# SAR TEST REPORT

## No. I15N01101-SAR

**For**

**TCL Communication Ltd.**

**GSM Quad band &UMTS Dual band mobile phone**

**Mode Name: 2045X**

**With**

**Hardware Version: PIO**

**Software Version: V1.0**

**FCC ID: 2ACCJB038**

**Issued Date: 2015-10-25**

**Note:**

The test results in this test report relate only to the devices specified in this report.This report shall not be reproduced except in full without the written approval of CTTL.

**Test Laboratory:**

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## REPORT HISTORY

| Report Number | Revision | Issue Date | Description |
|---|---|---|---|
| I15N01101-SAR | Rev.0 | 2015-10-25 | Initial creation of test report |

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# 1 Test Laboratory

## 1.1 Testing Location

| | |
|---|---|
| Company Name: | CTTL(South Branch) |
| Address: | TCL International E city No. 1001 Zhongshanyuan Road, Nanshan District, Shenzhen, Guangdong, China 518000 |

## 1.2 Testing Environment

| | |
|---|---|
| Temperature: | Min. = 15 °C, Max. = 30 °C |
| Relative humidity: | Min. = 30%, Max. = 70% |
| Ground system resistance: | < 0.5 Ω |
| Ambient noise & Reflection: | < 0.012 W/kg |

## 1.3 Project Data

| | |
|---|---|
| Project Leader: | Cao Junfei |
| Test Engineer: | He Guanyi |
| Testing Start Date: | October 24, 2015 |
| Testing End Date: | October 24, 2015 |

## 1.4 Signature

**He Guanyi**

**(Prepared this test report)**

**Cao Junfei**

**(Reviewed this test report)**

**Zhang Bojun**

**Deputy Director of the laboratory**

**(Approved this test report)**

## 2 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for TCL Communication Ltd. GSM Quad band &UMTS Dual band mobile phone 2045X are as follows:

**Table 2.1: Highest Reported SAR (1g)**

| Exposure Configuration | Technology Band | Highest Reported SAR 1g (W/Kg) | Equipment Class |
|---|---|---|---|
| Head (Separation Distance 0mm) | GSM 850 | 0.50 | PCE |
| | PCS 1900 | 0.40 | |
| Body-worn (Separation Distance 15mm) | GSM 850 | 0.82 | PCE |
| | PCS 1900 | **0.89** | |

The SAR values found for the Mobile Phone are below the maximum recommended levels of 1.6 W/Kg as averaged over any 1g tissue according to the ANSI C95.1-1992.

For body worn operation, this device has been tested and meets FCC RF exposure guidelines when used with any accessory that contains no metal and which provides a minimum separation distance of 15 mm between this device and the body of the user. Use 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 uniform power output.

The measurement together with the test system set-up is described in annex C of this test report. A detailed description of the equipment under test can be found in chapter 4 of this test report.
The highest reported SAR value is obtained at the case of **(Table 2.1),** and the values are**: 0.89 W/kg (1g).**

**Table 2.2: The sum of reported SAR values for main antenna and Bluetooth**

| | **Position** | **Main antenna** | **BT*** | **Sum** |
|---|---|---|---|---|
| **Highest reported SAR value for Head** | Left hand, Touch cheek | 0.40 | 0.17 | **0.57** |
| | Right hand, Touch cheek | 0.50 | 0.17 | **0.67** |
| **Highest reported SAR value for Body** | Rear | 0.89 | 0.06 | **0.95** |

BT* - Estimated SAR for Bluetooth (see the table 13.3)

# 3 Client Information

## 3.1 Applicant Information

| | |
|---|---|
| Company Name: | TCL Communication Ltd. |
| Address /Post: | 5F, C-Tower, No. 232, Liang Jing Road, ZhangJiang High-Tech Park, Pudong Area,Shanghai,201003,P.R.China |
| City: | Shanghai |
| Postal Code: | 201003 |
| Country: | P.R.China |
| Contact: | Tiffany.Tang |
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| Telephone: | +86(0)21 51798260 |
| Fax: | +86(0)21 6146 0600 |

## 3.2 Manufacturer Information

| | |
|---|---|
| Company Name: | TCL Communication Ltd. |
| Address /Post: | 5F, C-Tower, No. 232, Liang Jing Road, ZhangJiang High-Tech Park, Pudong Area,Shanghai,201003,P.R.China |
| City: | Shanghai |
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| Telephone: | +86(0)21 51798260 |
| Fax: | +86(0)21 6146 0600 |

# 4 Equipment Under Test (EUT) and Ancillary Equipment (AE)

## 4.1 About EUT

| | |
|---|---|
| Description: | GSM Quad band &UMTS Dual band mobile phone |
| Mode Name: | 2045X |
| Marketing Name: | / |
| Operating mode(s): | GSM 850/900/1800/1900, WCDMA 900/2100, BT, |
| Tested Tx Frequency: | 825 – 848.8 MHz (GSM 850) |
| | 1850.2 – 1910 MHz (GSM 1900) |
| GPRS Multislot Class: | 10 |
| GPRS capability Class: | B |
| Release Version: | GSM: Rel4 |
| | GPRS: Rel4 |
| Test device Production information: | Production unit |
| Device type: | Portable device |
| Antenna type: | Integrated antenna |
| Accessories/Body-worn configurations: | Headset |
| Hotspot mode: | / |
| Form factor: | 104.4 mm ×51.9 mm |

## 4.2 Internal Identification of EUT used during the test

| EUT ID* | SN or IMEI | HW Version | SW Version |
|---|---|---|---|
| EUT1 | 355626060090605 | PIO | V1.0 |

*EUT ID: is used to identify the test sample in the lab internally.

## 4.3 Internal Identification of AE used during the test

| AE ID* | Description | Model | SN | Manufacturer |
|---|---|---|---|---|
| AE1 | Battery | CAB3120000C1 | / | BYD |
| AE2 | Headset | CCB0010A11C7 | / | JIAYIKANG |
| AE3 | Headset | CCB0010A10C7 | / | JIAYIKANG |

*AE ID: is used to identify the test sample in the lab internally.

**Note:**

AE3 and AE2 are the same, so they can use the same results.

# 5 TEST METHODOLOGY

## 5.1 Applicable Limit Regulations

**ANSI C95.1–1992:** IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.
It specifies the maximum exposure limit of **1.6 W/kg** as averaged over any 1 gram of tissue for portable devices being used within 20 cm of the user in the uncontrolled environment.

## 5.2 Applicable Measurement Standards

**IEEE 1528–2013:** Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Experimental Techniques.

**KDB447498 D01: General RF Exposure Guidance v05r02:** Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

**KDB648474 D04 Handset SAR v01r02:** SAR Evaluation Considerations for Wireless Handsets.

**KDB941025 D06:** SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities

**KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r03:** SAR Measurement Requirements for 100 MHz to 6 GHz

**KDB 865664 D02 RF Exposure Reporting v01r01:** RF Exposure Compliance Reporting and Documentation Considerations

# 6 Specific Absorption Rate (SAR)

## 6.1 Introduction

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

## 6.2 SAR Definition

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

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

SAR is expressed in units of Watts per kilogram (W/kg)
SAR measurement can be either related to the temperature elevation in tissue by

$$SAR = c\left(\frac{\delta T}{\delta t}\right)$$

Where: C is the specific head capacity, $\delta T$ is the temperature rise and $\delta t$ is the exposure duration, or related to the electrical field in the tissue by

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

Where: $\sigma$ is the conductivity of the tissue, $\rho$ is the mass density of tissue and $E$ is the RMS electrical field strength.

However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

# 7 Tissue Simulating Liquids

## 7.1 Targets for tissue simulating liquid

**Table 7.1: Targets for tissue simulating liquid**

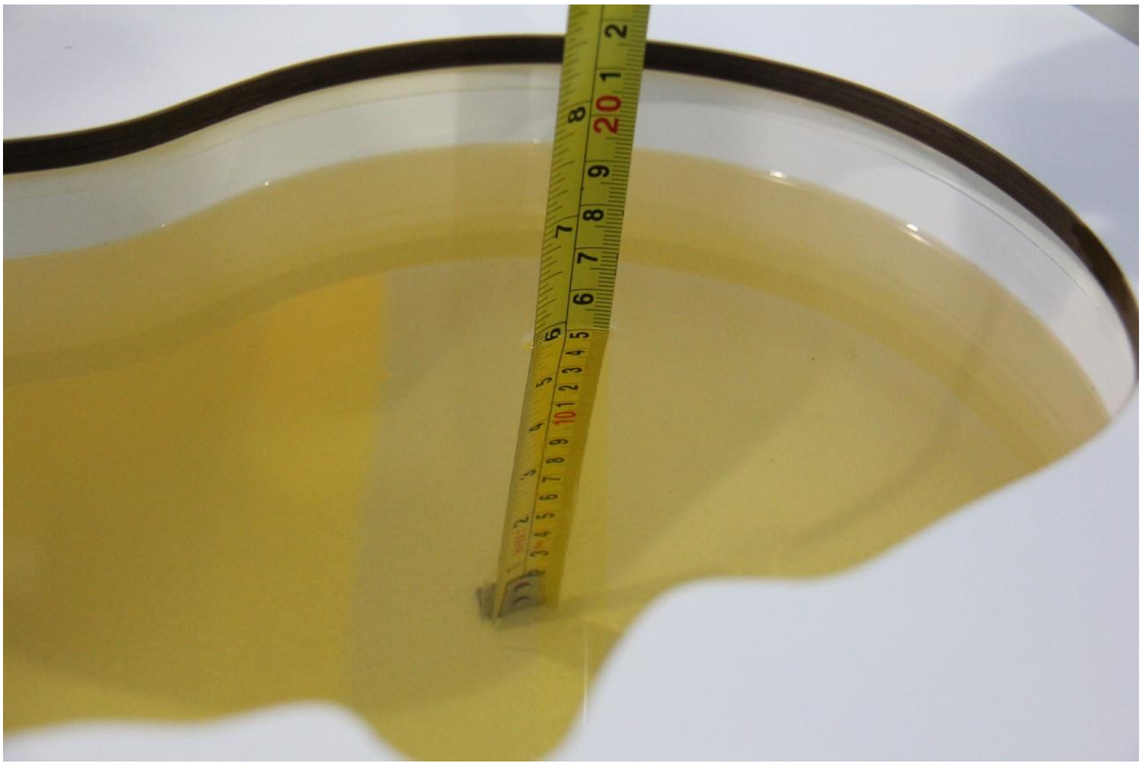
| Frequency (MHz) | Liquid Type | Conductivity (σ) | ± 5% Range | Permittivity (ε) | ± 5% Range |
|---|---|---|---|---|---|
| 835 | Head | 0.90 | 0.86～0.95 | 41.5 | 39.4～43.6 |
| 835 | Body | 0.97 | 0.92～1.02 | 55.2 | 52.4～58.0 |
| 1900 | Head | 1.40 | 1.33～1.47 | 40.0 | 38.0～42.0 |
| 1900 | Body | 1.52 | 1.44～1.60 | 53.3 | 50.6～56.0 |

## 7.2 Dielectric Performance

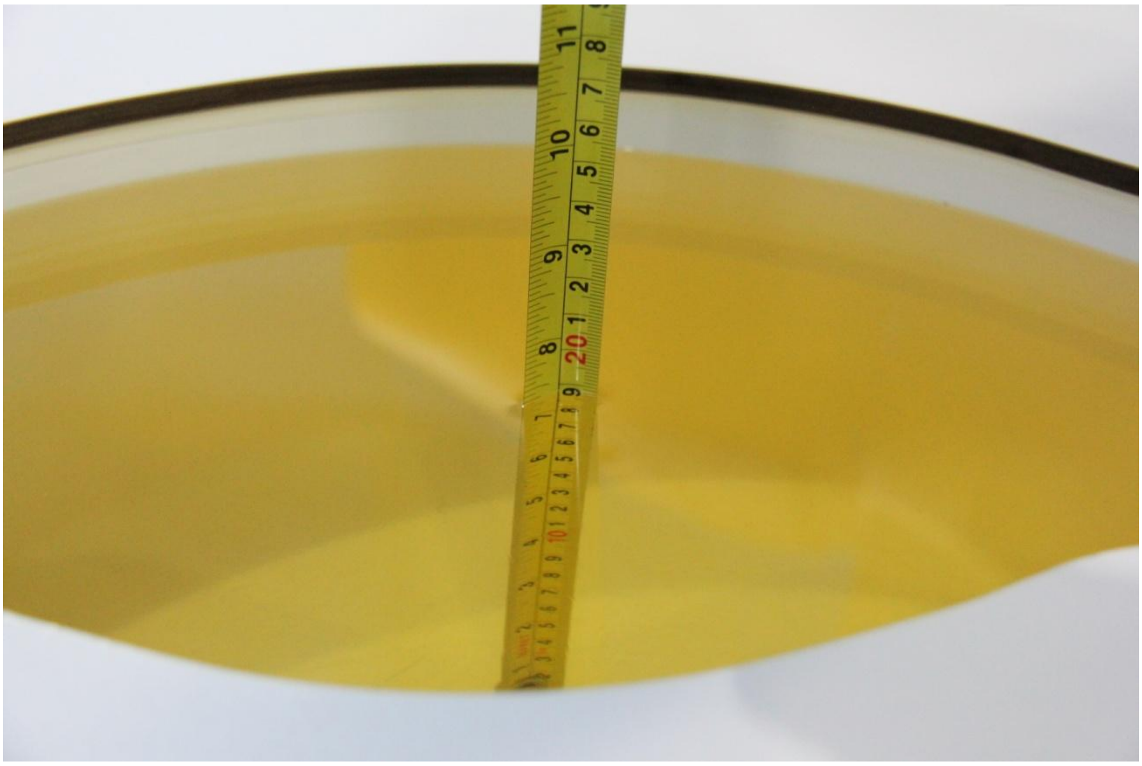
**Table 7.2: Dielectric Performance of Tissue Simulating Liquid**

| Measurement Date (yyyy-mm-dd) | Type | Frequency | Permittivity ε | Drift (%) | Conductivity σ (S/m) | Drift (%) |
|---|---|---|---|---|---|---|
| 2015-10-24 | Head | 835 MHz | 41.32 | -0.43 | 0.93 | 3.33 |
| 2015-10-24 | Body | 835 MHz | 53.50 | -3.08 | 0.97 | 0.00 |
| 2015-10-24 | Head | 1900 MHz | 40.85 | 2.13 | 1.39 | -0.71 |
| 2015-10-24 | Body | 1900 MHz | 50.79 | -4.71 | 1.54 | 1.32 |

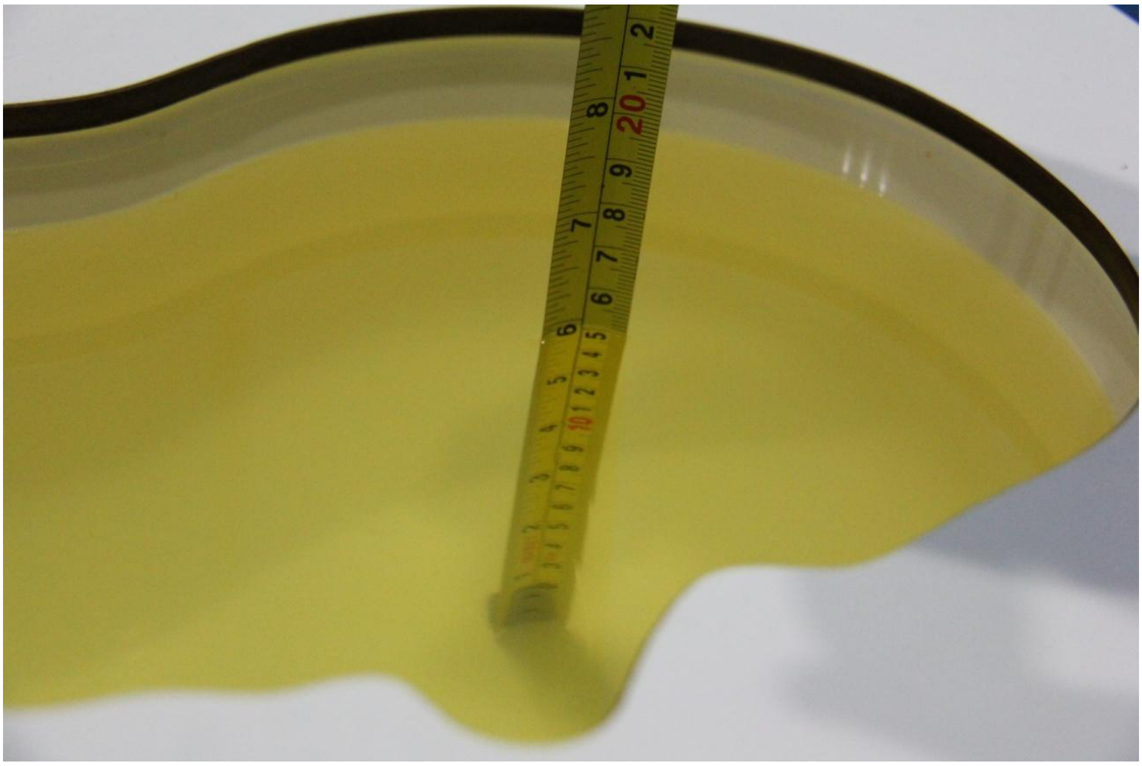
Note: The liquid temperature is 22.0 $^{o}$C



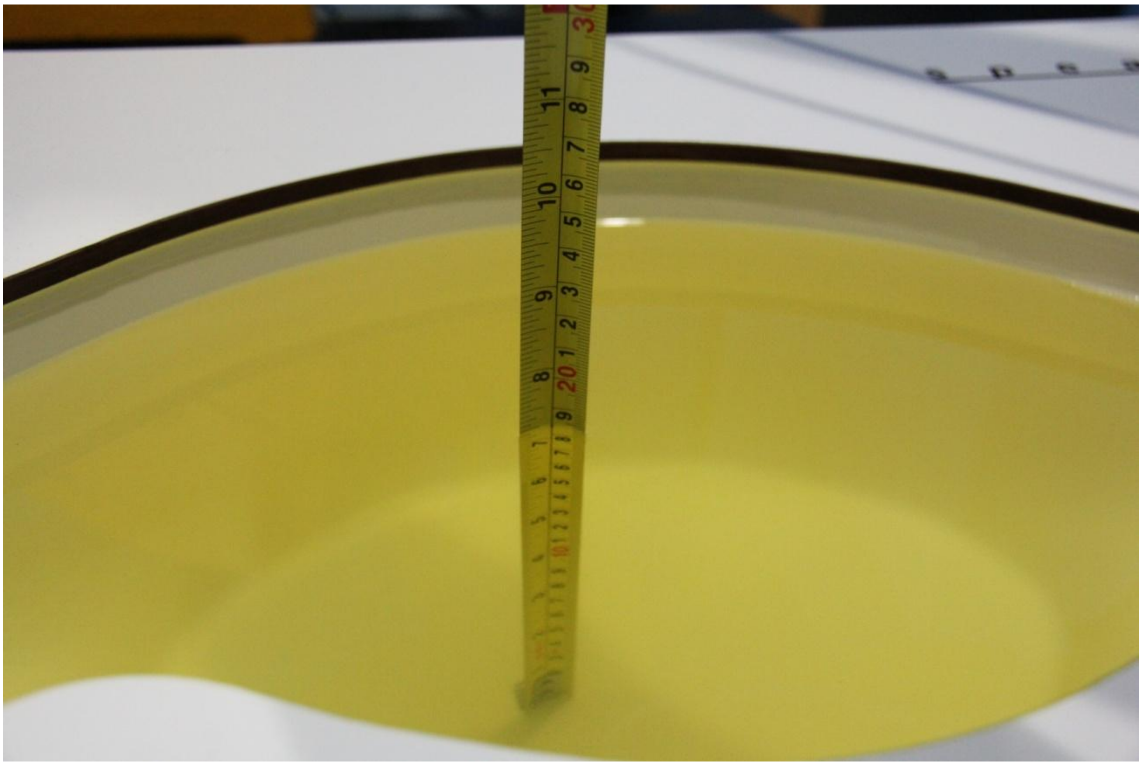
**Picture 7-1: Liquid depth in the Head Phantom (835 MHz)**



**Picture 7-2: Liquid depth in the Flat Phantom (835 MHz)**



Picture 7-3: Liquid depth in the Head Phantom (1900 MHz)

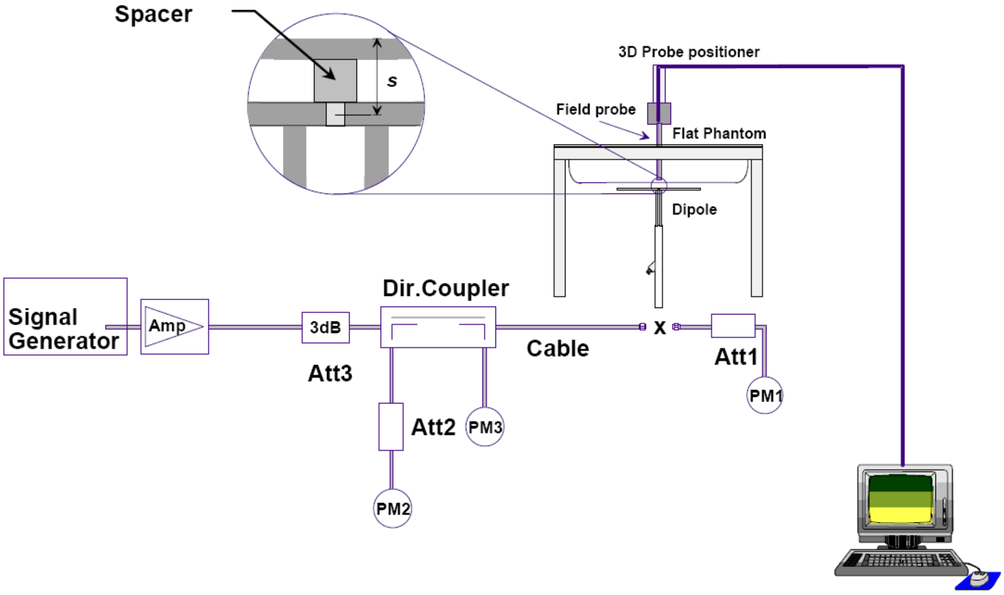


Picture 7-4 Liquid depth in the Flat Phantom (1900MHz)

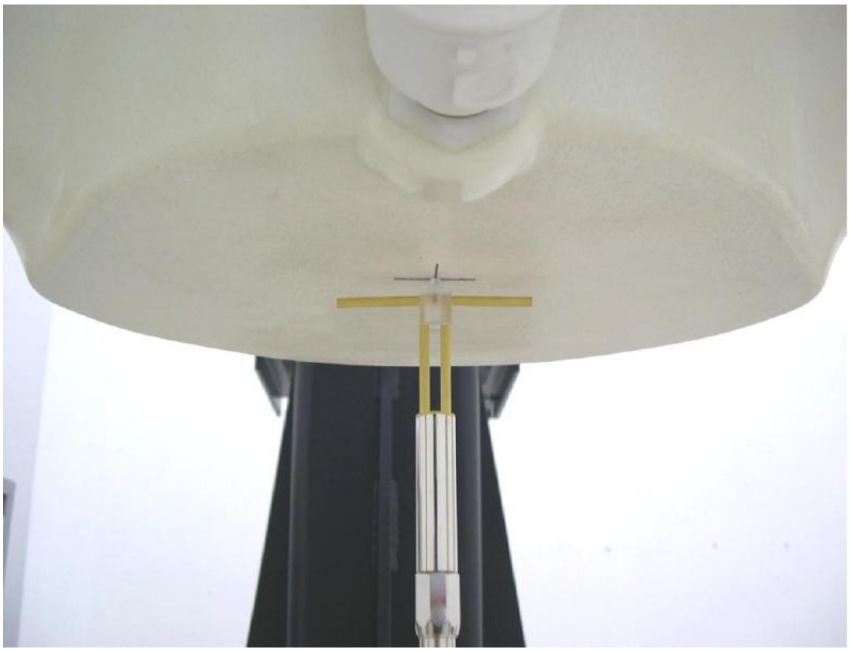
# 8 System verification

## 8.1 System Setup

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 beneath 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:




**Picture 8.1 System Setup for System Evaluation**



**Picture 8.2 Photo of Dipole Setup**

## 8.2 System Verification

SAR system verification is required to confirm measurement accuracy, according to the tissue dielectric media, probe calibration points and other system operating parameters required for measuring the SAR of a test device. The system verification must be performed for each frequency band and within the valid range of each probe calibration point required for testing the device.

The system verification results are required that the area scan estimated 1-g SAR is within 3% of the zoom scan 1-g SAR. The details are presented in annex B.

**Table 8.1: System Verification of Head**

| Measurement Date (yyyy-mm-dd) | Frequency | Target value (W/kg) | | Measured value (W/kg) | | Deviation | |
|---|---|---|---|---|---|---|---|
| | | 10 g Average | 1 g Average | 10 g Average | 1 g Average | 10 g Average | 1 g Average |
| 2015-10-24 | 835 MHz | 6.2 | 9.5 | 6.2 | 9.76 | 0.00% | 2.74% |
| 2015-10-24 | 1900 MHz | 20.9 | 40.5 | 20.4 | 40.64 | -2.39% | 0.35% |

**Table 8.2: System Verification of Body**

| Measurement Date (yyyy-mm-dd) | Frequency | Target value (W/kg) | | Measured value (W/kg) | | Deviation | |
|---|---|---|---|---|---|---|---|
| | | 10 g Average | 1 g Average | 10 g Average | 1 g Average | 10 g Average | 1 g Average |
| 2015-10-24 | 835 MHz | 6.4 | 9.5 | 6.32 | 9.84 | -1.25% | 3.58% |
| 2015-10-24 | 1900 MHz | 21.5 | 41.1 | 22.16 | 41.2 | 3.07% | 0.24% |

# 9 Measurement Procedures

## 9.1 Tests to be performed

In order to determine the highest value of the peak spatial-average SAR of a handset, all device positions, configurations and operational modes shall be tested for each frequency band according to steps 1 to 3 below. A flowchart of the test process is shown in picture 9.1.

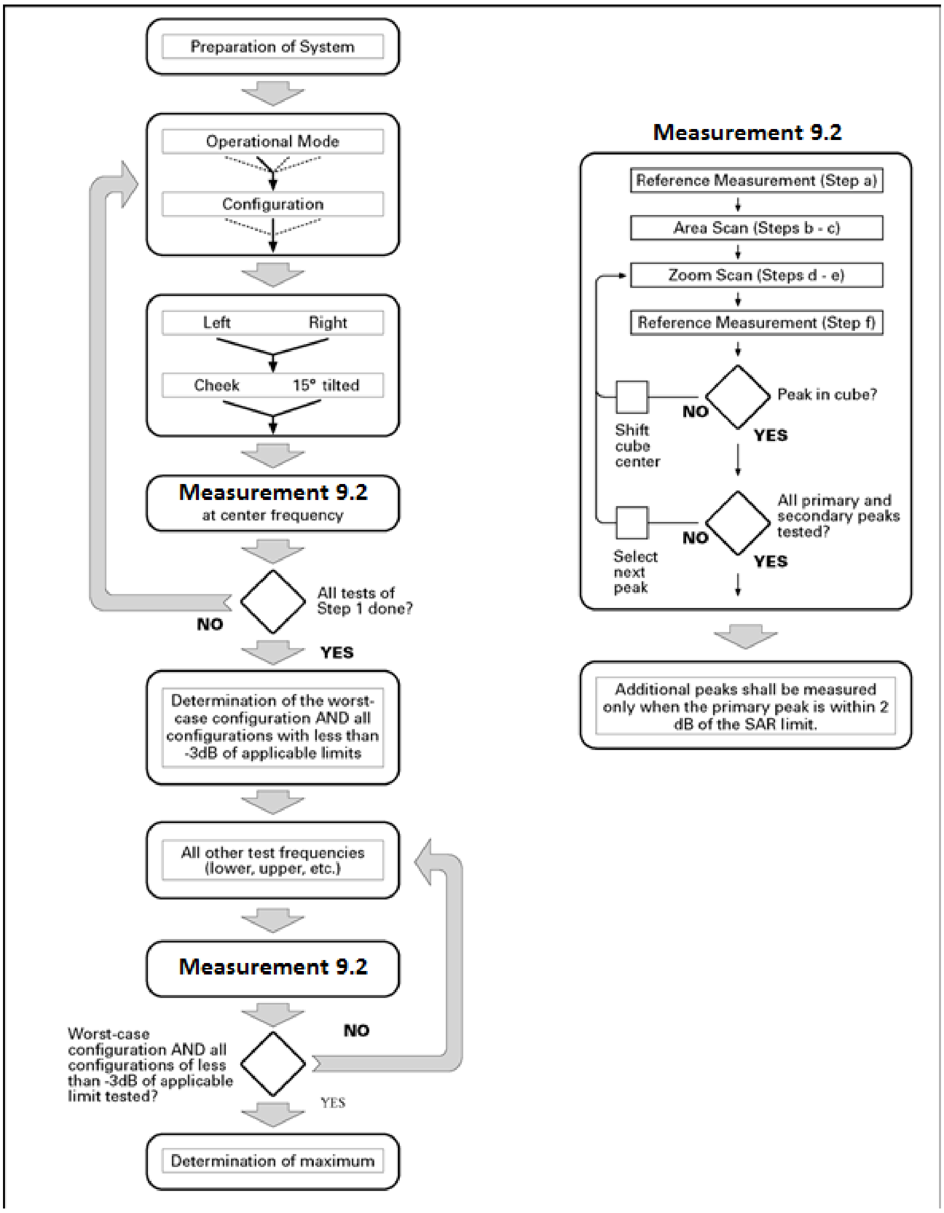
**Step 1**: The tests described in 9.2 shall be performed at the channel that is closest to the centre of the transmit frequency band ( $f_c$ ) for:

a) all device positions (cheek and tilt, for both left and right sides of the SAM phantom, as described in annex D),
b) all configurations for each device position in a), e.g., antenna extended and retracted, and
c) all operational modes, e.g., analogue and digital, for each device position in a) and configuration in b) in each frequency band.

If more than three frequencies need to be tested according to 11.1 (i.e., $N_c$ > 3), then all frequencies, configurations and modes shall be tested for all of the above test conditions.

**Step 2**: For the condition providing highest peak spatial-average SAR determined in Step 1, perform all tests described in 9.2 at all other test frequencies, i.e., lowest and highest frequencies. In addition, for all other conditions (device position, configuration and operational mode) where the peak spatial-average SAR value determined in Step 1 is within 3 dB of the applicable SAR limit, it is recommended that all other test frequencies shall be tested as well.

**Step 3**: Examine all data to determine the highest value of the peak spatial-average SAR found in Steps 1 to 2.




**Picture 9.1 Block diagram of the tests to be performed**

## 9.2 General Measurement Procedure

The area and zoom scan resolutions specified in the table below must be applied to the SAR measurements and fully documented in SAR reports to qualify for TCB approval. Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Both the probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1-g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements, according to the reference distribution functions specified in IEEE Std 1528-2003. The results should be documented as part of the system validation records and may be requested to support test results when all the measurement parameters in the following table are not satisfied.

| | | | ≤ 3 GHz | > 3 GHz |
|---|---|---|---|---|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | | | 5 ± 1 mm | ½·δ·ln(2) ± 0.5 mm |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location | | | 30° ± 1° | 20° ± 1° |
| Maximum area scan spatial resolution: $\Delta x_{Area}$, $\Delta y_{Area}$ | | | ≤ 2 GHz: ≤ 15 mm<br>2 – 3 GHz: ≤ 12 mm | 3 – 4 GHz: ≤ 12 mm<br>4 – 6 GHz: ≤ 10 mm |
| | | | When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device. | |
| Maximum zoom scan spatial resolution: $\Delta x_{Zoom}$, $\Delta y_{Zoom}$ | | | ≤ 2 GHz: ≤ 8 mm<br>2 – 3 GHz: ≤ 5 mm* | 3 – 4 GHz: ≤ 5 mm*<br>4 – 6 GHz: ≤ 4 mm* |
| Maximum zoom scan spatial resolution, normal to phantom surface | uniform grid: $\Delta z_{Zoom}(n)$ | | ≤ 5 mm | 3 – 4 GHz: ≤ 4 mm<br>4 – 5 GHz: ≤ 3 mm<br>5 – 6 GHz: ≤ 2 mm |
| | graded grid | $\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface | ≤ 4 mm | 3 – 4 GHz: ≤ 3 mm<br>4 – 5 GHz: ≤ 2.5 mm<br>5 – 6 GHz: ≤ 2 mm |
| | | $\Delta z_{Zoom}(n>1)$: between subsequent points | ≤ 1.5·$\Delta z_{Zoom}(n-1)$ | |
| Minimum zoom scan volume | x, y, z | | ≥ 30 mm | 3 – 4 GHz: ≥ 28 mm<br>4 – 5 GHz: ≥ 25 mm<br>5 – 6 GHz: ≥ 22 mm |

Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.

* When zoom scan is required and the *reported* SAR from the area scan based *1-g SAR estimation* procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

## 9.4 Bluetooth Measurement Procedures for SAR

Normal network operating configurations are not suitable for measuring the SAR of BT. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure that the results are consistent and reliable.

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in a test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.

### 9.5 Power Drift

To control the output power stability during the SAR test, DASY4 system calculates the power drift by measuring the E-field at the same location at the beginning and at the end of the measurement for each test position. These drift values can be found in Table 14.2 to Table 14.23 labeled as: (Power Drift [dB]). This ensures that the power drift during one measurement is within 5%.

## 10 Area Scan Based 1-g SAR

### 10.1 Requirement of KDB

According to the KDB447498 D01 v05, when the implementation is based the specific polynomial fit algorithm as presented at the 29th Bioelectromagnetics Society meeting (2007) and the estimated 1-g SAR is ≤ 1.2 W/kg, a zoom scan measurement is not required provided it is also not needed for any other purpose; for example, if the peak SAR location required for simultaneous transmission SAR test exclusion can be determined accurately by the SAR system or manually to discriminate between distinctive peaks and scattered noisy SAR distributions from area scans.

There must not be any warning or alert messages due to various measurement concerns identified by the SAR system; for example, noise in measurements, peaks too close to scan boundary, peaks are too sharp, spatial resolution and uncertainty issues etc. The SAR system verification must also demonstrate that the area scan estimated 1-g SAR is within 3% of the zoom scan 1-g SAR (See Annex B). When all the SAR results for each exposure condition in a frequency band and wireless mode are based on estimated 1-g SAR, the 1-g SAR for the highest SAR configuration must be determined by a zoom scan.

### 10.2 Fast SAR Algorithms

The approach is based on the area scan measurement applying a frequency dependent attenuation parameter. This attenuation parameter was empirically determined by analyzing a large number of phones. The MOTOROLA FAST SAR was developed and validated by the MOTOROLA Research Group in Ft. Lauderdale.

In the initial study, an approximation algorithm based on Linear fit was developed. The accuracy of the algorithm has been demonstrated across a broad frequency range (136-2450 MHz) and for both 1- and 10-g averaged SAR using a sample of 264 SAR measurements from 55 wireless handsets. For the sample size studied, the root-mean-squared errors of the algorithm are 1.2% and 5.8% for 1- and 10-g averaged SAR, respectively. The paper describing the algorithm in detail is expected to be published in August 2004 within the Special Issue of Transactions on MTT.

In the second step, the same research group optimized the fitting algorithm to an Polynomial fit whereby the frequency validity was extended to cover the range 30-6000MHz. Details of this study can be found in the BEMS 2007 Proceedings.

Both algorithms are implemented in DASY software.

# 11 Conducted Output Power

## 11.1 Manufacturing tolerance

**Table 11.1: GSM Speech**

| GSM 850 | | | |
|---|---|---|---|
| Channel | Channel 251 | Channel 190 | Channel 128 |
| Target (dBm) | 32.0 | 32.0 | 32.0 |
| Tolerance ±(dB) | 1 | 1 | 1 |
| GSM 1900 | | | |
| Channel | Channel 810 | Channel 661 | Channel 512 |
| Target (dBm) | 29 | 29 | 29 |
| Tolerance ±(dB) | 1 | 1 | 1 |

**Table 11.2: GPRS**

| GSM 850 GPRS | | | | |
|---|---|---|---|---|
| Channel | | **251** | **190** | **128** |
| 1 Txslot | Target (dBm) | 32.0 | 32.0 | 32.0 |
| | Tolerance ±(dB) | 1 | 1 | 1 |
| 2 Txslots | Target (dBm) | 31 | 31 | 31 |
| | Tolerance ±(dB) | 1 | 1 | 1 |
| GSM 1900 GPRS | | | | |
| Channel | | **810** | **661** | **512** |
| 1 Txslot | Target (dBm) | 29 | 29 | 29 |
| | Tolerance ±(dB) | 1 | 1 | 1 |
| 2 Txslots | Target (dBm) | 28 | 28 | 28 |
| | Tolerance ±(dB) | 1 | 1 | 1 |

**Table 11.3: Bluetooth**

| Mode | Target (dBm) | Tolerance ±(dB) |
|---|---|---|
| GFSK | 4 | 2 |
| EDR2M-4_DQPSK | 3 | 2 |
| EDR3M-8DPSK | 3 | 2 |

## 11.2 GSM Measurement result

During the process of testing, the EUT was controlled via Agilent Digital Radio Communication tester (E5515C) to ensure the maximum power transmission and proper modulation. This result contains conducted output power for the EUT. In all cases, the measured peak output power should be greater and within 5% than EMI measurement.

**Table 11.6: The conducted power measurement results for GSM850/1900**

| GSM 850MHz | Conducted Power (dBm) | | |
|---|---|---|---|
| | Channel 251(848.8MHz) | Channel 190(836.6MHz) | Channel 128(824.2MHz) |
| | 32.15 | 32.20 | 32.16 |
| GSM 1900MHz | Conducted Power (dBm) | | |
| | Channel 810(1909.8MHz) | Channel 661(1880MHz) | Channel 512(1850.2MHz) |
| | 29.00 | 29.02 | 29.08 |

**Table 11.7: The conducted power measurement results for GPRS**

| GSM 850 GPRS (GMSK) | Measured Power (dBm) | | | calculation | Averaged Power (dBm) | | |
|---|---|---|---|---|---|---|---|
| | **251** | **190** | **128** | | **251** | **190** | **128** |
| 1 Txslot | 32.15 | 32.20 | 32.16 | -9.03dB | 23.10 | 23.17 | 23.13 |
| **2 Txslots** | 31.39 | 31.45 | 31.40 | -6.02dB | **25.37** | **25.43** | **25.38** |
| PCS1900 GPRS (GMSK) | Measured Power (dBm) | | | calculation | Averaged Power (dBm) | | |
| | **810** | **661** | **512** | | **810** | **661** | **512** |
| 1 Txslot | 29.00 | 29.02 | 29.08 | -9.03dB | 19.97 | 19.99 | 20.05 |
| **2 Txslots** | 28.03 | 27.97 | 27.96 | -6.02dB | **22.01** | **21.95** | **21.94** |

NOTES:

1) Division Factors

To average the power, the division factor is as follows:

1TX-slot = 1 transmit time slot out of 8 time slots=> conducted power divided by (8/1) => -9.03dB

2TX-slots = 2 transmit time slots out of 8 time slots=> conducted power divided by (8/2) => -6.02dB

**According to the conducted power as above, the body measurements are performed with 2Txslots for GSM 850 and GSM 1900.**

## 11.3 BT Measurement result

The output power of BT antenna is as following:

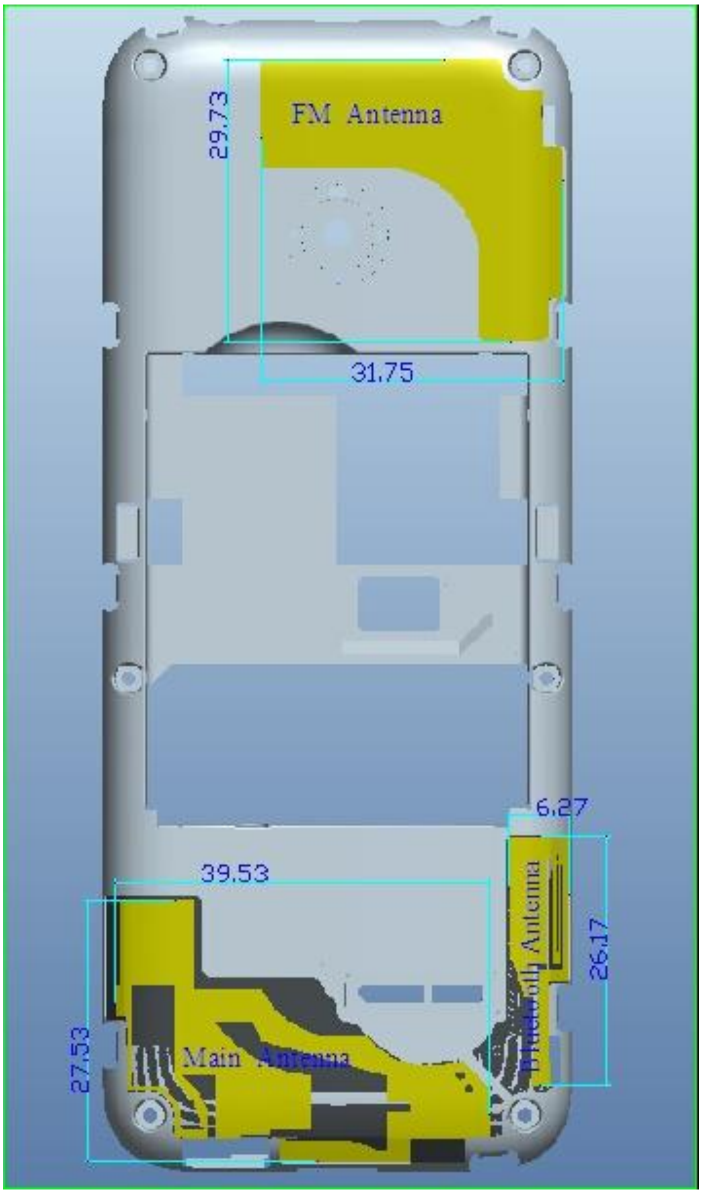
| Mode | Conducted Power (dBm) | | |
|---|---|---|---|
| | Channel 0 (2402MHz) | Channel 39 (2441MHz) | Channel 78 (2480MHz) |
| GFSK | 4.81 | 4.80 | 4.74 |
| EDR2M-4_DQPSK | 3.79 | 3.90 | 4.00 |
| EDR3M-8DPSK | 3.69 | 3.85 | 3.93 |

# 10 Simultaneous TX SAR Considerations

## 10.1 Introduction

The following procedures adopted from “FCC SAR Considerations for Cell Phones with Multiple Transmitters” are applicable to handsets with built-in unlicensed transmitters such as 802.11 a/b/g and Bluetooth devices which may simultaneously transmit with the licensed transmitter.
For this device, the BT and Wi-Fi can transmit simultaneous with other transmitters.

## 10.2 Transmit Antenna Separation Distances




**Picture 10.1 Antenna Locations**

## 10.3 Standalone SAR Test Exclusion Considerations

Standalone 1-g head or body SAR evaluation by measurement or numerical simulation is not required when the corresponding SAR Exclusion Threshold condition, listed below, is satisfied. The 1-g SAR test exclusion threshold for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR, where

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

**Table 10.1: Standalone SAR test exclusion considerations**

| Band/Mode | F(GHz) | Position | SAR test exclusion threshold (mW) | RF output power | | SAR test exclusion |
|---|---|---|---|---|---|---|
| | | | | dBm | mW | |
| Bluetooth | 2.441 | Head | 9.60 | 4.81 | 3.03 | Yes |
| | | Body | 19.20 | 4.81 | 3.03 | Yes |

## 13 Evaluation of Simultaneous

**Table 13.1: The sum of reported SAR values for main antenna and Bluetooth**

| | Position | Main antenna | BT* | Sum |
|---|---|---|---|---|
| **Highest reported SAR value for Head** | Left hand, Touch cheek | 0.40 | 0.17 | **0.57** |
| | Right hand, Touch cheek | 0.50 | 0.17 | **0.67** |
| **Highest reported SAR value for Body** | Rear | 0.89 | 0.06 | **0.95** |

BT* - Estimated SAR for Bluetooth (see the table 13.2)

**Table 13.2: Estimated SAR for Bluetooth**

| Position | F (GHz) | Distance (mm) | Upper limit of power * | | Estimated$_{1g}$ (W/kg) |
|---|---|---|---|---|---|
| | | | dBm | mW | |
| Head | 2.441 | 5 | 6 | 3.98 | 0.17 |
| Body | 2.441 | 15 | 6 | 3.98 | 0.06 |

* - Maximum possible output power declared by manufacturer

When standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:
(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)]·[√f(GHz)/x] W/kg for test separation distances ≤ 50 mm;
where x = 7.5 for 1-g SAR.
When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion

**Conclusion:**
According to the above tables, the sum of reported SAR values is < 1.6W/kg. So the simultaneous transmission SAR with volume scans is not required.

## 14 SAR Test Result

It is determined by user manual for the distance between the EUT and the phantom bottom.
The distance is 15mm and just applied to the condition of body worn accessory.
It is performed for all SAR measurements with area scan based 1-g SAR estimation (Fast SAR). A zoom scan measurement is added when the estimated 1-g SAR is the highest measured SAR in each exposure configuration, wireless mode and frequency band combination or > 1.2W/kg.
The calculated SAR is obtained by the following formula:

$$\text{Reported SAR} = \text{Measured SAR} \times 10^{(\mathrm{P_{Target}} - \mathrm{P_{Measured}})/10}$$

Where $P_{Target}$ is the power of manufacturing upper limit;
$P_{Measured}$ is the measured power in chapter 11.

**Table 14.1: Duty Cycle**

| **Mode** | **Duty Cycle** |
|---|---|
| Speech for GSM850/1900 | 1:8.3 |
| GPRS for GSM850 | 1:4 |
| BT | 1:1 |

## 14.1 SAR results for Fast SAR

**Table 14.1: SAR Values (GSM 850 MHz Band - Head)**

| Ambient Temperature: 22.5 °C | | | | | | | | | | | | Liquid Temperature: 22.0 °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency | | Side | Test Position | Figure No. | Conducted Power (dBm) | Max. tune-up Power (dBm) | Measured SAR(10g) (W/kg) | Reported SAR(10g) (W/kg) | Measured SAR(1g) (W/kg) | Reported SAR(1g) (W/kg) | Power Drift (dB) | |
| MHz | Ch. | | | | | | | | | | | |
| 836.6 | 190 | Left | Touch | / | 32.20 | 33.0 | 0.249 | **0.30** | 0.368 | **0.44** | -0.10 | |
| 836.6 | 190 | Left | Tilt | / | 32.20 | 33.0 | 0.119 | **0.14** | 0.173 | **0.21** | -0.02 | |
| 848.8 | 251 | Right | Touch | Fig.1 | 32.15 | 33.0 | 0.301 | **0.37** | 0.416 | **0.50** | -0.01 | |
| 836.6 | 190 | Right | Touch | / | 32.20 | 33.0 | 0.259 | **0.31** | 0.385 | **0.46** | 0.13 | |
| 824.2 | 128 | Right | Touch | / | 32.16 | 33.0 | 0.222 | **0.27** | 0.329 | **0.40** | -0.05 | |
| 836.6 | 190 | Right | Tilt | / | 32.20 | 33.0 | 0.167 | **0.20** | 0.247 | **0.30** | 0.02 | |

**Table 14.2: SAR Values (GSM 850 MHz Band - Body)**

| Frequency | | Test Position | Figure No. | Conducted Power (dBm) | Max. tune-up Power (dBm) | Measured SAR(10g) (W/kg) | Reported SAR(10g) (W/kg) | Measured SAR(1g) (W/kg) | Reported SAR(1g) (W/kg) | Power Drift (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| MHz | Ch. | | | | | | | | | |
| 836.6 | 190 | Front | / | 31.45 | 32 | 0.330 | **0.37** | 0.481 | **0.55** | -0.05 |
| 848.8 | 251 | Rear | / | 31.39 | 32 | 0.473 | **0.54** | 0.686 | **0.79** | 0.10 |
| 836.6 | 190 | Rear | Fig.2 | 31.45 | 32 | 0.530 | **0.60** | 0.721 | **0.82** | -0.02 |
| 824.2 | 128 | Rear | / | 31.40 | 32 | 0.475 | **0.55** | 0.691 | **0.79** | 0.09 |
| 836.6 | 190 | Rear Headset | / | 32.20 | 33.0 | 0.285 | **0.34** | 0.415 | **0.50** | 0.16 |

Note1: The distance between the EUT and the phantom bottom is 15mm

**Table 14.3: SAR Values (GSM 1900 MHz Band - Head)**

Ambient Temperature: 22.4 °C Liquid Temperature: 21.9 °C

| Frequency | | Side | Test Position | Figure No. | Conducted Power (dBm) | Max. tune-up Power (dBm) | Measured SAR(10g) (W/kg) | Reported SAR(10g) (W/kg) | Measured SAR(1g) (W/kg) | Reported SAR(1g) (W/kg) | Power Drift (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | Ch. | | | | | | | | | | |
| 1909.8 | 810 | Left | Touch | / | 29.00 | 30.0 | 0.162 | **0.20** | 0.286 | **0.36** | 0.10 |
| 1880 | 661 | Left | Touch | / | 29.02 | 30.0 | 0.187 | **0.23** | 0.310 | **0.39** | -0.13 |
| 1850.2 | 512 | Left | Touch | Fig.3 | 29.08 | 30.0 | 0.195 | **0.24** | 0.323 | **0.40** | -0.04 |
| 1880 | 661 | Left | Tilt | / | 29.02 | 30.0 | 0.094 | **0.10** | 0.155 | **0.19** | -0.01 |
| 1880 | 661 | Right | Touch | / | 29.02 | 30.0 | 0.149 | **0.19** | 0.243 | **0.30** | -0.16 |
| 1880 | 661 | Right | Tilt | / | 29.02 | 30.0 | 0.101 | **0.13** | 0.177 | **0.22** | 0.04 |

**Table 14.4: SAR Values (GSM 1900 MHz Band - Body)**

| Frequency | | Test Position | Figure No. | Conducted Power (dBm) | Max. tune-up Power (dBm) | Measured SAR(10g) (W/kg) | Reported SAR(10g) (W/kg) | Measured SAR(1g) (W/kg) | Reported SAR(1g) (W/kg) | Power Drift (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| MHz | Ch. | | | | | | | | | |
| 1880 | 661 | Front | / | 27.97 | 29.0 | 0.152 | **0.19** | 0.252 | **0.32** | -0.05 |
| 1909.8 | 810 | Rear | / | 28.03 | 29.0 | 0.373 | **0.47** | 0.625 | **0.78** | 0.14 |
| 1880 | 661 | Rear | / | 27.97 | 29.0 | 0.420 | **0.53** | 0.682 | **0.86** | 0.00 |
| 1850.2 | 512 | Rear | Fig.4 | 27.96 | 29.0 | 0.441 | **0.56** | 0.697 | **0.89** | -0.09 |
| 1850.2 | 512 | Rear Headset | / | 29.08 | 30.0 | 0.294 | **0.36** | 0.476 | **0.59** | 0.06 |

Note1: The distance between the EUT and the phantom bottom is 15mm.

### 14.2 SAR results for Standard procedure

There is zoom scan measurement to be added for the highest measured SAR in each exposure configuration/band.

**Table 14.5: SAR Values (GSM 850 MHz Band - Head)**

Ambient Temperature: 22.5 °C    Liquid Temperature: 22.0 °C

| Frequency | | Side | Test Position | Figure No. | Conducted Power (dBm) | Max. tune-up Power (dBm) | Measured SAR(10g) (W/kg) | Reported SAR(10g) (W/kg) | Measured SAR(1g) (W/kg) | Reported SAR(1g) (W/kg) | Power Drift (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | Ch. | | | | | | | | | | |
| 848.8 | 251 | Right | Touch | Fig.1 | 32.15 | 33.0 | 0.301 | **0.37** | 0.416 | **0.50** | -0.01 |

**Table 14.6: SAR Values (GSM 850 MHz Band - Body)**

| Frequency | | Test Position | Figure No. | Conducted Power (dBm) | Max. tune-up Power (dBm) | Measured SAR(10g) (W/kg) | Reported SAR(10g) (W/kg) | Measured SAR(1g) (W/kg) | Reported SAR(1g) (W/kg) | Power Drift (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| MHz | Ch. | | | | | | | | | |
| 836.6 | 190 | Rear | Fig.2 | 31.45 | 32 | 0.530 | **0.60** | 0.721 | **0.82** | -0.02 |

Note1: The distance between the EUT and the phantom bottom is 15mm

**Table 14.7: SAR Values (GSM 1900 MHz Band - Head)**

Ambient Temperature: 22.4 °C    Liquid Temperature: 21.9 °C

| Frequency | | Side | Test Position | Figure No. | Conducted Power (dBm) | Max. tune-up Power (dBm) | Measured SAR(10g) (W/kg) | Reported SAR(10g) (W/kg) | Measured SAR(1g) (W/kg) | Reported SAR(1g) (W/kg) | Power Drift (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | Ch. | | | | | | | | | | |
| 1850.2 | 512 | Left | Touch | Fig.3 | 29.08 | 30.0 | 0.195 | **0.24** | 0.323 | **0.40** | -0.04 |

**Table 14.8: SAR Values (GSM 1900 MHz Band - Body)**

| Frequency | | Test Position | Figure No. | Conducted Power (dBm) | Max. tune-up Power (dBm) | Measured SAR(10g) (W/kg) | Reported SAR(10g) (W/kg) | Measured SAR(1g) (W/kg) | Reported SAR(1g) (W/kg) | Power Drift (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| MHz | Ch. | | | | | | | | | |
| 1850.2 | 512 | Rear | Fig.4 | 27.96 | 29.0 | 0.441 | **0.56** | 0.697 | **0.89** | -0.09 |

Note1: The distance between the EUT and the phantom bottom is 15mm.

## 15 SAR Measurement Variability

SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium.

The following procedures are applied to determine if repeated measurements are required.

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.

2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.

3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).

4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

# 16 Measurement Uncertainty

## 16.1 Measurement Uncertainty for Normal SAR Tests (300MHz~3GHz)

| No. | Error Description | Type | Uncertainty value | Probably Distribution | Div. | (Ci) 1g | (Ci) 10g | Std. Unc. (1g) | Std. Unc. (10g) | Degree of freedom |
|---|---|---|---|---|---|---|---|---|---|---|
| **Measurement system** | | | | | | | | | | |
| 1 | Probe calibration | B | 5.5 | N | 1 | 1 | 1 | 5.5 | 5.5 | ∞ |
| 2 | Isotropy | B | 4.7 | R | $\sqrt{3}$ | 0.7 | 0.7 | 1.9 | 1.9 | ∞ |
| 3 | Boundary effect | B | 1.0 | R | $\sqrt{3}$ | 1 | 1 | 0.6 | 0.6 | ∞ |
| 4 | Linearity | B | 4.7 | R | $\sqrt{3}$ | 1 | 1 | 2.7 | 2.7 | ∞ |
| 5 | Detection limit | B | 1.0 | N | 1 | 1 | 1 | 0.6 | 0.6 | ∞ |
| 6 | Readout electronics | B | 0.3 | R | $\sqrt{3}$ | 1 | 1 | 0.3 | 0.3 | ∞ |
| 7 | Response time | B | 0.8 | R | $\sqrt{3}$ | 1 | 1 | 0.5 | 0.5 | ∞ |
| 8 | Integration time | B | 2.6 | R | $\sqrt{3}$ | 1 | 1 | 1.5 | 1.5 | ∞ |
| 9 | RF ambient conditions-noise | B | 0 | R | $\sqrt{3}$ | 1 | 1 | 0 | 0 | ∞ |
| 10 | RF ambient conditions-reflection | B | 0 | R | $\sqrt{3}$ | 1 | 1 | 0 | 0 | ∞ |
| 11 | Probe positioned mech. restrictions | B | 0.4 | R | $\sqrt{3}$ | 1 | 1 | 0.2 | 0.2 | ∞ |
| 10 | Probe positioning with respect to phantom shell | B | 2.9 | R | $\sqrt{3}$ | 1 | 1 | 1.7 | 1.7 | ∞ |
| 13 | Post-processing | B | 1.0 | R | $\sqrt{3}$ | 1 | 1 | 0.6 | 0.6 | ∞ |
| **Test sample related** | | | | | | | | | | |
| 14 | Test sample positioning | A | 3.3 | N | 1 | 1 | 1 | 3.3 | 3.3 | 71 |
| 15 | Device holder uncertainty | A | 3.4 | N | 1 | 1 | 1 | 3.4 | 3.4 | 5 |
| 16 | Drift of output power | B | 5.0 | R | $\sqrt{3}$ | 1 | 1 | 2.9 | 2.9 | ∞ |
| **Phantom and set-up** | | | | | | | | | | |
| 17 | Phantom uncertainty | B | 4.0 | R | $\sqrt{3}$ | 1 | 1 | 2.3 | 2.3 | ∞ |
| 18 | Liquid conductivity (target) | B | 5.0 | R | $\sqrt{3}$ | 0.64 | 0.43 | 1.8 | 1.2 | ∞ |
| 19 | Liquid conductivity (meas.) | A | 2.06 | N | 1 | 0.64 | 0.43 | 1.32 | 0.89 | 43 |
| 20 | Liquid permittivity (target) | B | 5.0 | R | $\sqrt{3}$ | 0.6 | 0.49 | 1.7 | 1.4 | ∞ |
| 21 | Liquid permittivity (meas.) | A | 1.6 | N | 1 | 0.6 | 0.49 | 1.0 | 0.8 | 521 |
| Combined standard uncertainty | | $u_c^{'} = \sqrt{\sum_{i=1}^{21} c_i^2 u_i^2}$ | | | | | | 9.25 | 9.10 | 257 |
| Expanded uncertainty (confidence interval of 95 %) | | $u_e = 2u_c$ | | | | | | 18.5 | 18.2 | |

### 16.2 Measurement Uncertainty for Fast SAR Tests (300MHz~3GHz)

| No. | Error Description | Type | Uncertainty value | Probably Distribution | Div. | (Ci) 1g | (Ci) 10g | Std. Unc. (1g) | Std. Unc. (10g) | Degree of freedom |
|---|---|---|---|---|---|---|---|---|---|---|
| **Measurement system** | | | | | | | | | | |
| 1 | Probe calibration | B | 5.5 | N | 1 | 1 | 1 | 5.5 | 5.5 | ∞ |
| 2 | Isotropy | B | 4.7 | R | $\sqrt{3}$ | 0.7 | 0.7 | 1.9 | 1.9 | ∞ |
| 3 | Boundary effect | B | 1.0 | R | $\sqrt{3}$ | 1 | 1 | 0.6 | 0.6 | ∞ |
| 4 | Linearity | B | 4.7 | R | $\sqrt{3}$ | 1 | 1 | 2.7 | 2.7 | ∞ |
| 5 | Detection limit | B | 1.0 | R | $\sqrt{3}$ | 1 | 1 | 0.6 | 0.6 | ∞ |
| 6 | Readout electronics | B | 0.3 | R | $\sqrt{3}$ | 1 | 1 | 0.3 | 0.3 | ∞ |
| 7 | Response time | B | 0.8 | R | $\sqrt{3}$ | 1 | 1 | 0.5 | 0.5 | ∞ |
| 8 | Integration time | B | 2.6 | R | $\sqrt{3}$ | 1 | 1 | 1.5 | 1.5 | ∞ |
| 9 | RF ambient conditions-noise | B | 0 | R | $\sqrt{3}$ | 1 | 1 | 0 | 0 | ∞ |
| 10 | RF ambient conditions-reflection | B | 0 | R | $\sqrt{3}$ | 1 | 1 | 0 | 0 | ∞ |
| 11 | Probe positioned mech. Restrictions | B | 0.4 | R | $\sqrt{3}$ | 1 | 1 | 0.2 | 0.2 | ∞ |
| 10 | Probe positioning with respect to phantom shell | B | 2.9 | R | $\sqrt{3}$ | 1 | 1 | 1.7 | 1.7 | ∞ |
| 13 | Post-processing | B | 1.0 | R | $\sqrt{3}$ | 1 | 1 | 0.6 | 0.6 | ∞ |
| 14 | Fast SAR z-Approximation | B | 7.0 | R | $\sqrt{3}$ | 1 | 1 | 4.0 | 4.0 | ∞ |
| **Test sample related** | | | | | | | | | | |
| 15 | Test sample positioning | A | 3.3 | N | 1 | 1 | 1 | 3.3 | 3.3 | 71 |
| 16 | Device holder uncertainty | A | 3.4 | N | 1 | 1 | 1 | 3.4 | 3.4 | 5 |
| 17 | Drift of output power | B | 5.0 | R | $\sqrt{3}$ | 1 | 1 | 2.9 | 2.9 | ∞ |
| **Phantom and set-up** | | | | | | | | | | |
| 18 | Phantom uncertainty | B | 4.0 | R | $\sqrt{3}$ | 1 | 1 | 2.3 | 2.3 | ∞ |
| 19 | Liquid conductivity (target) | B | 5.0 | R | $\sqrt{3}$ | 0.64 | 0.43 | 1.8 | 1.2 | ∞ |
| 20 | Liquid conductivity (meas.) | A | 2.06 | N | 1 | 0.64 | 0.43 | 1.32 | 0.89 | 43 |
| 21 | Liquid permittivity (target) | B | 5.0 | R | $\sqrt{3}$ | 0.6 | 0.49 | 1.7 | 1.4 | ∞ |
| 22 | Liquid permittivity (meas.) | A | 1.6 | N | 1 | 0.6 | 0.49 | 1.0 | 0.8 | 521 |
| Combined standard uncertainty | | $u_c^{'} = \sqrt{\sum_{i=1}^{22} c_i^2 u_i^2}$ | | | | | | 10.1 | 9.95 | 257 |
| Expanded uncertainty (confidence interval of 95 %) | | $u_e = 2u_c$ | | | | | | 20.2 | 19.9 | |

# 17 MAIN TEST INSTRUMENTS

**Table 17.1: List of Main Instruments**

| No. | Name | Type | Serial Number | Calibration Date | Valid Period |
|---|---|---|---|---|---|
| 01 | Network analyzer | Agilent E5071C | MY46103759 | December 17,2014 | One year |
| 04 | Power meter | NRVD | 101053 | March 5,2015 | One year |
| 05 | Power sensor | NRV-Z5 | 100333 | | |
| 07 | Signal Generator | E4438C | MY45095825 | January 13, 2015 | One year |
| 08 | Amplifier | VTL5400 | 0404 | No Calibration Requested | |
| 10 | BTS | E5515C | GB46110723 | May 20, 2015 | One year |
| 10 | E-field Probe | SPEAG EX3DV4 | 3633 | January 30, 2015 | One year |
| 13 | DAE | SPEAG DAE4 | 786 | November 20, 2014 | One year |
| 17 | Dipole Validation Kit | SPEAG D835V2 | 4d057 | November 4, 2014 | One year |
| 18 | Dipole Validation Kit | SPEAG D1900V2 | 873 | November 5, 2014 | One year |

***END OF REPORT BODY***

## ANNEX A Graph Results

### 850 Right Cheek High

Date/Time: 2015/10/24

Electronics: DAE4 Sn786

Medium: 900 Head

Medium parameters used (interpolated): f = 848.8 MHz; $\sigma$ = 0.906 S/m; $\varepsilon_r$ = 42.139; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:22.0$^o$C Liquid Temperature:21.5$^o$C

Communication System: UID 0, GSM Frequency: 848.8 MHz Duty Cycle: 1:8.3

Probe: EX3DV4 - SN3633 ConvF(8.95, 8.95, 8.95); Calibrated: 2015-1-30

**Right Cheek High/Area Scan (51x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.445 W/kg

**Right Cheek High/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 8.006 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 0.525 W/kg

**SAR(1 g) = 0.416 W/kg; SAR(10 g) = 0.301 W/kg**

Maximum value of SAR (measured) = 0.441 W/kg

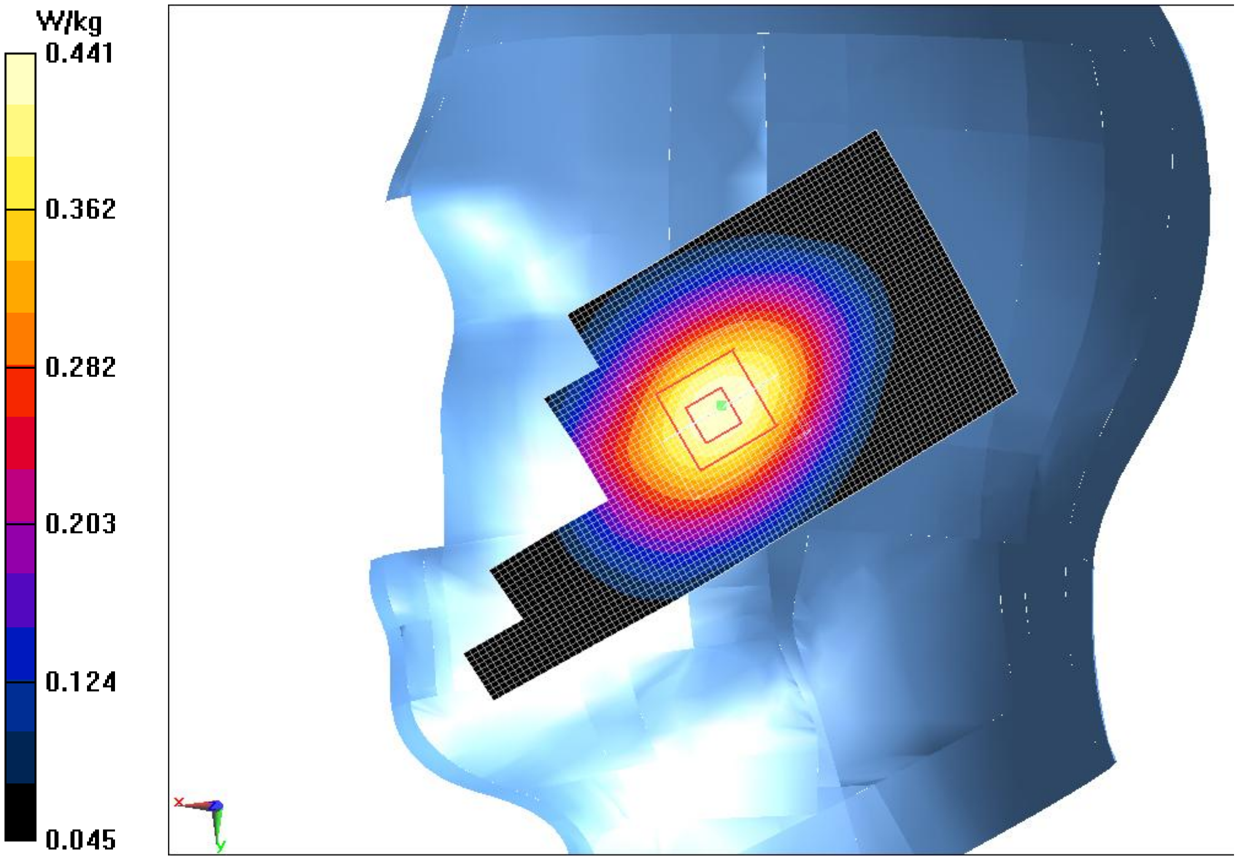



**Fig.1 850MHz CH251**

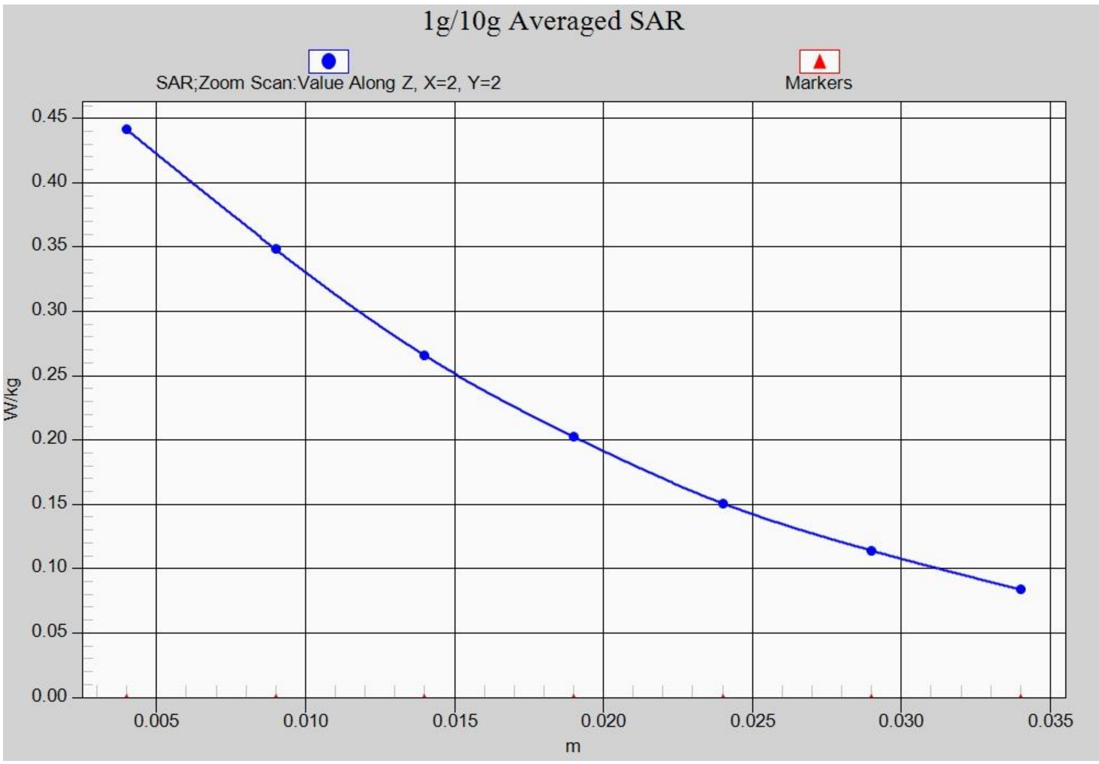



**Fig. 1-1 Z-Scan at power reference point (850 MHz CH251)**

## 850 Body Rear Middle

Date/Time: 2015/10/24
Electronics: DAE4 Sn786
Medium: Body 850 MHz
Medium parameters used (interpolated): f = 836.6 MHz; $\sigma$ = 0.971 S/m; $\varepsilon_r$ = 53.489; $\rho$ = 1000 kg/$m^3$
Ambient Temperature:22.0°C Liquid Temperature:21.5°C
Communication System: UID 0, 2 slot GPRS (0) Frequency: 836.6 MHz Duty Cycle: 1:4.00037
Probe: EX3DV4 - SN3633 ConvF(9.24, 9.24, 9.24); Calibrated: 2015-1-30

**Rear side Middle/Area Scan (51x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.785 W/kg

**Rear side Middle 03a/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 27.30 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 0.982 W/kg
**SAR(1 g) = 0.721 W/kg; SAR(10 g) = 0.530 W/kg**
Maximum value of SAR (measured) = 0.771 W/kg

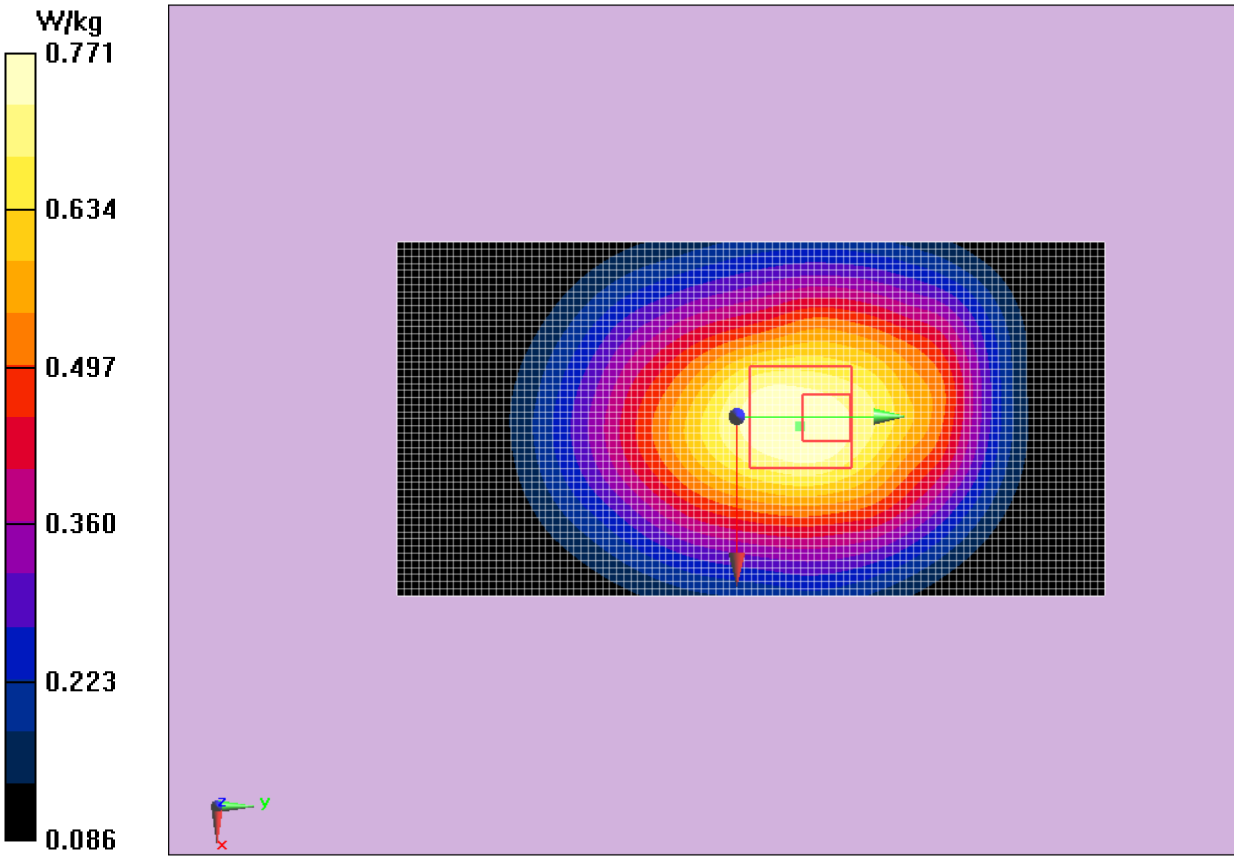



**Fig.2 850 MHz CH190**

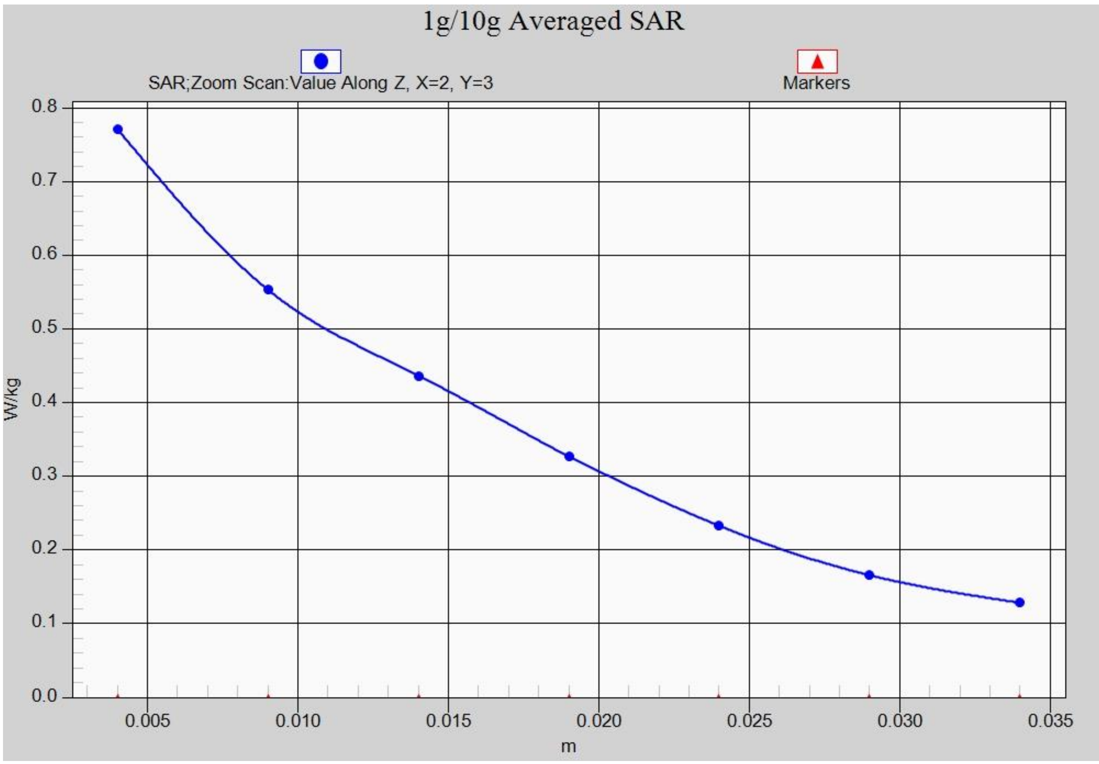



**Fig. 2-1 Z-Scan at power reference point (850 MHz CH190)**

## GSM1900 Left Cheek Low

Date/Time: 2015/10/24

Electronics: DAE4 Sn786

Medium: 1900 Head

Medium parameters used (interpolated): f = 1850.2 MHz; σ = 1.371 S/m; $\varepsilon_r$ = 38.323; ρ = 1000 kg/m$^3$

Ambient Temperature:22.0$^o$C Liquid Temperature:21.5$^o$C

Communication System: UID 0, GSM (0) Frequency: 1850.2 MHz Duty Cycle: 1:8.3

Probe:EX3DV4 - SN3633 ConvF(7.72, 7.72, 7.72);

**Left Cheek Low /Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.413 W/kg

**Left Cheek Low /Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 6.210 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 0.461 W/kg

**SAR(1 g) = 0.323 W/kg; SAR(10 g) = 0.195 W/kg**

Maximum value of SAR (measured) = 0.347 W/kg

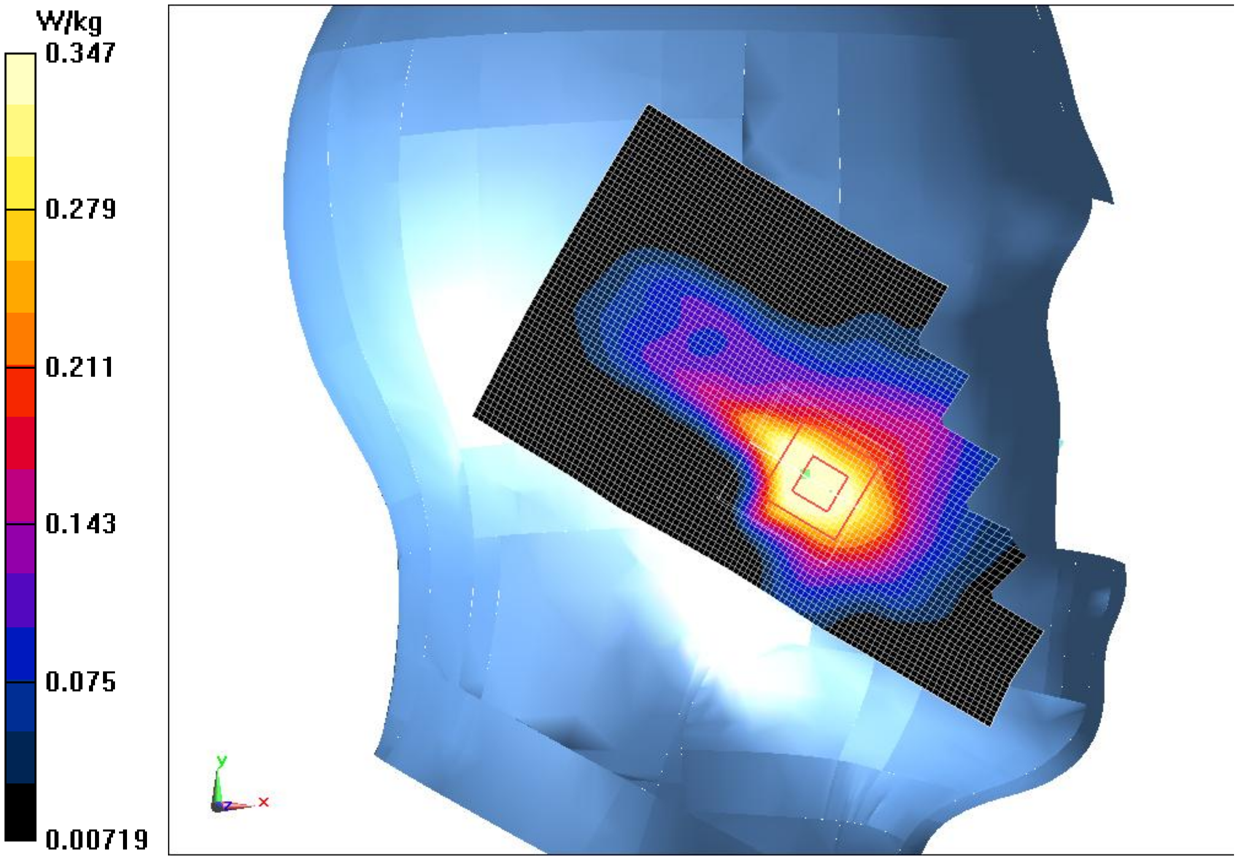



**Fig.3 1900 MHz CH512**

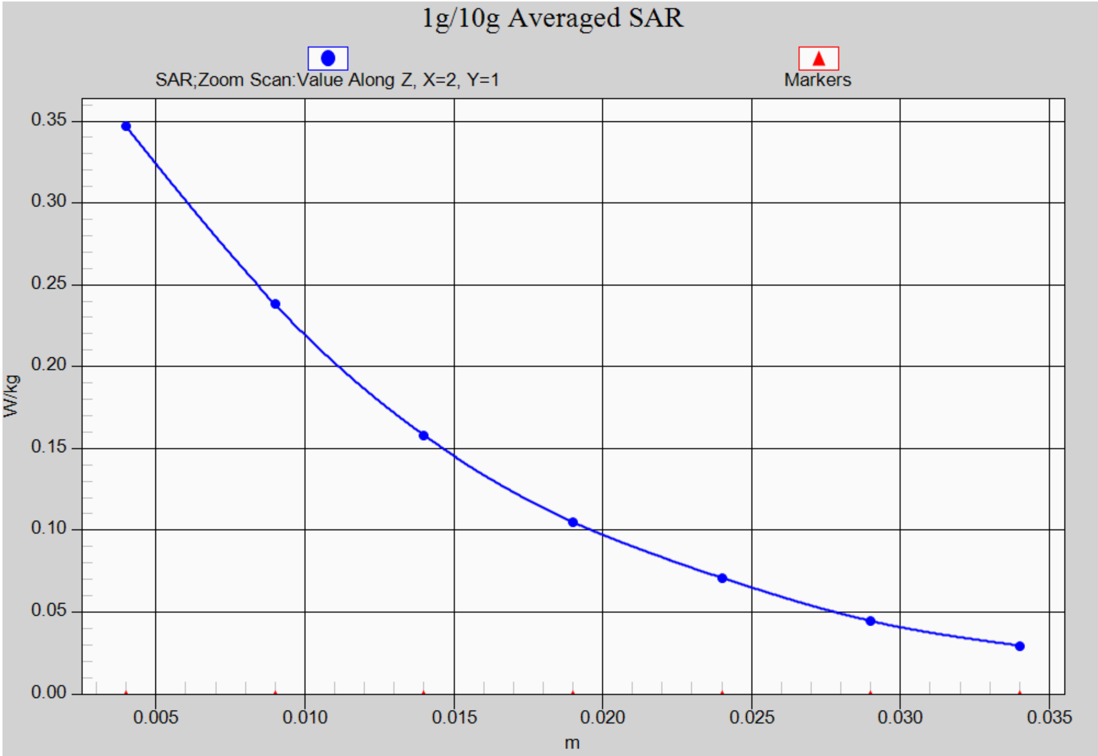



**Fig. 3-1 Z-Scan at power reference point (1900 MHz CH512)**

## GSM1900 Body Rear Low

Date/Time: 2015/10/24

Electronics: DAE4 Sn786

Medium: Body1900 MHz

Medium parameters used (interpolated): f = 1850.2 MHz; $\sigma$ = 1.518 S/m; $\varepsilon_r$ = 53.54; $\rho$ = 1000 kg/$m^3$

Ambient Temperature:22.0$^{o}$C Liquid Temperature:21.5$^{o}$C

Communication System: UID 0, 2 slot GPRS (0) Frequency: 1850.2 MHz Duty Cycle: 1:4.00037

Probe:EX3DV4 - SN3633 ConvF(7.36, 7.36, 7.36);

**Rear side Low/Area Scan (51x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.773 W/kg

**Rear side Low/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 7.099 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 1.13 W/kg

**SAR(1 g) = 0.697 W/kg; SAR(10 g) = 0.441 W/kg**

Maximum value of SAR (measured) = 0.739 W/kg

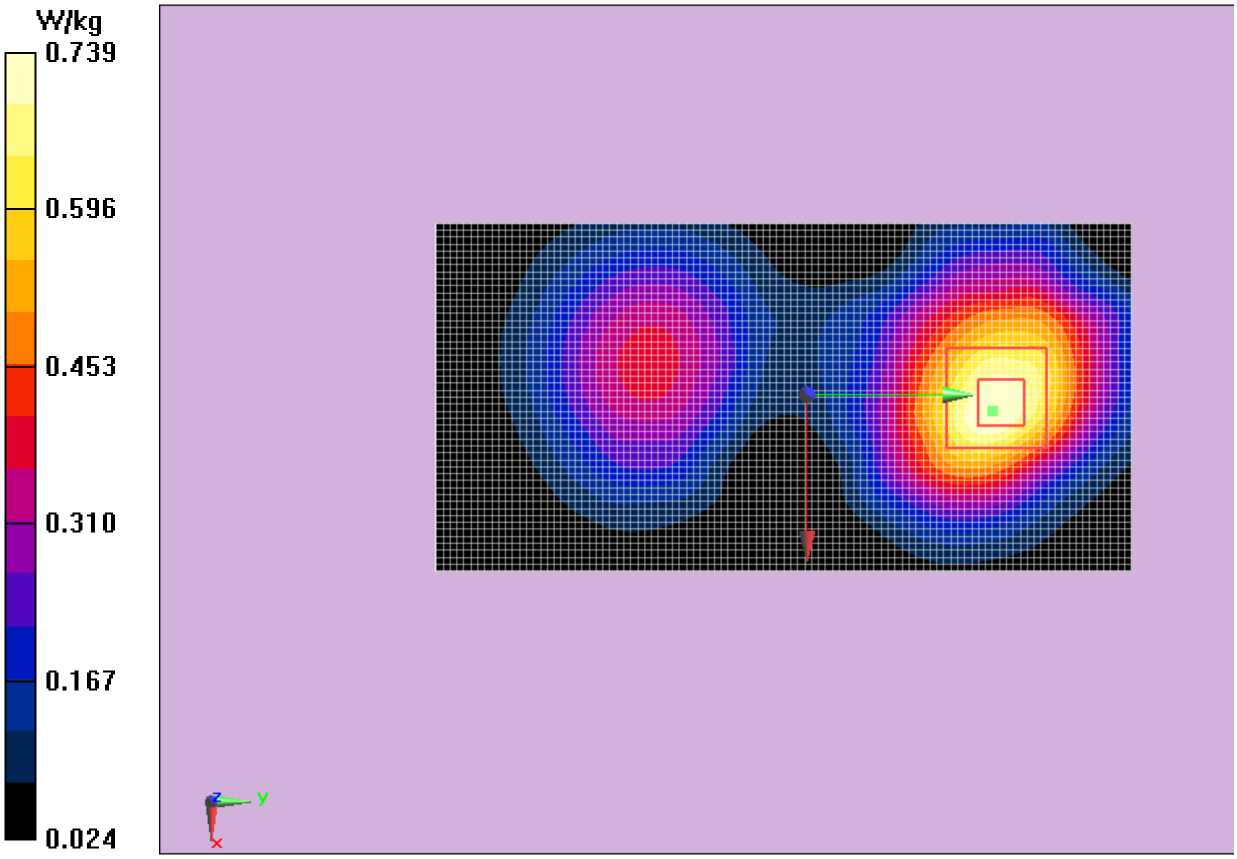



**Fig.4 1900 MHz CH512**

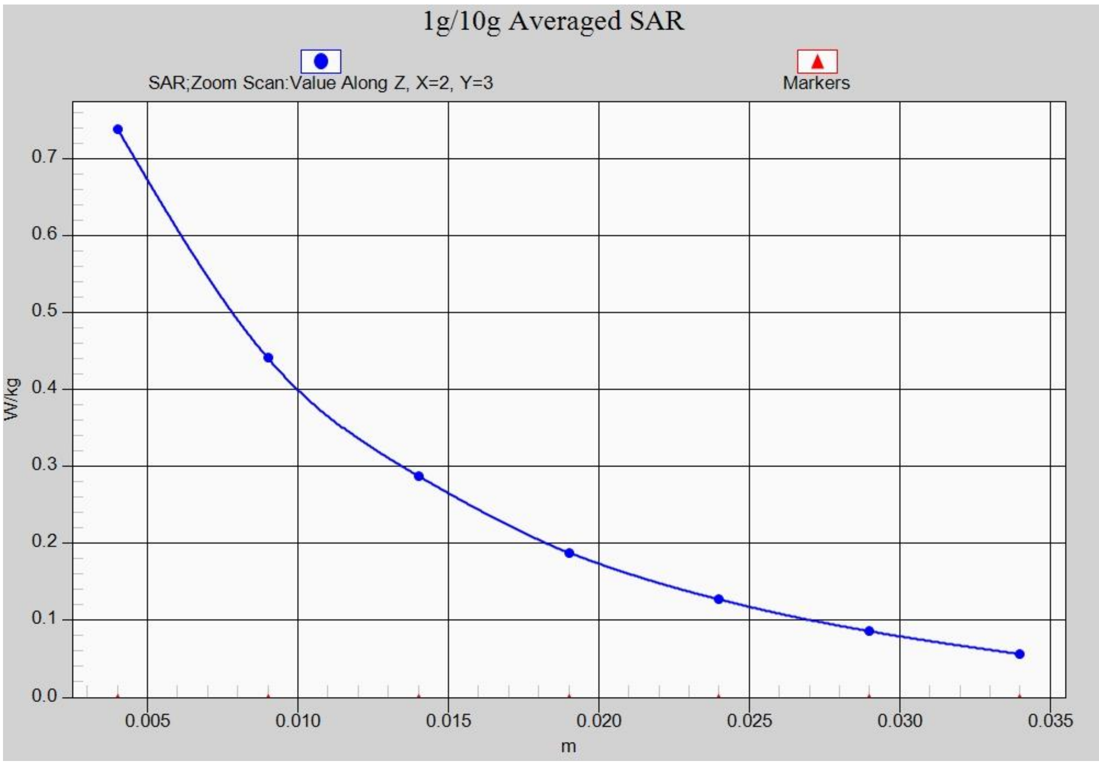



**Fig.4-1 Z-Scan at power reference point (1900 MHz CH512)**

# ANNEX B System Verification Results

## 835MHz

Date/Time: 2015-10-24
Electronics: DAE4 Sn786
Medium: Head 850
Medium parameters used (interpolated): f = 835 MHz; σ = 0.929 S/m; $\varepsilon_r$ = 41.315;; ρ = 1000 kg/m$^3$
Ambient Temperature:23.7$^o$C Liquid Temperature:23.2$^o$C
Communication System: CW_TMC Frequency: 835 MHz Duty Cycle: 1:1
Probe: EX3DV4 - SN3633 ConvF(8.95, 8.95, 8.95); Calibrated: 2015-1-30

**Configuration/835 Head/Area Scan (61x181x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 47.034 V/m; Power Drift = 0.10 dB
**Fast SAR: SAR(1 g) = 2.42 W/kg; SAR(10 g) = 1.52 W/kg**
Maximum value of SAR (interpolated) = 2.46 W/kg

**Configuration/835 Head/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 47.034 V/m; Power Drift = 0.10 dB
Peak SAR (extrapolated) = 2.87 W/kg
**SAR(1 g) = 2.44 W/kg; SAR(10 g) = 1.55 W/kg**
Maximum value of SAR (measured) = 2.47 W/kg

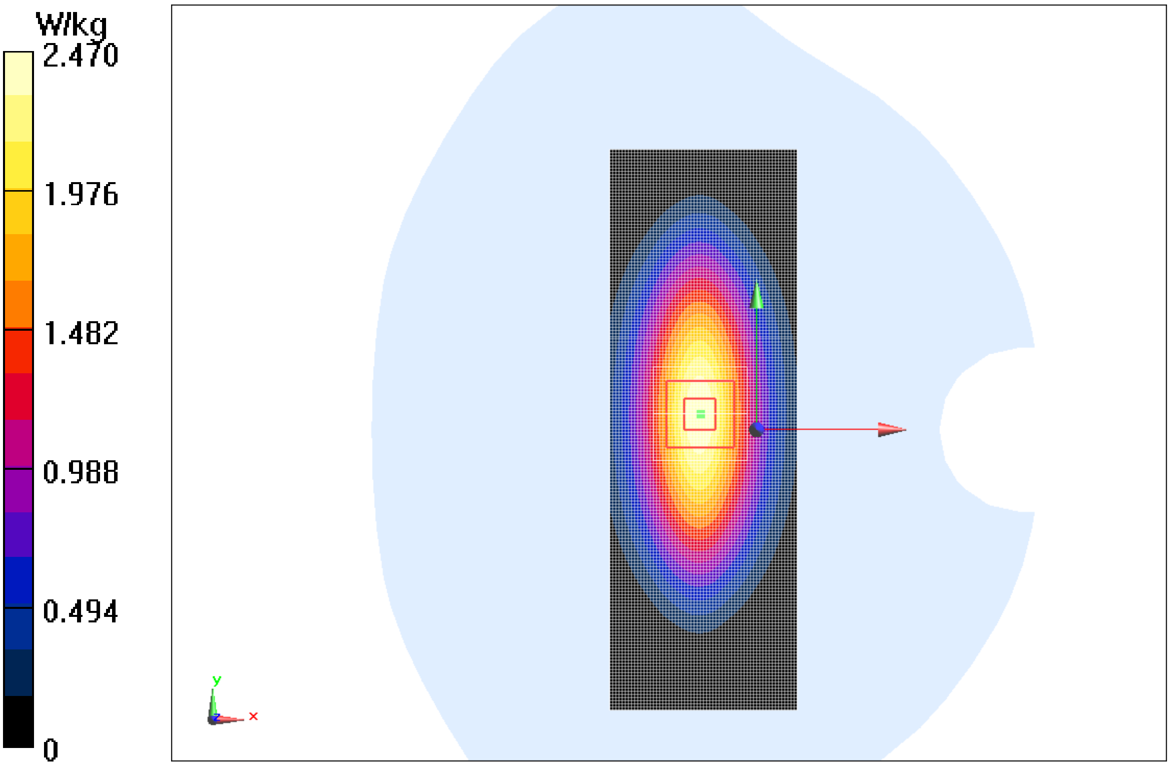



**Fig.B.1 Validation 835MHz 250mW**

**835MHz**

Date/Time: 2015-10-24

Electronics: DAE4 Sn786

Medium: Body850 MHz

Medium parameters used (interpolated): f = 835 MHz; $\sigma$ = 0.97 S/m; $\varepsilon_r$ = 53.498; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:22.0$^o$C Liquid Temperature:21.5$^o$C

Communication System: CW_TMC Frequency: 835 MHz Duty Cycle: 1:1

Probe: EX3DV4 - SN3633 ConvF(9.24, 9.24, 9.24); Calibrated: 2015-1-30

**Configuration/Area Scan (61x181x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

**Fast SAR:SAR(1 g) = 2.43 W/kg; SAR(10 g) = 1.56 W/kg**

Maximum value of SAR (interpolated) = 2.64 W/kg

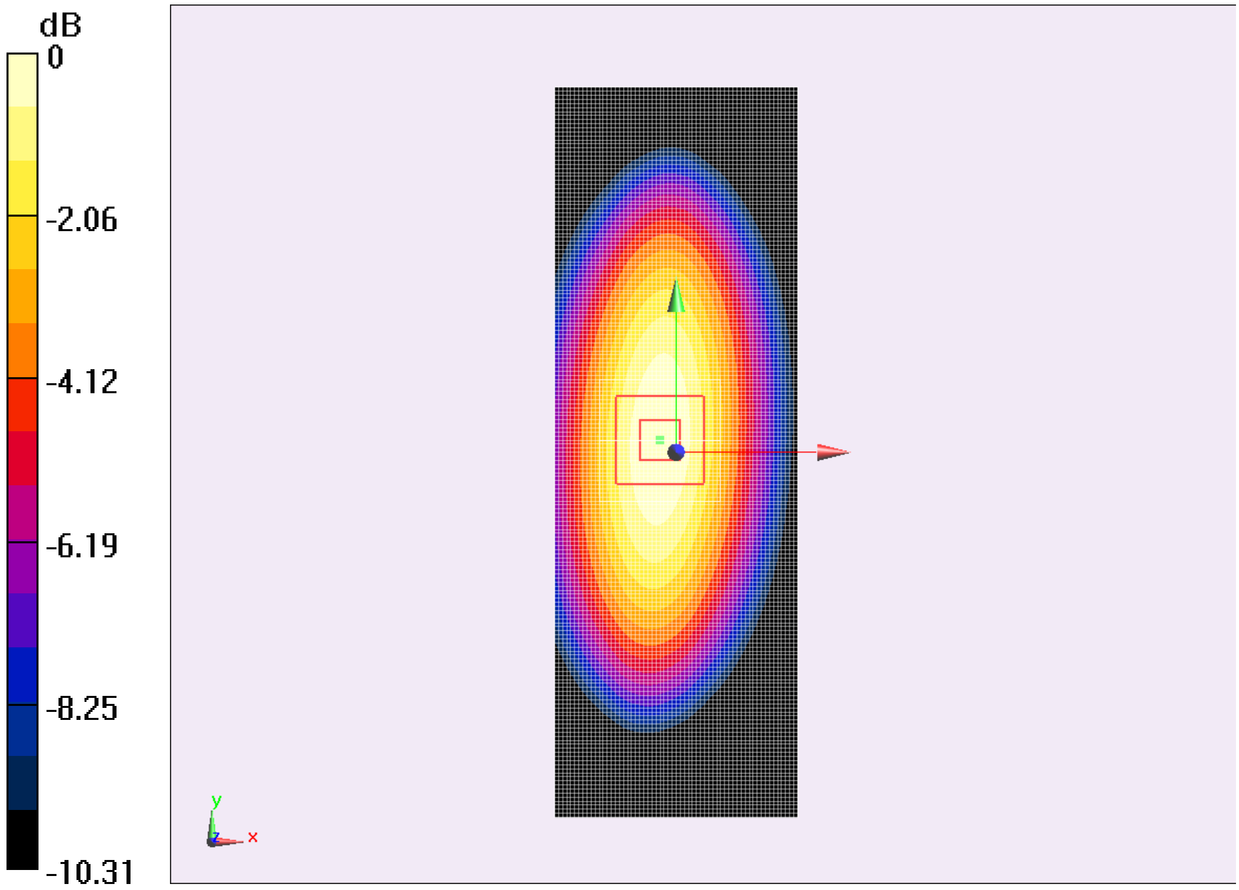
**Configuration/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 51.989 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 3.60 W/kg

**SAR(1 g) = 2.46 W/kg; SAR(10 g) = 1.58 W/kg**

Maximum value of SAR (measured) = 2.62 W/kg




0 dB = 2.62 W/kg = 4.18 dBW/kg

**Fig.B.2 validation 835MHz 250mW**

**1900MHz**

Date: 2015-10-24

Electronics: DAE4 Sn786

Medium: Head 1900 MHz

Medium parameters used: f = 1900 MHz; σ = 1.387 S/m; εr = 40.848; ρ = 1000 kg/m$^3$

Ambient Temperature: 22.5°C Liquid Temperature: 22.0°C

Communication System: CW Frequency: 1900 MHz Duty Cycle: 1:1

Probe:EX3DV4 - SN3633 ConvF(7.72, 7.72, 7.72);

**System Validation /Area Scan (81x101x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Reference Value = 86.259 V/m; Power Drift = -0.09 dB

**Fast SAR: SAR(1 g) = 9.88 W/kg; SAR(10 g) = 5.18 W/kg**

Maximum value of SAR (interpolated) = 13.5 W/kg

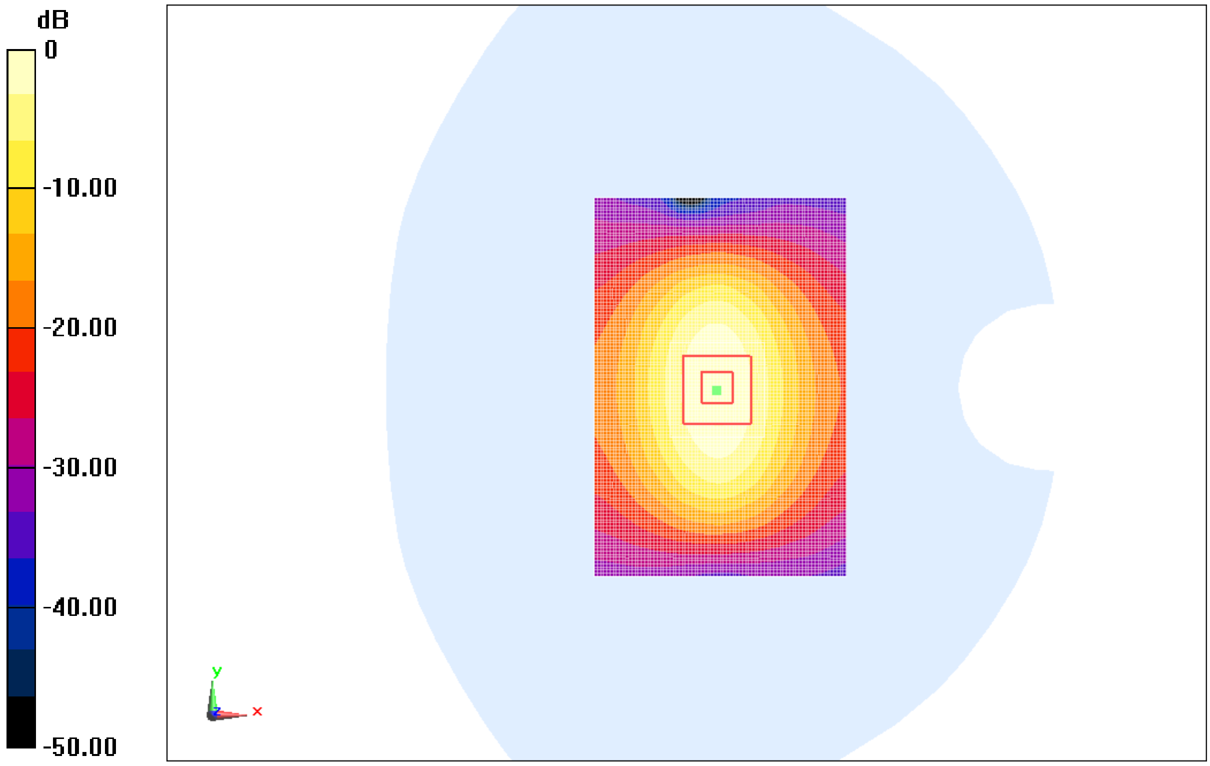
**System Validation /Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 86.259 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 18.4 W/kg

**SAR(1 g) = 10.16 W/kg; SAR(10 g) = 5.10 W/kg**

Maximum value of SAR (measured) = 11.3 W/kg




0 dB = 11.3 W/kg = 13.49 dBW/kg

**Fig.B.3 validation 1900MHz 250mW**

**1900MHz**

Date: 2015-10-24

Electronics: DAE4 Sn786

Medium: Body 1900 MHz

Medium parameters used: f = 1900 MHz; σ = 1.543 S/m; $\varepsilon_r$ = 50.791; ρ = 1000 kg/$m^3$

Ambient Temperature: 22.3°C      Liquid Temperature: 21.8°C

Communication System: CW Frequency: 1900 MHz Duty Cycle: 1:1

Probe:EX3DV4 - SN3633 ConvF(7.36, 7.36, 7.36);

**System validation /Area Scan (81x101x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Reference Value = 60.339 V/m; Power Drift = 0.08 dB

**Fast SAR: SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.40 W/kg**

Maximum value of SAR (interpolated) = 13.5 W/kg

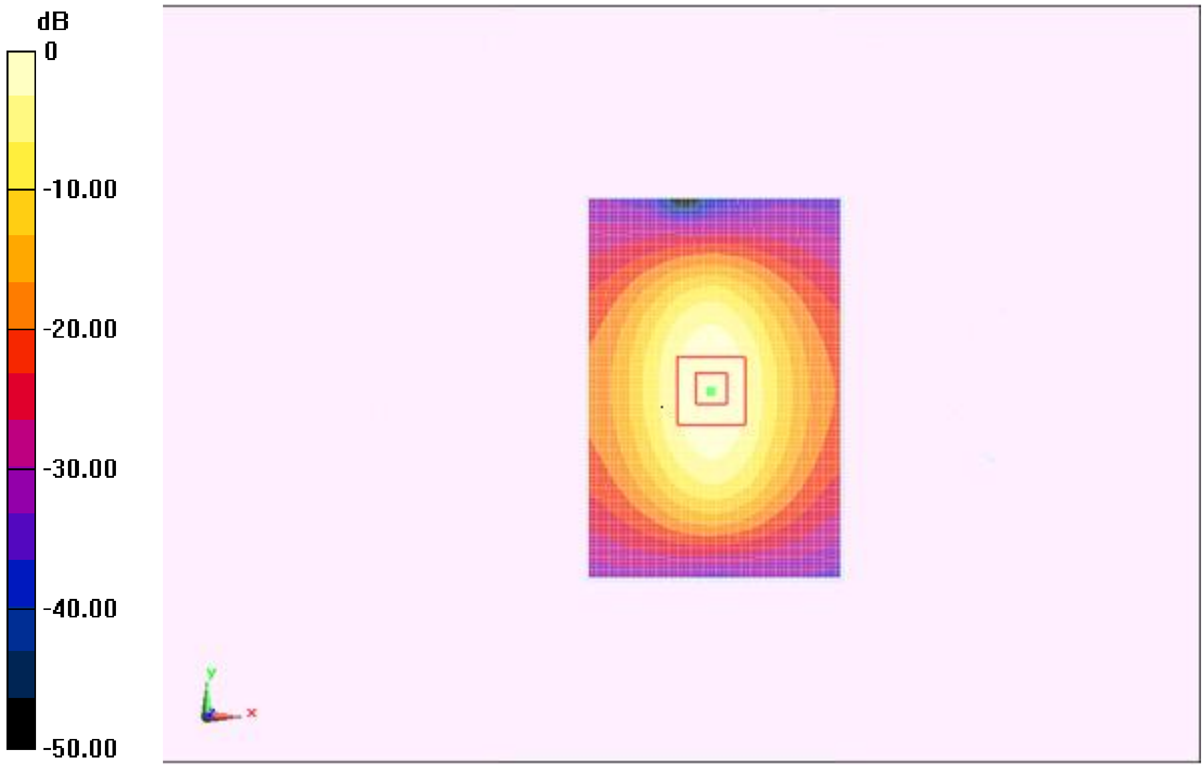
**System validation /Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 60.339 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 19.3 W/kg

**SAR(1 g) = 10.30 W/kg; SAR(10 g) = 5.54 W/kg**

Maximum value of SAR (measured) = 10.2 W/kg




0 dB = 10.4 W/kg = 16.60 dBW/kg

**Fig.B.4 validation 1900MHz 250mW**

The SAR system verification must be required that the area scan estimated 1-g SAR is within 3% of the zoom scan 1-g SAR.

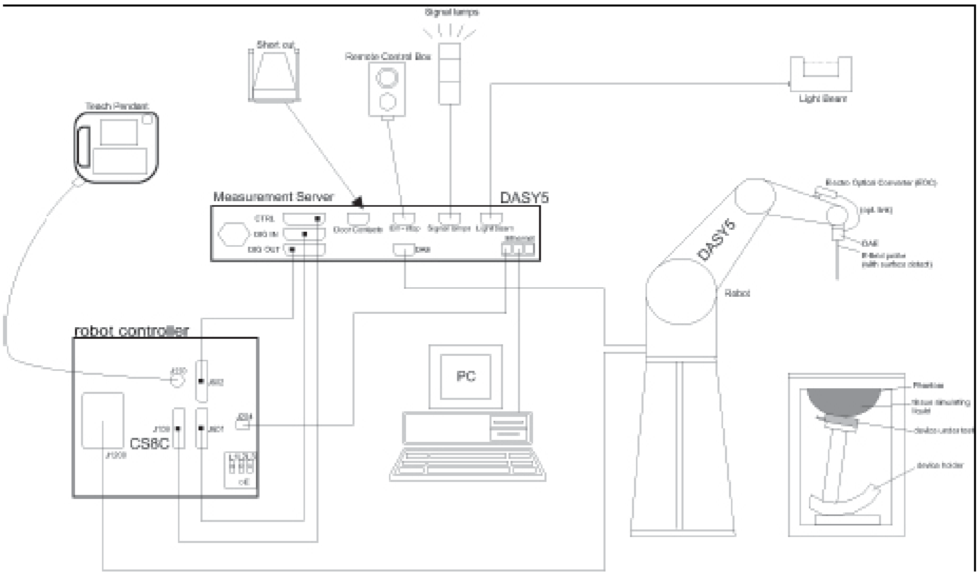
**Table B.1 Comparison between area scan and zoom scan for system verification**

| Band | Position | Area scan (1g) | Zoom scan (1g) | Drift (%) |
|---|---|---|---|---|
| 850 | Head | 2.42 | 2.44 | -0.82 |
| 850 | Body | 2.43 | 2.46 | -1.22 |
| 1900 | Head | 9.88 | 10.16 | -2.76 |
| 1900 | Body | 10.1 | 10.3 | -1.94 |

# ANNEX C SAR Measurement Setup

## C.1 Measurement Set-up

The Dasy4 or DASY5 system for performing compliance tests is illustrated above graphically. This system consists of the following items:




**Picture C.1 SAR Lab Test Measurement Set-up**

- A standard high precision 6-axis robot (Stäubli TX=RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP and the DASY4 or DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as
- warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

## C.2 Dasy4 or DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multifiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY4 or DASY5 software reads the reflection durning a software approach and looks for the maximum using $2^{nd}$ ord curve fitting. The approach is stopped at reaching the maximum.

**Probe Specifications:**

**Model:** ES3DV3, EX3DV4

**Frequency Range:** 10MHz — 6.0GHz(EX3DV4)
10MHz — 4GHz(ES3DV3)

**Calibration:** In head and body simulating tissue at Frequencies from 835 up to 5800MHz

**Linearity:** ± 0.2 dB(30 MHz to 6 GHz) for EX3DV4
± 0.2 dB(30 MHz to 4 GHz) for ES3DV3

**Dynamic Range:** 10 mW/kg — 100W/kg

**Probe Length:** 330 mm

**Probe Tip Length:** 20 mm

**Body Diameter:** 10 mm

**Tip Diameter:** 2.5 mm (3.9 mm for ES3DV3)

**Tip-Center:** 1 mm (2.0mm for ES3DV3)

**Application:** SAR Dosimetry Testing
Compliance tests of mobile phones
Dosimetry in strong gradient fields

**Picture C.2 Near-field Probe**

**Picture C.3 E-field Probe**

## C.3 E-field Probe Calibration

Each E-Probe/Probe Amplifier combination has unique calibration parameters. A TEM cell calibration procedure is conducted to determine the proper amplifier settings to enter in the probe parameters. The amplifier settings are determined for a given frequency by subjecting the probe to a known E-field density (1 mW/cm$^2$) using an RF Signal generator, TEM cell, and RF Power Meter.

The free space E-field from amplified probe outputs is determined in a test chamber. This calibration can be performed in a TEM cell if the frequency is below 1 GHz and inn a waveguide or other methodologies above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/ $cm^2$.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The E-field in the medium correlates with the temperature rise in the dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$SAR = C\frac{\Delta T}{\Delta t}$$

Where:

$\Delta t$ = Exposure time (30 seconds),

C = Heat capacity of tissue (brain or muscle),

$\Delta T$ = Temperature increase due to RF exposure.

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

Where:

σ = Simulated tissue conductivity,

ρ = Tissue density ($kg/m^3$).

## C.4 Other Test Equipment

### C.4.1 Data Acquisition Electronics(DAE)

The data acquisition electronics consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder with a control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

**PictureC.4: DAE**

### C.4.2 Robot

The SPEAG DASY system uses the high precision robots (DASY4: RX90XL; DASY5: RX160L) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability 0.02mm)
- High reliability (industrial design)
- Low maintenance costs (virtually maintenance free due to direct drive gears; no belt drives)
- Jerk-free straight movements (brushless synchron motors; no stepper motors)
- Low ELF interference (motor control fields shielded via the closed metallic construction shields)


**Picture C.6 DASY 5**

### C.4.3 Measurement Server

The Measurement server is based on a PC/104 CPU broad with CPU (dasy4: 166 MHz, Intel Pentium; DASY5: 400 MHz, Intel Celeron), chipdisk (DASY4: 32 MB; DASY5: 108MB), RAM (DASY4: 64 MB, DASY5: 108MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY I/O broad, which is directly connected to the PC/104 bus of the CPU broad.

The measurement server performs all real-time data evaluation of field measurements and surface detection, controls robot movements and handles safety operation. The PC operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with an expansion port which is reserved for future applications. Please note that this expansion port does not have a standardized pinout, and therefore only devices provided by SPEAG can be connected. Devices from any other supplier could seriously damage the measurement server.


**Picture C.7 Server for DASY 4**


**Picture C.8 Server for DASY 5**

### C.4.4 Device Holder for Phantom

The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5mm distance, a positioning uncertainty of ±0.5mm would produce a SAR uncertainty of ±20%. Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.

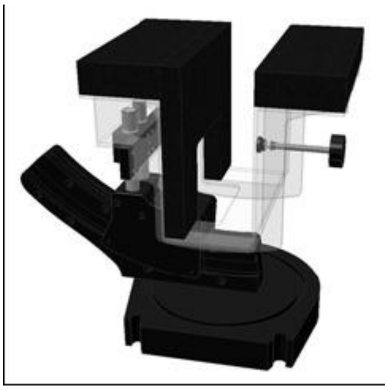
The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.

The DASY device holder is constructed of low-loss POM material having the following dielectric parameters: relative permittivity $\varepsilon$ =3 and loss tangent $\delta$ =0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

<Laptop Extension Kit>

The extension is lightweight and made of POM, acrylic glass and foam. It fits easily on the upper part of the Mounting Device in place of the phone positioner. The extension is fully compatible with the Twin-SAM and ELI phantoms.

**Picture C.9-1: Device Holder**



**Picture C.9-2: Laptop Extension Kit**

### C.4.5 Phantom

The SAM Twin Phantom V4.0 is constructed of a fiberglass shell integrated in a table. The shape of the shell is based on data from an anatomical study designed to

Represent the 90th percentile of the population. The phantom enables the dissymmetric evaluation of SAR for both left and right handed handset usage, as well as body-worn usage using the flat phantom region. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot. The shell phantom has a 2mm shell thickness (except the ear region where shell thickness increases to 6 mm).

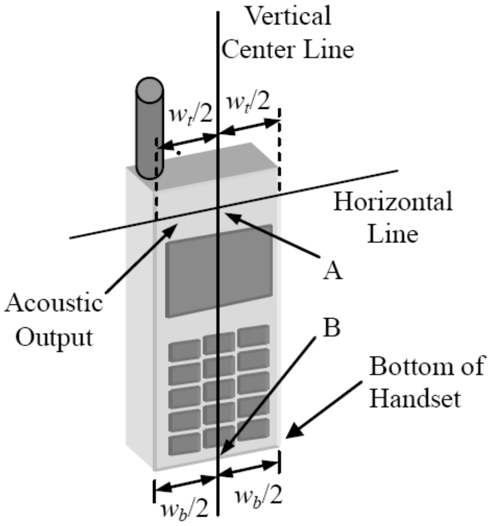
Shell Thickness: 2 ± 0. 2 mm
Filling Volume: Approx. 25 liters
Dimensions: 810 x l000 x 500 mm (H x L x W)
Available: Special

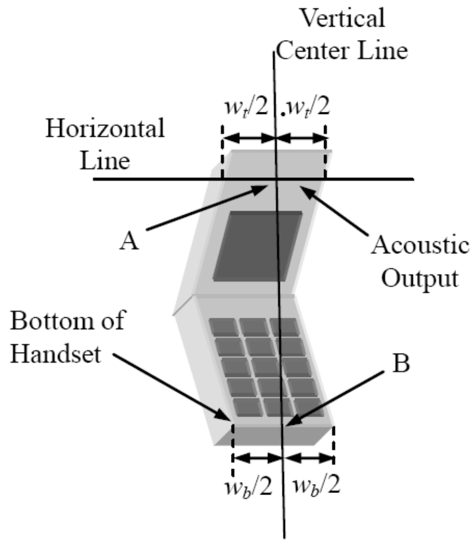
**Picture C.10: SAM Twin Phantom**

# ANNEX D Position of the wireless device in relation to the phantom

## D.1 General considerations

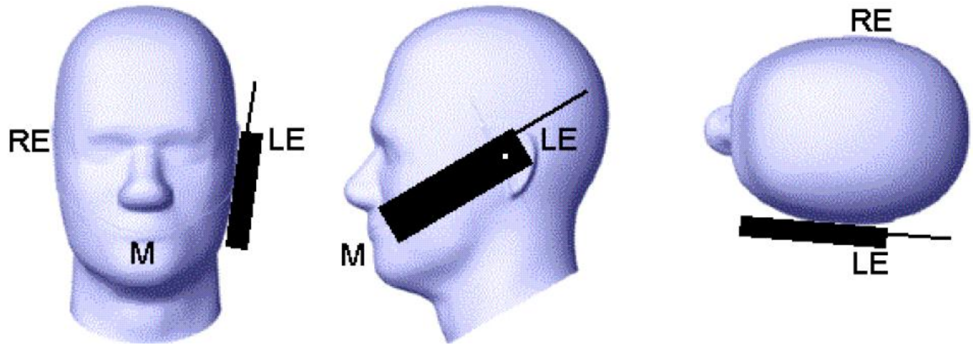
This standard specifies two handset test positions against the head phantom – the “cheek” position and the “tilt” position.



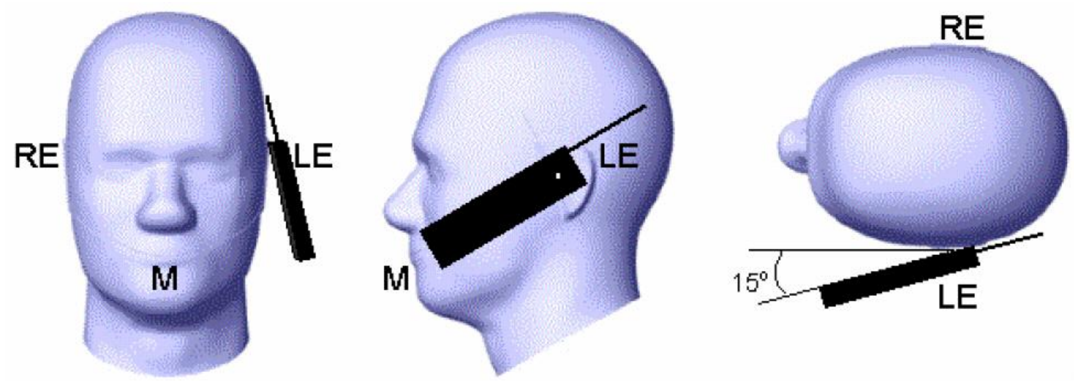




| | |
|---|---|
| $w_t$ | Width of the handset at the level of the acoustic |
| $w_b$ | Width of the bottom of the handset |
| A | Midpoint of the width $w_t$ of the handset at the level of the acoustic output |
| B | Midpoint of the width $w_b$ of the bottom of the handset |

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



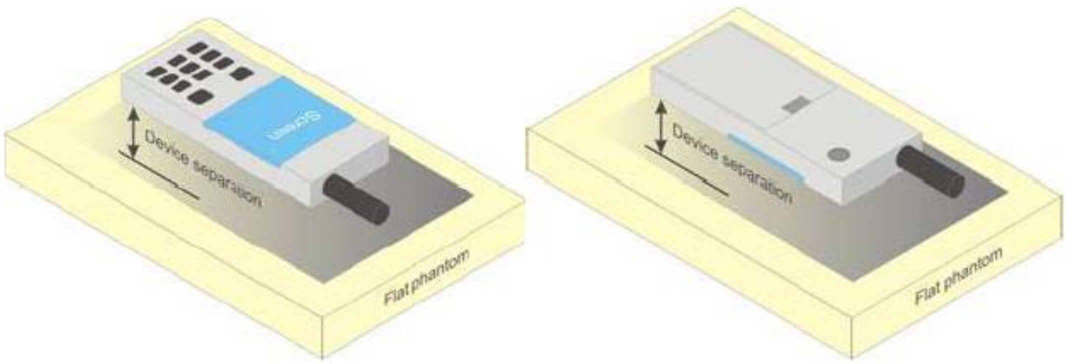

**Picture D.2 Cheek position of the wireless device on the left side of SAM**




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

## D.2 Body-worn device

A typical example of a body-worn device is a mobile phone, wireless enabled PDA or other battery operated wireless device with the ability to transmit while mounted on a person's body using a carry accessory approved by the wireless device manufacturer.

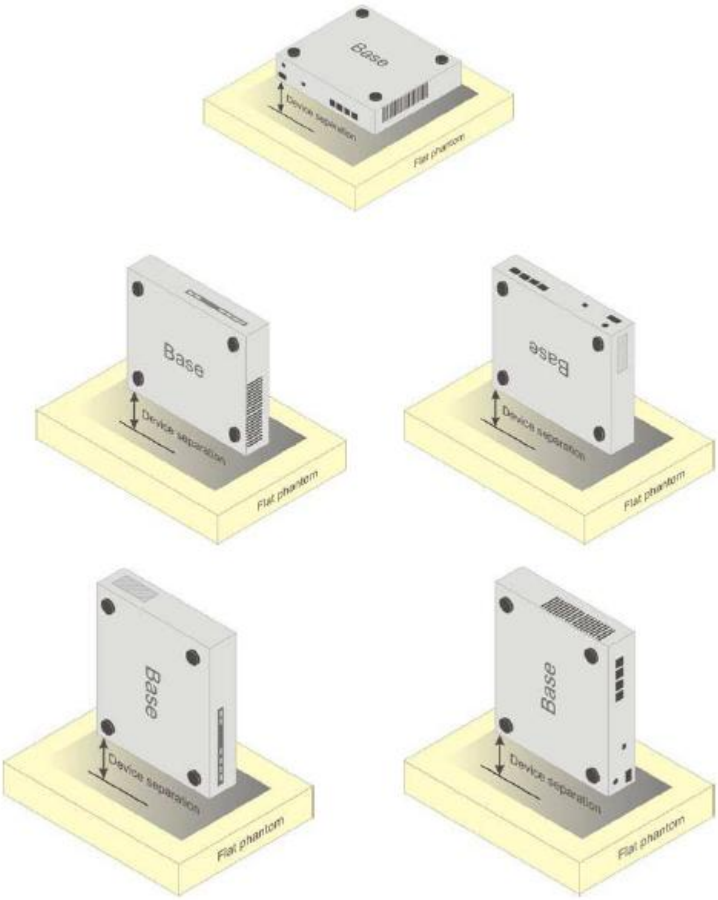



**Picture D.4 Test positions for body-worn devices**

## D.3 Desktop device

A typical example of a desktop device is a wireless enabled desktop computer placed on a table or desk when used.

The DUT shall be positioned at the distance and in the orientation to the phantom that corresponds to the intended use as specified by the manufacturer in the user instructions. For devices that employ an external antenna with variable positions, tests shall be performed for all antenna positions specified. Picture 8.5 show positions for desktop device SAR tests. If the intended use is not specified, the device shall be tested directly against the flat phantom.




**Picture D.5 Test positions for desktop devices**

## D.4 DUT Setup Photos


**Picture D.6**

## ANNEX E Equivalent Media Recipes

The liquid used for the frequency range of 800-3000 MHz consisted of water, sugar, salt, preventol, glycol monobutyl and Cellulose. The liquid has been previously proven to be suited for worst-case. The Table E.1 shows the detail solution. It's satisfying the latest tissue dielectric parameters requirements proposed by the IEEE 1528 and IEC 62209.

**Table E.1: Composition of the Tissue Equivalent Matter**

| Frequency (MHz) | 835 Head | 835 Body | 1900 Head | 1900 Body | 2450 Head | 2450 Body | 5800 Head | 5800 Body |
|---|---|---|---|---|---|---|---|---|
| Ingredients (% by weight) | | | | | | | | |
| Water | 41.45 | 52.5 | 55.242 | 69.91 | 58.79 | 72.60 | 65.53 | 65.53 |
| Sugar | 56.0 | 45.0 | \ | \ | \ | \ | \ | \ |
| Salt | 1.45 | 1.4 | 0.306 | 0.13 | 0.06 | 0.18 | \ | \ |
| Preventol | 0.1 | 0.1 | \ | \ | \ | \ | \ | \ |
| Cellulose | 1.0 | 1.0 | \ | \ | \ | \ | \ | \ |
| Glycol Monobutyl | \ | \ | 44.452 | 29.96 | 41.15 | 27.22 | \ | \ |
| Diethylenglycol monohexylether | \ | \ | \ | \ | \ | \ | 17.24 | 17.24 |
| Triton X-100 | \ | \ | \ | \ | \ | \ | 17.24 | 17.24 |
| Dielectric Parameters Target Value | ε=41.5 σ=0.90 | ε=55.2 σ=0.97 | ε=40.0 σ=1.40 | ε=53.3 σ=1.52 | ε=39.2 σ=1.80 | ε=52.7 σ=1.95 | ε=35.3 σ=5.27 | ε=48.2 σ=6.00 |

## ANNEX F System Validation

The SAR system must be validated against its performance specifications before it is deployed. When SAR probes, system components or software are changed, upgraded or recalibrated, these must be validated with the SAR system(s) that operates with such components.

**Table F.1: System Validation**

| Probe SN. | Liquid name | Validation date | Frequency point | Status (OK or Not) |
|---|---|---|---|---|
| 3633 | Head 850MHz | June 10, 2015 | 850 MHz | OK |
| 3633 | Head 1900MHz | June 10, 2015 | 1900 MHz | OK |
| 3633 | Body 850MHz | June 10, 2015 | 850 MHz | OK |
| 3633 | Body 1900MHz | June 10, 2015 | 1900 MHz | OK |

# ANNEX G Probe Calibration Certificate

**Probe EX3DV4-SN:3633 Calibration Certificate**

In Collaboration with
speag
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com Http://www.chinattl.cn

CALIBRATION
No. L0570

Client **CTTL(South Branch)** **Certificate No: Z15-97005**

## CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | EX3DV4 - SN:3633 |
| Calibration Procedure(s) | FD-Z11-2-004-01<br>Calibration Procedures for Dosimetric E-field Probes |
| Calibration date: | January 30, 2015 |

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)℃ and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power Meter NRP2 | 101919 | 01-Jul-14 (CTTL, No.J14X02146) | Jun-15 |
| Power sensor NRP-Z91 | 101547 | 01-Jul-14 (CTTL, No.J14X02146) | Jun-15 |
| Power sensor NRP-Z91 | 101548 | 01-Jul-14 (CTTL, No.J14X02146) | Jun-15 |
| Reference10dBAttenuator | 18N50W-10dB | 13-Mar-14(TMC,No.JZ14-1103) | Mar-16 |
| Reference20dBAttenuator | 18N50W-20dB | 13-Mar-14(TMC,No.JZ14-1104) | Mar-16 |
| Reference Probe EX3DV4 | SN 3617 | 28-Aug-14(SPEAG,No.EX3-3617_Aug14) | Aug-15 |
| DAE4 | SN 777 | 17-Sep-14 (SPEAG, DAE4-777_Sep14) | Sep -15 |
| | | | |
| Secondary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| SignalGeneratorMG3700A | 6201052605 | 01-Jul-14 (CTTL, No.J14X02145) | Jun-15 |
| Network Analyzer E5071C | MY46110673 | 15-Feb-14 (TMC, No.JZ14-781) | Feb-15 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Yu Zongying | SAR Test Engineer | |
| Reviewed by: | Qi Dianyuan | SAR Project Leader | |
| Approved by: | Lu Bingsong | Deputy Director of the laboratory | |

Issued: January 31, 2015

In Collaboration with
s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com Http://www.chinattl.cn

**Glossary:**

| | |
|---|---|
| TSL | tissue simulating liquid |
| NORMx,y,z | sensitivity in free space |
| ConvF | sensitivity in TSL / NORMx,y,z |
| DCP | diode compression point |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A,B,C,D | modulation dependent linearization parameters |
| Polarization Φ | Φ rotation around probe axis |
| Polarization θ | θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i θ=0 is normal to probe axis |
| Connector Angle | information used in DASY system to align probe sensor X to the robot coordinate system |

**Calibration is Performed According to the Following Standards:**

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013

b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300MHz to 3GHz)", February 2005

**Methods Applied and Interpretation of Parameters:**

- *NORMx,y,z:* Assessed for E-field polarization θ=0 (f≤900MHz in TEM-cell; f>1800MHz: waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not effect the $E^2$-field uncertainty inside TSL (see below ConvF).
- *NORM(f)x,y,z = NORMx,y,z* frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics.
- *Ax,y,z; Bx,y,z; Cx,y,z;VRx,y,z:*A,B,C are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f≤800MHz) and inside waveguide using analytical field distributions based on power measurements for f >800MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty valued are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORMx,y,z* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from±50MHz to±100MHz.
- *Spherical isotropy (3D deviation from isotropy):* in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset:* The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle:* The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

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# Probe EX3DV4

## SN: 3633

Calibrated: January 30, 2015

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

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# DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3633

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm(μV/(V/m)$^2$)[A] | 0.41 | 0.41 | 0.39 | ±10.8% |
| DCP(mV)[B] | 101.3 | 98.2 | 100.1 | |

## Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB√μV | C | D dB | VR mV | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 173.1 | ±2.5% |
| | | Y | 0.0 | 0.0 | 1.0 | | 175.8 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 166.5 | |

The reported uncertainty of measurement is stated as the standard uncertainty of Measurement multiplied by the coverage factor k=2, which for a normal distribution Corresponds to a coverage probability of approximately 95%.

[A] The uncertainties of Norm X, Y, Z do not affect the $E^2$-field uncertainty inside TSL (see Page 5 and Page 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainly is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

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# DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3633

## Calibration Parameter Determined in Head Tissue Simulating Media

| f [MHz][C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha[G] | Depth[G] (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 835 | 41.5 | 0.90 | 8.95 | 8.95 | 8.95 | 0.22 | 0.93 | ±12% |
| 900 | 41.5 | 0.97 | 8.81 | 8.81 | 8.81 | 0.24 | 0.95 | ±12% |
| 1750 | 40.1 | 1.37 | 7.82 | 7.82 | 7.82 | 0.21 | 1.08 | ±12% |
| 1900 | 40.0 | 1.40 | 7.72 | 7.72 | 7.72 | 0.20 | 1.18 | ±12% |
| 2300 | 39.5 | 1.67 | 7.35 | 7.35 | 7.35 | 0.33 | 0.86 | ±12% |
| 2450 | 39.2 | 1.80 | 7.01 | 7.01 | 7.01 | 0.40 | 0.86 | ±12% |
| 2600 | 39.0 | 1.96 | 6.84 | 6.84 | 6.84 | 0.65 | 0.68 | ±12% |

[C] Frequency validity of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequency below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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# DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3633

## Calibration Parameter Determined in Body Tissue Simulating Media

| f [MHz][C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha[G] | Depth[G] (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 835 | 55.2 | 0.97 | 9.24 | 9.24 | 9.24 | 0.19 | 1.31 | ±12% |
| 1750 | 53.4 | 1.49 | 7.50 | 7.50 | 7.50 | 0.17 | 1.37 | ±12% |
| 1900 | 53.3 | 1.52 | 7.36 | 7.36 | 7.36 | 0.17 | 1.39 | ±12% |
| 2300 | 52.9 | 1.81 | 7.43 | 7.43 | 7.43 | 0.28 | 1.50 | ±12% |
| 2450 | 52.7 | 1.95 | 7.21 | 7.21 | 7.21 | 0.29 | 1.33 | ±12% |
| 2600 | 52.5 | 2.16 | 7.11 | 7.11 | 7.11 | 0.32 | 1.15 | ±12% |

[C] Frequency validity of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequency below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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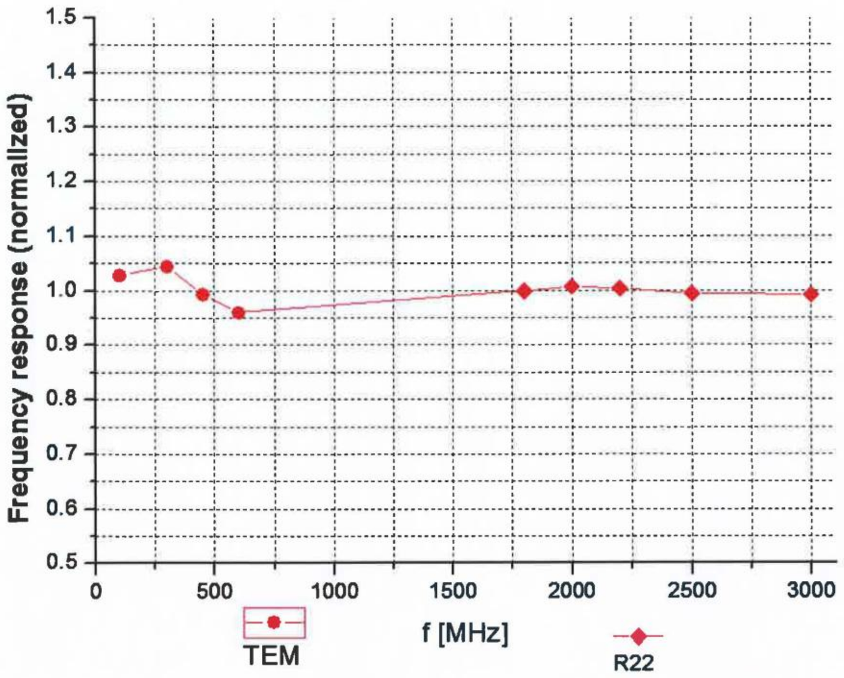
# Frequency Response of E-Field
## (TEM-Cell: ifi110 EXX, Waveguide: R22)




**Uncertainty of Frequency Response of E-field: ±7.5% (k=2)**