# TEST REPORT

**1. Applicant**

| | |
|---|---|
| **Name** | : Ericsson-LG Enterprise Co., Ltd. |
| **Address** | : 77,Heungan-daero 81 beon-gil,Dongan-gu, Anyang-si,Gyeonggi-do, Korea |

**2. Products**

| | |
|---|---|
| **Name** | : Wireless Handy Telephone |
| **Model** | : GDC-480H |
| **Manufacturer** | : Ericsson-LG Enterprise Co., Ltd. |

| | |
|---|---|
| **3. Test Standard** | : FCC 47 CFR § 2.1093, |
| **4. Test Method** | : IEEE 1528-2003 |
| **5. Test Results** | : Positive |
| **6. Date of Application** | : October 8, 2015 |
| **7. Date of Issue** | : November 30, 2015 |

| Tested by | Approved by |
|---|---|
| Jong-gon Ban | Jang tae-heon |
| RF Application Technology Center<br>Senior Engineer | RF Application Technology Center<br>Manager |

*The test results contained apply only to the test sample(s) supplied by the applicant, and this test report shall not be reproduced in full or in part without approval of the KTL in advance.*

**Korea Testing Laboratory**

# REVISION HISTORY

| REPORT No. | Version | Description | Issued Date |
|---|---|---|---|
| 12-056909-01-2 | Rev 01 | Initial Issue | Dec 26, 2012 |
| 15-059152-01-2 | Rev 02 | Removal of Bluetooth module.<br>All SAR results are re-used | Nov 30, 2015 |
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# 1. GENERAL INFORMATIONS

## 1.1. Applicant (Client)

| | |
|---|---|
| Name | Ericsson-LG Enterprise Co., Ltd. |
| Address | 77,Heungan-daero 81 beon-gil,Dongan-gu, Anyang-si,Gyeonggi-do, Korea |
| Contact Person | Sang-Jin Kang |
| Telephone No. | 82 31 8054 6017 |
| E-mail address | Sangjin.kang@ercssonlg.com |
| Manufacturer | Ericsson-LG Enterprise Co., Ltd. |
| Manufacturer Address | 77,Heungan-daero 81 beon-gil,Dongan-gu, Anyang-si,Gyeonggi-do, Korea |

## 1.2. Equipment (EUT)

| | |
|---|---|
| Product Name | Wireless Handy Telephone |
| Model Name | GDC-480H |
| FCC ID | 2ABGAGDC-480H |
| Device Category | Part 15 Unlicensed PCS portable Tx held to ear (PUE) |
| Type of Modulation | UPCS (GFSK) |
| Max. Conducted Power | UPCS : 18.34 mW |
| Tx Frequency Range | UPCS : 1921.536 MHz ~ 1928.448 MHz |
| Duty Cycle | UPCS (1:24) |
| Antenna Type | Internal Antenna |
| Operating Power | 3.7 VDC Battery |
| RF exposure Category | General Population/Uncontrolled |
| Maximum 1g SAR | Head : 0.043 mW/g<br>Body : 0.013 mW/g |

## 1.3. Testing Laboratory

| | |
|---|---|
| Testing Place | Korea Testing Labortory (KTL)<br>723, Haean-ro, Sangnok-gu, Ansan-si, Gyeonggi-do, KOREA (426-910) |
| FCC registration number | 408324 |
| Industry Canada filing number | 6298A |
| Test Engineer | Jong-gon Ban |
| Telephone number | +82 31 5000 133 |
| Facsimile number | +82 31 5000 149 |
| E-mail address | banjg@ktl.re.kr |
| Other Comments | - |

| Frequency Band | Frequency |
|---|---|
| Channel 1 | 1921.536 MHz |
| Channel 2 | 1923.264 MHz |
| Channel 3 | 1924.992 MHz |
| Channel 4 | 1926.720 MHz |
| Channel 5 | 1928.448 MHz |

# 2. SAR DEFINITION

Specific Absorption Rate (SAR) is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density(p). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body. (see Figure.1)

$$SAR = \frac{d}{dt}\left(\frac{dU}{dm}\right) = \frac{d}{dt}\left(\frac{dU}{pdv}\right)$$

**Figure 1. SAR Mathematical Equation**

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

$$\text{SAR} = \sigma E^2 / p$$

**Where :**

$\sigma$ = conductivity of the tissue-simulant material (S/m)

$p$ = mass density of the tissue-simulant material (kg/m$^3$)

$E$ = Total RMS electric field strength (V/m)

Note: The primary factors that control rate or energy absorption were found to be the wavelength of the incident field in realtions to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflectinf surfaces, and whether conductive contact is made by the organism with a ground plane.[4]

# 3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with IEEE Standard 1528-2003 and the following published KDB procedures.

- FCC KDB Publication 447498 D01v06 (General SAR Guidance)
- FCC KDB Publication 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
- FCC KDB Publication 865664 D02 SAR Reporting v01r02

# 4. DESCRIPTION OF SAR MEASUREMENT SYSTEM

## 4.1. SAR Measurement System

These measurements are performed using the DASY4 automated dosimetric assessment system. It is made by Sch- mid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of high precision robotics system (Staubli), robot controller, measurement server, Measurement computer, near-field probe, probe alignment sensor, and the SAM twin phantom containing the brain equivalent material. The robot is a six-axis industrial robot perfor- ming precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF) (see Fig.2).

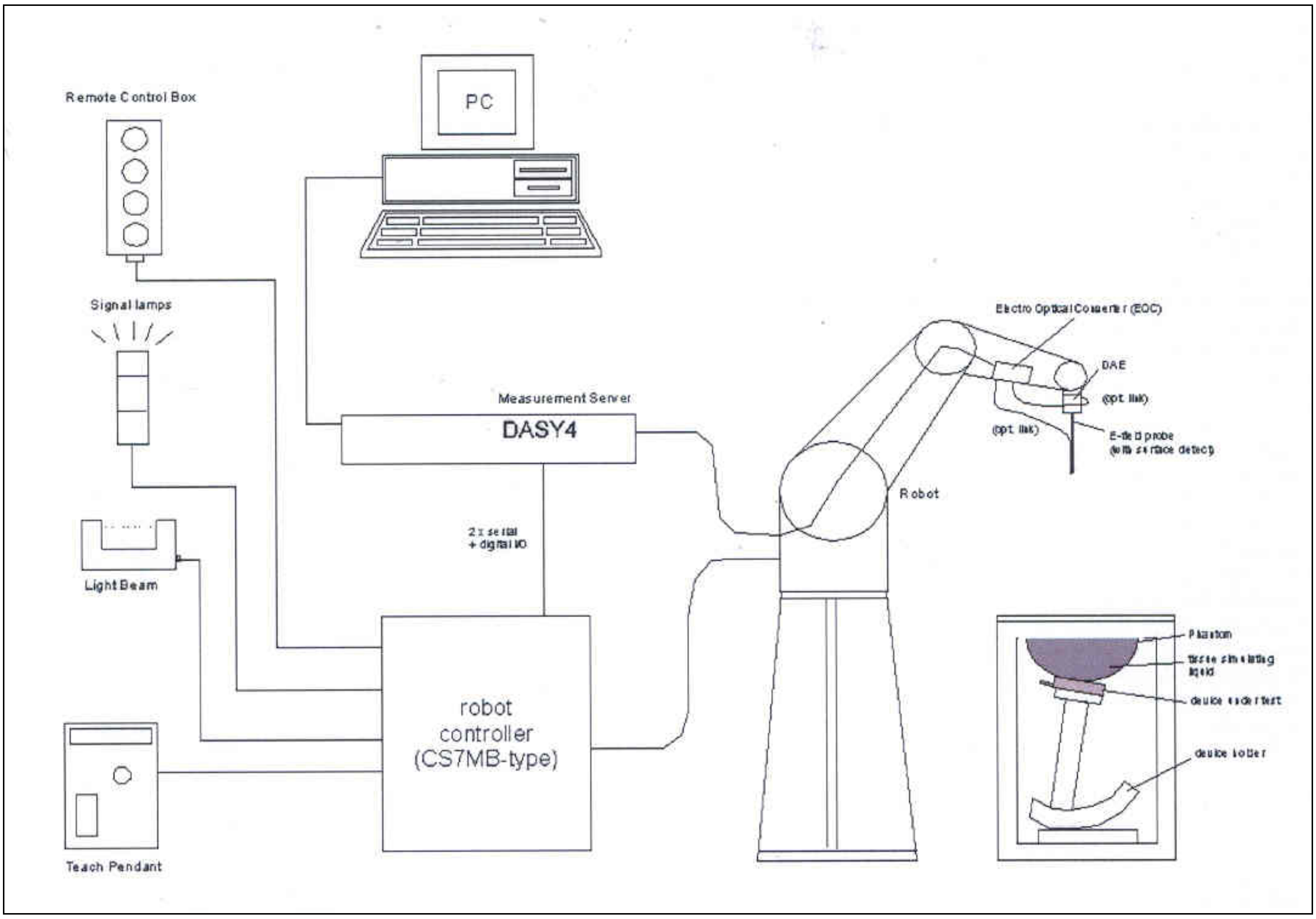



**Figure 2. SAR Measurement System**

The DAE4 consists 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 and control logic unit. Transmission to the PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for fronta- l and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer. The system is described in detail in [5].

## 4.2. E-Field Probe Type and Performance

The SAR measurements were conducted with the dosimetric probe designed in the classical triangular configuration [5] and optimised for dosimetric evaluation. The probe has been is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical mortifier 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 a 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 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped at reaching the maximum.

**Figure 3. Probe and DAE**

### Probe Specifications

| | |
|---|---|
| Construction | Symmetrical design with triangular core<br>Built-in optical fiber for surface detection System<br>Built-in shielding against static charges |
| Calibration | In air from 10 MHz to 2.5 GHz<br>In brain and muscle simulating tissue at<br>Frequencies of 450 MHz, 900 MHz and 1.8 GHz (accuracy 8%) |
| Frequency | 10 MHz to > 6 GHz; Linearity: 0.2 dB (30 MHz to 3 GHz) |
| Directivity | 0.2 dB in brain tissue (rotation around probe axis)<br>0.4 dB in brain tissue (rotation normal probe axis) |
| Dynamic | 5 uW/g to > 100 mW/g; |
| Range Linearity | 0.2 dB |
| Surface | 0.2 mm repeatability in air and clear liquids |
| Detection | Over diffuse reflecting surfaces. |
| Dimensions | Overall length: 337 mm<br>Tip length: 10 mm<br>Body diameter: 10 mm<br>Tip diameter: 4 mm<br>Distance from probe tip to dipole centers: 2.7 mm |
| Application | General dissymmetry up to 3 GHz<br>Compliance tests of mobile phones/ Fast automatic scanning in arbitrary phantoms |

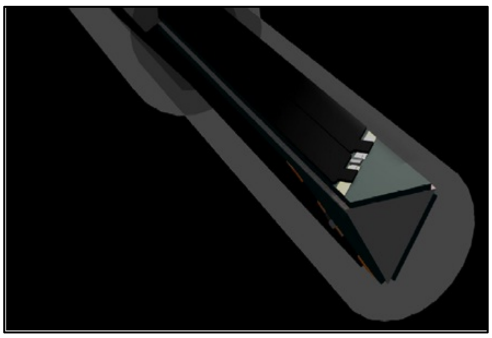


**Figure 4. E-Field Probe**

## 4.3. Probe Calibration Process (Dosimetric Assessment Procedure)

Each probe is calibrated according to a dosimetric assessment procedure described [6] with an accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure described in [7] and found to be better than +/- 0.25dB. The sensitivity parameters (NornX, NornY, NornZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe is tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies bellow 1 GHz, and in a waveguide 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.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium correlates to temperature rise in a 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 is proportional to $\Delta T / \Delta t$, the initial rate of tissue heating, before thermal diffusion takes place. Now it's possible to quantify the electric field in the simulated tissue by equating the thermally derived SAR to the E- field;

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

where:

$\sigma$ = simulated tissue conductivity,

$\rho$ = Tissue density (1.25 g/cm$^3$ for brain tissue)

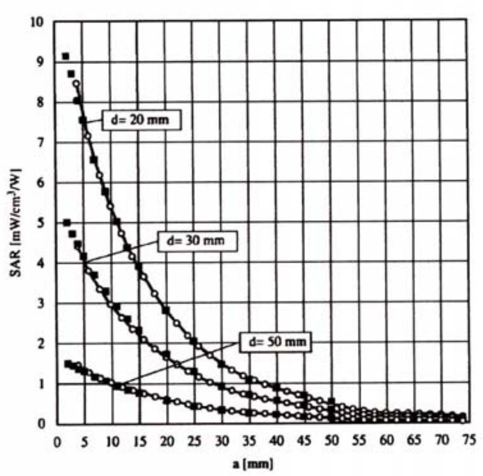



Figure B.1. E-Field and Temperature measurements at 900MHz[5]

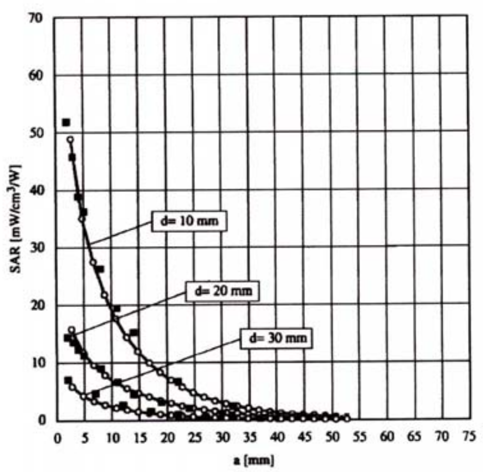



Figure B.2. E -field and temperature measurements at 1.8GHz[5]

## 4.4. Data Acquisition Electronics

The data acquisition electronics (DAE4) consists 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 and control logic unit. The input impedance of the DAE4 box is 200 Mohm; the inputs are symmetrical and floating. Common mode rejection is above 80dB.Transmission to the PC-card 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.

## 4.5. Phantom Properties

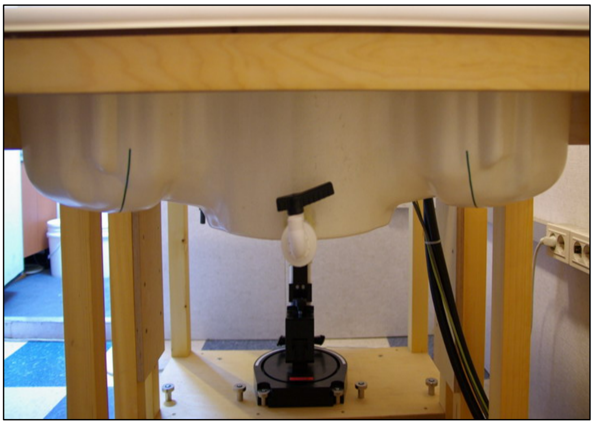


**Figure 5. SAM twin phantom**

The SAM Phantom is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90% of all users [9][10]. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents the evaporation of the liquid. 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.

| Phantom Properties | Requirement for specific EUT | Measured |
|---|---|---|
| Depth of Phantom | > 150 mm | 200 mm |
| Width of flat section | > 10 cm (Twice EUT Width) | 20 cm |
| Length of flat section | > 26 cm (Twice EUT Length) | 30 cm |
| Thickness of flat section | 2 mm ± 0.2 mm | 2.08 ~ 2.20 mm |

**Table 1. Flat Section Properties of SAM Twin Phantom**

### 4.6. Device Holder for DASY4

In combination with the SAM Phantom V4.0, the Mounting Device(POM) 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 repeatable positioned according to the FCC CENELEC specifications. The device holder can be locked at different phantom locations(left head, right head, flat phantom).

**Figure 6. Device Holder**

Note: A simulating human hand is not used due to the complex anatomical and geometrical structure of the hand that may produced infinite number of configurations [10]. To produce the Worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.

### 4.7. Brain & Muscle Simulating Mixture Characteristic

The brain and muscle mixtures consist of a viscous gel using hydroxethylcellulose (HEC) gelling agent and saline solution (see Table 2). Preservation with bacteriacide is added and visual inspection is made to make sure air bubbles are not trapped during the mixing process. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. The mixture characterizations used for the brain and muscle tissue simulating liquids are according to the data by C. Gabriel and G. Hartsgrove [11].

| Ingredients | 1900 MHz Brain | 1900 MHz Muscle |
|---|---|---|
| Water | 55.24% | 70.23% |
| Sugar | - | - |
| Salt | 0.31% | 0.29% |
| DGBE | 44.45% | 29.47% |
| Bacteriacide | - | - |
| HEC | - | - |

**Table 2 : Composition of Tissue Equivalent Matter**

# 5. SYSTEM VERIFICATION

## 5.1. Tissue Verification

The dielectric parameters of the brain and muscle simulating liquid were measured prior to SAR assessment using the HP85070D dielectric probe kit and Agilent 8753D Network Analyzer. The actual dielectric parameters are shown in the following table.

| Freq. [MHz] | Date | Liquid Temp [°C] | parameters | Target Value | Measured Value | Deviation (%) | Limit (%) |
|---|---|---|---|---|---|---|---|
| 1900 Head | November 1, 2012 | 21.0 | εr | 40.0 | 39.4 | -1.5 | ±5 |
| | | | σ | 1.40 | 1.38 | -1.5 | ±5 |
| 1900 Body | November 2, 2012 | 21.5 | εr | 53.3 | 52.1 | -2.3 | ±5 |
| | | | σ | 1.52 | 1.54 | +1.3 | ±5 |

**Table 3 : Measured Simulating Liquid Dielectric Values**

The humidity and dielectric/ambient temperatures are recorded during the assessment of the tissue material dielectric parameters. The difference between the ambient temperature of the liquid during the dielectric measurement and the temperature during tests was less than |2|°C.

## 5.2. System Validation

**Figure 7. Validation setup**

Prior to the SAR assessment, the system validation kit was used to verify that the DASY4 was operating within its specifications. The validation dipoles are highly symmetric and matched at the centre frequency for the specified liquid and distance to the phantom. The accurate distance between the liquid surface and the dipole centre is achieved with a distance holder that snaps onto the dipole.

System validation is performed by feeding a known power level into a reference dipole, set at a know distance from the phantom.

The measured SAR is compared to the theoretically derived level. The reference SAR values are derived using a reference dipole and flat phantom suitable. The forward power into the reference dipole for each SAR validation was adjusted to 250 mW.

These reference SAR values are normalized to 1 W. The measured 1g(10g) SAR should be within 10 % of the expected target reference values shown in table 4 below.

| System Validation Kit | Date | Liquid Temp.(˚C) | Ambient Temp.( ˚C) | Targeted SAR10g (mW/g) | Measured SAR 10 g (mW/g) | Deviation (%) |
|---|---|---|---|---|---|---|
| D1900V2 S/N: 5d038 | November 1, 2012 | 21.0 | 21.0 | 39.7 | 38.0 | -4.3 |
| D1900V2 S/N: 5d038 | November 2, 2012 | 21.5 | 21.0 | 39.7 | 40 | +0.7 |

**Table 4 : Deviation from Reference Validation Values**

## 5.3. Justification for Extended SAR Dipole Calibrations

According to maintaining return loss and impedance requirements per extended calibrations in KDB 865664, usage of SAR dipole calibrated less than 2 years ago but more than 1 year ago was confirmed.

**KDB 865664 requirements**

a ) return loss : < -20 dB, within 20% of prior calibration
b ) impedance : within 5Ω from prior calibration.

| D1900V2 S/N:5d038 | | | | | |
|---|---|---|---|---|---|
| **Head/Body** | **Date of Measurement** | **Return Loss (dB)** | **∆%** | **Impedance (Ω)** | **∆Ω** |
| **Head** | 11/25/2010 | -23.5 | - | 52.9 | - |
| | 07/16/2012 | -22.2 | -6.6 | 51.5 | -1.4 |
| **Body** | 04/19/2011 | -22.2 | - | 48.3 | - |
| | 07/12/2012 | -22.0 | -0.2 | 45.9 | -2.4 |

# 6.SAR MEASUREMENT PROCEDURE USING DASY4

The SAR evaluation was performed with the SPEAG DASY4 system. A summary of the procedure follows ;

a) A measurement of the SAR value at a fixed location is used as a reference value for assessing the power drop of the EUT. The SAR at this point is measured at the start of the test and then again at the end of the test.

b) The SAR distribution at the exposed side of the phantom is measured at a distance of 3.9 mm from the inner surface of the shell. The area covers the entire dimension of the EUT and the horizontal grid spacing is 15 mm x 15 mm( or 20mm x 20mm). The actual Area Scan has dimensions surrounding the test device. Based on this data, the area of the maximum absorption is determined by Spline interpolation.

c) Around this point, a volume is assessed by measuring 5 x 5 x 7 (7 x 7 x 7) points. On the basis of this data set, the spatial peak SAR value is evaluated with the following procedure ;

(i) The data at the surface are extrapolated, since the centre of the dipoles is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2 mm. The extrapolation is based on a least square algorithm[13]. A polynomial of the fourth order is calculated through the points in z-axes. This polynomial is then used to evaluate the points between the surface and the probe tip.

(ii) The maximum interpolated value is searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g and 10 g) are computed using the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three one-dimensional splines with the “Not a knot”- condition (in x, y and z-direction)[13][14]. The volume is integrated with the trapezoidal-algorithm. One thousand points (10 x 10 x 10) are interpolated to calculate the averages.

(iii) All neighbouring volumes are evaluated until no neighbouring volume with a higher average value is found.

(iv) The SAR value at the same location as in Step (a) is again measured (If the value changed by more than 5%, the evaluation is repeated.)

# 7.DESCRIPTION OF TEST POSITION

SAR measurements were performed in the "cheek" and "tilted" positions on left and right sides of the phantom according to IEEE 1528. Both were measured in the head section of the SAM Twin Phantom.

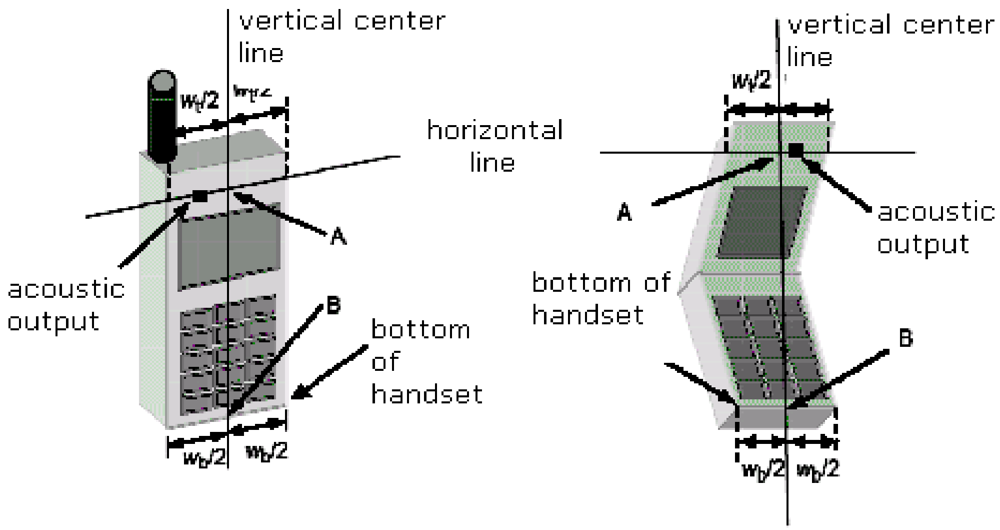



**Figure 8. Handset vertical and horizontal reference line**

## 7.1. Cheek Position

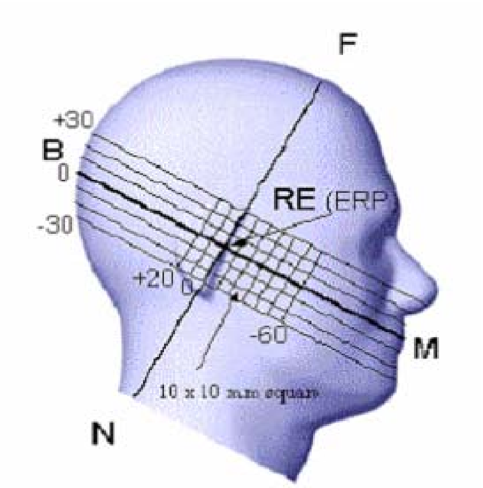



**Figure 9. Side view of SAM phantom**

The device was positioned with the vertical center line of the body of the device and the horizontal line crossing the center (see Figure 8) of the ear piece in a plane parallel to the sagittal plane of the phantom(see Figure 9). While maintaining the device in this plane, it was aligned the vertical center line with the reference plane containing the three ear and mouth reference points(M, RE and LE) and aligned the center of the ear piece with the line RE-LE. Then device was translated towards the phantom with the ear piece aligned with the line LE-RE until it touched the ear. While maintaining the device in the reference plane and maintaining the device contact with the ear, the bottom of the device was moved until any point on the front side is in contact with the cheek of the phantom.(see Figure 10)

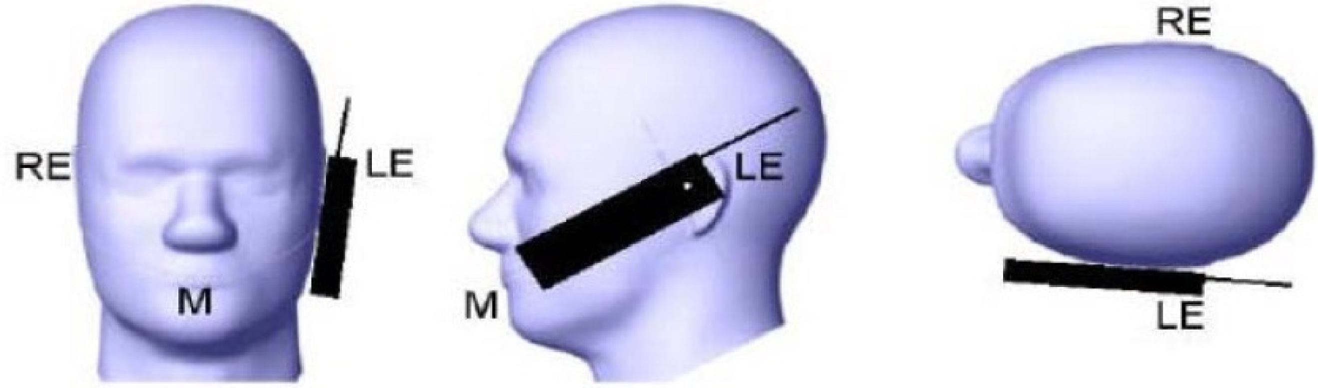



**Figure 10. Cheek/Touch Position**

## 7.2. Tilt Position

The device was positioned in the “Cheek” position. While maintaining the device in the reference plane described above cheek position and pivoting against the ear, device was moved outward away from the mouth by an angle of 15 degrees. (see Figure 11)

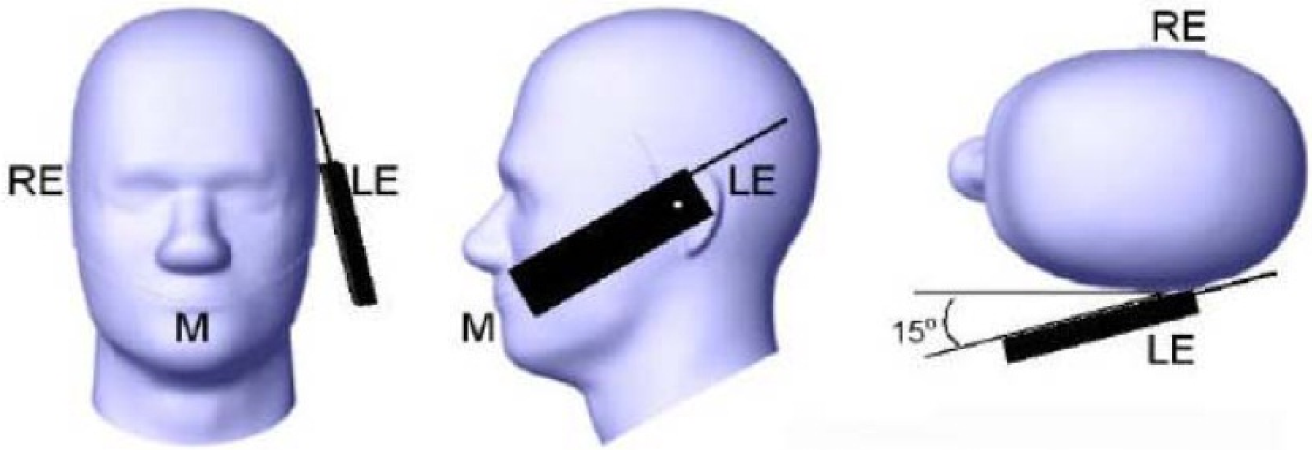



**Figure 11. Ear/Tilt Position**

## 7.3. Body Holster/ Belt Clip Configurations

Body-worn operating configurations are tested without the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration. A device with a headset output is tested with a headset connected to the device.

Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are tested with the device with each accessory. If multiple accessories share an identical metallic component(i.e. the same metallic belt-clip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.

Body-worn accessories may not always be supplied or available as options for some devices intended to be authorized for body-worn use. In this case, a test configuration with a separation distance between the back of the device and the flat phantom is used. Test position spacing was documented.

Transmitters that are designed to operate in front of a person's face, as the push-to-talk configurations, are test for SAR compliance with the front of the device positioned to face the flat phantom in brain fluid. For devices that are carried next to the body such as a shoulder, waist or chest-worn transmitters, SAR compliance is tested with the accessories, including headsets and microphones, attached to the device and positioned against a flat phantom in a normal use configuration.

In all cases SAR measurements are performed to investigate the worst-case positioning. Worst-case positioning is then documented and used to perform Body SAR testing.

# 8. MEASUREMENT UNCERTAINTY

Applicable for frequencies up to 6GHz

| Uncertainty Component | Tol. (%) | Prob Dist | Div | $c_i$ 1g | $c_i$ 10g | $u_i$(%) 1g | $u_i$(%) 10g | $v_i$ |
|---|---|---|---|---|---|---|---|---|
| **Measurement System** | | | | | | | | |
| Probe Calibration | ± 6.55 | N | 1 | 1 | 1 | ± 6.55 | ± 6.55 | ∞ |
| Axial Isotropy | ± 4.70 | R | $\sqrt{3}$ | 0.7 | 0.7 | ± 1.90 | ± 1.90 | ∞ |
| Hemispherical Isotropy | ± 9.60 | R | $\sqrt{3}$ | 0.7 | 0.7 | ± 3.38 | ± 3.38 | ∞ |
| Linearity | ± 4.70 | R | $\sqrt{3}$ | 1 | 1 | ± 2.71 | ± 2.71 | ∞ |
| System Detection Limits | ± 1.00 | R | $\sqrt{3}$ | 1 | 1 | ± 0.58 | ± 0.58 | ∞ |
| Boundary Effect | ± 1.00 | R | $\sqrt{3}$ | 1 | 1 | ± 0.58 | ± 0.58 | ∞ |
| Response Time | ± 0.80 | R | $\sqrt{3}$ | 1 | 1 | ± 0.46 | ± 0.46 | ∞ |
| RF Ambient conditions | ± 3.00 | R | $\sqrt{3}$ | 1 | 1 | ± 1.73 | ± 1.73 | ∞ |
| Readout Electronics | ± 1.00 | N | 1 | 1 | 1 | ± 1.00 | ± 1.00 | ∞ |
| Integration time | ± 2.60 | R | $\sqrt{3}$ | 1 | 1 | ± 1.50 | ± 1.50 | ∞ |
| Probe Positioner | ± 0.40 | R | $\sqrt{3}$ | 1 | 1 | ± 0.23 | ± 0.23 | ∞ |
| Probe Positioning | ± 2.90 | R | $\sqrt{3}$ | 1 | 1 | ± 1.67 | ± 1.67 | ∞ |
| Max. SAR evaluation | ± 1.00 | R | $\sqrt{3}$ | 1 | 1 | ± 0.58 | ± 0.58 | ∞ |
| **Test Sample Related** | | | | | | | | |
| Device Positioning | ± 2.90 | N | 1 | 1 | 1 | ± 2.90 | ± 2.90 | 145 |
| Device Holder | ± 3.60 | N | 1 | 1 | 1 | ± 3.60 | ± 3.60 | 5 |
| Power Drift | ± 5.00 | R | $\sqrt{3}$ | 1 | 1 | ± 2.89 | ± 2.89 | ∞ |
| **Phantom and Setup** | | | | | | | | |
| Phantom Uncertainty | ± 4.00 | R | $\sqrt{3}$ | 1 | 1 | ± 2.31 | ± 2.31 | ∞ |
| Liquid Conductivity (target) | ± 5.00 | R | $\sqrt{3}$ | 0.64 | 0.43 | ± 1.85 | ± 1.24 | ∞ |
| Liquid Conductivity (meas.) | ± 2.07 | N | 1 | 0.78 | 0.71 | ± 1.61 | ± 1.47 | 9 |
| Liquid Permittivity (target) | ± 5.00 | R | $\sqrt{3}$ | 0.60 | 0.49 | 1.73 | 1.43 | ∞ |
| Liquid Permittivity (meas.) | ± 3.07 | N | 1 | 0.26 | 0.26 | ± 0.80 | ± 0.80 | 9 |
| Combined Std. Uncertainty (k=1) | | RSS | | | | 10.43 | 10.33 | |
| **Expanded STD Uncertainty (95% CONFIDENCE LEVEL)** | | **k=2** | | | | 20.87 | 20.66 | |

**Table 5. Uncertainty Budget**

# 9.FCC RF Exposure Limits

| HUMAN EXPOSURE | UNCONTROLLED ENVIRONMENT<br><br>General Population (W/Kg) or (mW/g) | CONTROLLED ENVIRONMENT<br><br>Occupational (W/Kg) or (mW/g) |
|---|---|---|
| **SPATIAL PEAK SAR (Brain)** | 1.60 | 8.00 |
| **SPATIAL AVERAGE SAR (Whole Body)** | 0.08 | 0.40 |
| **SPATIAL PEAK SAR (Hand / Feet / Ankle / Wrist)** | 4.00 | 20.00 |

**Table. 6 Safety Limits for Partial Body Exposure**

NOTE :

* The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

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

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e.as a result of employment or occupation).

# 10.RF CONDUCTED POWERS

## 10.1.Nominal and Maximum Output Power Specifications

This device operates using the following maximum and nominal output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498 D01v06.

| Mode | | Modulated Average Power (dBm) |
|---|---|---|
| IEEE 802.11b (2.4G) | Maximum | 20.0 |
| | Nominal | 18.5 |

## 10.2.SAR scaling factors sample calculation

Scaled SAR results are derived after scaling factors are applied to the measured values as below. Scaling for maximum tune-up tolerance must be considered separately.

| SAR Section | Test Position | Mode | Dist. (mm) | Freq. (MHz) | CH # | Power (dBm] | | SAR 1g (W/kg) | Scaling Factor | Scaled SAR 1g (W/kg) | Plot. No. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Max. allowed | Mea-sured | | | | |
| Head | Right Touch | UPCS | N/A | 1934.992 | 3 | 20.0 | 18.34 | 0.029 | 1.466 | 0.043 | **1** |

*Scaled SAR = Measured SAR x Scaling Factor

0.043 = 0.029 x 1.466

# 11.SAR MEASUREMENT RESULTS

## 11.1. UPCS SAR Measurement Results

| SAR Section | Test Position | Mode | Dist. (mm) | Freq. (MHz) | CH # | Power (dBm] | | SAR 1g (W/kg) | Scaling Factor | Scaled SAR 1g (W/kg) | Plot. No. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Max. allowed | Mea-sured | | | | |
| Head | Right Touch | UPCS | N/A | 1924.992 | 3 | 20.0 | 18.34 | 0.029 | 1.466 | **0.043** | **1** |
| | Right Tilt | UPCS | N/A | 1924.992 | 3 | 20.0 | 18.34 | 0.015 | 1.466 | 0.022 | - |
| | Left Touch | UPCS | N/A | 1924.992 | 3 | 20.0 | 18.34 | 0.020 | 1.466 | 0.029 | - |
| | Left Tilt | UPCS | N/A | 1924.992 | 3 | 20.0 | 18.34 | 0.012 | 1.466 | 0.018 | - |
| Body | Front | UPCS | 15 | 1924.992 | 3 | 20.0 | 18.34 | 0.009 | 1.466 | **0.013** | **2** |
| | Rear | UPCS | 15 | 1924.992 | 3 | 20.0 | 18.34 | 0.009 | 1.466 | 0.013 | - |
| **ANSI/IEEE C95.1 – 1992-Safety Limit Spatial Peak** Uncontrolled Exposure/ General Population | | | | | | **1.6 W/kg (mW/g)** Averaged over 1 gram | | | | | |

NOTES:

1. The test data reported are the worst-case SAR value with the position set in a typical configuration
2. All modes of operation were investigated and the worst-case are reported.
3. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
4. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB 447498 D01v06.
5. Per FCC KDB 648474 D04v01, SAR was evaluated without a headset connected to the device. Since the standalone reported SAR was less than 1.2 W/kg, no additional SAR evaluation using a headset cable were required.
6. Per FCC KDB 865664 D01v01, variability SAR tests were not performed since the measured SAR results for all frequency bands were less than 0.8 W/kg. Please see Section 13 for variability analysis information.
7. Justification for reduced test configurations: per KDB 447498 D01v06, if the SAR measured at the middle channel for each test configuration (Left, right, cheek/touch, tilt/ear, extended and retracted) is at least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional for such test configuration(s).
8. Battery was fully charged for all readings.
9. Test Signal Call mode: Base Station Simulator (CMD60)
10. Duty Cycle is 1:24
11. Depth of simulation Tissue is 15.0 cm ± 0.2 cm

# 12. FCC MULTI-TX CONSIDERATION

This device doesn’t have any licensed transmitter. So there is no need consideration for Multi-Tx consideration

# 13. SAR MEASUREMENT VARIABILITY

## 13.1. Measurement Variability

Per FCC KDB Publication 865864 D01v01, SAR measurement variability was assessed when measured 1g SAR is > 0.80 W/kg or when measured 10g SAR is >2.00 W/kg. Since all measured 1g SAR values were <0.8 W/kg SAR measurement variability was not assessed.

## 13.2. Measurement Uncertainty

The measured SAR was <1.5 W/kg for all frequency bands. Therefore, per KDB Publication 865664 D01v01, the extended measurement uncertainty analysis per IEEE 1528-2003 was not required.

# 14.CONCLUSION

The SAR evaluation indicates that GDC-450H complies with the RF radiation exposure limits of the FCC. These measurements were taken to simulate the RF effects of RF exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The results and statements relate only to the item(s) tested.

# 15.EQUIPMENT LIST AND CALIBRATION DETAILS

| Equipment Type | Manufacturer | Model Number | Serial Number | Calibration Due | Used For this Test |
|---|---|---|---|---|---|
| Robot - Six Axes | Staubli | RX60 | N/A | N/A | ☒ |
| Robot Remote Control | SPEAG | CS7MB | F03/5U96A1 /C/01 | N/A | ☒ |
| SAM Twin Phantom | SPEAG | TP1276 | QD000P40CA | N/A | ☒ |
| Flat Phantom V4.4 | SPEAG | QD000P44BA, BB | 1001, higher | N/A | ☐ |
| Data Acquisition Electronics | SPEAG | DAE4 | 559 | 2013.01.23 | ☒ |
| Probe E-Field | SPEAG | ES3DV2 | 3020 | 2013.01.26 | ☒ |
| Antenna Dipole 835 MHz | SPEAG | D835V2 | 481 | 2013.03.15 | ☐ |
| Antenna Dipole 900 MHz | SPEAG | D900V2 | 194 | 2013.11.18 | ☐ |
| Antenna Dipole 1800 MHz | SPEAG | D1800V2 | 2d066 | 2014.01.26 | ☐ |
| Antenna Dipole 1900 MHz | SPEAG | D1900V2 | 5d038 | 2013.04.19 | ☒ |
| Antenna Dipole 1950 MHz | SPEAG | D1950V2 | 1027 | 2014.01.24 | ☐ |
| Antenna Dipole 2450 MHz | SPEAG | D2450V2 | 746 | 2014.01.24 | ☐ |
| High power RF Amplifier | EMPOWER | 2057-BBS3Q5KCK | 1002D/C0321 | 2013.02.15 | ☒ |
| Digital Communication Tester | R&S | CMD60 | 84289/006 | 2013.02.16 | ☒ |
| Signal Generator | Agilent | 8648C | 3629U00868 | 2013.02.07 | ☒ |
| RF Power Meter Dual | Hewlett Packard | E4419A | GB37170495 | 2013.02.08 | ☒ |
| RF Power Sensor 0.01 - 18 GHz | Hewlett Packard | 8481A | US37299851 | 2013.02.16 | ☒ |
| RF Power Sensor 0.01 - 18 GHz | Hewlett Packard | 8481A | 3318A92872 | 2013.02.16 | ☒ |
| S-Parameter Network Analyzer | Agilent | 8753D | 3410A07251 | 2013.03.13 | ☒ |
| Dual Directional Coupler | Hewlett Packard | 778D | 1144AO4576 | 2013.02.13 | ☒ |
| Directional Coupler | Agilent | 773D | MY28390213 | 2013.02.13 | ☒ |
| Bluetooth Test Set | Anritsu | MT8852B | 6K00006994 | 2013.01.28 | ☐ |

# APPENDIX A. SAR PLOTS

**- Test Laboratory: KTL**

**- D1900V2: HEAD 1900MHz Validation**

**- Test Date: November 1, 2012**

**- Measured Liquid Temperature: 21.0 ℃, Ambient Temperature: 21.0 ℃**

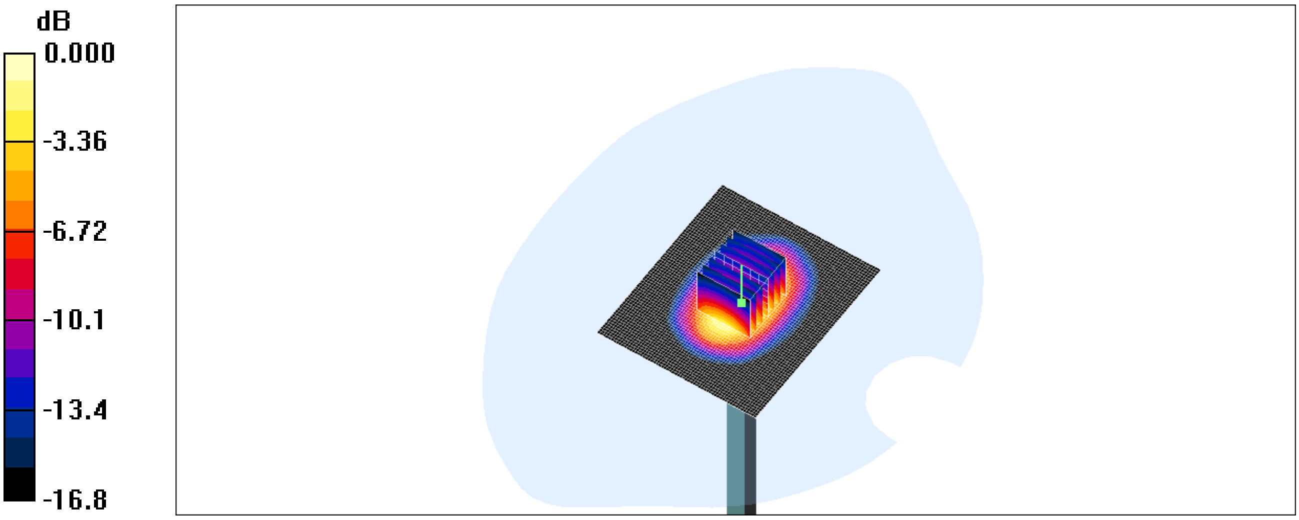
Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium: HSL1900 Medium parameters used: f = 1900 MHz; $\sigma$ = 1.38 mho/m; $\varepsilon_r$ = 39.4; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV2 - SN3020; ConvF(5, 5, 5); Calibrated: 2012-01-26
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn559; Calibrated: 2012-01-23
- Phantom: SAM Twin Phantom_1800MHz; Type: SAM; Serial: TP-1433
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

**Area Scan (61x71x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 12.8 mW/g

**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 93.1 V/m; Power Drift = -0.204 dB
Peak SAR (extrapolated) = 17.4 W/kg
**SAR(1 g) = 9.50 mW/g; SAR(10 g) = 5.02 mW/g**
Maximum value of SAR (measured) = 10.8 mW/g




0 dB = 10.8mW/g

**- SAR Plot : #1**

**- Test Laboratory: KTL**

**- Model: GDC-480H**

**- Position: RIGHT CHEEK TOUCH**

**- Test Date: December 1, 2012**

**- Measured Liquid Temperature: 21.0 ℃, Ambient Temperature: 21.0 ℃**

Communication System: UPCS1900; Frequency: 1924.99 MHz;Duty Cycle: 1:24
Medium: HSL1900 Medium parameters used: f = 1924.99 MHz; $\sigma$ = 1.38 mho/m; $\varepsilon_r$ = 39.2; $\rho$ = 1000 kg/m$^3$
Phantom section: Right Section
Measurement Standard: DASY4 (High Precision Assessment)

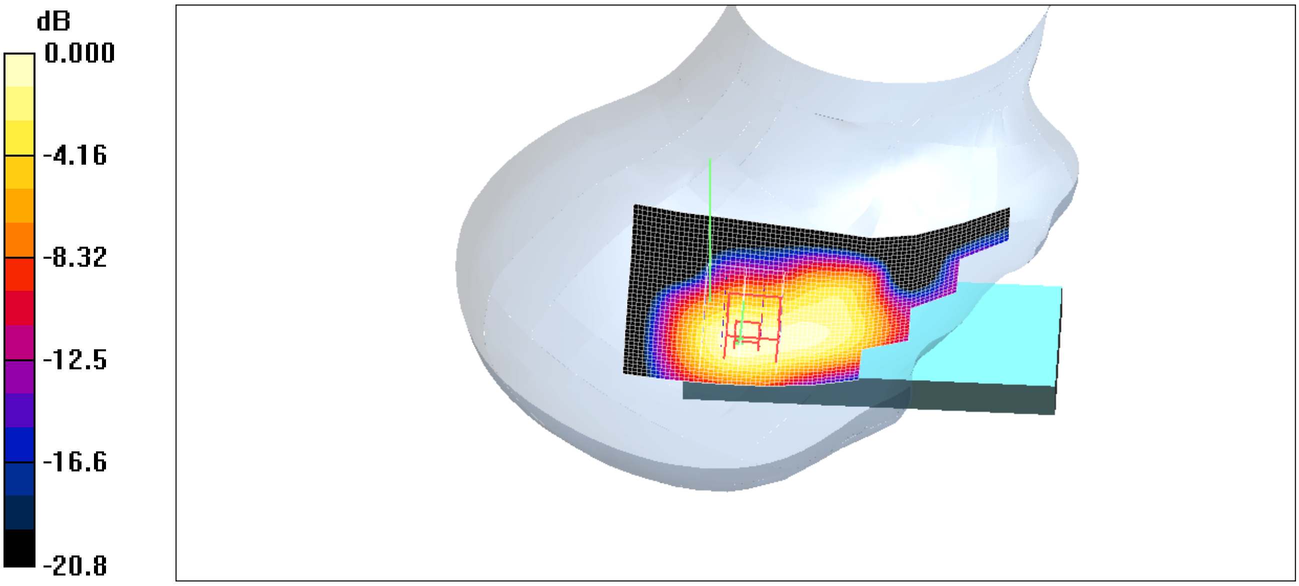
DASY4 Configuration:

- Probe: ES3DV2 - SN3020; ConvF(5, 5, 5); Calibrated: 2012-01-26
- Sensor-Surface: 4mm (Mechanical Surface Detection)Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn559; Calibrated: 2012-01-23
- Phantom: SAM Twin Phantom_1800MHz; Type: SAM; Serial: TP-1433
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

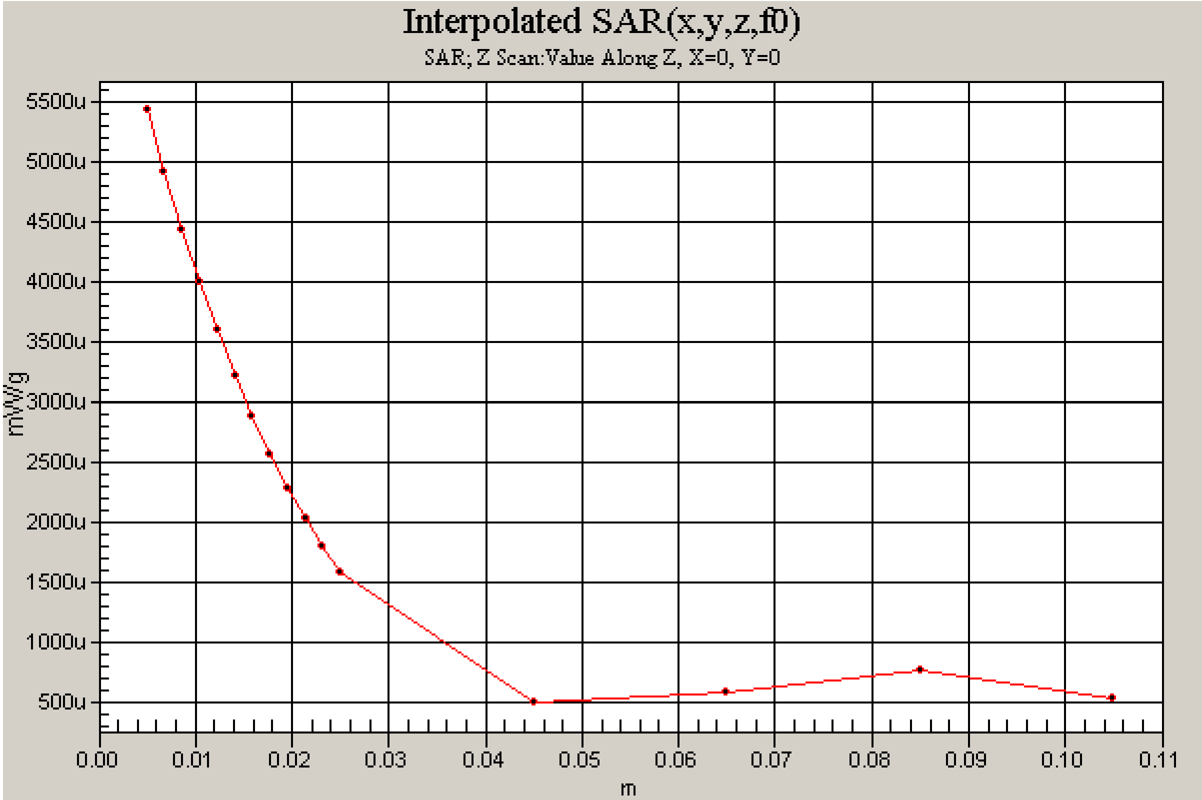
**Area Scan (41x81x1):** Measurement grid: dx=20mm, dy=20mm
Maximum value of SAR (interpolated) = 0.031 mW/g

**Z Scan (1x1x16):** Measurement grid: dx=20mm, dy=20mm, dz=20mm
Maximum value of SAR (interpolated) = 0.005 mW/g

**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 2.70 V/m; Power Drift = -0.089 dB
Peak SAR (extrapolated) = 0.051 W/kg
**SAR(1 g) = 0.029 mW/g; SAR(10 g) = 0.016 mW/g**
Maximum value of SAR (measured) = 0.031 mW/g




0 dB = 0.031mW/g


Interpolated SAR(x,y,z,f0)
SAR; Z Scan:Value Along Z, X=0, Y=0
5500u
5000u
4500u
4000u
3500u
3000u
2500u
2000u
1500u
1000u
500u
mW/g
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.10
0.11
m

**- Test Laboratory: KTL**

**- D1900V2: BODY 1900MHz Validation**

**- Test Date: November 2, 2012**

**- Measured Liquid Temperature: 21.5 ℃, Ambient Temperature: 21.0 ℃**

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium: MSL1900 Medium parameters used: f = 1900 MHz; $\sigma$ = 1.54 mho/m; $\varepsilon_r$ = 52.1; $\rho$ = 1000 kg/$m^3$
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

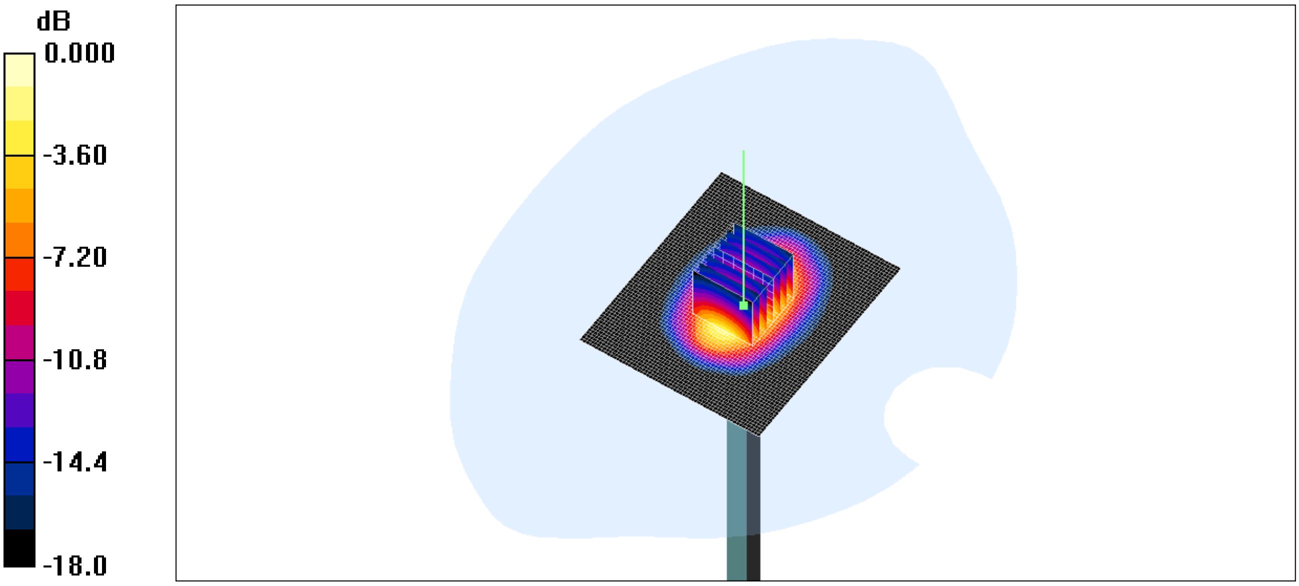
DASY4 Configuration:

- Probe: ES3DV2 - SN3020; ConvF(4.44, 4.44, 4.44); Calibrated: 2012-01-26
- Sensor-Surface: 4mm (Mechanical Surface Detection)Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn559; Calibrated: 2012-01-23
- Phantom: SAM Twin Phantom_1800MHz; Type: SAM; Serial: TP-1433
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

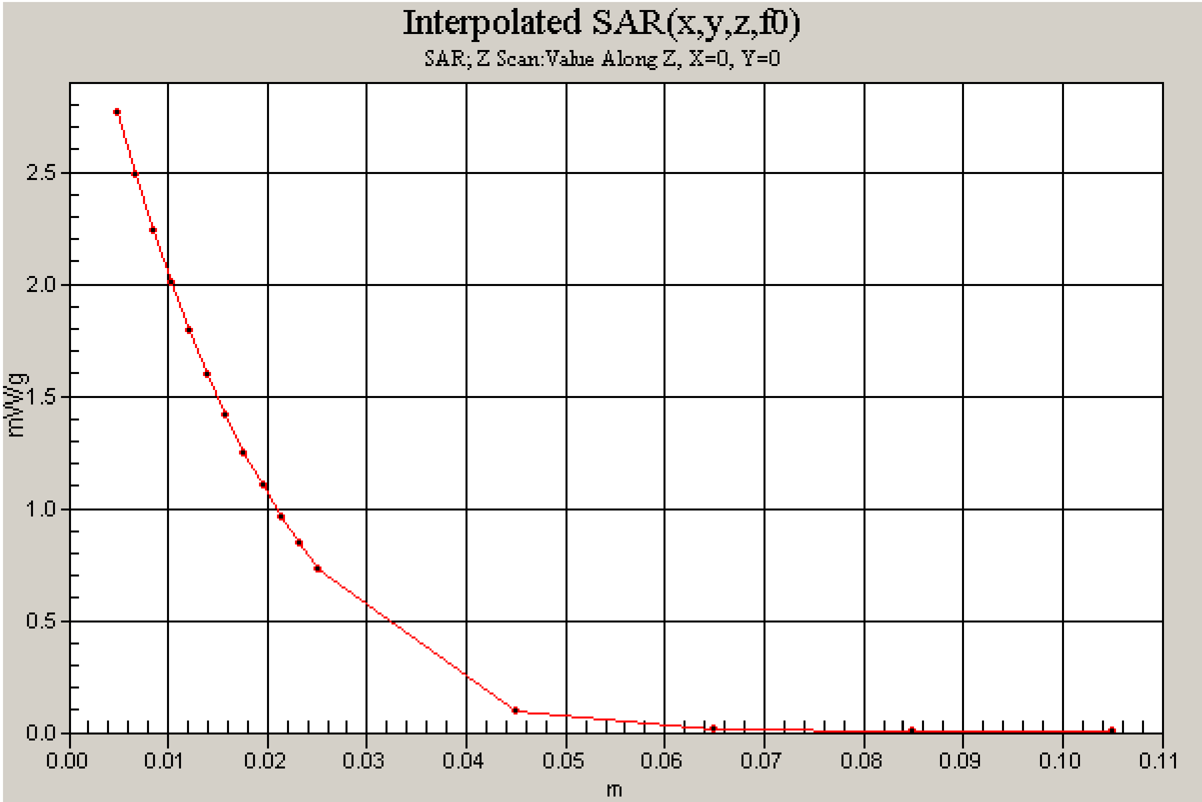
**Area Scan (61x71x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 12.3 mW/g

**Z Scan (1x1x16):** Measurement grid: dx=20mm, dy=20mm, dz=20mm
Maximum value of SAR (interpolated) = 2.74 mW/g

**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 87.3 V/m; Power Drift = -0.003 dB
Peak SAR (extrapolated) = 18.2 W/kg
**SAR(1 g) = 10.0 mW/g; SAR(10 g) = 5.2 mW/g**
Maximum value of SAR (measured) = 11.3 mW/g




0 dB = 11.3mW/g


Interpolated SAR(x,y,z,f0)
SAR; Z Scan:Value Along Z, X=0, Y=0
mW/g
2.5
2.0
1.5
1.0
0.5
0.0
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.10
0.11
m

**- Test Laboratory: KTL**

**- Model: GDC-480H**

**- Position: BODY FRONT FACING PHANTOM**

**- Test Date: December 2, 2012**

**- Measured Liquid Temperature: 21.5 ℃, Ambient Temperature: 21.0 ℃**

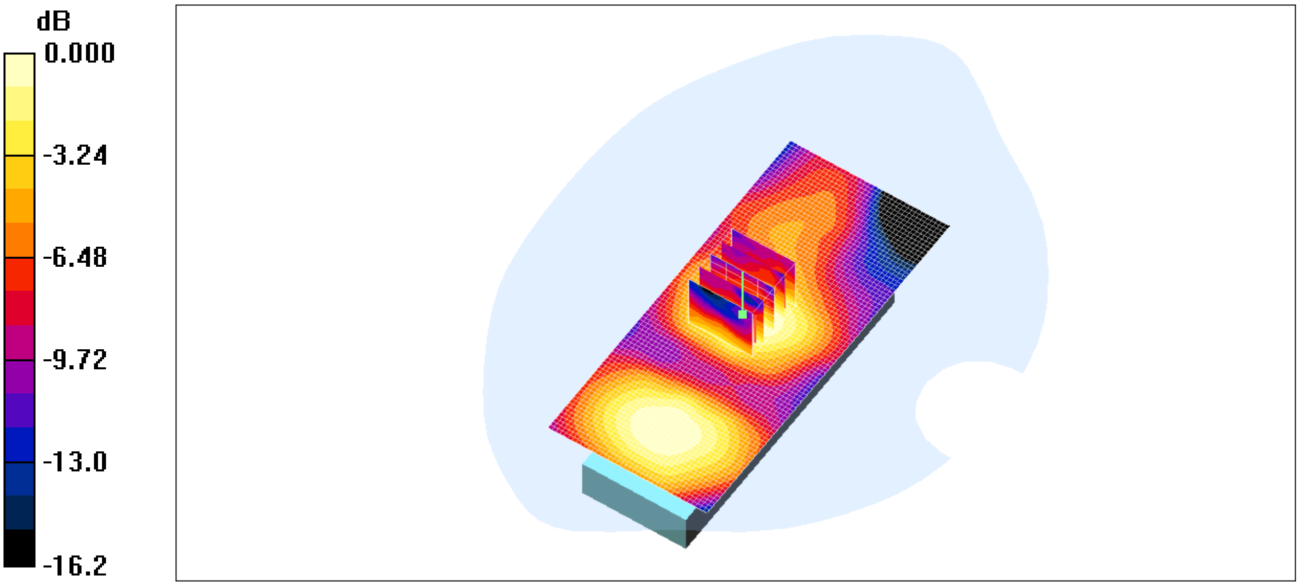
Communication System: UPCS1900; Frequency: 1924.99 MHz;Duty Cycle: 1:24
Medium: HSL1900 Medium parameters used: f = 1924.99 MHz; σ = 1.56 mho/m; $\varepsilon_r$ = 52.7; ρ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV2 - SN3020; ConvF(5, 5, 5); Calibrated: 2012-01-26
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn559; Calibrated: 2012-01-23
- Phantom: SAM Twin Phantom_1800MHz; Type: SAM; Serial: TP-1433
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

**Area Scan (41x91x1):** Measurement grid: dx=20mm, dy=20mm
Maximum value of SAR (interpolated) = 0.010 mW/g

**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 2.15 V/m; Power Drift = 0.057 dB
Peak SAR (extrapolated) = 0.015 W/kg
**SAR(1 g) = 0.00928 mW/g; SAR(10 g) = 0.00578 mW/g**
Maximum value of SAR (measured) = 0.010 mW/g




0 dB = 0.010mW/g

# Appendix B. CALIBRATION DATA SHEETS

## E-Field Probe 3020
## Dipole Antenna D1900V2-5d038

**Calibration Laboratory of**
Schmid & Partner
Engineering AG
**Zeughausstrasse 43, 8004 Zurich, Switzerland**

**S** **Schweizerischer Kalibrierdienst**
**C** **Service suisse d'étalonnage**
**S** **Servizio svizzero di taratura**
**Swiss Calibration Service**

Accredited by the Swiss Accreditation Service (SAS)
**The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates**

**Accreditation No.: SCS 108**

**Client** **KTL (Dymstec)**

**Certificate No: ES3-3020_Jan12**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | ES3DV2 - SN:3020 |
| Calibration procedure(s) | QA CAL-01.v8, QA CAL-23.v4, QA CAL-25.v4<br>Calibration procedure for dosimetric E-field probes |
| Calibration date: | January 26, 2012 |

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)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter E4419B | GB41293874 | 31-Mar-11 (No. 217-01372) | Apr-12 |
| Power sensor E4412A | MY41498087 | 31-Mar-11 (No. 217-01372) | Apr-12 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 29-Mar-11 (No. 217-01369) | Apr-12 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 29-Mar-11 (No. 217-01367) | Apr-12 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 29-Mar-11 (No. 217-01370) | Apr-12 |
| Reference Probe ES3DV2 | SN: 3013 | 29-Dec-11 (No. ES3-3013_Dec11) | Dec-12 |
| DAE4 | SN: 654 | 3-May-11 (No. DAE4-654_May11) | May-12 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-11) | In house check: Apr-13 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-11) | In house check: Oct-12 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Jeton Kastrati | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: January 26, 2012

## 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 | modulation dependent linearization parameters |
| Polarization $\varphi$ | $\varphi$ rotation around probe axis |
| Polarization $\vartheta$ | $\vartheta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis |

## Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
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 300 MHz to 3 GHz)", February 2005

## Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect 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 with CW signal (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 $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values 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 ± 50 MHz to ± 100 MHz.
- *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.

# Probe ES3DV2

## SN:3020

Manufactured: December 5, 2002
Calibrated: January 26, 2012

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

# DASY/EASY - Parameters of Probe: ES3DV2 - SN:3020

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm ($\mu V/(V/m)^2$)[A] | 1.10 | 0.98 | 1.03 | ± 10.1 % |
| DCP (mV)[B] | 105.2 | 106.2 | 100.9 | |

## Modulation Calibration Parameters

| UID | Communication System Name | PAR | | A dB | B dB | C dB | VR mV | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|
| 10000 | CW | 0.00 | X | 0.00 | 0.00 | 1.00 | 102.1 | ±1.9 % |
| | | | Y | 0.00 | 0.00 | 1.00 | 98.3 | |
| | | | Z | 0.00 | 0.00 | 1.00 | 95.5 | |

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

# DASY/EASY - Parameters of Probe: ES3DV2 - SN:3020

## 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 | Depth (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 835 | 41.5 | 0.90 | 6.21 | 6.21 | 6.21 | 0.30 | 1.56 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 5.20 | 5.20 | 5.20 | 0.47 | 1.33 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 5.00 | 5.00 | 5.00 | 0.46 | 1.35 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 4.22 | 4.22 | 4.22 | 0.54 | 1.41 | ± 12.0 % |

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters ($\varepsilon$ and $\sigma$) 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 ($\varepsilon$ and $\sigma$) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

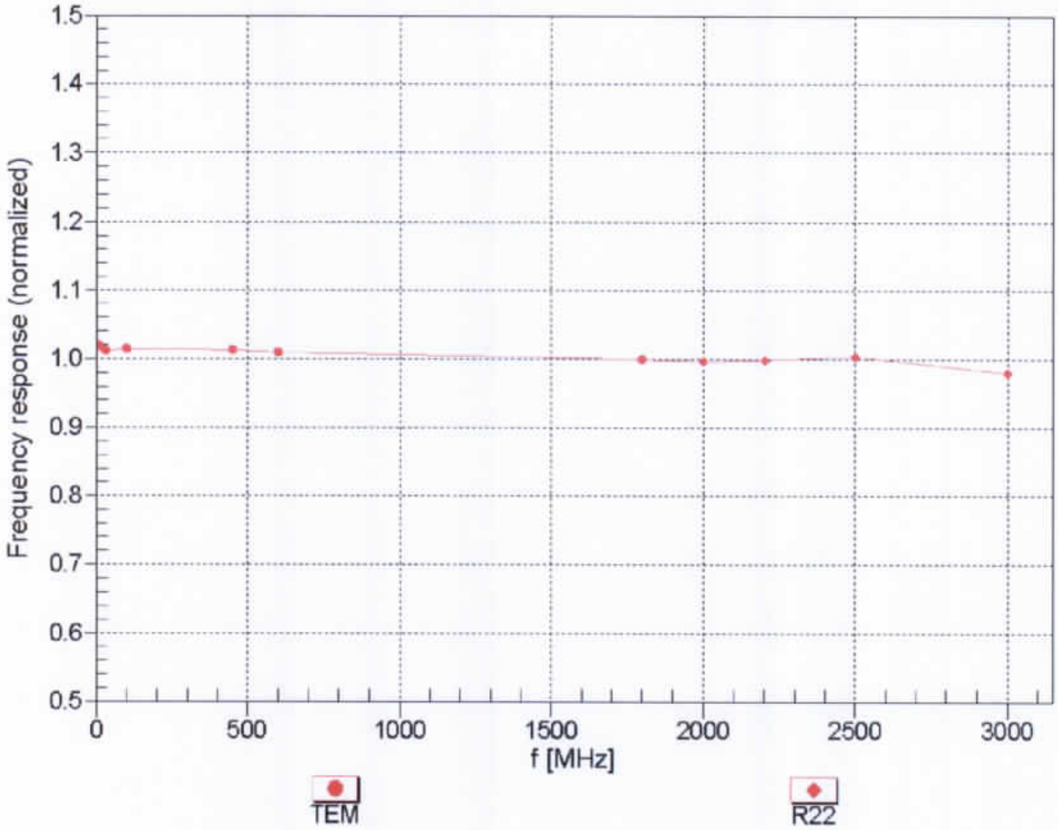
# DASY/EASY - Parameters of Probe: ES3DV2 - SN:3020

## 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 | Depth (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 835 | 55.2 | 0.97 | 6.18 | 6.18 | 6.18 | 0.35 | 1.50 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 5.21 | 5.21 | 5.21 | 0.43 | 1.81 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 4.44 | 4.44 | 4.44 | 0.43 | 1.77 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 3.95 | 3.95 | 3.95 | 0.74 | 1.16 | ± 12.0 % |

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters ($\varepsilon$ and $\sigma$) 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 ($\varepsilon$ and $\sigma$) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

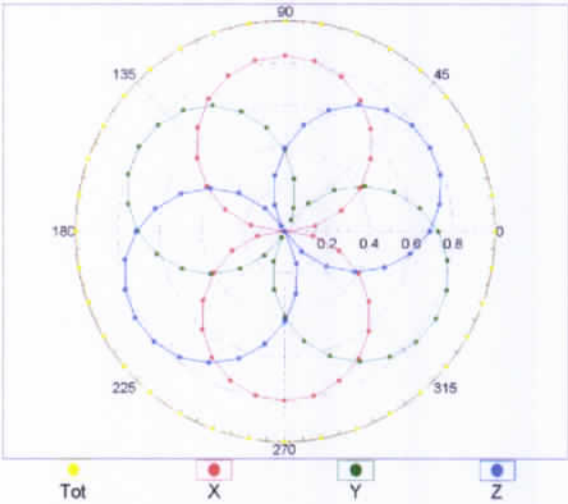
# Frequency Response of E-Field
**(TEM-Cell:ifi110 EXX, Waveguide: R22)**



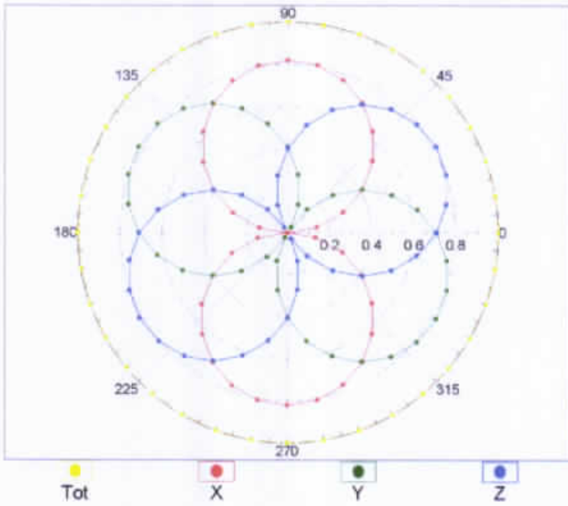

**Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)**

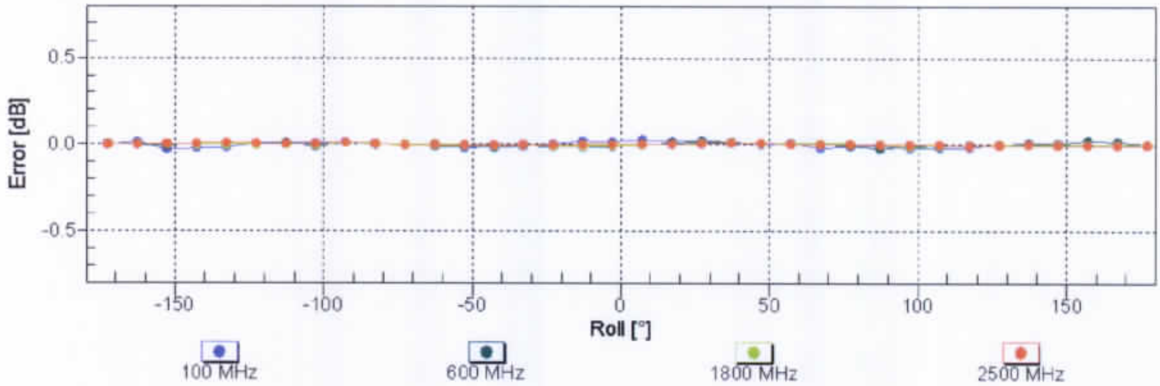
# Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



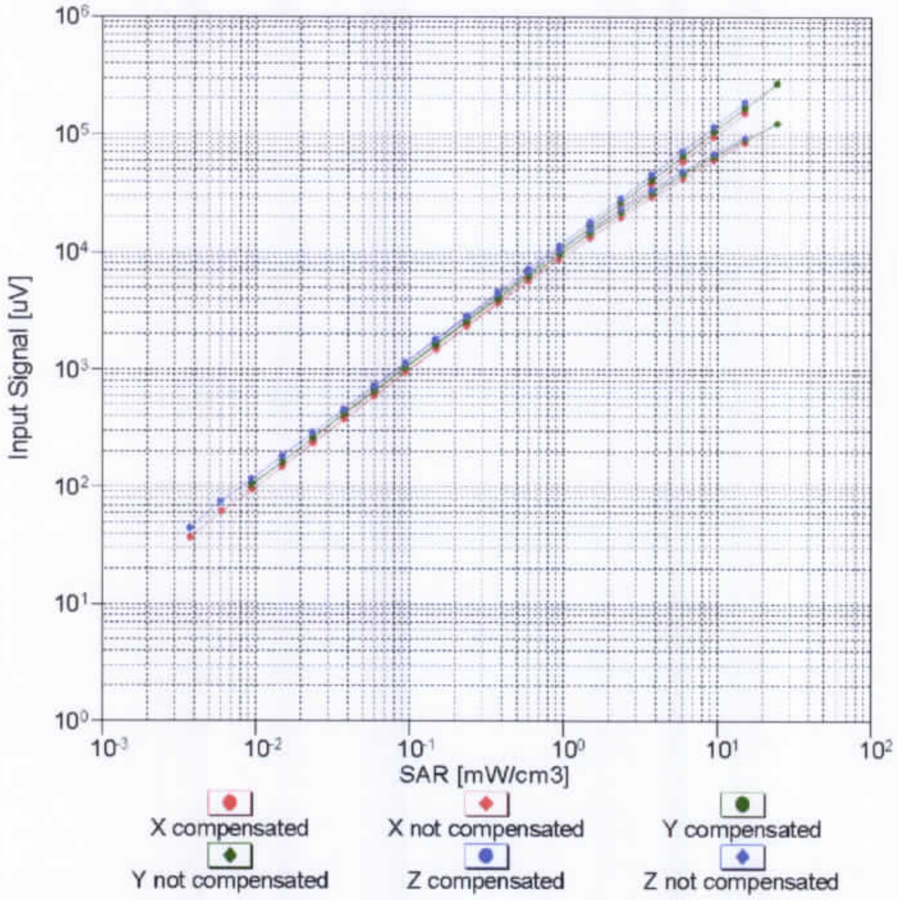

f=1800 MHz,R22

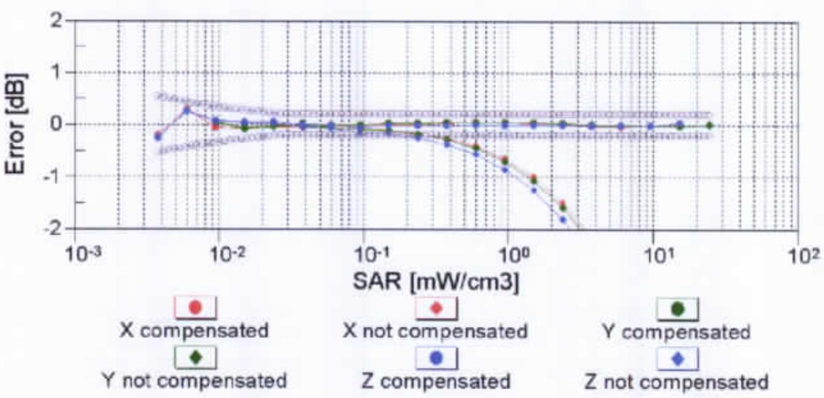



**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

# Dynamic Range f($SAR_{head}$)
**(TEM cell , f = 900 MHz)**

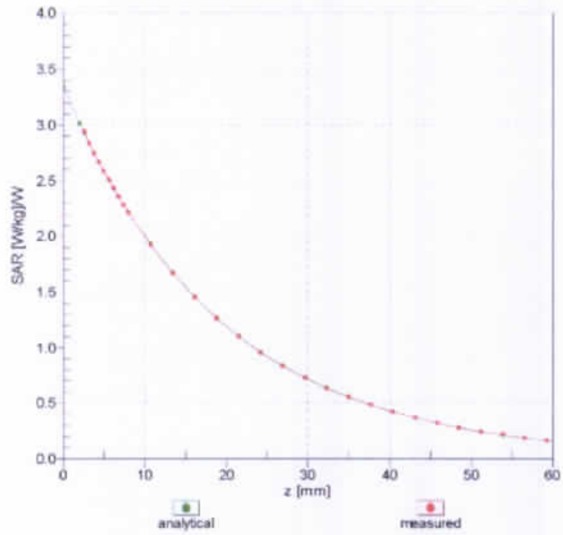


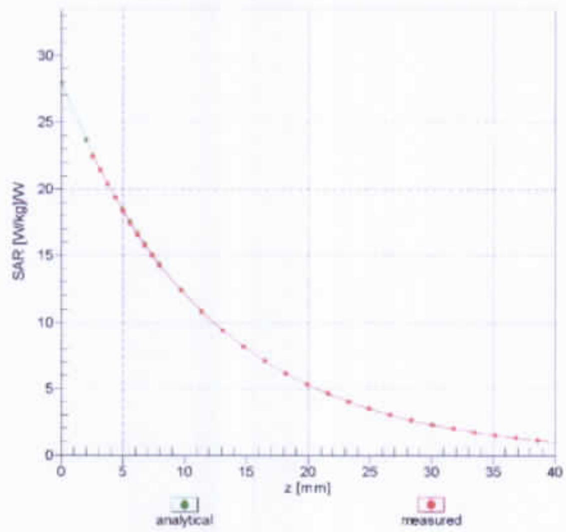

**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

# Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

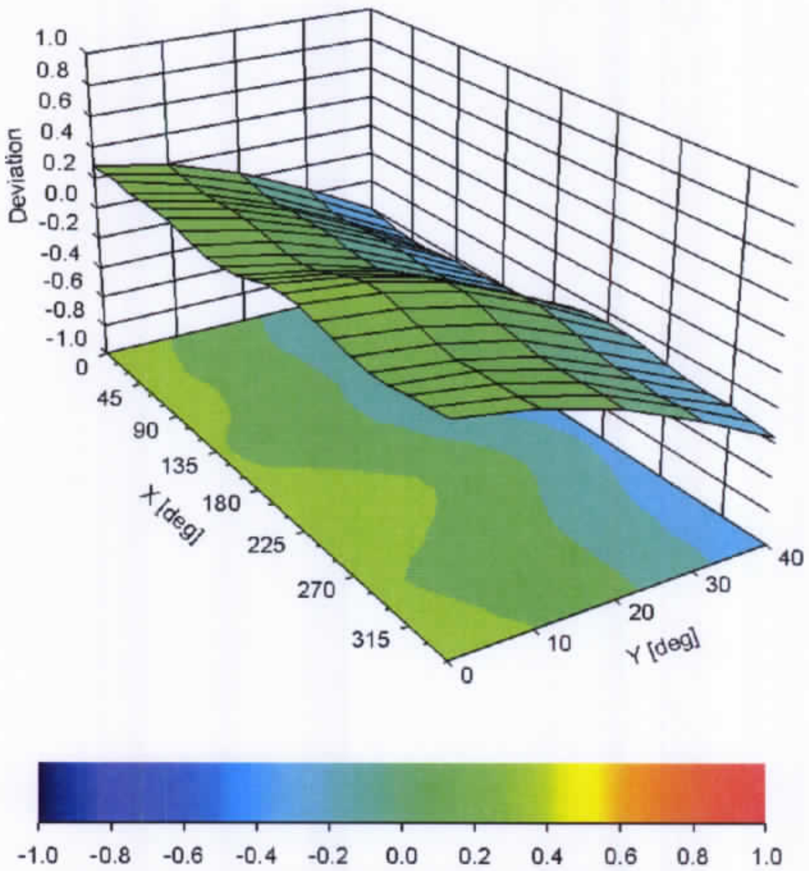



f = 1900 MHz,WGLS R22 (H_convF)




# Deviation from Isotropy in Liquid

**Error (ϕ, ϑ), f = 900 MHz**




**Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)**

# DASY/EASY - Parameters of Probe: ES3DV2 - SN:3020

## Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | Not applicable |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 10 mm |
| Tip Diameter | 4 mm |
| Probe Tip to Sensor X Calibration Point | 2 mm |
| Probe Tip to Sensor Y Calibration Point | 2 mm |
| Probe Tip to Sensor Z Calibration Point | 2 mm |
| Recommended Measurement Distance from Surface | 3 mm |

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**Accreditation No.: SCS 108**

**Client** **KTL (Dymstec)**

**Certificate No: D1900V2-5d038_Nov10**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D1900V2 - SN: 5d038 |
| Calibration procedure(s) | QA CAL-05.v7<br>Calibration procedure for dipole validation kits |
| Calibration date: | November 25, 2010 |

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)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter EPM-442A | GB37480704 | 06-Oct-10 (No. 217-01266) | Oct-11 |
| Power sensor HP 8481A | US37292783 | 06-Oct-10 (No. 217-01266) | Oct-11 |
| Reference 20 dB Attenuator | SN: 5086 (20g) | 30-Mar-10 (No. 217-01158) | Mar-11 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 30-Mar-10 (No. 217-01162) | Mar-11 |
| Reference Probe ES3DV3 | SN: 3205 | 30-Apr-10 (No. ES3-3205_Apr10) | Apr-11 |
| DAE4 | SN: 601 | 10-Jun-10 (No. DAE4-601_Jun10) | Jun-11 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power sensor HP 8481A | MY41092317 | 18-Oct-02 (in house check Oct-09) | In house check: Oct-11 |
| RF generator R&S SMT-06 | 100005 | 4-Aug-99 (in house check Oct-09) | In house check: Oct-11 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Jeton Kastrati | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: November 26, 2010

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Accreditation No.: **SCS 108**

## Glossary:

| | |
|---|---|
| TSL | tissue simulating liquid |
| ConvF | sensitivity in TSL / NORM x,y,z |
| N/A | not applicable or not measured |

## Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
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 300 MHz to 3 GHz)", February 2005
c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

## Additional Documentation:

d) DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

## Measurement Conditions

DASY system configuration, as far as not given on page 1.

| | | |
|---|---|---|
| **DASY Version** | DASY5 | V52.2 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom V5.0 | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 1900 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 40.0 | 1.40 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 39.3 ± 6 % | 1.40 mho/m ± 6 % |
| **Head TSL temperature during test** | (21.5 ± 0.2) °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 10.2 mW / g |
| SAR normalized | normalized to 1W | 40.8 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **40.7 mW /g ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.27 mW / g |
| SAR normalized | normalized to 1W | 21.1 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **21.0 mW /g ± 16.5 % (k=2)** |

## Appendix

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 52.9 Ω + 6.2 jΩ |
| Return Loss | - 23.5 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.199 ns |

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

### Additional EUT Data

| | |
|---|---|
| Manufactured by | SPEAG |
| Manufactured on | July 04, 2003 |

## DASY5 Validation Report for Head TSL

Date/Time: 25.11.2010 12:50:06

Test Laboratory: SPEAG, Zurich, Switzerland

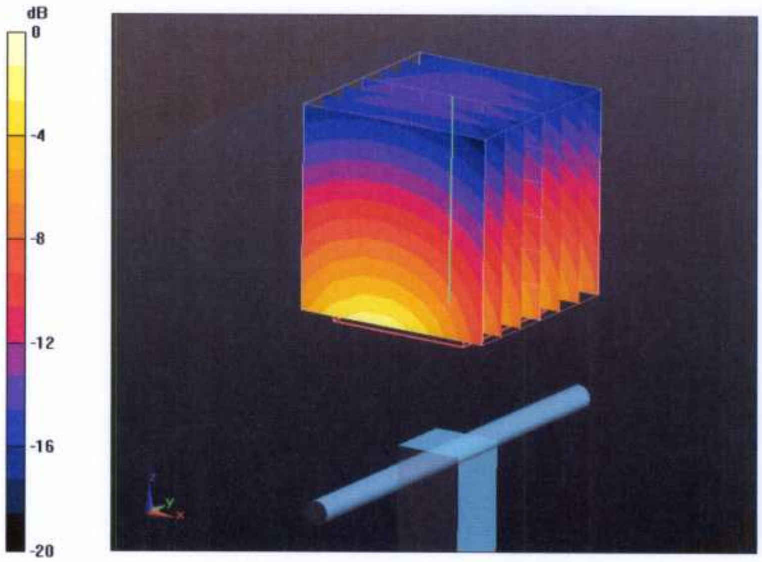
**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d038**

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium: HSL U12 BB
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.4 mho/m; $\varepsilon_r$ = 39.4; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

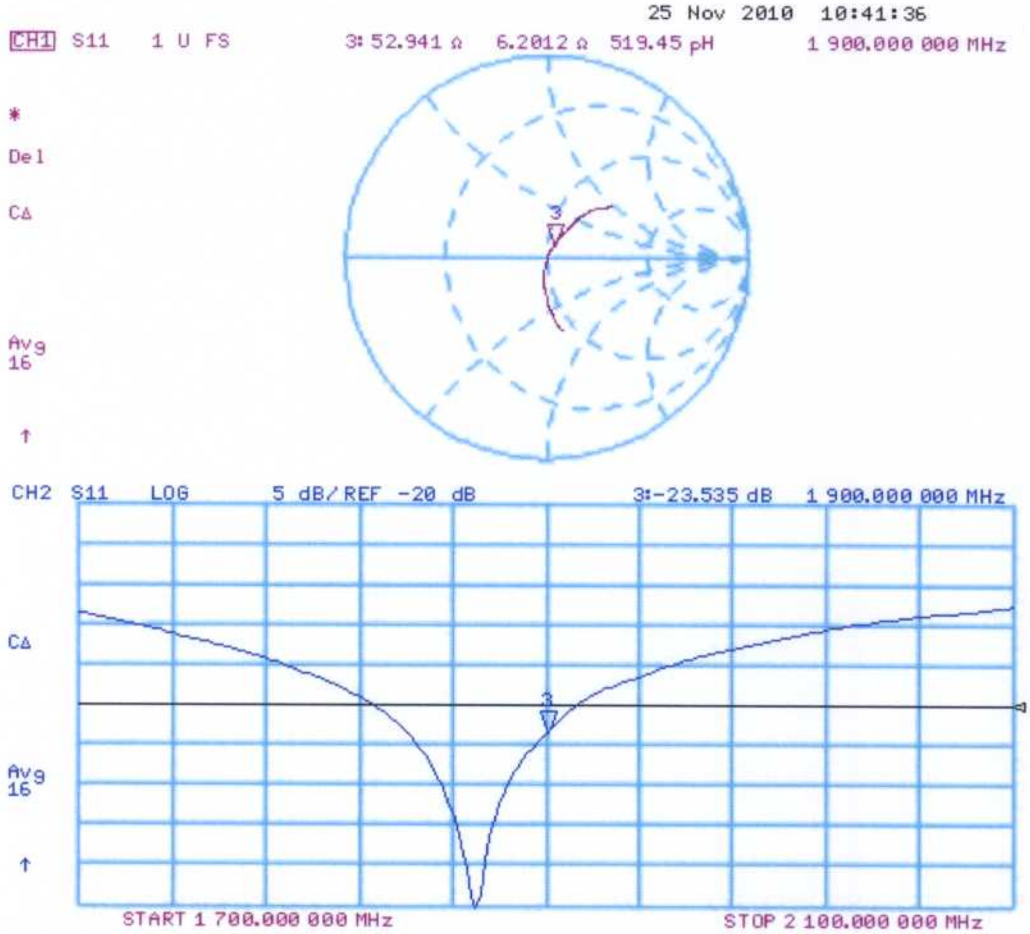
- Probe: ES3DV3 - SN3205; ConvF(5.09, 5.09, 5.09); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- Measurement SW: DASY52, V52.2 Build 0, Version 52.2.0 (163)
- Postprocessing SW: SEMCAD X, V14.2 Build 2, Version 14.2.2 (1685)

**Pin=250 mW /d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 97.6 V/m; Power Drift = 0.052 dB
Peak SAR (extrapolated) = 18.8 W/kg
**SAR(1 g) = 10.2 mW/g; SAR(10 g) = 5.27 mW/g**
Maximum value of SAR (measured) = 12.5 mW/g




0 dB = 12.5mW/g

## Impedance Measurement Plot for Head TSL



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**Accreditation No.: SCS 108**

**Client** **KTL (Dymstec)**

**Certificate No: D1900V2-5d038_Apr11**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D1900V2 - SN: 5d038 |
| Calibration procedure(s) | QA CAL-05.v8<br>Calibration procedure for dipole validation kits |
| Calibration date: | April 19, 2011 |

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)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter EPM-442A | GB37480704 | 06-Oct-10 (No. 217-01266) | Oct-11 |
| Power sensor HP 8481A | US37292783 | 06-Oct-10 (No. 217-01266) | Oct-11 |
| Reference 20 dB Attenuator | SN: 5086 (20g) | 29-Mar-11 (No. 217-01368) | Apr-12 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 29-Mar-11 (No. 217-01371) | Apr-12 |
| Reference Probe ES3DV3 | SN: 3205 | 30-Apr-10 (No. ES3-3205_Apr10) | Apr-11 |
| DAE4 | SN: 601 | 10-Jun-10 (No. DAE4-601_Jun10) | Jun-11 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power sensor HP 8481A | MY41092317 | 18-Oct-02 (in house check Oct-09) | In house check: Oct-11 |
| RF generator R&S SMT-06 | 100005 | 4-Aug-99 (in house check Oct-09) | In house check: Oct-11 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Claudio Leubler | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: April 19, 2011

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Accreditation No.: **SCS 108**

## Glossary:

| | |
|---|---|
| TSL | tissue simulating liquid |
| ConvF | sensitivity in TSL / NORM x,y,z |
| N/A | not applicable or not measured |

## Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
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 300 MHz to 3 GHz)", February 2005
c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

## Additional Documentation:

d) DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

## Measurement Conditions

DASY system configuration, as far as not given on page 1.

| | | |
|---|---|---|
| **DASY Version** | DASY5 | V52.6.2 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom V5.0 | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 1900 MHz ± 1 MHz | |

## Body TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 53.3 | 1.52 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 51.1 ± 6 % | 1.52 mho/m ± 6 % |
| **Body TSL temperature during test** | (21.8 ± 0.2) °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 10.1 mW / g |
| SAR normalized | normalized to 1W | 40.4 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **40.0 mW / g ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.29 mW / g |
| SAR normalized | normalized to 1W | 21.2 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **21.0 mW / g ± 16.5 % (k=2)** |

## Appendix

## Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 48.3 Ω + 7.5 jΩ |
| Return Loss | - 22.2 dB |

## General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.197 ns |

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

## Additional EUT Data

| | |
|---|---|
| Manufactured by | SPEAG |
| Manufactured on | July 03, 2003 |

**DASY5 Validation Report for Body TSL**

Date/Time: 19.04.2011 13:16:13

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d038**

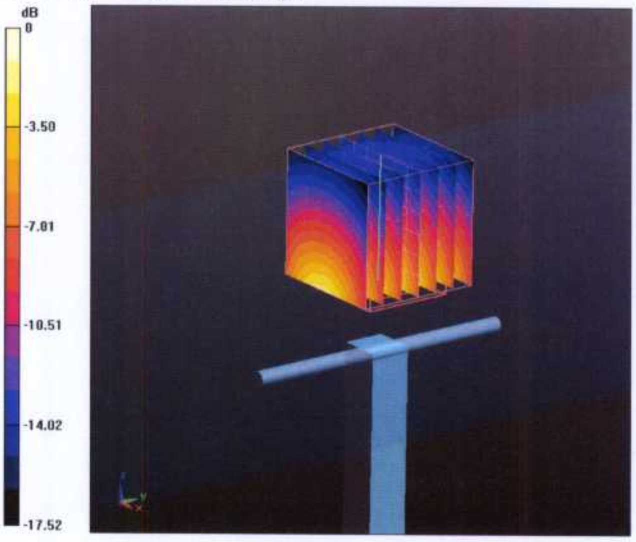
Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium: MSL U12 BB
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.52 mho/m; $\varepsilon_r$ = 51.1; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.59, 4.59, 4.59); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- Measurement SW: DASY52, V52.6.2 Build (424)
- Postprocessing SW: SEMCAD X, V14.4.2 Build (2829)

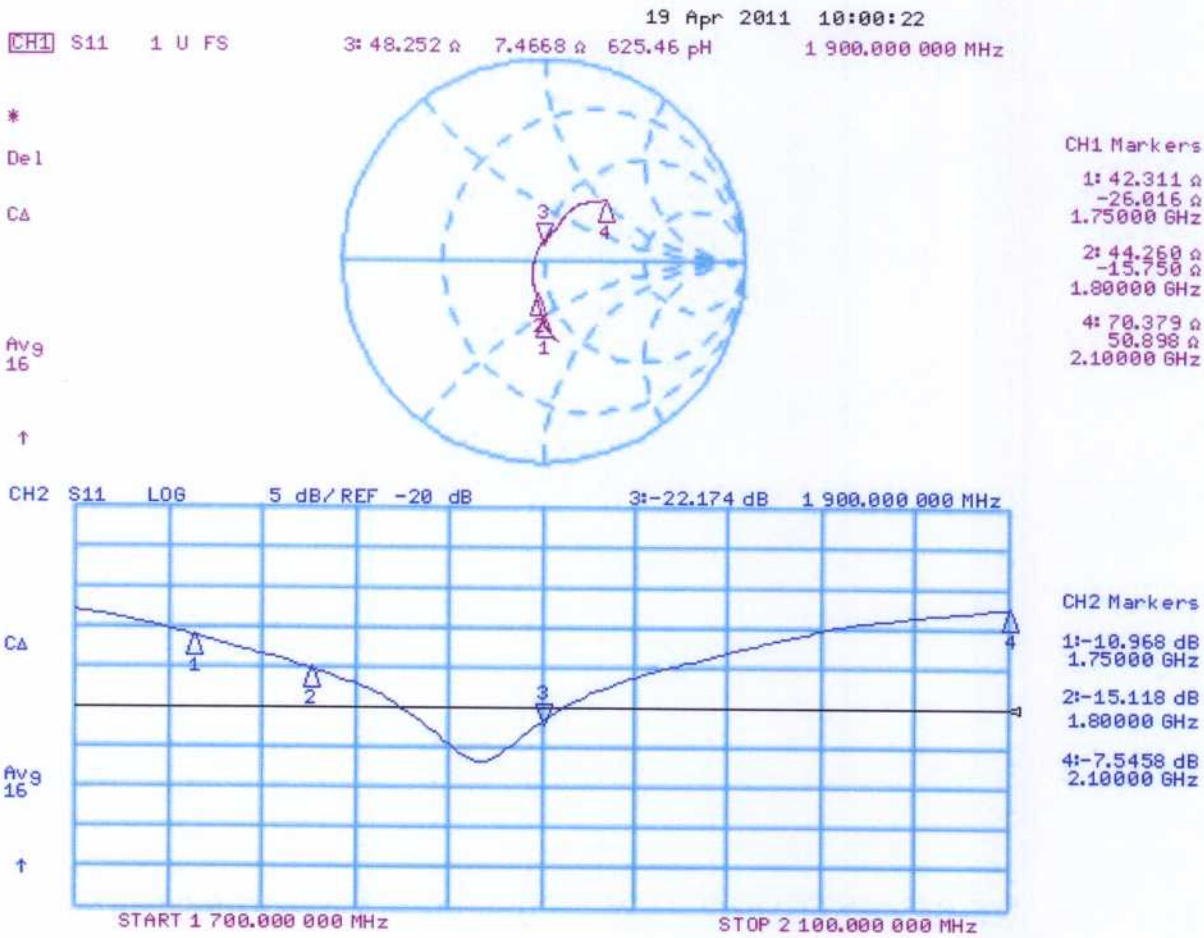
## Pin=250 mW, Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 96.371 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 17.425 W/kg
**SAR(1 g) = 10.1 mW/g; SAR(10 g) = 5.29 mW/g**
Maximum value of SAR (measured) = 12.716 mW/g



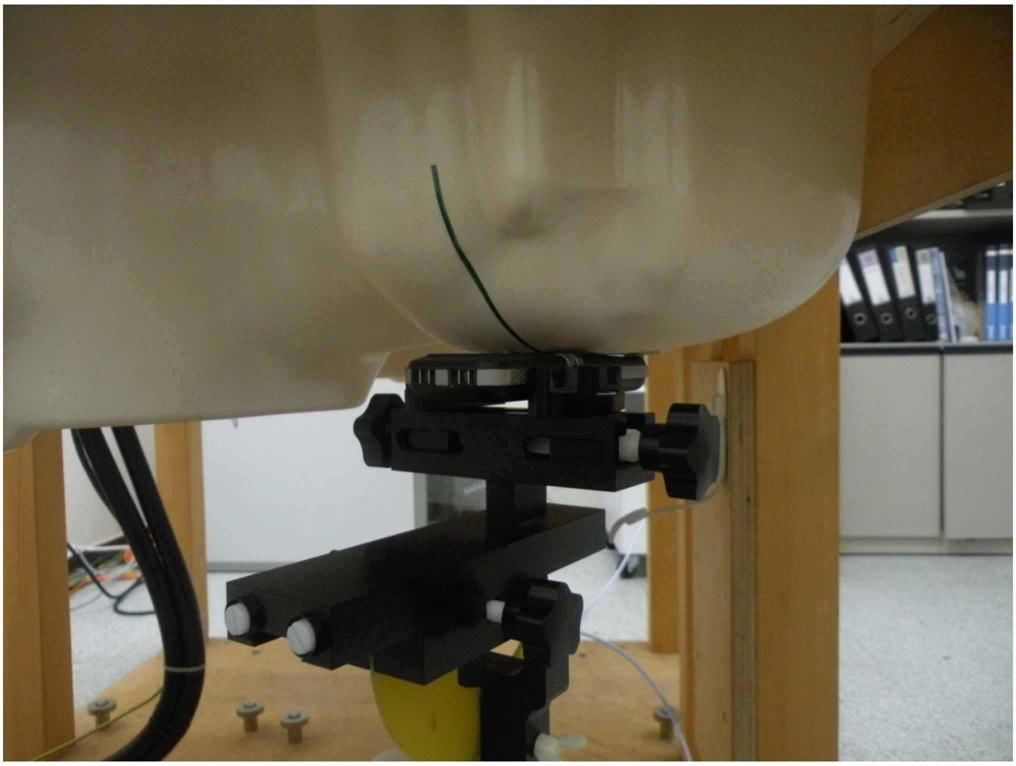

0 dB = 12.720mW/g

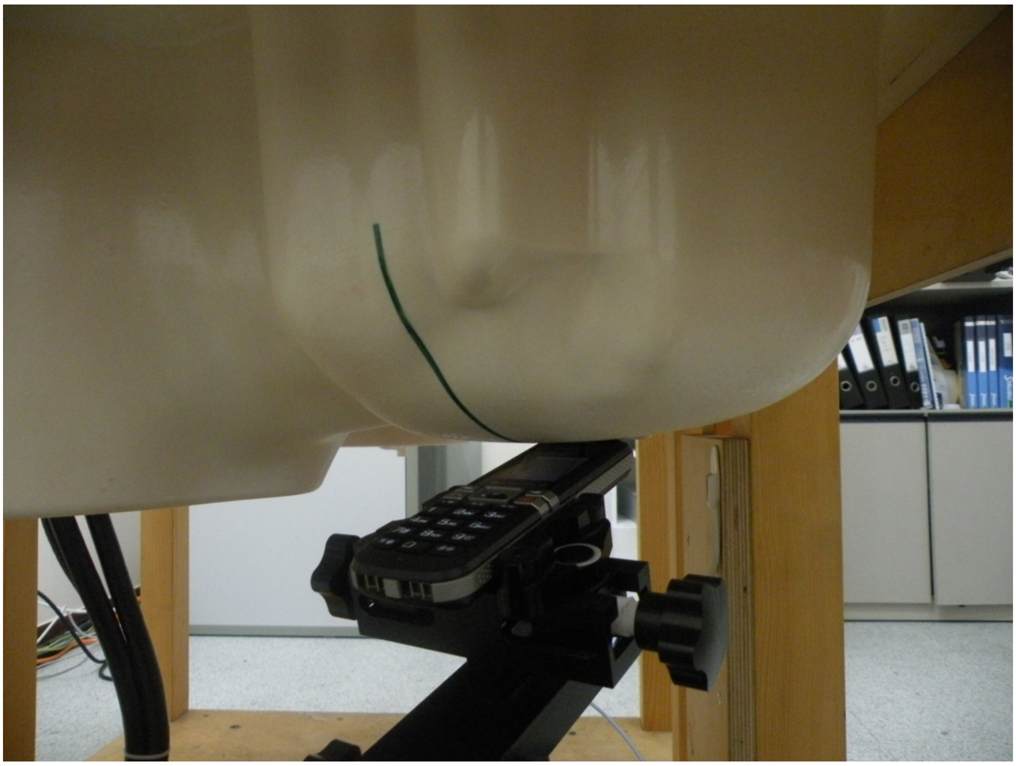
## Impedance Measurement Plot for Body TSL

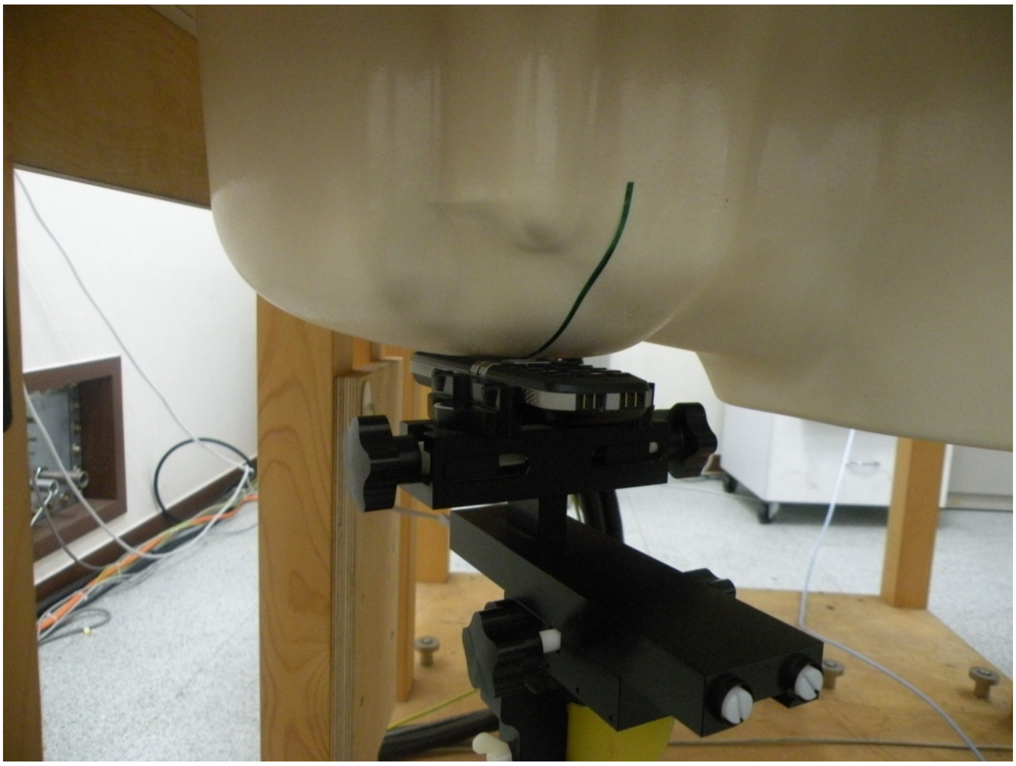


# Appendix C. SAR MEASUREMENT SETUP PHOTOS

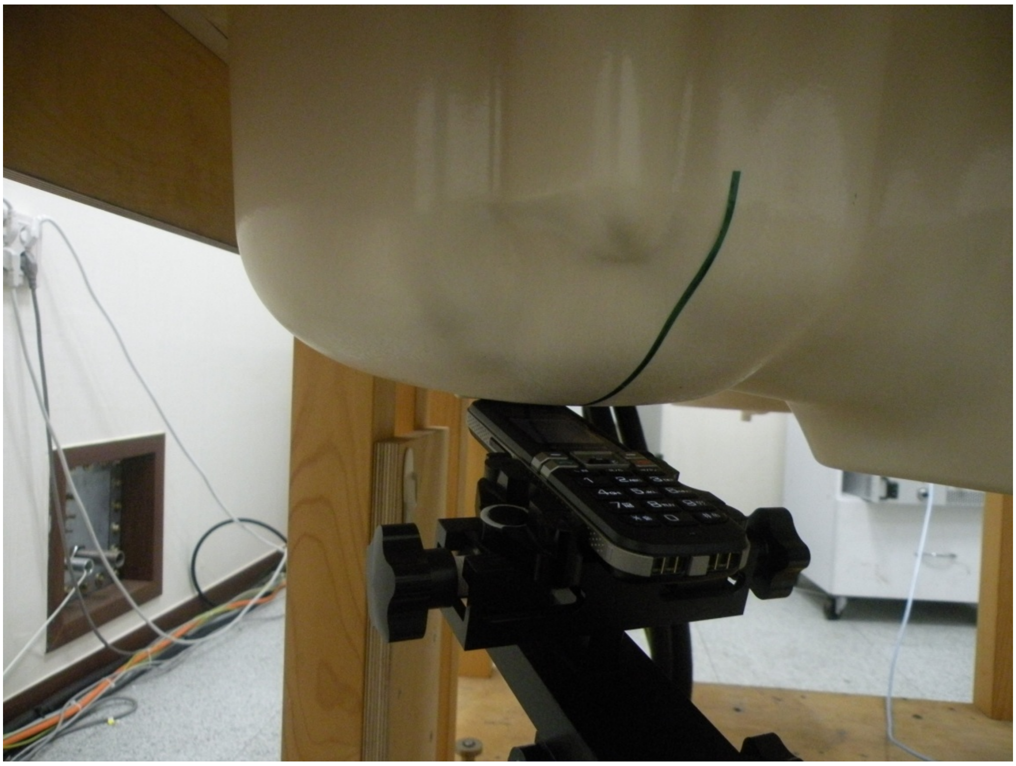
# Head SAR Configurations


< Left Cheek Touch >


< Left Ear Tilt >

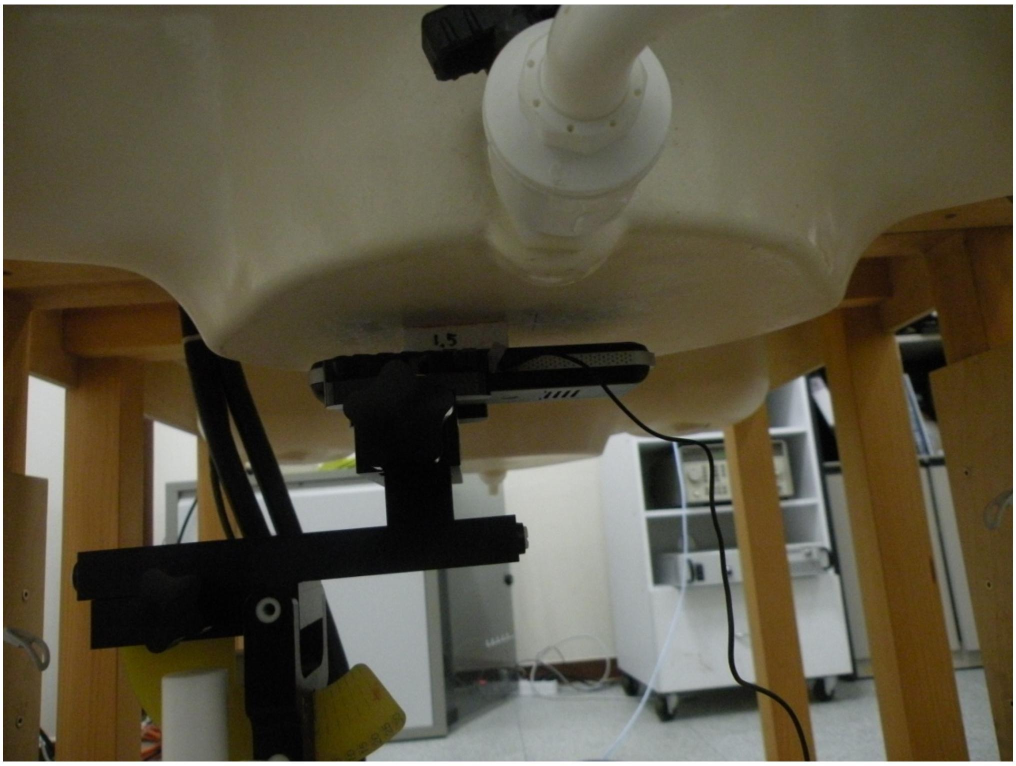


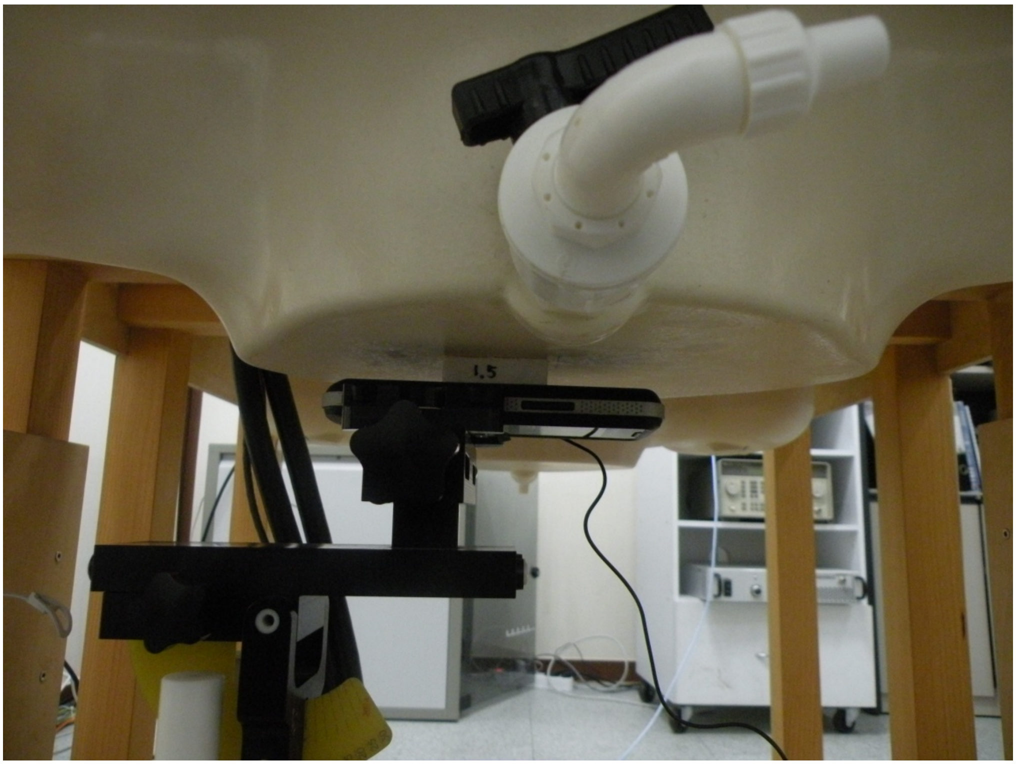
< Right Cheek Touch >



< Right Ear Tilt >.

# Body SAR Configurations


< Front facing Phantom >


< Rear facing Phantom >