

FCC SAR TEST REPORT

Test File No : F690501/RF-SAR002194-A1

Equipment Under Test	Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN
Model No.	LG-D724
Alternative models	LGD724, D724, LG-D723, LGD723, D723, LG-D723AR, LGD723AR, D723AR
Applicant	LG Electronics MobileComm U.S.A., Inc.
Address of Applicant	10101 Old Grove Road, San Diego, CA 92131
FCC ID	ZNFD724
Device Category	Portable Device
Exposure Category	General Population/Uncontrolled Exposure
Standards	FCC 47 CFR Part 2 (2.1093) IEEE 1528, 2003 ANSI/IEEE C95.1, C95.3
Date of Test(s)	2014-05-22 ~ 2014-07-03
Date of Issue	2014-07-04

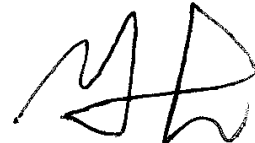
In the configuration tested, the EUT complied with the standards specified above.

Remarks:

This report details the results of the testing carried out on one sample, the results contained in this test report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report. This report may only be reproduced and distributed in full. If the product in this report is used in any configuration other than that detailed in the report, the manufacturer must ensure the new system complies with all relevant standards. Any mention of SGS Korea Co., Ltd. or testing done by SGS Korea Co., Ltd. in connection with distribution or use of the product described in this report must be approved by SGS Korea Co., Ltd. in writing.



Report prepared by /
Jongwon Ma
Test Engineer



Approved by /
Nicky You
Technical Manager

Revision history

Revision	Date of issue	Revisions	Revised By
-	June 27, 2014	Initial issue	-
A1	July 04, 2014	- Section 14. Added to the note. - Added SAR test the GPRS850 3-slot data (head and hotspot). - SAR exclusions table updated. - Section 23.4 and 23.5 Simultaneous Transmission updated. - Section 21.2 WCDMA1900 data table updated..	Jongwon Ma

Contents

1	Testing Laboratory	5
2	Details of Applicant	5
3	Description of EUT(s)	5
4	The Highest Reported SAR Values	5
5	Test Methodology	6
6	Test Environment	6
7	Specific Absorption Rate (SAR)	7
7.1	Introduction	7
7.2	SAR Definition	7
7.3	Test Standards and Limits	7
8	The SAR Measurement System	9
9	System Components	10
9.1	Probe	10
9.2	SAM Phantom	10
9.3	Device Holder	11
10	SAR Measurement Procedures	11
10.1	Normal SAR Measurement Procedure	11
11	Definition of Reference	13
11.1	EAR Reference Point	13
11.2	EUT constructions	14
11.3	Positioning for Touch	14
11.4	Positioning for Ear/15° Tilt	15
11.5	Body-Worn Accessory Configurations	15
11.6	Wireless Router Configurations	16
11.7	DUT Antenna Locations	17
11.8	Mobile Hotspot sides for SAR Testing configurations	17
12	SAR System Verification	18
13	Tissue Simulant Fluid for the Frequency Band	20
14	Test System Validation	22
15	Instruments List	23
15.1	Instruments List of Added SAR Test	24
16	FCC Power Measurement Procedures	25
17	Measured and Reported SAR	25
18	Nominal and Maximum Output Power Specifications	26
19	RF Conducted Power Measurement	28
19.1	GSM Conducted Power	28
19.2	WCDMA	29
19.3	WLAN	31
20	SAR Test Exclusions Applied	33
21	SAR Data Summary	34
21.1	Head SAR Data	34
21.2	Body-Worn SAR Data	35
21.3	Hotspot SAR Data	36
22	SAR Measurement Variability	39

22.1	Measurement Variability_____	39
22.2	Measurement Uncertainty_____	39
23	FCC Multi-TX and Antenna SAR considerations_____	40
23.1	Introduction_____	40
23.2	Simultaneous Transmission Procedures_____	40
23.3	Simultaneous Transmission Scenarios_____	40
23.4	Head SAR Simultaneous Transmission Analysis_____	41
23.5	Body-Worn SAR Simultaneous Transmission Analysis_____	43
23.6	Hotspot SAR Simultaneous Transmission Analysis_____	44
	Appendixes List_____	45
	Appendixes A.1_____	46
	Appendixes A.2_____	48
	Appendixes A.3_____	52
	Appendixes A.4_____	54
	Appendixes A.5_____	56
	Appendixes A.6_____	59
	Appendixes A.7_____	62
	Appendixes A.8_____	65
	Appendixes A.9_____	67
	Appendixes A.10_____	70
	Appendixes B.1_____	72
	Appendixes C.1_____	74
	Appendixes C.2_____	85
	Appendixes C.3_____	95
	END_____	118

1. Testing Laboratory

Company Name	SGS Korea Co., Ltd. (Gunpo Laboratory)
Address	Wireless Div. 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, 435-040 Republic of Korea
Telephone	+82 +31 428 5700
FAX	+82 +31 427 2371
Homepage	All SGS services are rendered in accordance with the applicable SGS conditions of service available on request and accessible at http://www.sgs.com/en/Terms-and-Conditions.aspx

2. Details of Manufacturer

Applicant	LG Electronics MobileComm U.S.A., Inc.
Address	10101 Old Grove Road, San Diego, CA 92131
Contact Person	Smyung-Lee
Email	Smyung.lee@lge.com
Phone No.	82-2-2033-4606

3. Description of EUT(s)

EUT Type	Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN
Model	LG-D724
Alternative models	LGD724, D724, LG-D723, LGD723, D723, LG-D723AR, LGD723AR, D723AR
Serial Number	404KPCA642467
Mode of Operation	GSM850 / GSM1900 / WCDMA850 / WCDMA1900 / WLAN / Bluetooth
Duty Cycle	8.3(GPRS 1Tx Slot), 4.15(GPRS 2Tx Slot), 2.77 (GPRS 3Tx Slot), 2.075 (GPRS 4Tx Slot), 1 (WCDMA, WLAN)
Body worn Accessory	None
Tx Frequency Range	GSM850 (824.20 MHz ~ 848.80 MHz) GSM1900 (1850.20 MHz ~ 1909.80 MHz) WCDMA 850 (826.40 MHz ~ 846.60 MHz) WCDMA 1900 (1852.40 MHz ~ 1907.60 MHz) 802.11b/g/n WLAN 2.4 GHz (2412.0 MHz ~ 2462.0 MHz) Bluetooth (2402.0 MHz ~ 2480.0 MHz)

4. The Highest Reported SAR Values

Equipment Class	Band	Tx Frequency (MHz)	Reported 1g SAR (W/kg)		
			Head	Body-Worn	Hotspot
PCE	GSM/GPRS850	824.2 ~ 848.8	0.28	0.42	0.53
PCE	GSM/GPRS1900	1850.2 ~ 1909.8	0.31	0.40	0.39
PCE	WCDMA 850	826.4 ~ 846.6	0.15	0.23	0.23
PCE	WCDMA 1900	1852.4 ~ 1907.6	0.65	1.07	1.08
DTS	2.4 GHz WLAN	2412.0 ~ 2462.0	0.33	0.07	0.07
DSS	Bluetooth	2402.0 ~ 2480.0	N/A	N/A	N/A
Simultaneous SAR per KDB 690783 D01v01r03			1.03	1.26	1.15

5. Test Methodology

ANSI C95.1-1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz. It specifies the maximum exposure limit of 1.6 W/kg as averaged over any 1 gram of tissue for portable devices being used within 20 cm of the user in the uncontrolled environment.

Test tests documented in this report were performed in accordance with IEEE Standard 1528-2003 & IEEE 1528a-2005 and the following published KDB procedures.

In additions;

☒	KDB 865664 D01v01r03	SAR Measurement Requirements for 100 MHz to 6 GHz
☒	KDB 447498 D01v05r02	Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies
☐	KDB 447498 D02v02	SAR Measurement Procedures for USB Dongle Transmitters
☒	KDB 248227 D01v01r02	SAR Measurement Procedures for 802.11a,b,g Transmitters
☐	KDB 615223 D01v01	802.16e/WiMax SAR Measurement Guidance
☐	KDB 616217 D04v01r01	SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers
☐	KDB 643646 D01v01r01	SAR Test Reduction Considerations for Occupational PTT Radios
☐	KDB 648474 D03v01r02	Evaluation and Approval Considerations for Handsets with Specific Wireless Charging Battery Covers
☒	KDB 648474 D04v01r02	SAR Evaluation Considerations for Wireless Handsets
☐	KDB 680106 D01v02	RF Exposure Considerations for Low Power Consumer Wireless Power Transfer Applications
☒	KDB 941225 D01v02	SAR Measurement Procedures for 3G Devices (CDMA 2000 / Ev-Do, WCDMA/HSDPA/HS-PA)
☒	KDB 941225 D02v02r02	SAR Guidance for HSPA, HSPA+, DC-HSDPA and 1x-Advanced
☒	KDB 941225 D03v01	Recommended SAR Test Reduction Procedures for GSM/GPRS/EDGE
☐	KDB 941225 D04v01	Evaluating SAR for GSM/(E)GPRS Dual Transfer Mode
☐	KDB 941225 D05v02r03	SAR Evaluation Considerations for LTE Devices
☒	KDB 941225 D06v01r01	SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities
☐	KDB 941225 D07v01r01	SAR Evaluation Procedures for UMPC Mini-Tablet Devices

6. Testing Environment

Ambient temperature	18°C ~ 25°C
Relative humidity	30% ~ 70%
Liquid temperature of during the test	< □ 2°C
Ambient noise & Reflection	< 0.012 W/kg

7. Specific Absorption Rate (SAR)

7.1 Introduction

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

7.2 SAR Definition

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

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

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

SAR measurement can be either related to the temperature elevation in tissue by

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

Where: C is the specific heat capacity, δT is the temperature rise and δt is the exposure duration, or related to the electrical field in the tissue by

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

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength.

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

7.3 Test Standards and Limits

According to FCC 47CFR §2.1093(d) The limits to be used for evaluation are based generally on criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate ("SAR") in Section 4.2 of "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," ANSI/IEEE C95.3-2003, Copyright 2003 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017. 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, Section 17.4.5. Copyright NCRP, 1986, Bethesda, Maryland 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. The criteria to be used are specified in paragraphs (d)(1) and (d)(2) of this section and shall apply for portable devices transmitting in the

frequency range from 100 kHz to 6 GHz. Portable devices that transmit at frequencies above 6 GHz are to be evaluated in terms of the MPE limits specified in § 1.1310 of this chapter. Measurements and calculations to demonstrate compliance with MPE field strength or power density limits for devices operating above 6 GHz should be made at a minimum distance of 5 cm from the radiating source.

(1) Limits for Occupational/Controlled exposure: 0.4 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 8 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 20 W/kg, as averaged over an 10 grams of tissue (defined as a tissue volume in the shape of a cube). Occupational/Controlled limits apply when persons are exposed as a consequence of their employment provided these persons are fully aware of and exercise control over their exposure. Awareness of exposure can be accomplished by use of warning labels or by specific training or education through appropriate means, such as an RF safety program in a work environment.

(2) Limits for General Population/Uncontrolled exposure: 0.08 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 1.6 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube). General Population/Uncontrolled limits apply when the general public may be exposed, or when persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or do not exercise control over their exposure. Warning labels placed on consumer devices such as cellular telephones will not be sufficient reason to allow these devices to be evaluated subject to limits for occupational/controlled exposure in paragraph (d)(1) of this section.

Human Exposure	Uncontrolled Environment General Population	Controlled Environment Occupational
Partial Peak SAR (Partial)	1.60 m W/g	8.00 m W/g
Partial Average SAR (Whole Body)	0.08 m W/g	0.40 m W/g
Partial Peak SAR (Hands/Feet/Ankle/Wrist)	4.00 m W/g	20.00 m W/g

1. The spatial Peak value of the SAR averaged over any 1g gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
2. The spatial Average value of the SAR averaged over the whole body.
3. The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

8. The SAR Measurement System

A block diagram of the SAR measurement System is given in Fig. a. This SAR Measurement System uses a Computer-controlled 3-D stepper motor system (SPEAG DASY 5 professional system). The model EX3DV4 field probe is used to determine the internal electric fields. The SAR can be obtained from the equation $SAR = \sigma (|E_i|^2) / \rho$ where σ and ρ are the conductivity and mass density of the tissue-simulant.

The DASY 5 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Staubli TX family) with controller, teach pendant and software. An arm extension is for accommodating the data acquisition electronics (DAE).
- A dosimeter probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- Data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.

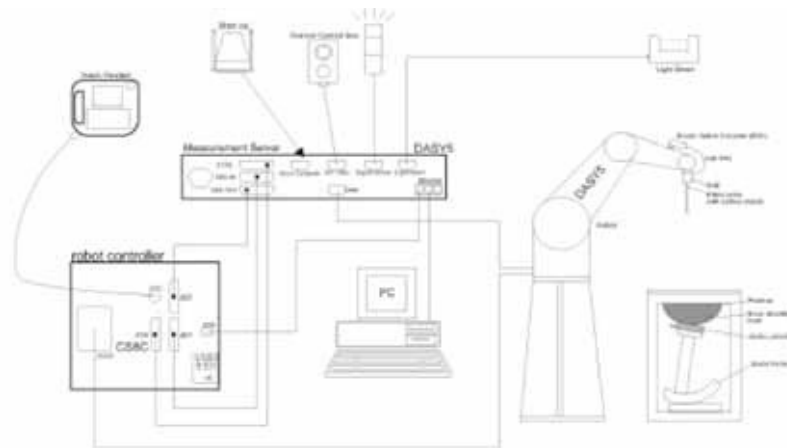


Fig a. The microwave circuit arrangement used for SAR system verification

- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows7
- DASY 5 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM phantom enabling testing left-hand and right-hand usage.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing to validate the proper functioning of the system.

9. System Components

9.1 Probe

Construction	: Symmetrical design with triangular core. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	: Basic Broad Band Calibration in air Conversion Factors (CF) for HSL 835 and HSL1900. Additional CF-Calibration for other liquids and frequencies upon request.
Frequency	: 10 MHz to 6 GHz; Linearity: ± 0.2 dB (30 MHz to 6 GHz)
Directivity	: ± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic Range	: $10\mu\text{W/g}$ to > 100 m W/g; Linearity: ± 0.2 dB(noise: typically $< 1\mu\text{W/g}$)
Dimensions	: Overall length: 337 mm (Tip length: 20 mm) Tip diameter: 2.5 mm (Body diameter: 12 mm) Distance from probe tip to dipole centers: 1 mm
Application	: High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%
Construction	: Symmetrical design with triangular core. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE)



EX3DV4 E-Field Probe

NOTE:

1. The Probe parameters have been calibrated by the SPEAG. Please reference "APPENDIX C" for the Calibration Certification Report.

9.2 SAM Phantom

Construction	: The SAM Phantom is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90 % of all users. 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
Shell Thickness	: $2.0\text{ mm} \pm 0.1\text{ mm}$
Filling Volume	: Approx. 25 liters



SAM Phantom

9.3 Device Holder

Construction: : In combination with the Twin SAM PhantomV4.0/V4.0C or Twin SAM, the Mounting Device (made from POM) enables the rotation of the mounted transmitter in spherical coordinates, whereby the rotation point is the ear opening. The devices can be easily and accurately positioned according to IEC, IEEE, CENELEC, FCC or other specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).



Device Holder

10. SAR Measurement Procedures

10.1 Normal SAR Measurement Procedure

Step 1: Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The Minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2 mm. This distance cannot be smaller than the Distance of sensor calibration points to probe tip as defined in the probe properties.

Step 2 and 3: Area Scan & Zoom Scan Procedures

The entire evaluation of the spatial peak values is performed within the Post-processing engine (SEMCAD). The system always gives the maximum values for the 1 g and 10 g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

1. The extraction of the measured data (grid and values) from the Zoom Scan.
2. The calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
3. The generation of a high-resolution mesh within the measured volume
4. The interpolation of all measured values from the measurement grid to the high-resolution grid
5. The extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
6. The calculation of the averaged SAR within masses of 1 g and 10 g.

Step 4: Power drift measurement

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

< Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01r03 >

			≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface			5 ± 1 mm	$\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location			$30^{\circ} \pm 1^{\circ}$	$20^{\circ} \pm 1^{\circ}$
Maximum area scan spatial resolution: Δx_{Area} , Δy_{Area}			≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
			When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be $\leq$ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	
Maximum zoom scan spatial resolution: Δx_{Zoom} , Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1 st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm
Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.				
* When zoom scan is required and the <u>reported</u> SAR from the area scan based <i>1-g SAR estimation</i> procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.				

11. Definition of Reference

11.1 EAR Reference Point

Fig 2 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 ear canal (EEC) along the B-M line (Back-Mouth), as shown in Fig 3. 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 Fig 4). 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.

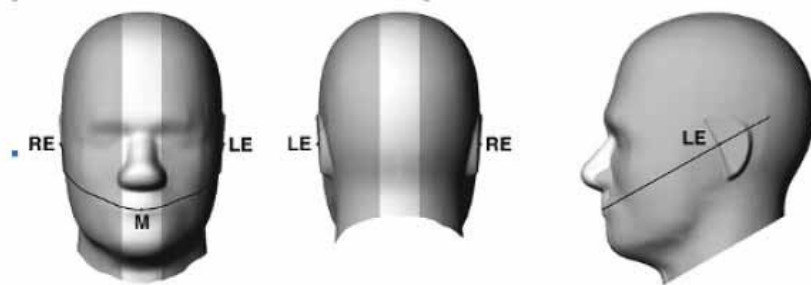


Fig 2 Front, back and side view of SAM Twin Phantom

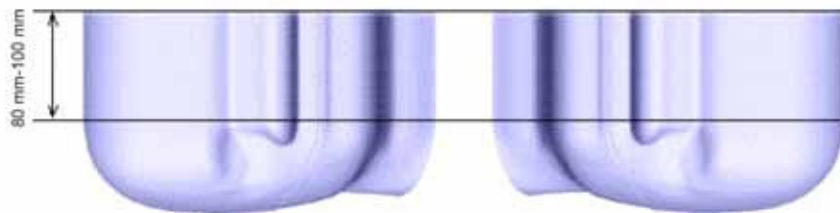


Fig 3 Sagittally bisected phantom with extended perimeter (shown placed on its side as used for device SAR tests)

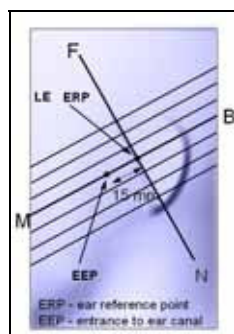


Fig 4 Close-up side view of ERP

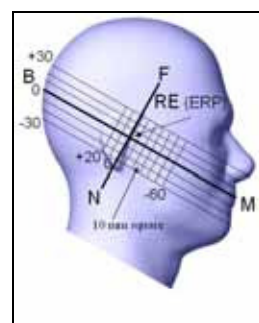


Fig 5 Side view of the phantom showing relevant markings

11.2 EUT constructions

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. 6). 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 outer surface of the both the left and right head phantoms on the ear reference point.

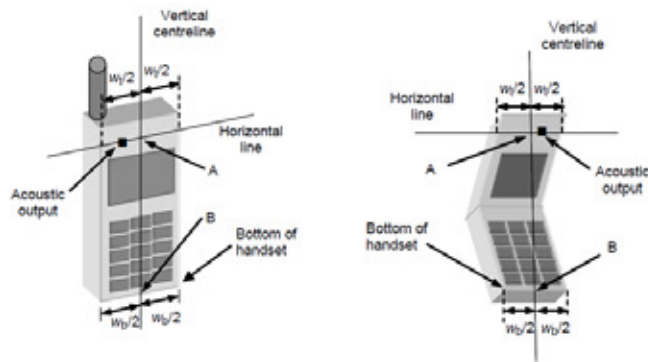


Fig 6 Handset Vertical Center & Horizontal Line Reference Points

11.3 Positioning for Touch

- a) Position the device with the vertical centre line of the body of the device and the horizontal line crossing the centre of the ear piece in a plane parallel to the sagittal plane of the phantom (initial position). While maintaining the device in this plane, align the vertical centre line with the reference plane containing the three ear and mouth reference points (M, RE and LE) and align the centre of the ear piece with the line RE-LE;
- b) Translate the handset towards the phantom along the line passing through RE and LE until the handset touches the ear.
- c) While maintaining the device in this plane, rotate it around the LE-RE line until the vertical centerline is in the plane normal to MB-NF including the line MB (called the reference plane).
- d) Rotate the phone around the vertical centerline until the phone (horizontal line) is symmetrical with respect to the line NF.
- e) 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, rotate the handset about the line NF until any point on the handset is in contact with a phantom point below the pinna (cheek). (see Fig. 7) The physical angles of rotation should be

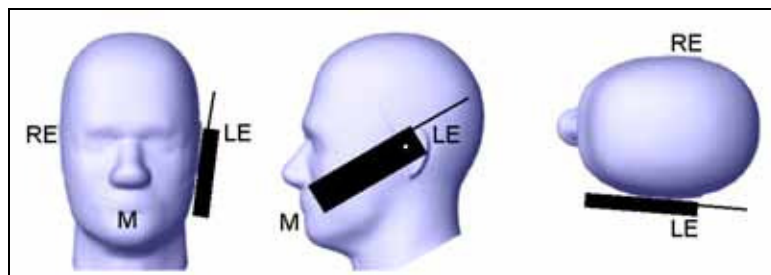


Fig 7 Cheek/Touch position of the wireless device on the left side of SAM

11.4 Positioning for Ear/15° Tilt

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

- a) While maintain the device in the reference plane described above and pivoting against the ear, move it outward away from the mouth by an angle of 15 degrees or until contact with the ear is lost.
- b) The phone was then rotated around the horizontal line by 15 degrees.
- c) While maintaining the orientation of the phone, the phone was moved parallel to the reference plane until any part of the handset touched 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. In this situation, 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 Fig 8).

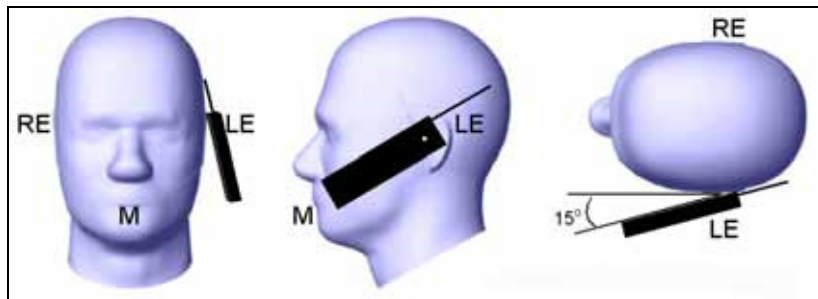


Fig 8 Ear/15° Tilt position of the wireless device on the left side of SAM

11.5 Body-Worn Accessory Configurations

Body-worn operation configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration. A device with a headset output is tested with a headset connected to the device.

Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are supplied with the device, the device is tested with each accessory that contains a unique metallic component. 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.

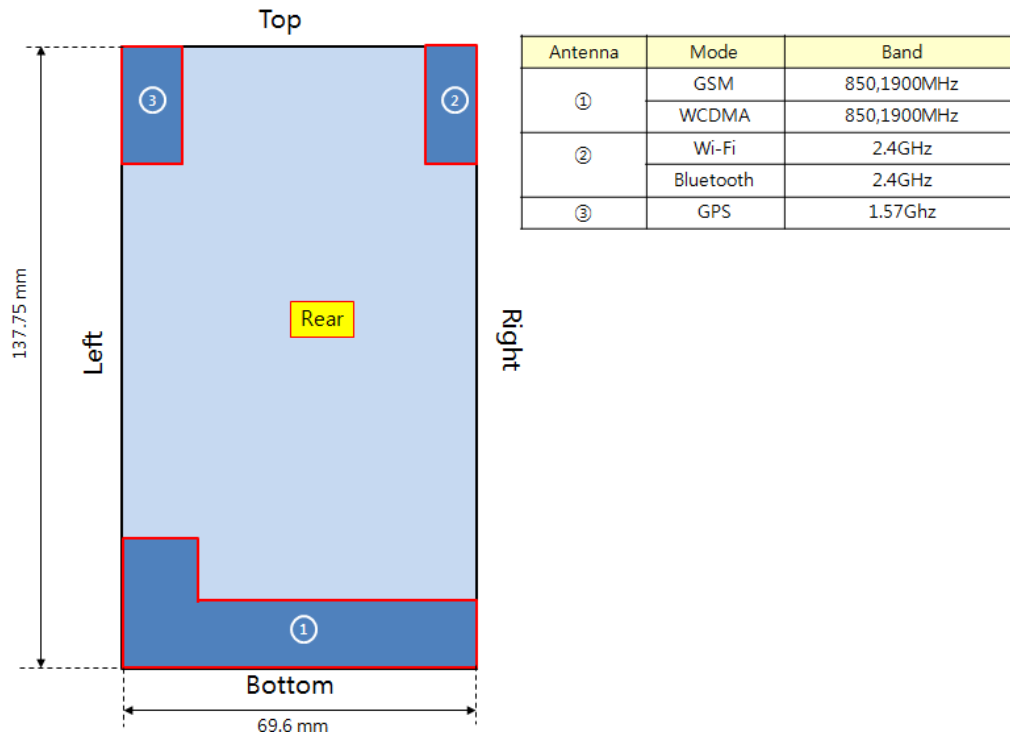
Body-worn accessories may not always be supplied of available as options for some devices intended to be authorized for body-worn use. In this case, a test configuration where a separation distances between the back of the device and the flat phantom is used. Test position spacing was documented.

11.6 Wireless Router Configurations

Some battery-operated handsets have the capability to transmit and receive user data through simultaneous transmission of WLAN simultaneously with a separate licensed transmitter. The FCC has provided guidance in FCC KDB Publication 941225 D06 v01r01 where SAR test considerations for handsets (L x W □ 9 cm x 5 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 WLAN 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 WLAN 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.

11.7 DUT Antenna Locations



11.8 Mobile Hotspot sides for SAR Testing configurations

Mode	Rear	Front	Left Edge	Right Edge	Bottom	Top
GPRS 850	Yes	Yes	Yes	Yes	Yes	No
GPRS 1900	Yes	Yes	Yes	Yes	Yes	No
WCDMA 850	Yes	Yes	Yes	Yes	Yes	No
WCDMA 1900	Yes	Yes	Yes	Yes	Yes	No
WLAN 2.4 GHz	Yes	Yes	No	Yes	No	Yes

Notes

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 Publication 941225 D06v01r01 guidance, page 2. The antenna document shows the distances between the transmit antennas and the edges of the device.

12. SAR System Verification

The microwave circuit arrangement for system verification is sketched in Fig. 9. The daily system accuracy verification occurs within the flat section of the SAM phantom. A SAR measurement was performed to see if the measured SAR was within $\pm 10\%$ from the target SAR values. These tests were done at 835 MHz, 1900 MHz and 2.4 GHz. The tests were conducted on the same days as the measurement of the DUT. The obtained results from the system accuracy verification are displayed in the table 1. (SAR values are normalized to 1W forward power delivered to the dipole). During the tests, the ambient temperature of the laboratory was in the range $(22 \pm 2)^\circ\text{C}$, the relative humidity was in the range $(55 \pm 5)\%$ R.H and the liquid depth above the ear reference points was $\geq 15\text{ cm} \pm 5\text{ mm}$ (frequency $\leq 3\text{ GHz}$) or $\geq 10\text{ cm} \pm 5\text{ mm}$ (frequency $> 3\text{ GHz}$) in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.

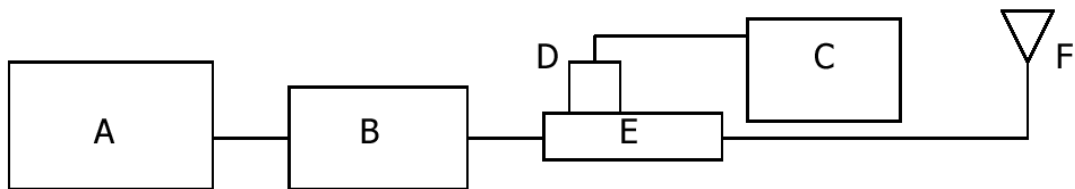


Fig 9. The microwave circuit arrangement used for SAR system verification

- A. Agilent Model E8247C Signal Generator
- B. EMPOWER Model 2001-BBS3Q7ECK Amplifier
- C. Agilent Model E4419B Power Meter
- D. Agilent Model 9300H Power Sensor
- E. Agilent Model 86205A Directional RF Bridges
- F. Reference dipole Antenna



Photo of the dipole Antenna

Verification Kit	Probe S/N	Tissue (MHz)	Target SAR 1 g from Standard (1 W)	Target SAR 10 g from Standard (1 W)	Normalized SAR 1 g (1 W)	Normalized SAR 10 g (1 W)	1g Deviation (%)	10g Deviation (%)	Date	Liquid Temp. (°C)
D835V2 SN:4d138	3862	835 Head	9.44	6.16	9.81	6.43	3.92	4.38	2014-05-22	21.9
D835V2 SN:4d138	3862	835 Body	9.32	6.12	9.37	6.25	0.54	2.12	2014-05-23	22.1
D835V2 SN:4d138	3862	835 Head	9.44	6.16	9.13	6.00	-3.28	-2.60	2014-07-03	22.2
D835V2 SN:4d138	3862	835 Body	9.32	6.12	9.33	6.20	0.11	1.31	2014-07-03	22.4
D1900V2 SN:5d158	3862	1900 Head	40.10	21.00	41.00	21.10	2.24	0.48	2014-05-24	22.2
D1900V2 SN:5d158	3862	1900 Body	39.70	21.10	40.60	21.30	2.27	0.95	2014-05-25	22.0
D1900V2 SN:5d158	3862	1900 Head	40.10	21.00	39.30	20.50	-2.00	-2.38	2014-06-10	21.8
D1900V2 SN:5d158	3862	1900 Body	39.70	21.10	40.30	21.20	1.51	0.47	2014-06-10	21.9
D2450V2 SN:892	3862	2450 Head	52.40	24.40	51.30	23.30	-2.10	-4.51	2014-05-28	22.2
D2450V2 SN:892	3862	2450 Body	50.10	23.20	51.30	23.40	2.40	0.86	2014-05-28	21.9

Table1. Results system verification

13. Tissue Simulant Fluid for the Frequency Band

The dielectric properties for this simulant fluid were measured by using the Speag Model DAK-3.5 Dielectric Probe in conjunction with Agilent E5071C and E5070B Network Analyzer by using a procedure detailed in Section V.

f (MHz)	Tissue type	Limits / Measured	Dielectric Parameters		
			Permittivity	Conductivity	Simulated Tissue Temp(°C)
835	Head	Measured, 2014-05-22	40.7	0.90	21.9
		Target Tissue	41.5	0.90	
		Deviation (%)	-1.93	0.00	
835	Body	Measured, 2014-05-23	55.9	0.95	22.1
		Target Tissue	55.2	0.97	
		Deviation (%)	1.27	-2.06	
835	Head	Measured, 2014-07-03	40.0	0.89	22.2
		Target Tissue	41.5	0.90	
		Deviation (%)	-3.61	-1.11	
835	Body	Measured, 2014-07-03	53.9	0.94	22.4
		Target Tissue	55.2	0.97	
		Deviation (%)	-2.36	-3.09	
1900	Head	Measured, 2014-05-24	39.3	1.44	22.2
		Target Tissue	40.0	1.40	
		Deviation (%)	-1.75	2.86	
1900	Body	Measured, 2014-05-25	53.8	1.52	22.0
		Target Tissue	53.3	1.52	
		Deviation (%)	0.94	0.00	
1900	Head	Measured, 2014-06-10	39.4	1.43	21.8
		Target Tissue	40.0	1.40	
		Deviation (%)	-1.50	2.14	
1900	Body	Measured, 2014-06-10	54.0	1.56	21.9
		Target Tissue	53.3	1.52	
		Deviation (%)	1.31	2.63	
2450	Head	Measured, 2014-05-28	38.2	1.78	22.2
		Target Tissue	39.2	1.80	
		Deviation (%)	-2.55	-1.11	
2450	Body	Measured, 2014-05-28	52.6	1.92	21.9
		Target Tissue	52.7	1.95	
		Deviation (%)	-0.19	-1.54	

The composition of the brain & muscle tissue simulating liquid

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

Ingredients (% by weight)	Frequency (MHz)									
	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (NaCl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (S/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

Salt: 99 +% Pure Sodium Chloride

Sugar: 98 +% Pure Sucrose

Water: De-ionized, 16 MΩ⁺ 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]ether

Simulating Liquids for 5 GHz, Manufactured by SPEAG

Ingredients	(% by weight)
Water	78
Mineral Oil	11
Emulsifiers	9
Additives and Salt	2

14. Test System Validation

Per FCC KDB 865664 D01v01r03, 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 require tissue-equivalent media for system validation, according to the procedures outlined in IEEE 1528-2003 and FCC KDB 865664 D01v01r03. Since 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 probe and tissue dielectric parameters has been included.

f (MHz)	Date	Probe S/N	Probe Cal point	Tissue Type	Dielectric Parameters		CW Validation			Modulated Validation		
					Permit tivity	Condu ctivity	Sensitivity	Probe Linearity	Probe Isotropy	Mod. Type	Duty Factor	PAR
835	2014-02-17	3862	835	Head	42.2	0.91	PASS	PASS	PASS	GMSK	PASS	N/A
835	2014-02-17	3862	835	Body	56.0	0.94	PASS	PASS	PASS	GMSK	PASS	N/A
1900	2014-02-18	3862	1900	Head	39.6	1.36	PASS	PASS	PASS	GMSK	PASS	N/A
1900	2014-02-18	3862	1900	Body	54.1	1.49	PASS	PASS	PASS	GMSK	PASS	N/A
2450	2014-02-14	3862	2450	Head	39.6	1.83	PASS	PASS	PASS	OFDM	N/A	PASS
2450	2014-02-14	3862	2450	Body	53.3	1.96	PASS	PASS	PASS	OFDM	N/A	PASS

< SAR System Validation Summary >

Note

All measurement were performed using probes calibrated for CW signal only. Modulations in the table above represent test configurations for which the measurement system has been validated per FCC KDB Publication 865664 D01v01r03. SAR system were validated for modulated signals with a periodic duty cycle, such as GMSK, or with a high peak to average ratio (>5 dB), such as OFDM according to KDB 865664 D01v01r03.

15. Instruments List Test Date 2014-05-22 ~ 2014-06-10

Manufacturer	Device	Type	Serial Number	Cal Date	Cal Interval	Cal Due
Stäubli	Robot	TX90XL	F12/5LP8A1/A/01	N/A	N/A	N/A
SPEAG	E-Field Probe	EX3DV4	3862	01/29/2014	Annual	01/29/2015
SPEAG	835 MHz System Validation Dipole	D835V2	4d138	09/27/2013	Biennial	09/27/2015
SPEAG	1900 MHz System Validation Dipole	D1900V2	5d158	09/27/2013	Biennial	09/27/2015
SPEAG	2450 MHz System Validation Dipole	D2450V2	892	09/26/2013	Biennial	09/26/2015
SPEAG	Data acquisition Electronics	DAE4	1340	05/19/2014	Annual	05/19/2015
SPEAG	Data acquisition Electronics	DAE4	614	09/20/2013	Annual	09/20/2014
SPEAG	Software	DASY5 V52	-	N/A	N/A	N/A
SPEAG	Phantom	SAM Phantom	TP-1720 TP-1721	N/A	N/A	N/A
Agilent	Network Analyzer	E5071C	MY46111535	06/27/2013	Annual	06/27/2014
SPEAG	Dielectric Assessment Kit	DAK-3.5	1107	01/19/2014	Annual	01/19/2015
Agilent	Power Meter	E4419B	GB43311715	06/26/2013	Annual	06/26/2014
Agilent	Power Sensor	E9300H	MY41495314	09/10/2013	Annual	09/10/2014
			MY41495307	09/10/2013	Annual	09/10/2014
Agilent	Signal Generator	E4421B	MY43350132	06/27/2013	Annual	06/27/2014
Empower RF Systems	Power Amplifier	2001-BBS3Q7ECK	1032 D/C 0336	01/02/2014	Annual	01/02/2015
Agilent	Directional Bridges	86205A	MY31402302	06/29/2013	Annual	06/29/2014
Microlab	LP Filter	LA-15N	N/A	09/09/2013	Annual	09/09/2014
Microlab	LP Filter	LA-30N	N/A	09/09/2013	Annual	09/09/2014
Agilent	Attenuator	8491B	50566	09/09/2013	Annual	09/09/2014
JUMBP	Hygro-Thermometer	BJ5478	12091382-1	07/02/2013	Annual	07/02/2014
LKM Electronic	Digital Thermometer	DTM3000	3027	07/01/2013	Annual	07/01/2014
Agilent	Spectrum Analyzer	E4445A	MY44020523	07/26/2013	Annual	07/26/2014
ROHDE & SCHWARZ	Communication Tester	CMW500	144030	03/03/2014	Annual	03/03/2015

15.1 Added SAR Test of Instruments List Test Date 2014-07-03

Manufacturer	Device	Type	Serial Number	Cal Date	Cal Interval	Cal Due
Stäubli	Robot	TX90XL	F12/5LP8A1/A/01	N/A	N/A	N/A
SPEAG	E-Field Probe	EX3DV4	3862	01/29/2014	Annual	01/29/2015
SPEAG	835 MHz System Validation Dipole	D835V2	4d138	09/27/2013	Biennial	09/27/2015
SPEAG	Data acquisition Electronics	DAE4	1340	05/19/2014	Annual	05/19/2015
SPEAG	Software	DASY5 V52	-	N/A	N/A	N/A
SPEAG	Phantom	SAM Phantom	TP-1720 TP-1721	N/A	N/A	N/A
Agilent	Network Analyzer	E5070B	MY42100282	01/02/2014	Annual	01/02/2015
SPEAG	Dielectric Assessment Kit	DAK-3.5	1107	01/19/2014	Annual	01/19/2015
Agilent	Power Meter	E4419B	GB43311715	06/25/2014	Annual	06/25/2015
Agilent	Power Sensor	E9300H	MY41495314	09/10/2013	Annual	09/10/2014
			MY41495307	09/10/2013	Annual	09/10/2014
Agilent	Signal Generator	E4421B	MY43350132	06/25/2014	Annual	06/25/2015
Empower RF Systems	Power Amplifier	2001-BBS3Q7ECK	1032 D/C 0336	01/02/2014	Annual	01/02/2015
Agilent	Directional Coupler	778D	50454	07/01/2014	Annual	07/01/2015
Microlab	LP Filter	LA-15N	N/A	09/09/2013	Annual	09/09/2014
Agilent	Attenuator	8491B	50566	09/09/2013	Annual	09/09/2014
JUMBP	Hygro-Thermometer	BJ5478	12091382-1	06/30/2014	Annual	06/30/2015
Agilent	Spectrum Analyzer	E4445A	MY44020523	07/26/2013	Annual	07/26/2014
ROHDE & SCHWARZ	Communication Tester	CMW500	144030	03/03/2014	Annual	03/03/2015

16. FCC Power Measurement Procedures

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

The handset was placed into a simulated call using a base station simulator in shielded chamber. SAR measurements were taken with a fully charged battery. In order to verify that the device was tested and maintained at full power, this was configured with the base station simulator. The SAR measurement Software calculates a reference point at the start and end of the test to check for power drifts. If conducted power deviations of more than 5 % occurred, the tests were repeated.

17. 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. Test highest reported SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r03.

18 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.

Mode / Band		Burst Average GMSK (dBm)				
		Voice	GPRS(GMSK) Data – CS1			
		GSM	1 slot	2 slot	3 slot	4 slot
GSM850	Maximum	33.7	33.7	31.7	29.7	27.7
	Nominal	33.2	33.2	31.2	29.2	27.2
PCS1900	Maximum	31.2	31.2	28.7	26.7	24.7
	Nominal	30.7	30.7	28.2	26.2	24.2
Mode / Band		Frame Average GMSK (dBm)				
		Voice	GPRS(GMSK) Data – CS1			
		GSM	1 slot	2 slot	3 slot	4 slot
GSM850	Maximum	24.67	24.67	25.68	25.44	24.69
	Nominal	24.17	24.17	25.18	24.94	24.19
PCS1900	Maximum	22.17	22.17	22.68	22.44	21.69
	Nominal	21.67	21.67	22.18	21.94	21.19
Tune-up Tolerance: -1.5 dB / + 0.5 dB						

Mode / Band		Modulated Average (dBm)		
		3GPP Rel 99	3GPP Rel 5	3GPP Rel 6
		RMC/AMR	HSDPA	HSUPA
WCDMA850	Maximum	23.7	-	-
	Nominal	23.2	-	-
Subtest 1	Maximum	-	23.7	23.7
	Nominal	-	23.2	23.2
Subtest 2	Maximum	-	23.7	21.7
	Nominal	-	23.2	21.2
Subtest 3	Maximum	-	23.2	22.7
	Nominal	-	22.7	22.2
Subtest 4	Maximum	-	23.2	21.7
	Nominal	-	22.7	21.2
Subtest 5	Maximum	-	-	23.7
	Nominal	-	-	23.2
Tune-up Tolerance: -1.5 dB / + 0.5 dB				

Mode / Band		Modulated Average (dBm)		
		3GPP Rel 99	3GPP Rel 5	3GPP Rel 6
		RMC/AMR	HSDPA	HSUPA
WCDMA1900	Maximum	24.2	-	-
	Nominal	23.7	-	-
Subtest 1	Maximum	-	24.2	24.2
	Nominal	-	23.7	23.7
Subtest 2	Maximum	-	24.2	22.2
	Nominal	-	23.7	21.7
Subtest 3	Maximum	-	23.7	23.2
	Nominal	-	23.2	22.7
Subtest 4	Maximum	-	23.7	22.2
	Nominal	-	23.2	21.7
Subtest 5	Maximum	-	-	24.2
	Nominal	-	-	23.7
Tune-up Tolerance: -1.5 dB / + 0.5 dB				

Average power for Production (dBm)					
Mode	Nominal & Maximum	b	g	n	
2.4 GHz WLAN	Maximum	17.0	15.0	14.0	
	Nominal	16.0	14.0	13.0	
Mode	Nominal & Maximum	GFSK	DPSK	8DPSK	LE
Bluetooth	Maximum	9.0	6.0	5.0	9.5
	Nominal	8.0	5.0	4.0	8.5

19 RF Conducted Power Measurement

The device in GSM, WCDMA was controlled by using a Communication tester (CMW500). The EUT was set to maximum power level during all tests. The DASY5 system measures power drift during SAR testing by comparing e-field in the same location at the beginning and at the end of measurement.

19.1 GSM Conducted Power

GSM	Channel	Frequency(MHz)	Burst -Conducted Average Power(dB m)				
			Voice	GPRS(GMSK) Data – CS1			
			GSM	1 Slot	2 Slot	3 Slot	4 Slot
GSM 850	128	824.2	33.64	33.62	31.31	29.39	27.33
	190	836.6	33.40	33.45	31.27	29.42	27.31
	251	848.8	33.48	33.56	31.26	29.47	27.42
PCS 1900	512	1850.2	30.54	30.51	28.30	26.15	24.15
	661	1880.0	30.64	30.42	28.14	26.02	24.11
	810	1909.8	30.55	30.42	28.12	26.03	24.21

GSM	Channel	Frequency(MHz)	Frame-Conducted Average Power(dB m)				
			Voice	GPRS(GMSK) Data – CS1			
			GSM	1 Slot	2 Slot	3 Slot	4 Slot
GSM 850	128	824.2	24.61	24.59	25.29	25.13	24.32
	190	836.6	24.37	24.42	25.25	25.16	24.30
	251	848.8	24.45	24.53	25.24	25.21	24.41
PCS 1900	512	1850.2	21.51	21.48	22.28	21.89	21.14
	661	1880.0	21.61	21.39	22.12	21.76	21.10
	810	1909.8	21.52	21.39	22.10	21.77	21.20

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 source-based frame-averaged output power was evaluated for all GPRS slot configurations. The configuration with the highest target frame averaged output power was evaluated for wireless router SAR. When the maximum frame-averaged powers are equivalent across two or more slots (within 0.25 dB), the configuration with the most number of time slots was tested.
- GPRS (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.

19.2 WCDMA

19.2.1 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”.

19.2.2 Head SAR Measurements

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 ¼ dB higher than that measured in 12.2 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 results in the highest SAR for that RF channel in 12.2 RMC.

19.2.3 Body SAR Measurements

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

19.2.4 Procedures Used to Establish RF Signal for SAR HSDPA Data Devices

Body SAR is not required for handsets with HSDPA capabilities when the maximum average output of each RF channel with HSDPA active is less than ¼ dB higher than that measured without HSDPA using 12.2 kbps RMC and the maximum SAR for 12.2 kbps RMC is ≤ 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 in 12.2 kbps RMC without HSDPA, on the maximum output channel with the body exposure configuration that results in the highest SAR in 12.2 kbps RMC for that RF channel.

Sub-Test 1 Setup for Release 5 HSDPA

Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	$\beta_{hs}^{(2)}$	CM (dB) ⁽²⁾
1	2/15	15/15	64	2/15	4/15	0.0
2	12/15 ⁽³⁾	15/15 ⁽³⁾	64	12/15 ⁽³⁾	24/15	1.0
3	15/15	8/15	64	15/8	30/15	1.5
4	15/15	4/15	64	15/4	30/15	1.5

Note 1: $\Delta_{ACK}, \Delta_{NACK}$ and $\Delta_{CQI} = 8 \Leftrightarrow A_{hs} = \beta_{hs}/\beta_c = 30/15 \Leftrightarrow \beta_{hs} = 30/15 * \beta_c$
 Note 2: CM = 1 for $\beta_c/\beta_d = 12/15$, $\beta_{hs}/\beta_c = 24/15$.
 Note 3: For subtest 2 the β_c/β_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 $\beta_d = 15/15$.

19.2.5 SAR Measurements for Conditions for HSUPA Data Devices

Body SAR is not required for handsets with HSPA capabilities when the maximum average output of each RF channel with HSUPA/HSDPA active is less than ¼ dB higher than that measured without HSUPA/HSDPA using 12.2 kbps RMC and the maximum SAR for 12.2 kbps RMC is ≤ 75 % of the SAR limit. Body SAR for HSPA is measured with E-DCH Sub-test 5, using H-Set 1 and QPSK for FRC and a 12.2 kbps RMC configured in Test Loop Mode 1 with power control algorithm 2, according to the highest body SAR configuration in 12.1 kbps RMC without HSPA. When VOIP is applicable for head exposure, SAR is not required when the maximum output of each RF channel with HSPA is less than ¼ dB higher than that measured using 12.2 kbps RMC; otherwise, the same HSPA configuration used for body measurement should be used to test for head exposure.

Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	$\beta_{hs}^{(1)}$	β_{ec}	β_{ed}	β_{ed} (SF)	β_{ed} (codes)	CM ⁽²⁾ (dB)	MPR (dB)	AG ⁽⁴⁾ Index	E-TFCI
1	11/15 ⁽³⁾	15/15 ⁽³⁾	64	11/15 ⁽³⁾	22/15	209/225	1039/225	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	$\beta_{ed1}: 47/15$ $\beta_{ed2}: 47/15$	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 ⁽⁴⁾	15/15 ⁽⁴⁾	64	15/15 ⁽⁴⁾	30/15	24/15	134/15	4	1	1.0	0.0	21	81

Note 1: Δ_{ACK} , Δ_{NACK} and $\Delta_{CQI} = 8 \Leftrightarrow A_{hs} = \beta_{hs}/\beta_c = 30/15 \Leftrightarrow \beta_{hs} = 30/15 * \beta_c$.

Note 2: CM = 1 for $\beta_c/\beta_d = 12/15$, $\beta_{hs}/\beta_c = 24/15$. For all other combinations of DPDCH, DPCCCH, HS-DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference.

Note 3: For subtest 1 the β_c/β_d ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 10/15$ and $\beta_d = 15/15$.

Note 4: For subtest 5 the β_c/β_d ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 14/15$ and $\beta_d = 15/15$.

Note 5: Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Table 5.1g.

Note 6: β_{ed} can not be set directly; it is set by Absolute Grant Value.

3GPP Release Version	Mode	3GPP 34.121 Subtest	Cellular Band (dBm)			3GPP MPR(dB)
	Channel		4132	4183	4233	
99	WCDMA	12.2 kbps RMC	23.51	23.49	23.51	-
5	HSDPA	Subtest 1	23.51	23.41	23.39	0
5		Subtest 2	23.46	23.42	23.38	0
5		Subtest 3	23.12	23.14	23.18	-0.5
5		Subtest 4	23.18	23.14	23.02	-0.5
6	HSUPA	Subtest 1	22.77	22.88	22.76	0
6		Subtest 2	21.66	21.62	21.35	-2
6		Subtest 3	22.24	22.23	22.42	-1
6		Subtest 4	21.58	21.64	21.65	-2
6		Subtest 5	22.71	22.78	22.86	0

3GPP Release Version	Mode	3GPP 34.121 Subtest	PCS Band (dBm)			3GPP MPR(dB)
	Channel		9262	9400	9538	
99	WCDMA	12.2 kbps RMC	23.59	23.61	23.54	-
5	HSDPA	Subtest 1	23.40	23.55	23.41	0
5		Subtest 2	23.49	23.41	23.42	0
5		Subtest 3	23.14	23.16	23.11	-0.5
5		Subtest 4	23.17	23.13	23.13	-0.5
6	HSUPA	Subtest 1	22.87	22.76	22.95	0
6		Subtest 2	21.78	21.86	21.74	-2
6		Subtest 3	22.24	22.23	22.23	-1
6		Subtest 4	21.81	21.87	21.64	-2
6		Subtest 5	22.82	22.74	22.89	0

Note

1. WCDMA SAR was tested under RMC 12.2 kbps with HSPA inactive per KDB Publication 941225 D01v02. 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

19.3 WLAN

19.3.1 General Device Setup

Normal Network operating configurations are not suitable for measuring the SAR of 802.11 a/b/g 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.

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.

19.3.2 Frequency Channel Configurations

802.11 a/b/g and 4.9 GHz operating modes are tested independently according to the service requirements in each frequency band. 802.11 b/g modes are tested on channel 1, 6, and 11. 802.11a is tested for UNII operations on channels 36 and 48 in the 5.15 ~ 5.25 GHz band, channels 52 and 64 in the 5.25 ~ 5.35 GHz band, channels 104, 116, 124 and 136 in the 5.470 ~ 5.725 GHz band, and channels 149 and 161 in the 5.8 GHz band. When 5.8 GHz §15.247 is also available, channels 149, 157 and 165 should be tested instead of the UNII channels. 802.11g mode was evaluated only if the output power was 0.25 dB higher than the 802.11b mode.

Mode	GHz	Channel	Turbo Channel	"Default Test Channels"	
				§15.247	UNII
802.11 b/g	2.412	1*		✓	▽
	2.437	6	6	✓	▽
	2.462	11*		✓	▽
802.11a	5.18	36			✓
	5.20	40			•
	5.22	44	42 (5.21 GHz)		•
	5.24	48			✓
	5.26	52	50 (5.25 GHz)		✓
	5.28	56			•
	5.30	60	58 (5.29 GHz)		•
	5.32	64			✓
	5.500	100			•
	5.520	104			✓
	5.540	108			•
	5.560	112			•
	5.580	116			✓
	5.600	120			•
	5.620	124			•
	5.640	128			•
	5.660	132			•
	5.680	136			✓
	5.700	140			•
	5.745	149		✓	✓
UNII or §15.247	5.765	153	152 (5.76 GHz)	•	•
	5.785	157		✓	•
	5.805	161	160 (5.80 GHz)	•	✓
	5.825	165		✓	

- ✓ = "default test channels"
- = possible 802.11 a channels with maximum average output > the "default test channels"
- ▽ = possible 802.11g channels with maximum average output ¼ dB ≥ the "default test channels"
- * = when output power is reduced for channel 1 and/or 11 to meet restricted band requirements the highest output channels closest to each of these channels should be tested

19.3.3 WLAN Conducted Powers

IEEE 802.11b Average RF Power

Mode	Frequency	Channel	802.11b (2.4 GHz) Conducted Power (dBm)			
			Data Rate (Mbps)			
			1	2	5.5	11
802.11b	2412	1	14.64	14.62	14.60	14.58
	2437	6	15.16	15.14	15.11	15.09
	2462	11	15.27	15.24	15.21	15.16

IEEE 802.11g Average RF Power

Mode	Frequency	Channel	802.11g (2.4 GHz) Conducted Power (dBm)							
			Data Rate (Mbps)							
			6	9	12	18	24	36	48	54
802.11g	2412	1	12.93	13.02	13.09	13.26	13.36	13.67	14.02	14.10
	2437	6	13.63	13.67	13.78	13.88	14.06	14.34	14.67	14.83
	2462	11	13.49	13.58	13.63	13.72	13.96	14.25	14.55	14.72

IEEE 802.11n Average RF Power 20 MHz Bandwidth

Mode	Frequency	Channel	802.11n (2.4 GHz) Conducted Power (dBm)							
			Data Rate (Mbps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n	2412	1	11.78	11.74	12.16	12.34	12.70	12.99	13.03	13.13
	2437	6	12.46	12.60	12.70	12.90	13.32	13.62	13.77	13.79
	2462	11	12.36	12.54	12.79	13.02	13.31	13.69	13.59	13.70

Bluetooth

Channel	Frequency (MHz)	GFSK (dBm)	PI/4DQPSK (dBm)	8DPSK (dBm)	LE (dBm)
Low	2402	6.95	3.07	2.83	7.06
Middle	2441	8.30	4.95	4.83	9.31
High	2480	6.63	3.48	3.76	7.55

20 SAR Test Exclusions Applied

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

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

Mode	Frequency	Maximum Allowed Power	Separation Distance	≤ 3.0
	[MHz]	[mW]	[mm]	
Bluetooth	2480	8	5	2.52
			10	1.26

Mode	Frequency	Maximum Allowed Power	Separation Distance	≤ 3.0
	[MHz]	[mW]	[mm]	
Bluetooth LE	2480	9	5	2.83
			10	1.42

Based on the maximum tune-up tolerance limit of Bluetooth the antenna to use separation distance,

Bluetooth SAR was not required $[(8/5)*\sqrt{2.480}] = 2.52 < 3.0$.

Bluetooth LE SAR was not required $[(9/5)*\sqrt{2.480}] = 2.83 < 3.0$.

21 SAR Data Summary

21.1 Head SAR Data

GSM850 Head SAR

Head	EUT Position	Mode	Battery	Traffic Channel		Power(dBm)		1-g SAR (W/kg)		Plot No
				Frequency (MHz)	Channel	Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
Right	Touch	GSM Voice	Standard	836.6	190	33.40	33.70	0.225	0.241	-
	Tilt		Standard	836.6	190	33.40	33.70	0.148	0.159	-
Left	Touch		Standard	836.6	190	33.40	33.70	0.167	0.179	-
	Tilt		Standard	836.6	190	33.40	33.70	0.135	0.145	-
Right	Touch	GPRS 2Tx	Standard	836.6	190	31.27	31.70	0.249	0.275	9
	Tilt		Standard	836.6	190	31.27	31.70	0.159	0.176	-
Left	Touch		Standard	836.6	190	31.27	31.70	0.183	0.202	-
	Tilt		Standard	836.6	190	31.27	31.70	0.152	0.168	-
Right	Touch	GPRS 3Tx	Standard	836.6	190	29.42	29.70	0.251	0.268	25
	Tilt		Standard	836.6	190	29.42	29.70	0.168	0.179	-
Left	Touch		Standard	836.6	190	29.42	29.70	0.208	0.222	-
	Tilt		Standard	836.6	190	29.42	29.70	0.173	0.185	-
ANSI / IEEE C95.1 1992 – Safety Limit Spatial Peak Uncontrolled Exposure / General Population						Head 1.6 W/kg (mW/g) Averaged over 1 gram				

GSM1900 Head SAR

Head	EUT Position	Mode	Battery	Traffic Channel		Power(dBm)		1-g SAR (W/kg)		Plot No
				Frequency (MHz)	Channel	Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
Right	Touch	GSM Voice	Standard	1880.0	661	30.64	31.20	0.154	0.175	-
	Tilt		Standard	1880.0	661	30.64	31.20	0.099	0.113	-
Left	Touch		Standard	1880.0	661	30.64	31.20	0.270	0.307	-
	Tilt		Standard	1880.0	661	30.64	31.20	0.162	0.184	-
Right	Touch	GPRS 2Tx	Standard	1880.0	661	28.14	28.70	0.169	0.192	-
	Tilt		Standard	1880.0	661	28.14	28.70	0.109	0.124	-
Left	Touch		Standard	1880.0	661	28.14	28.70	0.276	0.314	12
	Tilt		Standard	1880.0	661	28.14	28.70	0.162	0.184	-
ANSI / IEEE C95.1 1992 – Safety Limit Spatial Peak Uncontrolled Exposure / General Population						Head 1.6 W/kg (mW/g) Averaged over 1 gram				

WCDMA Band V Head SAR

Head	EUT Position	Mode	Battery	Traffic Channel		Power(dBm)		1-g SAR (W/kg)		Plot No
				Frequency (MHz)	Channel	Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
Right	Touch	RMC	Standard	836.6	4183	23.49	23.70	0.145	0.152	15
	Tilt		Standard	836.6	4183	23.49	23.70	0.095	0.100	-
Left	Touch		Standard	836.6	4183	23.49	23.70	0.110	0.115	-
	Tilt		Standard	836.6	4183	23.49	23.70	0.082	0.086	-
ANSI / IEEE C95.1 1992 – Safety Limit Spatial Peak Uncontrolled Exposure / General Population						Head 1.6 W/kg (mW/g) Averaged over 1 gram				

WCDMA Band II Head SAR

Head	EUT Position	Mode	Battery	Traffic Channel		Power(dBm)		1-g SAR (W/kg)		Plot No
				Frequency (MHz)	Channel	Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
Right	Touch	RMC	Standard	1880.0	9400	23.61	24.20	0.373	0.427	-
	Tilt		Standard	1880.0	9400	23.61	24.20	0.261	0.299	-
Left	Touch		Standard	1880.0	9400	23.61	24.20	0.566	0.648	18
	Tilt		Standard	1880.0	9400	23.61	24.20	0.400	0.458	-
ANSI / IEEE C95.1 1992 – Safety Limit Spatial Peak Uncontrolled Exposure / General Population						Head 1.6 W/kg (mW/g) Averaged over 1 gram				

WLAN 2.4 GHz Head SAR

Head	EUT Position	Mode	Battery	Traffic Channel		Power(dBm)		1-g SAR (W/kg)		Plot No
				Frequency (MHz)	Channel	Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
Right	Touch	802.11b	Standard	2462.0	11	15.27	17.00	0.223	0.332	20
	Tilt		Standard	2462.0	11	15.27	17.00	0.181	0.270	-
Left	Touch		Standard	2462.0	11	15.27	17.00	0.099	0.147	-
	Tilt		Standard	2462.0	11	15.27	17.00	0.117	0.174	-
ANSI / IEEE C95.1 1992 – Safety Limit Spatial Peak Uncontrolled Exposure / General Population						Head 1.6 W/kg (mW/g) Averaged over 1 gram				

21.2 Body-Worn SAR Data

GSM/WCDMA Band Body-Worn SAR

EUT Position	Mode	Battery	Traffic Channel		Separation Distance (mm)	Power(dBm)		1-g SAR (W/kg)		Plot No
			Frequency (MHz)	Channel		Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
Rear	GSM850	Standard	836.6	190	10	33.40	33.70	0.391	0.419	10
Rear	GSM1900	Standard	1880.0	661	10	30.64	31.20	0.350	0.398	13
Rear	WCDMA 850	Standard	836.6	4183	10	23.49	23.70	0.219	0.230	16
Rear	WCDMA 1900	Standard	1880.0	9400	10	23.61	24.20	0.835	0.957	-
Rear	WCDMA 1900	Standard	1852.4	9262	10	23.59	24.20	0.938	1.079	19
Rear	WCDMA 1900	Standard	1907.6	9538	10	23.54	24.20	0.726	0.845	-
Rear	WCDMA 1900	Standard	1852.4	9262	10	23.59	24.20	0.925	1.064	-
ANSI / IEEE C95.1 1992 – Safety Limit Spatial Peak Uncontrolled Exposure / General Population						Body 1.6 W/kg (mW/g) Averaged over 1 gram				

WLAN Body-Worn SAR

EUT Position	Mode	Battery	Traffic Channel		Separation Distance (mm)	Power(dBm)		1-g SAR (W/kg)		Plot No
			Frequency (MHz)	Channel		Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
Rear	802.11b 2.4 GHz	Standard	2462.0	11	10	15.27	17.00	0.047	0.070	21
ANSI / IEEE C95.1 1992 – Safety Limit Spatial Peak Uncontrolled Exposure / General Population						Body 1.6 W/kg (mW/g) Averaged over 1 gram				

21.3 Hotspot SAR Data

GSM850 Hotspot SAR

EUT Position	Mode	Battery	Traffic Channel		Separation Distance (mm)	Power(dBm)		1-g SAR (W/kg)		Plot No
			Frequency (MHz)	Channel		Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
Front	GPRS 2Tx	Standard	836.6	190	10	31.27	31.70	0.291	0.321	-
Rear		Standard	836.6	190	10	31.27	31.70	0.396	0.437	-
Right Edge		Standard	836.6	190	10	31.27	31.70	0.478	0.528	11
Left Edge		Standard	836.6	190	10	31.27	31.70	0.307	0.339	-
Bottom		Standard	836.6	190	10	31.27	31.70	0.167	0.184	-
Front	GPRS 3Tx	Standard	836.6	190	10	29.42	29.70	0.274	0.292	-
Rear		Standard	836.6	190	10	29.42	29.70	0.389	0.415	-
Right Edge		Standard	836.6	190	10	29.42	29.70	0.486	0.518	26
Left Edge		Standard	836.6	190	10	29.42	29.70	0.324	0.346	-
Bottom		Standard	836.6	190	10	29.42	29.70	0.099	0.106	-
ANSI / IEEE C95.1 1992 – Safety Limit Spatial Peak Uncontrolled Exposure / General Population					Body 1.6 W/kg (mW/g) Averaged over 1 gram					

GSM1900 Hotspot SAR

EUT Position	Mode	Battery	Traffic Channel		Separation Distance (mm)	Power(dBm)		1-g SAR (W/kg)		Plot No
			Frequency (MHz)	Channel		Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
Front	GPRS 2Tx	Standard	1880.0	661	10	28.14	28.70	0.215	0.232	-
Rear		Standard	1880.0	661	10	28.14	28.70	0.363	0.392	14
Right Edge		Standard	1880.0	661	10	28.14	28.70	0.054	0.058	-
Left Edge		Standard	1880.0	661	10	28.14	28.70	0.187	0.202	-
Bottom		Standard	1880.0	661	10	28.14	28.70	0.251	0.271	-
ANSI / IEEE C95.1 1992 – Safety Limit Spatial Peak Uncontrolled Exposure / General Population					Body 1.6 W/kg (mW/g) Averaged over 1 gram					

WCDMA Band V Hotspot SAR

EUT Position	Mode	Battery	Traffic Channel		Separation Distance (mm)	Power(dBm)		1-g SAR (W/kg)		Plot No
			Frequency (MHz)	Channel		Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
Front	RMC	Standard	836.6	4183	10	23.49	23.70	0.137	0.144	-
Rear		Standard	836.6	4183	10	23.49	23.70	0.219	0.230	-
Right Edge		Standard	836.6	4183	10	23.49	23.70	0.223	0.234	17
Left Edge		Standard	836.6	4183	10	23.49	23.70	0.162	0.170	-
Bottom		Standard	836.6	4183	10	23.49	23.70	0.069	0.072	-
ANSI / IEEE C95.1 1992 – Safety Limit Spatial Peak Uncontrolled Exposure / General Population					Body 1.6 W/kg (mW/g) Averaged over 1 gram					

WCDMA Band II Hotspot SAR

EUT Position	Mode	Battery	Traffic Channel		Separation Distance (mm)	Power(dBm)		1-g SAR (W/kg)		Plot No
			Frequency (MHz)	Channel		Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
Front	RMC	Standard	1880.0	9400	10	23.61	24.20	0.478	0.548	-
Rear		Standard	1880.0	9400	10	23.61	24.20	0.835	0.957	-
Right Edge		Standard	1880.0	9400	10	23.61	24.20	0.113	0.129	-
Left Edge		Standard	1880.0	9400	10	23.61	24.20	0.420	0.481	-
Bottom		Standard	1880.0	9400	10	23.61	24.20	0.561	0.643	-
Rear		Standard	1852.4	9262	10	23.59	24.20	0.938	1.079	19
Rear		Standard	1907.6	9538	10	23.54	24.20	0.726	0.845	-
Rear		Standard	1852.4	9262	10	23.59	24.20	0.925	1.064	-
ANSI / IEEE C95.1 1992 – Safety Limit Spatial Peak Uncontrolled Exposure / General Population					Body 1.6 W/kg (mW/g) Averaged over 1 gram					

WLAN 2.4 GHz Hotspot SAR

EUT Position	Mode	Battery	Traffic Channel		Separation Distance (mm)	Power(dBm)		1-g SAR (W/kg)		Plot No
			Frequency (MHz)	Channel		Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
Front	802.11b 2.4 GHz	Standard	2462.0	11	10	15.27	17.00	0.050	0.074	22
Rear	802.11b 2.4 GHz	Standard	2462.0	11	10	15.27	17.00	0.047	0.070	-
Right Edge	802.11b 2.4 GHz	Standard	2462.0	11	10	15.27	17.00	0.008	0.012	-
Top	802.11b 2.4 GHz	Standard	2462.0	11	10	15.27	17.00	0.040	0.060	-
ANSI / IEEE C95.1 1992 – Safety Limit Spatial Peak Uncontrolled Exposure / General Population					Body 1.6 W/kg (mW/g) Averaged over 1 gram					

General Notes

1. The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2003, FCC KDB Publication 865664 D01v02r03 and FCC KDB Publication 447498 D01v05r02.
2. All modes of operation were investigated, and worst-case results are reported.
3. The EUT is tested 2nd hot-spot peak, if it is less than 2 dB below the highest peak.
4. 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.
5. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01v05r02.
6. 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.
7. Per FCC KDB Publication 648474 D04v01r02, body worn SAR was evaluated without a headset connected to the device. Since the standalone reported SAR was ≤ 1.2 W/kg, no additional body worn SAR evaluations using a headset cable were required.
8. Per FCC KDB Publication 865664 D01v01r03, variability SAR tests were performed when the measured SAR results for a frequency band were greater than 0.8 W/kg. Please see section 24 for variability analysis.

GSM Notes

1. Body-Worn accessory testing is typically associated with voice operations. Therefore, GSM voice was evaluated for body-worn SAR.
2. Justification for reduced test configurations per KDB Publication 941225 D03v01: The source-based time-averaged output power was evaluated for all multi-slot operations. The multi-slot configuration with the highest frame averaged output power was evaluated for 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 ≤ 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 must be used.

WCDMA Notes

1. WCDMA mode in Body SAR was tested under RMC 12.2 kbps with HSPA inactive per KDB Publication 941225 D01v02. 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.
2. 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 ≤ 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 must be used.

WLAN Notes

1. For 2.4 GHz, justification for reduced test configuration for WIFI channels per KDB Publication 248227 and April 2010 FCC/TCB Meeting Notes: Highest average RF output power channel for the lowest data rate were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11g/n) were not investigated since the average output powers were not greater than 0.25 dB than that of the corresponding channel in the lowest data rate IEEE 802.11b modes.
2. Since the maximum extrapolated peak SAR of the zoom scan for the maximum output channel was ≤ 1.6 W/kg and the reported 1g averaged SAR was < 0.8 W/kg, SAR testing on other default channels was not required.
3. WLAN transmission was verified using a spectrum analyzer.

22 SAR Measurement Variability

22.1 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 ≥ 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 ≥ 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 ≥ 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

EUT Position	Mode	Traffic Channel		Separation Distance (mm)	Measured 1g SAR (W/kg)	1 st Repeated 1g SAR(W/kg)	Ratio	2 nd Repeated 1g SAR(W/kg)	Ratio	3 rd Repeated 1g SAR(W/kg)	Ratio
		Frequency (MHz)	Channel								
Rear	RMC	1852.4	9262	10	0.938	0.925	1.01	N/A	N/A	N/A	N/A

22.2 Measurement Uncertainty

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

23 FCC Multi-TX and Antenna SAR considerations

23.1 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.

23.2 Simultaneous Transmission Procedures

This device contains transmitters that may operate simultaneously. Therefore simultaneous transmission analysis is required. Per FCC KDB 447498 D01v05r02 IV.C.1iii, 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 ≤ 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 involving that transmitter.

$$\text{Estimated SAR} = \frac{\sqrt{f(\text{GHz})}}{7.5} * \frac{(\text{Max Power of channel, mW})}{\text{Min. Separation Distance, mm}}$$

Mode	Frequency	Maximum Allowed Power	Separation Distance	Estimated SAR
	[MHz]	[mW]	[mm]	[W/kg]
Bluetooth LE	2480	9	5	0.378
			10	0.189

22.3 Simultaneous Transmission Scenarios

No	Capable Transmit Configuration	Head	Body-Worn	Wireless Router
1	GSM 850 Voice + WLAN 2.4 GHz	Yes	Yes	N/A
2	GSM 1900 Voice + WLAN 2.4 GHz	Yes	Yes	N/A
3	GSM 850 Voice + Bluetooth	Yes	Yes	N/A
4	GSM 1900 Voice + Bluetooth	Yes	Yes	N/A
5	GPRS 850 + WLAN 2.4 GHz	Yes	Yes	Yes
6	GPRS1900 + WLAN 2.4 GHz	Yes	Yes	Yes
7	GPRS 850 + Bluetooth	Yes	Yes	N/A
8	GPRS 1900 + Bluetooth	Yes	Yes	N/A
9	WCDMA 850 + WLAN 2.4 GHz	Yes	Yes	Yes
10	WCDMA 1900 + WLAN 2.4 GHz	Yes	Yes	Yes
11	WCDMA 850 + Bluetooth	Yes	Yes	N/A
12	WCDMA 1900 + Bluetooth	Yes	Yes	N/A

Notes

1. GSM/GPRS, WCDMA share the same antenna and cannot transmit simultaneously.

23.4 Head SAR Simultaneous Transmission Analysis

Simultaneous Transmission Summation Scenario with 2.4 GHz WLAN (Head to Ear)

Simultaneous TX	Configuration	GSM850 Band Scaled SAR(W/kg)	2.4 GHz WLAN Scaled SAR (W/kg)	ΣSAR (W/kg)
Head	Right Touch	0.241	0.332	0.573
	Right Tilt	0.159	0.270	0.429
	Left Touch	0.179	0.147	0.326
	Left Tilt	0.145	0.174	0.319
	Configuration	GPRS850 Band Scaled SAR(W/kg)	2.4 GHz WLAN Scaled SAR (W/kg)	ΣSAR (W/kg)
	Right Touch	0.275	0.332	0.607
	Right Tilt	0.176	0.270	0.446
	Left Touch	0.202	0.147	0.349
	Left Tilt	0.168	0.174	0.342
	Configuration	GSM1900 Band Scaled SAR(W/kg)	2.4 GHz WLAN Scaled SAR (W/kg)	ΣSAR (W/kg)
	Right Touch	0.175	0.332	0.507
	Right Tilt	0.113	0.270	0.383
	Left Touch	0.307	0.147	0.454
	Left Tilt	0.184	0.174	0.358
	Configuration	GPRS1900 Band Scaled SAR(W/kg)	2.4 GHz WLAN Scaled SAR (W/kg)	ΣSAR (W/kg)
	Right Touch	0.192	0.332	0.524
	Right Tilt	0.124	0.270	0.394
	Left Touch	0.314	0.147	0.461
	Left Tilt	0.184	0.174	0.358
	configuration	WCDMA Band V Scaled SAR(W/kg)	2.4 GHz WLAN Scaled SAR (W/kg)	ΣSAR (W/kg)
	Right Touch	0.152	0.332	0.484
	Right Tilt	0.100	0.270	0.370
	Left Touch	0.115	0.147	0.262
	Left Tilt	0.086	0.174	0.260
	configuration	WCDMA Band II Scaled SAR(W/kg)	2.4 GHz WLAN Scaled SAR (W/kg)	ΣSAR (W/kg)
	Right Touch	0.427	0.332	0.759
	Right Tilt	0.299	0.270	0.569
	Left Touch	0.648	0.147	0.795
	Left Tilt	0.458	0.174	0.632

Simultaneous Transmission Summation Scenario with Bluetooth (Head to Ear)

Simultaneous TX	Configuration	GSM850 Band Scaled SAR(W/kg)	Bluetooth LE SAR (W/kg)	Σ SAR (W/kg)
Head	Right Touch	0.241	0.378	0.619
	Right Tilt	0.159	0.378	0.537
	Left Touch	0.179	0.378	0.557
	Left Tilt	0.145	0.378	0.523
	Configuration	GPRS850 Band Scaled SAR(W/kg)	Bluetooth LE SAR (W/kg)	Σ SAR (W/kg)
	Right Touch	0.275	0.378	0.653
	Right Tilt	0.176	0.378	0.554
	Left Touch	0.202	0.378	0.580
	Left Tilt	0.168	0.378	0.546
	Configuration	GSM1900 Band Scaled SAR(W/kg)	Bluetooth LE SAR (W/kg)	Σ SAR (W/kg)
	Right Touch	0.175	0.378	0.553
	Right Tilt	0.113	0.378	0.491
	Left Touch	0.307	0.378	0.685
	Left Tilt	0.184	0.378	0.562
	Configuration	GPRS1900 Band Scaled SAR(W/kg)	Bluetooth LE SAR (W/kg)	Σ SAR (W/kg)
	Right Touch	0.192	0.378	0.570
	Right Tilt	0.124	0.378	0.502
	Left Touch	0.314	0.378	0.692
	Left Tilt	0.184	0.378	0.562
	configuration	WCDMA Band V Scaled SAR(W/kg)	Bluetooth LE SAR (W/kg)	Σ SAR (W/kg)
	Right Touch	0.152	0.378	0.530
	Right Tilt	0.100	0.378	0.478
	Left Touch	0.115	0.378	0.493
	Left Tilt	0.086	0.378	0.464
	configuration	WCDMA Band II Scaled SAR(W/kg)	Bluetooth LE SAR (W/kg)	Σ SAR (W/kg)
	Right Touch	0.427	0.378	0.805
	Right Tilt	0.299	0.378	0.677
	Left Touch	0.648	0.378	1.026
	Left Tilt	0.458	0.378	0.836

Note

Bluetooth SAR was not required to be measured pre FCC KDB 447498 D01v05r02. Estimated SAR results were used in the above table to determine simultaneous transmission SAR test exclusion.

23.5 Body-Won SAR Simultaneous Transmission Analysis

Simultaneous Transmission Summation Scenario with 2.4 GHz WLAN (Body-Worn at 10 mm)

Simultaneous TX	configuration	GSM850 Scaled SAR(W/kg)	2.4 GHz WLAN Scaled SAR (W/kg)	Σ SAR (W/kg)
Body-Worn	Rear	0.419	0.070	0.489
	configuration	GSM1900 Scaled SAR(W/kg)	2.4 GHz WLAN Scaled SAR (W/kg)	Σ SAR (W/kg)
	Rear	0.398	0.070	0.468
	configuration	WCDMA Band V Scaled SAR(W/kg)	2.4 GHz WLAN Scaled SAR (W/kg)	Σ SAR (W/kg)
	Rear	0.230	0.070	0.300
	configuration	WCDMA Band II Scaled SAR(W/kg)	2.4 GHz WLAN Scaled SAR (W/kg)	Σ SAR (W/kg)
	Rear	1.074	0.070	1.144

Simultaneous Transmission Summation Scenario with Bluetooth (Body-Worn at 10 mm)

Simultaneous TX	configuration	GSM850 Scaled SAR(W/kg)	Bluetooth LE SAR (W/kg)	Σ SAR (W/kg)
Body-Worn	Rear	0.419	0.189	0.608
	configuration	GSM1900 Scaled SAR(W/kg)	Bluetooth LE SAR (W/kg)	Σ SAR (W/kg)
	Rear	0.398	0.189	0.687
	configuration	WCDMA Band V Scaled SAR(W/kg)	Bluetooth LE SAR (W/kg)	Σ SAR (W/kg)
	Rear	0.230	0.189	0.419
	configuration	WCDMA Band II Scaled SAR(W/kg)	Bluetooth LE SAR (W/kg)	Σ SAR (W/kg)
	Rear	1.074	0.189	1.263

Note

Bluetooth SAR was not required to be measured pre FCC KDB 447498 D01v05r02. Estimated SAR results were used in the above table to determine simultaneous transmission SAR test exclusion.

23.6 Hotspot SAR Simultaneous Transmission Analysis

Simultaneous Transmission Summation Scenario with 2.4 GHz WLAN (Hotspot at 10 mm)

Simultaneous TX	configuration	GPRS850 Scaled SAR(W/kg)	2.4 GHz WLAN Scaled SAR (W/kg)	Σ SAR (W/kg)
Hotspot	Front	0.321	0.074	0.395
	Rear	0.437	0.070	0.507
	Right Edge	0.528	0.012	0.540
	Left Edge	0.339	-	0.339
	Top	-	0.060	0.060
	Bottom	0.184	-	0.184
	configuration	GPRS1900 Scaled SAR(W/kg)	2.4 GHz WLAN Scaled SAR (W/kg)	Σ SAR (W/kg)
	Front	0.232	0.074	0.306
	Rear	0.392	0.070	0.462
	Right Edge	0.058	0.012	0.070
	Left Edge	0.202	-	0.202
	Top	-	0.060	0.060
	Bottom	0.271	-	0.271
	configuration	WCDMA Band V Scaled SAR(W/kg)	2.4 GHz WLAN Scaled SAR (W/kg)	Σ SAR (W/kg)
	Front	0.144	0.074	0.218
	Rear	0.230	0.070	0.300
	Right Edge	0.234	0.012	0.246
	Left Edge	0.170	-	0.170
	Top	-	0.060	0.060
	Bottom	0.072	-	0.072
	configuration	WCDMA Band II Scaled SAR(W/kg)	2.4 GHz WLAN Scaled SAR (W/kg)	Σ SAR (W/kg)
	Front	0.548	0.074	0.622
	Rear	1.079	0.070	1.149
	Right Edge	0.129	0.012	0.141
	Left Edge	0.481	-	0.481
	Top	-	0.060	0.060
	Bottom	0.643	-	0.643

Notes.

1. The above numerical summed SAR was below the SAR limit. Therefore, the above analysis is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit. Therefore, no volumetric SAR summation is required since the numerical sums are below the limit.
2. Hotspot Mode Per FCC KDB Publication 941225 D06v01r01, the devices edges with antennas more than 2.5 cm from edge are not required to be evaluated for SAR (“-”).

Appendixes List

Appendix A

- A.1 Verification Test Plots for 835 MHz (Plots No 1,2)
- A.2 Verification Test Plots for 1900 MHz (Plots No 3,4,5,6)
- A.3 Verification Test Plots for 2450 MHz (Plots No 7,8)
- A.4 Verification Test Plots for 835 (Plots No 23, 24)
- A.5 SAR Test Plots for GSM850 Band (Plots No 9, 10, 11)
- A.6 SAR Test Plots for GSM1900 Band (Plots No 12, 13, 14)
- A.7 SAR Test Plots for WCDMA850 Band (Plots No 15, 16, 17)
- A.8 SAS Test Plots for WCDMA1900 Band (Plots No 18,19)
- A.9 SAR Test Plots for WLAN 2.4 GHz (Plots No 20, 21, 22)
- A.10 SAR Test Plots for GPRS850 3-slot data (Plots No 25, 26)

Appendix B

- B.1 Uncertainty Analysis

Appendix C

- C.1 Calibration certificate for Probe
- C.2 Calibration certificate for DAE
- C.3 Calibration certificate for Dipole

Appendix A.1 Verification Test Plots for 835 MHz_Head

Date: 2014-05-22

Test Laboratory : SGS Korea (Gunpo Laboratory)
 File Name: [835MHz Head System Verification.da53:0](#)

Input Power : 100 mW

Ambient Temp : 23.6 °C Tissue Temp : 21.9 °C

DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: 4d138

Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 835$ MHz; $\sigma = 0.898$ S/m; $\epsilon_r = 40.701$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(9.76, 9.76, 9.76); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

System Verification/835MHz Head System Verification/Area Scan (81x81x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm

Maximum value of SAR (interpolated) = 1.24 W/kg

System Verification/835MHz Head System Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid:

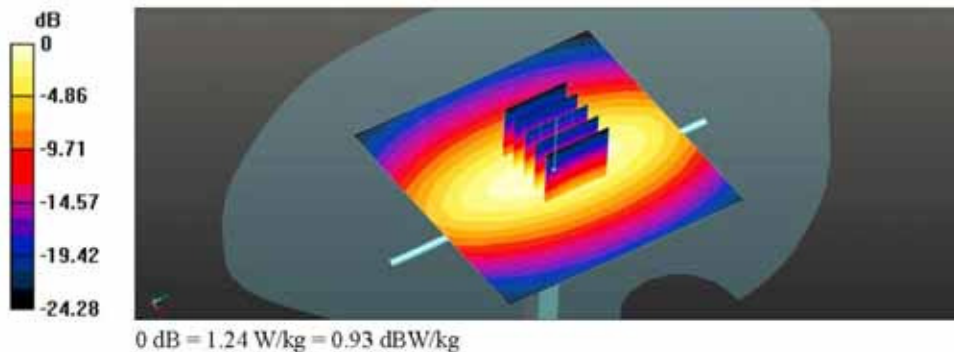
$dx=8$ mm, $dy=8$ mm, $dz=5$ mm

Reference Value = 38.055 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 1.45 W/kg

SAR(1 g) = 0.981 W/kg; SAR(10 g) = 0.643 W/kg

Maximum value of SAR (measured) = 1.24 W/kg



Appendix A.1 Verification Test Plots for 835 MHz_Body

Date: 2014-05-23

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: [835MHz Body System Verification.da53:0](#)

Input Power : 100 mW

Ambient Temp : 23.7 °C Tissue Temp : 22.1 °C

DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: 4d138

Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 835$ MHz; $\sigma = 0.948$ S/m; $\epsilon_r = 55.905$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(9.52, 9.52, 9.52); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

System Verification/835MHz Body System Verification/Area Scan (81x81x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm

Maximum value of SAR (interpolated) = 1.17 W/kg

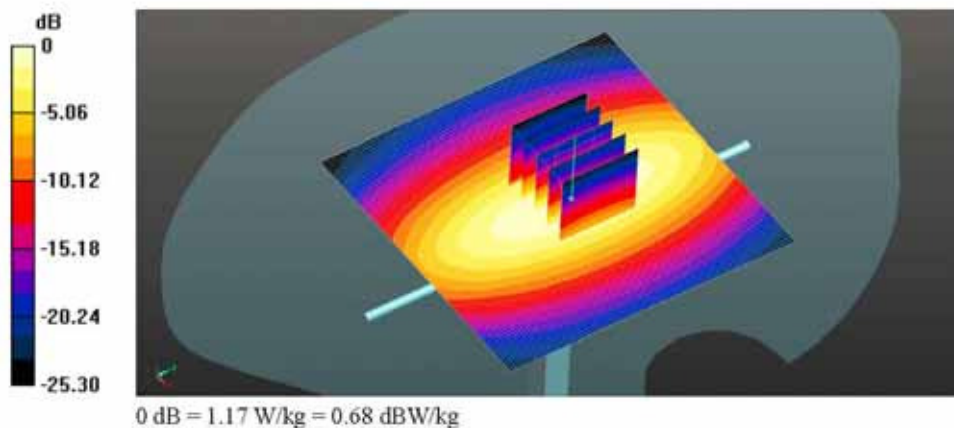
System Verification/835MHz Body System Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm

Reference Value = 35.844 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 1.35 W/kg

SAR(1 g) = 0.937 W/kg; SAR(10 g) = 0.625 W/kg

Maximum value of SAR (measured) = 1.16 W/kg



Appendix A.2 Verification Test Plots for 1900 MHz_Head

Date: 2014-05-24

Test Laboratory : SGS Korea (Gunpo Laboratory)

File Name: [1900MHz Head System Verification.da53:0](#)

Input Power : 100 mW

Ambient Temp : 23.8 °C Tissue Temp : 22.2 °C

DUT: Dipole 1900 MHz D1900V2; Type: D1900V2; Serial: D1900V2 - SN:5d158

Communication System: UID 0, CW (0); Frequency: 1900 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.44$ S/m; $\epsilon_r = 39.345$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(8.15, 8.15, 8.15); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Verification/1900MHz Head System Verification/Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 5.99 W/kg

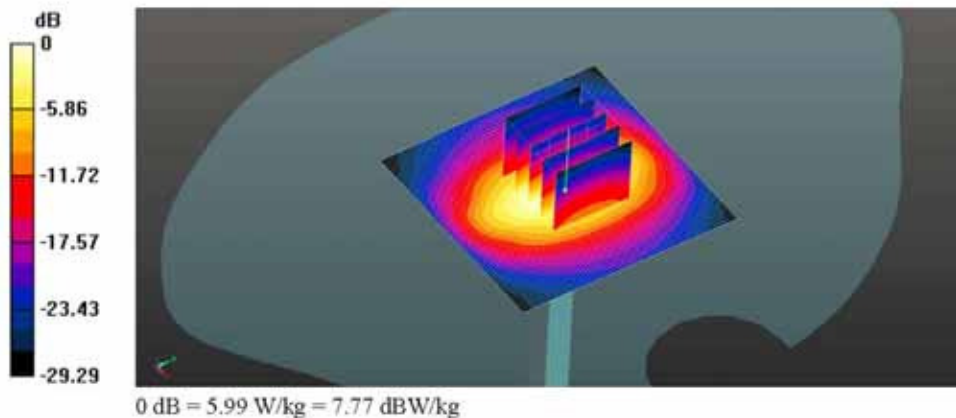
Verification/1900MHz Head System Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 65.455 V/m; Power Drift = -0.10 dB

Peak SAR (extrapolated) = 7.66 W/kg

SAR(1 g) = 4.1 W/kg; SAR(10 g) = 2.11 W/kg

Maximum value of SAR (measured) = 5.95 W/kg



Appendix A.2 Verification Test Plots for 1900 MHz_Body

Date: 2014-05-25

Test Laboratory : SGS Korea (Gunpo Laboratory)
 File Name: [1900MHz Body System Verification.da53:0](#)

Input Power : 100 mW

Ambient Temp : 23.6 °C Tissue Temp : 22.0 °C

DUT: Dipole 1900 MHz D1900V2; Type: D1900V2; Serial: D1900V2 - SN:5d158

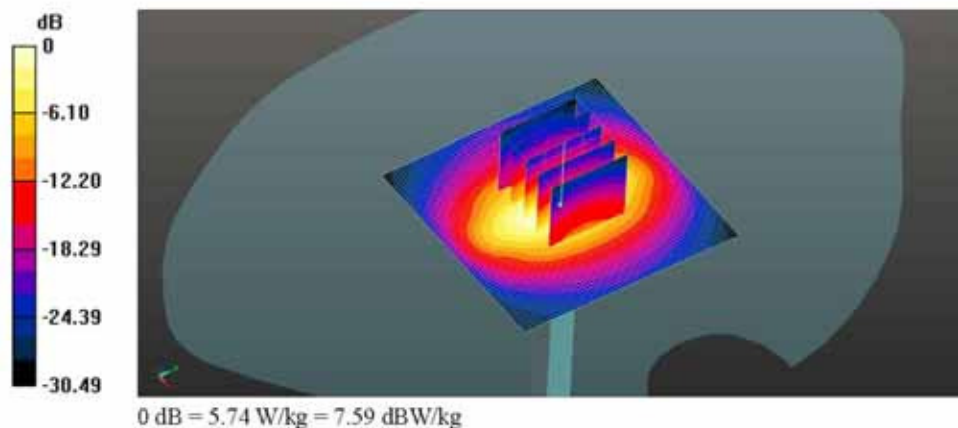
Communication System: UID 0, CW (0); Frequency: 1900 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 1900$ MHz; $\sigma = 1.524$ S/m; $\epsilon_r = 53.816$; $\rho = 1000$ kg/m³
 Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(7.63, 7.63, 7.63); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Verification/1900MHz Body System Verification/Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
 Maximum value of SAR (interpolated) = 5.74 W/kg

Verification/1900MHz Body System Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
 Reference Value = 62.614 V/m; Power Drift = -0.04 dB
 Peak SAR (extrapolated) = 7.18 W/kg
SAR(1 g) = 4.06 W/kg; SAR(10 g) = 2.13 W/kg
 Maximum value of SAR (measured) = 5.62 W/kg



Appendix A.2 Verification Test Plots for 1900 MHz_Head

Date: 2014-06-10

Test Laboratory : SGS Korea (Gunpo Laboratory)
 File Name: [1900MHz Head System Verification.da53:0](#)

Input Power : 100 mW

Ambient Temp : 23.4 °C Tissue Temp : 21.8 °C

DUT: Dipole 1900 MHz D1900V2; Type: D1900V2; Serial: D1900V2 - SN:5d158

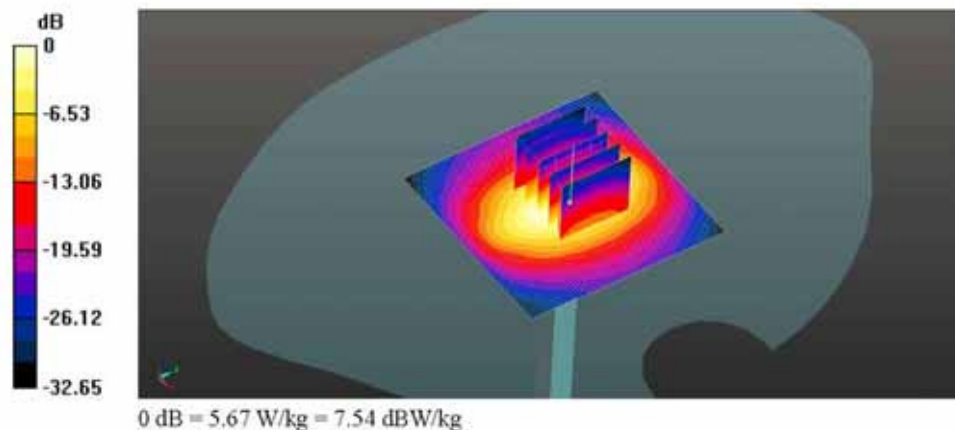
Communication System: UID 0, CW (0); Frequency: 1900 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 1900$ MHz; $\sigma = 1.426$ S/m; $\epsilon_r = 39.368$; $\rho = 1000$ kg/m³
 Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(8.15, 8.15, 8.15); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1340; Calibrated: 2014-05-19
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Verification/1900MHz Head System Verification/Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
 Maximum value of SAR (interpolated) = 5.67 W/kg

Verification/1900MHz Head System Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
 Reference Value = 63.850 V/m; Power Drift = 0.00 dB
 Peak SAR (extrapolated) = 7.12 W/kg
SAR(1 g) = 3.93 W/kg; SAR(10 g) = 2.05 W/kg
 Maximum value of SAR (measured) = 5.55 W/kg



Appendix A.2 Verification Test Plots for 1900 MHz_Body

Date: 2014-06-10

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: [1900MHz Body System Verification.da53.0](#)

Input Power : 100 mW

Ambient Temp : 23.4 °C Tissue Temp : 21.9 °C

DUT: Dipole 1900 MHz D1900V2; Type: D1900V2; Serial: D1900V2 - SN:5d158

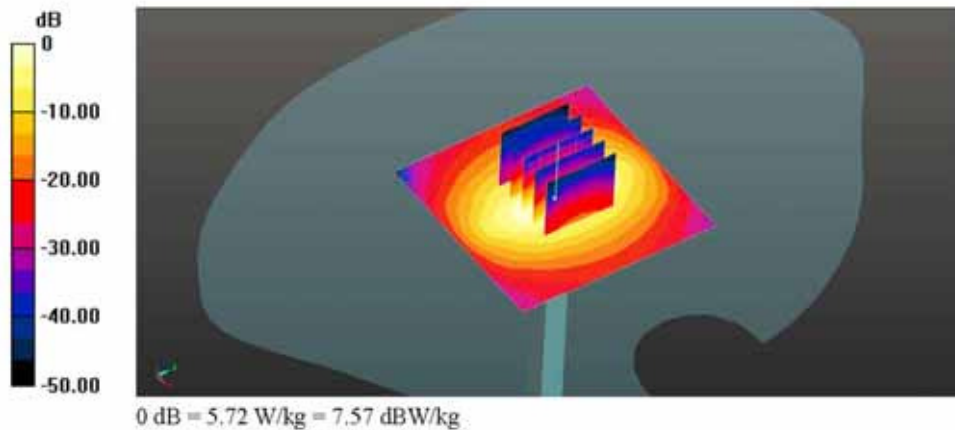
Communication System: UID 0, CW (0); Frequency: 1900 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 1900$ MHz; $\sigma = 1.557$ S/m; $\epsilon_r = 54.022$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(7.63, 7.63, 7.63); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1340; Calibrated: 2014-05-19
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Verification/1900MHz Body System Verification/Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 5.72 W/kg

Verification/1900MHz Body System Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 61.862 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 7.13 W/kg
SAR(1 g) = 4.03 W/kg; SAR(10 g) = 2.12 W/kg
Maximum value of SAR (measured) = 5.62 W/kg



Appendix A.3 Verification Test Plots for 2450 MHz_Head

Date: 2014-05-28

Test Laboratory : SGS Korea (Gunpo Laboratory)
 File Name: [2450MHz Head System Verification.da53:0](#)

Input Power : 100 mW

Ambient Temp : 23.8 °C Tissue Temp : 22.2 °C

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:892

Communication System: UID 0, CW (0); Frequency: 2450 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 2450$ MHz; $\sigma = 1.783$ S/m; $\epsilon_r = 38.159$; $\rho = 1000$ kg/m³
 Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(7.24, 7.24, 7.24); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Verification/2450MHz Head System Verification/Area Scan (101x101x1): Interpolated grid: $dx=1.000$ mm, $dy=1.000$ mm

Maximum value of SAR (interpolated) = 8.06 W/kg

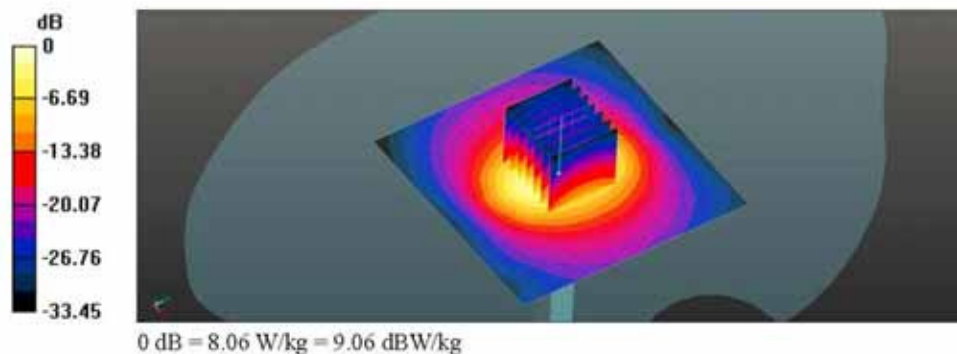
Verification/2450MHz Head System Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 68.082 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 11.2 W/kg

SAR(1 g) = 5.13 W/kg; SAR(10 g) = 2.33 W/kg

Maximum value of SAR (measured) = 8.07 W/kg



Appendix A.3 Verification Test Plots for 2450 MHz_Body

Date: 2014-05-28

Test Laboratory : SGS Korea (Gunpo Laboratory)
 File Name: [2450MHz Body System Verification.da53:0](#)

Input Power : 100 mW

Ambient Temp : 23.8 °C Tissue Temp : 21.9 °C

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:892

Communication System: UID 0, CW (0); Frequency: 2450 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 2450$ MHz; $\sigma = 1.919$ S/m; $\epsilon_r = 52.58$; $\rho = 1000$ kg/m³
 Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(7.17, 7.17, 7.17); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Verification/2450MHz Body System Verification/Area Scan (101x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 7.96 W/kg

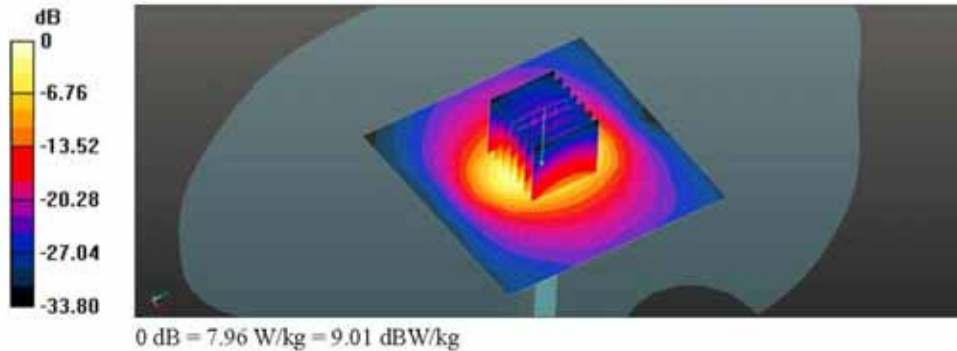
Verification/2450MHz Body System Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 63.435 V/m; Power Drift = 0.13 dB

Peak SAR (extrapolated) = 11.1 W/kg

SAR(1 g) = 5.13 W/kg; SAR(10 g) = 2.34 W/kg

Maximum value of SAR (measured) = 8.01 W/kg



Appendix A.4 Verification Test Plots for 835 MHz_Head

Date: 2014-07-03

Test Laboratory : SGS Korea (Gunpo Laboratory)
 File Name: [835MHz Head System Verification.da53:0](#)

Input Power : 100 mW

Ambient Temp : 23.7 °C Tissue Temp : 22.2 °C

DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: 4d138

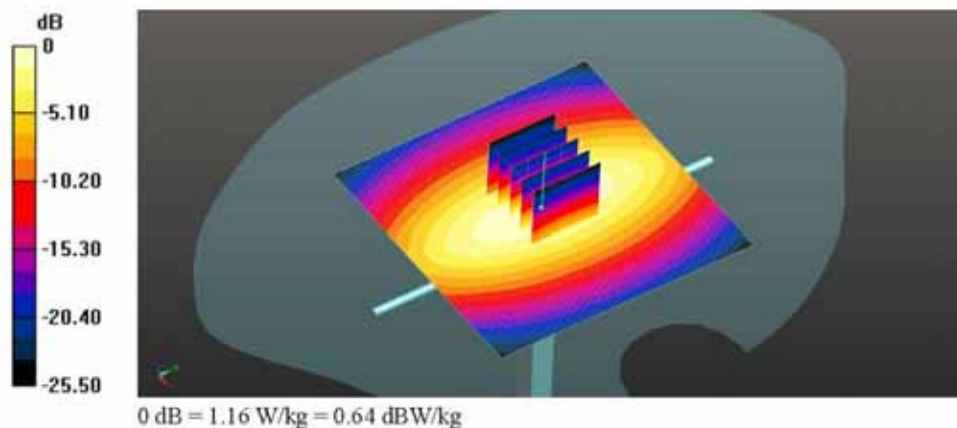
Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.886 \text{ S/m}$; $\epsilon_r = 40.02$; $\rho = 1000 \text{ kg/m}^3$
 Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(9.76, 9.76, 9.76); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1340; Calibrated: 2014-05-19
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

System Verification/835MHz Head System Verification/Area Scan (81x81x1): Interpolated grid:
 $dx=1.500 \text{ mm}$, $dy=1.500 \text{ mm}$
 Maximum value of SAR (interpolated) = 1.16 W/kg

System Verification/835MHz Head System Verification/Zoom Scan (5x5x7)/Cube 0: Measurement
 grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$
 Reference Value = 36.975 V/m; Power Drift = 0.01 dB
 Peak SAR (extrapolated) = 1.34 W/kg
SAR(1 g) = 0.913 W/kg; SAR(10 g) = 0.600 W/kg
 Maximum value of SAR (measured) = 1.15 W/kg



Appendix A.4 Verification Test Plots for 835 MHz_Body

Date: 2014-07-03

Test Laboratory : SGS Korea (Gunpo Laboratory)
 File Name: [835MHz Body System Verification.da53:0](#)

Input Power : 100 mW

Ambient Temp : 23.7 °C Tissue Temp : 22.4 °C

DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: 4d138

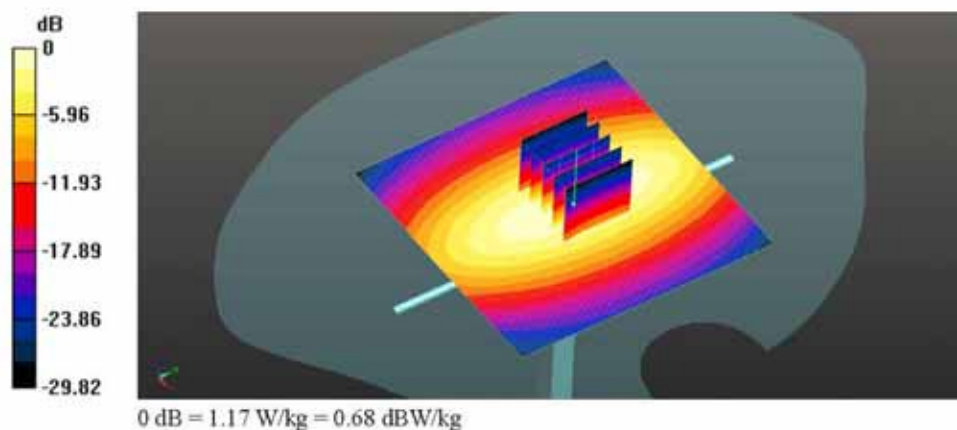
Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 835$ MHz; $\sigma = 0.944$ S/m; $\epsilon_r = 53.936$; $\rho = 1000$ kg/m³
 Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(9.52, 9.52, 9.52); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1340; Calibrated: 2014-05-19
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

System Verification/835MHz Body System Verification/Area Scan (81x81x1): Interpolated grid:
 $dx=1.500$ mm, $dy=1.500$ mm
 Maximum value of SAR (interpolated) = 1.17 W/kg

System Verification/835MHz Body System Verification/Zoom Scan (5x5x7)/Cube 0: Measurement
 grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm
 Reference Value = 35.854 V/m; Power Drift = 0.00 dB
 Peak SAR (extrapolated) = 1.35 W/kg
SAR(1 g) = 0.933 W/kg; SAR(10 g) = 0.620 W/kg
 Maximum value of SAR (measured) = 1.17 W/kg



Appendix A.5 SAR Test Plots for GSM850 Band (Head SAR)

Date: 2014-05-22

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: [GPRS 850_Right Touch_CH190.da53:0](#)

Ambient Temp : 23.6 °C Tissue Temp : 21.9 °C

DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467

Communication System: UID 0, GPRS850 2TX (0); Frequency: 836.6 MHz; Duty Cycle: 1:4.14954

Medium parameters used: $f = 837$ MHz; $\sigma = 0.9$ S/m; $\epsilon_r = 40.673$; $\rho = 1000$ kg/m³

Phantom section: Right Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(9.76, 9.76, 9.76); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Head/GPRS 850_Right Touch_CH190/Area Scan (81x121x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm
Maximum value of SAR (interpolated) = 0.286 W/kg

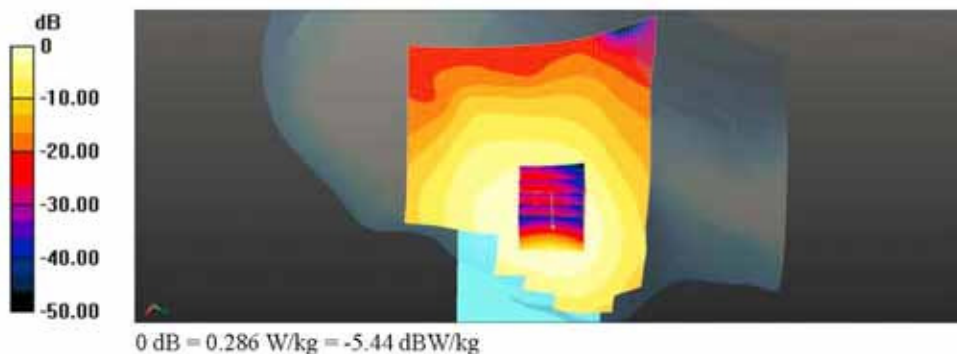
Head/GPRS 850_Right Touch_CH190/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm

Reference Value = 4.792 V/m; Power Drift = -0.11 dB

Peak SAR (extrapolated) = 0.309 W/kg

SAR(1 g) = 0.249 W/kg; SAR(10 g) = 0.192 W/kg

Maximum value of SAR (measured) = 0.281 W/kg



Appendix A.5 SAR Test Plots for GSM850 Band (Body-Worn SAR)

Date: 2014-05-23

Test Laboratory : SGS Korea (Gunpo Laboratory)

File Name: GSM_850_Rear_CH190.da53:0

Ambient Temp : 23.7 °C Tissue Temp : 22.1 °C

DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467

Communication System: UID 0, GSM850 (0); Frequency: 836.6 MHz; Duty Cycle: 1:8.30042

Medium parameters used: $f = 837$ MHz; $\sigma = 0.951$ S/m; $\epsilon_r = 55.879$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(9.52, 9.52, 9.52); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Body/GSM 850_Rear_CH190/Area Scan (81x121x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm

Maximum value of SAR (interpolated) = 0.448 W/kg

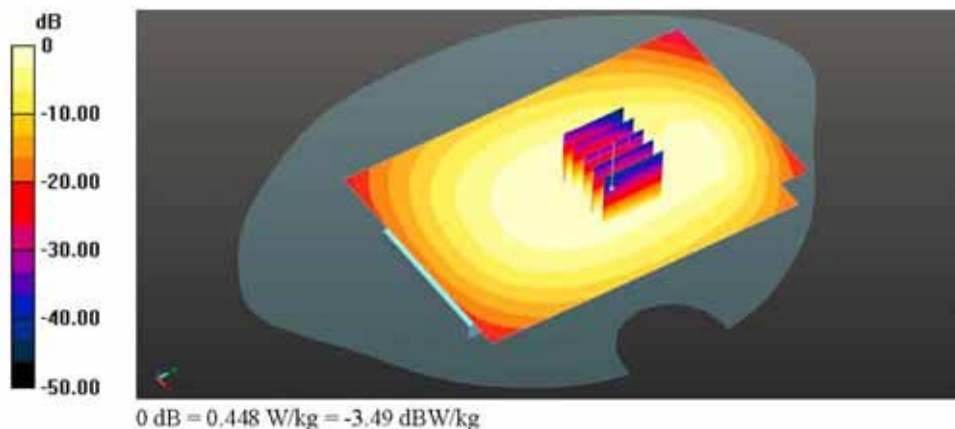
Body/GSM 850_Rear_CH190/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm

Reference Value = 20.650 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 0.480 W/kg

SAR(1 g) = 0.391 W/kg; SAR(10 g) = 0.304 W/kg

Maximum value of SAR (measured) = 0.442 W/kg



Appendix A.5 SAR Test Plots for GSM850 Band (Hotspot SAR)

Date: 2014-05-23

Test Laboratory : SGS Korea (Gunpo Laboratory)

File Name: [GPRS 850_Right Edge_CH190.da53.0](#)

Ambient Temp : 23.7 °C Tissue Temp : 22.1 °C

DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467

Communication System: UID 0, GPRS850 2TX (0); Frequency: 836.6 MHz; Duty Cycle: 1:4.14954

Medium parameters used: $f = 837 \text{ MHz}$; $\sigma = 0.951 \text{ S/m}$; $\epsilon_r = 55.879$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(9.52, 9.52, 9.52); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Body/GPRS 850_Right Edge_CH190/Area Scan (81x121x1): Interpolated grid: $dx=1.500 \text{ mm}$, $dy=1.500 \text{ mm}$

Maximum value of SAR (interpolated) = 0.573 W/kg

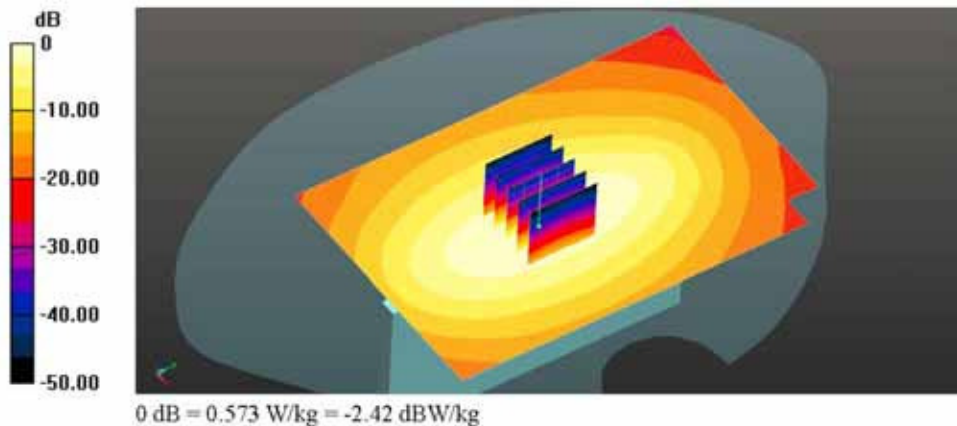
Body/GPRS 850_Right Edge_CH190/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 24.653 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 0.664 W/kg

SAR(1 g) = 0.478 W/kg; SAR(10 g) = 0.332 W/kg

Maximum value of SAR (measured) = 0.584 W/kg



Appendix A.6 SAR Test Plots for GSM1900 Band (Head SAR)

Date: 2014-06-10

Test Laboratory : SGS Korea (Gunpo Laboratory)
 File Name: GPRS 1900_Left Touch_CH661_da53:0

Ambient Temp : 23.4 °C Tissue Temp : 21.8 °C

DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467

Communication System: UID 0, GPRS1900 2TX (0); Frequency: 1880 MHz; Duty Cycle: 1:4.14954

Medium parameters used: $f = 1880$ MHz; $\sigma = 1.403$ S/m; $\epsilon_r = 39.453$; $\rho = 1000$ kg/m³

Phantom section: Left Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(8.15, 8.15, 8.15); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1340; Calibrated: 2014-05-19
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Head/GPRS 1900_Left Touch_CH661/Area Scan (81x121x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm

Maximum value of SAR (interpolated) = 0.377 W/kg

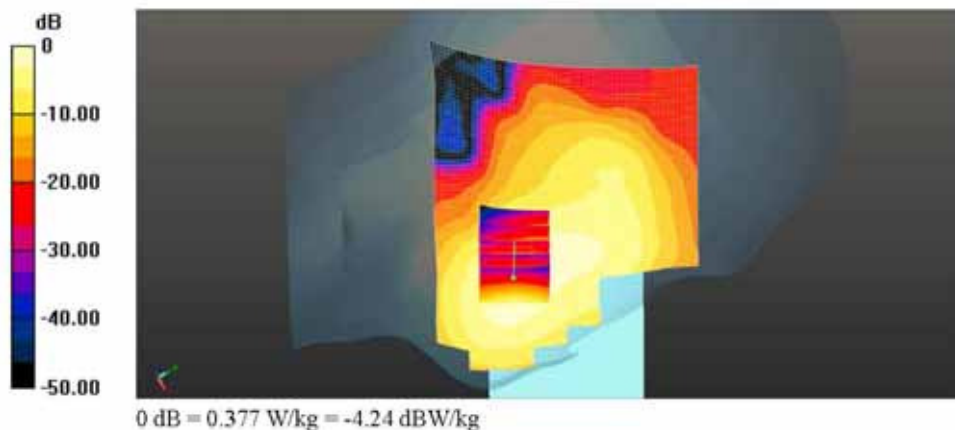
Head/GPRS 1900_Left Touch_CH661/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm

Reference Value = 4.002 V/m; Power Drift = 0.16 dB

Peak SAR (extrapolated) = 0.418 W/kg

SAR(1 g) = 0.276 W/kg; SAR(10 g) = 0.176 W/kg

Maximum value of SAR (measured) = 0.351 W/kg



Appendix A.6 SAR Test Plots for GSM1900 Band (Body-Worn)

Date: 2014-06-10

Test Laboratory : SGS Korea (Gunpo Laboratory)
 File Name: [GSM_1900_Rear_CH661.da53.0](#)

Ambient Temp : 23.4 °C Tissue Temp : 21.9 °C

DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467

Communication System: UID 0, PCS1900 (0); Frequency: 1880 MHz; Duty Cycle: 1:8.30042

Medium parameters used: $f = 1880$ MHz; $\sigma = 1.531$ S/m; $\epsilon_r = 54.081$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(7.63, 7.63, 7.63); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1340; Calibrated: 2014-05-19
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Body/GSM 1900_Rear_CH661/Area Scan (81x121x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm
 Maximum value of SAR (interpolated) = 0.436 W/kg

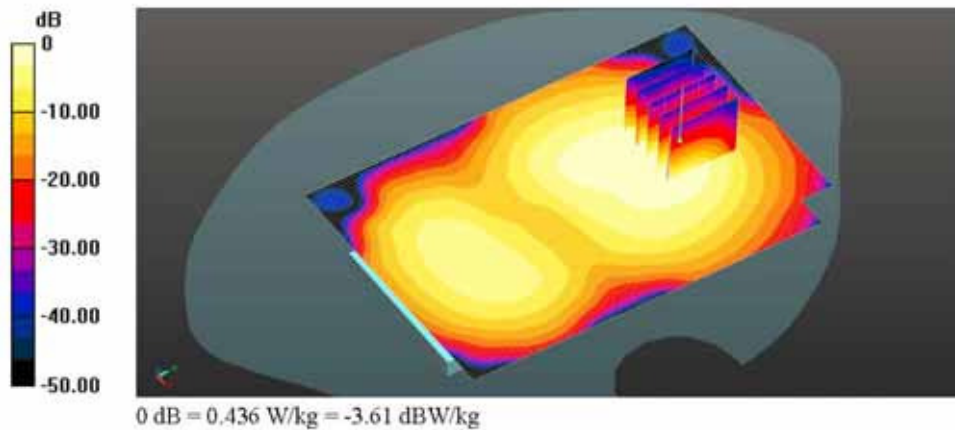
Body/GSM 1900_Rear_CH661/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm

Reference Value = 4.385 V/m; Power Drift = 0.12 dB

Peak SAR (extrapolated) = 0.667 W/kg

SAR(1 g) = 0.350 W/kg; SAR(10 g) = 0.186 W/kg

Maximum value of SAR (measured) = 0.508 W/kg



Appendix A.6 SAR Test Plots for GSM1900 Band (Hotspot SAR)

Date: 2014-06-10

Test Laboratory : SGS Korea (Gunpo Laboratory)
 File Name: [GPRS_1900_Rear_CH661.da53:0](#)

Ambient Temp : 23.4 °C Tissue Temp : 21.9 °C

DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467

Communication System: UID 0, GPRS1900 2TX (0); Frequency: 1880 MHz; Duty Cycle: 1:4.14954

Medium parameters used: $f = 1880$ MHz; $\sigma = 1.531$ S/m; $\epsilon_r = 54.081$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(7.63, 7.63, 7.63); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1340; Calibrated: 2014-05-19
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Body/GPRS 1900_Rear_CH661/Area Scan (81x121x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.442 W/kg

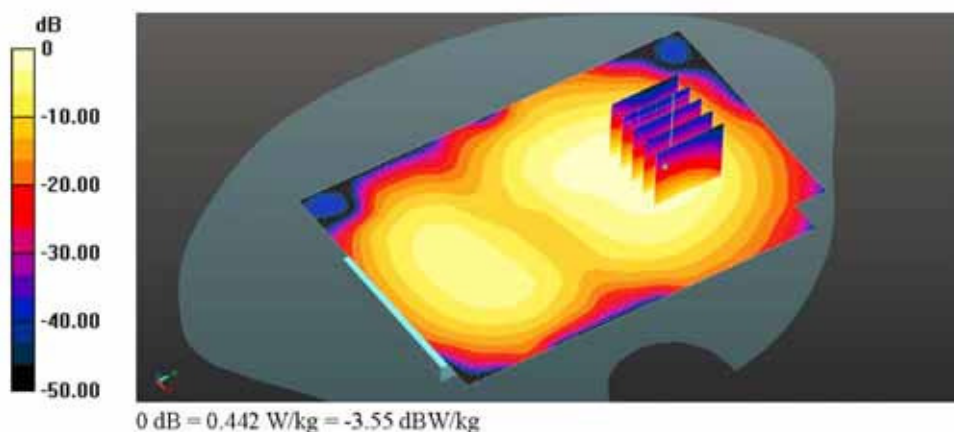
Body/GPRS 1900_Rear_CH661/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 4.080 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 0.691 W/kg

SAR(1 g) = 0.363 W/kg; SAR(10 g) = 0.191 W/kg

Maximum value of SAR (measured) = 0.544 W/kg



Appendix A.7 SAR Test Plots for WCDMA850 Band (Head SAR)

Date: 2014-05-22

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: [WCDMA 5_Right Touch_CH4183.da53:0](#)

Ambient Temp : 23.6 °C Tissue Temp : 21.9 °C

DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467

Communication System: UID 0, WCDMA5 (0); Frequency: 836.6 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 837$ MHz; $\sigma = 0.9$ S/m; $\epsilon_r = 40.673$; $\rho = 1000$ kg/m³

Phantom section: Right Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(9.76, 9.76, 9.76); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Head/WCDMA 5_Right Touch_CH4183/Area Scan (81x121x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.168 W/kg

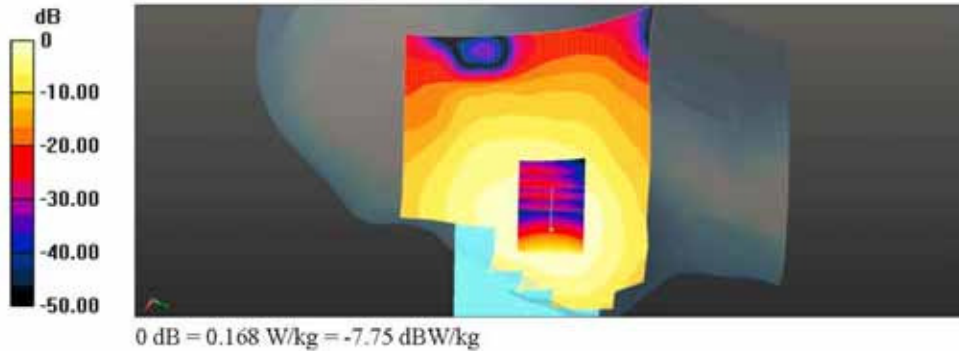
Head/WCDMA 5_Right Touch_CH4183/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 3.093 V/m; Power Drift = 0.15 dB

Peak SAR (extrapolated) = 0.180 W/kg

SAR(1 g) = 0.145 W/kg; SAR(10 g) = 0.111 W/kg

Maximum value of SAR (measured) = 0.163 W/kg



Appendix A.7 SAR Test Plots for WCDMA850 Band (Body-Worn)

Date: 2014-05-23

Test Laboratory : SGS Korea (Gunpo Laboratory)

File Name: [WCDMA 5_Rear_CH4183.da53:0](#)

Ambient Temp : 23.7 °C Tissue Temp : 22.1 °C

DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467

Communication System: UID 0, WCDMA5 (0); Frequency: 836.6 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 837$ MHz; $\sigma = 0.951$ S/m; $\epsilon_r = 55.879$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(9.52, 9.52, 9.52); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Body/WCDMA 5_Rear_CH4183/Area Scan (81x121x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.249 W/kg

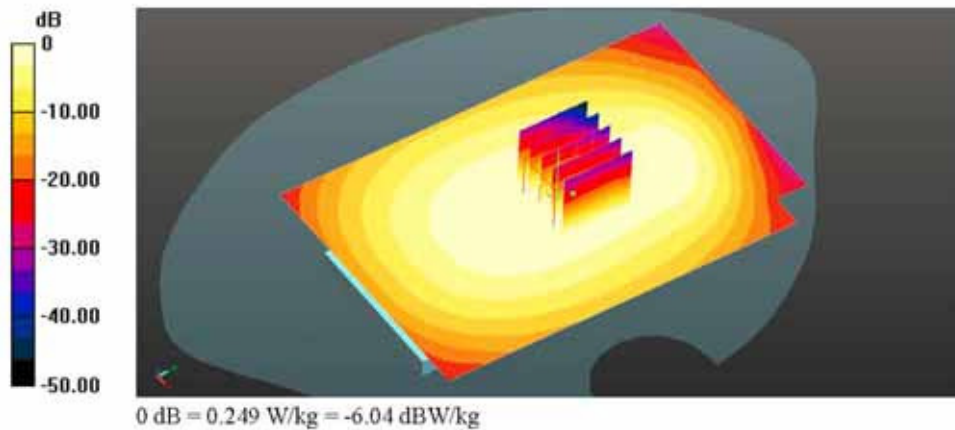
Body/WCDMA 5_Rear_CH4183/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 15.950 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 0.269 W/kg

SAR(1 g) = 0.219 W/kg; SAR(10 g) = 0.169 W/kg

Maximum value of SAR (measured) = 0.247 W/kg



Appendix A.7 SAR Test Plots for WCDMA850 Band (Hotspot SAR)

Date: 2014-05-23

Test Laboratory : SGS Korea (Gunpo Laboratory)
 File Name: [WCDMA 5_Right Edge_CH4183.da53:0](#)

Ambient Temp : 23.7 °C Tissue Temp : 22.1 °C

DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467

Communication System: UID 0, WCDMA5 (0); Frequency: 836.6 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 837$ MHz; $\sigma = 0.951$ S/m; $\epsilon_r = 55.879$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(9.52, 9.52, 9.52); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Body/WCDMA 5_Right Edge_CH4183/Area Scan (81x121x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm
 Maximum value of SAR (interpolated) = 0.274 W/kg

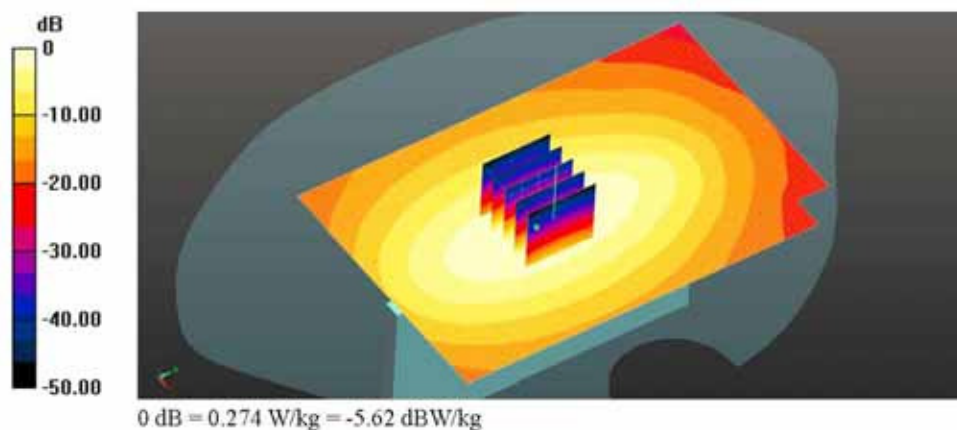
Body/WCDMA 5_Right Edge_CH4183/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm

Reference Value = 17.188 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 0.307 W/kg

SAR(1 g) = 0.223 W/kg; SAR(10 g) = 0.156 W/kg

Maximum value of SAR (measured) = 0.268 W/kg



Appendix A.8 SAR Test Plots for WCDMA1900 Band (Head SAR)

Date: 2014-05-24

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: [WCDMA 2 Left Touch CH9400.da53:0](#)

Ambient Temp : 23.8 °C Tissue Temp : 22.2 °C

DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467

Communication System: UID 0, WCDMA2 (0); Frequency: 1880 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 1880$ MHz; $\sigma = 1.426$ S/m; $\epsilon_r = 39.47$; $\rho = 1000$ kg/m³

Phantom section: Left Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(8.15, 8.15, 8.15); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Head/WCDMA 2 Left Touch CH9400/Area Scan (81x121x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm
Maximum value of SAR (interpolated) = 0.791 W/kg

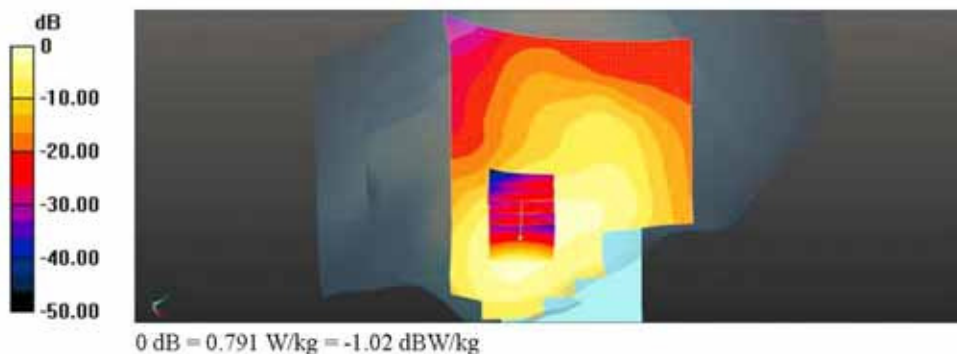
Head/WCDMA 2 Left Touch CH9400/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm

Reference Value = 5.640 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 0.884 W/kg

SAR(1 g) = 0.566 W/kg; SAR(10 g) = 0.356 W/kg

Maximum value of SAR (measured) = 0.727 W/kg



Appendix A.8 SAR Test Plots for WCDMA1900 Band (Body-Worn and Hotspot SAR)

Date: 2014-05-25

Test Laboratory : SGS Korea (Gunpo Laboratory)

File Name: [WCDMA 2_Rear_CH9262.da53:0](#)

Ambient Temp : 23.6 °C Tissue Temp : 22.0 °C

DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467

Communication System: UID 0, WCDMA2 (0); Frequency: 1852.4 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 1852.4$ MHz; $\sigma = 1.474$ S/m; $\epsilon_r = 53.947$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(7.63, 7.63, 7.63); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Body/WCDMA 2_Rear_CH9262/Area Scan (81x121x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (interpolated) = 1.42 W/kg

Body/WCDMA 2_Rear_CH9262/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

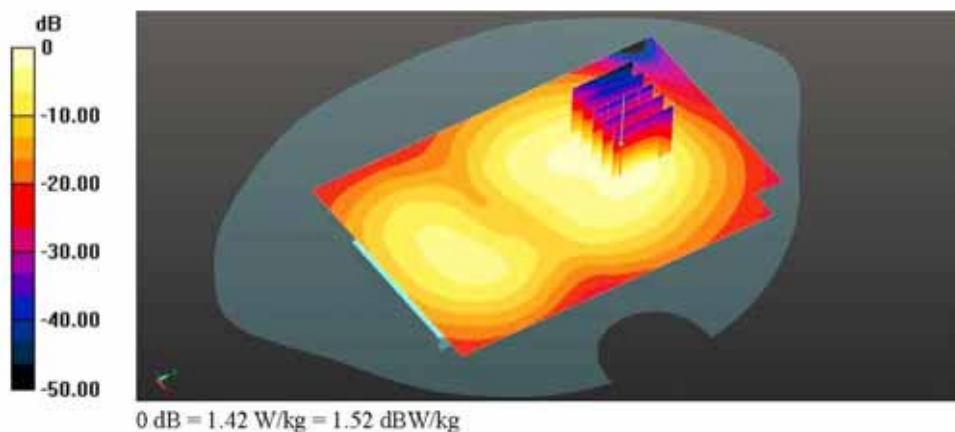
Reference Value = 10.246 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 1.68 W/kg

SAR(1 g) = 0.938 W/kg; SAR(10 g) = 0.525 W/kg

Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (measured) = 1.29 W/kg



Appendix A.9 SAR Test Plots for WLAN 2.4 GHz Band (Head SAR)

Date: 2014-05-28

Test Laboratory : SGS Korea (Gunpo Laboratory)

File Name: [WLAN_802.11b_1Mbps_Right Touch_CH11.da53:0](#)

Ambient Temp : 23.8 °C Tissue Temp : 22.2 °C

DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467

Communication System: UID 0, WLAN 2.45GHz (0); Frequency: 2462 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2462 \text{ MHz}$; $\sigma = 1.796 \text{ S/m}$; $\epsilon_r = 38.11$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(7.24, 7.24, 7.24); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Head/WLAN_802.11b_1Mbps_Right Touch_CH11/Area Scan (121x161x1): Interpolated grid: $dx=1.000 \text{ mm}$, $dy=1.000 \text{ mm}$

Maximum value of SAR (interpolated) = 0.387 W/kg

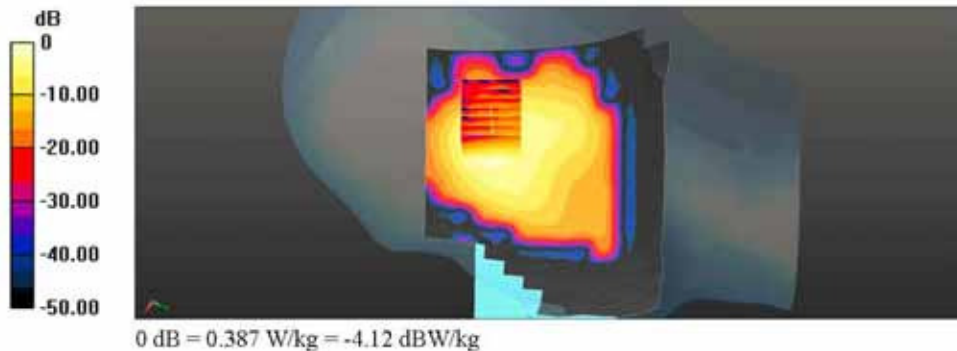
Head/WLAN_802.11b_1Mbps_Right Touch_CH11/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 7,660 V/m; Power Drift = 0.17 dB

Peak SAR (extrapolated) = 0.511 W/kg

SAR(1 g) = 0.223 W/kg; SAR(10 g) = 0.106 W/kg

Maximum value of SAR (measured) = 0.343 W/kg



Appendix A.9 SAR Test Plots for WLAN 2.4 GHz Band (Body-Worn)

Date: 2014-05-28

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: [WLAN_802.11b_1Mbps_Rear_CH11.da53:0](#)

Ambient Temp : 23.8 °C Tissue Temp : 21.9 °C

DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467

Communication System: UID 0, WLAN 2.45GHz (0); Frequency: 2462 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2462$ MHz; $\sigma = 1.934$ S/m; $\epsilon_r = 52.535$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(7.17, 7.17, 7.17); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Head/WLAN_802.11b_1Mbps_Rear_CH11/Area Scan (111x151x1): Interpolated grid: $dx=1.000$ mm, $dy=1.000$ mm

Maximum value of SAR (interpolated) = 0.0732 W/kg

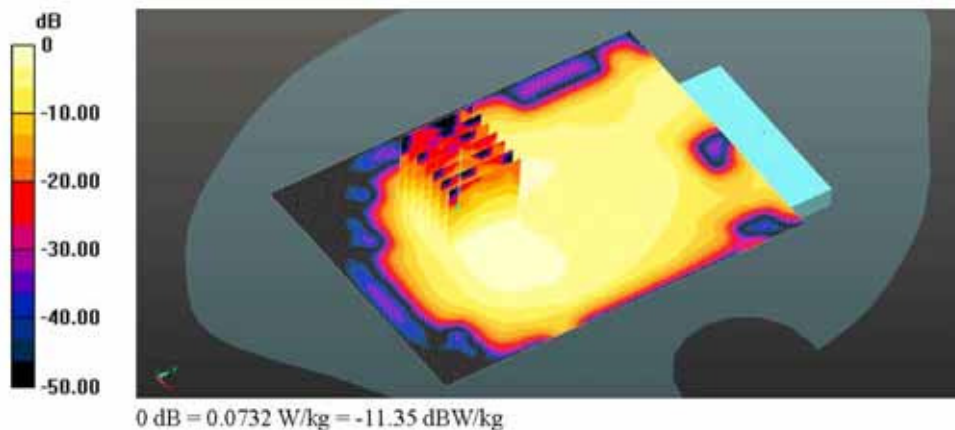
Head/WLAN_802.11b_1Mbps_Rear_CH11/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 3.541 V/m; Power Drift = 0.19 dB

Peak SAR (extrapolated) = 0.102 W/kg

SAR(1 g) = 0.047 W/kg; SAR(10 g) = 0.023 W/kg

Maximum value of SAR (measured) = 0.0723 W/kg



Appendix A.9 SAR Test Plots for WLAN 2.4 GHz Band (Hotspot SAR)

Date: 2014-05-28

Test Laboratory : SGS Korea (Gunpo Laboratory)

File Name: [WLAN_802.11b_1Mbps_Front_CH11.da53:0](#)

Ambient Temp : 23.8 °C Tissue Temp : 21.9 °C

DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467

Communication System: UID 0, WLAN 2.45GHz (0); Frequency: 2462 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2462 \text{ MHz}$; $\sigma = 1.934 \text{ S/m}$; $\epsilon_r = 52.535$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(7.17, 7.17, 7.17); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Head/WLAN_802.11b_1Mbps_Front_CH11/Area Scan (111x151x1): Interpolated grid: $dx=1.000 \text{ mm}$, $dy=1.000 \text{ mm}$

Maximum value of SAR (interpolated) = 0.0711 W/kg

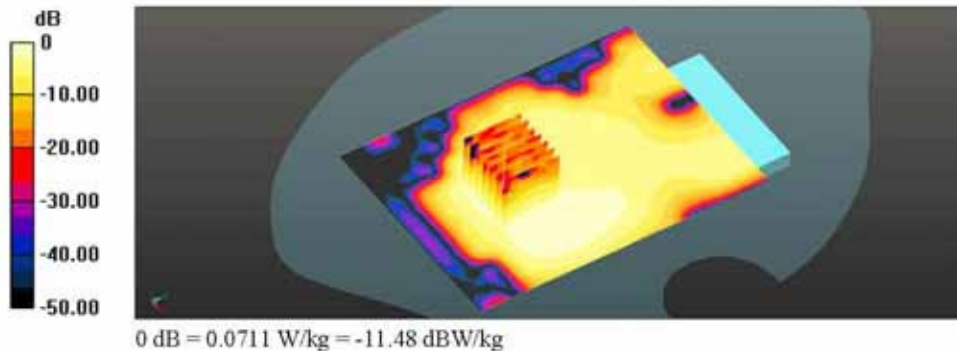
Head/WLAN_802.11b_1Mbps_Front_CH11/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 3.546 V/m; Power Drift = 0.16 dB

Peak SAR (extrapolated) = 0.0950 W/kg

SAR(1 g) = 0.050 W/kg; SAR(10 g) = 0.027 W/kg

Maximum value of SAR (measured) = 0.0702 W/kg



Appendix A.10 SAR Test Plots for GPRS850 3-slot data (Head SAR)

Date: 2014-07-03

Test Laboratory : SGS Korea (Gunpo Laboratory)
 File Name: GPRS 850_Right Touch_CH190_da53:0

Ambient Temp : 23.7 °C Tissue Temp : 22.2 °C

DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467

Communication System: UID 0, GPRS850 3TX (0); Frequency: 836.6 MHz; Duty Cycle: 1:2.77013

Medium parameters used: $f = 837$ MHz; $\sigma = 0.888$ S/m; $\epsilon_r = 39.995$; $\rho = 1000$ kg/m³

Phantom section: Right Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(9.76, 9.76, 9.76); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1340; Calibrated: 2014-05-19
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Head/GPRS 850_Right Touch_CH190/Area Scan (81x121x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.283 W/kg

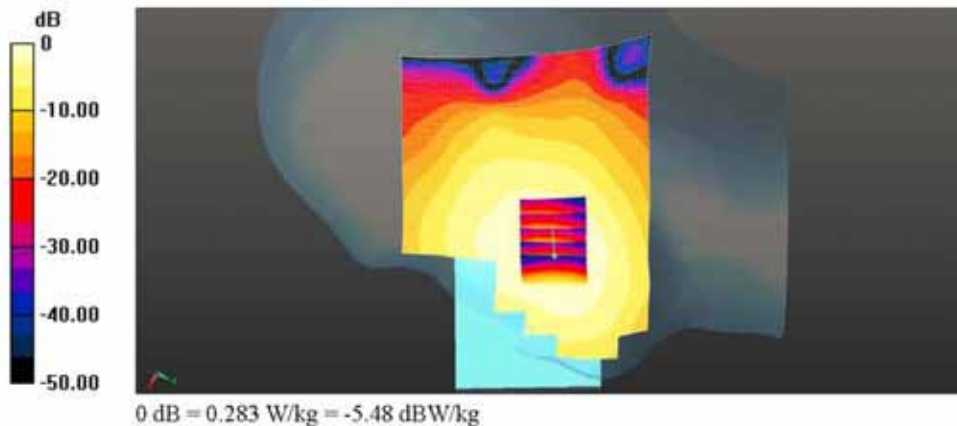
Head/GPRS 850_Right Touch_CH190/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 4.008 V/m; Power Drift = 0.15 dB

Peak SAR (extrapolated) = 0.307 W/kg

SAR(1 g) = 0.251 W/kg; SAR(10 g) = 0.194 W/kg

Maximum value of SAR (measured) = 0.278 W/kg



Appendix A.10 SAR Test Plots for GPRS850 3-slot data (Hotspot SAR)

Date: 2014-07-03

Test Laboratory : SGS Korea (Gunpo Laboratory)
 File Name: [GPRS 850_Right Edge_CH190.da53.0](#)

Ambient Temp : 23.7 °C Tissue Temp : 22.4 °C

DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467

Communication System: UID 0, GPRS850 3TX (0); Frequency: 836.6 MHz; Duty Cycle: 1:2.77013

Medium parameters used: $f = 837$ MHz; $\sigma = 0.946$ S/m; $\epsilon_r = 53.911$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(9.52, 9.52, 9.52); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1340; Calibrated: 2014-05-19
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

Body/GPRS 850_Right Edge_CH190/Area Scan (81x121x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.579 W/kg

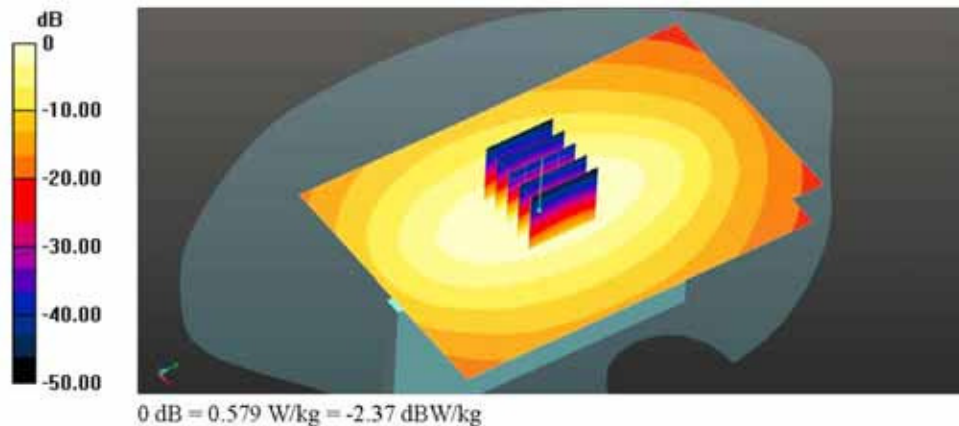
Body/GPRS 850_Right Edge_CH190/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 24.856 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 0.645 W/kg

SAR(1 g) = 0.486 W/kg; SAR(10 g) = 0.349 W/kg

Maximum value of SAR (measured) = 0.579 W/kg



Appendix B.1 Uncertainty Analysis

Measurement uncertainty for 300 MHz to 3 GHz averaged over 1 gram

a	b	c	d	e = f(d,k)	g	i = cxg/e	k
Uncertainty Component	Section in	Tol	Prob .	Div.	Ci	lg	Vi
	P1528	(%)	Dist.		(1g)	ui (%)	(Veff)
Probe calibration	E.2.1	6.0	N	1	1	6.0	∞
Axial isotropy	E.2.2	4.7	R	1.73	0.71	1.93	∞
hemispherical isotropy	E.2.2	9.6	R	1.73	0.71	3.94	∞
Boundary effect	E.2.3	1.0	R	1.73	1	0.58	∞
Linearity	E.2.4	4.7	R	1.73	1	2.72	∞
System detection limit	E.2.5	0.3	R	1.73	1	0.17	∞
Readout electronics	E.2.6	0.3	N	1	1	0.30	∞
Response time	E.2.7	0.5	R	1.73	1	0.29	∞
Integration time	E.2.8	2.6	R	1.73	1	1.50	∞
RF ambient Condition -Noise	E.6.1	3	R	1.73	1	1.73	∞
RF ambient Condition - reflections	E.6.1	3	R	1.73	1	1.73	∞
Probe positioning- mechanical tolerance	E.6.2	1.5	R	1.73	1	0.87	∞
Probe positioning- with respect to phantom	E.6.3	2.9	R	1.73	1	1.68	∞
Max. SAR evaluation	E.5.2	1.0	R	1.73	1	0.58	∞
Test sample positioning	E.4.2	1.32	N	1	1	1.32	9
Device holder uncertainty	E.4.1	3.6	N	1	1	3.60	4
Output power variation -SAR drift measurement	6.6.3	5	R	1.73	1	2.89	∞
Phantom uncertainty (shape and thickness tolerances)	E.3.1	4	R	1.73	1	2.31	∞
Liquid conductivity – deviation from target values	E.3.2	5	R	1.73	0.64	1.85	∞
Liquid conductivity - measurement uncertainty	E.3.2	0.38	N	1	0.64	0.24	9
Liquid permittivity – deviation from target values	E.3.3	5	R	1.73	0.6	1.73	∞
Liquid permittivity – deviation from target values	E.3.3	0.27	N	1	0.6	0.16	9
Combined standard uncertainty				RSS		10.82	287
Expanded uncertainty (95% CONFIDENCE INTERVAL)				k=2		21.00	

Measurement uncertainty for 3 GHz to 6 GHz averaged over 1 gram

a	b	c	d	e = f(d,k)	g	i = cxg/e	k
Uncertainty Component	Section in	Tol	Prob .	Div.	Ci	lg	Vi
	P1528	(%)	Dist.		(1g)	ui (%)	(Veff)
Probe calibration	E.2.1	6.55	N	1	1	6.55	∞
Axial isotropy	E.2.2	4.7	R	1.73	0.71	1.93	∞
hemispherical isotropy	E.2.2	9.6	R	1.73	0.71	3.94	∞
Boundary effect	E.2.3	1.0	R	1.73	1	0.58	∞
Linearity	E.2.4	4.7	R	1.73	1	2.72	∞
System detection limit	E.2.5	0.3	R	1.73	1	0.17	∞
Readout electronics	E.2.6	0.3	N	1	1	0.30	∞
Response time	E.2.7	0.5	R	1.73	1	0.29	∞
Integration time	E.2.8	2.6	R	1.73	1	1.50	∞
RF ambient Condition -Noise	E.6.1	3	R	1.73	1	1.73	∞
RF ambient Condition - reflections	E.6.1	3	R	1.73	1	1.73	∞
Probe positioning- mechanical tolerance	E.6.2	1.5	R	1.73	1	0.87	∞
Probe positioning- with respect to phantom	E.6.3	2.9	R	1.73	1	1.68	∞
Max. SAR evaluation	E.5.2	1.0	R	1.73	1	0.58	∞
Test sample positioning	E.4.2	1.32	N	1	1	1.32	9
Device holder uncertainty	E.4.1	3.6	N	1	1	3.60	4
Output power variation -SAR drift measurement	6.6.3	5	R	1.73	1	2.89	∞
Phantom uncertainty (shape and thickness tolerances)	E.3.1	4	R	1.73	1	2.31	∞
Liquid conductivity – deviation from target values	E.3.2	5	R	1.73	0.64	1.85	∞
Liquid conductivity - measurement uncertainty	E.3.2	0.38	N	1	0.64	0.24	9
Liquid permittivity – deviation from target values	E.3.3	5	R	1.73	0.6	1.73	∞
Liquid permittivity – deviation from target values	E.3.3	0.27	N	1	0.6	0.16	9
Combined standard uncertainty				RSS		10.82	324
Expanded uncertainty (95% CONFIDENCE INTERVAL)				k=2		21.64	

Appendix C.1 Calibration certificate for Probe_S/N 3862

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 **SGS (Dymstec)**

Certificate No: **EX3-3862_Jan14**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3862**

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: **January 29, 2014**

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 $(22 \pm 3)^{\circ}\text{C}$ 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	30-Dec-13 (No. ES3-3013_Dec13)	Dec-14
DAE4	SN: 660	13-Dec-13 (No. DAE4-660_Dec13)	Dec-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-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

Issued: January 30, 2014

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

**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**

Glossary:

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,y,z}
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization ϕ	ϕ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.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_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep 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_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}**: 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_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).

EX3DV4 – SN:3862

January 29, 2014

Probe EX3DV4

SN:3862

Manufactured: February 2, 2012

Calibrated: January 29, 2014

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

EX3DV4- SN:3862

January 29, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3862

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.43	0.44	0.37	± 10.1 %
DCP (mV) ^B	108.2	99.9	104.9	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	152.2	±3.3 %
		Y	0.0	0.0	1.0		154.0	
		Z	0.0	0.0	1.0		191.1	

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%.

^A The uncertainties of NormX,Y,Z do not affect the E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter; uncertainty not required.

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

EX3DV4- SN:3862

January 29, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3862

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unct. (k=2)
835	41.5	0.90	9.76	9.76	9.76	0.16	1.67	± 12.0 %
900	41.5	0.97	9.63	9.63	9.63	0.31	0.93	± 12.0 %
1750	40.1	1.37	8.37	8.37	8.37	0.80	0.56	± 12.0 %
1900	40.0	1.40	8.15	8.15	8.15	0.51	0.72	± 12.0 %
2300	39.5	1.67	7.69	7.69	7.69	0.30	0.92	± 12.0 %
2450	39.2	1.80	7.24	7.24	7.24	0.32	0.85	± 12.0 %
5200	36.0	4.66	4.89	4.89	4.89	0.31	1.80	± 13.1 %
5300	35.9	4.76	4.77	4.77	4.77	0.31	1.80	± 13.1 %
5500	35.6	4.96	4.72	4.72	4.72	0.32	1.80	± 13.1 %
5600	35.5	5.07	4.59	4.59	4.59	0.30	1.80	± 13.1 %
5800	35.3	5.27	4.25	4.25	4.25	0.35	1.80	± 13.1 %

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

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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

EX3DV4- SN:3862

January 29, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3862

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth (mm) ^G	Unct. (k=2)
835	55.2	0.97	9.52	9.52	9.52	0.31	1.06	± 12.0 %
1750	53.4	1.49	8.09	8.09	8.09	0.54	0.71	± 12.0 %
1900	53.3	1.52	7.63	7.63	7.63	0.25	1.04	± 12.0 %
2450	52.7	1.95	7.17	7.17	7.17	0.80	0.50	± 12.0 %
5200	49.0	5.30	4.46	4.46	4.46	0.35	1.90	± 13.1 %
5300	48.9	5.42	4.21	4.21	4.21	0.38	1.90	± 13.1 %
5500	48.6	5.65	4.04	4.04	4.04	0.38	1.90	± 13.1 %
5600	48.5	5.77	4.06	4.06	4.06	0.32	1.90	± 13.1 %
5800	48.2	6.00	4.08	4.08	4.08	0.44	1.90	± 13.1 %

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

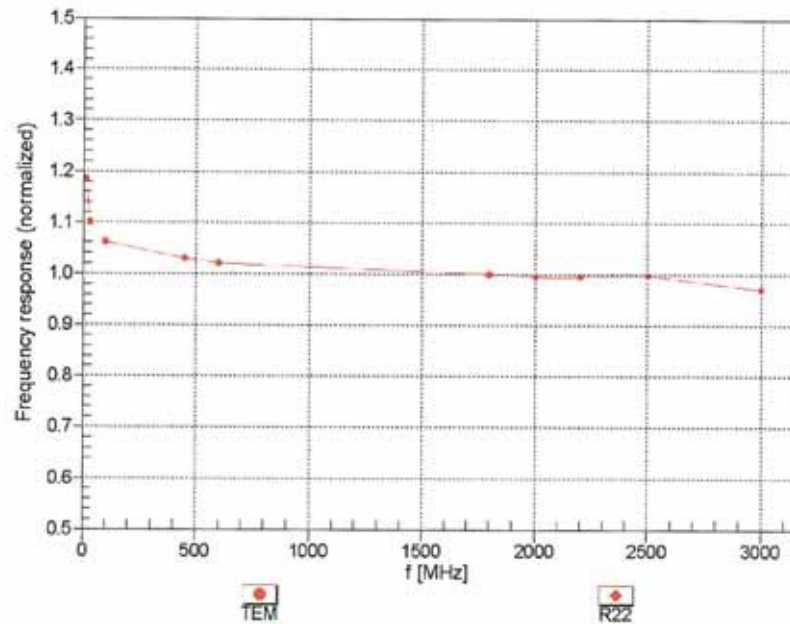
^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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

EX3DV4- SN:3862

January 29, 2014

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

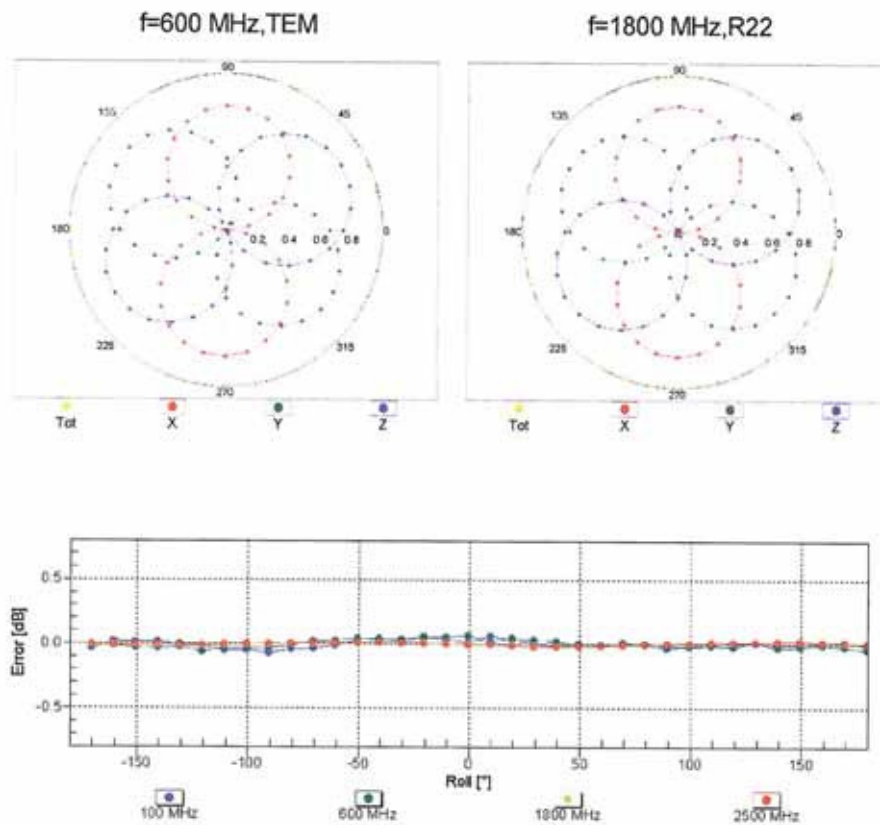


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

EX3DV4- SN:3862

January 29, 2014

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

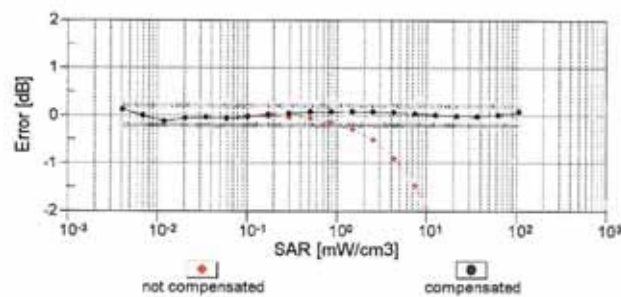
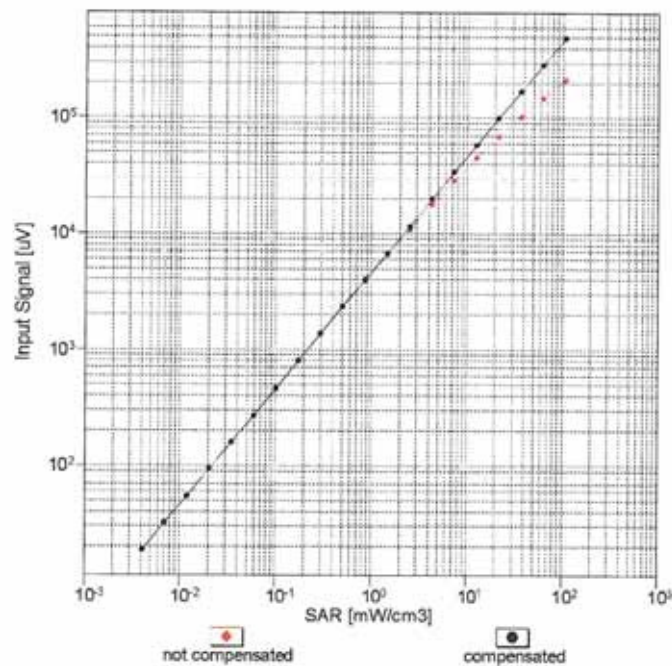


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

EX3DV4- SN:3862

January 29, 2014

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

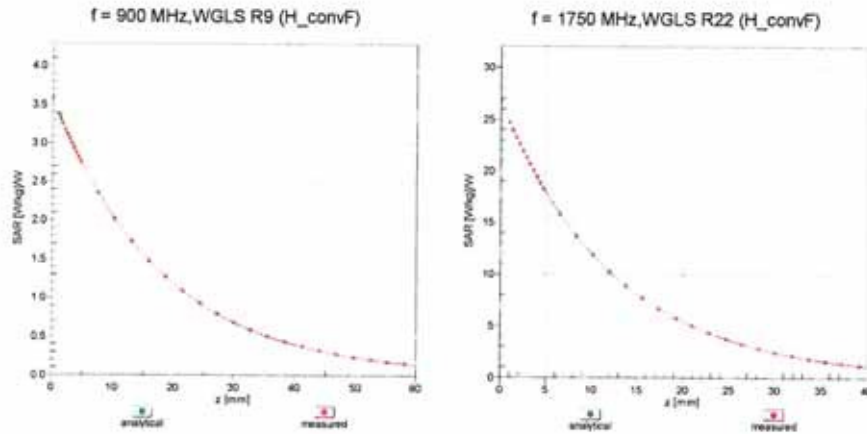


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

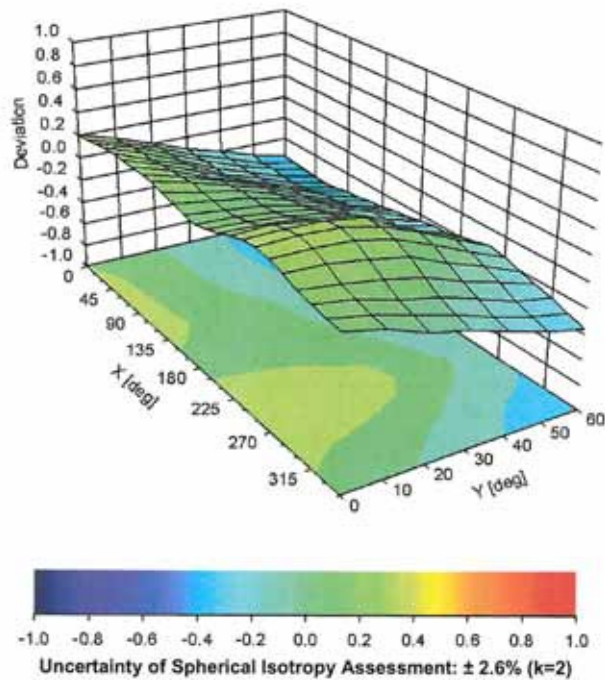
EX3DV4- SN:3862

January 29, 2014

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, θ), $f = 900 \text{ MHz}$



EX3DV4- SN:3862

January 29, 2014

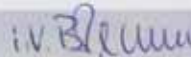
DASY/EASY - Parameters of Probe: EX3DV4 - SN:3862

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-70.6
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

Appendix C.2 Calibration certificate for DAE S/N 614

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 Dymstec	Certificate No: DAE4-614_Sep13	

CALIBRATION CERTIFICATE																							
Object	DAE4 - SD 000 D04 BM - SN: 614																						
Calibration procedure(s)	QA CAL-06.v26 Calibration procedure for the data acquisition electronics (DAE)																						
Calibration date:	September 20, 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 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) <table border="1"> <thead> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date (Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Keithley Multimeter Type 2001</td> <td>SN: 0810278</td> <td>02-Oct-12 (No:12728)</td> <td>Oct-13</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th>Secondary Standards</th> <th>ID #</th> <th>Check Date (in house)</th> <th>Scheduled Check</th> </tr> </thead> <tbody> <tr> <td>Auto DAE Calibration Unit</td> <td>SE UWS 053 AA 1001</td> <td>07-Jan-13 (in house check)</td> <td>In house check: Jan-14</td> </tr> <tr> <td>Calibrator Box V2.1</td> <td>SE UMS 006 AA 1002</td> <td>07-Jan-13 (in house check)</td> <td>In house check: Jan-14</td> </tr> </tbody> </table>				Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration	Keithley Multimeter Type 2001	SN: 0810278	02-Oct-12 (No:12728)	Oct-13	Secondary Standards	ID #	Check Date (in house)	Scheduled Check	Auto DAE Calibration Unit	SE UWS 053 AA 1001	07-Jan-13 (in house check)	In house check: Jan-14	Calibrator Box V2.1	SE UMS 006 AA 1002	07-Jan-13 (in house check)	In house check: Jan-14
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration																				
Keithley Multimeter Type 2001	SN: 0810278	02-Oct-12 (No:12728)	Oct-13																				
Secondary Standards	ID #	Check Date (in house)	Scheduled Check																				
Auto DAE Calibration Unit	SE UWS 053 AA 1001	07-Jan-13 (in house check)	In house check: Jan-14																				
Calibrator Box V2.1	SE UMS 006 AA 1002	07-Jan-13 (in house check)	In house check: Jan-14																				
Calibrated by:	Name R.Mayoraz	Function Technician	Signature 																				
Approved by:	Name Fin Bornholt	Function Deputy Technical Manager	Signature 																				
			Issued: September 20, 2013																				
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.																							

Certificate No: DAE4-614_Sep13

Page 1 of 5

**Calibration Laboratory of
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Engineering AG**

Zeughausstrasse 43, 8004 Zurich, Switzerland



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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**
Glossary

DAE data acquisition electronics
Connector angle information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

- **DC Voltage Measurement:** Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- **Connector angle:** The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
 - **DC Voltage Measurement Linearity:** Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
 - **Common mode sensitivity:** Influence of a positive or negative common mode voltage on the differential measurement.
 - **Channel separation:** Influence of a voltage on the neighbor channels not subject to an input voltage.
 - **AD Converter Values with inputs shorted:** Values on the internal AD converter corresponding to zero input voltage
 - **Input Offset Measurement:** Output voltage and statistical results over a large number of zero voltage measurements.
 - **Input Offset Current:** Typical value for information; Maximum channel input offset current, not considering the input resistance.
 - **Input resistance:** Typical value for information; DAE input resistance at the connector, during internal auto-zeroing and during measurement.
 - **Low Battery Alarm Voltage:** Typical value for information. Below this voltage, a battery alarm signal is generated.
 - **Power consumption:** Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1 μ V, full range = -100...+300 mV

Low Range: 1LSB = 61nV, full range = -1.....+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	403.807 $\pm$ 0.02% (k=2)	404.319 $\pm$ 0.02% (k=2)	404.934 $\pm$ 0.02% (k=2)
Low Range	3.94988 $\pm$ 1.50% (k=2)	3.96241 $\pm$ 1.50% (k=2)	3.99962 $\pm$ 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	224.5 $^{\circ}$ $\pm$ 1 $^{\circ}$
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Appendix

1. DC Voltage Linearity

High Range		Reading (μ V)	Difference (μ V)	Error (%)
Channel X	+ Input	199996.56	-0.37	-0.00
Channel X	+ Input	20005.71	5.55	0.03
Channel X	- Input	-19997.19	4.15	-0.02
Channel Y	+ Input	199997.81	1.11	0.00
Channel Y	+ Input	20004.00	3.84	0.02
Channel Y	- Input	-20000.85	0.52	-0.00
Channel Z	+ Input	199994.41	-2.32	-0.00
Channel Z	+ Input	20002.11	1.93	0.01
Channel Z	- Input	-20002.26	-0.91	0.00

Low Range		Reading (μ V)	Difference (μ V)	Error (%)
Channel X	+ Input	2001.50	1.30	0.06
Channel X	+ Input	201.44	0.70	0.35
Channel X	- Input	-199.12	-0.01	0.00
Channel Y	+ Input	2000.48	0.22	0.01
Channel Y	+ Input	199.97	-0.81	-0.41
Channel Y	- Input	-200.69	-1.50	0.76
Channel Z	+ Input	2000.24	0.06	0.00
Channel Z	+ Input	199.28	-1.43	-0.71
Channel Z	- Input	-200.15	-0.98	0.49

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μ V)	Low Range Average Reading (μ V)
Channel X	200	0.68	-0.63
	- 200	2.07	0.49
Channel Y	200	7.44	7.07
	- 200	-9.49	-9.32
Channel Z	200	-11.32	-11.48
	- 200	10.34	10.30

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μ V)	Channel Y (μ V)	Channel Z (μ V)
Channel X	200	-	4.11	0.42
Channel Y	200	9.94	-	5.29
Channel Z	200	5.90	6.43	-

4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	16250	17197
Channel Y	16372	16866
Channel Z	16119	17003

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
 Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	0.36	-0.77	1.54	0.50
Channel Y	-0.93	-2.14	0.95	0.48
Channel Z	-1.04	-2.00	-0.03	0.45

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kΩ)	Measuring (MΩ)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	-0.01	-8	-9

Appendix C.2 Calibration certificate for DAE S/N 1340

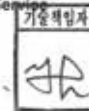
**Calibration Laboratory of
 Schmid & Partner
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 Zeughausstrasse 43, 8004 Zurich, Switzerland



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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 **SGS (Dymstec)**

Certificate No: **DAE4-1340_May14**

CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BJ - SN: 1340**

Calibration procedure(s) **QA CAL-06.v26
 Calibration procedure for the data acquisition electronics (DAE)**

Calibration date: **May 19, 2014**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	01-Oct-13 (No:13976)	Oct-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	07-Jan-14 (in house check)	In house check: Jan-15
Calibrator Box V2.1	SE UMS 006 AA 1002	07-Jan-14 (in house check)	In house check: Jan-15

Calibrated by: **Dominique Steffen** Function: **Technician** Signature: 

Approved by: **Fin Bomholt** Deputy Technical Manager



Issued: May 19, 2014

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

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



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Connector angle information used in DASY system to align probe sensor X to the robot coordinate system.

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 - **Input Offset Current:** Typical value for information; Maximum channel input offset current, not considering the input resistance.
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 - **Power consumption:** Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1 μ V, full range = -100...+300 mV

Low Range: 1LSB = 61nV, full range = -1.....+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	404.444 $\pm$ 0.02% (k=2)	404.371 $\pm$ 0.02% (k=2)	404.455 $\pm$ 0.02% (k=2)
Low Range	3.98216 $\pm$ 1.50% (k=2)	3.98232 $\pm$ 1.50% (k=2)	4.01144 $\pm$ 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	255.5 $^{\circ}$ $\pm$ 1 $^{\circ}$
---	-------------------------------------

Appendix

1. DC Voltage Linearity

High Range	Reading (μ V)	Difference (μ V)	Error (%)
Channel X + Input	199996.75	0.62	0.00
Channel X + Input	20002.86	2.07	0.01
Channel X - Input	-19998.70	2.14	-0.01
Channel Y + Input	199998.47	2.32	0.00
Channel Y + Input	19998.25	-2.43	-0.01
Channel Y - Input	-20003.12	-2.05	0.01
Channel Z + Input	199998.55	1.78	0.00
Channel Z + Input	20000.17	-0.46	-0.00
Channel Z - Input	-20002.80	-1.74	0.01

Low Range	Reading (μ V)	Difference (μ V)	Error (%)
Channel X + Input	2000.85	0.13	0.01
Channel X + Input	201.55	0.57	0.28
Channel X - Input	-198.00	0.97	-0.49
Channel Y + Input	2001.14	0.22	0.01
Channel Y + Input	200.26	-0.86	-0.43
Channel Y - Input	-200.11	-1.20	0.60
Channel Z + Input	2001.08	0.33	0.02
Channel Z + Input	200.51	-0.33	-0.17
Channel Z - Input	-199.40	-0.25	0.13

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μ V)	Low Range Average Reading (μ V)
Channel X	200	2.81	0.32
	- 200	1.56	-0.16
Channel Y	200	-13.87	-13.93
	- 200	11.69	11.57
Channel Z	200	-9.93	-10.42
	- 200	9.21	9.16

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μ V)	Channel Y (μ V)	Channel Z (μ V)
Channel X	200	-	-1.61	-2.83
Channel Y	200	6.75	-	1.34
Channel Z	200	10.61	3.30	-

4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	15824	15758
Channel Y	16240	16273
Channel Z	16028	14710

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Input 10M Ω

	Average (μ V)	min. Offset (μ V)	max. Offset (μ V)	Std. Deviation (μ V)
Channel X	-0.86	-2.43	-0.08	0.38
Channel Y	-1.68	-2.57	-0.85	0.37
Channel Z	-1.83	-2.96	-0.09	0.45

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	-0.01	-8	-9

Appendix C.3 Calibration certificate for Dipole 835 MHz

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

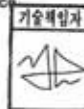


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Accreditation No.: SCS 108

2013. 10. 14



Client **SGS (Dymstec)**

Certificate No: D835V2-4d138_Sep13

CALIBRATION CERTIFICATE

Object **D835V2 - SN: 4d138**

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

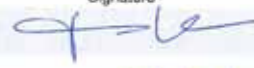
Calibration date: **September 27, 2013**

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 $(22 \pm 3)^{\circ}\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
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
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator F&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

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

Issued: September 27, 2013

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

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



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Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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.

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

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	41.4 $\pm$ 6 %	0.92 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.44 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.56 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	6.16 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	54.4 $\pm$ 6 %	1.01 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.41 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.32 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.57 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	6.12 W/kg $\pm$ 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.6 Ω -2.1 j Ω
Return Loss	- 31.7 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.7 Ω - 4.4 j Ω
Return Loss	- 24.9 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.397 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	July 22, 2011

DASY5 Validation Report for Head TSL

Date: 27.09.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d138

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

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.92 \text{ S/m}$; $\epsilon_r = 41.4$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.05, 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:

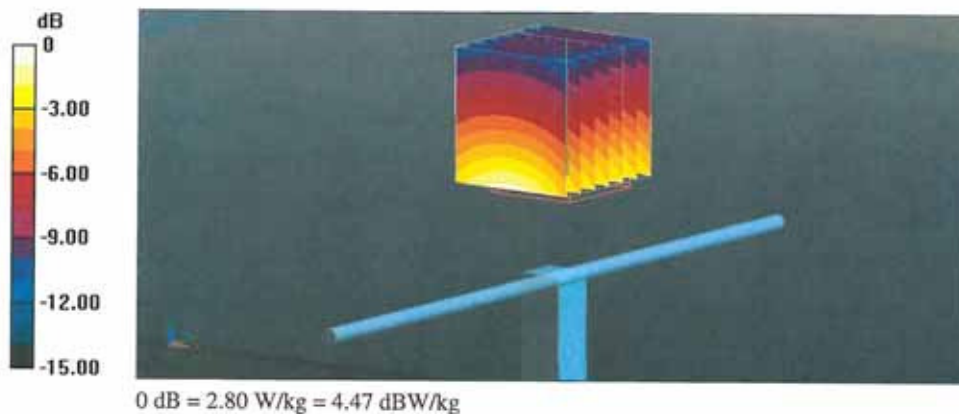
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 56.671 V/m; Power Drift = 0.04 dB

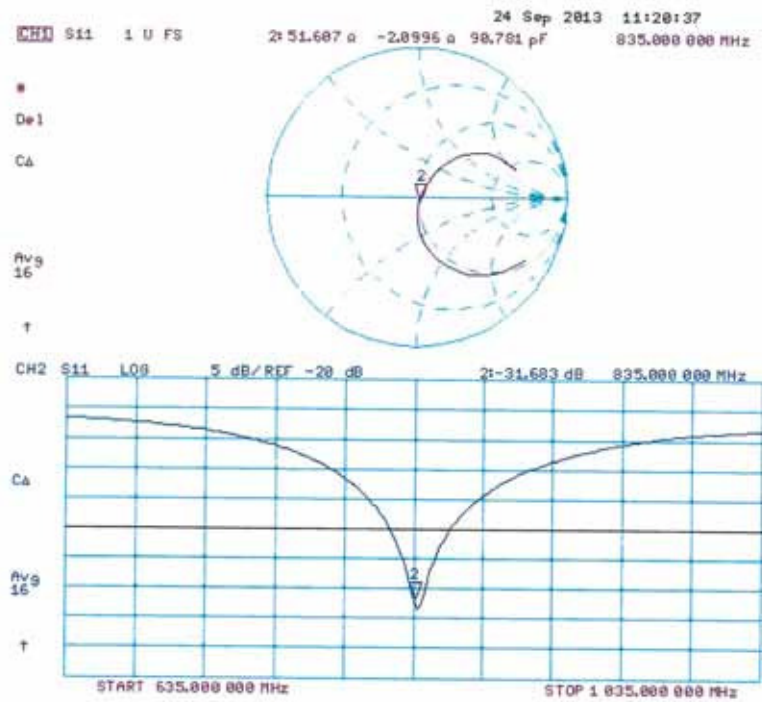
Peak SAR (extrapolated) = 3.63 W/kg

SAR(1 g) = 2.4 W/kg; SAR(10 g) = 1.56 W/kg

Maximum value of SAR (measured) = 2.80 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 26.09.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d138

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

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 1.01 \text{ S/m}$; $\epsilon_r = 54.4$; $\rho = 1000 \text{ kg/m}^3$

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:

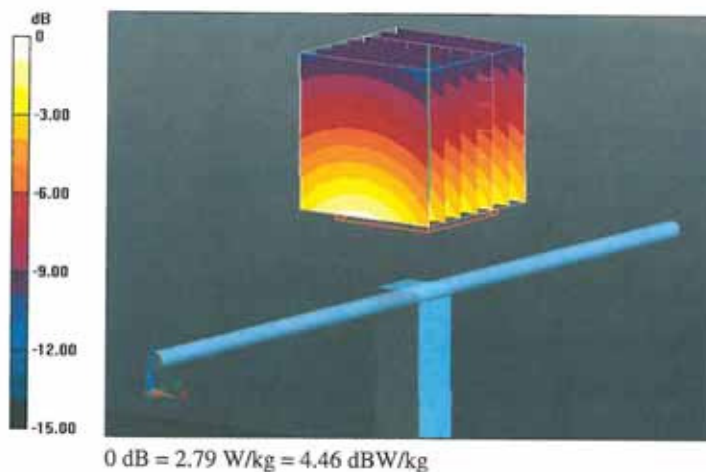
Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 54.246 V/m; Power Drift = 0.04 dB

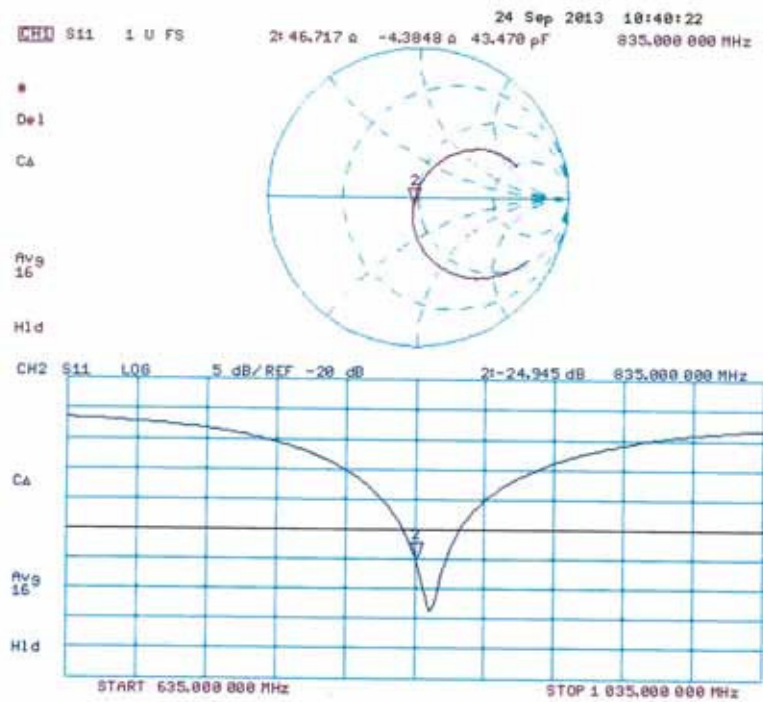
Peak SAR (extrapolated) = 3.53 W/kg

SAR(1 g) = 2.41 W/kg; SAR(10 g) = 1.57 W/kg

Maximum value of SAR (measured) = 2.79 W/kg



Impedance Measurement Plot for Body TSL

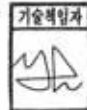


Appendix C.3 Calibration certificate for Dipole 1900 MHz

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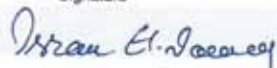
Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

2013.10.14

Client **SGS (Dymstec)**

Certificate No: D1900V2-5d158_Sep13

CALIBRATION CERTIFICATE																																															
Object	D1900V2 - SN: 5d158																																														
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz																																														
Calibration date:	September 27, 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 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) <table border="1"> <thead> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date (Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Power meter EPM-442A</td> <td>GB37480704</td> <td>01-Nov-12 (No. 217-01640)</td> <td>Oct-13</td> </tr> <tr> <td>Power sensor HP 8481A</td> <td>US37292783</td> <td>01-Nov-12 (No. 217-01640)</td> <td>Oct-13</td> </tr> <tr> <td>Reference 20 dB Attenuator</td> <td>SN: 5058 (20k)</td> <td>04-Apr-13 (No. 217-01736)</td> <td>Apr-14</td> </tr> <tr> <td>Type-N mismatch combination</td> <td>SN: 5047.3 / 06327</td> <td>04-Apr-13 (No. 217-01739)</td> <td>Apr-14</td> </tr> <tr> <td>Reference Probe ES3DV3</td> <td>SN: 3205</td> <td>28-Dec-12 (No. ES3-3205_Dec12)</td> <td>Dec-13</td> </tr> <tr> <td>DAE4</td> <td>SN: 601</td> <td>25-Apr-13 (No. DAE4-601_Apr13)</td> <td>Apr-14</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th>Secondary Standards</th> <th>ID #</th> <th>Check Date (in house)</th> <th>Scheduled Check</th> </tr> </thead> <tbody> <tr> <td>Power sensor HP 8481A</td> <td>MY41092317</td> <td>18-Oct-02 (in house check Oct-11)</td> <td>In house check: Oct-13</td> </tr> <tr> <td>RF generator R&S SMT-06</td> <td>100005</td> <td>04-Aug-99 (in house check Oct-11)</td> <td>In house check: Oct-13</td> </tr> <tr> <td>Network Analyzer HP 8753E</td> <td>US37390585 S4206</td> <td>18-Oct-01 (in house check Oct-12)</td> <td>In house check: Oct-13</td> </tr> </tbody> </table>				Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration	Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13	Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13	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	Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13	RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13	Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13
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Calibrated by:	Name Israe El-Naouq	Function Laboratory Technician	Signature 																																												
Approved by:	Katja Pokovic	Technical Manager																																													
This calibration certificate shall not be reproduced except in full without written approval of the laboratory. Issued: September 27, 2013																																															

Certificate No: D1900V2-5d158_Sep13

Page 1 of 8

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

Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- 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.

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

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	39.7 $\pm$ 6 %	1.37 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.92 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	40.1 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.0 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	53.2 $\pm$ 6 %	1.49 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	9.80 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	39.7 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.23 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.1 W/kg $\pm$ 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.2 Ω + 4.8 j Ω
Return Loss	- 25.1 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.1 Ω + 5.0 j Ω
Return Loss	- 25.8 dB

General Antenna Parameters and Design

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

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. 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 20, 2011

DASY5 Validation Report for Head TSL

Date: 27.09.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d158

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

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.37$ S/m; $\epsilon_r = 39.7$; $\rho = 1000$ kg/m³

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:

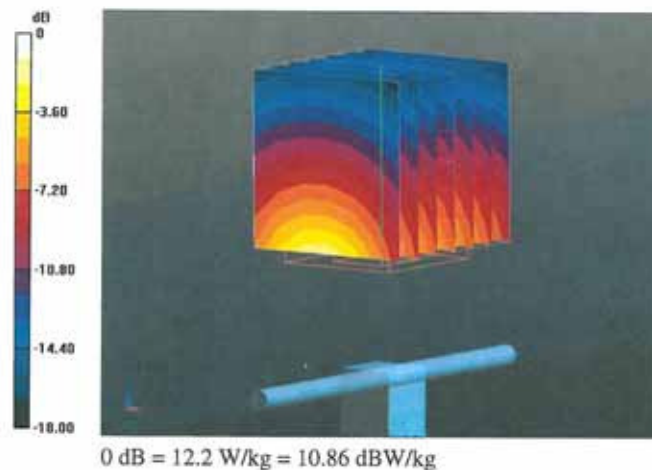
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.878 V/m; Power Drift = 0.05 dB

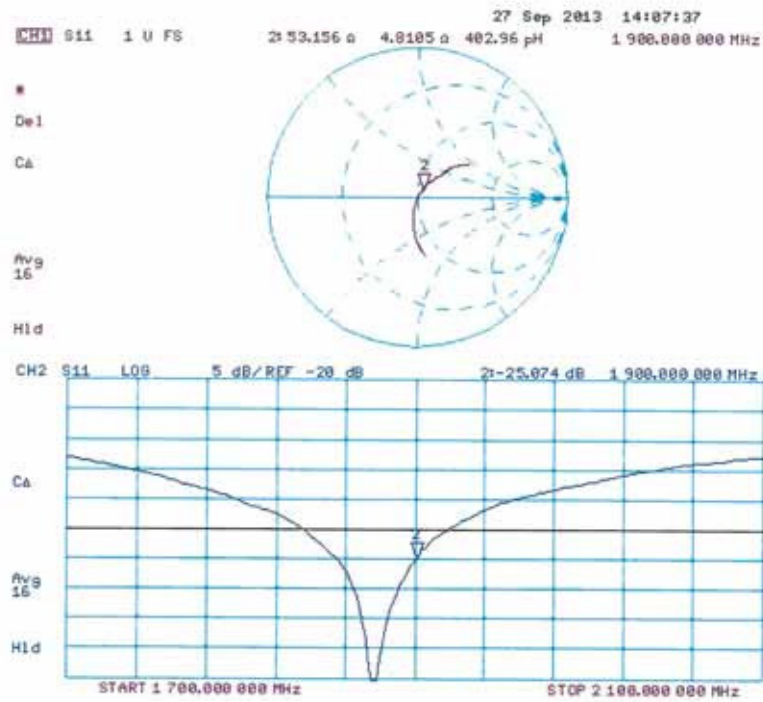
Peak SAR (extrapolated) = 18.0 W/kg

SAR(1 g) = 9.92 W/kg; SAR(10 g) = 5.22 W/kg

Maximum value of SAR (measured) = 12.2 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 27.09.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d158

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

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.49$ S/m; $\epsilon_r = 53.2$; $\rho = 1000$ kg/m³

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:

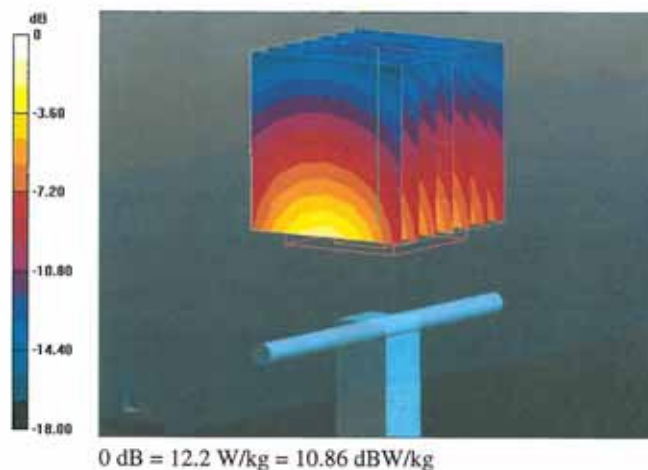
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.878 V/m; Power Drift = 0.02 dB

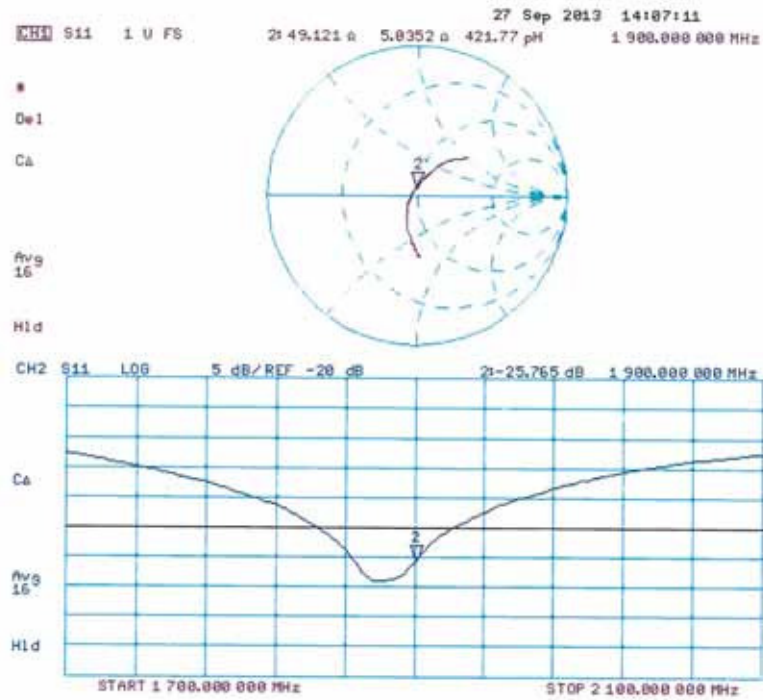
Peak SAR (extrapolated) = 16.8 W/kg

SAR(1 g) = 9.8 W/kg; SAR(10 g) = 5.23 W/kg

Maximum value of SAR (measured) = 12.2 W/kg



Impedance Measurement Plot for Body TSL



Appendix C.3 Calibration certificate for Dipole 2450 MHz

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



S Schweizerischer Kalibrierdienst
S Service suisse d'étalonnage
C 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 **SGS (Dymstec)**

Certificate No: **D2450V2-892_Sep13**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 892**

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

Calibration date: **September 26, 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 $(22 \pm 3)^{\circ}\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
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
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

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

Issued: September 27, 2013

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

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



S Schweizerischer Kalibrierdienst
S Service suisse d'étalonnage
C 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**

Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- 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.

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

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	39.4 $\pm$ 6 %	1.83 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.4 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.12 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.4 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	52.2 $\pm$ 6 %	2.00 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.7 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	50.1 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.85 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.2 W/kg $\pm$ 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.9 Ω + 2.2 j Ω
Return Loss	- 27.2 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.1 Ω + 4.3 j Ω
Return Loss	- 27.3 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.125 ns
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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	October 06, 2011

DASY5 Validation Report for Head TSL

Date: 26.09.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 892

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.83$ S/m; $\epsilon_r = 39.4$; $\rho = 1000$ kg/m³

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:

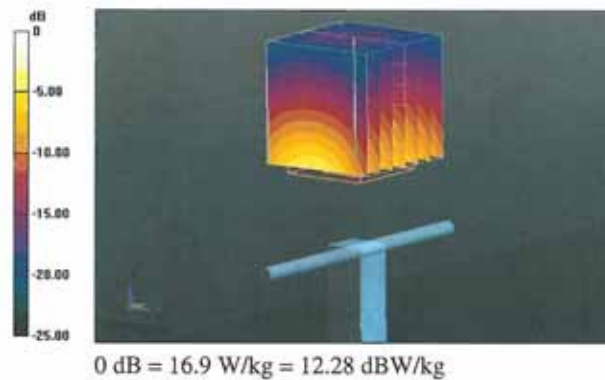
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.764 V/m; Power Drift = 0.04 dB

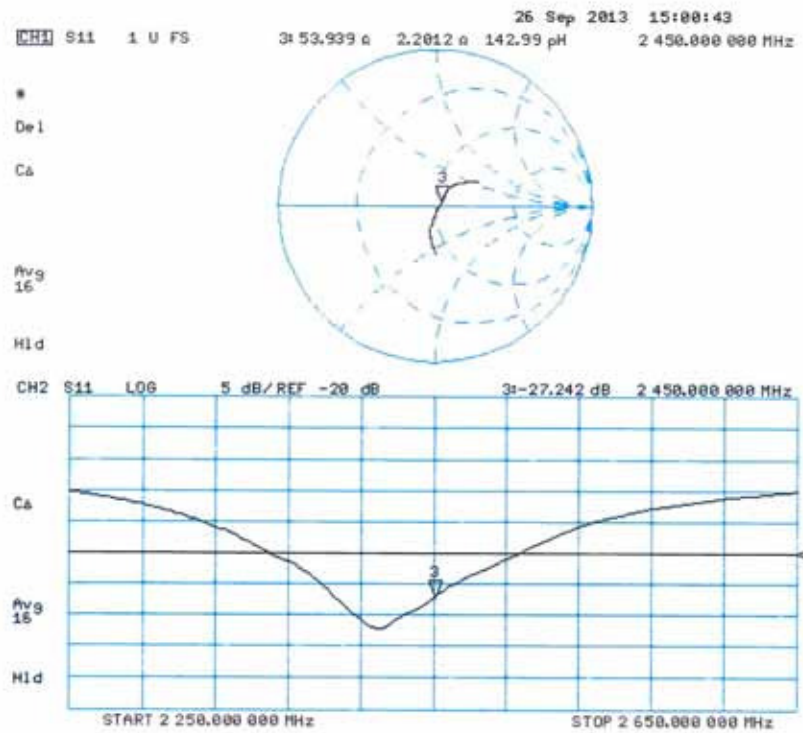
Peak SAR (extrapolated) = 27.5 W/kg

SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.12 W/kg

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



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 26.09.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 892

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 2$ S/m; $\epsilon_r = 52.2$; $\rho = 1000$ kg/m³

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:

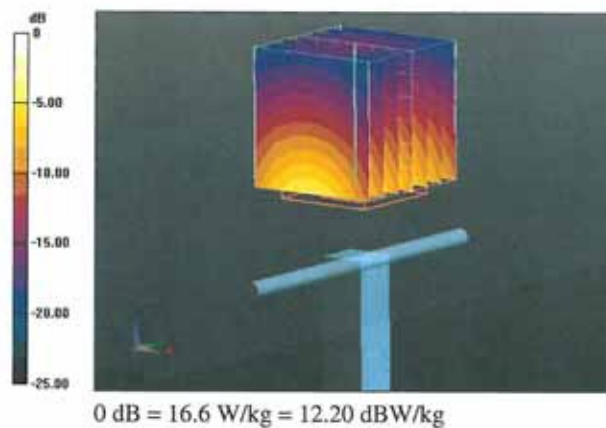
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.764 V/m; Power Drift = 0.01 dB

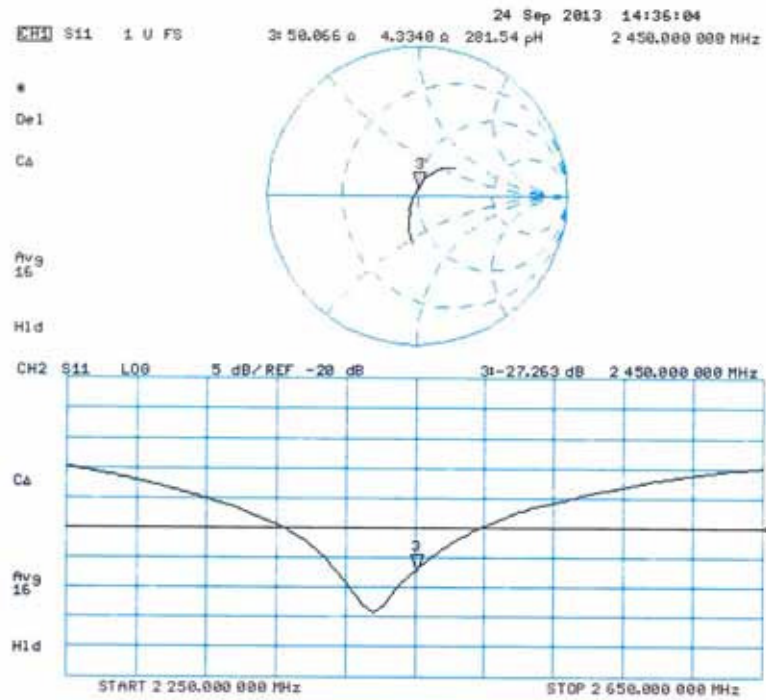
Peak SAR (extrapolated) = 26.5 W/kg

SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.85 W/kg

Maximum value of SAR (measured) = 16.6 W/kg



Impedance Measurement Plot for Body TSL



-THE END-