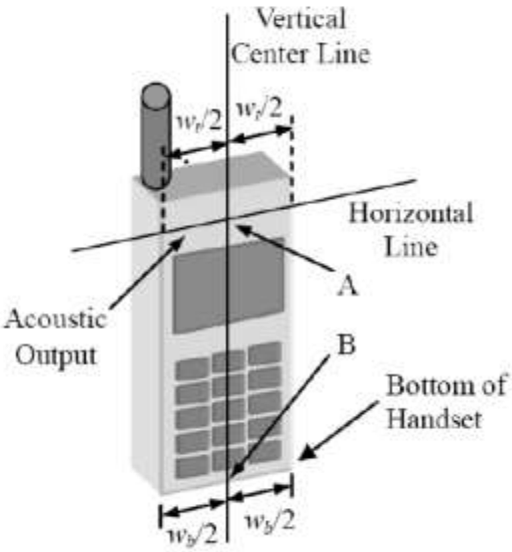
**General considerations**

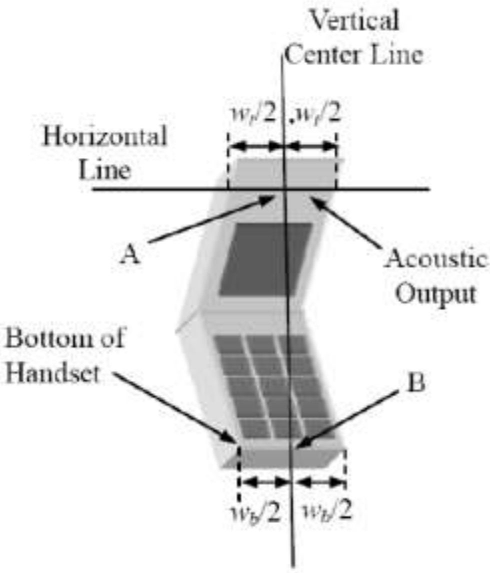
This standard specifies two handset test positions against the head phantom – the “cheek” position and the “tilt” position.

The power flow density is calculated assuming the excitation field as a free space field

$$P_{(\text{pwe})} = \frac{E_{tot}^2}{3770} \text{ or } P_{(\text{pwe})} = H_{tot}^2 \cdot 37.7$$

Where $P_{pwe}$=Equivalent power density of a plane wave in mW/cm2
$E_{tot}$=total electric field strength in V/m
$H_{tot}$=total magnetic field strength in A/m



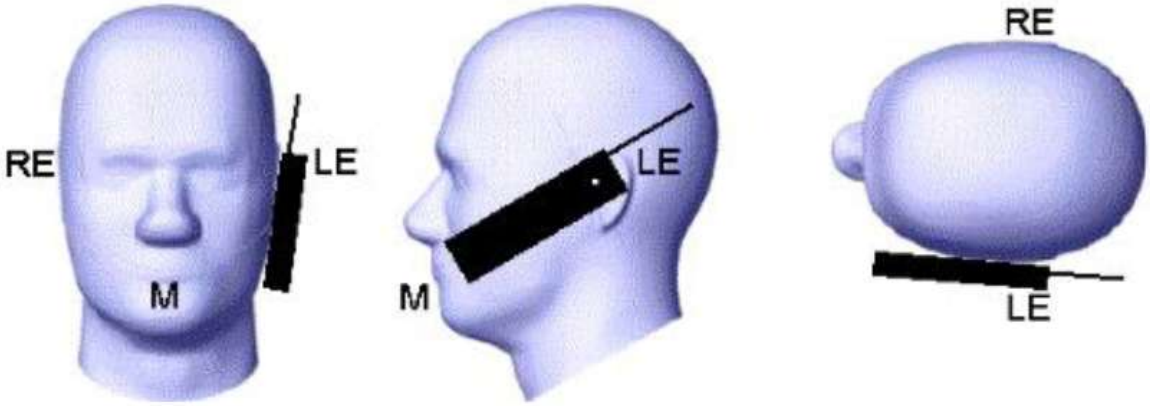

$W_t$ Width of the handset at the level of the acoustic

$W_b$ Width of the bottom of the handset

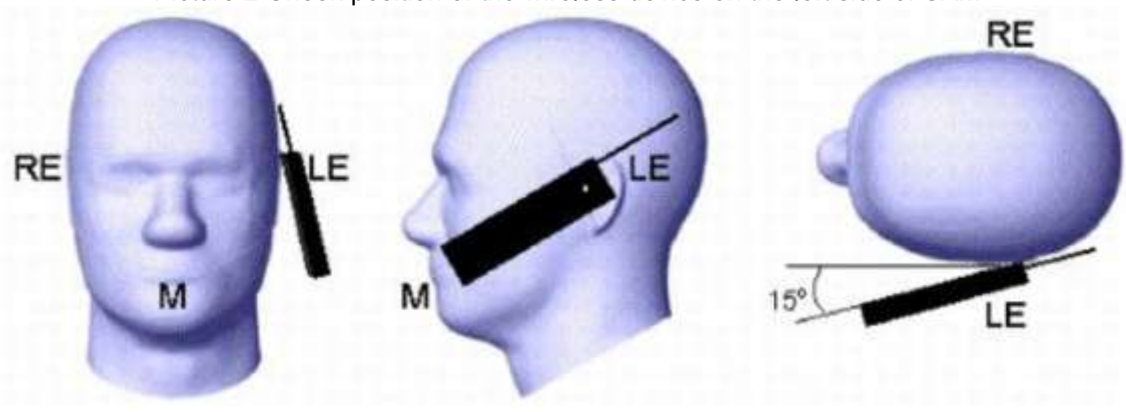
A Midpoint of the width $w_t$ of the handset at the level of the acoustic output

B Midpoint of the width $w_b$ of the bottom of the handset

Picture 1-a Typical “fixed” case handset Picture 1-b Typical “clam-shell” case handset




Picture 2 Cheek position of the wireless device on the left side of SAM




Picture 3 Tilt position of the wireless device on the left side of SAM

For body SAR test we applied to FCC KDB941225 D03v01, KDB447498 D01v05r02, KDB248227 D01v01r02, KDB616217 D04v01r01, KDB 447498 D01

## 3.8. Tissue Dielectric Parameters for Head and Body

The liquid used for the frequency range of 100MHz-6G consisted of water, sugar, salt and Cellulose. The liquid has been previously proven to be suited for worst-case. The folowing Tableshows the detail solution. It's satisfying the latest tissue dielectric parameters requirements proposed by the IEEE 1528 and IEC 62209.

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine of the determine of the dielectric parameter are within the tolerances of the specified target values.The measured cond-uctivity and relative permittivity should be within ±5% of the target values.

The folowing materials are used for producing the tissue-equivalent materials.

Table 2. Composition of the Head Tissue Equivalent Matter

| Ingredients (% by weight) | Frequency (MHz) | | | | |
|---|---|---|---|---|---|
| | 835 | 900 | 1800 | 2000 | 2450 |
| Water | 41.45 | 40.92 | 16.33 | 54.89 | 46.70 |
| Sugar | 56.0 | 56.5 | / | / | / |
| Salt | 4.45 | 1.48 | 0.41 | 0.18 | / |
| Preventol | 0.19 | 0.1 | / | / | / |
| Cellulose | 0.1 | 0.4 | / | / | / |
| Clycol Monobutyl | / | / | 65.3 | 44.93 | 53.3 |
| Dielectric ParametersTarget Value | f=835MHz<br>ε =41.5<br>σ =0.90 | f=900MHz<br>ε =41.5<br>σ =0.97 | f=1800MHz<br>ε =40.0<br>σ =1.40 | f=1950 MHz<br>ε =40.0<br>σ =1.40 | f=2450 MHz<br>ε =39.2<br>σ =1.80 |

Table 3. Composition of the Body Tissue Equivalent Matter

| Ingredients (% by weight) | Frequency (MHz) | | | | |
|---|---|---|---|---|---|
| | 835 | 1800 | 1900 | 2450 | 2600 |
| Water | 52.4 | 69.91 | 69.91 | 73.2 | 64.493 |
| Sugar | 45.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Salt | 1.4 | 0.13 | 0.13 | 0.04 | 0.024 |
| HEC | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Bactericide | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| Triton X-100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| DGBE | 0.0 | 29.96 | 29.96 | 26.7 | 32.252 |
| Dielectric ParametersTarget Value | f=835MHz<br>ε =55.2<br>σ =0.97 | f=1800MHz<br>ε =53.30<br>σ =1.52 | f=1900MHz<br>ε =53.30<br>σ =1.52 | f=2450 MHz<br>ε =52.7<br>σ =1.95 | f=2450 MHz<br>ε =52.5<br>σ =2.16 |

Table 4. Targets for tissue simulating liquid

| Frequency (MHz) | Liquid Type | Liquid Type (σ ) | ± 5% Range | Permittivity (ε ) | ± 5% Range |
|---|---|---|---|---|---|
| 150 | Head | 0.76 | 0.72～0.80 | 52.3 | 49.69～54.92 |
| 300 | Head | 0.87 | 0.83～0.91 | 45.3 | 43.04～47.57 |
| 450 | Head | 0.87 | 0.83～0.91 | 43.5 | 41.33～45.68 |
| 835 | Head | 0.90 | 0.86～0.95 | 41.5 | 39.43～43.58 |
| 900 | Head | 0.97 | 0.92～1.02 | 41.5 | 39.43～43.58 |
| 915 | Head | 0.98 | 0.93～1.03 | 41.5 | 39.43～43.58 |
| 1450 | Head | 1.20 | 1.14～1.26 | 40.5 | 38.48～42.53 |
| 1610 | Head | 1.29 | 1.23～1.35 | 40.3 | 38.29～42.32 |
| 1800-2000 | Head | 1.40 | 1.33～1.47 | 40.0 | 38.00～42.00 |
| 2450 | Head | 1.80 | 1.71～1.89 | 39.2 | 37.24～41.16 |
| 3000 | Head | 2.40 | 2.28～2.52 | 38.5 | 36.58～40.43 |
| 5800 | Head | 5.27 | 5.01～5.53 | 35.3 | 33.54～37.07 |
| 150 | Body | 0.80 | 0.76～0.84 | 61.9 | 58.81～65.00 |
| 300 | Body | 0.92 | 0.87～0.97 | 58.2 | 55.29～61.11 |
| 450 | Body | 0.94 | 0.89～0.99 | 56.7 | 53.87～59.54 |
| 835 | Body | 0.97 | 0.92～1.02 | 55.2 | 52.44～57.96 |
| 900 | Body | 1.05 | 1.00～1.10 | 55.0 | 52.25～57.75 |
| 915 | Body | 1.06 | 1.01～1.11 | 55.0 | 52.25～57.75 |
| 1450 | Body | 1.30 | 1.24～1.37 | 54.0 | 51.30～56.70 |
| 1610 | Body | 1.40 | 1.33～1.47 | 53.8 | 51.11～56.49 |
| 1800-2000 | Body | 1.52 | 1.44～1.60 | 53.3 | 50.64～55.97 |
| 2450 | Body | 1.95 | 1.85～2.05 | 52.7 | 50.07～55.34 |
| 3000 | Body | 2.73 | 2.59～2.87 | 52.0 | 49.40～54.60 |
| 5800 | Body | 6.00 | 5.70～6.30 | 48.2 | 45.79～50.61 |

## 3.9. Dielectric Performance

Dielectric Performance of Head and Body Tissue Simulating Liquid

| Measurement is made at temperature 22.0℃and relative humidity 52%. | | | | |
|---|---|---|---|---|
| Liquid temperature during the test: 22.0℃ | | | | |
| Measurement Date: 835 MHz September 08, 2015;1900 MHz September 09, 2015 | | | | |
| Frequency (MHz) | Body Tissue | | Head Tissue | |
| | Ơ(S/m) | εr | Ơ(S/m) | Er |
| 835 | 0.98 | 55.19 | 0.92 | 41.26 |
| 1900 | 1.53 | 53.28 | 1.43 | 40.15 |

## 3.10. Basic SAR system validation requirements

The SAR syetem must be validated against its performance specifications before it is deployed.when SAR probe and system component or sorftware are changed,upgraded or recalibrated,these must be validated with the SAR system(s) that operates with such component. Reference dipoles are used with the required tissure-equivalent media for system validation

The detailed syetem validation result are maintained by each test laboratory,which are normally not required for equip-ment approval. Only a tabulated summary of the system validation status, according to the validation date(s)measure-ment frequencies,SAR probe and tissue dielectric parameters is required in the SAR report.

LCS lab has performed the system validation at 10/28/2014,and all the measured results within ±10% of the system calibrated SAR targets.

## 3.11. System setup

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected.It is recommended that the system performance check be performed prior to any usage of system in order to guarantee reproducieble results. The system performance check uses normal SAR measurements in a simplified setup with a well characterized source. This setup was selected to give a high sensivity to all parameters that might fail or vary over time. The system check does not intend to replace the cali-bration of component, but indicates situations where the system uncertainty is exceeded due to drift or failure.

In the simplified setup for system evaluation, the DUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed benea-th the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:

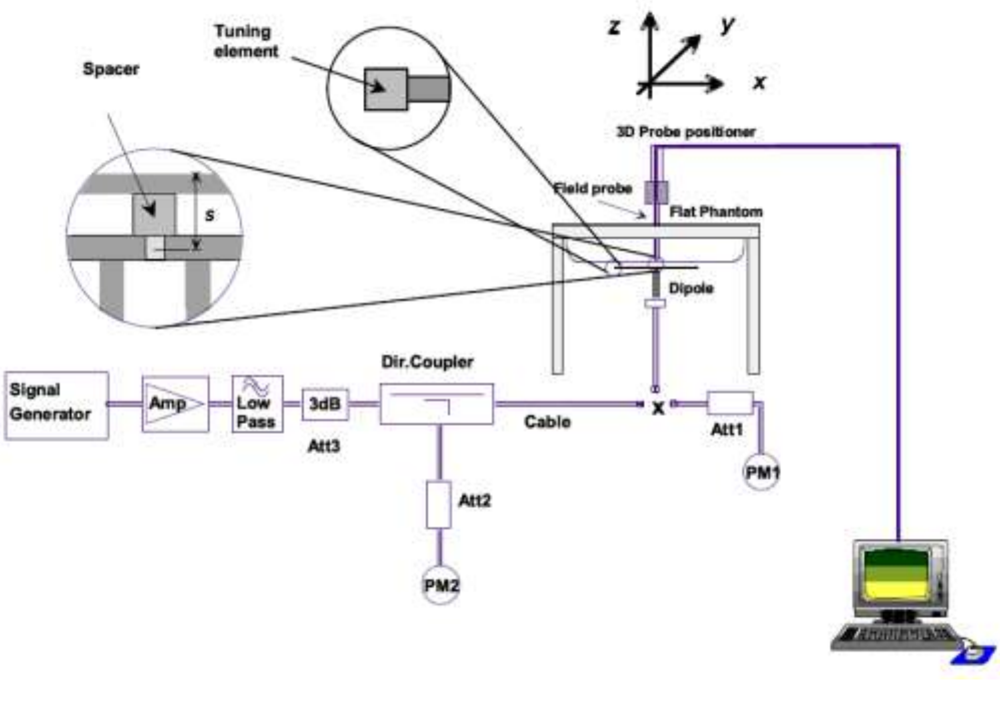


Photo of Dipole Setup

System Validation of Head

| Measurement is made at temperature 22.0 ℃ and relative humidity 52%. | | | | | | | |
|---|---|---|---|---|---|---|---|
| Measurement is made at temperature 22.0℃ and relative humidity 54%. | | | | | | | |
| Measurement Date: 835 MHz September 08, 2015;1900 MHz September 09, 2015;2450 MHz August 20, 2015; | | | | | | | |
| Verification Results | Frequency (MHz) | Target value (W/kg) | | Measured value(W/kg) | | Deviation | |
| | | 1 g Average | 10 g Average | 1 g Average | 10 g Average | 1 g Average | 10 g Average |
| Body | 835 | 9.90 | 6.39 | 9.87 | 6.43 | 0.303 | 0.625 |
| | 1900 | 43.33 | 21.59 | 42.16 | 20.75 | 2.70 | 3.890 |
| Head | 835 | 9.60 | 6.20 | 9.53 | 6.26 | 0.737 | 0.968 |
| | 1900 | 39.84 | 20.20 | 38.34 | 20.19 | 1.26 | 0.050 |

## 3.12. Measurement procedure

**The following procedure shall be performed for each of the test conditions**

1. Measure the local SAR at a test point within 4 mm or less in the normal direction from the inner surface of the phantom.
2. Measure the two-dimensional SAR distribution within the phantom (area scan procedure). The boundary of the measurement area shall not be closer than 20 mm from the phantom side walls. The distance between the measurement points should enable the detection of the location of localmaximum with an accuracy of better than half the linear dimension of the tissue cube after interpolation. A maximum grip spacing of 20 mm for frequencies below 3 GHz and (60/f [GHz]) mm for frequencies of 3GHz and greater is recommended. The maximum distance between the geometrical centre of the probe detectors and the inner surface of the phantom shall be 5 mm for frequencies below 3 GHz andδIn(2)/2 mm for frequencies of 3 GHz and greater, whereδis theplane wave skin depth and In(x) is the natural logarithm. The maximum variation of thesensor-phantom surface shall be ±1 mm for frequencies below 3 GHz and ±0.5 mm forfrequencies of 3 GHz and greater. At all measurement points the angle of the probe with respect tothe line normal to the surface should be less than 5°. If this cannot be achieved for ameasurement distance to the phantom inner surface shorter than the probe diameter, additionalmeasurement distance to the phantom inner surface shorter than the probe diameter, additional
3. From the scanned SAR distribution, identify the position of the maximum SAR value, in addition identify the positions of any local maxima with SAR values within 2 dB of the maximum value that are not within the zoom-scan volume; additional peaks shall be measured only when the primary peak is within 2 dB of the SAR limit. This is consistent with the 2 dB threshold already stated;
4. Measure the three-dimensional SAR distribution at the local maxima locations identified in step
5. The horizontal grid step shall be (24 / f[GHz] ) mm or less but not more than 8 mm. The minimum zoom size of 30 mm by 30 mm and 30 mm for frequencies below 3 GHz. For higher frequencies, the minimum zoom size of 22 mm by 22 mm and 22 mm. The grip step in the vertical direction shall be ( 8-f[GHz] ) mm or less but not more than 5 mm, if uniform spacing is used. If variable spacing is used in the vertical direction, the maximum spacing between the two closest measured points to the phantom shell shall be (12 / f[GHz]) mm or less but not more than 4 mm, and the spacing between father points shall increase by an incremental factor not exceeding 1.5. When variable spacing is used, extrapolation routines shall be tested with the same spacing as used in measurements. The maximum distance between the geometrical centre of the probe detectors and the inner surface of the phantom shall be 5 mm for frequencies below 3 GHz andδIn(2)/2 mm for frequencies of 3 GHz and greater, where δis the plane wave skin depth and In(x)is the natural logarithm. Separate grids shall be centered on each of the local SAR maxima foundin step c). Uncertainties due to field distortion between the media boundary and the dielectricenclosure of the probe should also be minimized, which is achieved is the distance between thephantom surface and physical tip of the probe is larger than probe tip diameter. Other methodsmay utilize correction procedures for these boundary effects that enable high precisionmeasurements closer than half the probe diameter. For all measurement points, the angle of theprobe with respect to the flat phantom surface shall be less than 5. If this cannot be achievedan additional uncertainty evaluation is needed.
6. Use post processing( e.g. interpolation and extrapolation ) procedures to determine the localSAR values at the spatial resolution needed for mass averaging.

# 4.OUTPUT POWER VERIFICATION

## 4.1. Test condition:

1. All test measurements carried out are traceable to national standard. The uncertainty of the measurement at a confidence level of approximately 95%(in the case where distributions are nomal),with a coverage factor of 2, In the range of 30MHz-40GHz is±1.5dB.
2. Evironment conditions:

   Temperature 23℃
   Relative Humidy 53%
   Atmospheric Pressure 1019mbar
3. Test Date: September 08,2015~September 09,2015
   Tested By:Dick

## 4.2. Test Procedure:

**EUT radio output power measurement**

1. The transmitter output port was connected to base station emulator.
2. Establish communication link between emulator and EUT and Set EUT to operate at maximum output power all the time.
3. Select lowest, middle, and highest channels for each band and different possible test mode.
4. Measure the conducted peak burst power and conducted average bust power from EUT antenna port.

## 4.3. Conducted Power Measurement

During the process of testing, the EUT was controlled via Rhode & Schwarz Digital Radio Communication tester (CMU200) to ensure the maximum power transmission and proper modulation. Max Conducted power measurement results and power drift from the 2G report by Shenzhen LCS Compliance Testing Laboratory Ltd. **Note**: CMU200 measures GSM peak and average output power for active timeslots.for SAR the timebased average power is relevant. The difference in between depends on the duty cycle of the TDMA signal:

**Source-based Time Averaged Bust Power calculation:**

| Number of Time slot | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Duty cycle | 1:8 | 1:4 | 1:2.66 | 1:2 |
| Duty cycle factor | -9.03dB | -6.02dB | -4.26dB | -3.01dB |
| Crest factor | 8 | 4 | 2.66 | 2 |

***Remark:Time slot duty cycle factor=10*log(1/Time slot Duty Cycle)***

*Source based time averaged power=Maximum bust averaged power (1 Uplink)-9.03dB*
*Source based time averaged power=Maximum bust averaged power (2 Uplink)-6.02dB*
*Source based time averaged power=Maximum bust averaged power (3 Uplink)-4.26dB*
*Source based time averaged power=Maximum bust averaged power (4 Uplink)-3.01dB*

The signalling modes differ as follows:

| Mode | Code Scheme | Modulation | Mode | Code Scheme |
|---|---|---|---|---|
| GPRS | CS1 to CS4 | GMSK | GPRS | CS1 to CS4 |

## Conducted power measurement results for GSM850/PCS1900

| GSM850 | Conducted Power (dBm) | | |
|---|---|---|---|
| | Channel 128 (824.2MHz) | Channel 190 (836.6MHz) | Channel 251 (848.8MHz) |
| | 32.44 | 32.57 | 32.55 |
| PCS1900 | Conducted Power (dBm) | | |
| | Channel 512 (1850.2MHz) | Channel 661 (1880.0MHz) | Channel 810 (1909.8MHz) |
| | 29.55 | 29.59 | 29.63 |

## Conducted power measurements of GSM 850

| GPRS | Measured Power (dBm) | | | Calculation (dB) | Averaged Power (dBm) | | |
|---|---|---|---|---|---|---|---|
| | 824.2MHz | 836.6MHz | 848.8MHz | | 824.2MHz | 836.6MHz | 848.8MHz |
| 1 Txslot | 32.12 | 32.15 | 32.13 | -9.03 | 23.09 | 23.12 | 23.1 |
| 2 Txslot | 31.25 | 31.14 | 31.20 | -6.02 | 25.23 | 25.12 | 25.18 |
| 3 Txslot | 29.31 | 29.27 | 29.37 | -4.26 | 25.05 | 25.01 | 25.11 |
| 4 Txslot | 27.36 | 27.22 | 27.31 | -3.01 | 24.35 | 24.21 | 24.3 |

## Conducted power measurements of EDGE 850

| EGPRS | Measured Power (dBm) | | | Calculation (dB) | Averaged Power (dBm) | | |
|---|---|---|---|---|---|---|---|
| | 824.2MHz | 836.6MHz | 848.8MHz | | 824.2MHz | 836.6MHz | 848.8MHz |
| 1 Txslot | 26.52 | 26.44 | 26.56 | -9.03 | 17.49 | 17.41 | 17.53 |
| 2 Txslot | 25.45 | 25.33 | 25.51 | -6.02 | 19.43 | 19.31 | 19.49 |
| 3 Txslot | 24.62 | 24.63 | 24.58 | -4.26 | 20.36 | 20.37 | 20.32 |
| 4 Txslot | 24.14 | 24.17 | 24.15 | -3.01 | 21.13 | 21.16 | 21.14 |

***Note：***

1. *The conducted power of GSM850 is measured with RMS dector.*
2. *Frame-averaged output power was calculated from the measured bust-averaged output power by converting the slot powers into liner units and calculating the energy over 8 timeslots.*
3. *According the KDB941225 D03 ,the bolded GPRS 2TX mode was selected for SAR testing according to the highest frame-averaged output power table.*

## Conducted power measurements of PCS 1900

| GPRS | Measured Power (dBm) | | | Calculation (dB) | Averaged Power (dBm) | | |
|---|---|---|---|---|---|---|---|
| | 1850.2MHz | 1880.0MHz | 1909.8MHz | | 1850.2MHz | 1880.0MHz | 1909.8MHz |
| 1 Txslot | 29.24 | 29.28 | 29.31 | -9.03 | 20.21 | 20.25 | 20.28 |
| 2 Txslot | 28.66 | 28.68 | 28.62 | -6.02 | 22.64 | 22.66 | 22.6 |
| 3 Txslot | 26.51 | 26.57 | 26.53 | -4.26 | 22.25 | 22.31 | 22.27 |
| 4 Txslot | 24.41 | 24.29 | 24.36 | -3.01 | 21.40 | 21.28 | 21.35 |

## Conducted power measurements of EDGE 1900

| EGPRS | Measured Power (dBm) | | | Calculation (dB) | Averaged Power (dBm) | | |
|---|---|---|---|---|---|---|---|
| | 1850.2MHz | 1880.0MHz | 1909.8MHz | | 1850.2MHz | 1880.0MHz | 1909.8MHz |
| 1 Txslot | 24.45 | 24.40 | 24.52 | -9.03 | 15.42 | 15.37 | 15.49 |
| 2 Txslot | 23.35 | 23.44 | 23.55 | -6.02 | 17.33 | 17.42 | 17.53 |
| 3 Txslot | 22.52 | 22.66 | 22.57 | -4.26 | 18.26 | 18.4 | 18.31 |
| 4 Txslot | 22.25 | 22.31 | 22.22 | -3.01 | 19.24 | 19.3 | 19.21 |

***Note：***

1. *The conducted power of GSM1900 is measured with RMC dector.*
2. *Frame-averaged output power was calculated from the measured bust-averaged output power by converting the slot powers into liner units and calculating the energy over 8 timeslots.*
3. *According the KDB941225 D03 ,the bolded GPRS 2TX mode was selected for SAR testing according to the highest frame-averaged output power table.*

# 5.SAR TEST RESULT

## 5.1. Test condition:

1. SAR Measuremnt
   The distance between the EUT and the antenna of the emulator is more than 50cm and the out put power radiated from the emulator antenna is at least 30dB less than the output power of EUT.
2. Measurement Uncertainty: See page 36and37 for detail
3. Environmental Conditions

| | |
|---|---|
| Temperature | 23℃ |
| Relative Humidity | 53% |
| Atmospheric Pressure | 1019mbar |

4. Test Date: September 08,2015~September 09,2015
   Test By：Dick

## 5.2. Operation Mode

・According to KDB 447498 D01 v05r02 ,for each exposure position, if the highest 1-g SAR is ≤0.8 W/kg, testing for low and high channel is optional.

・Per KDB 865664 D01 v01r03,for each frequency band, if the measured SAR is ≥0.8W/Kg, testing for repeated SAR measurement is required , that the highest measured SAR is only to be tested. When the SAR results are near the limit, the following procedures are required for each device to verify these types of SAR measurement related variation concerns by repeating the highest measured SAR configuration in each frequency band.

(1) When the original highest measured SAR is ≥0.8W/Kg, repeat that measurement once.

(2) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is ＞1.20 or when the original or repeated measurement is ≥1.45 W/Kg.

(3) Perform a third repeated measurement only if the original, first and second repeated measurement is ≥ 1.5 W/Kg and ratio of largest to smallest SAR for the original, first and second measurement is ≥1.20.

・Body-worn exposure conditions are intended to voice call operations, therefore GSM voice call mode is selected to be test.

(1) the procedures explained in footnote 11 of the standard may be applied to reduce SAR test requirements for GPRS and EDGE modes when the source-based time-averaged output power for each data mode is lower than that in the normal GSM voice mode.

(2) when multiple slots can be used, the device should be tested to account for the maximum source-based time-averaged output power.

(3) when the 1-g SAR is ≤ 0.8 W/kg, testing for low and high channel is optional.

・According to 248227 D01, SAR is not required for 802.11g channels when the maximum average output power is less than 1/4dB higher than measured on the corresponding 802.11b channels.

・Maximum Scaling SAR in order to calculate the Maximum SAR values to test under the standard Peak Power, Calculation method is as follows:

Maximum Scaling SAR =tested SAR (Max.) ×[maximum turn-up power (mw)/ maximum measurement output power(mw) ]

## 5.3. SAR summary Test result

***SAR Values for GSM850 Band***

| Frequency | | Test Position (15mm) | Test Mode | SAR 1g(W/kg) | Power Drift (%) | Conducted Power (dBm) | Tune-up Power (dBm) | Scaled SAR 1g(W/kg) | Limit 1g(W/kg) |
|---|---|---|---|---|---|---|---|---|---|
| MHz | Channel | | | | | | | | |
| **836.0** | **190** | **Left Cheek** | **GSM** | **0.336** | **-1.35** | **32.57** | **33.00** | **0.340** | **1.60** |
| 836.0 | 190 | Left Tilt | GSM | 0.192 | -1.52 | 32.57 | 33.00 | 0.195 | 1.60 |
| 836.0 | 190 | Right Cheek | GSM | 0.333 | 3.20 | 32.57 | 33.00 | 0.337 | 1.60 |
| 836.0 | 190 | Right Tilt | GSM | 0.202 | -0.59 | 32.57 | 33.00 | 0.205 | 1.60 |
| 836.0 | 190 | Front(15mm) | GPRS(2TX) | 0.181 | -2.60 | 31.14 | 32.00 | 0.186 | 1.60 |
| **836.0** | **190** | **Back(0mm)** | **GPRS(2TX)** | **0.351** | **-2.78** | **31.14** | **32.00** | **0.361** | **1.60** |

Note:

1.SAR test was performed in the middle channel only the measured leve was<50% of the SAR of limit,test in the low and high channel is optional.

2.The EUT is a Class B mobile phone which can be attached to both GPRS and GSM services,using one service at a time

3.The Multi-slot Classes of EUT is Class12 which has maximum 1 Downlink slots and 2 Uplink slots, the maximum active slots is 5, when perform the multiple slots scan, 1DL+2UL is the worse case base on the out put power measurements above.

***SAR Values for PCS1900 Band***

| Frequency | | Test Position | Test Mode | SAR 1g(W/kg) | Power Drift (%) | Conducted Power (dBm) | Tune-up Power (dBm) | Scaled SAR 1g(W/kg) | Limit 1g(W/kg) |
|---|---|---|---|---|---|---|---|---|---|
| MHz | Channel | | | | | | | | |
| **1880.0** | **661** | **Left Cheek** | **GSM** | **0.033** | **-4.64** | **29.59** | **30.00** | **0.033** | **1.60** |
| 1880.0 | 661 | Left Tilt | GSM | 0.015 | -3.92 | 29.59 | 30.00 | 0.015 | 1.60 |
| 1880.0 | 661 | Right Cheek | GSM | 0.024 | 1.32 | 29.59 | 30.00 | 0.024 | 1.60 |
| 1880.0 | 661 | Right Tilt | GSM | 0.008 | -3.13 | 29.59 | 30.00 | 0.008 | 1.60 |
| 1880.0 | 661 | Front(15mm) | GPRS(2TX) | 0.014 | -3.82 | 28.68 | 29.00 | 0.014 | 1.60 |
| **1880.0** | **661** | **Back(0mm)** | **GPRS(2TX)** | **0.143** | **-0.88** | **28.68** | **29.00** | **0.145** | **1.60** |

**Note**:

1. SAR test was performed in the middle channel only the measured leve was<50% of the SAR of limit,test in the low and high channel is optional.

2.The EUT is a Class B mobile phone which can be attached to both GPRS and GSM services,using one service at a time

1. The Multi-slot Classes of EUT is Class12 which has maximum 1 Downlink slots and 4 Uplink slots, the maximum active slots is 5, when perform the multiple slots scan, 1DL+2UL is the worse case base on the out put power measurements above.

## 5.4. Testreduction procedure

**Simultaneous multi-band transmission**

The following tables list information which is relevant for the decision if a simultaneous transmit evaluation is necessary according to FCC KDB447498D01 General RF Exposure Guidence v05r02.

Figure 1:The diagonal dimension of the DUT

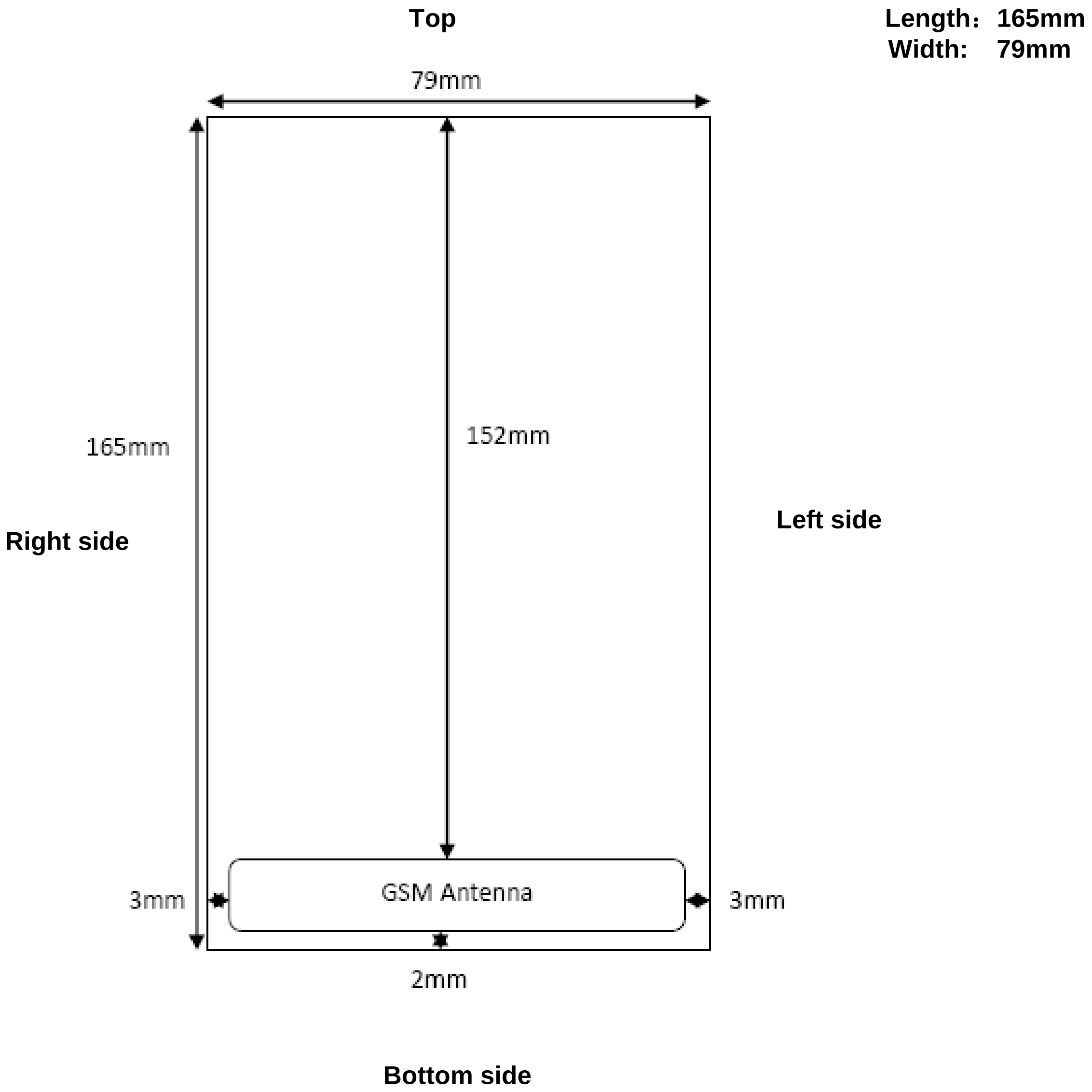


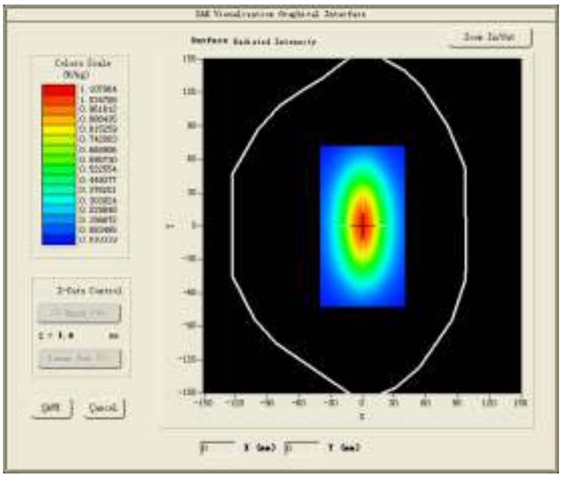
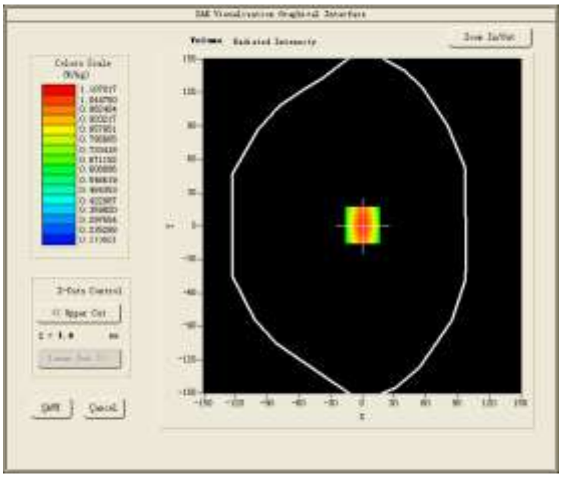

Figure1:The antenna position of the DUT

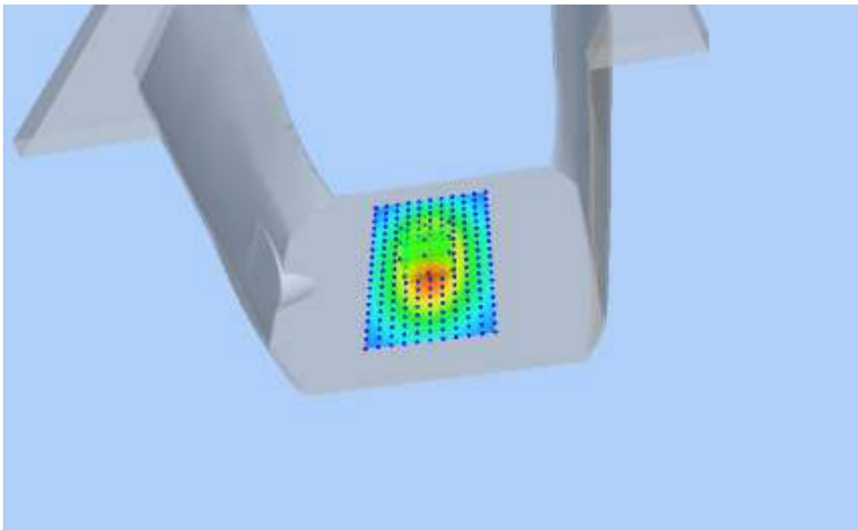
## 5.5. Measurement Uncertainty (700MHz-3GHz)

| Uncertainty Component | Sec. | Tol (+- %) | Prob. Dist. | Div. | Ci (1g) | Ci (10g) | 1g Ui (+-%) | 10g Ui (+-%) | Vi |
|---|---|---|---|---|---|---|---|---|---|
| **Measurement System** | | | | | | | | | |
| Probe calibration | 7.2.1 | 5.8 | N | ı | 1 | 1 | 5.80 | 5.80 | ∞ |
| Axial Isotropy | 7.2.1.1 | 3.5 | R | √3 | (1-Cp)^1/2 | (1-Cp)^1/2 | 1.43 | 1.43 | ∞ |
| Hemispherical Isotropy | 7.2.1.1 | 5.9 | R | √3 | (Cp)^1/2 | (Cp)^1/2 | 2.41 | 2.41 | ∞ |
| Boundary effect | 7.2.1.4 | 1.0 | R | √3 | 1 | 1 | 0.58 | 0.58 | ∞ |
| Linearity | 7.2.1.2 | 4.7 | R | √3 | 1 | 1 | 2.71 | 2.71 | ∞ |
| System detection limits | 7.2.1.2 | 1.0 | R | √3 | 1 | 1 | 0.58 | 0.58 | ∞ |
| Modulation response | 7.2.1.3 | 3.00 | N | ı | 1 | 1 | 3.00 | 3.00 | ∞ |
| Readout Electronics | 7.2.1.5 | 0.50 | N | ı | 1 | 1 | 0.50 | 0.50 | ∞ |
| Reponse Time | 7.2.1.6 | 0.0 | R | √3 | 1 | 1 | 0.00 | 0.00 | ∞ |
| Integration Time | 7.2.1.7 | 1.4 | R | √3 | 1 | 1 | 0.81 | 0.81 | ∞ |
| RF ambient Conditions - Noise | 7.2.3.7 | 3.0 | R | √3 | 1 | 1 | 1.73 | 1.73 | ∞ |
| RF ambient Conditions - Reflections | 7.2.3.7 | 3.0 | R | √3 | 1 | 1 | 1.73 | 1.73 | ∞ |
| Probe positioner Mechanical Tolerance | 7.2.2.1 | 1.4 | R | √3 | 1 | 1 | 0.81 | 0.81 | ∞ |
| Probe positioning with respect to Phantom Shell | 7.2.2.3 | 1.40 | R | √3 | 1 | 1 | 0.81 | 0.81 | ∞ |
| Extrapolation, interpolation and integration Algoritms for Max. SAR Evaluation | 7.2.4 | 2.3 | R | √3 | 1 | 1 | 1.33 | 1.33 | ∞ |
| **Test sample Related** | | | | | | | | | |
| Test sample positioning | 7.2.2.4.4 | 2.60 | N | ı | 1 | 1 | 2.60 | 2.60 | ıı |
| Device Holder Uncertainty | 7.2.2.4.2<br>7.2.2.4.3 | 3.00 | N | ı | 1 | 1 | 3.00 | 3.00 | □ |
| Output power Variation - SAR drift measurement | 7.2.3.6 | 5.00 | R | √3 | 1 | 1 | 2.89 | 2.89 | ∞ |
| SAR scaling | 7.2.5 | 2.00 | R | √3 | 1 | 1 | 1.15 | 1.15 | ∞ |
| **Phantom and Tissue Parameters** | | | | | | | | | |
| Phantom Uncertainty (Shape and thickness tolerances) | 7.2.2.2 | 4.00 | R | √3 | 1 | 1 | 2.31 | 2.31 | ∞ |
| Uncertainty in SAR correction for deviation (in permittivity and conductivity) | 7.2.6 | 2.00 | N | ı | 1 | 0.84 | 2.00 | 1.68 | ∞ |
| Liquid conductivity (temperature uncertainty) | 7.2.3.5 | 2.50 | N | ı | 0.78 | 0.71 | 1.95 | 1.78 | □ |
| Liquid conductivity - measurement uncertainty | 7.2.3.3 | 4.00 | N | ı | 0.23 | 0.26 | 0.92 | 1.04 | □ |
| Liquid permittivity (temperature uncertainty) | 7.2.3.5 | 2.50 | N | ı | 0.78 | 0.71 | 1.95 | 1.78 | ∞ |
| Liquid permittivity - measurement uncertainty | 7.2.3.4 | 5.00 | N | ı | 0.23 | 0.26 | 1.15 | 1.30 | ∞ |
| Combined Standard Uncertainty | | | RSS | | | | 10.63 | 10.54 | |
| Expanded Uncertainty (95% Confidence interval) | | | k | | | | 21.26 | 21.08 | |

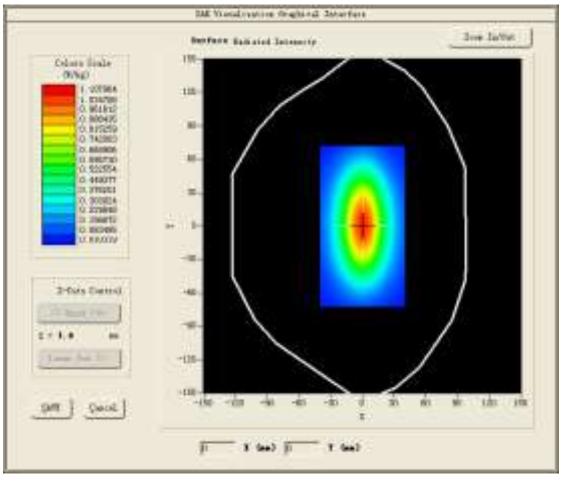
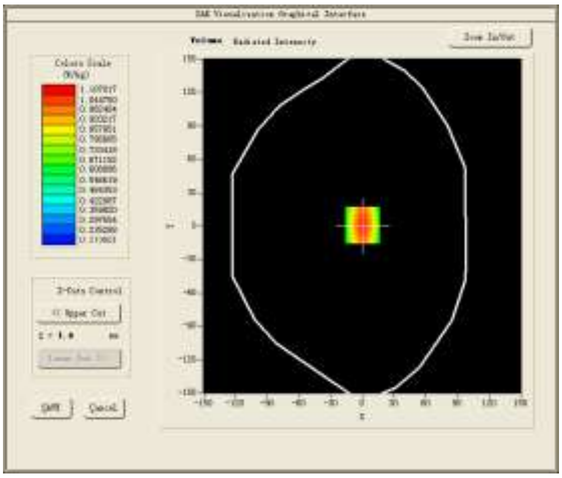
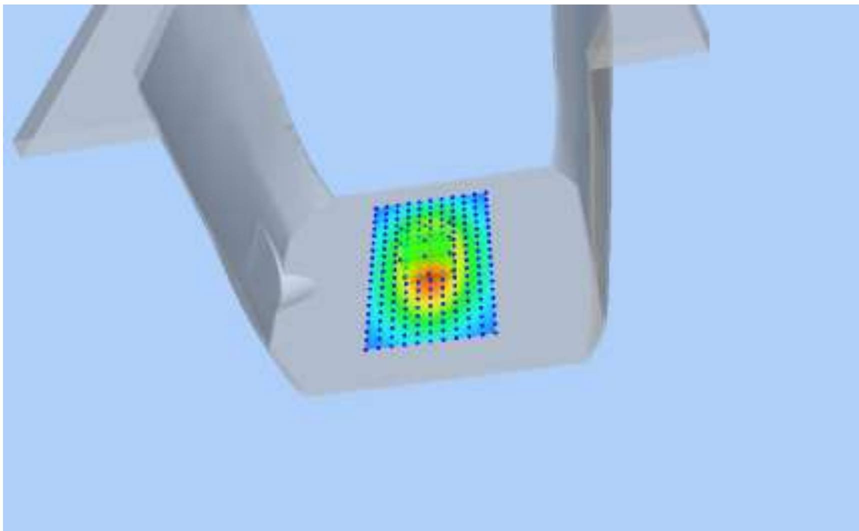
## 5.6. System Check Results

Test mode:835MHz(Head)
Product Description:Validation
Model:Dipole SID835
E-Field Probe:SSE5(SN17/14 EP220)
Test Date: September 08, 2015

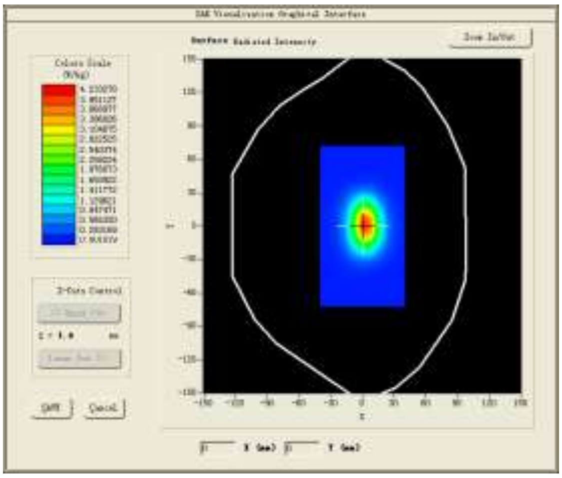
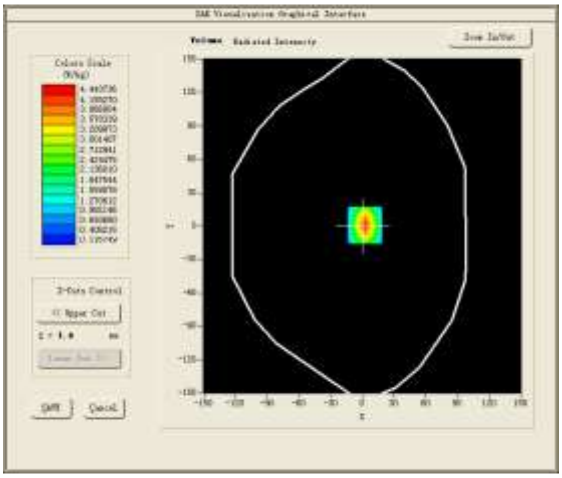
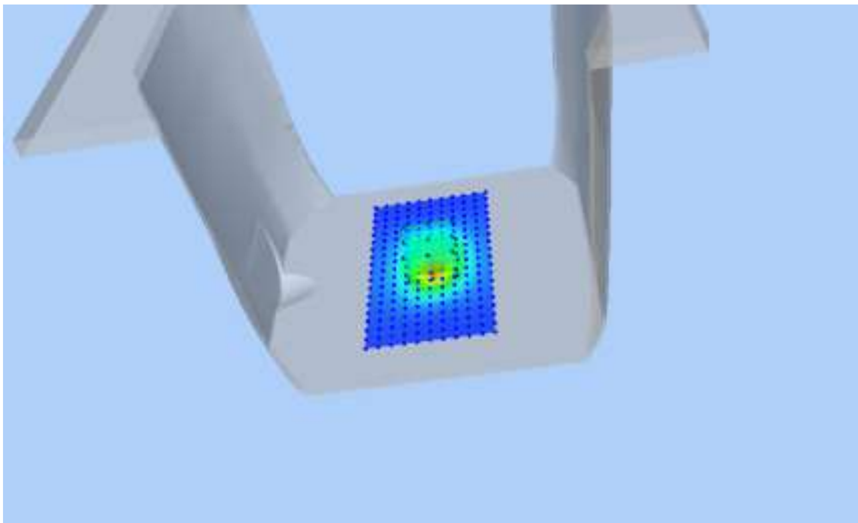
| | |
|---|---|
| Medium(liquid type) | HSL_900 |
| Frequency (MHz) | 835.0000 |
| Relative permittivity (real part) | 41.26 |
| Conductivity (S/m) | 0.92 |
| Input power | 100mW |
| Crest Factor | 1.0 |
| Conversion Factor | 4.86 |
| Variation (%) | -0.010000 |
| SAR 10g (W/Kg) | 0.626382 |
| SAR 1g (W/Kg) | 0.953343 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |



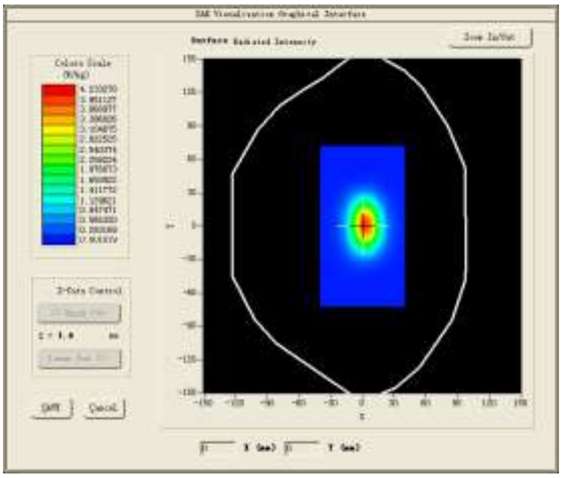
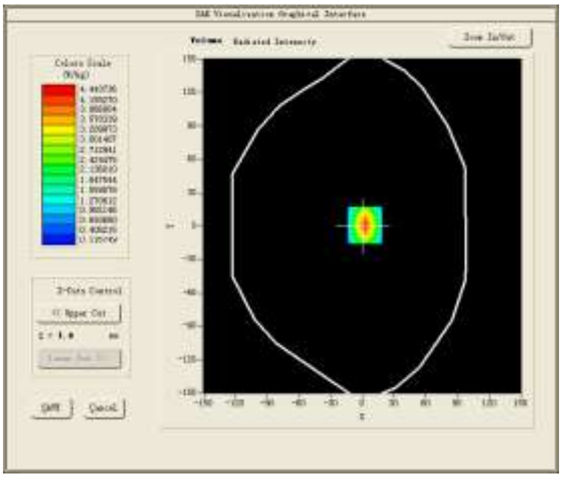
Test mode:835MHz(Body)
Product Description:Validation
Model:Dipole SID835
E-Field Probe:SSE5(SN17/14 EP220)
Test Date:September 08, 2015

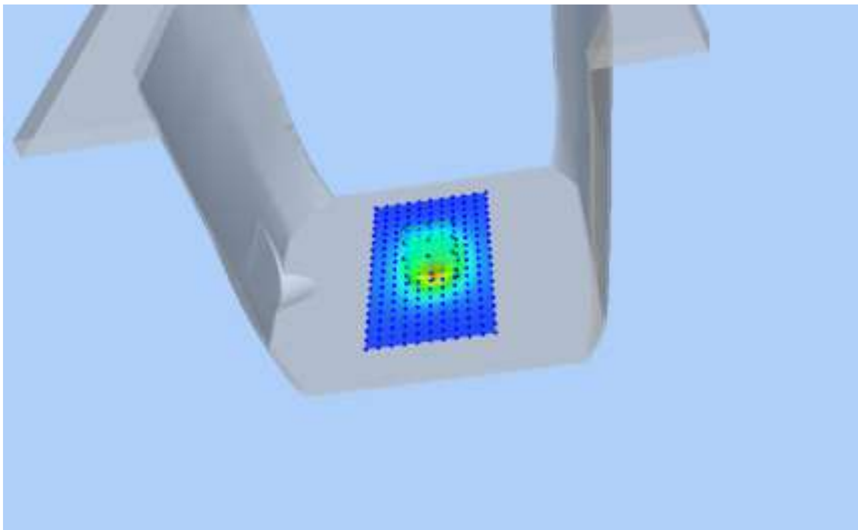
| | |
|---|---|
| Medium(liquid type) | BSL_900 |
| Frequency (MHz) | 835.0000 |
| Relative permittivity (real part) | 55.19 |
| Conductivity (S/m) | 0.98 |
| Input power | 100mW |
| Crest Factor | 1.0 |
| Conversion Factor | 5.04 |
| Variation (%) | -0.010000 |
| SAR 10g (W/Kg) | 0.643381 |
| SAR 1g (W/Kg) | 0.987156 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |
|  | |

Test mode:1900MHz(Head)
Product Description:Validation
Model :Dipole SID1900
E-Field Probe:SSE5(SN17/14 EP221)
Test Date: September 09, 2015

| | |
|---|---|
| Medium(liquid type) | HSL_1800 |
| Frequency (MHz) | 1900.0000 |
| Relative permittivity (real part) | 40.15 |
| Conductivity (S/m) | 1.43 |
| Input power | 100mW |
| Crest Factor | 1.0 |
| Conversion Factor | 4.71 |
| Variation (%) | -0.240000 |
| SAR 10g (W/Kg) | 2.192452 |
| SAR 1g (W/Kg) | 3.834373 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |
|  | |

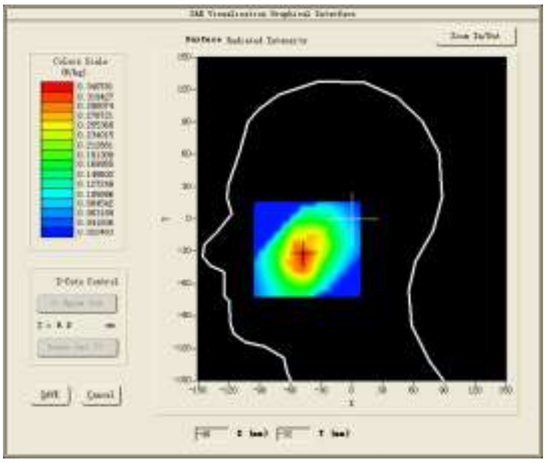
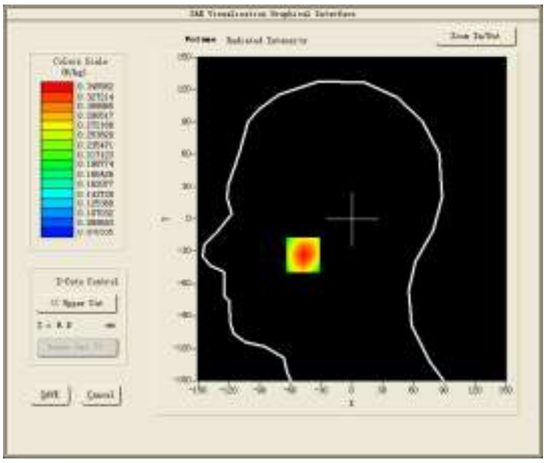
Test mode:1900MHz(Body)
Product Description:Validation
Model :Dipole SID1900
E-Field Probe:SSE5(SN17/14 EP221)
Test Date:September 09, 2015

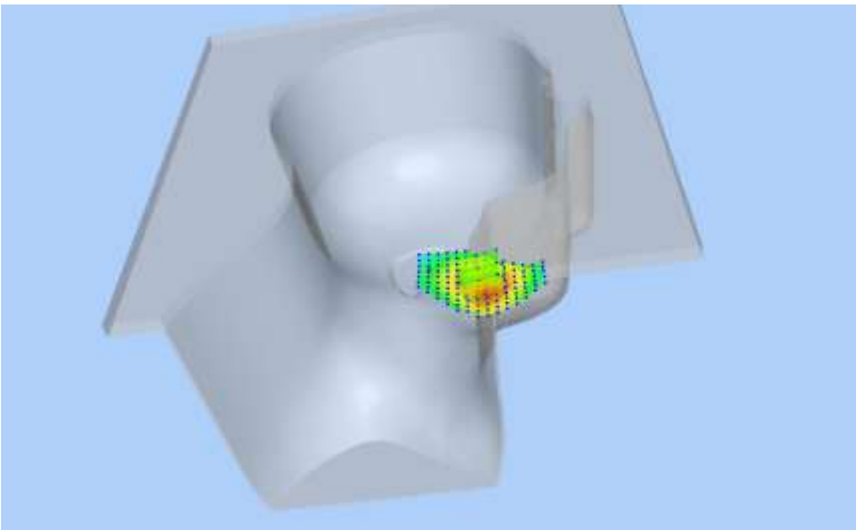
| Medium(liquid type) | BSL_1800 |
|---|---|
| Frequency (MHz) | 1900.0000 |
| Relative permittivity (real part) | 53.28 |
| Conductivity (S/m) | 1.53 |
| Input power | 100mW |
| Crest Factor | 1.0 |
| Conversion Factor | 4.85 |
| Variation (%) | -0.240000 |
| SAR 10g (W/Kg) | 2.075454 |
| SAR 1g (W/Kg) | 4.2164373 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |



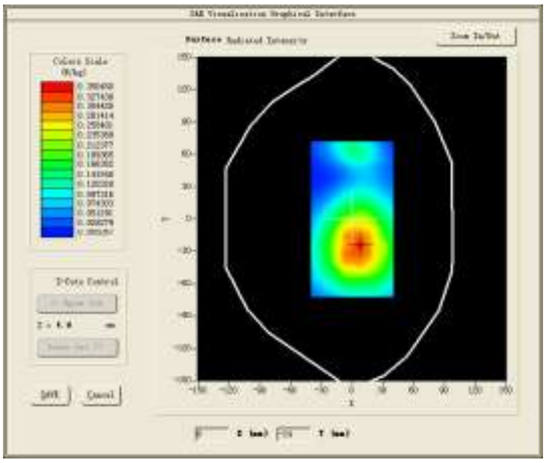
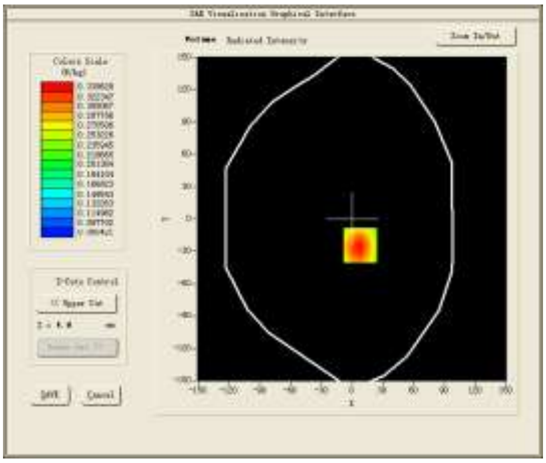
## 5.7. SAR Test Graph Results

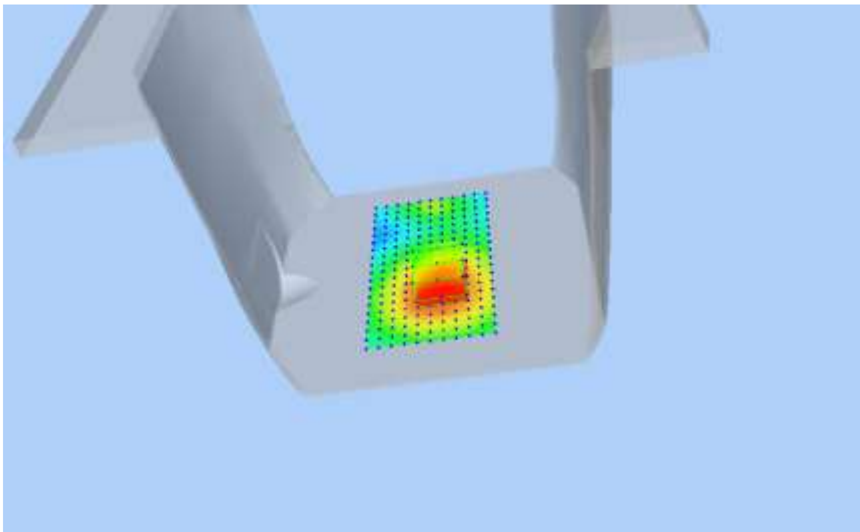
Test Mode:GSM 850MHz,Mid channel(Head Left Cheek)
Product Description: Portable Data Collector
Model:NLS-MT65
Test Date:September 08, 2015

| | |
|---|---|
| Medium(liquid type) | HSL_900 |
| Frequency (MHz) | 836.400024 |
| Relative permittivity (real part) | 41.26 |
| Conductivity (S/m) | 0.92 |
| E-Field Probe | SN 17/14 EP220 |
| Crest Factor | 2.0 |
| Conversion Factor | 4.86 |
| Sensor | 4mm |
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Variation (%) | -1.350000 |
| SAR 10g (W/Kg) | 0.235848 |
| SAR 1g (W/Kg) | 0.335863 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |

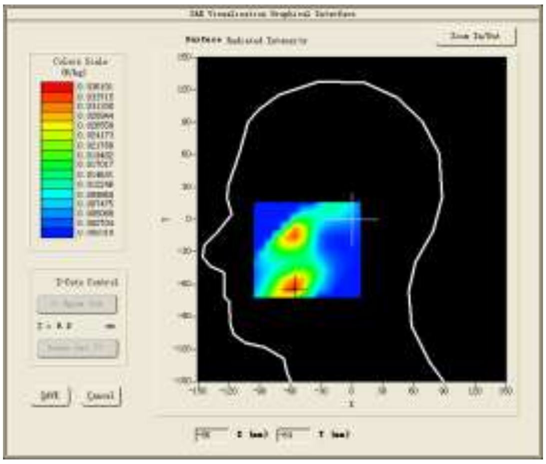
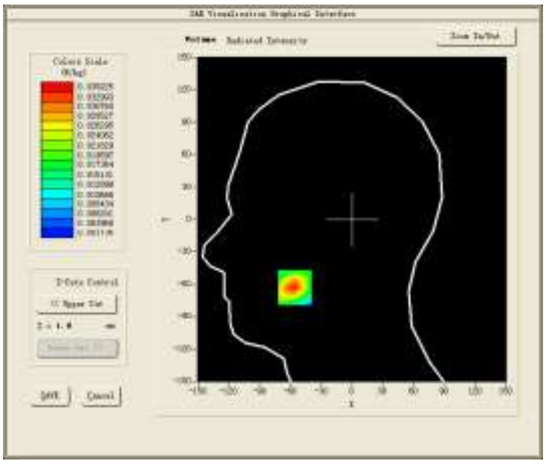


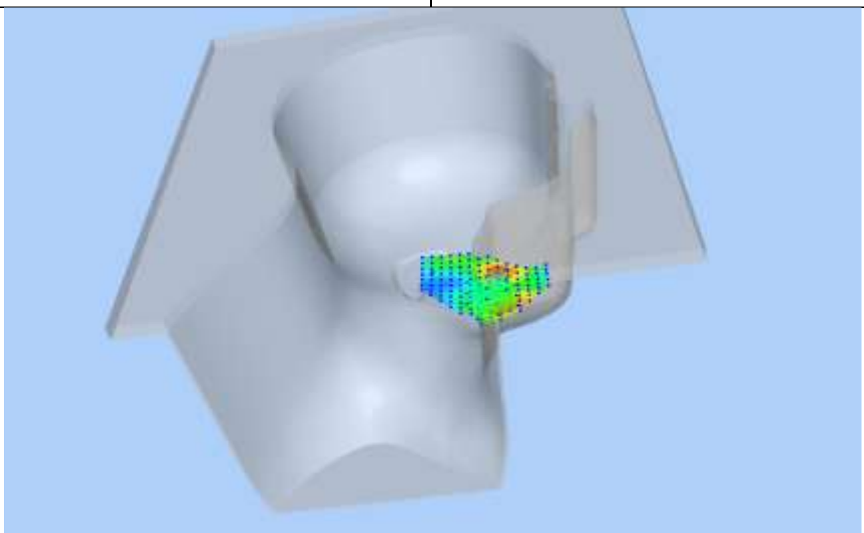
Test Mode:GPRS850MHz,Mid channel(Body SAR Back side)
Product Description:Portable Data Collector
Model:NLS-MT65
Test Date: September 08, 2015

| | |
|---|---|
| Medium(liquid type) | BSL_900 |
| Frequency (MHz) | 836.400024 |
| Relative permittivity (real part) | 55.19 |
| Conductivity (S/m) | 0.98 |
| E-Field Probe | SN 17/14 EP220 |
| Crest Factor | 2.0 |
| Conversion Factor | 5.04 |
| Sensor | 4mm |
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Variation (%) | -2.780000 |
| SAR 10g (W/Kg) | 0.249981 |
| SAR 1g (W/Kg) | 0.350874 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |

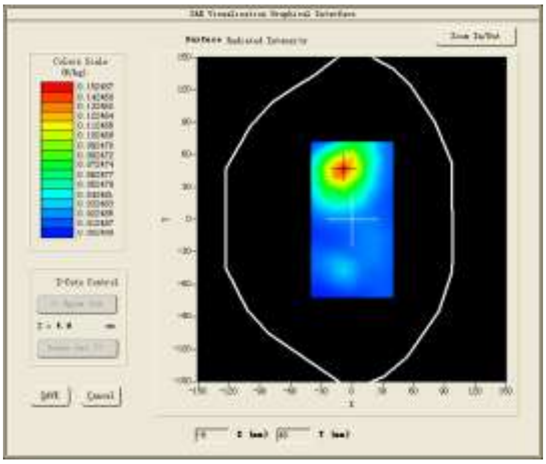
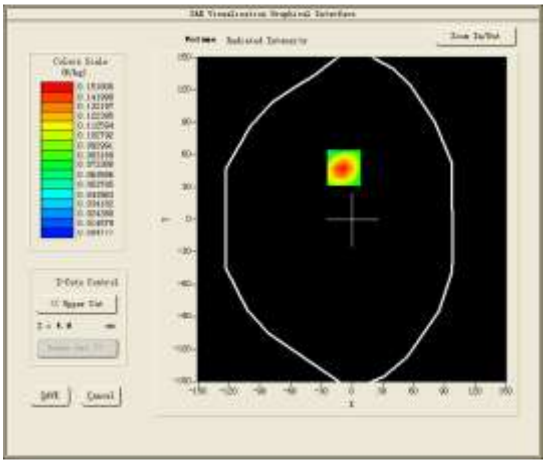


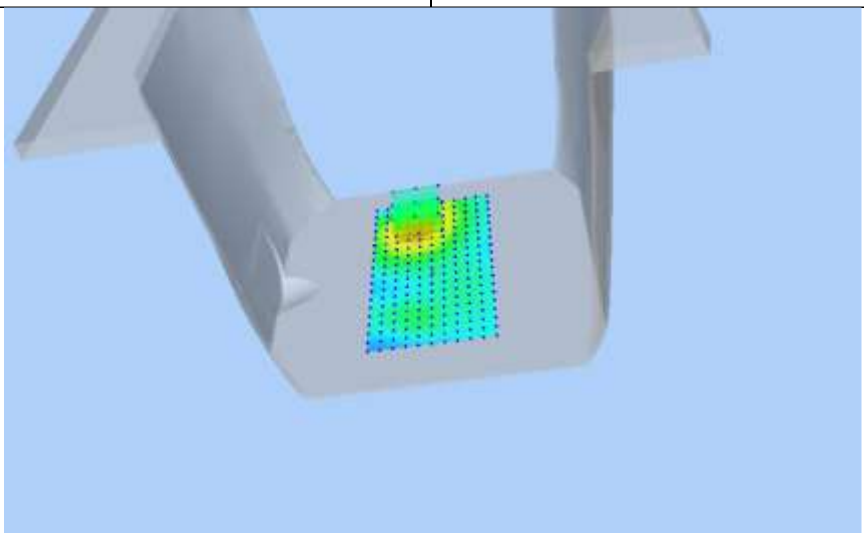
Test Mode:GSM 1900MHz,Mid channel(Head Left Cheek)
Product Description: Portable Data Collector
Model:NLS-MT65
Test Date:September 09, 2015

| | |
|---|---|
| Medium(liquid type) | HSL_1800 |
| Frequency (MHz) | 1909.599976 |
| Relative permittivity (real part) | 40.15 |
| Conductivity (S/m) | 1.43 |
| E-Field Probe | SN 17/14 EP221 |
| Crest Factor | 2.0 |
| Conversion Factor | 4.71 |
| Sensor | 4mm |
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Variation (%) | -4.640000 |
| SAR 10g (W/Kg) | 0.017084 |
| SAR 1g (W/Kg) | 0.033008 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |



Test Mode:GPRS1900MHz,Mid channel(Body Back SIDE)
Product Description: Portable Data Collector
Model:NLS-MT65
Test Date:September 09, 2015

| | |
|---|---|
| Medium(liquid type) | BSL_1800 |
| Frequency (MHz) | 1909.599976 |
| Relative permittivity (real part) | 53.28 |
| Conductivity (S/m) | 1.53 |
| E-Field Probe | SN 17/14 EP221 |
| Crest Factor | 2.0 |
| Conversion Factor | 4.85 |
| Sensor | 4mm |
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Variation (%) | -0.880000 |
| SAR 10g (W/Kg) | 0.079523 |
| SAR 1g (W/Kg) | 0.142971 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |



# 6.CALIBRATION CERTIFICATES

**SARTIMO Calibration Certificate-Extended Dipole Calibrations**

According to KDB 450824 D02, Dipoles must be recalibrated at least once every three years; however, immediate re-calibration is required for following conditions. The test laboratory must ensure that the required supporting information and documentation have been included in the SAR report to qualify for extended 3-year calibration interval.

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

Summary Result:

| **SID835** | | | |
|---|---|---|---|
| Frquency | Return Loss(dB) | Requirement(dB) | Impedence |
| 835 | -24.46 | -20 | 55.4Ω+2.4jΩ |

| **SID1900** | | | |
|---|---|---|---|
| Frquency | Return Loss(dB) | Requirement(dB) | Impedence |
| 1900 | -23.68 | -20 | 51.2Ω+6.4jΩ |

## 6.1. Probe Calibration Ceriticate

SATIMO
The microwave vision company

# COMOSAR E-Field Probe Calibration Report

Ref : ACR.287.1.14.SATU.A

**SHENZHEN LCS COMPLIANCE TESTING LABORATORY LTD.**
**1F., XINGYUAN INDUSTRIAL PARK, TONGDA ROAD, BAO'AN BLVD**
**BAO'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA**
**SATIMO COMOSAR DOSIMETRIC E-FIELD PROBE**
**SERIAL NO.: SN 17/14 EP220**

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

ilac-MRA
A2LA ACCREDITED
Calibration CERT #2246-02

**10/01/2014**

*Summary:*

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

COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.287.1.14.SATU.A

| | *Name* | *Function* | *Date* | *Signature* |
|---|---|---|---|---|
| *Prepared by :* | Jérôme LUC | Product Manager | 10/14/2014 | |
| *Checked by :* | Jérôme LUC | Product Manager | 10/14/2014 | |
| *Approved by :* | Kim RUTKOWSKI | Quality Manager | 10/14/2014 | |

| | *Customer Name* |
|---|---|
| *Distribution :* | Shenzhen LCS Compliance Testing Laboratory Ltd. |

| *Issue* | *Date* | *Modifications* |
|---|---|---|
| A | 10/14/2014 | Initial release |
| | | |
| | | |
| | | |

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# TABLE OF CONTENTS

# 1 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | COMOSAR DOSIMETRIC E FIELD PROBE |
| Manufacturer | Satimo |
| Model | SSE5 |
| Serial Number | SN 17/14 EP220 |
| Product Condition (new / used) | New |
| Frequency Range of Probe | 0.7 GHz-3GHz |
| Resistance of Three Dipoles at Connector | Dipole 1: R1=0.179 MΩ<br>Dipole 2: R2=0.175 MΩ<br>Dipole 3: R3=0.180 MΩ |

A yearly calibration interval is recommended.

# 2 PRODUCT DESCRIPTION

## 2.1 GENERAL INFORMATION

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

**Figure 1** – *Satimo COMOSAR Dosimetric E field Dipole*

| | |
|---|---|
| Probe Length | 330 mm |
| Length of Individual Dipoles | 4.5 mm |
| Maximum external diameter | 8 mm |
| Probe Tip External Diameter | 5 mm |
| Distance between dipoles / probe extremity | 2.7 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**<br>95 % confidence level k = 2 | | | | | 12.0% |

## 5 CALIBRATION MEASUREMENT RESULTS

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

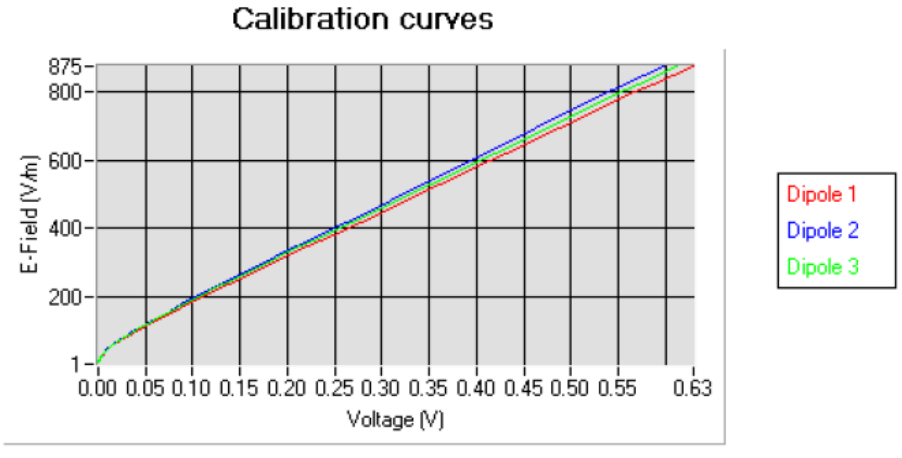
### 5.1 SENSITIVITY IN AIR

| Normx dipole 1 ($\mu V/(V/m)^2$) | Normy dipole 2 ($\mu V/(V/m)^2$) | Normz dipole 3 ($\mu V/(V/m)^2$) |
|---|---|---|
| 6.02 | 5.52 | 5.72 |

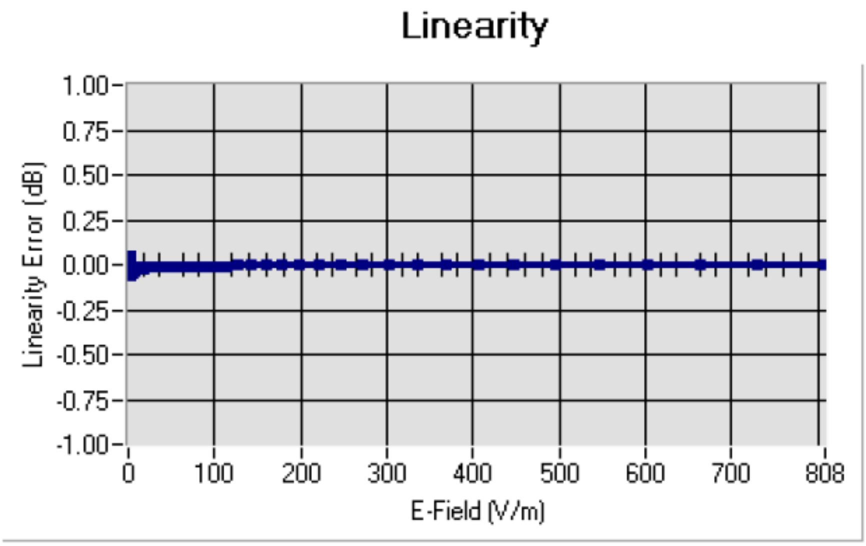
| DCP dipole 1 (mV) | DCP dipole 2 (mV) | DCP dipole 3 (mV) |
|---|---|---|
| 99 | 98 | 99 |

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

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



## 5.2 LINEARITY




Linearity:+/-1.47% (+/-0.06dB)

## 5.3 SENSITIVITY IN LIQUID

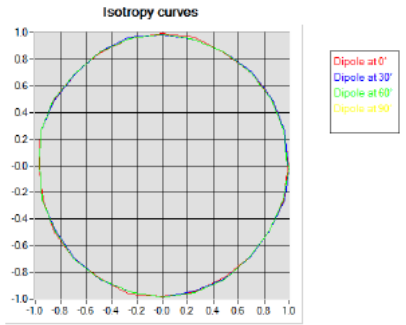
| Liquid | Frequency (MHz +/- 100MHz) | Permittivity | Epsilon (S/m) | ConvF |
|---|---|---|---|---|
| HL750 | 750 | 42.06 | 0.89 | 4.58 |
| BL750 | 750 | 56.57 | 0.99 | 4.71 |
| HL850 | 835 | 42.81 | 0.89 | 4.86 |
| BL850 | 835 | 53.46 | 0.96 | 5.04 |
| HL900 | 900 | 42.47 | 0.96 | 4.74 |
| BL900 | 900 | 56.69 | 1.08 | 4.92 |
| HL1800 | 1800 | 41.31 | 1.38 | 4.16 |
| BL1800 | 1800 | 53.27 | 1.51 | 4.29 |
| HL2000 | 2000 | 39.72 | 1.43 | 4.19 |
| BL2000 | 2000 | 53.91 | 1.53 | 4.28 |
| HL2450 | 2450 | 39.05 | 1.77 | 3.94 |
| BL2450 | 2450 | 52.97 | 1.93 | 4.05 |

LOWER DETECTION LIMIT: 7mW/kg

## 5.4 ISOTROPY

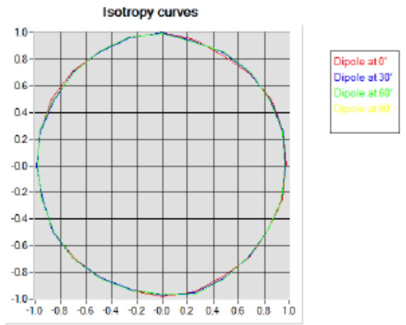
**HL900 MHz**

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




**HL1800 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 | Satimo | 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 | 02/2013 | 02/2016 |
| Reference Probe | Satimo | EP 94 SN 37/08 | 10/2013 | 10/2014 |
| 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 | 11-661-9 | 8/2012 | 8/2015 |

# COMOSAR E-Field Probe Calibration Report

Ref : ACR.262.1.14.SATU.A

**SHENZHEN LCS COMPLIANCE TESTING LABORATORY LTD.**
**1F., XINGYUAN INDUSTRIAL PARK, TONGDA ROAD, BAO'AN BLVD**
**BAO'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA**
**SATIMO COMOSAR DOSIMETRIC E-FIELD PROBE**
**SERIAL NO.: SN 17/14 EP221**

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

**09/01/2014**

*Summary:*

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

| | Name | Function | Date | Signature |
|---|---|---|---|---|
| Prepared by : | Jérôme LUC | Product Manager | 9/19/2014 | |
| Checked by : | Jérôme LUC | Product Manager | 9/19/2014 | |
| Approved by : | Kim RUTKOWSKI | Quality Manager | 9/19/2014 | |

| | Customer Name |
|---|---|
| Distribution : | Shenzhen LCS Compliance Testing Laboratory Ltd. |

| Issue | Date | Modifications |
|---|---|---|
| A | 9/19/2014 | Initial release |
| | | |
| | | |
| | | |

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# 1 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | COMOSAR DOSIMETRIC E FIELD PROBE |
| Manufacturer | Satimo |
| Model | SSE5 |
| Serial Number | SN 17/14 EP221 |
| Product Condition (new / used) | New |
| Frequency Range of Probe | 0.4 GHz- 6 GHz |
| Resistance of Three Dipoles at Connector | Dipole 1: R1=0.179 MΩ<br>Dipole 2: R2=0.167 MΩ<br>Dipole 3: R3=0.178 MΩ |

A yearly calibration interval is recommended.

# 2 PRODUCT DESCRIPTION

## 2.1 GENERAL INFORMATION

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

**Figure 1** – *Satimo COMOSAR Dosimetric E field Dipole*

| | |
|---|---|
| Probe Length | 330 mm |
| Length of Individual Dipoles | 4.5 mm |
| Maximum external diameter | 8 mm |
| Probe Tip External Diameter | 5 mm |
| Distance between dipoles / probe extremity | 2.7 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**<br>95 % confidence level k = 2 | | | | | 12.0% |

## 5 CALIBRATION MEASUREMENT RESULTS

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

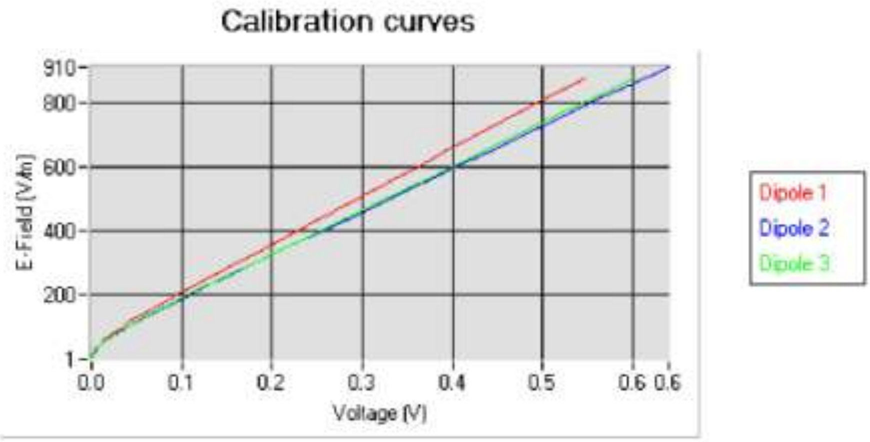
### 5.1 SENSITIVITY IN AIR

| Normx dipole 1 ($\mu V/(V/m)^2$) | Normy dipole 2 ($\mu V/(V/m)^2$) | Normz dipole 3 ($\mu V/(V/m)^2$) |
|---|---|---|
| 4.81 | 6.15 | 6.02 |

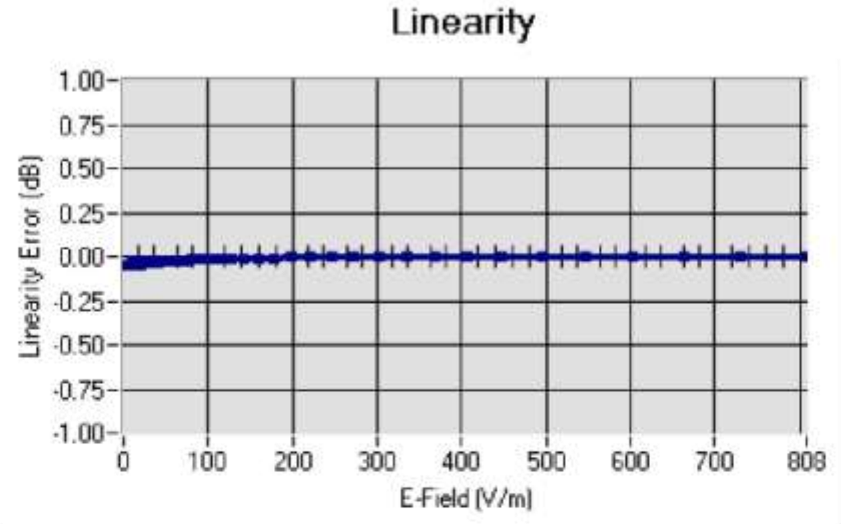
| DCP dipole 1 (mV) | DCP dipole 2 (mV) | DCP dipole 3 (mV) |
|---|---|---|
| 95 | 100 | 90 |

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

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



## 5.2 LINEARITY




Linearity:+/-1.16% (+/-0.05dB)

## 5.3 SENSITIVITY IN LIQUID

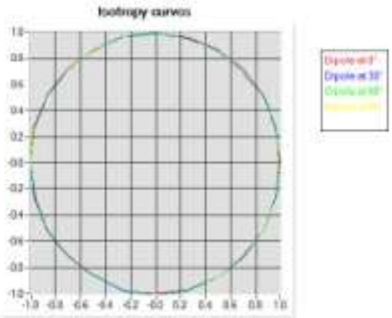
| Liquid | Frequency (MHz +/- 100MHz) | Permittivity | Epsilon (S/m) | ConvF |
|---|---|---|---|---|
| HL450 | 450 | 43.90 | 0.87 | 4.84 |
| BL450 | 450 | 58.63 | 0.98 | 4.98 |
| HL750 | 750 | 42.06 | 0.89 | 4.53 |
| BL750 | 750 | 56.57 | 0.99 | 4.70 |
| HL850 | 835 | 42.81 | 0.89 | 4.83 |
| BL850 | 835 | 53.46 | 0.96 | 5.02 |
| HL900 | 900 | 42.47 | 0.96 | 4.74 |
| BL900 | 900 | 56.69 | 1.08 | 4.89 |
| HL1800 | 1800 | 41.31 | 1.38 | 4.25 |
| BL1800 | 1800 | 53.27 | 1.51 | 4.34 |
| HL1900 | 1900 | 41.09 | 1.42 | 4.71 |
| BL1900 | 1900 | 54.20 | 1.54 | 4.85 |
| HL2000 | 2000 | 39.72 | 1.43 | 4.27 |
| BL2000 | 2000 | 53.91 | 1.53 | 4.44 |
| HL2450 | 2450 | 39.05 | 1.77 | 4.11 |
| BL2450 | 2450 | 52.97 | 1.93 | 4.25 |
| HL2600 | 2600 | 38.35 | 1.92 | 4.20 |
| BL2600 | 2600 | 51.81 | 2.19 | 4.32 |

LOWER DETECTION LIMIT: 7mW/kg

### 5.4 ISOTROPY

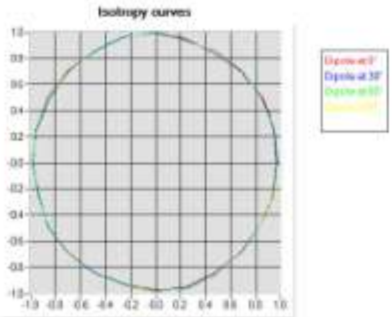
**HL900 MHz**

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




**HL1800 MHz**

- Axial isotropy: 0.05 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 | Satimo | 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 | 02/2013 | 02/2016 |
| Reference Probe | Satimo | EP 94 SN 37/08 | 10/2013 | 10/2014 |
| 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 | 11-661-9 | 8/2012 | 8/2015 |

## 6.2. SID835Dipole Calibration Ceriticate

# SAR Reference Dipole Calibration Report

Ref : ACR.287.4.14.SATU.A

**SHENZHEN LCS COMPLIANCE TESTING LABORATORY LTD.**
**1F., XINGYUAN INDUSTRIAL PARK, TONGDA ROAD, BAO'AN BLVD**
**BAO'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA**
**SATIMO COMOSAR REFERENCE DIPOLE**
**FREQUENCY: 835 MHZ**
**SERIAL NO.: SN 07/14 DIP 0G835-303**

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

Calibration CERT #2246-02

**10/01/2014**

*Summary:*

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

SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.4.14.SATU.A

| | Name | Function | Date | Signature |
|---|---|---|---|---|
| Prepared by : | Jérôme LUC | Product Manager | 10/14/2014 | |
| Checked by : | Jérôme LUC | Product Manager | 10/14/2014 | |
| Approved by : | Kim RUTKOWSKI | Quality Manager | 10/14/2014 | Kim Rutkowski |

| | Customer Name |
|---|---|
| Distribution : | Shenzhen LCS Compliance Testing Laboratory Ltd. |

| Issue | Date | Modifications |
|---|---|---|
| A | 10/14/2014 | Initial release |
| | | |
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# 1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, OET 65 Bulletin C 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 | Satimo |
| Model | SID835 |
| Serial Number | SN 07/14 DIP 0G835-303 |
| Product Condition (new / used) | New |

A yearly calibration interval is recommended.

# 3 PRODUCT DESCRIPTION

## 3.1 GENERAL INFORMATION

Satimo's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.

**Figure 1** – *Satimo COMOSAR Validation Dipole*

## 4 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C 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 constucted 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 |

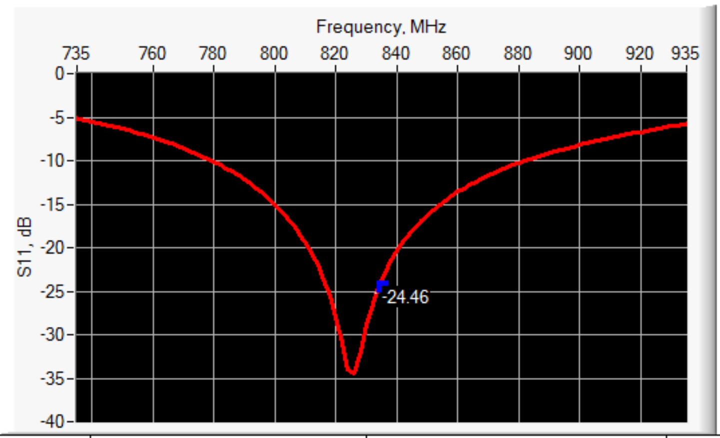
### 5.3 VALIDATION MEASUREMENT

The guidelines outlined in the IEEE 1528, OET 65 Bulletin C, 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




| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 835 | -24.46 | -20 | 55.4 Ω + 2.4 jΩ |

## 6.2 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, OET 65 Bulletin C 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 ($\varepsilon_r'$) | | Conductivity ($\sigma$) S/m | |
|---|---|---|---|---|
| | required | measured | required | measured |
| 300 | 45.3 ±5 % | | 0.87 ±5 % | |
| 450 | 43.5 ±5 % | | 0.87 ±5 % | |
| 750 | 41.9 ±5 % | | 0.89 ±5 % | |
| 835 | 41.5 ±5 % | 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 % | |
| 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 % | |

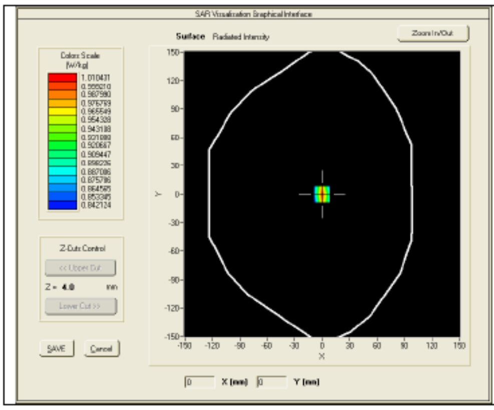
### 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

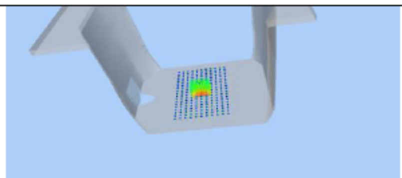
The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is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

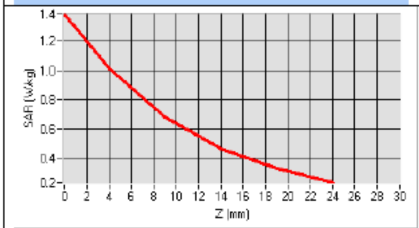
| | |
|---|---|
| Software | OPENSAR V4 |
| Phantom | SN 20/09 SAM71 |
| Probe | SN 18/11 EPG122 |
| Liquid | Head Liquid Values: eps' : 42.3 sigma : 0.92 |
| Distance between dipole center and liquid | 15.0 mm |
| Area scan resolution | dx=8mm/dy=8mm |

| | |
|---|---|
| Zoon Scan Resolution | dx=8mm/dy=8m/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 | 9.60 (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 | |





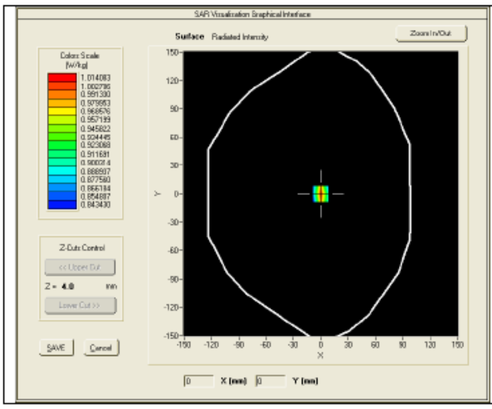
## 7.3 BODY LIQUID MEASUREMENT

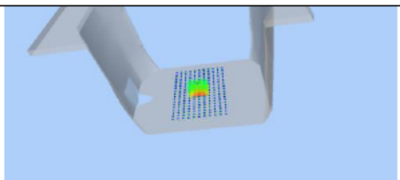
| Frequency MHz | Relative permittivity ($\varepsilon_r$') | | Conductivity (σ) S/m | |
|---|---|---|---|---|
| | required | measured | required | measured |
| 150 | 61.9 ±5 % | | 0.80 ±5 % | |
| 300 | 58.2 ±5 % | | 0.92 ±5 % | |
| 450 | 56.7 ±5 % | | 0.94 ±5 % | |
| 750 | 55.5 ±5 % | | 0.96 ±5 % | |
| 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 % | |
| 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 % | |
| 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 % | |

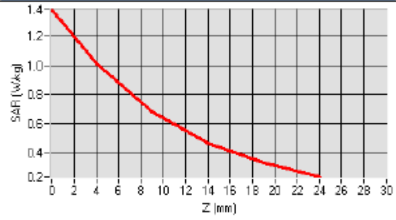
## 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

| | |
|---|---|
| Software | OPENSAR V4 |
| Phantom | SN 20/09 SAM71 |
| Probe | SN 18/11 EPG122 |
| Liquid | Body Liquid Values: eps' : 54.1 sigma : 0.97 |
| Distance between dipole center and liquid | 15.0 mm |
| Area scan resolution | dx=8mm/dy=8mm |
| Zoon Scan Resolution | dx=8mm/dy=8m/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 | 9.90 (0.99) | 6.39 (0.64) |







## 8 LIST OF EQUIPMENT

| Equipment Summary Sheet | | | | |
|---|---|---|---|---|
| **Equipment Description** | **Manufacturer / Model** | **Identification No.** | **Current Calibration Date** | **Next Calibration Date** |
| SAM Phantom | Satimo | 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 | 02/2013 | 02/2016 |
| Calipers | Carrera | CALIPER-01 | 12/2013 | 12/2016 |
| Reference Probe | Satimo | EPG122 SN 18/11 | 10/2013 | 10/2014 |
| 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. |
| Temperature and Humidity Sensor | Control Company | 11-661-9 | 8/2012 | 8/2015 |

## 6.3. SID1900 Dipole Calibration Ceriticate

# SAR Reference Dipole Calibration Report

Ref : ACR.262.8.14.SATU.A

**SHENZHEN LCS COMPLIANCE TESTING LABORATORY LTD.**
**1F., XINGYUAN INDUSTRIAL PARK, TONGDA ROAD, BAO'AN BLVD**
**BAO'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA**
**SATIMO COMOSAR REFERENCE DIPOLE**
**FREQUENCY: 1900 MHZ**
**SERIAL NO.: SN 30/14 DIP1G900-333**

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

**09/01/2014**

*Summary:*

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

| | Name | Function | Date | Signature |
|---|---|---|---|---|
| Prepared by : | Jérôme LUC | Product Manager | 9/19/2014 | |
| Checked by : | Jérôme LUC | Product Manager | 9/19/2014 | |
| Approved by : | Kim RUTKOWSKI | Quality Manager | 9/19/2014 | |

| | Customer Name |
|---|---|
| Distribution : | Shenzhen LCS Compliance Testing Laboratory Ltd. |

| Issue | Date | Modifications |
|---|---|---|
| A | 9/19/2014 | Initial release |
| | | |
| | | |
| | | |

## TABLE OF CONTENTS

# 1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, OET 65 Bulletin C 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 | Satimo |
| Model | SID1900 |
| Serial Number | SN 30/14 DIP1G900-333 |
| Product Condition (new / used) | New |

A yearly calibration interval is recommended.

# 3 PRODUCT DESCRIPTION

## 3.1 GENERAL INFORMATION

Satimo's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.

**Figure 1** – *Satimo COMOSAR Validation Dipole*

# 4 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C 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 constucted 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 |

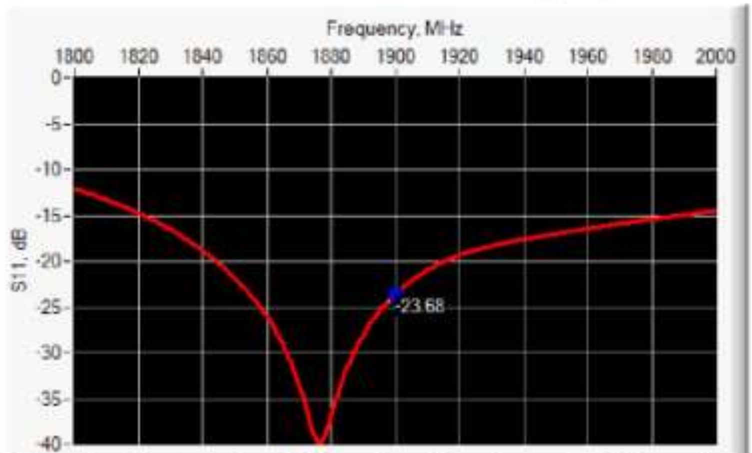
## 5.3 VALIDATION MEASUREMENT

The guidelines outlined in the IEEE 1528, OET 65 Bulletin C, 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 % |

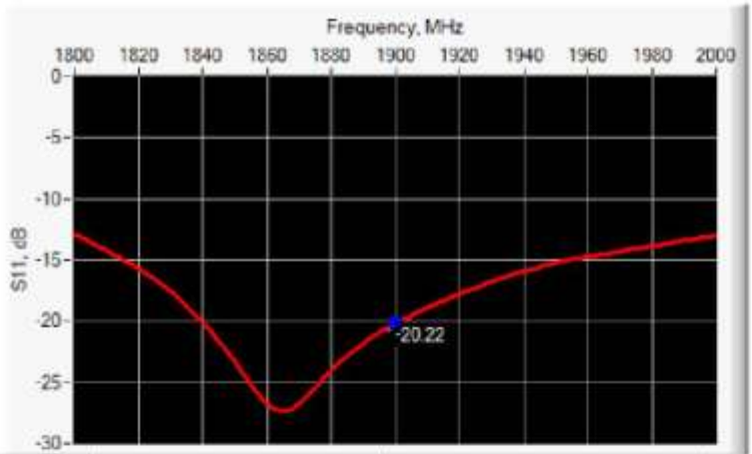
# 6 CALIBRATION MEASUREMENT RESULTS

## 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID




| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 1900 | -23.68 | -20 | 51.2 Ω + 6.4 jΩ |

## 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID




| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 1900 | -20.22 | -20 | 48.8 Ω + 9.6 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, OET 65 Bulletin C 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 ($\varepsilon_r'$) | | Conductivity ($\sigma$) S/m | |
|---|---|---|---|---|
| | required | measured | required | measured |
| 300 | 45.3 ±5 % | | 0.87 ±5 % | |
| 450 | 43.5 ±5 % | | 0.87 ±5 % | |
| 750 | 41.9 ±5 % | | 0.89 ±5 % | |
| 835 | 41.5 ±5 % | | 0.90 ±5 % | |
| 900 | 41.5 ±5 % | | 0.97 ±5 % | |
| 1450 | 40.5 ±5 % | | 1.20 ±5 % | |
| 1500 | 40.4 ±5 % | | 1.23 ±5 % | |
| 1640 | 40.2 ±5 % | | 1.31 ±5 % | |
| 1750 | 40.1 ±5 % | | 1.37 ±5 % | |
| 1800 | 40.0 ±5 % | | 1.40 ±5 % | |
| 1900 | 40.0 ±5 % | PASS | 1.40 ±5 % | PASS |
| 1950 | 40.0 ±5 % | | 1.40 ±5 % | |
| 2000 | 40.0 ±5 % | | 1.40 ±5 % | |

| | | | | |
|---|---|---|---|---|
| 2100 | 39.8 ±5 % | | 1.49 ±5 % | |
| 2300 | 39.5 ±5 % | | 1.67 ±5 % | |
| 2450 | 39.2 ±5 % | | 1.80 ±5 % | |
| 2600 | 39.0 ±5 % | | 1.96 ±5 % | |
| 3000 | 38.5 ±5 % | | 2.40 ±5 % | |
| 3500 | 37.9 ±5 % | | 2.91 ±5 % | |

## 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

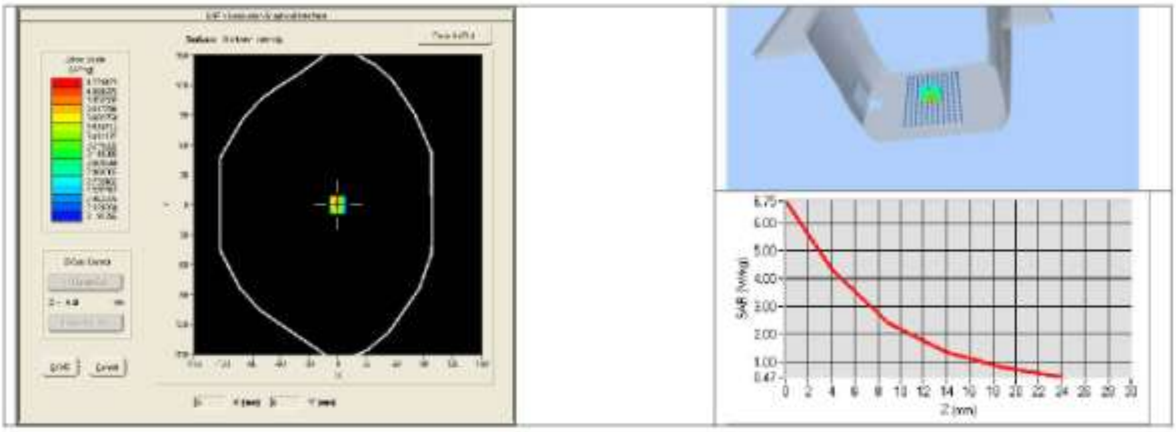
The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is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

| | |
|---|---|
| Software | OPENSAR V4 |
| Phantom | SN 20/09 SAM71 |
| Probe | SN 18/11 EPG122 |
| Liquid | Head Liquid Values: eps' : 41.1 sigma : 1.42 |
| Distance between dipole center and liquid | 10.0 mm |
| Area scan resolution | dx=8mm/dy=8mm |
| Zoon Scan Resolution | dx=8mm/dy=8m/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 | 39.84 (3.98) | 20.5 | 20.20 (2.02) |
| 1950 | 40.5 | | 20.9 | |
| 2000 | 41.1 | | 21.1 | |
| 2100 | 43.6 | | 21.9 | |
| 2300 | 48.7 | | 23.3 | |

SATIMO **SAR REFERENCE DIPOLE CALIBRATION REPORT** Ref: ACR.262.8.14.SATU.A

| | | | | |
|---|---|---|---|---|
| 2450 | 52.4 | | 24 | |
| 2600 | 55.3 | | 24.6 | |
| 3000 | 63.8 | | 25.7 | |
| 3500 | 67.1 | | 25 | |




## 7.3 BODY LIQUID MEASUREMENT

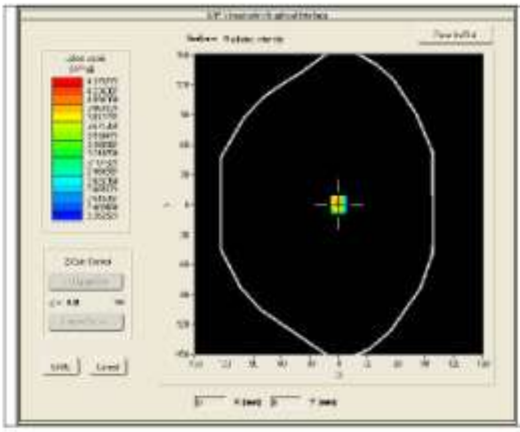
| Frequency MHz | Relative permittivity ($\varepsilon_r'$) | | Conductivity ($\sigma$) S/m | |
|---|---|---|---|---|
| | required | measured | required | measured |
| 150 | 61.9 ±5 % | | 0.80 ±5 % | |
| 300 | 58.2 ±5 % | | 0.92 ±5 % | |
| 450 | 56.7 ±5 % | | 0.94 ±5 % | |
| 750 | 55.5 ±5 % | | 0.96 ±5 % | |
| 835 | 55.2 ±5 % | | 0.97 ±5 % | |
| 900 | 55.0 ±5 % | | 1.05 ±5 % | |
| 915 | 55.0 ±5 % | | 1.06 ±5 % | |
| 1450 | 54.0 ±5 % | | 1.30 ±5 % | |
| 1610 | 53.8 ±5 % | | 1.40 ±5 % | |
| 1800 | 53.3 ±5 % | | 1.52 ±5 % | |
| 1900 | 53.3 ±5 % | PASS | 1.52 ±5 % | PASS |
| 2000 | 53.3 ±5 % | | 1.52 ±5 % | |
| 2100 | 53.2 ±5 % | | 1.62 ±5 % | |
| 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 % | |
| 5200 | 49.0 ±10 % | | 5.30 ±10 % | |
| 5300 | 48.9 ±10 % | | 5.42 ±10 % | |
| 5400 | 48.7 ±10 % | | 5.53 ±10 % | |

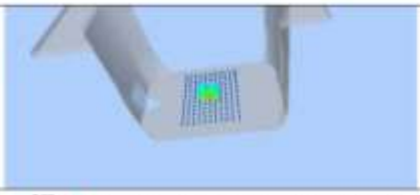
| | | | | |
|---|---|---|---|---|
| 5500 | 48.6 ±10 % | | 5.65 ±10 % | |
| 5600 | 48.5 ±10 % | | 5.77 ±10 % | |
| 5800 | 48.2 ±10 % | | 6.00 ±10 % | |

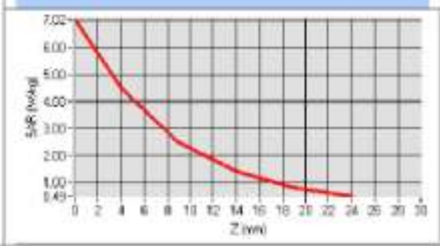
## 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

| | |
|---|---|
| Software | OPENSAR V4 |
| Phantom | SN 20/09 SAM71 |
| Probe | SN 18/11 EPG122 |
| Liquid | Body Liquid Values: eps' : 54.2 sigma : 1.54 |
| Distance between dipole center and liquid | 10.0 mm |
| Area scan resolution | dx=8mm/dy=8mm |
| Zoon Scan Resolution | dx=8mm/dy=8m/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 | 43.33 (4.33) | 21.59 (2.16) |



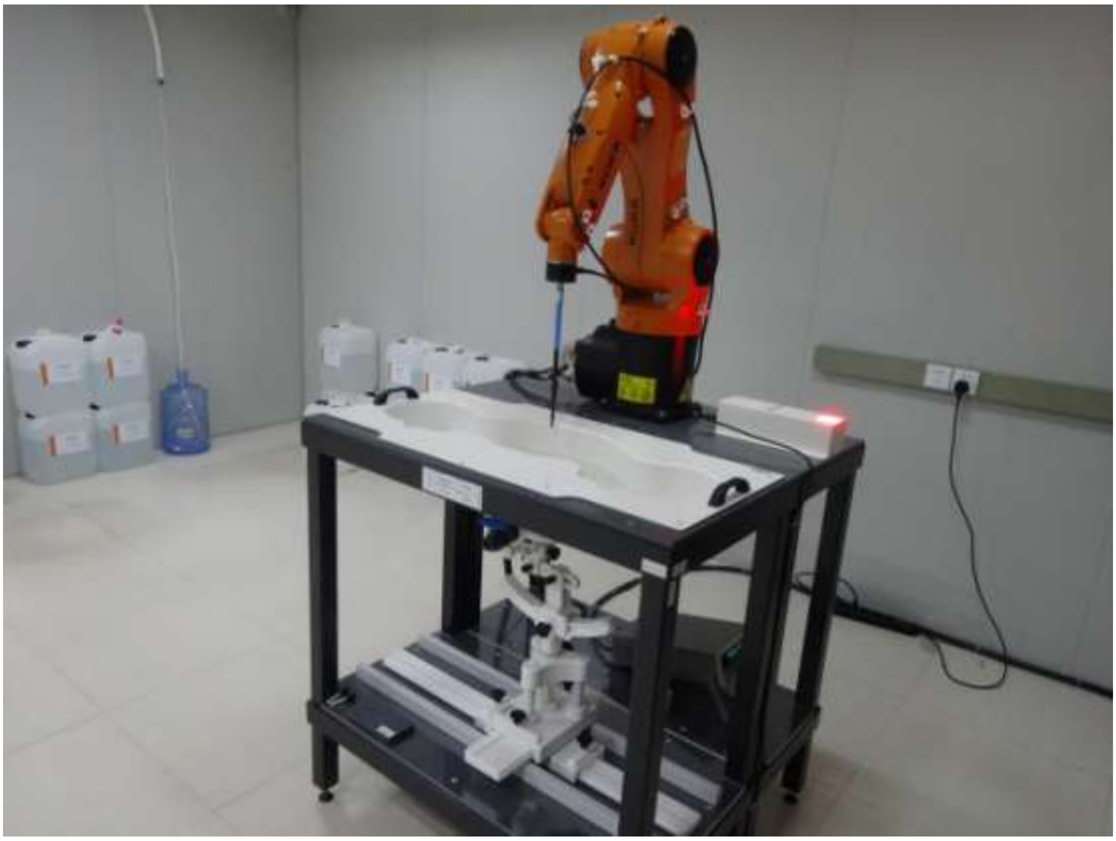




## 8 LIST OF EQUIPMENT

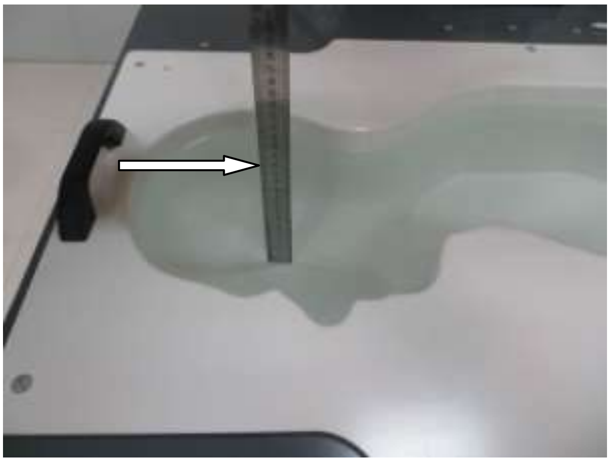
| Equipment Summary Sheet | | | | |
|---|---|---|---|---|
| **Equipment Description** | **Manufacturer / Model** | **Identification No.** | **Current Calibration Date** | **Next Calibration Date** |
| SAM Phantom | Satimo | SN-20/09-SAM71 | Validated. No cal required. | Validated. No cal required. |
| COMOSAR Test Bench | Version 3 | NA | Validated. No cal required. | Validated. No cal required. |
| Network Analyzer | Rhode & Schwarz ZVA | SN100132 | 02/2013 | 02/2016 |
| Calipers | Carrera | CALIPER-01 | 12/2013 | 12/2016 |
| Reference Probe | Satimo | EPG122 SN 18/11 | 10/2013 | 10/2014 |
| 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. |
| Temperature and Humidity Sensor | Control Company | 11-661-9 | 8/2012 | 8/2015 |

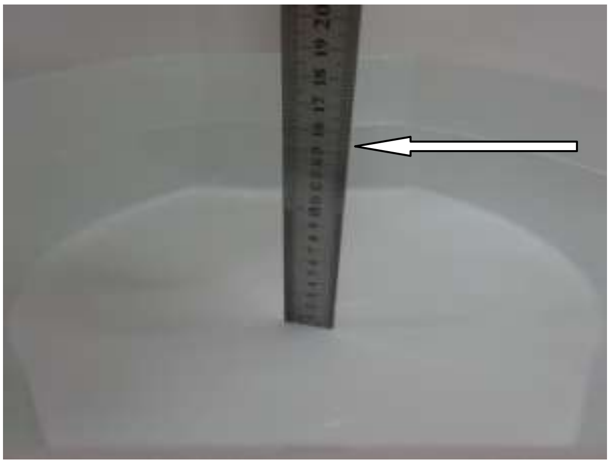
# 7. SAR System PHOTOGRAPHS



**DEPTH OF THE LIQUID IN THE PHANTOM—ZOOM IN**

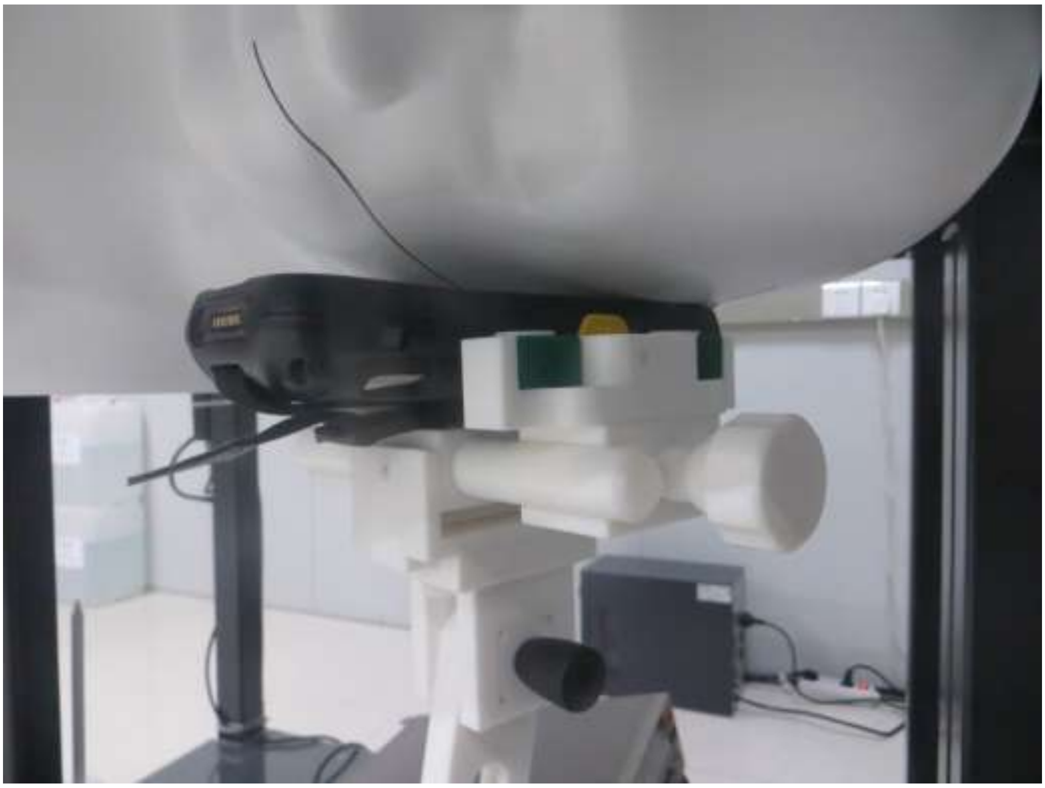
Note:The position used in the measurement were according to IEEE1528-2013



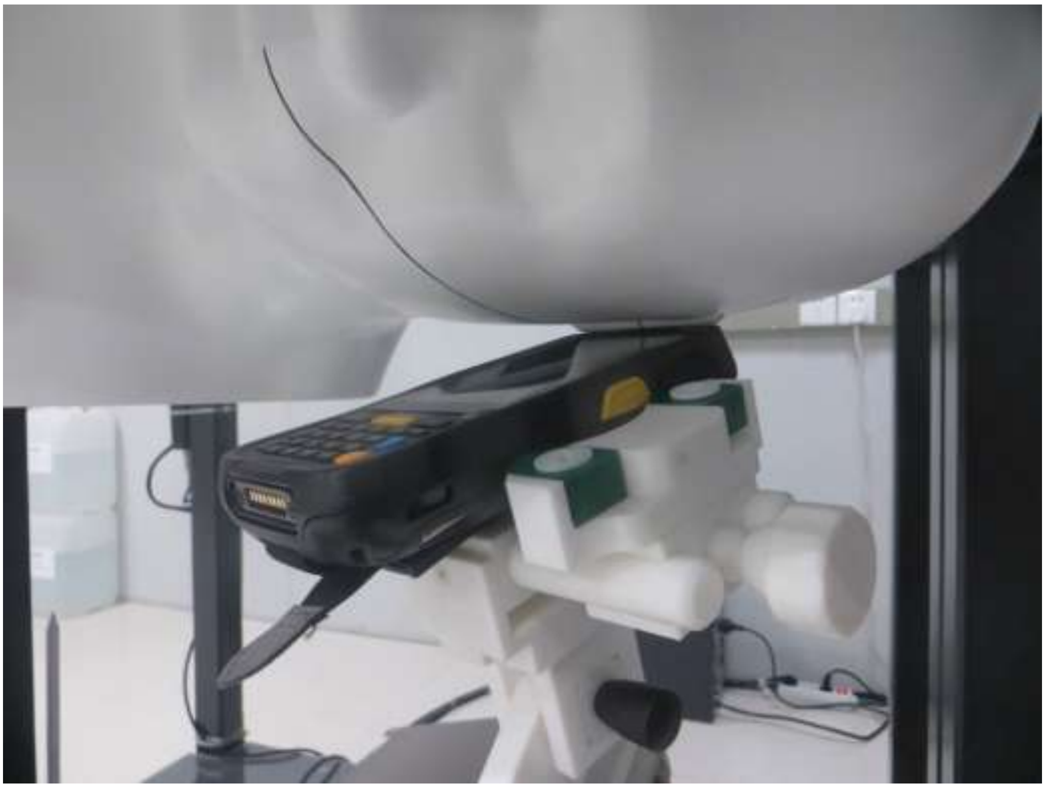


# 8. SETUP PHOTOGRAPHS

**HeadSetup Photo(Left cheek)**



**Head Setup Photo(LeftTilt )**

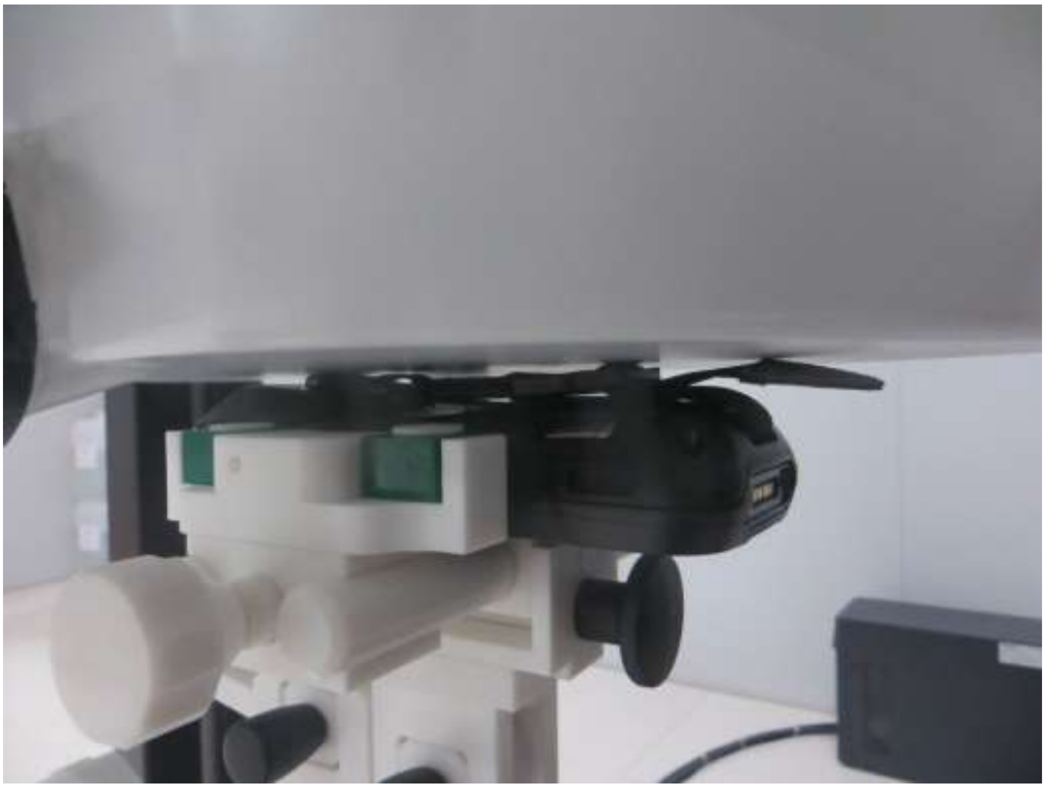


**Head Setup Photo(Right Cheek )**

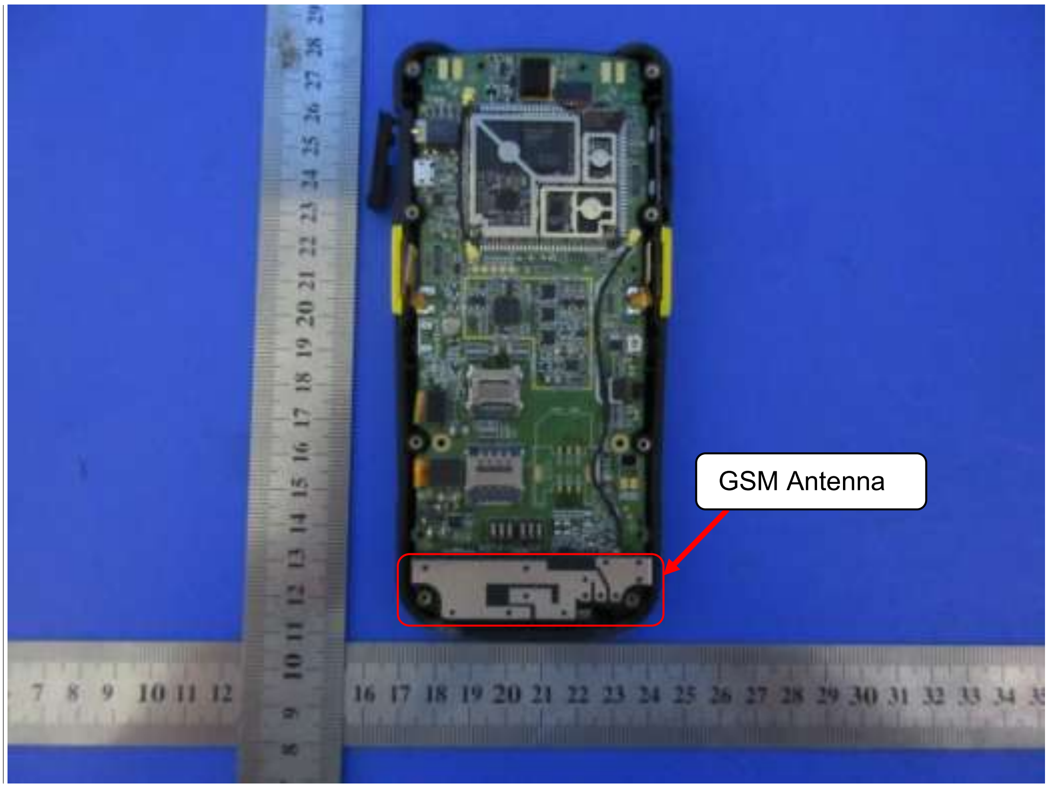
**Head Setup Photo(Right Tilt )**

**15mm body-worn Front Side Setup Photo**

**0mm body-worn Back Side Setup Photo**



# 9. EUTPHOTOGRAPHS




....................The End of Test Report......................