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# TEST REPORT

Report number : Z101C-14093

Issue date : October 30, 2014

The device, as described herewith, was tested pursuant to applicable test procedure and complies with the requirements of;

## FCC 47CFR §2. 1093

The test results are traceable to the international or national standards.

Applicant	: KYOCERA Corporation
Equipment under test (EUT)	: Mobile Phone
Model number	: KC-01
FCC ID	: JOYKC-01

Date of test : September 16-19, 22-27, October 28-30 2014  
 Test place : TÜV SÜD Zacta Ltd. Yonezawa Testing Center  
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 Test results : Complied

The results in this report are applicable only to the equipment tested.  
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 This test report must not be used by client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government.

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## ***Table of contents***

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	<b>Page</b>
<b>1. Summary of Test .....</b>	<b>4</b>
1.1 Purpose of test .....	4
1.2 Standards .....	4
1.3 Modification to the EUT by laboratory .....	4
<b>2. Equipment Under Test .....</b>	<b>5</b>
2.1 General description of equipment .....	5
2.2 EUT information .....	5
2.3 Variation of the family model(s) .....	6
2.4 Description of test modes .....	6
2.5 Test Results .....	7
2.6 Nominal and Maximum Output Power Specifications .....	8
2.7 DUT Antenna Locations & SAR Test Configurations .....	9
2.8 SAR Test Exclusions Applied .....	10
2.9 Power Reduction for SAR .....	11
2.10 Device Serial Numbers .....	11
<b>3. Introduction .....</b>	<b>12</b>
<b>4. Description of test equipment .....</b>	<b>13</b>
4.1 SAR Measurement Setup .....	13
4.2 Probe measurement system .....	14
4.3 Probe calibration process .....	15
4.4 SAM Twin phantom .....	17
4.5 Device Holder for Transmitters .....	18
4.6 Brain & Muscle Simulating Mixture Characterization .....	18
4.7 SAR Test equipment .....	19
<b>5. Test system specifications .....</b>	<b>20</b>
<b>6. SAR Measurement Procedure .....</b>	<b>21</b>
<b>7. Definition of reference points .....</b>	<b>22</b>
7.1 EAR Reference Point .....	22
7.2 Handset Reference Points .....	22
7.3 Device Holder .....	23
7.4 Positioning for Cheek/Touch .....	23
7.5 Positioning for Ear / 15 ° Tilt .....	23
7.6 Body-Worn Accessory Configurations .....	24
7.7 Extremity Exposure Configurations .....	24
7.8 Wireless Router Configurations .....	24
<b>8. ANSI / IEEE C95.1-2005 RF Exposure Limits .....</b>	<b>25</b>
<b>9. FCC Measurement Procedures .....</b>	<b>26</b>
9.1 Measured and Reported SAR .....	26
9.2 Procedures Used to Establish RF Signal for SAR .....	26
9.3 SAR Measurement Conditions for WCDMA(UMTS) .....	26
9.3.1 Output Power Verification .....	26
9.3.2 Head SAR Measurements for Handsets .....	26
9.3.3 Body SAR Measurements .....	26



Zacta

9.3.4 SAR Measurements for Handsets with Rel 5 HSDPA.....	27
9.3.5 SAR Measurements for Handsets with Rel 6 HSUPA.....	27
<b>9.4 SAR Testing with 802.11 Transmitters.....</b>	<b>28</b>
9.4.1 General Device Setup .....	28
9.4.2 Frequency Channel Configurations .....	28
<b>10. RF Conducted Power.....</b>	<b>29</b>
10.1 GSM Conducted Powers.....	29
10.2 WCDMA Conducted Powers.....	30
10.3 WLAN Conducted Powers .....	31
10.4 Bluetooth Conducted Powers .....	32
<b>11. System Verification.....</b>	<b>33</b>
11.1 Tissue verification.....	33
11.2 Test system verification .....	35
<b>12. SAR Test Results.....</b>	<b>37</b>
12.1 Head SAR Results .....	37
12.2 Standalone Body-Worn SAR Results .....	41
12.3 Standalone Wireless router SAR Results .....	43
12.4 SAR Test Notes .....	47
<b>13. FCC Multi-TX and Antenna SAR Considerations.....</b>	<b>49</b>
13.1 Introduction .....	49
13.2 Simultaneous Transmission Procedures.....	49
13.3 Simultaneous Transmission Capabilities.....	49
13.4 Simultaneous Transmission SAR Analysis .....	50
13.5 Head SAR Simultaneous Transmission Analysis .....	51
13.6 Body-Worn Simultaneous Transmission Analysis .....	52
13.7 Hotspot SAR Simultaneous Transmission Analysis.....	53
13.8 Simultaneous Transmission Conclusion .....	53
<b>14. SAR Measurement Variability.....</b>	<b>56</b>
14.1 Measurement Variability.....	56
14.2 Measurement Uncertainty.....	56
<b>15. IEEE P1528 - Measurement uncertainties .....</b>	<b>57</b>
<b>16. Conclusion.....</b>	<b>63</b>
<b>17. References.....</b>	<b>64</b>
<b>Attachment 1. Probe calibration data .....</b>	<b>66</b>
<b>Attachment 2. Dipole calibration data .....</b>	<b>77</b>
<b>Attachment 3. SAR system validation.....</b>	<b>101</b>

## **1. Summary of Test**

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### **1.1 Purpose of test**

It is the original test in order to verify conformance to standards listed in section 1.2.

### **1.2 Standards**

FCC 47CFR §2. 1093

#### **1.2.1 Guidance applied**

- FCC OET Bulletin 65 Supplement C [June 2001]
- IEEE 1528-2003
- FCC KDB Publication 941225 D01-D06 (2G/3G and Hotspot)
- FCC KDB Publication 248227 D01v01r02 (SAR Considerations for 802.11 Devices)
- FCC KDB Publication 447498 D01 v05r02 (General SAR Guidance)
- FCC KDB Publication 865664 D01-D02 (SAR Measurements up to 6 GHz)
- October 2012 TCB Workshop Notes (IEEE 802.11ac)

#### **1.2.2 Deviation from standards**

None

### **1.3 Modification to the EUT by laboratory**

None



## **2. Equipment Under Test**

### **2.1 General description of equipment**

EUT is the Mobile Phone.

### **2.2 EUT information**

Applicant : KYOCERA Corporation  
 Yokohama Office 2-1-1 Kagahara, Tsuzuki-ku Yokohama-shi, Kanagawa,  
 Japan  
 Phone: +81-45-943-6253 Fax: +81-45-943-6314

Equipment under test : Mobile Phone

Trade name : Kyocera

Model number : KC-01

Serial number : N/A

EUT condition : Pre-Production

Power ratings : Battery: DC 3.8V

Size : (W) 64 × (D) 11.1 × (H) 127.0 mm

Environment : Indoor and Outdoor use

Terminal limitation : -20°C to 60°C

RF Specification

Equipment type : Transceiver

Mode(s) of operation : GSM 850, PCS 1900, WCDMA 850,  
 2.4GHz W-LAN(802.11b, 802.11g, 802.11n HT20)

Antenna type : Internal antenna

Antenna gain : GSM 850: -1.6dBi  
 PCS 1900: -0.4dBi  
 WCDMA 850: -1.6dBi  
 2.4GHz W-LAN: -1.0dBi

Frequency of operation : Up Link  
 GSM 850: 824.2-848.8MHz(Cellular Band)  
 PCS 1900: 1850.2-1909.8MHz(PCS Band)  
 WCDMA 850: 826.4-846.6MHz(WCDMA FDD V)  
 802.11b: 2412-2462MHz

Down Link  
 GSM 850: 869.2-893.8MHz(Cellular Band)  
 PCS 1900: 1930.2-1989.8MHz(PCS Band)  
 WCDMA 850: 871.4-891.6MHz(WCDMA FDD V)  
 802.11b: 2412-2462MHz

### 2.3 Variation of the family model(s)

None

### 2.4 Description of test modes

The EUT had been tested under operating condition.  
There are three channels have been tested as following:

Band	Channel	Test mode
GSM 850	128, 190, 251	Voice/Data
PCS 1900	512, 661, 810	Voice/ Data
WCDMA 850	4132, 4183, 4233	Voice/ Data
2.4GHz W-LAN	1, 6, 11	Data
Bluetooth	0, 39, 78	Data

For the second mode, and test it against RF exposure of the best at each position of the channel in the worst case.



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## 2.5 Test Results

Equipment Class	Band	Measured Conducted Power [dBm]	Reported SAR 1g SAR [W/kg]		
			Head	Body-worn	Hotspot
PCE	GSM 850	33.32	0.449	0.662	-
	GPRS 850	30.02	0.752	1.284	1.284
	PCS 1900	29.95	0.587	0.325	-
	GPRS 1900	27.01	1.119	0.686	0.686
	WCDMA 850	24.45	0.419	0.804	0.804
DTS	2.4GHz W-LAN	16.01	0.215	0.254	0.254
DSS/DTS	Bluetooth	8.26	N/A	N/A	N/A
Simultaneous SAR per KDB 690783 D01v01r03			1.205	1.538	1.538

## 2.6 Nominal and Maximum Output Power Specifications

This device operates using the following maximum and nominal output power specifications.

SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498 D01v05r02.

Band & Mode		Voice [dBm]	Burst Average GMSK [dBm]			
			1TX Slot	2TX Slot	3TX Slot	4TX Slot
GSM/GPRS 850	Maximum	33.5	33.5	32.5	30.5	29.0
	Nominal	32.5	32.5	31.5	29.5	28.0
GSM/GPRS 1900	Maximum	30.5	30.5	30.0	28.5	27.5
	Nominal	29.5	29.5	29.0	27.5	26.5

Band & Mode		Modulated Average [dBm]		
		3GPP RMC	3GPP HSDPA	3GPP HSUPA
WCDMA 850	Maximum	24.5	24.5	24.5
	Nominal	22.5	22.5	22.5

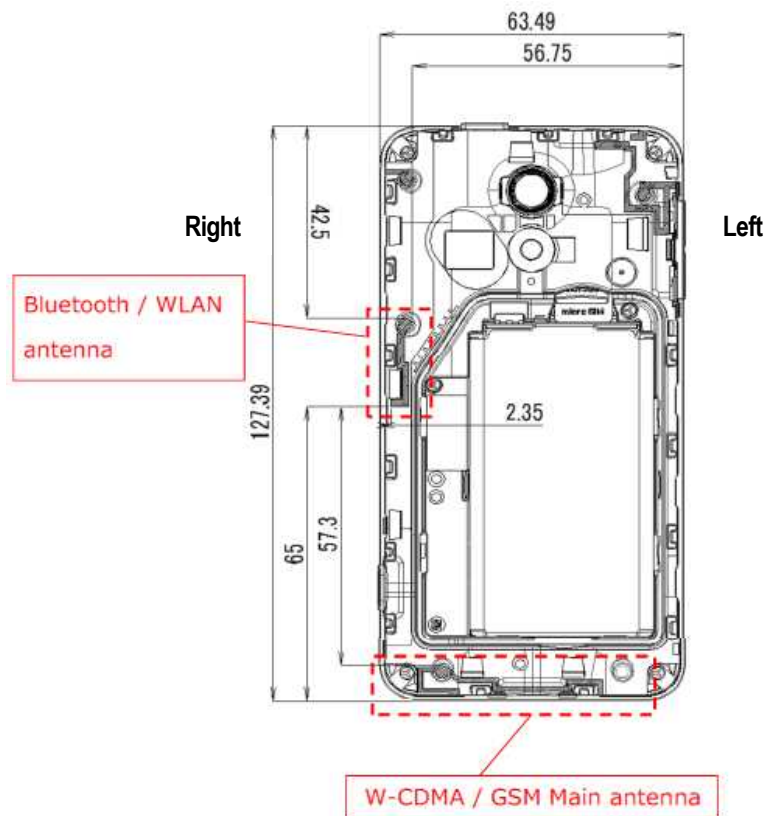
Band & Mode		Modulated Average [dBm]
IEEE 802.11b (2.4 GHz)	Maximum	16.9
	Nominal	16.0
IEEE 802.11g (2.4 GHz)	Maximum	12.9
	Nominal	12.0
IEEE 802.11n (2.4 GHz)	Maximum	12.9
	Nominal	12.0
Bluetooth	Maximum	8.4
	Nominal	7.5
Bluetooth LE	Maximum	-4.1
	Nominal	-5.0



## 2.7 DUT Antenna Locations & SAR Test Configurations

### DUT Antenna Locations(Rear side view)

Note: Specific antenna dimensions and separation distances are shown in the antenna distance document.



### SAR Test Configurations

Mode	Mobile Hotspot Sides for SAR Testing					
	Top	Bottom	Front	Rear	Right	Left
GSM 850	X	O	O	O	O	O
GSM 1900	X	O	O	O	O	O
WCDMA 850	X	O	O	O	O	O
2.4GHz W-LAN(802.11b/g/n)	X	X	O	O	O	X

Table 2.1 Mobile Hotspot Sides for SAR Testing

Note:

- Particular DUT edges were not required to be evaluated for Wireless Router SAR if the edges were greater than 2.5 cm from the transmitting antenna according to FCC KDB Publication 941225 D06v02 guidance, page 2. The antenna document shows the distances between the transmit antennas and the edges of the device.
- WIFI Direct GO is supported in the 2.4 GHz band only. The manufacturer expects 2.4 GHz WIFI Direct GO may be used in a similar manner to wireless router usage. Therefore, 2.4 GHz WIFI Direct GO was evaluated for SAR similarly to wireless router SAR procedures in FCC KDB Publication 941225.

## 2.8 SAR Test Exclusions Applied

### (A) WIFI & BT

Since Wireless Router operations are not allowed by the chipset firmware using 2.4 GHz WIFI, only 2.4 GHz WIFI Hotspot SAR tests and combinations are considered for SAR with respect to Wireless Router configurations according to FCC KDB 941225 D06v02.

Per FCC KDB 447498 D01v05r02, the SAR exclusion threshold for distances < 50 mm is defined by the following equation:

$$\frac{\text{Max Power of Channel (mW)}}{\text{Test Separation Dist (mm)}} * \sqrt{\text{Frequency(GHz)}} \leq 3.0$$

Based on the maximum conducted power of Bluetooth (rounded to the nearest mW) and the antenna to user separation distance, Bluetooth SAR was not required;  $[(6/10) * \sqrt{2.480}] = 1.0 < 3.0$ .

Based on the maximum conducted power of Bluetooth LE (rounded to the nearest mW) and the antenna to user separation distance, Bluetooth LE SAR was not required;  $[(1/10) * \sqrt{2.480}] = 0.2 < 3.0$ .

Based on the maximum conducted power of 2.4 GHz WIFI (rounded to the nearest mW) and the antenna to user separation distance, 2.4 GHz WIFI SAR was required;  $[(50/10) * \sqrt{2.437}] = 7.8 > 3.0$ .

Per KDB Publication 447498 D01v05r02, the maximum power of the channel was rounded to the nearest mW before calculation.

### (B) Licensed Transmitter(s)

GSM/GPRS DTM is not supported for US bands.

Therefore, the GSM Voice modes in this report do not transmit simultaneously with GPRS Data. And this device is only supported for EDGE Rx.

WCDMA 850 support HSDPA and HSUPA.

## 2.9 Power Reduction for SAR

There is no power reduction used for any band/mode implemented in this device for SAR purposes.

## 2.10 Device Serial Numbers

Mode	Head Serial Number	Body-Worn Serial Number	Hotspot Serial Number
GSM 850	FCC #1	FCC #1	FCC #1
GSM 1900			
WCDMA 850			
2.4GHz W-LAN			

### 3. Introduction

The FCC and Industry Canada have adopted the guidelines for evaluating the environmental effects of radio frequency (RF) radiation in ET Docket 93-62 on Aug. 6, 1996 and Health Canada Safety Code 6 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices.

The FCC has adopted the guidelines for evaluating the environmental effects of radio frequency radiation in ET Docket 93-62 on Aug. 6, 1996 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices. The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95\*.1-2005 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz. 1992 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017.

The measurement procedure described in IEEE/ANSI C95.3-1992 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave is used for guidance in measuring SAR due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements (NCRP) in Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields," NCRP Report No. 86 NCRP, 1986, Bethesda, MD 20814. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

#### 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.

$$\text{SAR} = \frac{d}{dt} \left[ \frac{dU}{dm} \right] = \frac{d}{dt} \left[ \frac{dU}{\rho dV} \right]$$

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

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

Where:

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

$\rho$  = mass density of the tissue-simulating material (kg/m<sup>3</sup>)

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

NOTE: The primary factors that control rate of 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.

## 4. Description of test equipment

### 4.1 SAR Measurement Setup

Measurements are performed using the DASY5 automated dosimetric assessment system. The DASY5 is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of high precision robotics system (Staubli), robot controller, desktop computer, near-field probe, probe alignment sensor, and the generic 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. 4.1).

A cell controller system contains the power supply, robot controller teach pendant (Joystick), and a remote control used to drive the robot motors. The PC consists of the Intel Core i7-3770 3,40 GHz desktop computer with Windows NT system and SAR Measurement Software DASY5, A/D interface card, monitor, mouse, and keyboard. The Staubli 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 PC plug-in card.

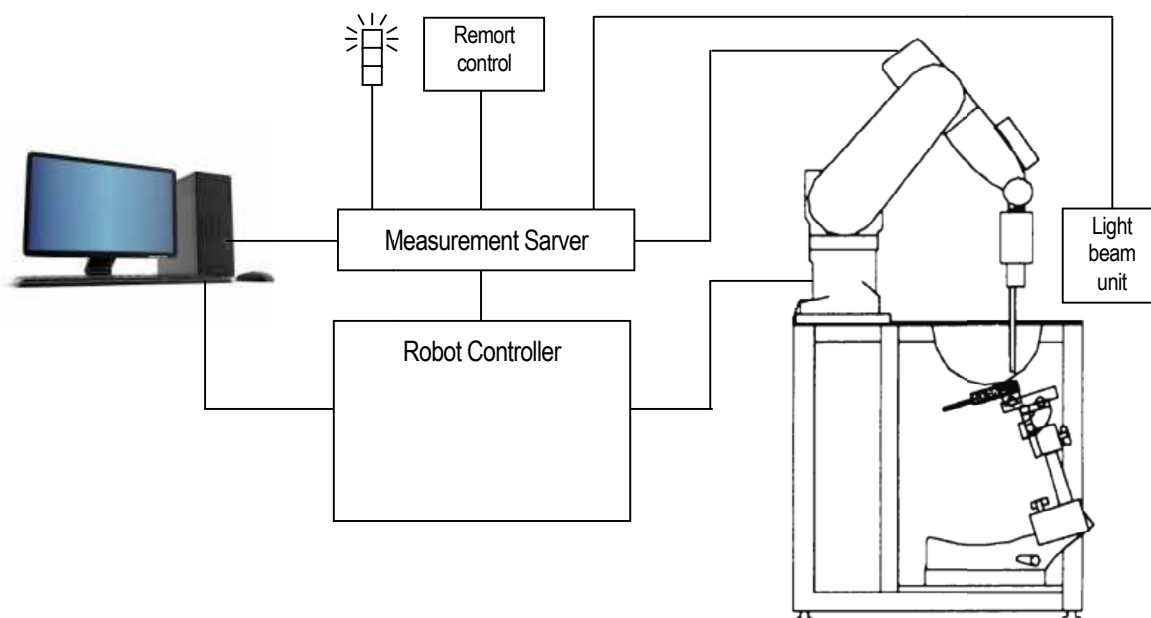


Figure 4.1 SAR Measurement system setup

The DAE consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit.

Transmission to the PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for 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. The system is described in detail.

## 4.2 Probe measurement system

The SAR measurements were conducted with the dosimetric probe EX3DV4, designed in the classical triangular configuration (see Fig. 4.2) and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multi fiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY5 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped at reaching the maximum.



DAE System

### Probe specifications

Calibration	In air from 10 MHz to 6 GHz In brain and muscle simulating tissue at Frequencies of 750MHz, 835MHz, 900MHz, 1750MHz, 1900MHz, 2000MHz 2300MHz, 2450MHz, 2600MHz, 3500MHz, 5200MHz, 5300MHz, 5500MHz, 5600MHz, 5800MHz
Frequency	10 MHz to 6 GHz
Linearity	± 0.2 dB(30 MHz to 6 GHz)
Dynamic	10 μW/g to > 100 mW/g
Range linearity	± 0.2 dB
Dimensions Overall length	337 mm(Tip: 20 mm)
Tip diameter	2.5 mm(Body: 12 mm)
Typical distance from probe tip to dipole centers:	1 mm
Application	Dosimetry testing Compliance tests of mobile phones

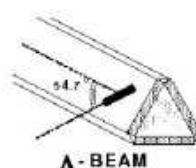


Figure 4.2 Triangular Probe Configurations



Figure 4.3 Probe Thick-Film Technique

### 4.3 Probe calibration process

#### Dosimetric Assessment Procedure

Each probe is calibrated according to a dosimetric assessment procedure described in with accuracy better than +/-10%. The spherical isotropy was evaluated with the procedure described in and found to be better than +/-0.25dB. The sensitivity parameters (Norm X, Norm Y, Norm Z), the diode compression parameter (DCP) and the conversion factor (Conv F) 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, and in a waveguide above 1GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity 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 the remits or based temperature probe is used in conjunction with the E-field probe.

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

Where:

- $\Delta t$  = exposure time (30 seconds),
- C = heat capacity of tissue (brain or muscle),
- $\Delta T$  = temperature increase due to RF exposure.

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

Where:

- $\sigma$  = simulated tissue conductivity,
- $\rho$  = Tissue density (1.25 g/cm<sup>3</sup> for brain tissue)

SAR is proportional to  $\Delta T / \Delta t$ , the initial rate of tissue heating, before thermal diffusion takes place. Now it's possible to quantify the electric field in the simulated tissue by equating the thermally derived SAR to the E- field;

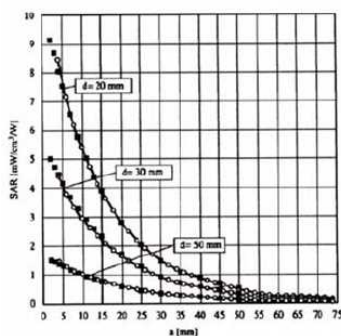


Figure 4.4 E-Field and Temperature Measurements at 900MHz

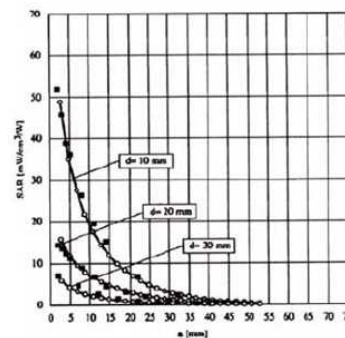


Figure 4.5 E-Field and Temperature Measurements at 1800MHz

### Data Extrapolation

The DASY software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given like below;

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

with  $V_i$  = linearized voltage of channel i (uV) (i = x,y,z)  
 $U_i$  = measured voltage of channel i (uV) (i = x,y,z)  
 $cf$  = crest factor of exciting field (DASY parameter)  
 $dcp_i$  = diode compression point of channel i (uV) (Probe parameter, i = x,y,z)

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

**E – fieldprobes :**

$$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

with  $V_i$  = linearized voltage of channel i (i = x,y,z)  
 $Norm_i$  = sensor sensitivity of channel i (i = x,y,z)  
 $\mu V / (V/m)^2$  for E-field Probes  
 $ConvF$  = sensitivity enhancement in solution  
 $E_i$  = electric field strength of channel i in V/m

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

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

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

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

with  $SAR$  = local specific absorption rate in mW/g  
 $E_{tot}$  = total field strength in V/m  
 $\sigma$  = conductivity in [mho/m] or [Siemens/m]  
 $\rho$  = equivalent tissue density in g/cm<sup>3</sup>

The power flow density is calculated assuming the excitation field to be a free space field.

$$P_{pwe} = \frac{E_{tot}^2}{3770}$$

with  $P_{pwe}$  = equivalent power density of a plane wave in mW/cm<sup>2</sup>  
 $E_{tot}$  = total electric field strength in V/m



#### 4.4 SAM Twin phantom

The SAM Twin Phantom V5.0 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 Fig. 4.6)



Figure 4.6 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 and IEC 62209. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot. Twin SAM V5.0 has the same shell geometry and is manufactured from the same material as Twin SAM V4.0, but has reinforced top structure.
Shell Thickness	2 ± 0.2 mm
Filling Volume	Approx. 25 liters
Dimensions	Length: 1000 mm Width: 500 mm Height: adjustable feet

#### Specific Anthropomorphic Mannequin (SAM) Specifications

The phantom for handset SAR assessment testing is a low-loss dielectric shell, with shape and dimensions derived from the anthropometric data of the 90th percentile adult male head dimensions as tabulated by the US Army. The SAM Twin Phantom shell is bisected along the mid-sagittal plane into right and left halves (see Fig. 4.7). The perimeter side walls of each phantom halves are extended to allow filling with liquid to a depth that is sufficient to minimized reflections from the upper surface.

The liquid depth is maintained at a minimum depth of 15cm to minimize reflections from the upper surface.



Figure 4.7 Sam Twin Phantom shell

#### 4.5 Device Holder for Transmitters

In combination with the Twin SAM Phantom V5.0 or ELI5, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to IEC, IEEE, FCC or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat).

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



Figure 4.8 Mounting Device

#### 4.6 Brain & Muscle Simulating Mixture Characterization



Simulated Tissue

The brain and muscle mixtures consist of a viscous gel using hydrox-ethyl cellulose (HEC) gelling agent and saline solution. (see Table 4.1)  
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 mixture characterizations used for the brain and muscle tissue simulating liquids are according to the data by C. Gabriel and G. Harts grove.

Table 4.1 Composition of the Equivalent Matter

Ingredients [% by weight]	Frequency [MHz]									
	750		835		1900		2450		5200 - 5800	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	42.10	50.00	40.19	50.75	55.24	70.23	71.88	73.40	65.52	80.00
Salt(NaCl)	1.500	0.800	1.480	0.940	0.310	0.290	0.160	0.060	-	-
Sugar	56.00	48.80	57.90	48.21	-	-	-	-	-	-
HEC	0.200	0.200	0.250	-	-	-	-	-	-	-
Bactericide	0.200	0.200	0.180	0.100	-	-	-	-	-	-
Triton X-100	-	-	-	-	-	-	19.97	-	17.24	-
DGBE	-	-	-	-	48.45	29.48	7.990	26.54	-	-
Diethylenglycol monohexylether	-	-	-	-	-	-	-	-	17.24	-
Polysorbate (Tween) 80	-	-	-	-	-	-	-	-	-	20.00
Target for Dielectric Constant	<b>41.9</b>	<b>55.5</b>	<b>41.5</b>	<b>55.2</b>	<b>40.0</b>	<b>53.3</b>	<b>39.2</b>	<b>52.7</b>	-	-
Target for Conductivity (S/m)	<b>0.89</b>	<b>0.96</b>	<b>0.90</b>	<b>0.97</b>	<b>1.40</b>	<b>1.52</b>	<b>1.80</b>	<b>1.95</b>	-	-

Salt: 99 % Pure Sodium Chloride Sugar: 98 % Pure Sucrose

Water: De-ionized, 16M resistivity HEC: Hydroxyethyl Cellulose

DGBE: 99 % Di(ethylene glycol) butyl ether,[2-(2-butoxyethoxy) ethanol]

Triton X-100(ultra pure): Polyethylene glycol mono [4-(1, 1, 3, 3-tetramethylbutyl)phenyl]



## 4.7 SAR Test equipment

**Table 4.2 Test Equipment Calibration**

USE	Equipment	Company	Model No.	Serial No.	Cal. Due	Cal. Date
X	SAR Test Room	TOKIN	N/A	N/A	N/A	N/A
X	Robot Arm	speag	TX60L	F13/5SC6C1/A/01	N/A	N/A
X	Robot Controller	speag	CS8c	F13/5SC6C1/A/01	N/A	N/A
X	Probe Alignment Unit LB	speag	N/A	N/A	N/A	N/A
X	Mounting Device	speag	SD000H01KA	N/A	N/A	N/A
X	Laptop Holder	speag	SMLH1001CD	N/A	N/A	N/A
X	SAM Twin Phantom	speag	QD000P40CD	1799	N/A	N/A
X	SAM Flat Phantom	speag	QDOVA001BB	1230	N/A	N/A
X	Data Acquisition Electronics	speag	DAE4	1409	Nov. 30, 2014	Nov. 22, 2013
X	Dosimetric E-Field Probe	speag	EX3DV4	3957	Dec. 31, 2014	Dec. 3, 2013
	750MHz SAR Dipole	speag	D750V3	1100	Dec. 31, 2014	Dec. 4, 2013
X	835MHz SAR Dipole	speag	D835V2	4d163	Dec. 31, 2014	Dec. 4, 2013
	900MHz SAR Dipole	speag	D900V2	1d161	Dec. 31, 2014	Dec. 4, 2013
	1450MHz SAR Dipole	speag	D1450V2	1048	Dec. 31, 2014	Dec. 3, 2013
	1750MHz SAR Dipole	speag	D1750V2	1106	Dec. 31, 2014	Dec. 4, 2013
X	1900MHz SAR Dipole	speag	D1900V2	5d183	Dec. 31, 2014	Dec. 2, 2013
	1950MHz SAR Dipole	speag	D1950V3	1150	Dec. 31, 2014	Dec. 2, 2013
X	2450MHz SAR Dipole	speag	D2450V2	925	Dec. 31, 2014	Dec. 3, 2013
	2600MHz SAR Dipole	speag	D2600V2	1072	Dec. 31, 2014	Dec. 3, 2013
	5000MHz SAR Dipole	speag	D5GHzV2	1166	Dec. 31, 2014	Dec. 3, 2013
X	Dielectric Assessment Kit	speag	DAK-3.5	1141	Nov. 30, 2014	Nov. 26, 2013
X	Network Analyzer	Agilent	8720ES	US39172791	Nov. 30, 2014	Nov. 8, 2013
X	Signal generator	ROHDE	SMB100A	177525	Feb. 28, 2015	Feb. 19, 2014
X	Power Amplifier	R&K	CGA020M602-2633R	B40240	Mar. 31, 2015	Mar. 7, 2014
X	Power meter	ROHDE	NRP2	103269	Dec. 31, 2014	Dec. 19, 2013
X	Power sensor	ROHDE	NRP-Z81	102459	Dec. 31, 2014	Dec. 19, 2013
X	Power sensor	ROHDE	NRP-Z81	102467	Dec. 31, 2014	Dec. 19, 2013
X	Directional Coupler	Narda	4226-20	09886	Feb.28, 2015	Feb. 14, 2014
X	Attenuator(3dB)	AEROFLEX	26A-03	081217-07	Nov. 30, 2014	Nov. 5, 2013
X	Attenuator(10dB)	SUHNER	6810.19A	10005430	Nov. 30, 2014	Nov. 5, 2013
X	Microwave cable(1m)	SUHNER	SUCOFLEX104	199120/4	Nov. 30, 2014	Nov. 12, 2013
X	Microwave cable(1.5m)	SUHNER	SUCOFLEX104	199121/4	Oct. 31, 2014	Oct. 7, 2013
X	Wideband Radio Frequency Tester	ROHDE	CMW500	126079	Aug. 31, 2015	Aug. 7, 2013
X	PC	HP	HP Compaq Elite 8300	CZC3234D1P	N/A	N/A
X	Software	speag	DAK	Ver 1.10.321.11	N/A	N/A
X	Software	speag	DASY5	Ver 52.8.7.1137	N/A	N/A

NOTE: The E-field probe was calibrated by SPEAG, by temperature measurement procedure. Dipole Verification measurement is performed by TÜV SÜD Zacta before each test. The brain simulating material is calibrated by TÜV SÜD Zacta using the dielectric probe system and network analyzer to determine the conductivity and permittivity (dielectric constant) of the brain-equivalent material.

## 5. Test system specifications

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### Automated TEST SYSTEM SPECIFICATIONS:

#### Positioner

Robot	Stäubli Unimation Corp. Robot Model: TX60L
Repeatability	0.02mm
No. of axis	6

#### Data Acquisition Electronic (DAE) System

##### Cell Controller

Processor	Intel Core i7-3770
Clock Speed	3.40 GHz
Operating System	Windows 7 Professional
Data Card	DASY5 PC-Board

##### Data Converter

Features	Signal, multiplexer, A/D converter. & control logic
Software	DASY5
Connecting Lines	Optical downlink for data and status info Optical uplink for commands and clock

##### PC Interface Card

Function	24 bit (64 MHz) DSP for real time processing Link to DAE 4 16 bit A/D converter for surface detection system serial link to robot direct emergency stop output for robot
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##### E-Field Probes

Model	EX3DV4 S/N: 3957
Construction	Triangular core fiber optic detection system
Frequency	10 MHz to 6 GHz
Linearity	$\pm 0.2$ dB (30 MHz to 6 GHz)

##### Phantom

Phantom	SAM Twin Phantom (V5.0)
Shell Material	Composite
Thickness	$2.0 \pm 0.2$ mm



Figure 5.1 DASY5 Test System

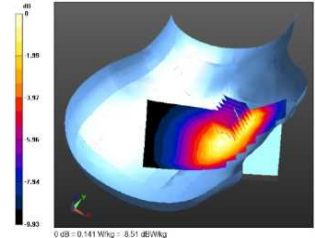
## 6. SAR Measurement Procedure

The evaluation was performed using the following procedure:

1. The SAR distribution at the exposed side of the head or body was measured at a distance no greater than 5.0 mm from the inner surface of the shell.

The area covered the entire dimension of the device-head and body interface and the horizontal grid resolution was determined per FCC KDB Publication 865664D01v01r03.

2. The point SAR measurement was taken at the maximum SAR region determined from Step 1 to enable the monitoring of SAR fluctuations/drifts during the 1g/10g cube evaluation. SAR at this fixed point was measured and used as a reference value.



Sample SAR Area Scan

3. Based on the area scan data, the peak of the region with maximum SAR was determined by spline interpolation. Around this point, a volume was assessed according to the measurement resolution and volume size requirements of FCC KDB Publication 865664 D01v01r03 (See Table 6.1).

On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the DASY manual online for more details):

- a. The data was extrapolated to the surface of the outer-shell of the phantom. The combined distance extrapolated was the combined distance from the center of the dipoles 2.7mm away from the tip of the probe housing plus the 1.2 mm distance between the surface and the lowest measuring point. The extrapolation was based on a least-squares algorithm. A polynomial of the fourth order was calculated through the points in the z-axis (normal to the phantom shell).
  - b. After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1g or 10g) using a 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 then integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were obtained through interpolation, in order to calculate the averaged SAR.
  - c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as step 2, was re-measured after the zoom scan was complete to calculate the SAR drift. If the drift deviated by more than 5%, the SAR test and drift measurements were repeated.

Table 6.1 Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01r03

Frequency	Maximum Area Scan Resolution[mm] ( $\Delta X_{area}$ : $\Delta Y_{area}$ )	Maximum Zoom Scan Resolution[mm] ( $\Delta X_{zoom}$ : $\Delta Y_{zoom}$ )	Maximum Zoom Scan Spatial Resolution[mm] $\Delta Z_{zoom}(n)$	Minimum Zoom Scan Volume[mm](x,y,z)
$\leq 2$ GHz	$\leq 15$	$\leq 8$	$\leq 5$	$\geq 30$
2-3GHz	$\leq 12$	$\leq 5$	$\leq 5$	$\geq 30$
3-4GHz	$\leq 12$	$\leq 5$	$\leq 4$	$\geq 28$
4-5GHz	$\leq 10$	$\leq 4$	$\leq 3$	$\geq 25$
5-6GHz	$\leq 10$	$\leq 4$	$\leq 2$	$\geq 22$

## 7. Definition of reference points

### 7.1 EAR Reference Point

Figure 7.1 shows the front, back and side views of the SAM Twin Phantom. The point “M” is the reference point for the center of the mouth, “LE” is the left ear reference point(ERP), and “RE” is the right ERP. The ERPs are 15mm posterior to the entrance to the Earcanal (EEC) along the B- M line (Back-Mouth), as shown in Figure 7.1. The plane Passing, through the two ear canals and M is defined as the Reference Plane. The line N-F (Neck- Front) is perpendicular to the reference plane and passing through the RE (or LE) is called the Reference Pivoting Line (see Figure 7.2).

Line B-M is perpendicular to the N-F line. Both N-F and B-M lines are marked on the external phantom shell to facilitate handset positioning.

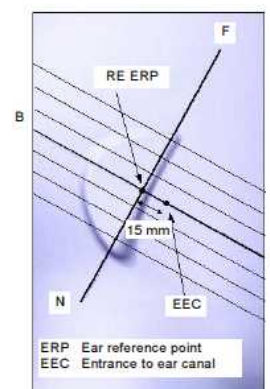


Figure 7.1 Close-up side view of ERPs

### 7.2 Handset Reference Points

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. 7.3). 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 top and bottom edges, positioning the “ear reference point” on the outersurface of the both the left and right head phantoms on the ear reference point.



Figure 7.2 Front, back and side view of SAM Twin Phantom

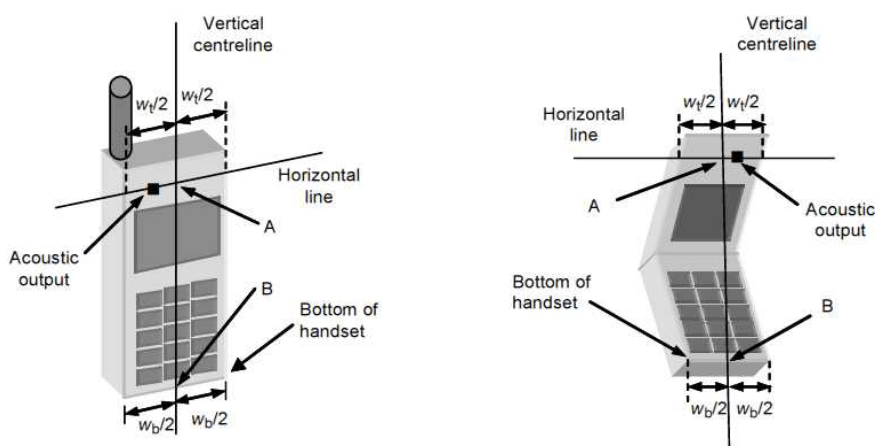


Figure 7.3 Handset Vertical Center & Horizontal Line Reference Points

### 7.3 Device Holder

The device holder is made out of low-loss POM material having the following dielectric parameters: relative permittivity  $\epsilon = 3$  and loss tangent  $\delta = 0.02$ .

### 7.4 Positioning for Cheek/Touch

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 Fig. 7.4), 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.

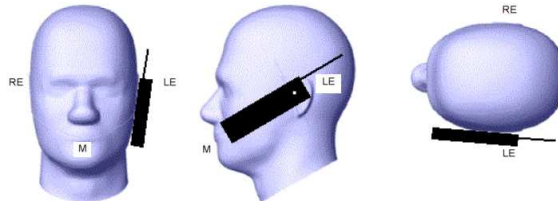


Figure 7.4 Front, Side and Top View of Cheek/Touch Position

2. The handset was translated towards the phantom along the line passing through RE & LE until the handset touches the ear.
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).
4. The phone was then rotated around the vertical centerline until the phone (horizontal line) was symmetrical with respect to the line NF.
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 Fig. 7.5)

### 7.5 Positioning for Ear / 15° Tilt

With the test device aligned in the "Cheek/Touch Position":

1. 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.
2. The phone was then rotated around the horizontal line by 15 degree.
3. 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 (see Figure 7.6).

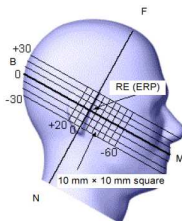


Figure 7.5 Side view/relevant markings

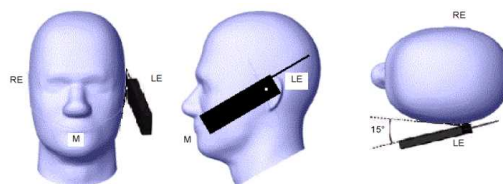


Figure 7.6 Front, Side and Top View of Ear/15° Position

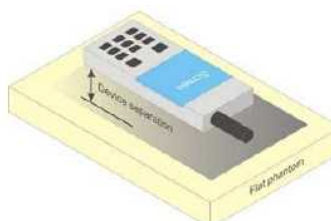


Figure 7.7 Sample Body-Worn Diagram

## 7.6 Body-Worn Accessory 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 Fig. 7.7). Per FCC KDB Publication 648474 D04v01, Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in FCC KDB Publication 447498 D01v05r02 should be used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode, when applicable. When the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is  $> 1.2 \text{ W/kg}$ , the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

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

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

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

## 7.7 Extremity Exposure Configurations

Devices that are designed or intended for use on extremities or mainly operated in extremity only exposure conditions; i.e., hands, wrists, feet and ankles, may require extremity SAR evaluation. When the device also operates in close proximity to the user's body, SAR compliance for the body is also required. The 1-g body and 10-g extremity SAR Exclusion Thresholds found in KDB Publication 447498 D01v05r02 should be applied to determine SAR test requirements.

Per KDB Publication 447498 D01v05r02, Cell phones (handsets) are not normally designed to be used on extremities or operated in extremity only exposure conditions. The maximum output power levels of handsets generally do not require extremity SAR testing to show compliance. Therefore, extremity SAR was not evaluated for this device.

## 7.8 Wireless Router Configurations

Some battery-operated handsets have the capability to transmit and receive user data through simultaneous transmission of WIFI simultaneously with a separate licensed transmitter. The FCC has provided guidance in FCC KDB Publication 941225 D06 v02 where SAR test considerations for handsets ( $L \times W \geq 9 \text{ cm} \times 5 \text{ cm}$ ) are based on a composite test separation distance of 10 mm from the front, back and edges of the device containing transmitting antennas within 2.5 cm of their edges, determined from general mixed use conditions for this type of devices. Since the hotspot SAR results may overlap with the body-worn accessory SAR requirements, the more conservative configurations can be considered, thus excluding some body-worn accessory SAR tests.

When the user enables the personal wireless router functions for the handset, actual operations include simultaneous transmission of both the WIFI transmitter and another licensed transmitter. Both transmitters often do not transmit at the same transmitting frequency and thus cannot be evaluated for SAR under actual use conditions due to the limitations of the SAR assessment probes. Therefore, SAR must be evaluated for each frequency transmission and mode separately and spatially summed with the WIFI transmitter according to FCC KDB Publication 447498 D01v05r02 publication procedures.

The "Portable Hotspot" feature on the handset was NOT activated during SAR assessments, to ensure the SAR measurements were evaluated for a single transmission frequency RF signal at a time.



## 8. 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 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 employment, which 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 8.1 SAR Human Exposure Specified in ANSI/IEEE C95.1-2005**

	HUMAN EXPOSURE LIMITS	
	General Public Exposure (W/kg) or (mW/g)	Occupational Exposure (W/kg) or (mW/g)
SPATIAL PEAK SAR * (Brain)	1.60	8.00
SPATIAL AVERAGE SAR ** (Whole Body)	0.08	0.40
SPATIAL PEAK SAR *** (Hands / Feet / Ankle / Wrist)	4.00	20.0

#### NOTES:

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

\*\* The Spatial Average value of the SAR averaged over the whole-body.

\*\*\* The Spatial Peak value of the SAR averaged over any 10 g of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

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

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

## 9. FCC Measurement Procedures

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Power measurements were performed using a base station simulator under digital average power.

### 9.1 Measured and Reported SAR

Per FCC KDB Publication 447498 D01v05r02, When SAR is not measured at the maximum power level allowed for production units, the results must be scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested to determine compliance. For simultaneous transmission, the measured aggregate SAR must be scaled according to the sum of the differences between the maximum tune-up tolerance and actual power used to test each transmitter. When SAR is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as reported SAR. The highest reported SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r02.

### 9.2 Procedures Used to Establish RF Signal for SAR

The following procedures are according to FCC KDB Publication 941225 D01v03 "SAR Measurement Procedures for 3G Devices" v02, October 2007.

The device was placed into a simulated call using a base station simulator in a RF shielded chamber. Establishing connections in this manner ensure a consistent means for testing SAR and are recommended for evaluating SAR [4].

Devices under test were evaluated prior to testing, with a fully charged battery and were configured to operate at maximum output power. In order to verify that the device was tested throughout the SAR test at maximum output power, the SAR measurement system measures a "point SAR" at an arbitrary reference point at the start and end of the 1 gram SAR evaluation, to assess for any power drifts during the evaluation. If the power drift deviated by more than 5%, the SAR test and drift measurements were repeated.

### 9.3 SAR Measurement Conditions for WCDMA(UMTS)

#### 9.3.1 Output Power Verification

Maximum output power is measured on the High, Middle and Low channels for each applicable transmission band according to the general descriptions in section 5.2 of 3GPP TS 34.121, using the appropriate RMC or AMR with TPC (transmit power control) set to all "1s".

Maximum output power is verified on the High, Middle and Low channels according to the general descriptions in section 5.2 of 3GPP TS 34.121 (release 5), using the appropriate RMC with TPC (transmit power control) set to all "1s" or applying the required inner loop power control procedures to maintain maximum output power while HSUPA is active.

Results for all applicable physical channel configurations (DPCCH, DPDCH and spreading codes, HS-DPCCH etc) are tabulated in this test report. All configurations that are not supported by the DUT or cannot be measured due to technical or equipment limitations are identified.

#### 9.3.2 Head SAR Measurements for Handsets

SAR for head exposure configurations is measured using the 12.2 kbps RMC with TPC bits configured to all "1s". SAR in AMR configurations is not required when the maximum average output of each RF channel for 12.2 kbps AMR is less than 0.25 dB higher than that measured in 2.2 kbps RMC. Otherwise, SAR is measured on the maximum output channel in 12.2 AMR with a 3.4 kbps SRB (signaling radio bearer) using the exposure configuration that resulted in the highest SAR for that RF channel in the 12.2 kbps RMC mode.

#### 9.3.3 Body SAR Measurements

SAR for body exposure configurations is measured using the 12.2 kbps RMC with the TPC bits all "1s".

### 9.3.4 SAR Measurements for Handsets with Rel 5 HSDPA

Body SAR for HSDPA is not required for handsets with HSDPA capabilities when the maximum average output power of each RF channel with HSDPA active is less than 0.25 dB higher than that measured without HSDPA using 12.2 kbps RMC and the maximum SAR for 12.2 kbps RMC is  $\leq 75\%$  of the SAR limit. Otherwise, SAR is measured for HSDPA, using an FRC with H-Set 1 in Sub-test 1 and a 12.2 kbps RMC configured in Test Loop Mode 1, using the highest body SAR configuration measured in 12.2 kbps RMC without HSDPA, on the maximum output channel with the body exposure configuration that resulted in the highest SAR in 12.2 kbps RMC mode for that RF channel. The H-set used in FRC for HSDPA should be configured according to the UE category of a test device.

The number of HS-DSCH/HSPDSCHs, HARQ processes, minimum inter-TTI interval, transport block sizes and RV coding sequence are defined by the applicable H-set. To maintain a consistent test configuration and stable transmission conditions, QPSK is used in the FRC for SAR testing.

HS-DPCCH should be configured with a CQI feedback cycle of 2 ms to maintain a constant rate of active CQI slots. DPCCH and DPDCH gain factors of  $\beta_c=9$  and  $\beta_d=15$ , and power offset parameters of  $\Delta_{ACK} = \Delta_{NACK} = 5$  and  $\Delta_{CQI}=2$  is used. The CQI value is determined by the UE category, transport block size, number of HS-PDSCHs and modulation used in the FRC.

Figure 9.1 Table C.10.1.4 of TS 234.121-1

Subtest	$\beta_c$	$\beta_d$	$\beta_d$ (SF)	$\beta_c / \beta_d$	$\beta_{HS}$ (Note 1, Note 2)	CM, dB (Note 3)	MPR, dB (Note 3)
1	2/15	15/15	64	2/15	4/15	0.0	0.0
2	12/15 (Note 4)	15/15 (Note 4)	64	12/15 (Note 4)	24/15	1.0	0.0
3	15/15	8/15	64	15/8	30/15	1.5	0.5
4	15/15	4/15	64	15/4	30/15	1.5	0.5

Notes:

- $\Delta_{ACK}$ ,  $\Delta_{NACK}$  and  $\Delta_{CQI} = 30/15$  with  $\beta_{HS} = 30/15 * \beta_c$ .
- For clauses 5.2C, 5.7A, 5.13.1A and 5.13.1AA,  $\Delta_{ACK}$  and  $\Delta_{NACK} = 30/15$  with  $\beta_{HS} = 30/15 * \beta_c$ , and  $\Delta_{CQI} = 24/15$  with  $\beta_{HS} = 24/15 * \beta_c$ .
- CM = 1 for  $\beta_c/\beta_d = 12/15$ ,  $\beta_{HS}/\beta_c = 24/15$ . For all other combinations of DPDCH, DPCCH and HS-DPCCH, the MPR is based on the relative CM difference. This is applicable for only UEs that support HSDPA in release 6 and later releases.
- For Subtest 2, the  $\beta_c/\beta_d$  ratio of 12/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 11/15$  and  $\beta_d = 15/15$ .

### 9.3.5 SAR Measurements for Handsets with Rel 6 HSUPA

Body SAR for HSUPA is not required when the maximum average output of each RF channel with HSUPA/HSDPA active is less than 0.25 dB higher than as measured without HSUPA/HSDPA using 12.2 kbps RMC and maximum SAR for 12.2 kbps RMC is  $\leq 75\%$  of the SAR limit. Otherwise SAR is measured on the maximum output channel for the body exposure configuration produced highest SAR in 12.2 kbps RMC for that RF channel, using the additional procedures under "Release 6 HSPA data devices" Head SAR for VOIP operations under HSPA is not required when maximum average output of each RF channel with HSPA is less than 0.25 dB higher than as measured using 12.2 kbps RMC. Otherwise SAR is measured using same HSPA configuration as used for body SAR.

Figure 9.2 Table C.11.1.3 of TS 234.121-1

Sub-test	$\beta_c$	$\beta_d$	$\beta_d$ (SF)	$\beta_c/\beta_d$	$\beta_{HS}$ (Note 1)	$\beta_{ec}$	$\beta_{ed}$ (Note 5, Note 6)	$\beta_{ed}$ (SF)	$\beta_{ed}$ (Codes)	CM (dB) (Note 2)	MPR (dB) (Note 2)	AG Index (Note 6)	E-TFCI
1	11/15 (Note 3)	15/15 (Note 3)	64	11/15 (Note 3)	22/15	209/ 225	1309/ 225	4	1	1.0	0.0	20	75
2	6/15	15/15	64	6/15	12/15	12/15	94/75	4	1	3.0	2.0	12	67
3	15/15	9/15	64	15/9	30/15	30/15	$\beta_{ec1}$ : 47/15 $\beta_{ec2}$ : 47/15	4 4	2	2.0	1.0	15	92
4	2/15	15/15	64	2/15	4/15	2/15	56/75	4	1	3.0	2.0	17	71
5	15/15 (Note 4)	15/15 (Note 4)	64	15/15 (Note 4)	30/15	24/15	134/ 15	4	1	1.0	0.0	21	81

Notes:

- $\Delta_{ACK}$ ,  $\Delta_{NACK}$  and  $\Delta_{CQI} = 30/15$  with  $\beta_{HS} = 30/15 * \beta_c$ .
- CM = 1 for  $\beta_c/\beta_d = 12/15$ ,  $\beta_{HS}/\beta_c = 24/15$ . For all other combinations of DPDCH, DPCCH, HS-DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference.
- For subtest 1 the  $\beta_c/\beta_d$  ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 10/15$  and  $\beta_d = 15/15$ .
- For subtest 5 the  $\beta_c/\beta_d$  ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 14/15$  and  $\beta_d = 15/15$ .
- In case of testing by UE using E-DPDCH Physical Layer category 1, Sub-test 3 is omitted according to TS25.306 Table 5.1g.
- $\beta_{ec}$  cannot be set directly, it is set by Absolute Grant Value.



#### **9.4 SAR Testing with 802.11 Transmitters**

Normal network operating configurations are not suitable for measuring the SAR of 802.11 a/b/g/n /ac transmitters. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure the results are consistent and reliable. See KDB Publication 248227 D01v01r02 for more details.

##### **9.4.1 General Device Setup**

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

##### **9.4.2 Frequency Channel Configurations**

For 2.4 GHz, the highest average RF output power channel between the low, mid and high channel at the lowest data rate was selected for SAR evaluation in 802.11b mode. 802.11g/n modes and higher data rates for 802.11b were additionally evaluated for SAR if the output power of the respective mode was 0.25 dB or higher than the powers of the SAR configurations tested in the 802.11b mode.

If the maximum extrapolated peak SAR of the zoom scan for the highest output channel was less than 1.6 W/kg and if the 1g averaged SAR was less than 0.8 W/kg, SAR testing was not required for the other test channels in the band.

## 10. RF Conducted Power

### 10.1 GSM Conducted Powers

Band	Channel	Frequency [MHz]	Voice GSM CS 1slot	Maximum Burst-Averaged Output Power [dBm]							
				GPRS/EDGE(GMSK)Data				EDGE(8-PSK)Data			
				GPRS 1 TX Slot	GPRS 2 TX Slot	GPRS 3 TX Slot	GPRS 4 TX Slot	EDGE 1 TX Slot	EDGE 2 TX Slot	EDGE 3 TX Slot	EDGE 4 TX Slot
GSM 850	128	824.2	<b>33.37</b>	33.37	32.24	30.11	28.79	N/A	N/A	N/A	N/A
	190	836.6	33.32	33.21	32.09	30.02	28.97	N/A	N/A	N/A	N/A
	251	848.8	33.27	33.18	32.16	30.21	28.96	N/A	N/A	N/A	N/A
GSM 1900	512	1850.2	<b>30.04</b>	30.03	29.87	28.21	27.04	N/A	N/A	N/A	N/A
	661	1880.0	29.95	29.94	29.82	28.29	27.01	N/A	N/A	N/A	N/A
	810	1909.8	29.73	29.71	29.64	28.05	26.81	N/A	N/A	N/A	N/A
Band	Channel	Frequency [MHz]	Voice GSM CS 1slot	Calculated Maximum Frame-Averaged Output Power [dBm]							
				GPRS/EDGE(GMSK)Data				EDGE(8-PSK)Data			
				GPRS 1 TX Slot	GPRS 2 TX Slot	GPRS 3 TX Slot	GPRS 4 TX Slot	EDGE 1 TX Slot	EDGE 2 TX Slot	EDGE 3 TX Slot	EDGE 4 TX Slot
GSM 850	128	824.2	24.34	24.34	<b>26.22</b>	25.85	25.78	N/A	N/A	N/A	N/A
	190	836.6	24.29	24.18	<b>26.07</b>	25.76	25.96	N/A	N/A	N/A	N/A
	251	848.8	24.24	24.15	<b>26.14</b>	25.95	25.95	N/A	N/A	N/A	N/A
GSM 1900	512	1850.2	21.01	21.00	23.85	23.95	<b>24.03</b>	N/A	N/A	N/A	N/A
	661	1880.0	20.92	20.91	23.80	24.03	<b>24.00</b>	N/A	N/A	N/A	N/A
	810	1909.8	20.70	20.68	23.62	23.79	<b>23.80</b>	N/A	N/A	N/A	N/A

Table 10.1 The power was measured by CMW500

Note:

- Both burst-averaged and calculated frame-averaged powers are included. Frame-averaged power was calculated from the measured burst-averaged power by converting the slot powers into linear units and calculating the energy over 8 timeslots.
- The bolded GPRS modes were selected according to the highest frame-averaged output power table according to KDB 941225 D03v01.
- GPRS/EDGE (GMSK) output powers were measured with coding scheme setting of 1 (CS1) on the base station simulator. CS1 was configured to measure GPRS output power measurements and SAR to ensure GMSK modulation in the signal. Our Investigation has shown that CS1 - CS4 settings do not have any impact on the output levels or modulation in the GPRS modes.
- This device does not support EDGE. (EDGE RX only)

GSM Class: B  
 GPRS Multislot class: 12 (max 4 TX Uplink slots)  
 DTM Multislot Class: N/A

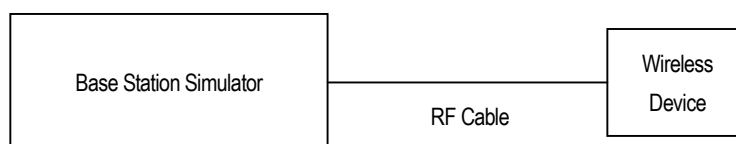


Figure 10.1 Power Measurement Setup

## 10.2 WCDMA Conducted Powers

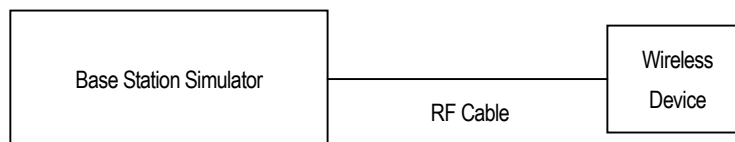
3GPP Release Version	Mode		Sub-Test	Cellular Band [dBm]			MPR	Bc	fd	Bc/fd
	Channel			4132	4183	4233				
	Frequency [MHz]			826.4	836.6	846.6				
99	W-CDMA	RMC	-	24.11	<u>24.45</u>	24.23	-	-	-	-
		AMR	-	23.93	24.37	24.17	-	-	-	-
5	HSDPA	1	1	23.01	23.36	23.09	0	2/15	15/15	2/15
5		2	2	21.62	21.96	21.86	0	12/15	15/15	12/15
5		3	3	20.67	21.01	20.81	0.5	15/15	8/15	15/8
5		4	4	20.56	20.89	20.71	0.5	15/15	4/15	15/4
6	HSUPA	1	1	22.20	22.68	22.38	0	11/15	15/15	11/15
6		2	2	21.21	21.61	21.49	2	6/15	15/15	6/15
6		3	3	21.70	21.79	21.65	1	15/15	9/15	15/9
6		4	4	21.73	22.07	22.37	2	2/15	15/15	2/15
6		5	5	22.99	23.09	22.83	0	15/15	15/15	15/15

**Table 10.2** The power was measured by CMW500

WCDMA SAR was tested under RMC 12.2 kbps with HSPA Inactive per KDB Publication 941225 D01v02r02.

HSPA SAR was not required since the average output power of the HSPA subtests was not more than 0.25 dB higher than the RMC level and SAR was less than 1.2 W/kg.

This device does not support DC-HSDPA.



**Figure 10.2** Power Measurement Setup

### 10.3 WLAN Conducted Powers

Mode	Frequency [MHz]	802.11b (2.4 GHz) Conducted Power [dBm]			
		Data Rate [Mbps]			
		1	2	5.5	11
802.11b	2412	<u>16.37</u>	16.36	16.35	16.34
	2437	15.49	15.48	15.47	15.45
	2462	16.01	16.00	16.00	15.99

Table 10.3 IEEE 802.11b Average RF Power

Mode	Frequency [MHz]	802.11g (2.4 GHz) Conducted Power [dBm]							
		Data Rate [Mbps]							
		6	9	12	18	24	36	48	54
802.11g	2412	<u>12.32</u>	12.31	12.31	12.30	12.27	12.29	11.22	11.23
	2437	11.34	11.33	11.33	11.32	11.31	11.32	10.27	10.26
	2462	11.87	11.86	11.86	11.85	11.85	11.84	10.82	10.81

Table 10.4 IEEE 802.11g Average RF Power

Mode	Frequency [MHz]	802.11n HT20 (2.4 GHz) Conducted Power [dBm]							
		Data Rate [Mbps]							
		0	1	2	3	4	5	6	7
802.11n (HT20)	2412	<u>12.34</u>	12.33	12.32	12.31	12.31	11.29	11.27	11.26
	2437	11.29	11.28	11.27	11.24	11.23	10.13	10.12	10.11
	2462	11.85	11.82	11.81	11.78	11.77	10.75	10.74	10.73

Table 10.5 IEEE 802.11n Average RF Power

Justification for reduced test configurations for WIFI channels per KDB Publication 248227 D01v01r02 and October 2012 / April 2013 FCC/TCB Meeting Notes:

- For 2.4 GHz, highest average RF output power channel for the lowest data rate for IEEE 802.11b were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11g/n) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11b mode.
- When the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is <1.6 W/kg and the reported 1g averaged SAR is <0.8 W/kg, SAR testing on other channels is not required. Otherwise, the other default (or corresponding required) test channels were additionally tested using the lowest data rate.
- The underlined data rate and channel above were tested for SAR.

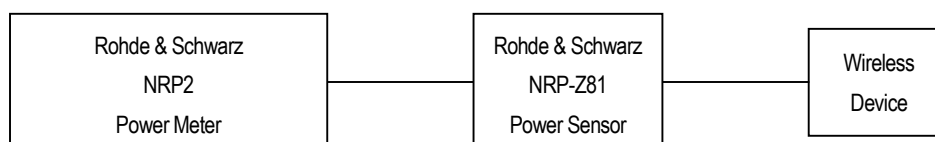


Figure 10.3 Power Measurement Setup for Bandwidths &lt; 50 MHz

## 10.4 Bluetooth Conducted Powers

Mode	Frequency [MHz]	Output Power [1Mbps]		Output Power [2Mbps]		Output Power [3Mbps]	
		[dBm]	[mW]	[dBm]	[mW]	[dBm]	[mW]
Low	2402	8.080	6.427	5.790	3.793	5.800	3.802
Mid	2441	6.760	4.742	4.480	2.805	4.490	2.812
High	2480	<b>8.260</b>	<b>6.699</b>	5.930	3.917	5.940	3.926

Table 10.6 Bluetooth Average RF Power

Mode	Frequency [MHz]	Output Power [LE]	
		[dBm]	[mW]
Low	2402	<b>-5.330</b>	<b>0.293</b>
Mid	2440	-6.920	0.203
High	2480	-6.900	0.204

Table 10.7 Bluetooth Average RF Power

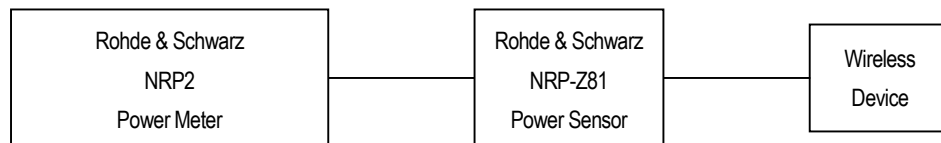


Figure 10.4 Power Measurement Setup



## 11. System Verification

### 11.1 Tissue verification

MEASURED TISSUE PARAMETERS										
Date(s)	Tissue Type	Ambient Temp. [°C]	Liquid Temp. [°C]	Measured Frequency [MHz]	Target Dielectric constant, $\epsilon_r$	Target Conductivity, $\sigma$ [S/m]	Measured Dielectric constant, $\epsilon_r$	Measured Conductivity, $\sigma$ [S/m]	$\epsilon_r$ Deviation [%]	$\sigma$ Deviation [%]
Sep. 17, 2014	835 Head	22.0	23.0	824.2	41.603	0.910	41.67	0.912	0.16	0.23
				826.4	41.589	0.910	41.66	0.916	0.17	0.68
				835.0	41.523	0.910	41.60	0.925	0.19	1.62
				836.6	41.511	0.910	41.58	0.928	0.17	1.95
				846.6	41.500	0.917	41.42	0.936	-0.19	2.02
				848.8	41.500	0.919	41.42	0.939	-0.19	2.13
Sep. 18, 2014	835 Body	22.8	22.8	824.2	55.203	0.980	54.53	0.996	-1.22	1.70
				826.4	55.200	0.980	54.50	0.998	-1.27	1.81
				835.0	55.200	0.980	54.40	1.008	-1.44	2.86
				836.6	55.200	0.980	54.39	1.008	-1.47	2.86
				846.6	55.200	0.987	54.31	1.020	-1.61	3.34
				848.8	55.200	0.989	54.36	1.020	-1.52	3.13
Sep. 18, 2014	835 Head	22.4	22.7	824.2	41.603	0.910	40.87	0.897	-1.76	-1.44
				826.4	41.589	0.910	40.90	0.897	-1.66	-1.46
				835.0	41.523	0.910	40.72	0.906	-1.95	-0.47
				836.6	41.511	0.910	40.76	0.909	-1.80	-0.11
				846.6	41.500	0.917	40.60	0.916	-2.17	-0.09
				848.8	41.500	0.919	40.63	0.919	-2.10	-0.03
Sep. 19, 2014	835 Body	23.8	22.7	824.2	55.203	0.980	55.20	1.005	-0.01	2.58
				826.4	55.200	0.980	55.15	1.004	-0.09	2.45
				835.0	55.200	0.980	55.01	1.015	-0.34	3.57
				836.6	55.200	0.980	55.09	1.018	-0.20	3.88
				846.6	55.200	0.987	54.86	1.026	-0.62	3.95
				848.8	55.200	0.989	54.90	1.024	-0.54	3.54
Sep. 22, 2014	835 Body	22.9	23.1	824.2	55.203	0.980	54.25	1.000	-1.73	2.02
				826.4	55.200	0.980	54.16	1.001	-1.88	2.14
				835.0	55.200	0.980	54.10	1.010	-2.00	3.06
				836.6	55.200	0.980	54.19	1.011	-1.84	3.16
				846.6	55.200	0.987	54.05	1.023	-2.08	3.65
				848.8	55.200	0.989	53.99	1.025	-2.20	3.64
Oct. 28, 2014	835 Head	23.7	23.5	824.2	41.603	0.910	42.35	0.900	1.80	-1.15
				826.4	41.589	0.910	42.34	0.900	1.81	-1.11
				835.0	41.523	0.910	42.20	0.911	1.63	0.05
				836.6	41.511	0.910	42.22	0.910	1.71	0.02
				846.6	41.500	0.917	42.02	0.920	1.25	0.35
				848.8	41.500	0.919	42.05	0.925	1.33	0.66
Oct. 29, 2014	835 Body	23.9	23.2	824.2	55.203	0.980	54.95	1.008	-0.46	2.89
				826.4	55.200	0.980	54.94	1.009	-0.47	2.96
				835.0	55.200	0.980	54.85	1.019	-0.63	3.98
				836.6	55.200	0.980	54.81	1.021	-0.71	4.18
				846.6	55.200	0.987	54.69	1.030	-0.92	4.36
				848.8	55.200	0.989	54.74	1.034	-0.83	4.55

MEASURED TISSUE PARAMETERS										
Date(s)	Tissue Type	Ambient Temp. [°C]	Liquid Temp. [°C]	Measured Frequency [MHz]	Target Dielectric constant, $\epsilon_r$	Target Conductivity, $\sigma$ [S/m]	Measured Dielectric constant, $\epsilon_r$	Measured Conductivity, $\sigma$ [S/m]	$\epsilon_r$ Deviation [%]	$\sigma$ Deviation [%]
Sep. 23, 2014	1900 Body	23.3	23.1	1850.2	53.300	1.520	52.56	1.468	-1.39	-3.42
				1880.0	53.300	1.520	52.45	1.504	-1.59	-1.05
				1900.0	53.300	1.520	52.32	1.522	-1.85	0.13
				1909.8	53.300	1.520	52.32	1.536	-1.84	1.05
Sep. 24, 2014	1900 Head	23.3	23.0	1850.2	40.000	1.400	39.71	1.364	-0.72	-2.57
				1880.0	40.000	1.400	39.61	1.388	-0.97	-0.86
				1900.0	40.000	1.400	39.52	1.407	-1.20	0.50
				1909.8	40.000	1.400	39.43	1.418	-1.43	1.29
Sep. 25, 2014	1900 Head	23.2	22.7	1850.2	40.000	1.400	39.18	1.348	-2.05	-3.71
				1880.0	40.000	1.400	39.04	1.376	-2.40	-1.71
				1900.0	40.000	1.400	38.98	1.397	-2.56	-0.21
				1909.8	40.000	1.400	38.92	1.408	-2.70	0.57
Sep. 26, 2014	1900 Body	23.7	21.5	1850.2	53.300	1.520	53.36	1.495	0.11	-1.64
				1880.0	53.300	1.520	53.21	1.533	-0.17	0.86
				1900.0	53.300	1.520	53.19	1.548	-0.21	1.84
				1909.8	53.300	1.520	53.10	1.562	-0.38	2.76
Sep. 27, 2014	1900 Body	22.8	22.3	1850.2	53.300	1.520	51.99	1.489	-2.46	-2.04
				1880.0	53.300	1.520	51.89	1.528	-2.64	0.53
				1900.0	53.300	1.520	51.84	1.546	-2.74	1.71
				1909.8	53.300	1.520	51.77	1.563	-2.87	2.83
Oct. 30, 2014	1900 Head	23.4	23.1	1850.2	40.000	1.400	39.44	1.362	-1.40	-2.71
				1880.0	40.000	1.400	39.31	1.388	-1.72	-0.86
				1900.0	40.000	1.400	39.26	1.409	-1.85	0.64
				1909.8	40.000	1.400	39.18	1.412	-2.05	0.86
Sep. 16, 2014	2450 Head	22.9	22.6	2412	39.252	1.770	39.01	1.809	-0.62	2.20
				2437	39.200	1.790	38.89	1.834	-0.79	2.46
				2450	39.200	1.800	38.84	1.851	-0.92	2.83
				2462	39.200	1.814	38.80	1.866	-1.02	2.87
Sep. 17, 2014	2450 Body	23.6	22.0	2412	52.752	1.914	52.45	1.931	-0.57	0.89
				2437	52.700	1.940	52.34	1.961	-0.68	1.08
				2450	52.700	1.950	52.29	1.982	-0.78	1.64
				2462	52.700	1.969	52.25	1.999	-0.85	1.52

### Tissue Verification Note

Note: The above measured tissue parameters were used in the DASY software. The DASY software was used to perform interpolation to determine the dielectric parameters at the SAR test device frequencies (per IEEE 1528 6.6.1.2). The tissue parameters listed in the SAR test plots may slightly differ from the table above due to significant digit rounding in the software.

### Measurement Procedure for Tissue verification

- 1) The network analyzer and probe system was configured and calibrated.
- 2) The probe was immersed in the sample which was placed in a nonmetallic container. Trapped air bubbles beneath the flange were minimized by placing the probe at a slight angle.
- 3) The complex admittance with respect to the probe aperture was measured.
- 4) The complex relative permittivity, for example from the below equation (Poumaropoulos and Misra):

$$Y = \frac{j2\omega\epsilon'_r \epsilon_0}{[\ln(b/a)]^2} \int_a^b \int_a^b \int_0^\pi \cos \phi' \frac{\exp\left[-j\omega(\epsilon_0\epsilon'_r \epsilon_0)^{1/2} r\right]}{r} d\phi' d\rho' d\rho$$

Where Y is the admittance of the probe in contact with the sample, the primed and unprimed coordinates refer to source and observation points, respectively,  $r^2 = \rho'^2 + \rho^2 - 2\rho\rho' \cos \phi'$ ,  $\omega$  is the angular frequency, and  $j = \sqrt{-1}$ .

## 11.2 Test system verification

Prior to assessment, the system is verified to the  $\pm 10\%$  of the specifications at 835 MHz, 1900 MHz, 2450 MHz by using the SAR Dipole kit(s). (Graphic Plots Attached)

SYSTEM DIPOLE VERIFICATION TARGET & MEASURED											
Freq. [MHz]	SAR Dipole Kits	Date(s)	Liquid	Ambient Temp.[°C]	Liquid Temp.[°C]	Probe S/N	Input Power [mW]	1W Targeted SAR 1g [W/kg]	Measured SAR 1g [W/kg]	1W Normalized SAR 1g [W/kg]	Deviation [%]
835	D835V2, S/N: 4d163	Sep. 17, 2014	Head	22.0	23.0	3957	250	9.45	2.51	10.04	6.24
835	D835V2, S/N: 4d163	Sep. 18, 2014	Body	22.3	21.1	3957	250	9.43	2.54	10.16	7.74
835	D835V2, S/N: 4d163	Sep. 18, 2014	Head	22.4	22.7	3957	250	9.45	2.49	9.96	5.40
835	D835V2, S/N: 4d163	Sep. 19, 2014	Body	23.8	22.7	3957	250	9.43	2.46	9.84	4.35
835	D835V2, S/N: 4d163	Sep. 22, 2014	Body	22.9	23.1	3957	250	9.43	2.43	9.72	3.08
835	D835V2, S/N: 4d163	Oct. 28, 2014	Head	22.4	22.7	3957	250	9.45	2.50	10.00	5.82
835	D835V2, S/N: 4d163	Oct. 29, 2014	Body	23.9	22.8	3957	250	9.43	2.44	9.76	3.50
1900	D1900V2, S/N: 5d183	Sep. 23, 2014	Body	23.3	23.1	3957	250	40.6	9.78	39.12	-3.65
1900	D1900V2, S/N: 5d183	Sep. 24, 2014	Head	23.3	23.0	3957	250	40.5	9.58	38.32	-5.38
1900	D1900V2, S/N: 5d183	Sep. 25, 2014	Head	23.2	22.7	3957	250	40.5	9.63	38.52	-4.89
1900	D1900V2, S/N: 5d183	Sep. 26, 2014	Body	23.7	21.5	3957	250	40.6	9.96	39.84	-1.87
1900	D1900V2, S/N: 5d183	Sep. 27, 2014	Body	22.8	22.3	3957	250	40.6	9.89	39.56	-2.56
1900	D1900V2, S/N: 5d183	Oct. 30, 2014	Head	23.4	23.1	3957	250	40.6	9.75	39.00	-3.94
2450	D2450V2, S/N: 925	Sep. 16, 2014	Head	22.9	22.6	3957	250	52.8	13.10	52.40	-0.76
2450	D2450V2, S/N: 925	Sep. 17, 2014	Body	23.8	22.0	3957	250	50.6	13.10	52.40	3.56

Note1 : Validation was measured with input 250 mW, 100 mW and normalized to 1W.

Note2 : To confirm the proper SAR liquid depth, the z-axis plots from the system verifications were included since the system verifications were performed using the same liquid, probe and DAE as the SAR tests in the same time period.

Note3: Full system validation status and results can be found in Attachment 3.

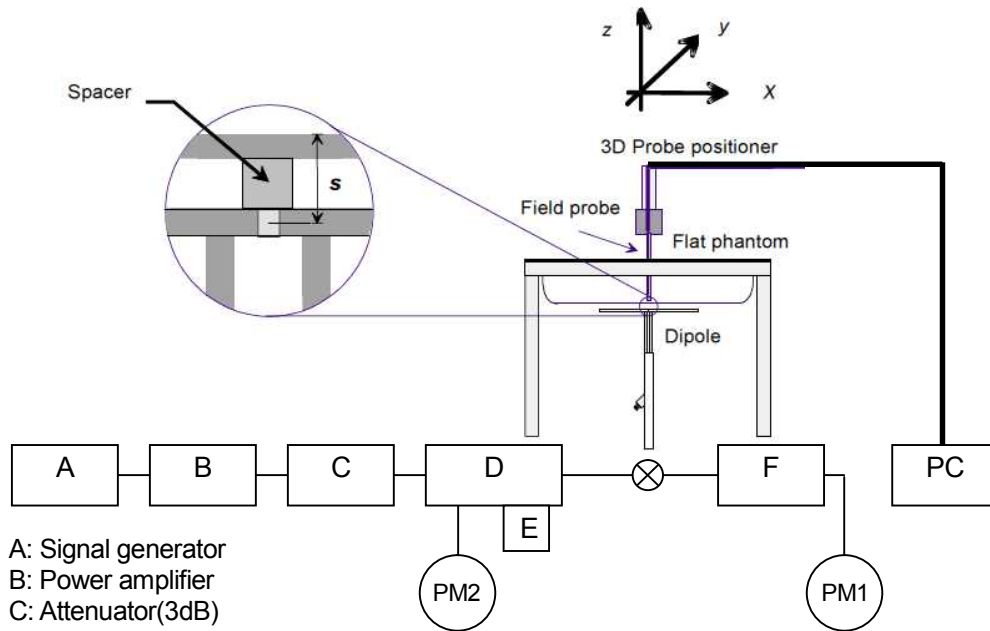


Figure10.1 Dipole Verification Test Setup

- A: Signal generator
- B: Power amplifier
- C: Attenuator(3dB)
- D: Directional coupler
- E: Terminator(50  $\Omega$ )
- F: Attenuator(10dB)
- PM1: Power sensor A
- PM2: Power sensor B



## 12. SAR Test Results

### 12.1 Head SAR Results

MEASUREMENT RESULTS														
Frequency		Mode/ Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Drift Power [dB]	Phantom Position	Device Serial Number	# of Time slots	Duty Cycle	1g SAR [W/kg]	Scaling Factor	1g Scaled SAR [W/kg]	Plot No.
MHz	Ch													
836.6	190	GSM850	GSM	33.5	33.32	-0.16	Left Touch	FCC #1	1	1:8.3	0.389	1.042	0.405	1
836.6	190	GSM850	GSM	33.5	33.32	-0.03	Right Touch	FCC #1	1	1:8.3	0.431	1.042	<b>0.449</b>	2
836.6	190	GSM850	GSM	33.5	33.32	0.00	Left Tilt	FCC #1	1	1:8.3	0.333	1.042	0.347	3
836.6	190	GSM850	GSM	33.5	33.32	0.14	Right Tilt	FCC #1	1	1:8.3	0.381	1.042	0.397	4
836.6	190	GSM850	GPRS	33.5	33.21	0.00	Right Touch	FCC #1	1	1:8.3	0.416	1.069	0.445	5
836.6	190	GSM850	GPRS	32.5	32.09	-0.05	Right Touch	FCC #1	2	1:4.2	0.673	1.099	0.740	6
836.6	190	GSM850	GPRS	30.5	30.02	-0.16	Right Touch	FCC #1	3	1:2.8	0.673	1.117	<b>0.752</b>	7
836.6	190	GSM850	GPRS	29.0	28.97	-0.19	Right Touch	FCC #1	4	1:2.1	0.596	1.007	0.600	8
836.6	190	GSM850	GPRS	32.5	32.09	0.11	Left Touch	FCC #1	2	1:4.2	0.567	1.099	0.623	9
836.6	190	GSM850	GPRS	32.5	32.09	0.07	Left Tilt	FCC #1	2	1:4.2	0.388	1.099	0.426	10
836.6	190	GSM850	GPRS	32.5	32.09	0.01	Right Tilt	FCC #1	2	1:4.2	0.373	1.099	0.410	11
ANSI / IEEE C95.1-2005- SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure							Head 1.6 W/kg(mW/g) averaged over 1 gram							

Table 12.1 GSM/GPRS 850 Head SAR



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MEASUREMENT RESULTS														
Frequency		Mode/ Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Drift Power [dB]	Phantom Position	Device Serial Number	# of Time slots	Duty Cycle	1g SAR [W/kg]	Scaling Factor	1g Scaled SAR [W/kg]	Plot No.
MHz	Ch													
1880.0	661	PCS1900	PCS	30.5	29.95	-0.13	Left Touch	FCC #1	1	1.8.3	0.326	1.135	0.370	12
1880.0	661	PCS1900	PCS	30.5	29.95	0.08	Right Touch	FCC #1	1	1.8.3	0.517	1.135	<b>0.587</b>	13
1880.0	661	PCS1900	PCS	30.5	29.95	0.14	Left Tilt	FCC #1	1	1.8.3	0.142	1.135	0.161	14
1880.0	661	PCS1900	PCS	30.5	29.95	0.01	Right Tilt	FCC #1	1	1.8.3	0.161	1.135	0.183	15
1880.0	661	PCS1900	GPRS	30.5	29.94	-0.04	Right Touch	FCC #1	1	1.8.3	0.475	1.138	0.540	16
1850.2	512	PCS1900	GPRS	30.0	29.87	0.13	Right Touch	FCC #1	2	1.4.2	0.806	1.030	0.830	17
1880.0	661	PCS1900	GPRS	30.0	29.82	0.01	Right Touch	FCC #1	2	1.4.2	0.975	1.042	1.016	18
1909.8	810	PCS1900	GPRS	30.0	29.64	0.19	Right Touch	FCC #1	2	1.4.2	0.920	1.086	1.000	19
1850.2	512	PCS1900	GPRS	28.5	28.21	-0.07	Right Touch	FCC #1	3	1.2.8	0.976	1.069	1.043	20
1880.0	661	PCS1900	GPRS	28.5	28.29	0.13	Right Touch	FCC #1	3	1.2.8	0.986	1.050	1.035	21
1909.8	810	PCS1900	GPRS	28.5	28.05	-0.02	Right Touch	FCC #1	3	1.2.8	0.898	1.109	0.996	22
1850.2	512	PCS1900	GPRS	27.5	27.04	0.01	Right Touch	FCC #1	4	1.2.1	0.979	1.112	1.088	23
1880.0	661	PCS1900	GPRS	27.5	27.01	0.02	Right Touch	FCC #1	4	1.2.1	1.000	1.119	<b>1.119</b>	24
1909.8	810	PCS1900	GPRS	27.5	26.81	0.18	Right Touch	FCC #1	4	1.2.1	0.947	1.172	1.110	25
1880.0	661	PCS1900	GPRS	27.5	27.01	-0.09	Left Touch	FCC #1	4	1.2.1	0.606	1.119	0.678	26
1880.0	661	PCS1900	GPRS	27.5	27.01	-0.01	Left Tilt	FCC #1	4	1.2.1	0.235	1.119	0.263	27
1880.0	661	PCS1900	GPRS	27.5	27.01	0.01	Right Tilt	FCC #1	4	1.2.1	0.311	1.119	0.348	28
1880.0	661	PCS1900	GPRS	27.5	27.01	-0.02	Right Touch	FCC #1	4	1.2.1	1.000	1.119	1.119	85
ANSI / IEEE C95.1-2005- SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure							Head 1.6 W/kg(mW/g) averaged over 1 gram							

Table 12.2 PCS/GPRS 1900 Head SAR

Note: Blue entries represent repeatability measurements.



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MEASUREMENT RESULTS													
Frequency		Mode/ Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Drift Power [dB]	Phantom Position	Device Serial Number	Duty Cycle	1g SAR [W/kg]	Scaling Factor	1g Scaled SAR [W/kg]	Plot No.
MHz	Ch												
836.6	4183	WCDMA850	RMC	24.5	24.45	-0.12	Left Touch	FCC #1	1:1	0.4	1.002	0.401	29
836.6	4183	WCDMA850	RMC	24.5	24.45	-0.17	Right Touch	FCC #1	1:1	0.418	1.002	<b>0.419</b>	30
836.6	4183	WCDMA850	RMC	24.5	24.45	0.06	Left Tilt	FCC #1	1:1	0.338	1.002	0.339	31
836.6	4183	WCDMA850	RMC	24.5	24.45	0.01	Right Tilt	FCC #1	1:1	0.35	1.002	0.351	32
ANSI / IEEE C95.1-2005- SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure							Head 1.6 W/kg(mW/g) averaged over 1 gram						

Table 12.3 WCDMA 850 Head SAR



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MEASUREMENT RESULTS														
Frequency		Mode/ Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Drift Power [dB]	Phantom Position	Device Serial Number	Data Rate [Mbps]	Duty Cycle	1g SAR [W/kg]	Scaling Factor	1g Scaled SAR [W/kg]	Plot No.
MHz	Ch													
2462	11	802.11b	DSSS	16.9	16.01	0.15	Left Touch	FCC #1	1	1:1	0.175	1.227	<b>0.215</b>	33
2462	11	802.11b	DSSS	16.9	16.01	0.16	Right Touch	FCC #1	1	1:1	0.0698	1.227	0.0857	34
2462	11	802.11b	DSSS	16.9	16.01	0.04	Left Tilt	FCC #1	1	1:1	0.0441	1.227	0.0541	35
2462	11	802.11b	DSSS	16.9	16.01	0.19	Right Tilt	FCC #1	1	1:1	0.0336	1.227	0.0412	36
ANSI / IEEE C95.1-2005– SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure							Head 1.6 W/kg(mW/g) averaged over 1 gram							

Table 12.4 DTS Head SAR



## 12.2 Standalone Body-Worn SAR Results

MEASUREMENT RESULTS														
Frequency		Mode/ Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Drift Power [dB]	Spacing [Side]	Device Serial Number	# of Time slots	Duty Cycle	1g SAR [W/kg]	Scaling Factor	1g Scaled SAR [W/kg]	Plot No.
MHz	Ch													
836.6	190	GSM850	GSM	33.5	33.32	-0.18	10mm [Front]	FCC #1	1	1:8.3	0.446	1.042	0.465	37
836.6	190	GSM850	GSM	33.5	33.32	-0.09	10mm [Rear]	FCC #1	1	1:8.3	0.635	1.042	<b>0.662</b>	38
824.2	128	GSM850	GPRS	32.5	32.24	0.13	10mm [Front]	FCC #1	2	1:4.2	0.643	1.062	0.683	39
836.6	190	GSM850	GPRS	32.5	32.09	0.03	10mm [Front]	FCC #1	2	1:4.2	0.741	1.099	0.814	40
848.8	251	GSM850	GPRS	32.5	32.16	-0.17	10mm [Front]	FCC #1	2	1:4.2	0.67	1.081	0.725	41
824.2	128	GSM850	GPRS	32.5	32.24	-0.04	10mm [Rear]	FCC #1	2	1:4.2	0.969	1.062	1.029	42
836.6	190	GSM850	GPRS	32.5	32.09	-0.08	10mm [Rear]	FCC #1	2	1:4.2	1.01	1.099	1.110	43
848.8	251	GSM850	GPRS	32.5	32.16	0.05	10mm [Rear]	FCC #1	2	1:4.2	0.905	1.081	0.979	44
824.2	128	GSM850	GPRS	30.5	30.11	-0.06	10mm [Front]	FCC #1	3	1:2.8	0.717	1.094	0.784	82
836.6	190	GSM850	GPRS	30.5	30.02	-0.04	10mm [Front]	FCC #1	3	1:2.8	0.77	1.117	0.860	83
848.8	251	GSM850	GPRS	30.5	30.21	0.05	10mm [Front]	FCC #1	3	1:2.8	0.713	1.069	0.762	84
824.2	128	GSM850	GPRS	30.5	30.11	0.01	10mm [Rear]	FCC #1	3	1:2.8	1.1	1.094	1.203	47
836.6	190	GSM850	GPRS	30.5	30.02	-0.13	10mm [Rear]	FCC #1	3	1:2.8	1.15	1.117	<b>1.284</b>	48
848.8	251	GSM850	GPRS	30.5	30.21	-0.04	10mm [Rear]	FCC #1	3	1:2.8	1.01	1.069	1.080	49
1880.0	661	PCS1900	PCS	30.5	29.95	0.11	10mm [Front]	FCC #1	1	1:8.3	0.286	1.135	<b>0.325</b>	59
1880.0	661	PCS1900	PCS	30.5	29.95	0.18	10mm [Rear]	FCC #1	1	1:8.3	0.281	1.135	0.319	60
1880.0	661	PCS1900	GPRS	27.5	27.01	0.02	10mm [Front]	FCC #1	4	1:2.1	0.552	1.119	0.618	61
1880.0	661	PCS1900	GPRS	27.5	27.01	0.02	10mm [Rear]	FCC #1	4	1:2.1	0.613	1.119	<b>0.686</b>	62
836.6	4183	WCDMA850	RMC	24.5	24.45	-0.19	10mm [Front]	FCC #1	N/A	1:1	0.565	1.012	0.572	71
826.4	4132	WCDMA850	RMC	24.5	24.11	-0.07	10mm [Rear]	FCC #1	N/A	1:1	0.68	1.094	0.744	72
836.6	4183	WCDMA850	RMC	24.5	24.45	0.14	10mm [Rear]	FCC #1	N/A	1:1	0.795	1.012	<b>0.804</b>	73
846.6	4233	WCDMA850	RMC	24.5	24.23	-0.06	10mm [Rear]	FCC #1	N/A	1:1	0.717	1.064	0.763	74
ANSI / IEEE C95.1-2005– SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure							Head 1.6 W/kg(mW/g) averaged over 1 gram							

Table 12.5 GSM/PCS/WCDMA Body-Worn SAR



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MEASUREMENT RESULTS														
Frequency		Mode/ Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Drift Power [dB]	Spacing [Side]	Device Serial Number	Data Rate [Mbps]	Duty Cycle	1g SAR [W/kg]	Scaling Factor	1g Scaled SAR [W/kg]	Plot No.
MHz	Ch													
2462	11	802.11b	DSSS	16.9	16.01	0.20	10mm [Front]	FCC #1	1	1:1	0.0372	1.227	0.0457	79
2462	11	802.11b	DSSS	16.9	16.01	0.03	10mm [Rear]	FCC #1	1	1:1	0.207	1.227	<b>0.254</b>	80
ANSI / IEEE C95.1-2005– SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure							Head 1.6 W/kg(mW/g) averaged over 1 gram							

Table 12.6 DTS Body-Worn SAR

### 12.3 Standalone Wireless router SAR Results

MEASUREMENT RESULTS														
Frequency		Mode/ Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Drift Power [dB]	Spacing [Side]	Device Serial Number	# of Time slots	Duty Cycle	1g SAR [W/kg]	Scaling Factor	1g Scaled SAR [W/kg]	Plot No.
MHz	Ch													
836.6	190	GSM850	GPRS	32.5	32.09	0.17	10mm [Bottom]	FCC #1	2	1:4.2	0.156	1.099	0.171	45
836.6	190	GSM850	GPRS	30.5	30.02	-0.04	10mm [Front]	FCC #1	3	1:2.8	0.77	1.117	0.860	83
836.6	190	GSM850	GPRS	33.5	33.21	-0.11	10mm [Rear]	FCC #1	1	1:8.3	0.711	1.069	0.760	46
824.2	128	GSM850	GPRS	32.5	32.24	-0.04	10mm [Rear]	FCC #1	2	1:4.2	0.969	1.062	1.029	42
836.6	190	GSM850	GPRS	32.5	32.09	-0.08	10mm [Rear]	FCC #1	2	1:4.2	1.01	1.099	1.110	43
848.8	251	GSM850	GPRS	32.5	32.16	0.05	10mm [Rear]	FCC #1	2	1:4.2	0.905	1.081	0.979	44
824.2	128	GSM850	GPRS	30.5	30.11	0.01	10mm [Rear]	FCC #1	3	1:2.8	1.1	1.094	1.203	47
836.6	190	GSM850	GPRS	30.5	30.02	-0.13	10mm [Rear]	FCC #1	3	1:2.8	1.15	1.117	<b>1.284</b>	48
848.8	251	GSM850	GPRS	30.5	30.21	-0.04	10mm [Rear]	FCC #1	3	1:2.8	1.01	1.069	1.080	49
824.2	128	GSM850	GPRS	29.0	28.79	0.17	10mm [Rear]	FCC #1	4	1:2.1	0.993	1.050	1.042	50
836.6	190	GSM850	GPRS	29.0	28.97	0.04	10mm [Rear]	FCC #1	4	1:2.1	1.17	1.007	1.178	51
848.8	251	GSM850	GPRS	29.0	28.96	0.10	10mm [Rear]	FCC #1	4	1:2.1	1.03	1.009	1.040	52
836.6	190	GSM850	GPRS	32.5	32.09	-0.13	10mm [Right]	FCC #1	2	1:4.2	0.63	1.099	0.692	53
824.2	128	GSM850	GPRS	32.5	32.24	0.09	10mm [Left]	FCC #1	2	1:4.2	0.726	1.062	0.771	54
836.6	190	GSM850	GPRS	32.5	32.09	0.09	10mm [Left]	FCC #1	2	1:4.2	0.798	1.099	0.877	55
848.8	251	GSM850	GPRS	32.5	32.16	-0.02	10mm [Left]	FCC #1	2	1:4.2	0.77	1.081	0.833	56
836.6	190	GSM850	GPRS	32.5	32.09	0.01	10mm [Rear]	FCC #1	2	1:4.2	1.1	1.099	1.209	57
836.6	190	GSM850	GPRS	30.5	30.02	0.13	10mm [Rear]	FCC #1	3	1:2.8	1.13	1.099	1.242	58
ANSI / IEEE C95.1-2005- SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure							Head 1.6 W/kg(mW/g) averaged over 1 gram							

Table 12.7 GSM850 GPRS Hotspot SAR

Note: Yellow entries represent measurements with connected earphone cable. / Blue entries represent repeatability measurements.



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MEASUREMENT RESULTS														
Frequency		Mode/ Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Drift Power [dB]	Spacing [Side]	Device Serial Number	# of Time slots	Duty Cycle	1g SAR [W/kg]	Scaling Factor	1g Scaled SAR [W/kg]	Plot No.
MHz	Ch													
1880.0	661	PCS1900	GPRS	27.5	27.01	-0.09	10mm [Bottom]	FCC #1	4	1:2.1	0.456	1.119	0.510	63
1880.0	661	PCS1900	GPRS	27.5	27.01	0.02	10mm [Front]	FCC #1	4	1:2.1	0.552	1.119	0.618	61
1880.0	661	PCS1900	GPRS	30.5	29.94	0.12	10mm [Rear]	FCC #1	1	1:8.3	0.264	1.138	0.300	64
1880.0	661	PCS1900	GPRS	30.0	29.82	0.01	10mm [Rear]	FCC #1	2	1:4.2	0.572	1.042	0.596	65
1880.0	661	PCS1900	GPRS	28.5	28.29	0.13	10mm [Rear]	FCC #1	3	1:2.8	0.576	1.050	0.605	66
1880.0	661	PCS1900	GPRS	27.5	27.01	0.03	10mm [Rear]	FCC #1	4	1:2.1	0.613	1.119	<b>0.686</b>	62
1880.0	661	PCS1900	GPRS	27.5	27.01	-0.06	10mm [Right]	FCC #1	4	1:2.1	0.426	1.119	0.477	67
1880.0	661	PCS1900	GPRS	27.5	27.01	-0.04	10mm [Left]	FCC #1	4	1:2.1	0.113	1.119	0.126	68
1850.2	512	PCS1900	GPRS	27.5	27.01	0.01	10mm [Rear]	FCC #1	4	1:2.1	0.580	1.119	0.649	69
1880.0	661	PCS1900	GPRS	27.5	27.01	0.06	10mm [Rear]	FCC #1	4	1:2.1	0.610	1.119	0.683	70
ANSI / IEEE C95.1-2005- SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure							Head 1.6 W/kg(mW/g) averaged over 1 gram							

Table 12.8 PCS1900 GPRS Hotspot SAR

Note: Yellow entries represent measurements with connected earphone cable. / Blue entries represent repeatability measurements.



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MEASUREMENT RESULTS														
Frequency		Mode/ Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Drift Power [dB]	Spacing [Side]	Device Serial Number	# of Time slots	Duty Cycle	1g SAR [W/kg]	Scaling Factor	1g Scaled SAR [W/kg]	Plot No.
MHz	Ch													
836.6	4183	WCDMA850	RMC	24.5	24.45	0.08	10mm [Bottom]	FCC#1	N/A	1:1	0.124	1.012	0.125	75
836.6	4183	WCDMA850	RMC	24.5	24.45	-0.19	10mm [Front]	FCC#1	N/A	1:1	0.565	1.012	0.572	71
826.4	4132	WCDMA850	RMC	24.5	24.11	-0.07	10mm [Rear]	FCC#1	N/A	1:1	0.68	1.094	0.744	72
836.6	4183	WCDMA850	RMC	24.5	24.45	0.14	10mm [Rear]	FCC#1	N/A	1:1	0.795	1.012	<b>0.804</b>	73
846.6	4233	WCDMA850	RMC	24.5	24.23	-0.06	10mm [Rear]	FCC#1	N/A	1:1	0.717	1.064	0.763	74
836.6	4183	WCDMA850	RMC	24.5	24.45	0.05	10mm [Right]	FCC#1	N/A	1:1	0.584	1.012	0.591	76
836.6	4183	WCDMA850	RMC	24.5	24.45	0.00	10mm [Left]	FCC#1	N/A	1:1	0.67	1.012	0.678	77
836.6	4183	WCDMA850	RMC	24.5	24.45	0.02	10mm [Rear]	FCC#1	N/A	1:1	0.788	1.012	0.797	78
ANSI / IEEE C95.1-2005- SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure							Head 1.6 W/kg(mW/g) averaged over 1 gram							

Table 12.9 WCDMA Hotspot SAR

Note: Blue entries represent repeatability measurements.



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MEASUREMENT RESULTS														
Frequency		Mode/ Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Drift Power [dB]	Spacing [Side]	Device Serial Number	Data Rate [Mbps]	Duty Cycle	1g SAR [W/kg]	Scaling Factor	1g Scaled SAR [W/kg]	Plot No.
MHz	Ch													
2462	11	802.11b	DSSS	16.9	16.01	0.20	10mm [Front]	FCC #1	1	1:1	0.0372	1.227	0.0457	79
2462	11	802.11b	DSSS	16.9	16.01	0.03	10mm [Rear]	FCC #1	1	1:1	0.207	1.227	<b>0.254</b>	80
2462	11	802.11b	DSSS	16.9	16.01	0.14	10mm [Right]	FCC #1	1	1:1	0.174	1.227	0.214	81
ANSI / IEEE C95.1-2005– SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure							Head 1.6 W/kg(mW/g) averaged over 1 gram							

Table 12.10 W-LAN Hotspot SAR

## 12.4 SAR Test Notes

### General Notes:

1. The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2003, FCC/OET Bulletin 65, Supplement C [June 2001] and FCC KDB Publication 447498 D01v05r02.
2. Batteries are fully charged at the beginning of the SAR measurements. A standard battery was used for all SAR measurements.
3. This DUT does not have NFC functions.
4. Liquid tissue depth was at least 15.0 cm for all frequencies.
5. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
6. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01v05r02.
7. Device was tested using a fixed spacing for body-worn accessory testing. A separation distance of 10 mm was considered because the manufacturer has determined that there will be body-worn accessories available in the marketplace for users to support this separation distance.
8. Per FCC KDB Publication 648474 D04v01r01, SAR was evaluated without a headset connected to the device. Since the standalone reported SAR was  $\leq 1.2$  W/kg, no additional SAR evaluations using a headset cable were required.
9. During SAR Testing for the Wireless Router conditions per FCC KDB Publication 941225 D06v02, the actual Portable Hotspot operation (with actual simultaneous transmission of a transmitter with WIFI) was not activated (See Section 6.7 for more details).
10. Per FCC KDB 865664 D01v01r03, variability SAR tests were performed when the measured SAR results for a frequency band were greater than 0.8 W/kg. Repeated SAR measurements are highlighted in the tables above for clarity. Please see Section 14 for variability analysis.

### GSM Notes:

1. This device supports GSM VOIP in the head and body-worn configurations, therefore GPRS was additionally evaluated for head and body-worn compliance.
2. Body-Worn accessory testing is typically associated with voice operations. Therefore, GSM voice was evaluated for body-worn SAR.
3. Per FCC KDB Publication 447498 D01v05r02, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is  $\leq 0.8$  W/kg then testing at the other channels is not required for such test configuration(s). When the maximum output power variation across the required test channels is  $> \frac{1}{2}$  dB, instead of the middle channel, the highest output power channel was used.

### WCDMA Notes:

1. WCDMA mode was tested under RMC 12.2 kbps with HSPA Inactive per KDB Publication 941225 D01v03.
2. Body SAR for HSPA is not required for handsets with HSDPA capabilities when the maximum average output power of each RF channel with HSPA active is less than 0.25 dB higher than that measured without HSPA using 12.2 kbps RMC and the maximum SAR for 12.2 kbps RMC is  $\leq 75\%$  of the SAR limit.
3. Per FCC KDB Publication 447498 D01v05r02, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is  $\leq 0.8$  W/kg then testing at the other channels is not required for such test configuration(s). When the maximum output power variation across the required test channels is  $> \frac{1}{2}$  dB, instead of the middle channel, the highest output power channel was used.



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**WLAN Notes:**

1. Justification for reduced test configurations for WIFI channels per KDB Publication 248227 D01v01r02 and October 2012 FCC/TCB Meeting Notes for 2.4 GHz WIFI: Highest average RF output power channel for the lowest data rate was selected for SAR evaluation in 802.11b. Other IEEE 802.11 modes (including 802.11g/n) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11b mode.
2. WIFI Direct GO is supported in the 2.4 GHz band only. The manufacturer expects 2.4 GHz WIFI Direct GO may be used in a similar manner to wireless router usage. Therefore, 2.4 GHz WIFI Direct GO was evaluated for SAR similarly to wireless router SAR procedures in FCC KDB Publication 941225.
3. WIFI transmission was verified using a spectrum analyzer.
4. Since the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is  $<1.6$  W/kg and the reported 1g averaged SAR is  $<0.8$  W/kg, SAR testing on other default channels was not required.



## 13. FCC Multi-TX and Antenna SAR Considerations

### 13.1 Introduction

The following procedures adopted from FCC KDB Publication 447498 D01v05r02 are applicable to handsets with built-in unlicensed transmitters such as 802.11a/b/g/n/ac and Bluetooth devices which may simultaneously transmit with the licensed transmitter.

### 13.2 Simultaneous Transmission Procedures

This device contains transmitters that may operate simultaneously. Therefore simultaneous transmission analysis is required. Per FCC KDB 447498 D01v05r02 IV.C.1.iii, simultaneous transmission SAR test exclusion may be applied when the sum of the 1-g SAR for all the simultaneous transmitting antennas in a specific a physical test configuration is  $\leq 1.6$  W/kg. When standalone SAR is not required to be measured, per FCC KDB 447498 D01v05r02 4.3.2 2), the following equation must be used to estimate the standalone 1g SAR for simultaneous transmission assessment involving that transmitter.

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

Table 13.1 Estimated SAR

Mode	Frequency	Maximum Allowed Power		Separation Distance (Body)	Estimated SAR (Body)
	MHz	[dBm]	[mW]	[mm]	[W/kg]
Bluetooth	2480	8.3	7	10	0.147

Note : Held-to ear configurations are not applicable to Bluetooth operations and therefore were not considered for simultaneous transmission. Per KDB Publication 447498 D01v05r02, the maximum power of the channel was rounded to the nearest mW before calculation.

### 13.3 Simultaneous Transmission Capabilities

According to FCC KDB Publication 447498 D01v05r02, transmitters are considered to be transmitting simultaneously when there is overlapping transmission, with the exception of transmissions during network hand-offs with maximum hand-off duration less than 30 seconds. Possible transmission paths for the DUT are shown in Figure 13.1 and are color-coded to indicate communication modes which share the same path. Modes which share the same transmission path cannot transmit simultaneously with one another.



Figure 13.1 Simultaneous Transmission Paths

This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis according to FCC KDB Publication 447498 D01v05r02 3) procedures.

### 13.4 Simultaneous Transmission SAR Analysis

KDB 447498 D01 General RF Exposure Guidance v05, introduces a new formula for calculating the SAR to Peak Location Ratio (SPLSR) between pairs of simultaneously transmitting antennas:

$$SPLSR = (SAR_1 + SAR_2)^{1.5} / Ri$$

Where:

**SAR1** is the highest measured or estimated SAR for the first of a pair of simultaneous transmitting antennas, in a specific test operating mode and exposure condition

**SAR2** is the highest measured or estimated SAR for the second of a pair of simultaneous transmitting antennas, in the same test operating mode and exposure condition as the first

**Ri** is the separation distance between the pair of simultaneous transmitting antennas. When the SAR is measured, for both antennas in the pair, it is determined by the actual x, y and z coordinates in the 1-g SAR for each SAR peak location, based on the extrapolated and interpolated result in the zoom scan measurement, using the formula of

$$[(x_1-x_2)^2 + (y_1-y_2)^2 + (z_1-z_2)^2]$$

A new threshold of 0.04 is also introduced in the draft KDB. Thus, in order for a pair of simultaneous transmitting antennas with the sum of 1-g SAR > 1.6 W/kg to qualify for exemption from Simultaneous Transmission SAR measurements, it has to satisfy the condition of:

$$(SAR_1 + SAR_2)^{1.5} / Ri < 0.04$$

Table 13.2 Simultaneous Transmission Scenarios

Ref.	Simultaneous Transmit Configurations	Head	Body-Worn Accessory	Hot Spot	Note
		IEEE1528 Supp C	Supplement C	FCC KDB 941225 D06 Edges/sides	
1	GSM850 Voice + 2.4GHz WIFI	Yes	Yes	N/A	
2	PCS1900 Voice + 2.4GHz WIFI	Yes	Yes	N/A	
3	WCDMA850 + 2.4GHz WIFI	Yes	Yes	Yes	
4	GSM850 GPRS + 2.4GHz WIFI	Yes	Yes	Yes	
5	GPRS1900 GPRS + 2.4GHz WIFI	Yes	Yes	Yes	
6	GSM850 Voice + Bluetooth	N/A	Yes	N/A	
7	PCS1900 Voice + Bluetooth	N/A	Yes	N/A	
8	GSM850 GPRS + Bluetooth	N/A	Yes	N/A	
9	GPRS1900 GPRS + Bluetooth	N/A	Yes	N/A	
10	WCDMA850 + Bluetooth	N/A	Yes	N/A	

Notes:

- 2.4 GHz WIFI is supported Hotspot and WIFI-Direct.
- 5 GHz WIFI is not supported Hotspot and not supported WIFI-Direct.
- WCDMA, GPRS is supported Hotspot.
- Bluetooth and WIFI cannot transmit simultaneously since they share the same chip.
- GSM and WCDMA cannot transmit simultaneously since they share the same chip.
- VoIP is supported in WCDMA, GSM.

Per the manufacturer, WIFI Direct is expected to be used in conjunction with a held-to-ear or body-worn accessory voice call. Simultaneous transmission scenarios involving WIFI Direct are specified above.

### 13.5 Head SAR Simultaneous Transmission Analysis

Simult TX	Configuration	GSM850 SAR [W/kg]	2.4G W-LAN (802.11b) SAR [W/kg]	$\Sigma$ SAR [W/kg]	SPLSR [Yes/No]	Simult TX	Configuration	PCS1900 SAR [W/kg]	2.4G W-LAN (802.11b) SAR [W/kg]	$\Sigma$ SAR [W/kg]	SPLSR [Yes/No]
Head SAR	Right Touch	0.449	0.0857	0.5347	No	Head SAR	Right Touch	0.587	0.0857	0.6727	No
	Left Touch	0.405	0.215	0.62	No		Left Touch	0.37	0.215	0.585	No
	Right Tilt	0.397	0.0412	0.4382	No		Right Tilt	0.183	0.0412	0.2242	No
	Left Tilt	0.347	0.0541	0.4011	No		Left Tilt	0.161	0.0541	0.2151	No

**Table 13.3 Simultaneous Transmission Scenario with 2.4 GHz W-LAN (Held to Ear)**

Simult TX	Configuration	GPRS 850 SAR [W/kg]	2.4G W-LAN (802.11b) SAR [W/kg]	$\Sigma$ SAR [W/kg]	SPLSR [Yes/No]	Simult TX	Configuration	GPRS 1900 SAR [W/kg]	2.4G W-LAN (802.11b) SAR [W/kg]	$\Sigma$ SAR [W/kg]	SPLSR [Yes/No]
Head SAR	Right Touch	0.752	0.0857	0.8377	No	Head SAR	Right Touch	1.119	0.0857	<b>1.205</b>	No
	Left Touch	0.623	0.215	0.838	No		Left Touch	0.678	0.215	0.893	No
	Right Tilt	0.41	0.0412	0.4512	No		Right Tilt	0.348	0.0412	0.3892	No
	Left Tilt	0.426	0.0541	0.4801	No		Left Tilt	0.263	0.0541	0.3171	No

**Table 13.4 Simultaneous Transmission Scenario with 2.4 GHz W-LAN (Held to Ear)**

Simult TX	Configuration	WCDMA 850 SAR [W/kg]	2.4G W-LAN (802.11b) SAR [W/kg]	$\Sigma$ SAR [W/kg]	SPLSR [Yes/No]
Head SAR	Right Touch	0.419	0.0857	0.5047	No
	Left Touch	0.401	0.215	0.616	No
	Right Tilt	0.351	0.0412	0.3922	No
	Left Tilt	0.339	0.0541	0.3931	No

**Table 13.5 Simultaneous Transmission Scenario with 2.4 GHz W-LAN (Held to Ear)**

### 13.6 Body-Worn Simultaneous Transmission Analysis

Configuration	Mode	2G/3G SAR [W/kg]	2.4G W-LAN (802.11b) SAR [W/kg]	$\Sigma$ SAR [W/kg]	SPLSR [Yes/No]
Front Side	GSM 850	0.465	0.0457	0.5107	No
Rear Side	GSM 850	0.662	0.254	0.916	No
Front Side	GPRS 850	0.86	0.0457	0.9057	No
Rear Side	GPRS 850	1.284	0.254	<b>1.538</b>	No
Front Side	PCS 1900	0.325	0.0457	0.3707	No
Rear Side	PCS 1900	0.319	0.254	0.573	No
Front Side	GPRS 1900	0.618	0.0457	0.6637	No
Rear Side	GPRS 1900	0.686	0.254	0.94	No
Front Side	WCDMA 850	0.572	0.0457	0.6177	No
Rear Side	WCDMA 850	0.804	0.254	1.058	No

**Table 13.6 Simultaneous Transmission Scenario with 2.4 GHz W-LAN (Body-Worn at 10 mm)**

Configuration	Mode	2G/3G SAR [W/kg]	Bluetooth SAR [W/kg]	$\Sigma$ SAR [W/kg]	SPLSR [Yes/No]
Front Side	GSM 850	0.465	0.141	0.606	No
Rear Side	GSM 850	0.662	0.141	0.803	No
Front Side	GPRS 850	0.86	0.141	1.001	No
Rear Side	GPRS 850	1.284	0.141	1.425	No
Front Side	PCS 1900	0.325	0.141	0.466	No
Rear Side	PCS 1900	0.319	0.141	0.46	No
Front Side	GPRS 1900	0.618	0.141	0.759	No
Rear Side	GPRS 1900	0.686	0.141	0.827	No
Front Side	WCDMA 850	0.572	0.141	0.713	No
Rear Side	WCDMA 850	0.804	0.141	0.945	No

**Table 13.7 Simultaneous Transmission Scenario with Bluetooth (Body-Worn at 10 mm)**

Note: Bluetooth SAR was not required to be measured per FCC KDB 447498. Estimated SAR results were used in the above table to determine simultaneous transmission SAR test exclusion.

### 13.7 Hotspot SAR Simultaneous Transmission Analysis

Per FCC KDB Publication 941225 D06v02, the device edges with antennas more than 2.5 cm from edge are not required to be evaluated for SAR ("-").

Simult TX	Configuration	GPRS	2.4G W-LAN	$\Sigma$ SAR	SPLSR
		850 SAR [W/kg]	(802.11b) SAR [W/kg]		
Body SAR	Top	-	-	-	No
	Bottom	0.171	-	0.171	No
	Front	0.86	0.0457	0.9057	No
	Rear	1.284	0.254	<u>1.538</u>	No
	Right	0.692	0.214	0.906	No
	Left	0.877	-	0.877	No

Simult TX	Configuration	GPRS	2.4G W-LAN	$\Sigma$ SAR	SPLSR
		1900 SAR [W/kg]	(802.11b) SAR [W/kg]		
Body SAR	Top	-	-	-	No
	Bottom	0.51	-	0.51	No
	Front	0.618	0.0457	0.6637	No
	Rear	0.686	0.254	0.94	No
	Right	0.477	0.214	0.691	No
	Left	0.126	-	0.126	No

Table 13.8 Simultaneous Transmission Scenario (Hotspot at 10 mm)

Simult TX	Configuration	WCDMA	2.4G W-LAN	$\Sigma$ SAR	SPLSR
		850 SAR [W/kg]	(802.11b) SAR [W/kg]		
Body SAR	Top	-	-	-	No
	Bottom	0.125	-	0.125	No
	Front	0.572	0.0457	0.6177	No
	Rear	0.804	0.254	1.058	No
	Right	0.591	0.214	0.805	No
	Left	0.678	-	0.678	No

Table 13.9 Simultaneous Transmission Scenario (Hotspot at 10 mm)

### 13.8 Simultaneous Transmission Conclusion

The above numerical summed SAR results for all the worst-case simultaneous transmission conditions were below the SAR limit. Therefore, the above analysis is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit and therefore no measured volumetric simultaneous SAR summation is required per FCC KDB Publication 447498 D01v05r02.

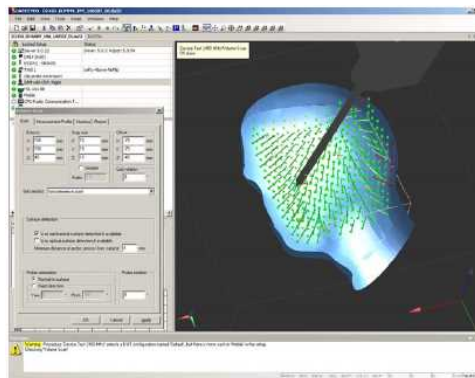
### **Description of Volume Scan:**

In order to determine the EM field distribution in a three-dimensional spatial extension, volume scans are required. In free space, these assessments can help to gain more information on the performance of the DUT(e.g., to determine the degree of symmetry of the field radiated from a horn antenna).

For dosimetric application, it is necessary to assess the peak spatial SAR value averaged over a volume. For this purpose, fine resolution volume scans need to be performed at the peak SAR location(s) determined during the Area Scan. In DASY5 software these scans are called Zoom Scan jobs. The default Zoom Scan measures 7 x 7 x 7 points with a step size of 5 mm. Faster evaluations can be achieved with a reduced number of measurement points. For example, a Zoom Scan with a grid step size in x- and y-directions of 7.5 mm (5 x 5 x 7cube configuration) reduces the measurement time to almost half with only 1-2% difference in SAR reading compared to the fine-resolution 7 x 7 x 7 scan.

For SAR evaluations with larger spatial extensions (e.g., within a complete phantom head section) a Volume Scan job should be used.

The Volume Scan job is compatible with DASY5 SAR, PRO and NEO system levels. Volume Scans are used to assess peak SAR and averaged SAR measurement in largely extended 3-dimensional volumes within any phantom. This measurement does not need any previous area scan. The grid can be anchored to a user specific point or to the current probe location. With an Administrator access mode, the grid can be optionally graded in Z-direction, whereby the smallest grid step and the grading ratio can be defined. Chosen grading ratio is automatically adjusted so that the desired extent in Z-direction is fully covered.



Under the Report page, the quantity to be evaluated for an instant report may be selected.

## SAR Assessment:

### Alternative 1

- Evaluation Method
  - Maximum summed SAR Value
- Description
  - Easiest and most conservative method to determine the upper limit of multi-band SAR
- Example
  - F1's SAR Value is 0.9
  - F2's SAR Value is 1.3
  - Multi-band SAR Value is  $0.9 + 1.3 = 2.2$

### Alternative 2

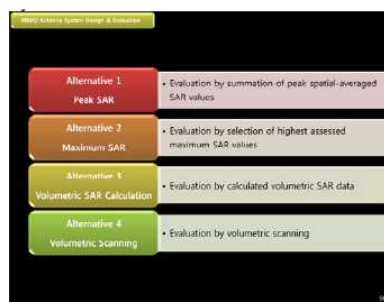
- Evaluation Method
  - Selection of highest assessed maximum SAR Value
- Description
  - Accurate estimate of the multi-band SAR
- Example
  - F1's SAR Value is 0.9
  - F2's SAR Value is 1.3
  - Multi-band SAR Value is 1.3

### Alternative 3

- Evaluation Method
  - Combining existing Area and Zoom Scan results by Post-Processor
- Description
  - Rapid way of obtaining the multi-band SAR. It is always applicable.
- Example
  - F1's SAR Value is 0.9
  - F2's SAR Value is 1.3
  - Combining results by Post-Processor

### Alternative 4

- Evaluation Method
  - Combining existing Area and Zoom Scan results by Post-Processor
- Description
  - The most accurate way of assessing the multi-band SAR and always
- Example
  - F1's SAR Value is 0.9
  - F2's SAR Value is 1.3
  - Combining results by Post-Processor



## 14. SAR Measurement Variability

### 14.1 Measurement Variability

Per FCC KDB Publication 865664 D01v01r03, SAR measurement variability was assessed for each frequency band, which was determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media were required for SAR measurements in a frequency band, the variability measurement procedures were applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium.

These additional measurements were repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device was returned to ambient conditions (normal room temperature) with the battery fully charged before it was re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

SAR Measurement Variability was assessed using the following procedures for each frequency band:

1. When the original highest measured SAR is  $\geq 0.80$  W/kg, the measurement was repeated once.
2. A second repeated measurement was performed only if the ratio of largest to smallest SAR for the original and first repeated measurements was  $> 1.20$  or when the original or repeated measurement was  $\geq 1.45$  W/kg ( $\sim 10\%$  from the 1-g SAR limit).
3. A third repeated measurement was performed only if the original, first or second repeated measurement was  $\geq 1.5$  W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is  $> 1.20$ .
4. Repeated measurements are not required when the original highest measured SAR is  $< 0.80$  W/kg.

Table 14.1 SAR Measurement Variability Results

Frequency		Mode	Service	# of Time Slots	Spacing [Side]	Measured SAR(1g)	1st Repeated SAR(1g)	Ratio	2nd Repeated SAR(1g)	Ratio	3rd Repeated SAR(1g)	Ratio
MHz	Ch					[W/kg]	[W/kg]		[W/kg]		[W/kg]	
836.6	190	GSM850	GPRS	3	10 mm [Rear]	1.150	1.130	1.02	N/A	N/A	N/A	N/A
1880.0	661	PCS1900	GPRS	4	Right Touch	1.000	1.000	1.00	N/A	N/A	N/A	N/A
836.6	4183	WCDMA850	RMC	N/A	10 mm [Rear]	0.795	0.788	1.01	N/A	N/A	N/A	N/A
ANSI / IEEE C95.1-2005 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General population Exposure							Body 1.6 W/kg(mW/g) averaged over 1 gram					

### 14.2 Measurement Uncertainty

The measured SAR was  $< 1.5$  W/kg for all frequency bands. Therefore, per KDB Publication 865664D01v01r03, the standard measurement uncertainty analysis per IEEE 1528-2003 was not required.



## 15. IEEE P1528 - Measurement uncertainties

Expanded uncertainties stated are calculated with a coverage Factor  $k=2$ .

Please note that these results are not taken into account when determining compliance or non-compliance with test result.

### 835MHz Head

Error Description	Uncertainty Value ± %	Probability distribution	Divisor	ci (1g)	Standard uncertainty ±%,(1g)	vi or v <sub>eff</sub>
<b>Measurement System</b>						
Probe Calibration	± 6.0	N	1	1	± 6.0	∞
Axial Isotropy	± 4.7	R	$\sqrt{3}$	0.7	± 1.9	∞
Hemispherical Isotropy	± 9.6	R	$\sqrt{3}$	0.7	± 3.9	∞
Boundary Effect	± 1.0	R	$\sqrt{3}$	1	± 0.6	∞
Linearity	± 4.7	R	$\sqrt{3}$	1	± 2.7	∞
System Detection Limits	± 1.0	R	$\sqrt{3}$	1	± 0.6	∞
Readout Electronics	± 0.3	N	1	1	± 0.3	∞
Response Time	± 0.8	R	$\sqrt{3}$	1	± 0.5	∞
Integration Time	± 2.6	R	$\sqrt{3}$	1	± 1.5	∞
RF Ambient Noise	± 3.0	R	$\sqrt{3}$	1	± 1.7	∞
RF Ambient Reflections	± 3.0	R	$\sqrt{3}$	1	± 1.7	∞
Probe Positioner	± 0.4	R	$\sqrt{3}$	1	± 0.2	∞
Probe Positioning	± 2.9	R	$\sqrt{3}$	1	± 1.7	∞
Max. SAR Eval.	± 1.0	R	$\sqrt{3}$	1	± 0.6	∞
<b>Test sample related</b>						
Device Positioning	± 2.9	N	1	1	± 2.9	145
Device Holder	± 3.6	N	1	1	± 3.6	5
Power Drift	± 5.0	R	$\sqrt{3}$	1	± 2.9	∞
<b>Phantom and set-up</b>						
Phantom Uncertainty	± 4.0	R	$\sqrt{3}$	1	± 2.3	∞
Liquid conductivity (target)	± 5.0	R	$\sqrt{3}$	0.64	± 1.8	∞
Liquid conductivity (meas.)	± 3.9	R	1	0.64	± 2.5	∞
Liquid permittivity (target)	± 5.0	R	$\sqrt{3}$	0.6	± 1.7	∞
Liquid permittivity (meas.)	± 0.9	R	1	0.6	± 0.5	∞
Combined Std. Uncertainty					± 12.1	387
<b>Expanded uncertainty (95% confidence interval)</b>					<b>± 24.2</b>	

**835MHz Body**

Error Description	Uncertainty Value ± %	Probability distribution	Divisor	ci (1g)	Standard uncertainty ±%,(1g)	vi or veff
<b>Measurement System</b>						
Probe Calibration	± 6.0	N	1	1	± 6.0	∞
Axial Isotropy	± 4.7	R	$\sqrt{3}$	0.7	± 1.9	∞
Hemispherical Isotropy	± 9.6	R	$\sqrt{3}$	0.7	± 3.9	∞
Boundary Effect	± 1.0	R	$\sqrt{3}$	1	± 0.6	∞
Linearity	± 4.7	R	$\sqrt{3}$	1	± 2.7	∞
System Detection Limits	± 1.0	R	$\sqrt{3}$	1	± 0.6	∞
Readout Electronics	± 0.3	N	1	1	± 0.3	∞
Response Time	± 0.8	R	$\sqrt{3}$	1	± 0.5	∞
Integration Time	± 2.6	R	$\sqrt{3}$	1	± 1.5	∞
RF Ambient Noise	± 3.0	R	$\sqrt{3}$	1	± 1.7	∞
RF Ambient Reflections	± 3.0	R	$\sqrt{3}$	1	± 1.7	∞
Probe Positioner	± 0.4	R	$\sqrt{3}$	1	± 0.2	∞
Probe Positioning	± 2.9	R	$\sqrt{3}$	1	± 1.7	∞
Max. SAR Eval.	± 1.0	R	$\sqrt{3}$	1	± 0.6	∞
<b>Test sample related</b>						
Device Positioning	± 2.9	N	1	1	± 2.9	145
Device Holder	± 3.6	N	1	1	± 3.6	5
Power Drift	± 5.0	R	$\sqrt{3}$	1	± 2.9	∞
<b>Phantom and set-up</b>						
Phantom Uncertainty	± 4.0	R	$\sqrt{3}$	1	± 2.3	∞
Liquid conductivity (target)	± 5.0	R	$\sqrt{3}$	0.64	± 1.8	∞
Liquid conductivity (meas.)	± 2.2	R	1	0.64	± 1.4	∞
Liquid permittivity (target)	± 5.0	R	$\sqrt{3}$	0.6	± 1.7	∞
Liquid permittivity (meas.)	± 4.0	R	1	0.6	± 2.4	∞
Combined Std. Uncertainty					± 12.9	387
<b>Expanded uncertainty (95% confidence interval)</b>					<b>± 25.8</b>	

**1900MHz Head**

Error Description	Uncertainty Value ± %	Probability distribution	Divisor	ci (1g)	Standard uncertainty ±%,(1g)	vi or v <sub>eff</sub>
<b>Measurement System</b>						
Probe Calibration	± 6.0	N	1	1	± 6.0	∞
Axial Isotropy	± 4.7	R	$\sqrt{3}$	0.7	± 1.9	∞
Hemispherical Isotropy	± 9.6	R	$\sqrt{3}$	0.7	± 3.9	∞
Boundary Effect	± 1.0	R	$\sqrt{3}$	1	± 0.6	∞
Linearity	± 4.7	R	$\sqrt{3}$	1	± 2.7	∞
System Detection Limits	± 1.0	R	$\sqrt{3}$	1	± 0.6	∞
Readout Electronics	± 0.3	N	1	1	± 0.3	∞
Response Time	± 0.8	R	$\sqrt{3}$	1	± 0.5	∞
Integration Time	± 2.6	R	$\sqrt{3}$	1	± 1.5	∞
RF Ambient Noise	± 3.0	R	$\sqrt{3}$	1	± 1.7	∞
RF Ambient Reflections	± 3.0	R	$\sqrt{3}$	1	± 1.7	∞
Probe Positioner	± 0.4	R	$\sqrt{3}$	1	± 0.2	∞
Probe Positioning	± 2.9	R	$\sqrt{3}$	1	± 1.7	∞
Max. SAR Eval.	± 1.0	R	$\sqrt{3}$	1	± 0.6	∞
<b>Test sample related</b>						
Device Positioning	± 2.9	N	1	1	± 2.9	145
Device Holder	± 3.6	N	1	1	± 3.6	5
Power Drift	± 5.0	R	$\sqrt{3}$	1	± 2.9	∞
<b>Phantom and set-up</b>						
Phantom Uncertainty	± 4.0	R	$\sqrt{3}$	1	± 2.3	∞
Liquid conductivity (target)	± 5.0	R	$\sqrt{3}$	0.64	± 1.8	∞
Liquid conductivity (meas.)	± 2.7	R	1	0.64	± 1.7	∞
Liquid permittivity (target)	± 5.0	R	$\sqrt{3}$	0.6	± 1.7	∞
Liquid permittivity (meas.)	± 3.7	R	1	0.6	± 2.2	∞
Combined Std. Uncertainty					± 13.0	387
<b>Expanded uncertainty (95% confidence interval)</b>					<b>± 26.0</b>	

**1900MHz Body**

Error Description	Uncertainty Value ± %	Probability distribution	Divisor	ci (1g)	Standard uncertainty ±%,(1g)	vi or v <sub>eff</sub>
<b>Measurement System</b>						
Probe Calibration	± 6.0	N	1	1	± 6.0	∞
Axial Isotropy	± 4.7	R	$\sqrt{3}$	0.7	± 1.9	∞
Hemispherical Isotropy	± 9.6	R	$\sqrt{3}$	0.7	± 3.9	∞
Boundary Effect	± 1.0	R	$\sqrt{3}$	1	± 0.6	∞
Linearity	± 4.7	R	$\sqrt{3}$	1	± 2.7	∞
System Detection Limits	± 1.0	R	$\sqrt{3}$	1	± 0.6	∞
Readout Electronics	± 0.3	N	1	1	± 0.3	∞
Response Time	± 0.8	R	$\sqrt{3}$	1	± 0.5	∞
Integration Time	± 2.6	R	$\sqrt{3}$	1	± 1.5	∞
RF Ambient Noise	± 3.0	R	$\sqrt{3}$	1	± 1.7	∞
RF Ambient Reflections	± 3.0	R	$\sqrt{3}$	1	± 1.7	∞
Probe Positioner	± 0.4	R	$\sqrt{3}$	1	± 0.2	∞
Probe Positioning	± 2.9	R	$\sqrt{3}$	1	± 1.7	∞
Max. SAR Eval.	± 1.0	R	$\sqrt{3}$	1	± 0.6	∞
<b>Test sample related</b>						
Device Positioning	± 2.9	N	1	1	± 2.9	145
Device Holder	± 3.6	N	1	1	± 3.6	5
Power Drift	± 5.0	R	$\sqrt{3}$	1	± 2.9	∞
<b>Phantom and set-up</b>						
Phantom Uncertainty	± 4.0	R	$\sqrt{3}$	1	± 2.3	∞
Liquid conductivity (target)	± 5.0	R	$\sqrt{3}$	0.64	± 1.8	∞
Liquid conductivity (meas.)	± 2.9	R	1	0.64	± 1.9	∞
Liquid permittivity (target)	± 5.0	R	$\sqrt{3}$	0.6	± 1.7	∞
Liquid permittivity (meas.)	± 3.4	R	1	0.6	± 2.0	∞
Combined Std. Uncertainty					± 13.0	387
<b>Expanded uncertainty (95% confidence interval)</b>					<b>± 26.0</b>	

**2450MHz Head**

Error Description	Uncertainty Value ± %	Probability distribution	Divisor	ci (1g)	Standard uncertainty ±%,(1g)	vi or v <sub>eff</sub>
<b>Measurement System</b>						
Probe Calibration	± 6.0	N	1	1	± 6.0	∞
Axial Isotropy	± 4.7	R	$\sqrt{3}$	0.7	± 1.9	∞
Hemispherical Isotropy	± 9.6	R	$\sqrt{3}$	0.7	± 3.9	∞
Boundary Effect	± 1.0	R	$\sqrt{3}$	1	± 0.6	∞
Linearity	± 4.7	R	$\sqrt{3}$	1	± 2.7	∞
System Detection Limits	± 1.0	R	$\sqrt{3}$	1	± 0.6	∞
Readout Electronics	± 0.3	N	1	1	± 0.3	∞
Response Time	± 0.8	R	$\sqrt{3}$	1	± 0.5	∞
Integration Time	± 2.6	R	$\sqrt{3}$	1	± 1.5	∞
RF Ambient Noise	± 3.0	R	$\sqrt{3}$	1	± 1.7	∞
RF Ambient Reflections	± 3.0	R	$\sqrt{3}$	1	± 1.7	∞
Probe Positioner	± 0.4	R	$\sqrt{3}$	1	± 0.2	∞
Probe Positioning	± 2.9	R	$\sqrt{3}$	1	± 1.7	∞
Max. SAR Eval.	± 1.0	R	$\sqrt{3}$	1	± 0.6	∞
<b>Test sample related</b>						
Device Positioning	± 2.9	N	1	1	± 2.9	145
Device Holder	± 3.6	N	1	1	± 3.6	5
Power Drift	± 5.0	R	$\sqrt{3}$	1	± 2.9	∞
<b>Phantom and set-up</b>						
Phantom Uncertainty	± 4.0	R	$\sqrt{3}$	1	± 2.3	∞
Liquid conductivity (target)	± 5.0	R	$\sqrt{3}$	0.64	± 1.8	∞
Liquid conductivity (meas.)	± 1.0	R	1	0.64	± 0.6	∞
Liquid permittivity (target)	± 5.0	R	$\sqrt{3}$	0.6	± 1.7	∞
Liquid permittivity (meas.)	± 2.9	R	1	0.6	± 1.7	∞
Combined Std. Uncertainty					± 11.4	387
<b>Expanded uncertainty (95% confidence interval)</b>					<b>± 22.8</b>	

**2450MHz Body**

Error Description	Uncertainty Value ± %	Probability distribution	Divisor	ci (1g)	Standard uncertainty ±%,(1g)	vi or v <sub>eff</sub>
<b>Measurement System</b>						
Probe Calibration	± 6.0	N	1	1	± 6.0	∞
Axial Isotropy	± 4.7	R	$\sqrt{3}$	0.7	± 1.9	∞
Hemispherical Isotropy	± 9.6	R	$\sqrt{3}$	0.7	± 3.9	∞
Boundary Effect	± 1.0	R	$\sqrt{3}$	1	± 0.6	∞
Linearity	± 4.7	R	$\sqrt{3}$	1	± 2.7	∞
System Detection Limits	± 1.0	R	$\sqrt{3}$	1	± 0.6	∞
Readout Electronics	± 0.3	N	1	1	± 0.3	∞
Response Time	± 0.8	R	$\sqrt{3}$	1	± 0.5	∞
Integration Time	± 2.6	R	$\sqrt{3}$	1	± 1.5	∞
RF Ambient Noise	± 3.0	R	$\sqrt{3}$	1	± 1.7	∞
RF Ambient Reflections	± 3.0	R	$\sqrt{3}$	1	± 1.7	∞
Probe Positioner	± 0.4	R	$\sqrt{3}$	1	± 0.2	∞
Probe Positioning	± 2.9	R	$\sqrt{3}$	1	± 1.7	∞
Max. SAR Eval.	± 1.0	R	$\sqrt{3}$	1	± 0.6	∞
<b>Test sample related</b>						
Device Positioning	± 2.9	N	1	1	± 2.9	145
Device Holder	± 3.6	N	1	1	± 3.6	5
Power Drift	± 5.0	R	$\sqrt{3}$	1	± 2.9	∞
<b>Phantom and set-up</b>						
Phantom Uncertainty	± 4.0	R	$\sqrt{3}$	1	± 2.3	∞
Liquid conductivity (target)	± 5.0	R	$\sqrt{3}$	0.64	± 1.8	∞
Liquid conductivity (meas.)	± 0.9	R	1	0.64	± 0.6	∞
Liquid permittivity (target)	± 5.0	R	$\sqrt{3}$	0.6	± 1.7	∞
Liquid permittivity (meas.)	± 1.6	R	1	0.6	± 1.0	∞
Combined Std. Uncertainty					± 10.7	387
<b>Expanded uncertainty (95% confidence interval)</b>					<b>± 21.4</b>	



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## **16. Conclusion**

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### **Measurement 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 the worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The tested device complies with the requirements in respect to all parameters subject to the test. 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 impossible biological effect 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.

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## Attachment 1. Probe calibration data

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



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

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

Accreditation No.: **SCS 108**Client **TÜV SÜD Zacta (PTT)**Certificate No: **EX3-3957\_Dec13/2**

### CALIBRATION CERTIFICATE (Replacement of No: EX3-3957\_Dec13)

Object **EX3DV4 - SN:3957**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6  
Calibration procedure for dosimetric E-field probes**

Calibration date: **December 3, 2013**

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 ( $22 \pm 3$ °C) and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013 Dec12)	Dec-13
DAE4	SN: 660	4-Sep-13 (No. DAE4-660_Sep13)	Sep-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

Issued: December 12, 2013

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



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



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Accreditation No.: **SCS 108**

The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

### Glossary:

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

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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<sub>x,y,z</sub>**: Assessed for E-field polarization  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- NORM(f)<sub>x,y,z</sub>** = NORM<sub>x,y,z</sub> \* 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<sub>x,y,z</sub>**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800$  MHz) and inside waveguide using analytical field distributions based on power measurements for  $f > 800$  MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<sub>x,y,z</sub> \* 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.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM<sub>x</sub> (no uncertainty required).



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EX3DV4 – SN:3957

December 3, 2013

# Probe EX3DV4

## SN:3957

Manufactured: August 6, 2013  
Calibrated: December 3, 2013

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



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EX3DV4- SN:3957

December 3, 2013

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3957

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	0.46	0.45	0.48	± 10.1 %
DCP (mV) <sup>B</sup>	100.1	101.5	101.8	

### Modulation Calibration Parameters

UID	Communication System Name		A	B	C	D	VR	Unc <sup>E</sup> (k=2)
			dB	dB $\sqrt{\mu\text{V}}$		dB	mV	
0	CW	X	0.0	0.0	1.0	0.00	154.3	±3.3 %
		Y	0.0	0.0	1.0		151.6	
		Z	0.0	0.0	1.0		159.1	

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<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 6).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

<sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3957

### Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct. (k=2)
750	41.9	0.89	10.35	10.35	10.35	0.42	0.85	± 12.0 %
835	41.5	0.90	10.02	10.02	10.02	0.30	1.03	± 12.0 %
900	41.5	0.97	9.82	9.82	9.82	0.37	0.95	± 12.0 %
1450	40.5	1.20	9.22	9.22	9.22	0.50	0.78	± 12.0 %
1750	40.1	1.37	8.58	8.58	8.58	0.46	0.75	± 12.0 %
1900	40.0	1.40	8.35	8.35	8.35	0.80	0.58	± 12.0 %
1950	40.0	1.40	8.02	8.02	8.02	0.62	0.64	± 12.0 %
2450	39.2	1.80	7.49	7.49	7.49	0.39	0.79	± 12.0 %
2600	39.0	1.96	7.21	7.21	7.21	0.36	0.84	± 12.0 %
5200	36.0	4.66	4.94	4.94	4.94	0.50	1.80	± 13.1 %
5300	35.9	4.76	5.03	5.03	5.03	0.35	1.80	± 13.1 %
5500	35.6	4.96	4.81	4.81	4.81	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.52	4.52	4.52	0.39	1.80	± 13.1 %
5800	35.3	5.27	4.68	4.68	4.68	0.37	1.80	± 13.1 %

<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3957

### Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth (mm) <sup>G</sup>	Unct. (k=2)
750	55.5	0.96	9.91	9.91	9.91	0.61	0.72	± 12.0 %
835	55.2	0.97	9.78	9.78	9.78	0.53	0.75	± 12.0 %
900	55.0	1.05	9.62	9.62	9.62	0.42	0.86	± 12.0 %
1450	54.0	1.30	8.64	8.64	8.64	0.47	0.74	± 12.0 %
1750	53.4	1.49	8.33	8.33	8.33	0.71	0.68	± 12.0 %
1900	53.3	1.52	7.91	7.91	7.91	0.58	0.67	± 12.0 %
1950	53.3	1.52	8.09	8.09	8.09	0.28	1.11	± 12.0 %
2450	52.7	1.95	7.33	7.33	7.33	0.80	0.55	± 12.0 %
2600	52.5	2.16	7.20	7.20	7.20	0.80	0.50	± 12.0 %
5200	49.0	5.30	4.48	4.48	4.48	0.37	1.90	± 13.1 %
5300	48.9	5.42	4.27	4.27	4.27	0.38	1.90	± 13.1 %
5500	48.6	5.65	4.00	4.00	4.00	0.42	1.90	± 13.1 %
5600	48.5	5.77	4.05	4.05	4.05	0.29	1.90	± 13.1 %
5800	48.2	6.00	4.07	4.07	4.07	0.45	1.90	± 13.1 %

<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

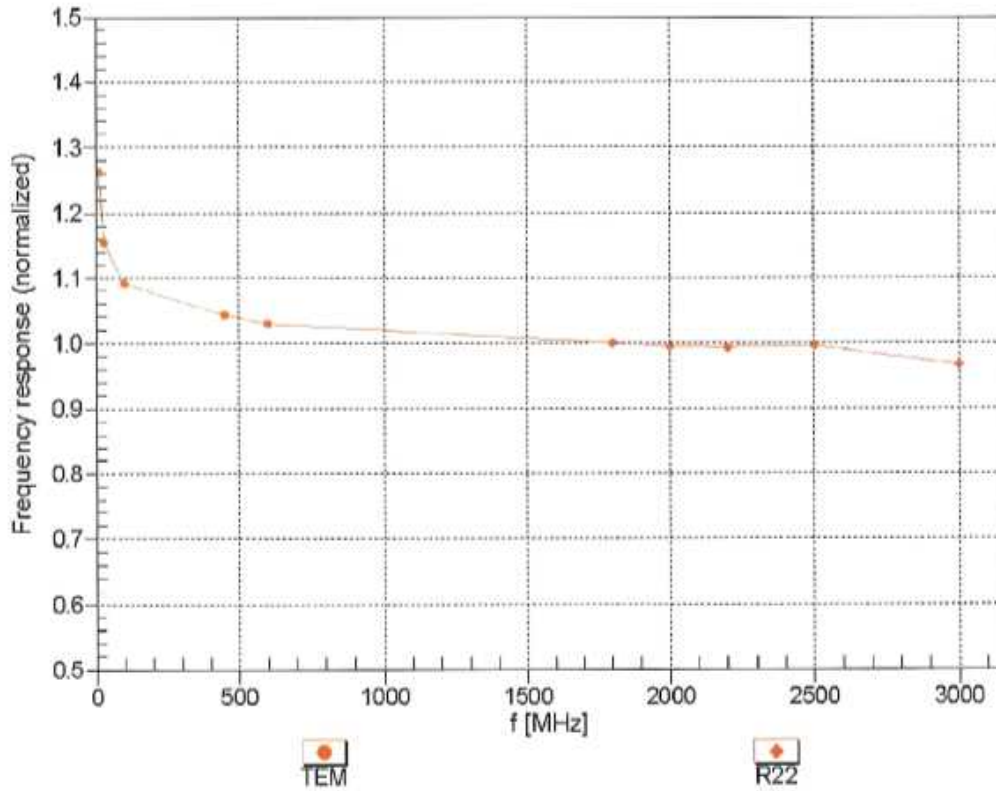


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EX3DV4- SN:3957

December 3, 2013

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

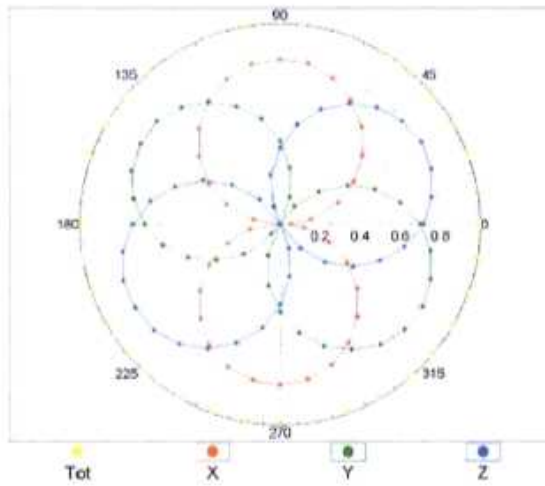


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

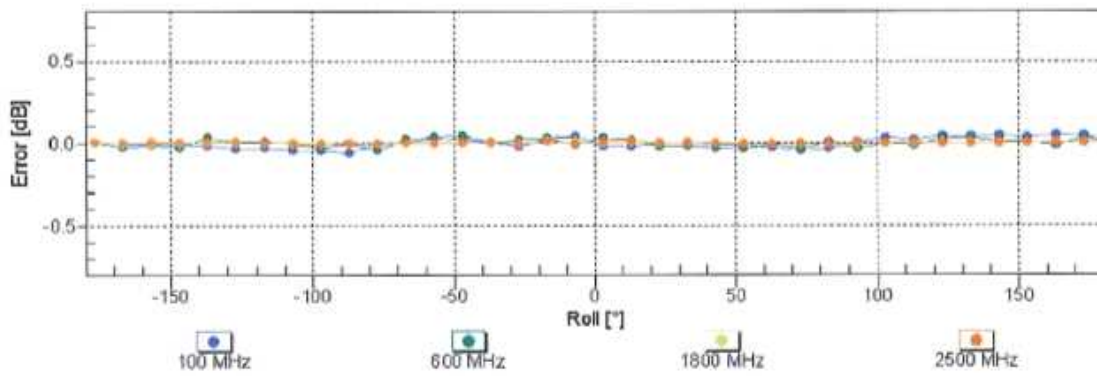
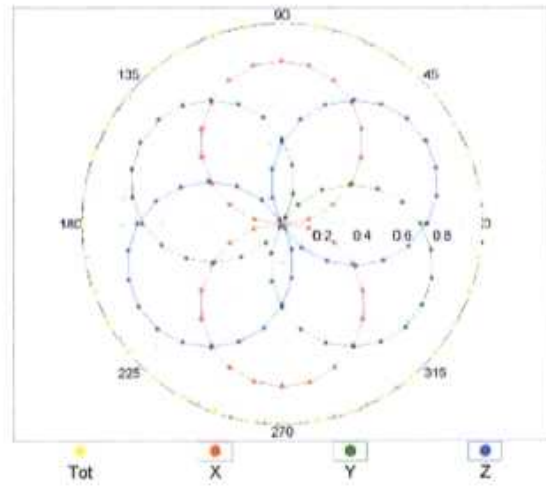


### Receiving Pattern ( $\phi$ ), $\vartheta = 0^\circ$

f=600 MHz,TEM

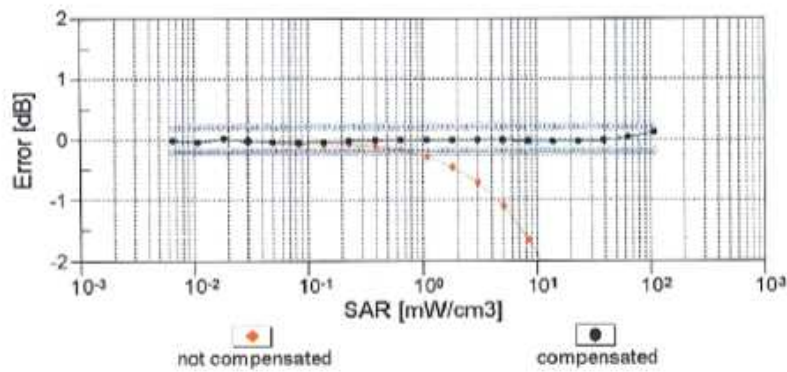
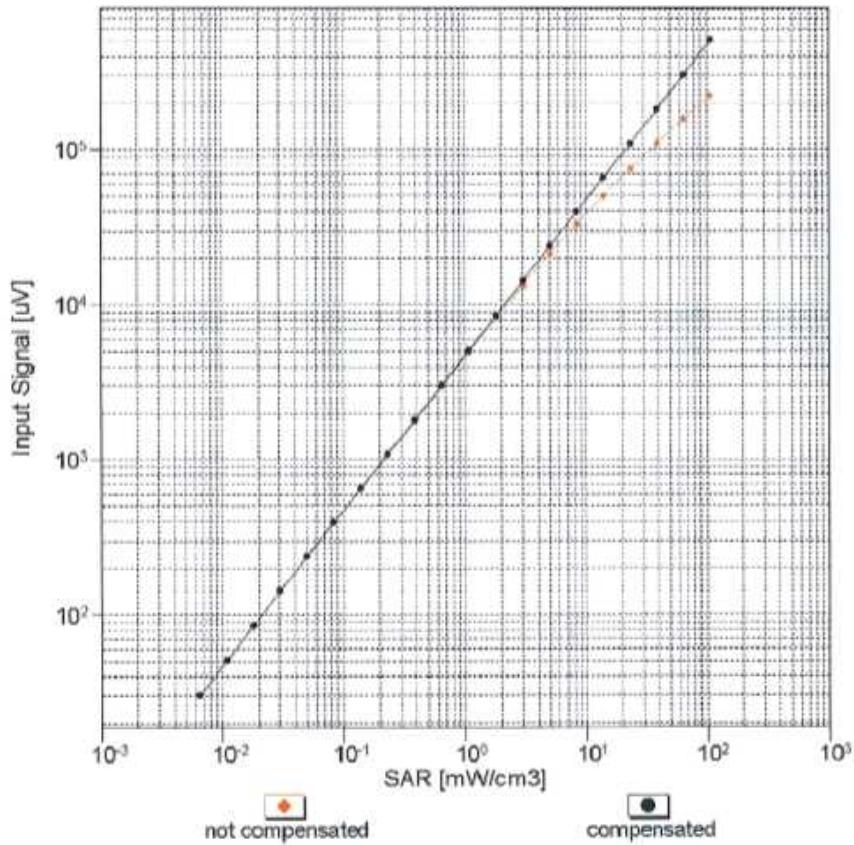


f=1800 MHz,R22



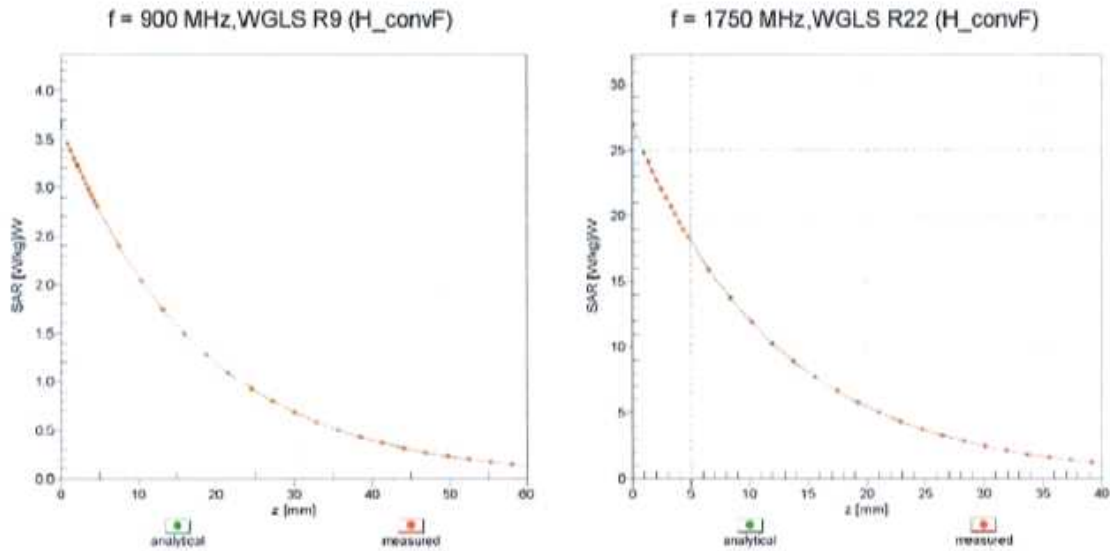
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)

### Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell , $f = 900 \text{ MHz}$ )

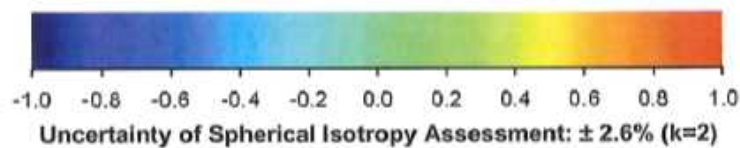
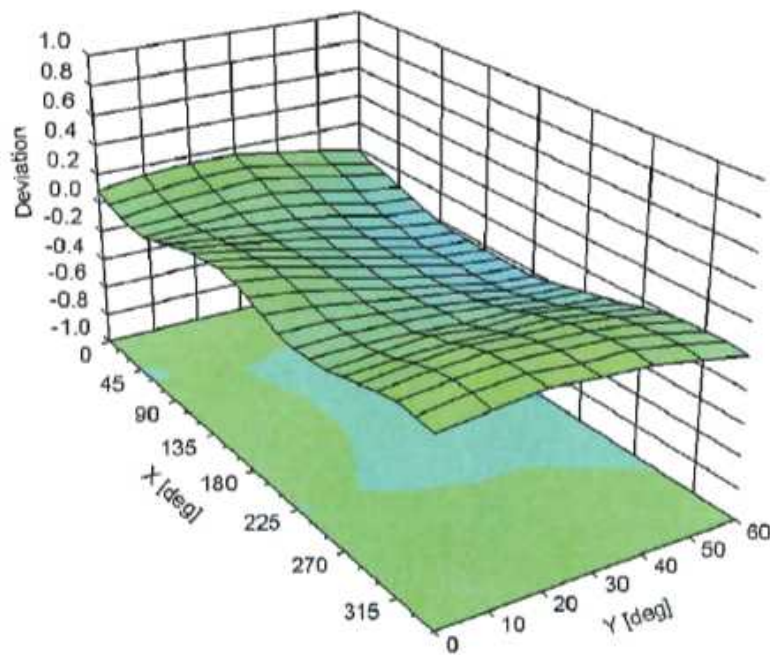


Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

## Conversion Factor Assessment



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





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EX3DV4– SN:3957

December 3, 2013

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3957

### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-16.9
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm



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## Attachment 2. Dipole calibration data

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



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

Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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Multilateral Agreement for the recognition of calibration certificates

Client **TÜV Süd Zacta (PTT)**Certificate No: **D835V2-4d163\_Dec13**

### CALIBRATION CERTIFICATE

Object **D835V2 - SN: 4d163**

Calibration procedure(s) **QA CAL-05.v9**  
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **December 04, 2013**

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 ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&amp;TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-15
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

Calibrated by: **Jeton Kastrati**      **Laboratory Technician**

Approved by: **Katja Pokovic**      **Technical Manager**

Issued: December 4, 2013

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

Certificate No: D835V2-4d163\_Dec13

Page 1 of 8



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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 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### 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.

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%.

## Measurement Conditions

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

<b>DASY Version</b>	DASY5	V52.8.7
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Modular Flat Phantom	
<b>Distance Dipole Center - TSL</b>	15 mm	with Spacer
<b>Zoom Scan Resolution</b>	dx, dy, dz = 5 mm	
<b>Frequency</b>	835 MHz $\pm$ 1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	41.5	0.90 mho/m
<b>Measured Head TSL parameters</b>	(22.0 $\pm$ 0.2) °C	40.8 $\pm$ 6 %	0.94 mho/m $\pm$ 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Head TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	250 mW input power	2.45 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>9.45 W/kg <math>\pm</math> 17.0 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	250 mW input power	1.58 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>6.14 W/kg <math>\pm</math> 16.5 % (k=2)</b>

## Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	55.2	0.97 mho/m
<b>Measured Body TSL parameters</b>	(22.0 $\pm$ 0.2) °C	54.7 $\pm$ 6 %	1.01 mho/m $\pm$ 6 %
<b>Body TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Body TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>	Condition	
SAR measured	250 mW input power	2.43 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>9.43 W/kg <math>\pm</math> 17.0 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b>	condition	
SAR measured	250 mW input power	1.58 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>6.17 W/kg <math>\pm</math> 16.5 % (k=2)</b>



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## Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.7 $\Omega$ - 2.5 j $\Omega$
Return Loss	- 28.8 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.1 $\Omega$ - 4.4 j $\Omega$
Return Loss	- 25.2 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.436 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. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

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	December 28, 2012



## DASY5 Validation Report for Head TSL

Date: 04.12.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d163**

Communication System: UID 0 - CW ; Frequency: 835 MHz

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.94$  S/m;  $\epsilon_r = 40.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.05, 6.05, 6.05); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

### Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

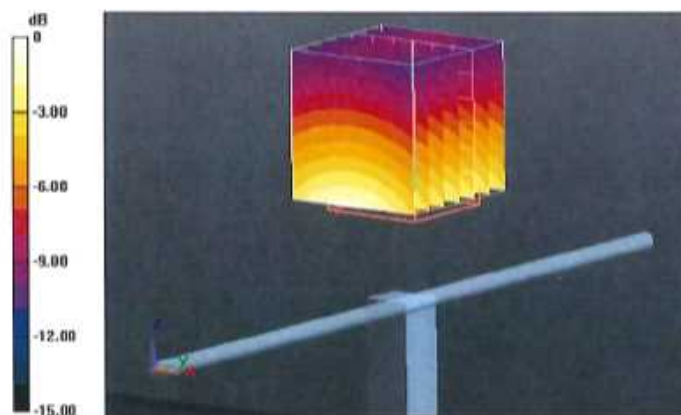
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 58.700 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 3.76 W/kg

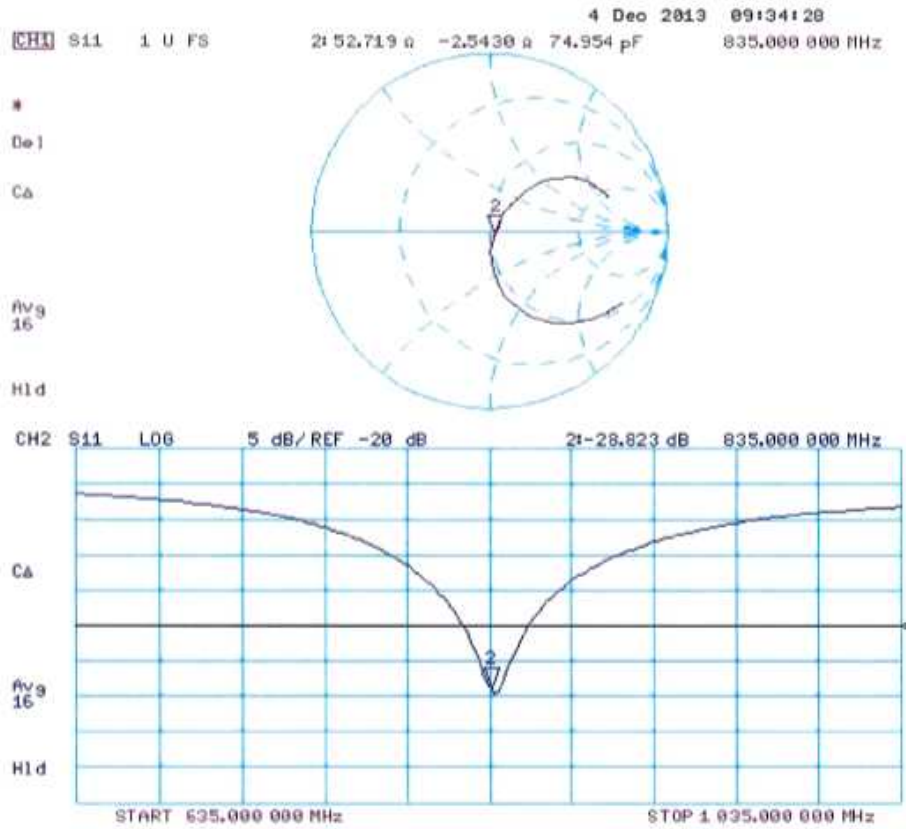
**SAR(1 g) = 2.45 W/kg; SAR(10 g) = 1.58 W/kg**

Maximum value of SAR (measured) = 2.87 W/kg



0 dB = 2.87 W/kg = 4.58 dBW/kg

### Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 02.12.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d163**

Communication System: UID 0 - CW ; Frequency: 835 MHz

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 1.007 \text{ S/m}$ ;  $\epsilon_r = 54.7$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.04, 6.04, 6.04); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

### Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

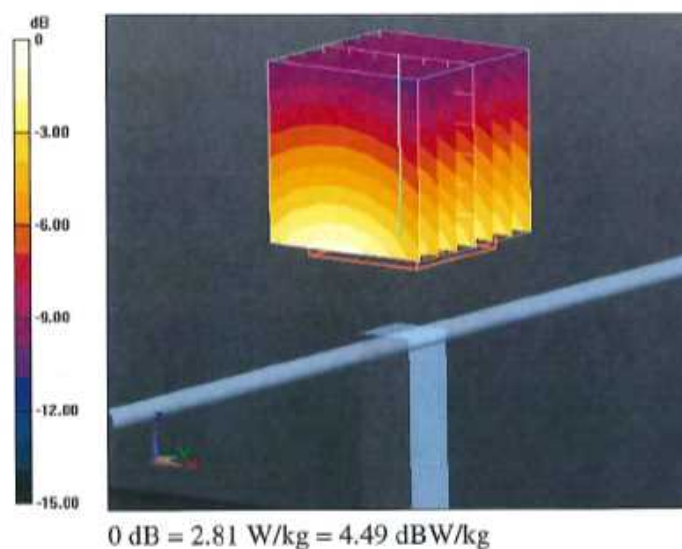
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$ 

Reference Value = 54.673 V/m; Power Drift = 0.02 dB

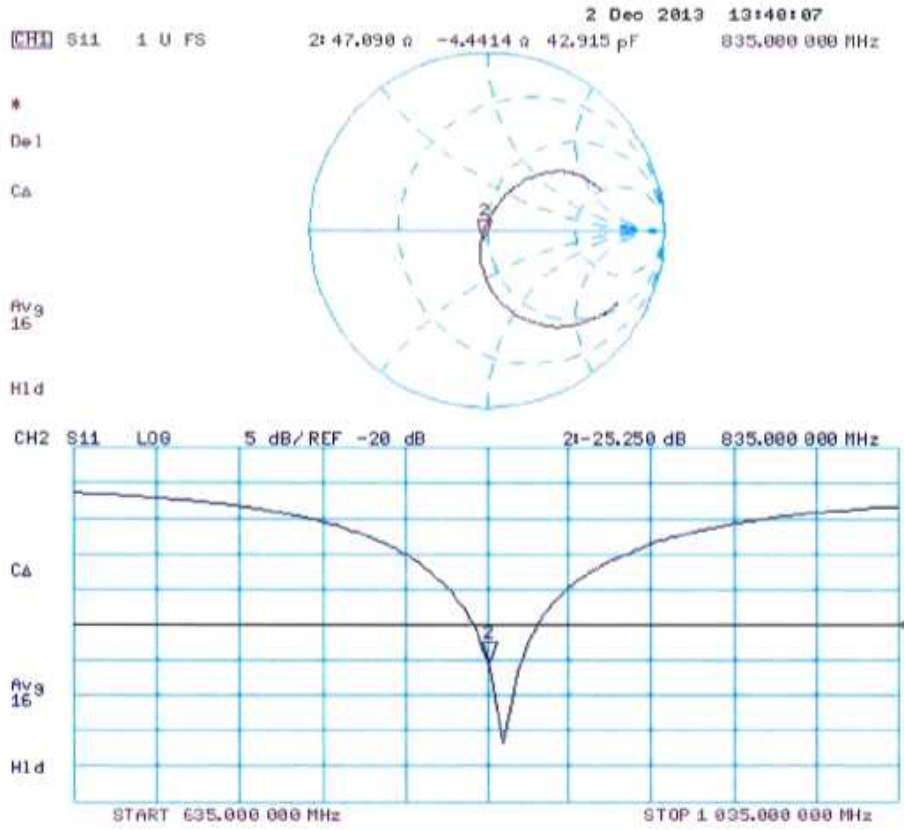
Peak SAR (extrapolated) = 3.58 W/kg

**SAR(1 g) = 2.43 W/kg; SAR(10 g) = 1.58 W/kg**

Maximum value of SAR (measured) = 2.81 W/kg



### Impedance Measurement Plot for Body TSL





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Client **TÜV Süd Zacta (PTT)**Certificate No: **D1900V2-5d183\_Dec13**

## CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d183**

Calibration procedure(s) **QA CAL-05.v9**  
**Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **December 02, 2013**

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 ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&amp;TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-15
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

Issued: December 2, 2013

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

Certificate No: D1900V2-5d183\_Dec13

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Accredited by the Swiss Accreditation Service (SAS)

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Accreditation No.: **SCS 108**

### Glossary:

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

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### 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.

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%.

## Measurement Conditions

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

<b>DASY Version</b>	DASY5	V52.8.7
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Modular Flat Phantom	
<b>Distance Dipole Center - TSL</b>	10 mm	with Spacer
<b>Zoom Scan Resolution</b>	dx, dy, dz = 5 mm	
<b>Frequency</b>	1900 MHz $\pm$ 1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	40.0	1.40 mho/m
<b>Measured Head TSL parameters</b>	(22.0 $\pm$ 0.2) °C	39.8 $\pm$ 6 %	1.39 mho/m $\pm$ 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Head TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	250 mW input power	10.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>40.5 W/kg <math>\pm</math> 17.0 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	250 mW input power	5.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>21.2 W/kg <math>\pm</math> 16.5 % (k=2)</b>

## Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	53.3	1.52 mho/m
<b>Measured Body TSL parameters</b>	(22.0 $\pm$ 0.2) °C	53.4 $\pm$ 6 %	1.51 mho/m $\pm$ 6 %
<b>Body TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Body TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>	Condition	
SAR measured	250 mW input power	10.1 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>40.6 W/kg <math>\pm</math> 17.0 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b>	condition	
SAR measured	250 mW input power	5.35 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>21.5 W/kg <math>\pm</math> 16.5 % (k=2)</b>



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## Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.0 $\Omega$ + 6.0 j $\Omega$
Return Loss	- 24.2 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.7 $\Omega$ + 6.3 j $\Omega$
Return Loss	- 23.3 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.208 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. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

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	August 23, 2013



## DASY5 Validation Report for Head TSL

Date: 02.12.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d183**

Communication System: UID 0 - CW ; Frequency: 1900 MHz

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.39$  S/m;  $\epsilon_r = 39.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.98, 4.98, 4.98); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

### Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

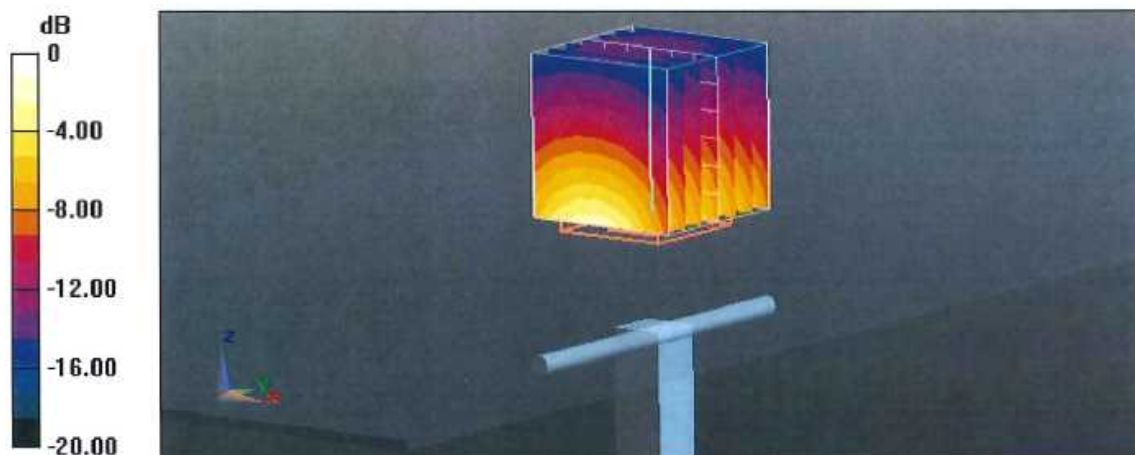
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.554 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 18.5 W/kg

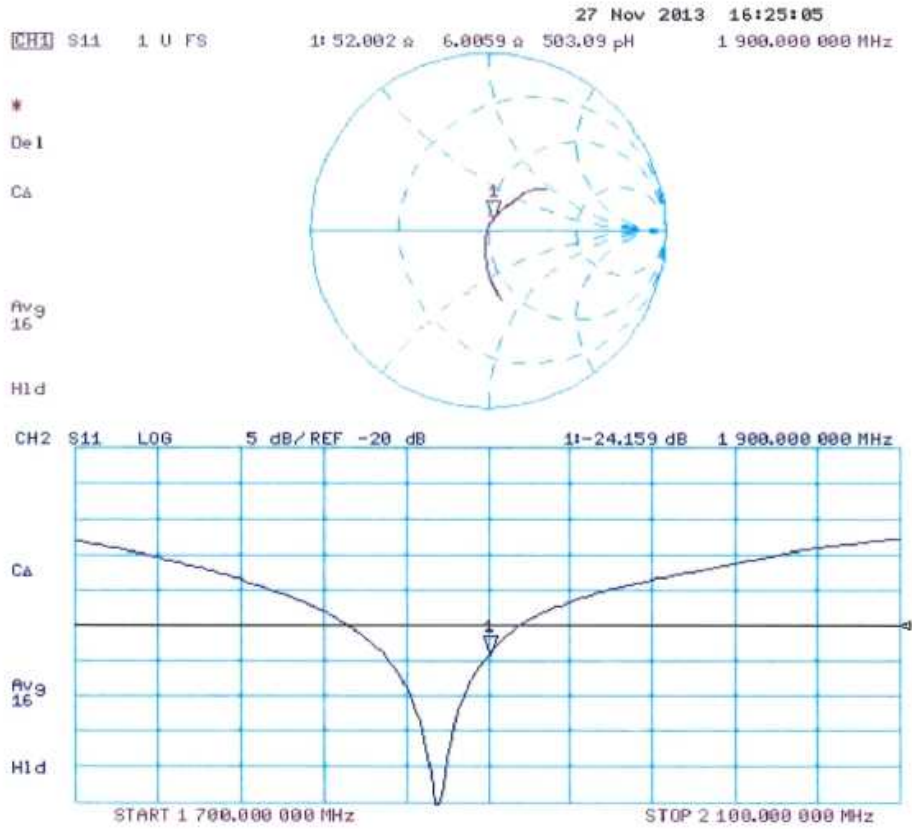
SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.29 W/kg

Maximum value of SAR (measured) = 12.4 W/kg



0 dB = 12.4 W/kg = 10.93 dBW/kg

### Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 02.12.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d183**

Communication System: UID 0 - CW ; Frequency: 1900 MHz

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.51$  S/m;  $\epsilon_r = 53.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.6, 4.6, 4.6); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

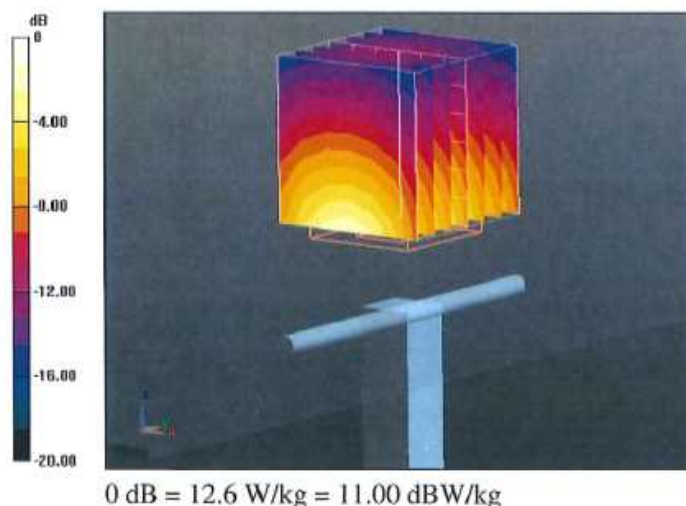
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.554 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 17.2 W/kg

**SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.35 W/kg**

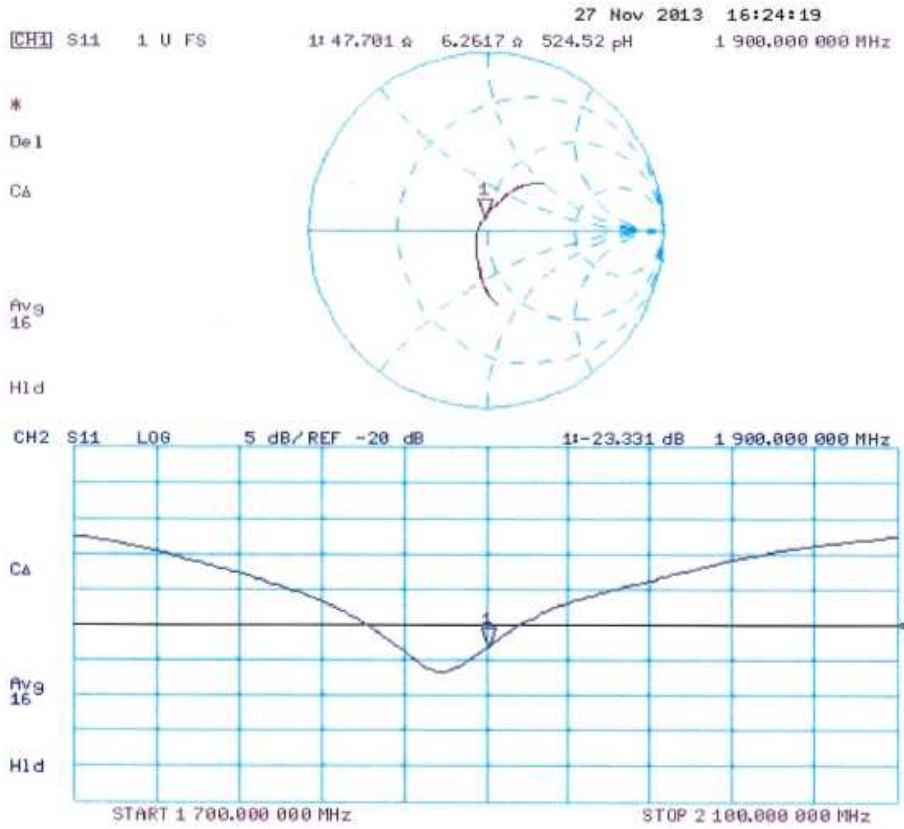
Maximum value of SAR (measured) = 12.6 W/kg





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### Impedance Measurement Plot for Body TSL





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



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

Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**Client **TUV SÜD Zacta (PTT)**Certificate No: **D2450V2-925\_Dec13**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 925**

Calibration procedure(s) **QA CAL-05.v9  
Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **December 03, 2013**

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 ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&amp;TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-15
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

Calibrated by:	Name <b>Lelf Klysner</b>	Function <b>Laboratory Technician</b>	Signature 
Approved by:	<b>Katja Pokovic</b>	<b>Technical Manager</b>	

Issued: December 4, 2013

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

Certificate No: **D2450V2-925\_Dec13**

Page 1 of 8



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Accreditation No.: **SCS 108**

#### Glossary:

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

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### 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.

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%.

## Measurement Conditions

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

<b>DASY Version</b>	DASY5	V52.8.7
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Modular Flat Phantom	
<b>Distance Dipole Center - TSL</b>	10 mm	with Spacer
<b>Zoom Scan Resolution</b>	dx, dy, dz = 5 mm	
<b>Frequency</b>	2450 MHz $\pm$ 1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	39.2	1.80 mho/m
<b>Measured Head TSL parameters</b>	(22.0 $\pm$ 0.2) °C	39.7 $\pm$ 6 %	1.84 mho/m $\pm$ 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Head TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	250 mW input power	13.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>52.8 W/kg <math>\pm</math> 17.0 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	250 mW input power	6.11 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>24.4 W/kg <math>\pm</math> 16.5 % (k=2)</b>

## Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	52.7	1.95 mho/m
<b>Measured Body TSL parameters</b>	(22.0 $\pm$ 0.2) °C	52.1 $\pm$ 6 %	2.02 mho/m $\pm$ 6 %
<b>Body TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Body TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>	Condition	
SAR measured	250 mW input power	12.9 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>50.6 W/kg <math>\pm</math> 17.0 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b>	condition	
SAR measured	250 mW input power	5.94 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>23.5 W/kg <math>\pm</math> 16.5 % (k=2)</b>



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## Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.6 $\Omega$ + 2.2 j $\Omega$
Return Loss	- 26.2 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	51.1 $\Omega$ + 4.6 j $\Omega$
Return Loss	- 26.6 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.159 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. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

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	September 26, 2013



## DASY5 Validation Report for Head TSL

Date: 03.12.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 925**

Communication System: UID 0 - CW ; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.84$  S/m;  $\epsilon_r = 39.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.52, 4.52, 4.52); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

### Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

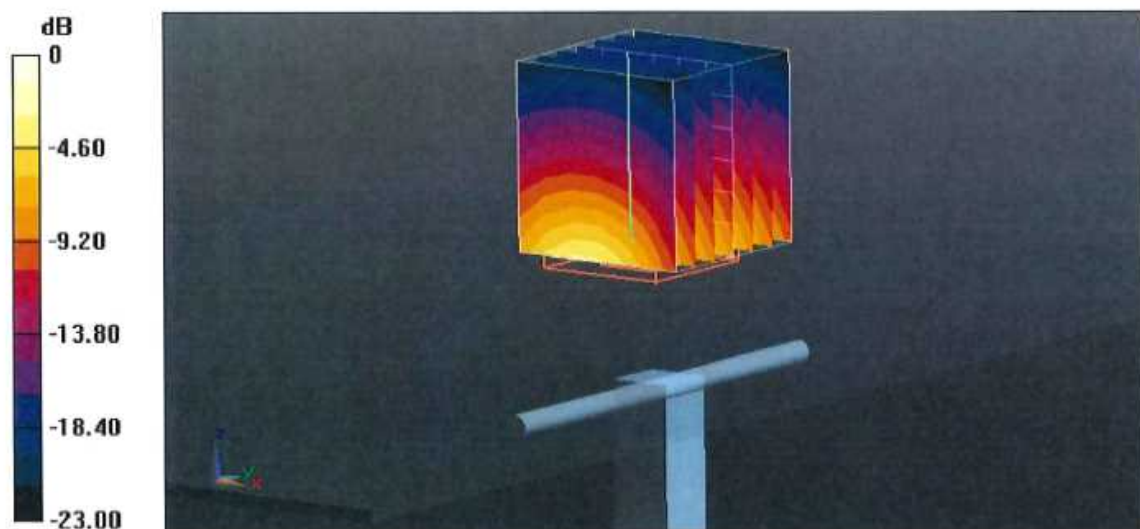
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.264 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 27.9 W/kg

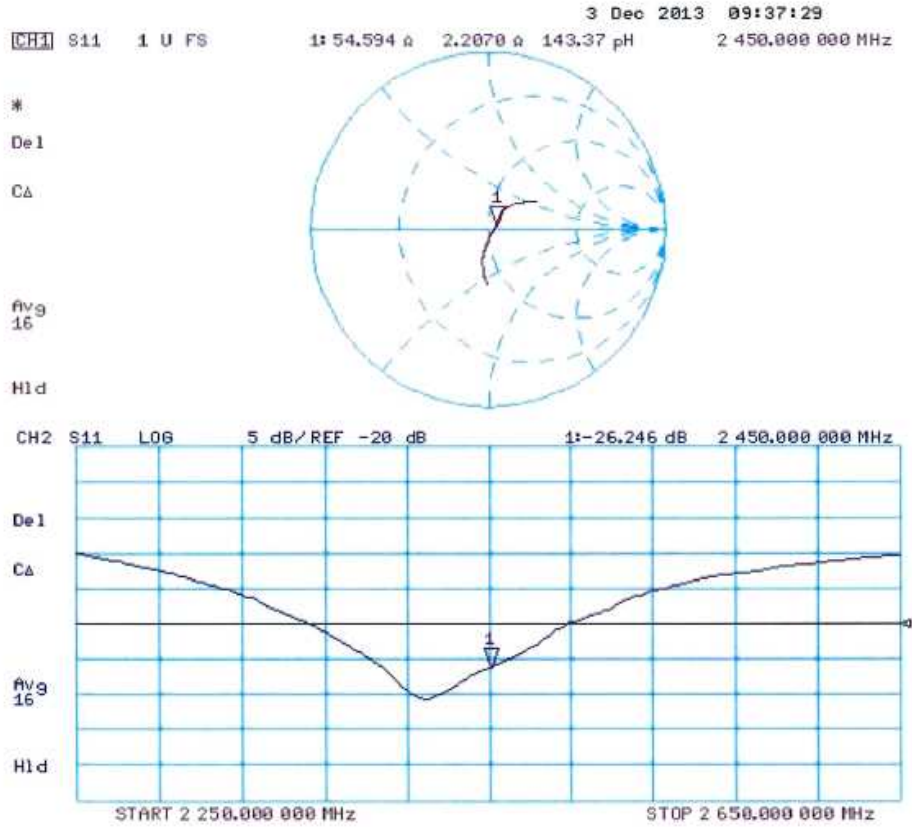
**SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.11 W/kg**

Maximum value of SAR (measured) = 16.8 W/kg



0 dB = 16.8 W/kg = 12.25 dBW/kg

### Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 03.12.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 925**

Communication System: UID 0 - CW ; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.02$  S/m;  $\epsilon_r = 52.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.42, 4.42, 4.42); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

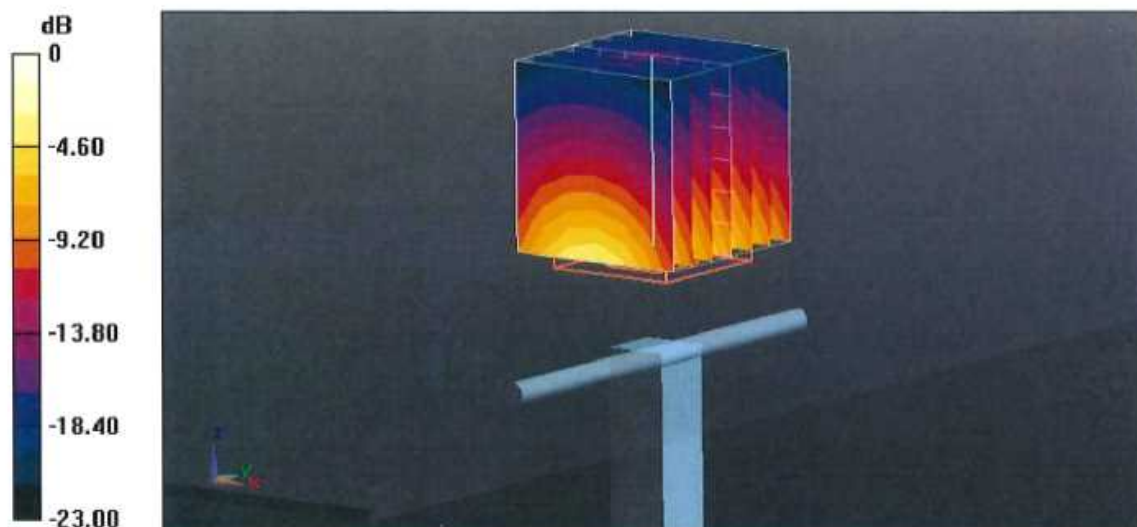
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.264 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 27.2 W/kg

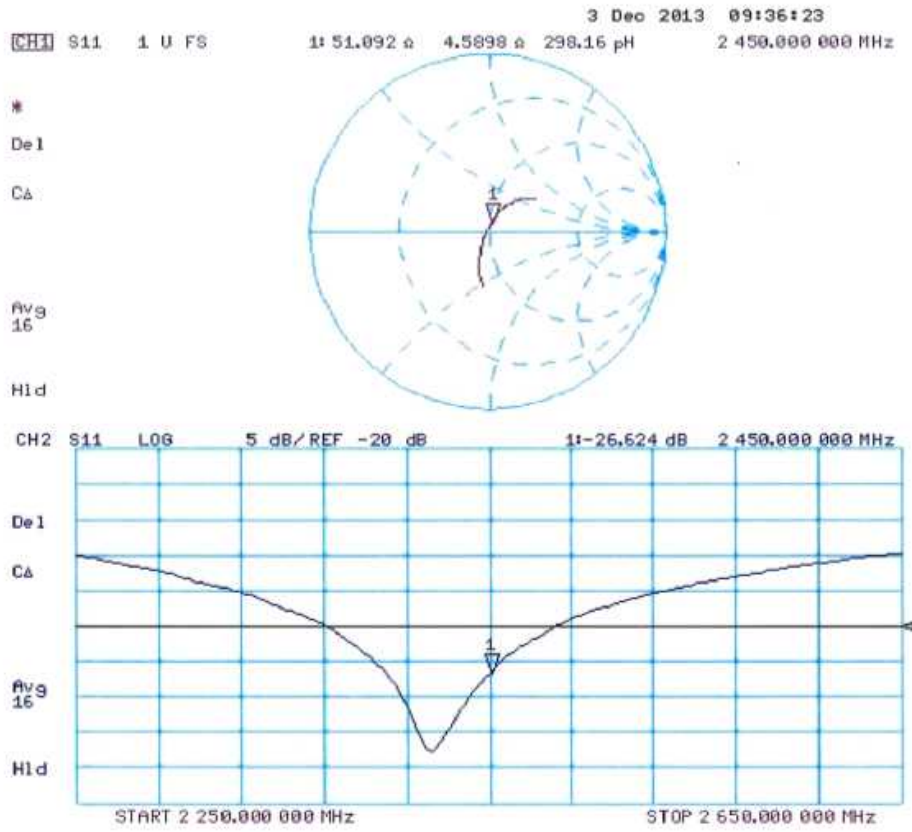
SAR(1 g) = 12.9 W/kg; SAR(10 g) = 5.94 W/kg

Maximum value of SAR (measured) = 16.9 W/kg



0 dB = 16.9 W/kg = 12.28 dBW/kg

### Impedance Measurement Plot for Body TSL





## **Attachment 3. SAR system validation**

### **SAR System Validation**

Per FCC KDB 865664 D02v01r01, SAR system validation status should be documented to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the required tissue- equivalent media for system validation, according to the procedures outlined in IEEE 1528-2003 and FCC KDB 865664 D01v01r01. Since SAR probe calibrations are frequency dependent, each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media. A tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probes and tissue dielectric parameters has been included.

**Table Attachment 3.1 SAR System Validation Summary**

SAR System	Freq. [MHz]	Data	Probe Type	Probe CAL. Point		PERM.	COND.	CW Validation			MOD. Validation		
						( $\epsilon_r$ )	( $\sigma$ )	Sensitivity	Probe Linearity	Probe Isotropy	MOD. Type	Duty Factor	PAR
E	835	2014-09-17	3957	835	Head	41.603	0.925	PASS	PASS	PASS	GMSK	PASS	N/A
E	1900	2014-09-24	3957	1900	Head	39.519	1.407	PASS	PASS	PASS	GMSK	PASS	N/A
E	2450	2014-09-16	3957	2450	Head	38.838	1.851	PASS	PASS	PASS	OFDM	N/A	PASS
E	835	2014-09-18	3957	835	Body	54.404	1.008	PASS	PASS	PASS	GMSK	PASS	N/A
E	1900	2014-09-23	3957	1900	Body	52.315	1.522	PASS	PASS	PASS	GMSK	PASS	N/A
E	2450	2014-09-17	3957	2450	Body	52.291	1.982	PASS	PASS	PASS	OFDM	N/A	PASS