



SAMSUNG ELECTRONICS Co., Ltd.,  
Regulatory Compliance Group  
IT R&D Center

416, Maetan-3dong,  
Yeongtong-gu, Suwon-si,  
Gyeonggi-do, Korea 443-742

# TEST REPORT ON SAR

Model Tested: GT-C5110  
FCC ID (Requested): A3LGTC5110  
Job No: FG-099  
Report No: FG-099-S1  
Date issued: May.21, 2009

- Abstract -

This document reports on SAR Tests carried out in accordance with FCC/OET Bulletin 65, Supplement C(July 2001).

Prepared By

S PARK - Test Engineer

Authorized By

JD JANG - Technical Manager



# Contents

|   |           |
|---|-----------|
| <b>1. GENERAL INFORMATION.....</b>                              | <b>3</b>  |
| <b>2. DESCRIPTION OF DEVICE .....</b>                           | <b>3</b>  |
| <b>3. DESCRIPTION OF TEST EQUIPMENT .....</b>                   | <b>4</b>  |
| 3.1 SAR Measurement Setup .....                                 | 4         |
| 3.2 E-field Probe .....   | 6         |
| 3.3 Phantom.....  | 8         |
| 3.4 Brain & Muscle Simulating Mixture Characterization .....    | 9         |
| 3.5 Device Holder for Transmitters .....                        | 10        |
| 3.6 Validation Dipole .....                                     | 10        |
| 3.7 Equipment Calibration.....                                  | 11        |
| <b>4. SAR MEASUREMENT PROCEDURE .....</b>                       | <b>12</b> |
| <b>5. DESCRIPTION OF TEST POSITION .....</b>                    | <b>13</b> |
| 5.1 SAM Phantom Shape.....                                      | 13        |
| 5.2 Cheek/Touch Position .....                                  | 13        |
| 5.3 EAR/Tilt 15° Position.....                                  | 15        |
| 5.4 Body Holster/Belt Clip Configurations.....                  | 16        |
| <b>6. MEASUREMENT UNCERTAINTY.....</b>                          | <b>18</b> |
| <b>7. SYSTEM VERIFICATION .....</b>                             | <b>19</b> |
| 7.1 Tissue Verification .....                                   | 19        |
| 7.2 Test System Validation .....                                | 19        |
| <b>8. SAR MEASUREMENT RESULTS.....</b>                          | <b>20</b> |
| 8.1 Measurement Results(GSM1900 Right Head SAR - Touch) .....   | 22        |
| 8.2 Measurement Results(GSM1900 Right Head SAR - Tilt) .....    | 23        |
| 8.3 Measurement Results(GSM1900 Left Head SAR - Touch).....     | 24        |
| 8.4 Measurement Results(GSM1900 Left Head SAR - Tilt).....      | 25        |
| 8.5 Measurement Results(GPRS1900 Body SAR without Holster)..... | 26        |
| <b>9. CONCLUSION .....</b>                                      | <b>27</b> |
| <b>10. REFERENCES.....</b>                                      | <b>28</b> |



## 1. GENERAL INFORMATION

Test Sample : Single-Band PCS GSM/EDGE Phone with Bluetooth  
Model Number : GT-C5110  
Serial Number : Identical prototype (S/N : # FG-099-A)

Manufacturer : SAMSUNG ELECTRONICS Co., Ltd.  
Contact : WI DO

Phone : +82-31-301-5063  
Fax : +82-31-279-4288  
Test Standard : §2.1093; FCC/OET Bulletin 65, Supplement C(July 2001)  
FCC Classification : Licensed Portable Transmitter Held to Ear (PCE)  
Test Dates : Apr.21, 2009  
Tested for : FCC/TCB Certification

## 2. DESCRIPTION OF DEVICE

Tx Freq. Range : 1850.20 ~ 1909.80 MHz (GSM1900)  
2402 ~ 2480 MHz (Bluetooth)

Rx Freq. Range : 1930.20 ~ 1989.80 MHz (GSM1900)  
2402 ~ 2480 MHz (Bluetooth)

Antenna Manufacturer : Ethertronics  
Model No.: GT-C5110

Antenna Dimensions : 42.72\*13.11\*6 mm

GPRS : Class 10

Separation distance between  
Main and Bluetooth antenna : 83mm

### 3. DESCRIPTION OF TEST EQUIPMENT

#### 3.1 SAR Measurement Setup

##### Robotic System

Measurements are performed using the DASY4 automated dosimetric assessment system. Which is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of high precision robotics system (Stäubli), robot controller, measurement server, Samsung 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 performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF) (see Fig. 3.1).



**Figure 3.1 SAR Measurement System Setup**

##### System Hardware

A cell controller system contains the power supply, robot controller, teach pendant (Joystick), and a remote control is used to drive the robot motors. The PC consists of the Samsung computer with Windows XP system and SAR Measurement Software DASY4, LCD monitor, mouse and keyboard. The Stäubli Robot is connected to the cell controller to allow software manipulation of the robot. A



data acquisition electronic (DAE) circuit that performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the measurement server

### **System Electronics**

The DAE4(or DAE3) 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 measurement server 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 frontal 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.

### 3.2 E-field Probe



The SAR measurement were conducted with the dosimetric probe ES3DV2, designed in the classical triangular configuration (see Fig.3.3) and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. 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 2<sup>nd</sup> order fitting (see Fig.3.2). The approach is stopped at reaching the maximum.

**Figure 3.2 DAE System**

#### Probe Specifications

|              |  |
|--------------|--|
| Construction | <ul style="list-style-type: none"> <li>Symmetrical design with triangular core</li> <li>Interleaved sensors</li> <li>Built-in shielding against static charges</li> <li>PEEK enclosure material (resistant to organic solvents, e.g., DGBE)</li> </ul> |
| Calibration  | <ul style="list-style-type: none"> <li>Basic Broad Band Calibration in air: 10-3000 MHz</li> <li>Conversion Factors (CF) for HSL 900 and HSL 1800</li> <li>Additional CF for other liquids and frequencies upon request</li> </ul>                     |
| Frequency    | 10 MHz to > 6 GHz; Linearity: $\pm 0.2$ dB (30 MHz to 3 GHz)   |
| Directivity  | <ul style="list-style-type: none"> <li><math>\pm 0.2</math> dB in HSL (rotation around probe axis)</li> <li><math>\pm 0.3</math> dB in tissue material (rotation normal to probe axis)</li> </ul>  |



Dynamic Range       $5\mu\text{W/g}$  to  $> 100\text{mW/g}$ ; Linearity:  
 $\pm 0.2\text{dB}$

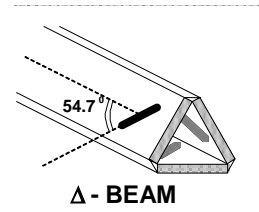


Figure 3.3 Triangular Probe Configuration

Dimensions      Overall length: 330 mm (Tip: 20 mm)  
Tip diameter: 3.9 mm (Body: 12 mm)  
Distance from probe tip to dipole centers:  
2.1 mm



Figure 3.4 Probe Thick-Film Technique

Application      General dosimetry up to 5 GHz  
Dosimetry in strong gradient fields  
Compliance tests of mobile phones

### 3.3 Phantom

#### SAM Twin Phantom

The SAM Twin Phantom V4.0 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. 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. (See Figure 3.5)



**Figure 3.5 SAM Twin Phantom**

#### SAM Twin Phantom Specification

|                 |   |
|-----------------|---|
| Construction    | The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528-2003, CENELEC 50361 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. |
| Shell Thickness | $2 \pm 0.2$ mm  |
| Filling Volume  | Approx. 25 liters   |
| Dimensions      | Height: 810 mm; Length: 1000 mm; Width: 500 mm  |

#### Modular Flat Phantom

The Modular Flat Phantom V5.1 is constructed of a fiberglass shell integrated in a wooden table. Also It consists of three identical flat phantoms (modules) which can be installed and removed separately without emptying the liquid, as well as a wooden support.. It enables the dosimetric evaluation of 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. (See Figure 3.6)



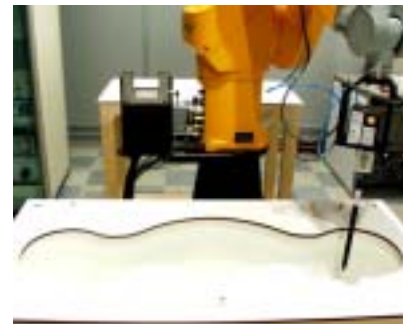
**Figure 3.6 Modular Flat Phantom**

### **Modular Flat Phantom Specification**

|                 |   |
|-----------------|---|
| Construction    | The shell corresponds to the specifications of IEEE 1528-2003. It enables the dosimetric evaluation of body mounted usage above 800 MHz at the flat phantom region. A cover prevents evaporation of the liquid. |
| Shell Thickness | $2 \pm 0.2$ mm  |
| Filling Volume  | Approx. 10 liters   |
| Dimension       | Wooden support - Height: 810 mm; Length: 830 mm; Width: 500 mm<br>Each Module - Height: 190 mm; Length: 200 mm; width: 300 mm   |

### **3.4 Brain & Muscle Simulating Mixture Characterization**

The brain and muscle mixtures consist of a viscous gel using hydroxyethylcellulose (HEC) gelling agent and saline solution (see Table 3.1). Preservation with a bactericide 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 head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 have been incorporated in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations.



**Figure 3.7 Simulated Tissue**

**Table 3.1 Composition of the Brain & Muscle Tissue Equivalent Matter**

| INGREDIENTS                | 1900MHz Brain | 1900MHz Muscle |
|----------------------------|---------------|----------------|
| WATER                      | 55.24%        | 70.23%         |
| SUGAR                      | -             | -              |
| SALT                       | 0.31%         | 0.29%          |
| DGBE                       | 44.45%        | 29.47%         |
| BACTERIACIDE               | -             | -              |
| HEC                        | -             | -              |
| Dielectric Constant Target | 40.0          | 53.3           |
| Conductivity Target (S/m)  | 1.40          | 1.52           |

### 3.5 Device Holder for Transmitters

In combination with the Twin SAM Phantom V4.0, the Mounting Device (see Fig. 3.7) enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation points is the ear opening.



The devices can be easily, accurately and repeatedly be positioned according to the FCC specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

\*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 configuration. To produce worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.

**Figure 3.8 Device Holder**

### 3.6 Validation Dipole

The reference dipole should have a return loss better than  $-20$  dB (measured in the setup) at the resonant frequency to reduce the uncertainty in the power measurement.

|             |   |
|-------------|---|
| Frequency   | 1900 MHz  |
| Return Loss | < -20 dB at specified validation position             |
| Dimensions  | D1900V2: dipole length: 68 mm; overall height: 300 mm |



### 3.7 Equipment Calibration

**Table 3.2 Test Equipment Calibration**

| Type                            | Calibration Due Date | Serial No.      |
|---------------------------------|----------------------|-----------------|
| SPEAG DAE4 V2                   | Jul.22, 2009         | 468             |
| SPEAG E-Field Probe ES3DV2      | Sep.22, 2009         | 3017            |
| SPEAG Validation Dipole D1900V2 | Jan.06, 2011         | 5d023           |
| Stäubli Robot RX90BL            | Not Required         | F02/5R79A1/A/01 |
| SPEAG SAM Twin Phantom V4.0     | Not Required         | TP-1248         |
| SPEAG Modular Phantom           | Not Required         | MP-1003         |
| E4421B Signal Generator         | Oct.23, 2009         | MY41000654      |
| BBS3Q7ECK Power Amp             | Dec.09, 2009         | 1024            |
| HP-8753ES Network Analyzer      | Apr.28, 2009         | US39173712      |
| HP85070C Dielectric Probe Kit   | Not Required         | US99360087      |
| NRVD Power Meter                | Mar.04, 2010         | 836416/030      |
| NRV-Z55 Power Sensor            | Mar.04, 2010         | 834558/012      |
| NRV-Z55 Power Sensor            | Mar.04, 2010         | 834558/014      |
| E4419B Power Meter              | Dec.15, 2009         | GB43312299      |
| E9300B Power Sensor             | May.02, 2009         | MY41495872      |
| DASY4 S/W (ver 4.7)             | Not Required         | -               |
| Directional Coupler             | May.26, 2009         | 18862           |
| Base Station Simulator          | Feb.02, 2010         | GB45360270      |

**NOTE:**

The E-field probe was calibrated by SPEAG, by temperature measurement procedure. Dipole Validation measurement is performed by Samsung Lab. before each test. (see § 7.2) The brain simulating material is calibrated by Samsung using the dielectric probe system and network analyzer to determine the conductivity and permittivity (dielectric constant) of the brain-equivalent material. (see § 7.1)



## **4. SAR MEASUREMENT PROCEDURE**

The evaluation was performed using the following procedure.

### **STEP 1**

The SAR measurement was taken at a selected spatial reference point to monitor power variations during testing. This fixed location point was measured and used as a reference value.

### **STEP 2**

The SAR distribution at the exposed side of the head was measured at a distance of 3.9mm from the inner surface of the shell. The area covered the entire dimension of the head and the horizontal grid spacing was 20mm x 20mm. Based on the area scan data, the area of the maximum absorption was determined by spline interpolation.

### **STEP 3**

Around this point, a volume of 32mm x 32mm x 30mm (fine resolution volume scan, zoom scan) was assessed by measuring 5 x 5 x 7 points. On this basis of this data set, the spatial peak SAR value was evaluated with the following procedure:

The data at the surface was extrapolated, since the center of the dipoles is 2.7mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2mm. (This can be variable. Refer to the probe specification) The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip. The maximum interpolated value was searched with a straight-forward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1g or 10g) were 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 directions). The volume was integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the average. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.

### **STEP 4**

The SAR value at the same location as in step 1 was again measured. (If the value changed by more than 5%, the evaluation is repeated.)

## 5. DESCRIPTION OF TEST POSITION

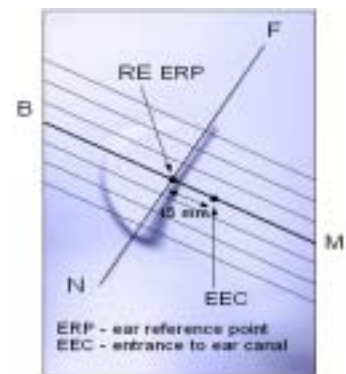
### 5.1 SAM Phantom Shape

Figure 5.1 shows the front, back and side views of SAM. The point “M” is the reference point for the center of mouth, “LE” is the left ear reference point (ERP), and “RE” is the right ERP. The ERPs are 15 mm posterior to the entrance to ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 5.2.



**Figure 5.1 Front, back and side view of SAM**

The plane passing through the two ear canals and M is defined as the Reference Plane. The line N-F (Neck-Front) perpendicular to the reference plane and passing through the RE (or LE) is called the Reference Pivoting Line (see Figure 5.3). Line B-M is perpendicular to the N-F line. Both N-F and B-M lines should be marked on the external phantom shell to facilitate handset positioning. Posterior to the N-F line, the thickness of the phantom shell with the shape of an ear is a flat surface 6 mm thick at the ERPs.

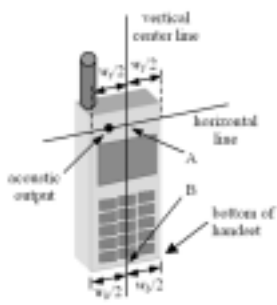


**Figure 5.2 Close up side view**

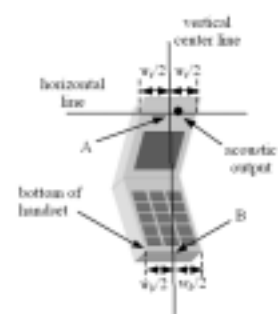
### 5.2 Cheek/Touch Position

Two imaginary lines on the handset were established: the vertical centerline and the horizontal line. The test device was placed in a normal operating position with the “test device reference point” located along the “vertical centerline” on the front of the device aligned to the “ear reference point” (see Fig. 5.4). The “test device reference point” was then located at the same level as the center of

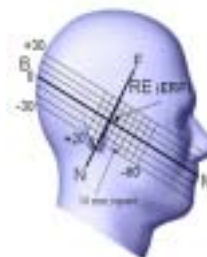
the ear reference point. The test device was positioned so that the “vertical centerline” was bisecting the front surface of the handset at its tip and bottom edges, positioning the “ear reference point” on the outer surface of the both the left and right head phantoms on the ear reference point



**Figure 5.4 Handset vertical and horizontal reference lines**



**Figure 5.3 Side view of the phantom showing relevant markings**



**Figure 5.5 Front, Side and Top View of Cheek/Touch Position**

### Step 1

The test device was positioned with the handset close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 5.5), such that the plane defined by the vertical center line and the horizontal line of the phone is approximately parallel to the sagittal plane of the phantom

### Step 2

The handset was translated towards the phantom along the line passing through RE & LE until the handset touches the ear.

**Step 3**

While maintaining the handset in this plane, the handset was rotated around the LE-RE line until the vertical centerline was in the plane normal to MB-NF including the line MB (reference plane).

**Step 4**

Rotate the handset around the vertical centerline until the phone (horizontal line) was symmetrical was respect to the line NF.

**Step 5**

While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the phone contact with the ear, the handset was rotated about the line NF until any point on the handset made contact with a phantom point below the ear (cheek). See Figure 5.2.

**5.3 EAR/Tilt 15° Position**

With the test device aligned in the “Cheek/Touch Position”:

**Step 1**

Repeat steps 1 to 5 of 5.2 to place the device in the “Cheek/Touch Position”



**Figure 5.6 Front, side and Top View of Ear/Tilt 15° Position**

**Step 2**

While maintaining the orientation of the phone, the phone was retracted parallel to the reference plane far enough to enable a rotation of the phone by 15 degree.

### Step 3

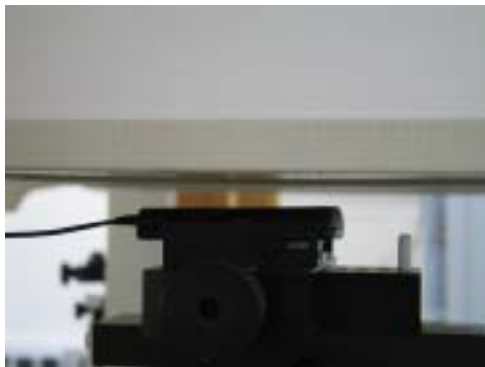
The phone was then rotated around the horizontal line by 15 degree.

### Step 4

While maintaining the orientation of the phone, the phone was moved parallel to the reference plane until any part of the phone touches the head. (In this position, point A was located on the line RE-LE). The tilted position is obtained when the contact is on the pinna. If the contact was at any location other than the pinna, the angle of the phone would then be reduced. The tilted position was obtained when any part of the phone was in contact of the ear as well as a second part of the phone was in contact with the head.

## 5.4 Body Holster/Belt Clip Configurations

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration (see Figure 5.7). A device with a headset output is tested with a headset connected to the device. Body dielectric parameters are used.



**Figure 5.7 Body Belt Clip and Holster Configurations**

Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that 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 supplied with the device, the device is tested with each accessory that contains unique metallic component. If multiple accessory 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 where a separation distance between the back of the device and the flat phantom is used.

Transmitters that are designed to operate in front of a person's face, as in push-to-talk configurations, are tested for SAR compliance with the front of the device positioned to face the flat phantom. For devices that are carried next to the body such as a shoulder, waist or chest-worn transmitters, SAR compliance is tested with the accessory(ies), 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.

In order for users to be aware of the body-worn operating requirements for meeting RF exposure compliance, operating instructions and cautions statements must be included in the user's manual.



## 6. MEASUREMENT UNCERTAINTY

**Table 6.1 Uncertainty Budget at 1900MHz (Mar 2008)**

| Error Description                            | Uncertainty Value (±%) | Probability Distribution | Divisor | $c_i$ | Standard uncertainty (±%) | $v_i^2$ or $v_{eff}$ |
|--|------------------------|--------------------------|---------|-------|---------------------------|----------------------|
| <b>Measurement System</b>                    |                        |                          |         |       |                           |                      |
| Probe Calibration                            | 11.80                  | normal                   | 2.000   | 1     | 5.90                      | ∞                    |
| Axial Isotropy                               | 4.70                   | rectangular              | 1.732   | 0.7   | 1.90                      | ∞                    |
| Hemispherical Isotropy                       | 9.60                   | rectangular              | 1.732   | 0.7   | 3.88                      | ∞                    |
| Linearity                                    | 4.70                   | rectangular              | 1.732   | 1     | 2.71                      | ∞                    |
| System Detection Limits                      | 0.25                   | rectangular              | 1.732   | 1     | 0.14                      | ∞                    |
| Boundary effects                             | 1.00                   | rectangular              | 1.732   | 1     | 0.58                      | ∞                    |
| Readout electronics                          | 0.30                   | normal                   | 1.000   | 1     | 0.30                      | ∞                    |
| Response time                                | 0.80                   | rectangular              | 1.732   | 1     | 0.46                      | ∞                    |
| RF ambient conditions                        | 3.00                   | rectangular              | 1.732   | 1     | 1.73                      | ∞                    |
| Integration time                             | 0.00                   | rectangular              | 1.732   | 1     | 0.00                      | ∞                    |
| Mechanical constrains of robot               | 1.50                   | rectangular              | 1.732   | 1     | 0.87                      | ∞                    |
| Probe positioning                            | 2.90                   | rectangular              | 1.732   | 1     | 1.67                      | ∞                    |
| Extrapolation and integration                | 1.00                   | rectangular              | 1.732   | 1     | 0.58                      | ∞                    |
| <b>Test Sample Related</b>                   |                        |                          |         |       |                           |                      |
| Test Sample positioning                      | 1.16                   | normal                   | 1.000   | 1     | 1.16                      | 14                   |
| Device holded uncertainty                    | 4.37                   | normal                   | 1.000   | 1     | 4.37                      | ∞                    |
| Power Drift                                  | 5.00                   | rectangular              | 1.732   | 1     | 2.89                      | ∞                    |
| <b>Phantom and Setup</b>                     |                        |                          |         |       |                           |                      |
| Modular Phantom uncertainty                  | 6.02                   | normal                   | 1.000   | 1     | 6.02                      | 2                    |
| Phantom uncertainty                          | 4.00                   | rectangular              | 1.732   | 1     | 2.31                      | ∞                    |
| Liquid conductivity (deviation from target)  | 5.00                   | rectangular              | 1.732   | 0.64  | 1.85                      | ∞                    |
| Liquid conductivity (measurement error)      | 5.18                   | normal                   | 1.000   | 0.64  | 3.32                      | ∞                    |
| Liquid permittivity (deviation from target)  | 5.00                   | rectangular              | 1.732   | 0.6   | 1.73                      | ∞                    |
| Liquid permittivity (measurement error)      | 4.65                   | normal                   | 1.000   | 0.6   | 2.79                      | ∞                    |
| <b>Combined Standard Uncertainty</b>         |                        | Normal                   | -       | -     | <b>11.30</b>              | <b>127727</b>        |
| <b>Extended Standard Uncertainty(K=2.00)</b> |                        |                          |         |       | <b>22.60</b>              | <b>127727</b>        |

## 7. SYSTEM VERIFICATION

### 7.1 Tissue Verification

**Table 7.1 MEASURED TISSUE PARAMETERS**

|                        | 1900MHz Brain |              | 1900MHz Muscle |              |
|------------------------|---------------|--------------|----------------|--------------|
|                        | Target        | Measured     | Target         | Measured     |
| Date                   | -             | Apr.21, 2009 | -              | Apr.21, 2009 |
| Liquid Temperature(°C) | -             | 22.3         | -              | 22.1         |
| Dielectric Constant:   | 40.0          | 39.6         | 53.3           | 51.8         |
| Conductivity:          | 1.40          | 1.43         | 1.52           | 1.56         |

The measured value must be within  $\pm 5\%$  of the target value.

### 7.2 Test System Validation

Prior to assessment, the system is verified to the  $\pm 10\%$  of the specification at 1900MHz by using the system validation kit(s). (see Appendix E, Graphic Plot Attached)

**Table 7.2 System Validation Results**

| System Validation Kit | Tissue        | Targeted SAR <sub>1g</sub> (mW/g) | Measured SAR <sub>1g</sub> (mW/g) | Deviation (%) | Date         | Liquid Temperature(°C) | Ambient Temperature(°C) |
|-----------------------|---------------|-----------------------------------|-----------------------------------|---------------|--------------|------------------------|-------------------------|
| 5d023                 | 1900MHz Brain | 40.3                              | 39.04                             | -3.13         | Apr.21, 2009 | 21.9                   | 22.5                    |

\*Validation was measured with input power 250 mW and normalized to 1W.

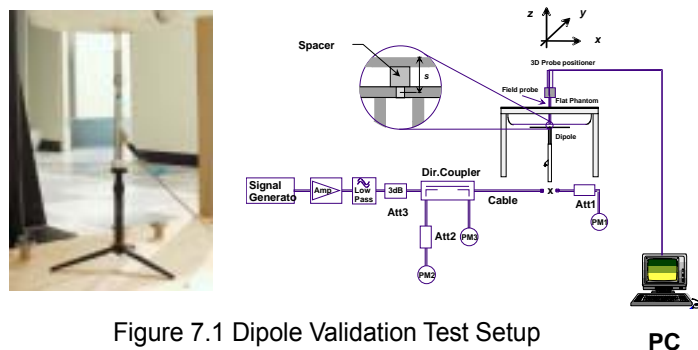


Figure 7.1 Dipole Validation Test Setup



## 8. SAR MEASUREMENT RESULTS

### Procedures Used To Establish Test Signal

The handset was placed into simulated call mode using manufacturers test codes. Such test signals offer a consistent means for testing SAR and are recommended for evaluating SAR. When test modes are not available or inappropriate for testing a handset, the actual transmission is activated through a base station simulator or similar equipment. See data pages for actual procedure used in measurement.

### Device Test Conditions

The handset is battery operated. Each SAR measurement was taken with a fully charged battery. In order to verify that the device was tested at full power, conducted output power measurements were performed before and after each SAR measurement to confirm the output power. If a conducted power deviation of more than 5% occurred, the test was repeated.

### Simultaneous Transmission

Refer to the FCC OET document, 'SAR Evaluation Considerations for Handsets with Multiple Transmitters and Antennas' (Feb 2008)

**Table 8.1 Output Power Thresholds for Unlicensed Transmitters**

|       | 2.45 | 5.15 - 5.35 | 5.47 - 5.85 | GHz |
|-------|------|-------------|-------------|-----|
| P Ref | 12   | 6           | 5           | mW  |

Device output power should be rounded to the nearest mW to compare with values specified in this table



Table 8.2 Summary of SAR Evaluation Requirements for Cell phones with Multiple Transmitters

|                         | Individual Transmitter  | Simultaneous Transmission   |
|-------------------------|---|---|
| Licensed Transmitters   | <b><u>Routine evaluation required</u></b>   | <p><b>SAR not required:</b></p> <p><b><u>Unlicensed only</u></b></p> <ul style="list-style-type: none"> <li>o when stand-alone 1-g SAR is not required and antenna is &gt; 5 cm from other antennas</li> </ul> <p><b><u>Licensed &amp; Unlicensed</u></b></p> <ul style="list-style-type: none"> <li>o when the sum of the 1-g SAR is &lt;1.6 W/kg for all simultaneous transmitting antennas</li> <li>o when SAR to antenna separation ratio of simultaneous transmitting antenna pair is &lt; 0.3</li> </ul> <p><b>SAR required:</b></p> <p><b><u>Licensed &amp; Unlicensed</u></b></p> <p>antenna pairs with SAR to antenna separation ratio 0.3; test is only required for the configuration that results in the highest SAR in standalone configuration for each wireless mode and exposure condition</p> <p>Note: simultaneous transmission exposure conditions for head and body can be different for different style phones; therefore, different test requirements may apply</p> |
| Unlicensed Transmitters | <p><b>When there is no simultaneous transmission –</b></p> <ul style="list-style-type: none"> <li>o output &lt; 60/f: SAR not required</li> <li>o output 60/f: stand-alone SAR required</li> </ul> <p><b>When there is simultaneous transmission –</b></p> <p><b><u>Stand-alone SAR not required when</u></b></p> <ul style="list-style-type: none"> <li>o output <math>\leq 2 \cdot P_{Ref}</math> and antenna is &gt; 5.0 cm from other antennas</li> <li>o output <math>\leq P_{Ref}</math> and antenna is &gt; 2.5 cm from other antennas, each either output power output <math>\leq P_{Ref}</math> or 1-g SAR &lt; 1.2 W/Kg</li> </ul> <p><b><u>Otherwise stand-alone SAR is required</u></b></p> <p><b>When stand-alone SAR is required</b></p> <ul style="list-style-type: none"> <li>o test SAR on highest output channel for each wireless mode and exposure condition</li> <li>o if SAR for highest output channel is &gt; 50% of SAR limit, evaluate all channels according to normal procedures</li> </ul> |   |



## 8.1 Measurement Results(GSM1900 Right Head SAR - Touch)

Mixture Type : 1900 MHz Brain

| FREQUENCY   |     | Modulation | Begin/End POWER* |       |          | Device Test Position                           | Antenna Position | Slide | SAR (W/kg)   |
|---|-----|------------|------------------|-------|----------|--|------------------|-------|--------------|
| MHz   | Ch. |            | (dBm)            |       | Battery  |  |                  |       |              |
| 1880.0  | 661 | PCS GSM    | 29.55            | 29.59 | Standard | Cheek/Touch                                    | Intenna          | Down  | <b>0.343</b> |
| 1880.0  | 661 | PCS GSM    | 29.51            | 29.57 | Standard | Cheek/Touch                                    | Intenna          | Up    | 0.260        |
| <b>ANSI / IEEE C95.1 2005– SAFETY LIMIT<br/>Spatial Peak<br/>Uncontrolled Exposure / General Population</b> |     |            |                  |       |          | <b>1.6W/kg (mW/g)<br/>averaged over 1 gram</b> |                  |       |              |

### NOTES:

- The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
  - All modes of operation were investigated, and the worst-case results are reported.
  - Tissue parameters and temperatures are listed on the SAR plot.
  - Liquid tissue depth is  $15.2 \pm 0.2$ cm
  - Battery is fully charged for all readings.
- \*Power Measured  Conducted
- Battery Option  Standard  Extended  Slim
  - Phantom Configuration  Left Head  Flat Phantom  Right Head
  - SAR Configuration  Head  Body  Hand
  - Test Signal Call Mode  Manu. Test Codes  Base Station Simulator
  - Justification for reduced test configurations: Per FCC/OET Bulletin 65 Supplement C (July, 2001), if the SAR measured at the middle channel for each test configuration (left, right, cheek/touch, tilt/ear, extended and retracted) is least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional for such test configuration(s).



## 8.2 Measurement Results(GSM1900 Right Head SAR - Tilt)

Mixture Type : 1900 MHz Brain

| FREQUENCY   |     | Modulation | Begin/End POWER* |       |          | Device Test Position                           | Antenna Position | Slide | SAR (W/kg)   |
|---|-----|------------|------------------|-------|----------|--|------------------|-------|--------------|
| MHz   | Ch. |            | (dBm)            |       | Battery  |  |                  |       |              |
| 1880.0  | 661 | PCS GSM    | 29.49            | 29.55 | Standard | Ear/Tilt 15°                                   | Intenna          | Down  | 0.188        |
| 1880.0  | 661 | PCS GSM    | 29.57            | 29.59 | Standard | Ear/Tilt 15°                                   | Intenna          | Up    | <b>0.193</b> |
| <b>ANSI / IEEE C95.1 2005– SAFETY LIMIT<br/>Spatial Peak<br/>Uncontrolled Exposure / General Population</b> |     |            |                  |       |          | <b>1.6W/kg (mW/g)<br/>averaged over 1 gram</b> |                  |       |              |

### NOTES:

- The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
- All modes of operation were investigated, and the worst-case results are reported.
- Tissue parameters and temperatures are listed on the SAR plot.
- Liquid tissue depth is 15.2 ± 0.2cm
- Battery is fully charged for all readings.  
\*Power Measured  Conducted
- Battery Option  Standard  Extended  Slim
- Phantom Configuration  Left Head  Flat Phantom  Right Head
- SAR Configuration  Head  Body  Hand
- Test Signal Call Mode  Manu. Test Codes  Base Station Simulator
- Justification for reduced test configurations: Per FCC/OET Bulletin 65 Supplement C (July, 2001), if the SAR measured at the middle channel for each test configuration (left, right, cheek/touch, tilt/ear, extended and retracted) is least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional for such test configuration(s).



### 8.3 Measurement Results(GSM1900 Left Head SAR - Touch)

Mixture Type : 1900 MHz Brain

| FREQUENCY   |     | Modulation | Begin/End POWER* |       |          | Device Test Position                           | Antenna Position | Slide | SAR (W/kg)   |
|---|-----|------------|------------------|-------|----------|--|------------------|-------|--------------|
| MHz   | Ch. |            | (dBm)            |       | Battery  |  |                  |       |              |
| 1880.0  | 661 | PCS GSM    | 29.50            | 29.51 | Standard | Cheek/Touch                                    | Intenna          | Down  | 0.308        |
| 1880.0  | 661 | PCS GSM    | 29.59            | 29.57 | Standard | Cheek/Touch                                    | Intenna          | Up    | <b>0.444</b> |
| <b>ANSI / IEEE C95.1 2005– SAFETY LIMIT<br/>Spatial Peak<br/>Uncontrolled Exposure / General Population</b> |     |            |                  |       |          | <b>1.6W/kg (mW/g)<br/>averaged over 1 gram</b> |                  |       |              |

#### NOTES:

- The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
- All modes of operation were investigated, and the worst-case results are reported.
- Tissue parameters and temperatures are listed on the SAR plot.
- Liquid tissue depth is  $15.2 \pm 0.2$ cm
- Battery is fully charged for all readings.  
\*Power Measured  Conducted
- Battery Option  Standard  Extended  Slim
- Phantom Configuration  Left Head  Flat Phantom  Right Head
- SAR Configuration  Head  Body  Hand
- Test Signal Call Mode  Manu. Test Codes  Base Station Simulator
- Justification for reduced test configurations: Per FCC/OET Bulletin 65 Supplement C (July, 2001), if the SAR measured at the middle channel for each test configuration (left, right, cheek/touch, tilt/ear, extended and retracted) is least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional for such test configuration(s).



### 8.4 Measurement Results(GSM1900 Left Head SAR - Tilt)

Mixture Type : 1900 MHz Brain

| FREQUENCY   |     | Modulation | Begin/End POWER* |       |          | Device Test Position                           | Antenna Position | Slide | SAR (W/kg)   |
|---|-----|------------|------------------|-------|----------|--|------------------|-------|--------------|
| MHz   | Ch. |            | (dBm)            |       | Battery  |  |                  |       |              |
| 1880.0  | 661 | PCS GSM    | 29.60            | 29.62 | Standard | Ear/Tilt 15°                                   | Intenna          | Down  | <b>0.149</b> |
| 1880.0  | 661 | PCS GSM    | 29.57            | 29.63 | Standard | Ear/Tilt 15°                                   | Intenna          | Up    | 0.136        |
| <b>ANSI / IEEE C95.1 2005– SAFETY LIMIT<br/>Spatial Peak<br/>Uncontrolled Exposure / General Population</b> |     |            |                  |       |          | <b>1.6W/kg (mW/g)<br/>averaged over 1 gram</b> |                  |       |              |

**NOTES:**

1. The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
2. All modes of operation were investigated, and the worst-case results are reported.
3. Tissue parameters and temperatures are listed on the SAR plot.
4. Liquid tissue depth is 15.2 ± 0.2cm
5. Battery is fully charged for all readings.  
\*Power Measured  Conducted
6. Battery Option  Standard  Extended  Slim
7. Phantom Configuration  Left Head  Flat Phantom  Right Head
8. SAR Configuration  Head  Body  Hand
9. Test Signal Call Mode  Manu. Test Codes  Base Station Simulator
10. Justification for reduced test configurations: Per FCC/OET Bulletin 65 Supplement C (July, 2001), if the SAR measured at the middle channel for each test configuration (left, right, cheek/touch, tilt/ear, extended and retracted) is least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional for such test configuration(s).



## 8.5 Measurement Results(GPRS1900 Body SAR without Holster)

Mixture Type : 1900 MHz Muscle

| FREQUENCY   |     | Modulation | Begin/End POWER* |       |          | Device Test Position                           | Antenna Position | Slide | SAR (W/kg)   |
|---|-----|------------|------------------|-------|----------|--|------------------|-------|--------------|
| MHz   | Ch. |            | (dBm)            |       | Battery  |  |                  |       |              |
| 1850.2  | 512 | PCS GSM    | 29.22            | 29.29 | Standard | 1.5 cm [w/o Holster]                           | Intenna          | Down  | 0.270        |
| 1880.0  | 661 | PCS GSM    | 29.59            | 29.63 | Standard | 1.5 cm [w/o Holster]                           | Intenna          | Down  | 0.467        |
| 1909.8  | 810 | PCS GSM    | 29.45            | 29.52 | Standard | 1.5 cm [w/o Holster]                           | Intenna          | Down  | <b>0.723</b> |
| <b>ANSI / IEEE C95.1 2005– SAFETY LIMIT<br/>Spatial Peak<br/>Uncontrolled Exposure / General Population</b> |     |            |                  |       |          | <b>1.6W/kg (mW/g)<br/>averaged over 1 gram</b> |                  |       |              |

### NOTES:

- The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
  - All modes of operation were investigated, and the worst-case results are reported.
  - Tissue parameters and temperatures are listed on the SAR plot.
  - Liquid tissue depth is  $15.2 \pm 0.2$ cm
  - Battery is fully charged for all readings.
- \*Power Measured  Conducted
6. Battery Option  Standard  Extended  Slim
7. Phantom Configuration  Left Head  Flat Phantom  Right Head
8. SAR Configuration  Head  Body  Hand
9. Test Signal Call Mode  Manu. Test Codes  Base Station Simulator
10. Test Configuration  With Holster  Without Holster
11. Justification for reduced test configurations: This model supports GPRS CLASS "10" (2Tx) and EDGE. The burst power and timing period is more than 2dB higher in GPRS mode than in GSM1900 mode. Hence, the GSM1900 mode was not measured. EDGE mode was also measured but not reported because it's TX power is 4dB lower than GPRS mode.



## 9. CONCLUSION

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

Please note that the absorption and distribution of electromagnetic energy in the body are very complex phenomena that depend on the mass, shape, and size of the body, the orientation of the body with respect to the field vectors, and the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because innumerable factors may interact to determine the specific biological outcome of an exposure to electromagnetic fields, any protection guide shall consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables.

The highest reported SAR values are as follows:

GSM1900: Head: 0.444 W/Kg : Body-worn: 0.723 W/Kg



## 10. REFERENCES

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[21] FCC SAR Measurement Procedures for 3G Devices, June 2006

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## APPENDIX A

### 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 ( $\rho$ ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Fig. A.1) .

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

Figure A.1 SAR Mathematical Equation

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

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

**Where :**

- = conductivity of the tissue-simulant material (S/m)
- $\rho$  = mass density of the tissue-simulant material ( $\text{kg/m}^3$ )
- $E$  = 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 relations 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 reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.

## APPENDIX B

### Probe Calibration Process

#### Dosimetric Assessment Procedure

Each probe is calibrated according to a dosimetric assessment procedure described in **K. Pokovic, T.Schmid, N. Kuster, *Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies*, ICECOM97, Oct. 1997, pp. 120-124** with an accuracy better than +/-10%. The spherical isotropy was evaluated with the procedure described in **K. Pokovic, T.Schmid, N. Kuster, *E-field Probe with improved isotropy in brain simulating liquids*, Proceedings of the ELMAR, Zadar, June 23-25, 1996, pp. 172-175** and found to be better than +/-0.25dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe is tested.

#### Free Space Assessment

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies below 1 GHz (see Fig. B.1), 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.

#### Temperature Assessment

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 (see Fig. B.2).

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

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

where:

**t** = exposure time (30 seconds)

**C** = heat capacity of tissue (brain or muscle).

**T** = temperature increase due to RF exposure.

SAR is proportional to  $T/t$ , 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;

where:

= simulated tissue conductivity

**p** = Tissue density (1.25 g/cm<sup>3</sup> for brain tissue)

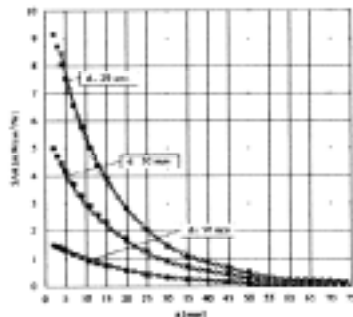


Figure B.1. E-Field and Temperature measurements at 900MHz

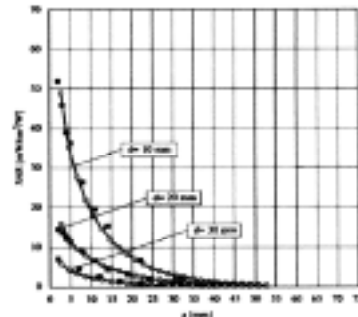


Figure B.2. E-Field and temperature measurements at 1.9GHz

## APPENDIX C

### ANSI/IEEE C95.1 – 2005 RF EXPOSURE LIMITS

#### Uncontrolled Environment

UNCONTROLLED ENVIRONMENTS are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

#### Controlled Environment

CONTROLLED ENVIRONMENTS are defined as locations where there is the exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

**Table C.1 Safety Limits for Partial Body Exposure**

|  | UNCONTROLLED ENVIRONMENT<br>General Population<br>(W/kg) or (mW/g) | CONTROLLED ENVIRONMENT<br>General Population<br>(W/kg) or (mW/g) |
|--|--|--|
| SPATIAL PEAK SAR <sup>1</sup><br>Brain                       | 1.60   | 8.00   |
| SPATIAL PEAK SAR <sup>2</sup><br>Whole Body                  | 0.08   | 0.40   |
| SPATIAL PEAK SAR <sup>3</sup><br>Hands, Feet, Ankles, Wrists | 4.00   | 20.00  |

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

<sup>2</sup> The Spatial Average value of the SAR averaged over the whole body.

<sup>3</sup> The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

## **APPENDIX D**

### **Test Setup Photographs**

## **APPENDIX E**

### **The Validation Measurements**

DUT: Dipole 1900 MHz; Serial: 5d023

Program Name: 1900MHz Dipole Validation 2009.04.21

Procedure Name: 1900MHz

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

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.43$  mho/m;  $\epsilon_r = 39.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV2 - SN3017; ConvF(4.92, 4.92, 4.92); Calibrated: 2008-09-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn468; Calibrated: 2008-07-22
- Phantom: SAM PHANTOM #2; Type: SAM; Serial: TP-1248
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

**1900MHz/Area Scan (51x51x1):** Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR (interpolated) = 14.7 mW/g

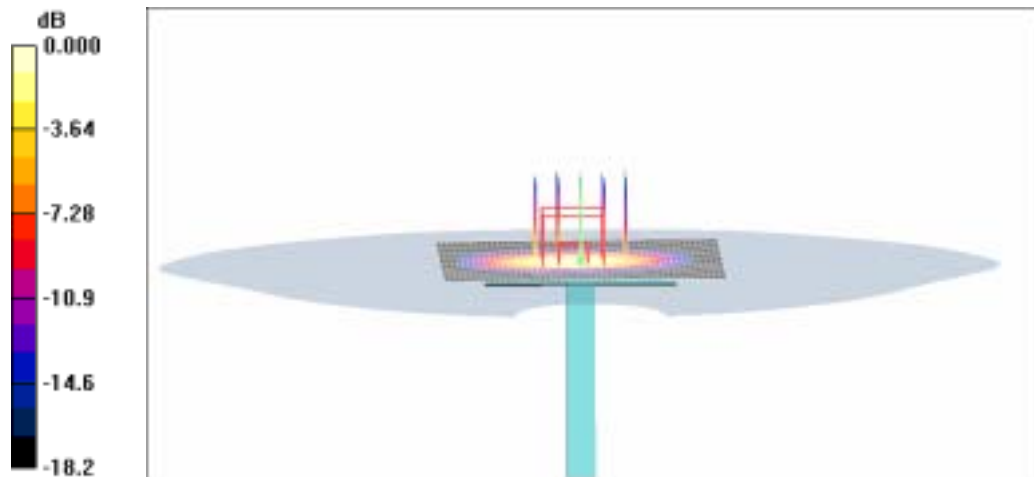
**1900MHz/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 89.2 V/m; Power Drift = -0.047 dB

Peak SAR (extrapolated) = 17.5 W/kg

**SAR(1 g) = 9.76 mW/g; SAR(10 g) = 5.1 mW/g**

Maximum value of SAR (measured) = 10.9 mW/g



0 dB = 10.9mW/g

## **APPENDIX F**

### **Plots of The SAR Measurements**

SAMSUNG FCC ID : A3LGTC5110 GSM1900 Head SAR

DUT: GT-C5110(Down); Serial: FG-099-A

Program Name: GT-C5110 GSM1900 Right Slide Down (Job No. :FG-099)

Procedure Name: Cheek/Touch, Ch.661, Ant.Intenna, Bat.Standard

Meas. Ambient Temp(celsius)-22.7; Tissue Temp(celsius)-22.3; Test Date-21/Apr/2009

Communication System: GSM 1900; Frequency: 1880 MHz;Duty Cycle: 1:8.3

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.43$  mho/m;  $\epsilon_r = 39.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Right Section

DASY4 Configuration:

- Probe: ES3DV2 - SN3017; ConvF(4.92, 4.92, 4.92); Calibrated: 2008-09-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn468; Calibrated: 2008-07-22
- Phantom: SAM PHANTOM #2; Type: SAM; Serial: TP-1248
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

**Cheek/Touch, Ch.661, Ant.Intenna, Bat.Standard/Area Scan (51x71x1):** Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR (interpolated) = 0.373 mW/g

**Cheek/Touch, Ch.661, Ant.Intenna, Bat.Standard/Zoom Scan (5x5x7)/Cube 0:**

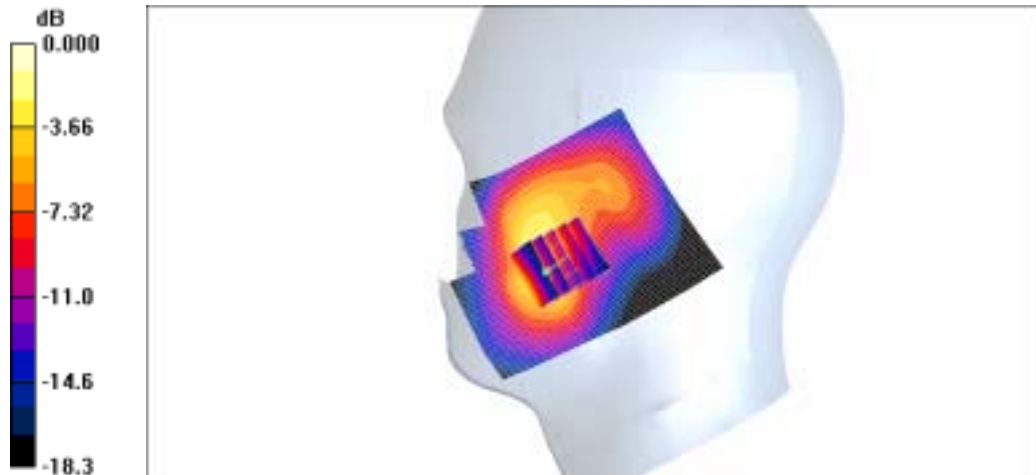
Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 14.8 V/m; Power Drift = 0.124 dB

Peak SAR (extrapolated) = 0.545 W/kg

**SAR(1 g) = 0.343 mW/g; SAR(10 g) = 0.196 mW/g**

Maximum value of SAR (measured) = 0.392 mW/g



0 dB = 0.392mW/g

SAMSUNG FCC ID : A3LGTC5110 GSM1900 Head SAR

DUT: GT-C5110(Down); Serial: FG-099-A

Program Name: GT-C5110 GSM1900 Right Slide Down (Job No. :FG-099)

Procedure Name: Ear/Tilt, Ch.661, Ant.Intenna, Bat.Standard

Meas. Ambient Temp(celsius)-22.7; Tissue Temp(celsius)-22.3; Test Date-21/Apr/2009

Communication System: GSM 1900; Frequency: 1880 MHz;Duty Cycle: 1:8.3

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.43$  mho/m;  $\epsilon_r = 39.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Right Section

DASY4 Configuration:

- Probe: ES3DV2 - SN3017; ConvF(4.92, 4.92, 4.92); Calibrated: 2008-09-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn468; Calibrated: 2008-07-22
- Phantom: SAM PHANTOM #2; Type: SAM; Serial: TP-1248
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

Ear/Tilt, Ch.661, Ant.Intenna, Bat.Standard/Area Scan (51x71x1): Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR (interpolated) = 0.192 mW/g

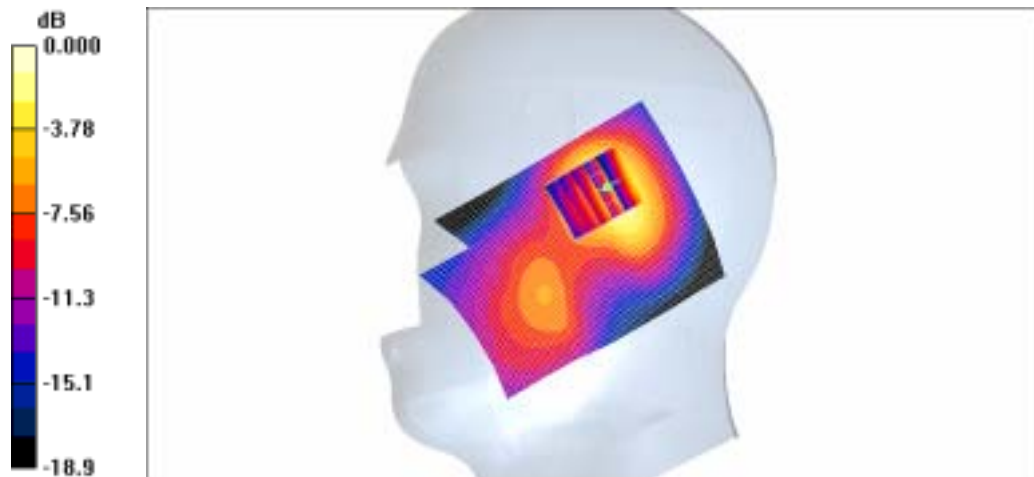
Ear/Tilt, Ch.661, Ant.Intenna, Bat.Standard/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 9.92 V/m; Power Drift = 0.076 dB

Peak SAR (extrapolated) = 0.303 W/kg

**SAR(1 g) = 0.188 mW/g; SAR(10 g) = 0.108 mW/g**

Maximum value of SAR (measured) = 0.201 mW/g



0 dB = 0.201mW/g

SAMSUNG FCC ID : A3LGTC5110 GSM1900 Head SAR

DUT: GT-C5110(Down); Serial: FG-099-A

Program Name: GT-C5110 GSM1900 Left Slide Down (Job No. : FG-099)

Procedure Name: Cheek/Touch, Ch.661, Ant.Intenna, Bat.Standard

Meas. Ambient Temp(celsius)-22.7; Tissue Temp(celsius)-22.3; Test Date-21/Apr/2009

Communication System: GSM 1900; Frequency: 1880 MHz;Duty Cycle: 1:8.3

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.43$  mho/m;  $\epsilon_r = 39.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Left Section

DASY4 Configuration:

- Probe: ES3DV2 - SN3017; ConvF(4.92, 4.92, 4.92); Calibrated: 2008-09-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn468; Calibrated: 2008-07-22
- Phantom: SAM PHANTOM #2; Type: SAM; Serial: TP-1248
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

**Cheek/Touch, Ch.661, Ant.Intenna, Bat.Standard/Area Scan (51x71x1):** Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR (interpolated) = 0.346 mW/g

**Cheek/Touch, Ch.661, Ant.Intenna, Bat.Standard/Zoom Scan (5x5x7)/Cube 0:**

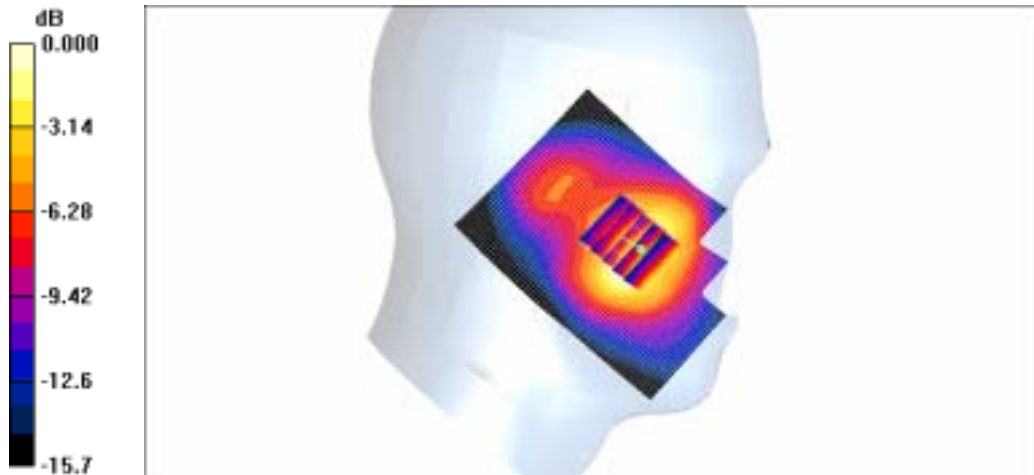
Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 15.6 V/m; Power Drift = -0.069 dB

Peak SAR (extrapolated) = 0.441 W/kg

**SAR(1 g) = 0.308 mW/g; SAR(10 g) = 0.198 mW/g**

Maximum value of SAR (measured) = 0.332 mW/g



0 dB = 0.332mW/g

SAMSUNG FCC ID : A3LGTC5110 GSM1900 Head SAR

DUT: GT-C5110(Down); Serial: FG-099-A

Program Name: GT-C5110 GSM1900 Left Slide Down (Job No. : FG-099)

Procedure Name: Ear/Tilt, Ch.661, Ant.Intenna, Bat.Standard

Meas. Ambient Temp(celsius)-22.7; Tissue Temp(celsius)-22.3; Test Date-21/Apr/2009

Communication System: GSM 1900; Frequency: 1880 MHz;Duty Cycle: 1:8.3

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.43$  mho/m;  $\epsilon_r = 39.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Left Section

DASY4 Configuration:

- Probe: ES3DV2 - SN3017; ConvF(4.92, 4.92, 4.92); Calibrated: 2008-09-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn468; Calibrated: 2008-07-22
- Phantom: SAM PHANTOM #2; Type: SAM; Serial: TP-1248
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

Ear/Tilt, Ch.661, Ant.Intenna, Bat.Standard/Area Scan (51x71x1): Measurement grid:

$dx=20$ mm,  $dy=20$ mm

Maximum value of SAR (interpolated) = 0.170 mW/g

Ear/Tilt, Ch.661, Ant.Intenna, Bat.Standard/Zoom Scan (5x5x7)/Cube 0: Measurement

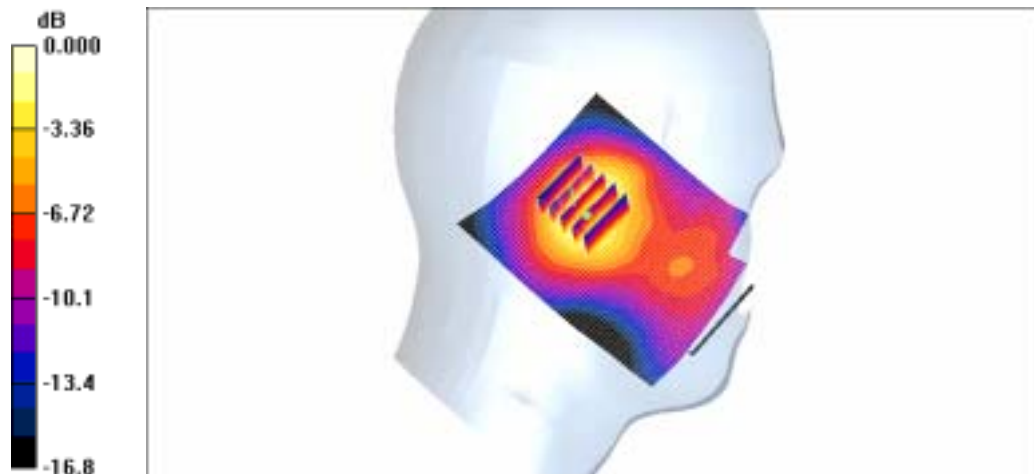
grid:  $dx=8$ mm,  $dy=8$ mm,  $dz=5$ mm

Reference Value = 10.5 V/m; Power Drift = 0.011 dB

Peak SAR (extrapolated) = 0.227 W/kg

**SAR(1 g) = 0.149 mW/g; SAR(10 g) = 0.091 mW/g**

Maximum value of SAR (measured) = 0.159 mW/g



0 dB = 0.159mW/g

SAMSUNG FCC ID : A3LGTC5110 GSM1900 Head SAR

DUT: GT-C5110(Up); Serial: FG-099-A

Program Name: GT-C5110 GSM1900 Right Slide Up (Job No. :FG-099)

Procedure Name: Cheek/Touch, Ch.661, Ant.Intenna, Bat.Standard

Meas. Ambient Temp(celsius)-22.7; Tissue Temp(celsius)-22.3; Test Date-21/Apr/2009

Communication System: GSM 1900; Frequency: 1880 MHz;Duty Cycle: 1:8.3

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.43$  mho/m;  $\epsilon_r = 39.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Right Section

DASY4 Configuration:

- Probe: ES3DV2 - SN3017; ConvF(4.92, 4.92, 4.92); Calibrated: 2008-09-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn468; Calibrated: 2008-07-22
- Phantom: SAM PHANTOM #2; Type: SAM; Serial: TP-1248
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

**Cheek/Touch, Ch.661, Ant.Intenna, Bat.Standard/Area Scan (51x71x1):** Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR (interpolated) = 0.278 mW/g

**Cheek/Touch, Ch.661, Ant.Intenna, Bat.Standard/Zoom Scan (5x5x7)/Cube 0:**

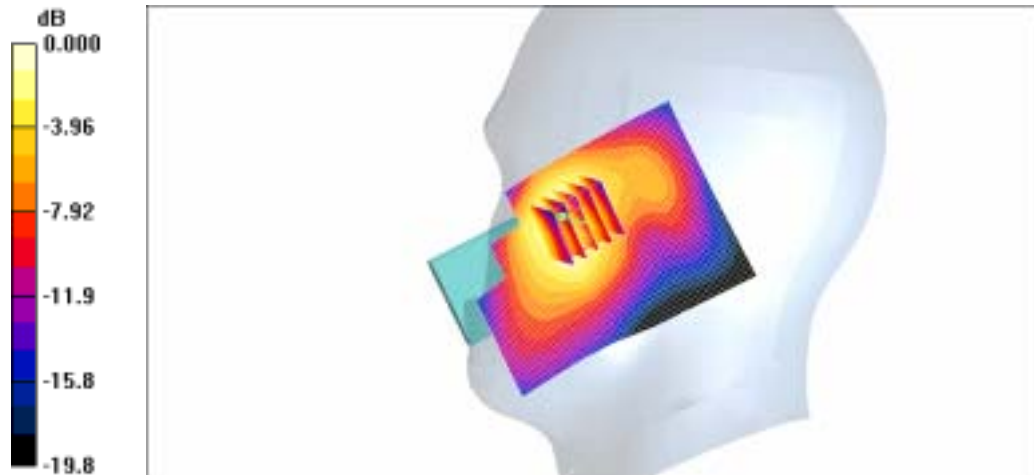
Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 12.9 V/m; Power Drift = 0.063 dB

Peak SAR (extrapolated) = 0.388 W/kg

**SAR(1 g) = 0.260 mW/g; SAR(10 g) = 0.165 mW/g**

Maximum value of SAR (measured) = 0.279 mW/g



0 dB = 0.279mW/g

SAMSUNG FCC ID : A3LGTC5110 GSM1900 Head SAR

DUT: GT-C5110(Up); Serial: FG-099-A

Program Name: GT-C5110 GSM1900 Right Slide Up (Job No. :FG-099)

Procedure Name: Ear/Tilt, Ch.661, Ant.Intenna, Bat.Standard

Meas. Ambient Temp(celsius)-22.7; Tissue Temp(celsius)-22.3; Test Date-21/Apr/2009

Communication System: GSM 1900; Frequency: 1880 MHz;Duty Cycle: 1:8.3

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.43$  mho/m;  $\epsilon_r = 39.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Right Section

DASY4 Configuration:

- Probe: ES3DV2 - SN3017; ConvF(4.92, 4.92, 4.92); Calibrated: 2008-09-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn468; Calibrated: 2008-07-22
- Phantom: SAM PHANTOM #2; Type: SAM; Serial: TP-1248
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

Ear/Tilt, Ch.661, Ant.Intenna, Bat.Standard/Area Scan (51x71x1): Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR (interpolated) = 0.202 mW/g

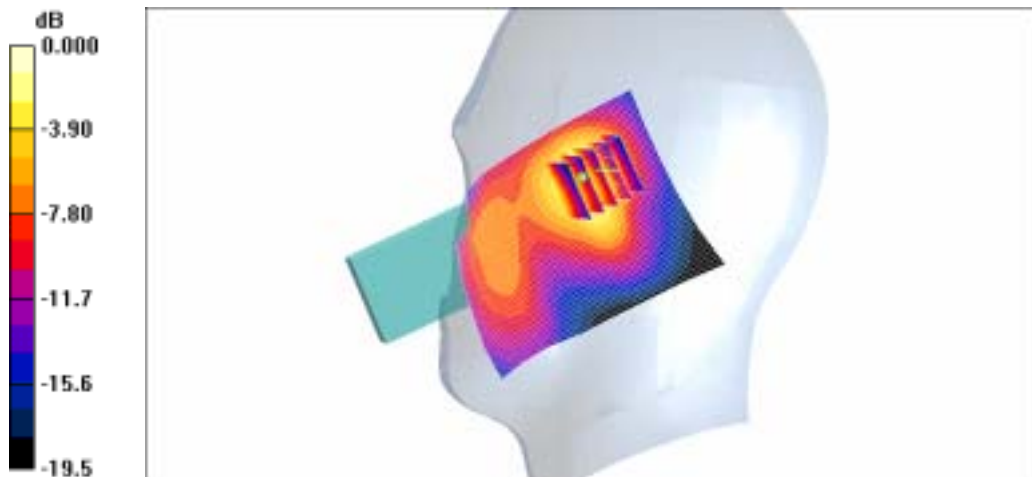
Ear/Tilt, Ch.661, Ant.Intenna, Bat.Standard/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 9.57 V/m; Power Drift = 0.001 dB

Peak SAR (extrapolated) = 0.315 W/kg

**SAR(1 g) = 0.193 mW/g; SAR(10 g) = 0.110 mW/g**

Maximum value of SAR (measured) = 0.211 mW/g



0 dB = 0.211mW/g

SAMSUNG FCC ID : A3LGTC5110 GSM1900 Head SAR

DUT: GT-C5110(Up); Serial: FG-099-A

Program Name: GT-C5110 GSM1900 Left Slide Up (Job No. : FG-099)

Procedure Name: Cheek/Touch, Ch.661, Ant.Intenna, Bat.Standard

Meas. Ambient Temp(celsius)-22.7; Tissue Temp(celsius)-22.3; Test Date-21/Apr/2009

Communication System: GSM 1900; Frequency: 1880 MHz;Duty Cycle: 1:8.3

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.43$  mho/m;  $\epsilon_r = 39.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Left Section

DASY4 Configuration:

- Probe: ES3DV2 - SN3017; ConvF(4.92, 4.92, 4.92); Calibrated: 2008-09-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn468; Calibrated: 2008-07-22
- Phantom: SAM PHANTOM #2; Type: SAM; Serial: TP-1248
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

**Cheek/Touch, Ch.661, Ant.Intenna, Bat.Standard/Area Scan (51x71x1):** Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR (interpolated) = 0.486 mW/g

**Cheek/Touch, Ch.661, Ant.Intenna, Bat.Standard/Zoom Scan (5x5x7)/Cube 0:**

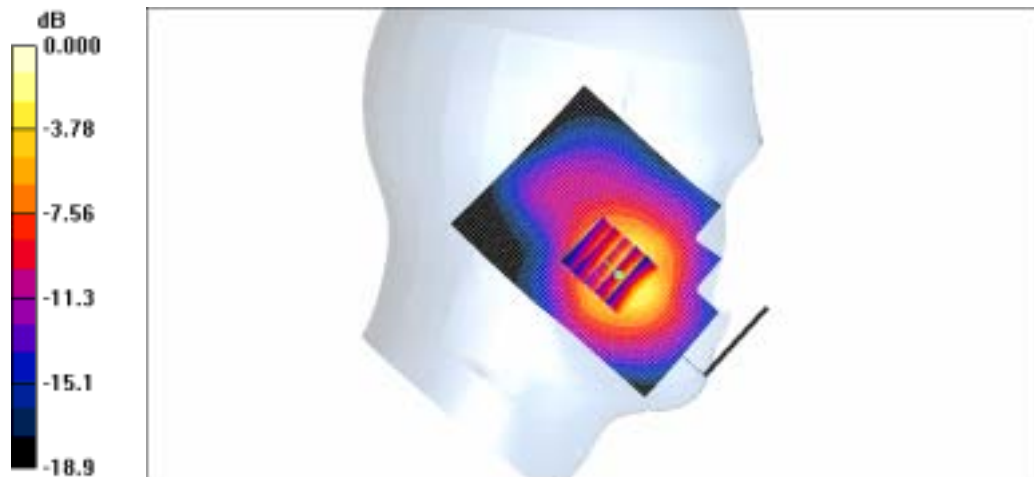
Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 13.7 V/m; Power Drift = 0.080 dB

Peak SAR (extrapolated) = 0.727 W/kg

**SAR(1 g) = 0.444 mW/g; SAR(10 g) = 0.246 mW/g**

Maximum value of SAR (measured) = 0.497 mW/g



0 dB = 0.497mW/g

SAMSUNG FCC ID : A3LGTC5110 GSM1900 Head SAR

DUT: GT-C5110(Up); Serial: FG-099-A

Program Name: GT-C5110 GSM1900 Left Slide Up (Job No. : FG-099)

Procedure Name: Ear/Tilt, Ch.661, Ant.Intenna, Bat.Standard

Meas. Ambient Temp(celsius)-22.7; Tissue Temp(celsius)-22.3; Test Date-21/Apr/2009

Communication System: GSM 1900; Frequency: 1880 MHz;Duty Cycle: 1:8.3

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.43$  mho/m;  $\epsilon_r = 39.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Left Section

DASY4 Configuration:

- Probe: ES3DV2 - SN3017; ConvF(4.92, 4.92, 4.92); Calibrated: 2008-09-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn468; Calibrated: 2008-07-22
- Phantom: SAM PHANTOM #2; Type: SAM; Serial: TP-1248
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

Ear/Tilt, Ch.661, Ant.Intenna, Bat.Standard/Area Scan (51x71x1): Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR (interpolated) = 0.168 mW/g

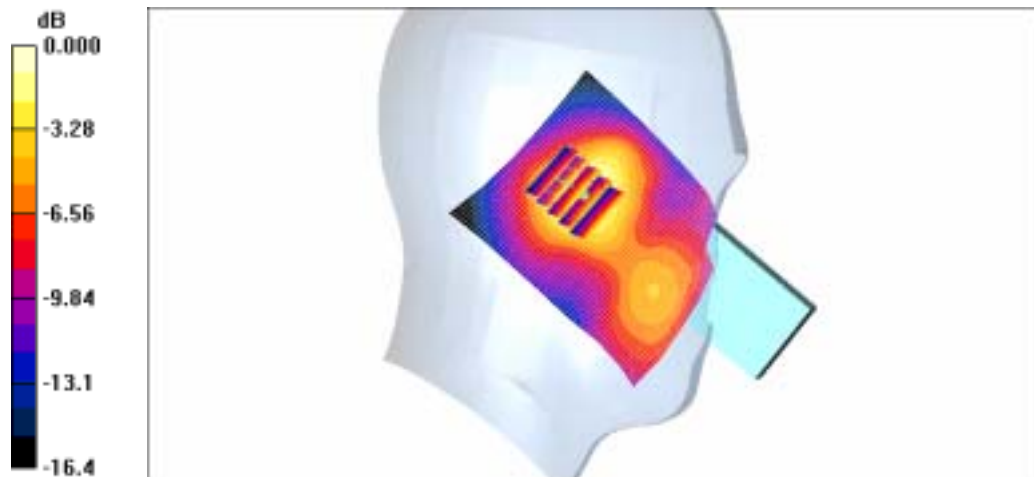
Ear/Tilt, Ch.661, Ant.Intenna, Bat.Standard/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 9.48 V/m; Power Drift = -0.033 dB

Peak SAR (extrapolated) = 0.211 W/kg

**SAR(1 g) = 0.136 mW/g; SAR(10 g) = 0.083 mW/g**

Maximum value of SAR (measured) = 0.143 mW/g



0 dB = 0.143mW/g

SAMSUNG FCC ID : A3LGTC5110 GSM1900 Head SAR

DUT: GT-C5110(Up); Serial: FG-099-A

Program Name: GT-C5110 GSM1900 Left Slide Up (Job No. : FG-099)

Procedure Name: Cheek/Touch, Ch.661, Ant.Intenna, Bat.Standard

Meas. Ambient Temp(celsius)-22.7; Tissue Temp(celsius)-22.3; Test Date-21/Apr/2009

Communication System: GSM 1900; Frequency: 1880 MHz;Duty Cycle: 1:8.3

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.43$  mho/m;  $\epsilon_r = 39.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Left Section

DASY4 Configuration:

- Probe: ES3DV2 - SN3017; ConvF(4.92, 4.92, 4.92); Calibrated: 2008-09-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn468; Calibrated: 2008-07-22
- Phantom: SAM PHANTOM #2; Type: SAM; Serial: TP-1248
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

**Cheek/Touch, Ch.661, Ant.Intenna, Bat.Standard/Area Scan (51x71x1):** Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR (interpolated) = 0.486 mW/g

**Cheek/Touch, Ch.661, Ant.Intenna, Bat.Standard/Zoom Scan (5x5x7)/Cube 0:**

Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 13.7 V/m; Power Drift = 0.080 dB

Peak SAR (extrapolated) = 0.727 W/kg

**SAR(1 g) = 0.444 mW/g; SAR(10 g) = 0.246 mW/g**

Maximum value of SAR (measured) = 0.497 mW/g



SAMSUNG FCC ID : A3LGTC5110 GPRS1900 Body SAR

DUT: GT-C5110(Down); Serial: FG-099-A

Program Name: GT-C5110 GPRS1900 Body (Job No. : FG-099)

Procedure Name: Body, Ch.810, Ant.Intenna, Bat.Standard

Meas. Ambient Temp(celsius)-22.7; Tissue Temp(celsius)-22.1; Test Date-21/Apr/2009

Communication System: GPRS 1900; Frequency: 1909.8 MHz;Duty Cycle: 1:4.15

Medium parameters used:  $f = 1909.8$  MHz;  $\sigma = 1.56$  mho/m;  $\epsilon_r = 51.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Right Section

DASY4 Configuration:

- Probe: ES3DV2 - SN3017; ConvF(4.61, 4.61, 4.61); Calibrated: 2008-09-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn468; Calibrated: 2008-07-22
- Phantom: Triple Flat Phantom 5.1; Type: Triple Flat Phantom 5.1; Serial: 1001
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

**Body, Ch.810, Ant.Intenna, Bat.Standard/Area Scan (71x51x1):** Measurement grid:

$dx=20$ mm,  $dy=20$ mm

Maximum value of SAR (interpolated) = 0.758 mW/g

**Body, Ch.810, Ant.Intenna, Bat.Standard/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:

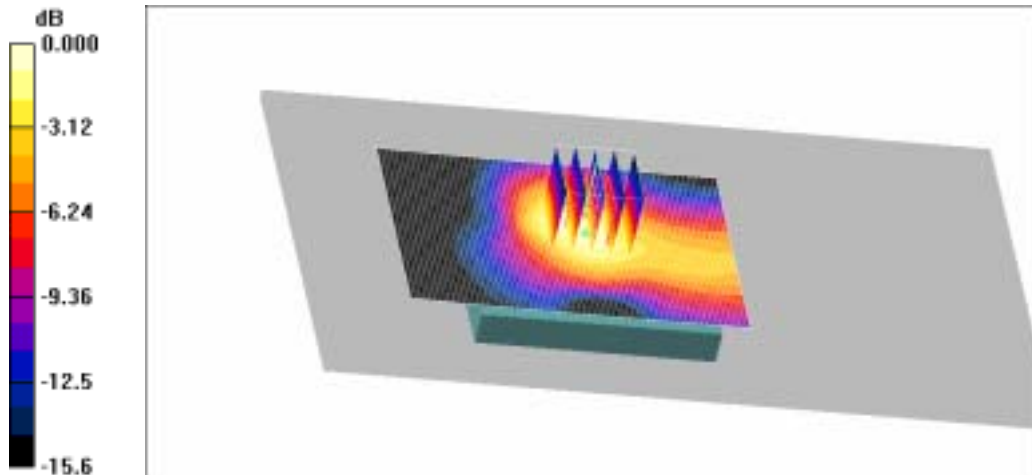
$dx=8$ mm,  $dy=8$ mm,  $dz=5$ mm

Reference Value = 14.9 V/m; Power Drift = -0.009 dB

Peak SAR (extrapolated) = 1.18 W/kg

**SAR(1 g) = 0.723 mW/g; SAR(10 g) = 0.425 mW/g**

Maximum value of SAR (measured) = 0.790 mW/g



0 dB = 0.790mW/g

SAMSUNG FCC ID : A3LGTC5110 GPRS1900 Body SAR

DUT: GT-C5110(Down); Serial: FG-099-A

Program Name: GT-C5110 GPRS1900 Body (Job No. : FG-099)

Procedure Name: Body, Ch.810, Ant.Intenna, Bat.Standard

Meas. Ambient Temp(celsius)-22.7; Tissue Temp(celsius)-22.1; Test Date-21/Apr/2009

Communication System: GPRS 1900; Frequency: 1909.8 MHz;Duty Cycle: 1:4.15

Medium parameters used:  $f = 1909.8$  MHz;  $\sigma = 1.56$  mho/m;  $\epsilon_r = 51.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Right Section

DASY4 Configuration:

- Probe: ES3DV2 - SN3017; ConvF(4.61, 4.61, 4.61); Calibrated: 2008-09-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn468; Calibrated: 2008-07-22
- Phantom: Triple Flat Phantom 5.1; Type: Triple Flat Phantom 5.1; Serial: 1001
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

**Body, Ch.810, Ant.Intenna, Bat.Standard/Area Scan (71x51x1):** Measurement grid:

$dx=20$ mm,  $dy=20$ mm

Maximum value of SAR (interpolated) = 0.758 mW/g

**Body, Ch.810, Ant.Intenna, Bat.Standard/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:

$dx=8$ mm,  $dy=8$ mm,  $dz=5$ mm

Reference Value = 14.9 V/m; Power Drift = -0.009 dB

Peak SAR (extrapolated) = 1.18 W/kg

**SAR(1 g) = 0.723 mW/g; SAR(10 g) = 0.425 mW/g**

Maximum value of SAR (measured) = 0.790 mW/g



## **APPENDIX G**

### **Probe Calibration**



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 **Samsung (Dymstec)**

Certificate No: **ES3-3017\_Sep08**

## CALIBRATION CERTIFICATE

Object: **ES3DV2 - SN:3017**

Calibration procedure(s): **QA CAL-01.v6 and QA CAL-23.v3  
Calibration procedure for dosimetric E-field probes**

Calibration date: **September 22, 2008**

Condition of the calibrated item: **In Tolerance**

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 ± 2)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards          | ID #           | Cal Date (Certificate No.)    | Scheduled Calibration |
|----------------------------|----------------|-------------------------------|-----------------------|
| Power meter E4419B         | GD41203074     | 1-Apr-08 (No. 217-00798)      | Apr-08                |
| Power sensor E4412A        | MY41495277     | 1-Apr-08 (No. 217-00798)      | Apr-08                |
| Power sensor E4412A        | MY41498007     | 1-Apr-08 (No. 217-00798)      | Apr-08                |
| Reference 3 dB Attenuator  | SN: 50054 (30) | 1-Jul-06 (No. 217-00865)      | Jul-06                |
| Reference 20 dB Attenuator | SN: 50066 (20) | 31-Mar-06 (No. 217-00767)     | Apr-06                |
| Reference 30 dB Attenuator | SN: 55129 (30) | 1-Jul-06 (No. 217-00865)      | Jul-06                |
| Reference Probe ES3DV2     | SN: 3013       | 2-Jan-08 (No. ES3-3013_Jan08) | Jan-08                |
| DAG4                       | SN: 660        | 9-Sep-05 (No. DAG4-660_Sep05) | Sep-05                |

| Secondary Standards       | ID #         | Check Date (in house)             | Scheduled Check        |
|---------------------------|--------------|-----------------------------------|------------------------|
| RF generator HP 8548C     | US3642L01700 | 4-Aug-09 (in house check Oct-07)  | In house check: Oct-09 |
| Network Analyzer HP 8733E | US37380666   | 15-Oct-01 (in house check Oct-07) | In house check: Oct-08 |

| Calibrated by: | Name         | Function          | Signature |
|----------------|--------------|-------------------|-----------|
|                | Raja Pollock | Technical Manager |           |
| Approved by:   | Fin Beutler  | R&D Director      |           |

Issued: September 24, 2008

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

OK to use   
2008. 11. 9



**Glossary:**

|                       |  |
|-----------------------|--|
| TSL                   | tissue simulating liquid   |
| $NORM_{x,y,z}$        | sensitivity in free space  |
| ConvF                 | sensitivity in TSL / $NORM_{x,y,z}$  |
| DCP                   | diode compression point  |
| Polarization $\phi$   | $\phi$ rotation around probe axis  |
| Polarization $\theta$ | $\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ is normal to probe axis |

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

- 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
- 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:**

- $NORM_{x,y,z}$ : Assessed for E-field polarization  $\theta = 0$  ( $f < 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide).  $NORM_{x,y,z}$  are only intermediate values, i.e., the uncertainties of  $NORM_{x,y,z}$  does not effect the  $E^2$ -field uncertainty inside TSL (see below ConvF).
- $NORM(f)_{x,y,z} = NORM_{x,y,z} * frequency\_response$  (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.
- DCP $_{x,y,z}$ : DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- 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  $NORM_{x,y,z} * ConvF$  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  $\pm 50$  MHz to  $\pm 100$  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:3017

|                  |                    |
|------------------|--------------------|
| Manufactured:    | December 5, 2002   |
| Last calibrated: | September 26, 2007 |
| Recalibrated:    | September 22, 2008 |

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

**DASY - Parameters of Probe: ES3DV2 SN:3017****Sensitivity in Free Space<sup>A</sup>**

|       |              |                              |       |       |
|-------|--------------|------------------------------|-------|-------|
| NormX | 1.61 ± 10.1% | $\mu\text{V}/(\text{V/m})^2$ | DCP X | 97 mV |
| NormY | 1.66 ± 10.1% | $\mu\text{V}/(\text{V/m})^2$ | DCP Y | 92 mV |
| NormZ | 1.79 ± 10.1% | $\mu\text{V}/(\text{V/m})^2$ | DCP Z | 90 mV |

**Diode Compression<sup>B</sup>****Sensitivity in Tissue Simulating Liquid (Conversion Factors)**

Please see Page 8.

**Boundary Effect****TSL**            **900 MHz**    Typical SAR gradient: 5 % per mm

|   |                              |        |        |
|---|------------------------------|--------|--------|
| Sensor Center to Phantom Surface Distance |                              | 3.0 mm | 4.0 mm |
| SAR <sub>90%</sub> [%]                    | Without Correction Algorithm | 8.2    | 5.4    |
| SAR <sub>90%</sub> [%]                    | With Correction Algorithm    | 0.6    | 0.6    |

**TSL**            **1510 MHz**    Typical SAR gradient: 10 % per mm

|   |                              |        |        |
|---|------------------------------|--------|--------|
| Sensor Center to Phantom Surface Distance |                              | 3.0 mm | 4.0 mm |
| SAR <sub>90%</sub> [%]                    | Without Correction Algorithm | 7.8    | 5.0    |
| SAR <sub>90%</sub> [%]                    | With Correction Algorithm    | 0.6    | 0.3    |

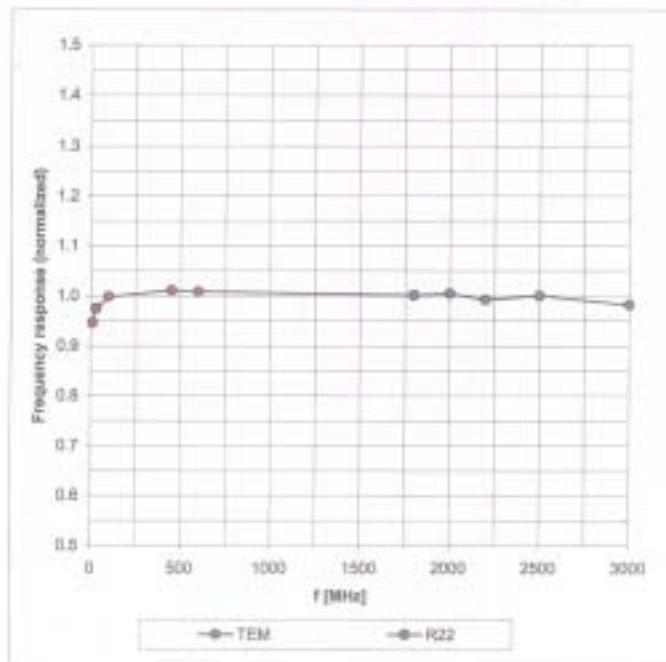
**Sensor Offset**Probe Tip to Sensor Center                            **2.1 mm**

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%.

<sup>A</sup> The uncertainties of NormX,Y,Z do not affect the  $E^2$ -field uncertainty inside TSL, (see Page 6).<sup>B</sup> Numerical linearization parameter, uncertainty not required.

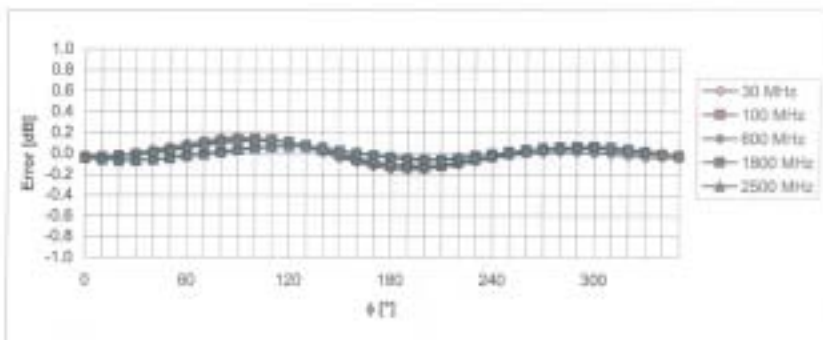
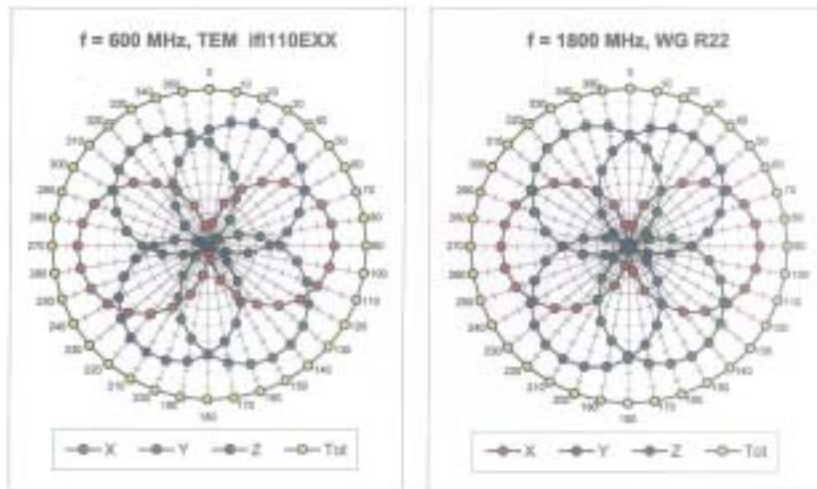
## Frequency Response of E-Field

(TEM-Cell:if1110 EXX, Waveguide: R22)



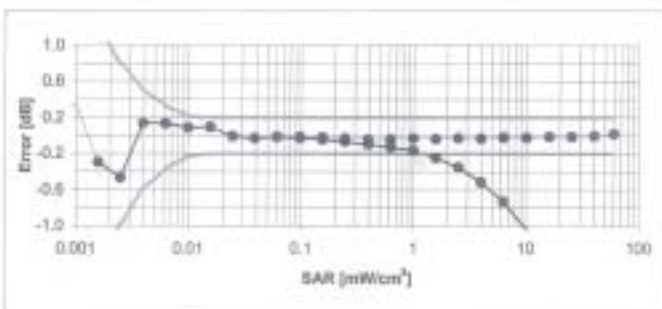
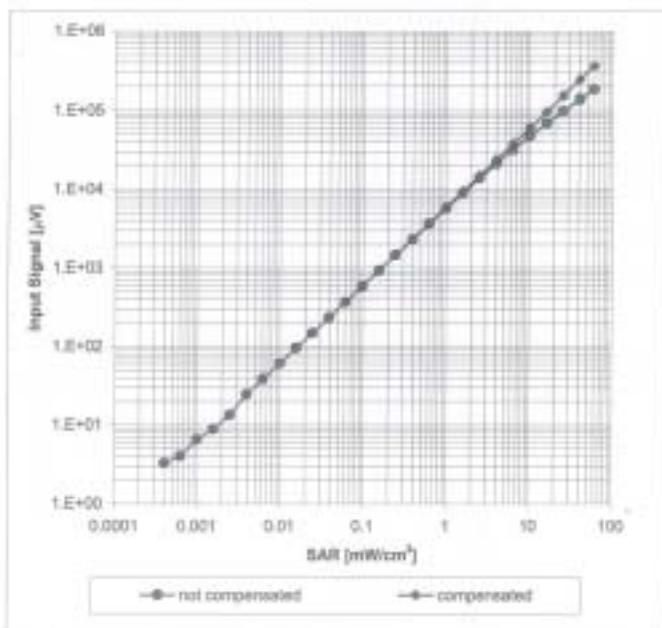
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

Receiving Pattern ( $\phi$ ),  $\theta = 0^\circ$



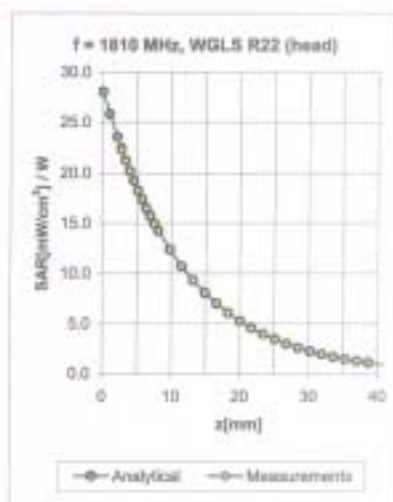
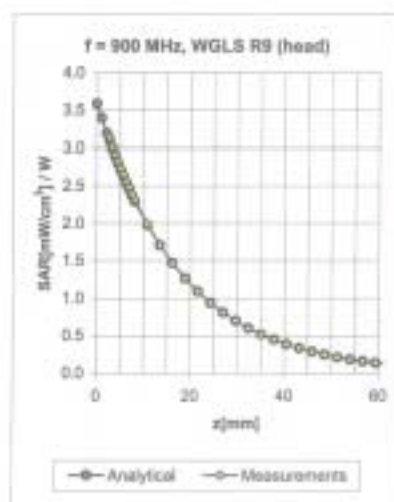
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

**Dynamic Range  $f(SAR_{head})$**   
 (Waveguide R22,  $f = 1800$  MHz)



Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

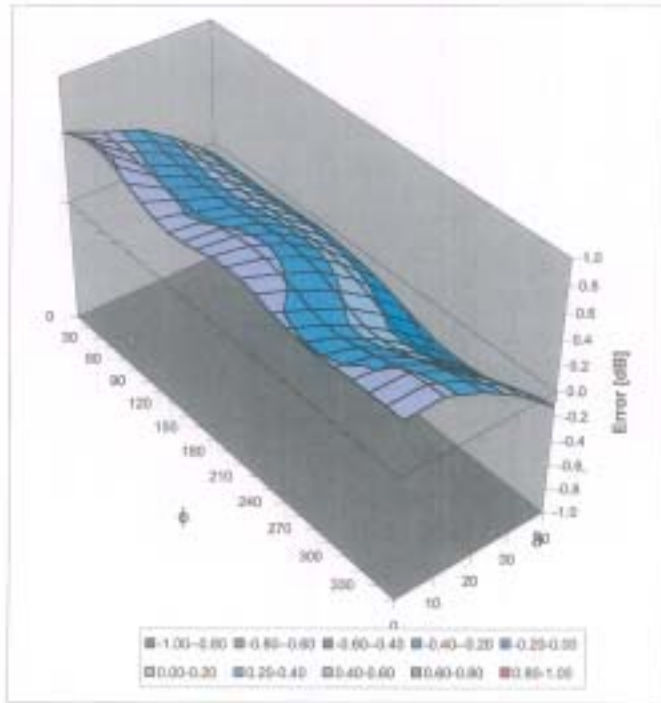
## Conversion Factor Assessment



| f [MHz] | Validity [MHz] <sup>2</sup> | TSL  | Permittivity | Conductivity | Alpha | Depth | ConvF              | Uncertainty |
|---------|-----------------------------|------|--------------|--------------|-------|-------|--------------------|-------------|
| 900     | ± 50 / ± 100                | Head | 41.5 ± 5%    | 0.87 ± 5%    | 0.38  | 1.50  | 6.08 ± 11.0% (k=2) |             |
| 1810    | ± 50 / ± 100                | Head | 40.0 ± 5%    | 1.40 ± 5%    | 0.24  | 2.26  | 4.92 ± 11.0% (k=2) |             |
| 2000    | ± 50 / ± 100                | Head | 40.0 ± 5%    | 1.40 ± 5%    | 0.24  | 2.18  | 4.75 ± 11.0% (k=2) |             |
| 900     | ± 50 / ± 100                | Body | 55.0 ± 5%    | 1.05 ± 5%    | 0.31  | 1.70  | 6.00 ± 11.0% (k=2) |             |
| 1810    | ± 50 / ± 100                | Body | 53.3 ± 5%    | 1.52 ± 5%    | 0.25  | 2.99  | 4.61 ± 11.0% (k=2) |             |
| 2000    | ± 50 / ± 100                | Body | 53.3 ± 5%    | 1.52 ± 5%    | 0.23  | 3.65  | 4.36 ± 11.0% (k=2) |             |
| 2600    | ± 50 / ± 100                | Body | 52.5 ± 5%    | 2.16 ± 5%    | 0.43  | 1.75  | 3.56 ± 11.0% (k=2) |             |

<sup>2</sup> The validity of ± 100 MHz only applies for DASY v6.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

### Deviation from Isotropy in HSL Error ( $\phi$ , $\theta$ ), $f = 900$ MHz



Uncertainty of Spherical Isotropy Assessment:  $\pm 2.6\%$  ( $k=2$ )

## **APPENDIX H**

### **Calibration of The Validation Dipole**



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 **Samsung (Dymstec)**

Certificate No: **D1900V2-5d023-Jan09**

## CALIBRATION CERTIFICATE

Object: **D1900V2 - SN: 5d023**

Calibration procedure(s): **QA CAL-05.v7  
Calibration procedure for dipole validation kits**

Calibration date: **January 06, 2009**

Condition of the calibrated item: **In Tolerance**

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 (Calibrated by, Certificate No.) | Scheduled Calibration  |
|-----------------------------|--------------------|---|------------------------|
| Power meter EPM-442A        | GB37480704         | 08-Oct-08 (No. 217-00898)                 | Oct-09                 |
| Power sensor HP 8481A       | US37292783         | 08-Oct-08 (No. 217-00898)                 | Oct-09                 |
| Reference 20 dB Attenuator  | SN: 5086 (20g)     | 01-Jul-08 (No. 217-00864)                 | Jul-09                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 01-Jul-08 (No. 217-00867)                 | Jul-09                 |
| Reference Probe ES30V2      | SN: 3025           | 28-Apr-08 (No. ES3-3025_Apr08)            | Apr-09                 |
| DAE4                        | SN: 601            | 14-Mar-08 (No. DAE4-601_Mar08)            | Mar-09                 |
| Secondary Standards         | ID #               | Check Date (in house)                     | Scheduled Check        |
| Power sensor HP 8481A       | MY41092317         | 18-Oct-02 (in house check Oct-07)         | In house check: Oct-09 |
| RF generator R&S SMT-06     | 100005             | 4-Aug-99 (in house check Oct-07)          | In house check: Oct-09 |
| Network Analyzer HP 8753E   | US37390585 S4208   | 18-Oct-01 (in house check Oct-08)         | In house check: Oct-09 |

Calibrated by: **Jeton Kasrat** (Name), **Laboratory Technician** (Function), *[Signature]* (Signature)

Approved by: **Katja Pokovic** (Name), **Technical Manager** (Function), *[Signature]* (Signature)

Issued: January 7, 2009

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

*[Handwritten Signature]*  
2009.03.03

SIST - JE - 01(C)



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**

**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:**

- 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
- CENELEC EN 50361, "Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz - 3 GHz), July 2001
- 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:**

- 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                     | V5.0        |
| 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 $\pm$ 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 $\pm$ 0.2) °C | 39.2 $\pm$ 6 % | 1.47 mho/m $\pm$ 6 % |
| Head TSL temperature during test | (21.0 $\pm$ 0.2) °C | —              | —                    |

## SAR result with Head TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | condition          |                                |
|---|--------------------|--------------------------------|
| SAR measured  | 250 mW input power | 10.4 mW / g                    |
| SAR normalized  | normalized to 1W   | 41.6 mW / g                    |
| SAR for nominal Head TSL parameters <sup>1</sup>      | normalized to 1W   | 40.3 mW / g $\pm$ 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | Condition          |                                |
|---|--------------------|--------------------------------|
| SAR measured  | 250 mW input power | 5.40 mW / g                    |
| SAR normalized  | normalized to 1W   | 21.6 mW / g                    |
| SAR for nominal Head TSL parameters <sup>1</sup>        | normalized to 1W   | 21.3 mW / g $\pm$ 16.5 % (k=2) |

<sup>1</sup> Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities"

**Antenna Parameters with Head TSL**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 49.8 $\Omega$ + 7.6 j $\Omega$ |
| Return Loss                          | - 22.3 dB                      |

**General Antenna Parameters and Design**

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1,196 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 | March 28, 2008 |

## DASY5 Validation Report for Head TSL

Date/Time: 06.01.2009 14:02:16

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d023**

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

Medium: HSL U10 BB

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.47$  mho/m;  $\epsilon_r = 39.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC)

DASY5 Configuration:

- Probe: ES3DV2 - SN3025; ConvF(4.9, 4.9, 4.9); Calibrated: 28.04.2008
- Sensor-Surface: 3.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 14.03.2008
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- Measurement SW: DASY5, V5.0 Build 120; SEMCAD X Version 13.4 Build 45

**Pin = 250 mW; dip = 10 mm, scan at 3.4mm/Zoom Scan (dist=3.4mm, probe 0deg)**

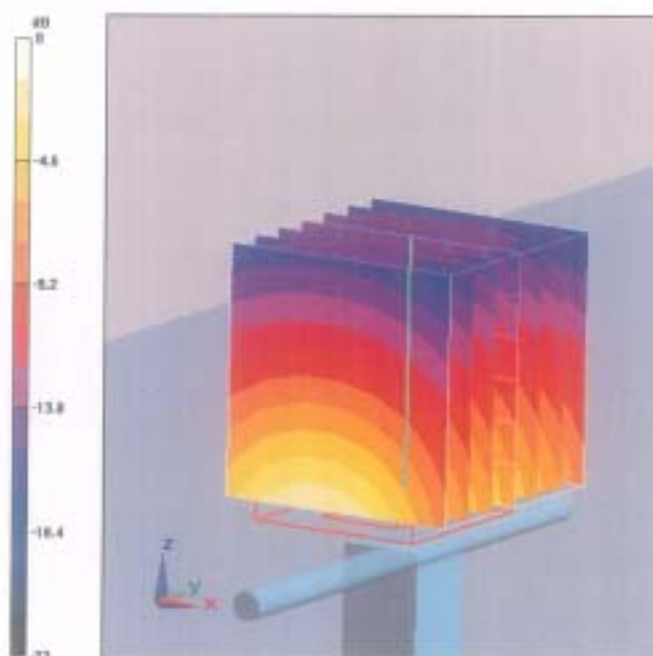
**(7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.2 V/m; Power Drift = 0.043 dB

Peak SAR (extrapolated) = 19.4 W/kg

**SAR(1 g) = 10.4 mW/g; SAR(10 g) = 5.4 mW/g**

Maximum value of SAR (measured) = 12.2 mW/g



0 dB = 12.2mW/g

# Impedance Measurement Plot for Head TSL

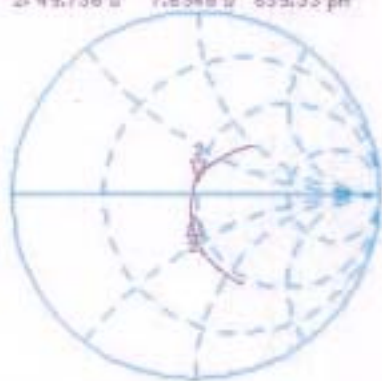
5 Jan 2009 10:12:49

CH1 S11 1 V FS 2i 49.736  $\Omega$  7.6348  $\mu$  539.53  $\mu$ H 1 900,000 000 MHz

#  
Del  
Cor

Avg  
15

#



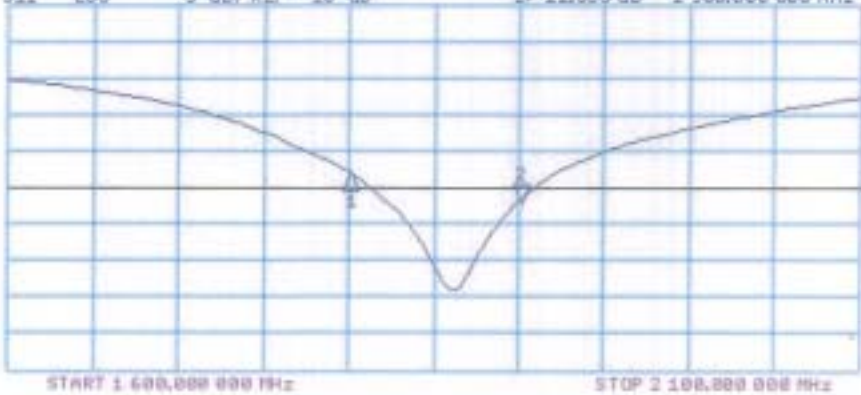
CH1 Markers  
1i 49.500  $\Omega$   
-11.820  $\mu$   
1.00000 GHz

CH2 S11 LOB 5 dB/REF -20 dB 2i -22.325 dB 1 900,000 000 MHz

Cor

Avg  
16

#



CH2 Markers  
1i -17.968 dB  
1.00000 GHz

START 1 500,000 000 MHz

STOP 2 100,000 000 MHz