FCC SAR TEST REPORT

Test File No : F690501/RF-SAR002278-A1

Equipment Under Test	Cellular/PCS GSM/WCDMA Phone with WLAN, Bluetooth
Model No.	LG-H540T
Alternative Model	LGH540T, H540T, LG-H540t, LGH540t, H540t, LG-H540, H540, LGH540, LG-H542, H542, LGH542
Applicant	LG Electronics MobileComm U.S.A., Inc.
Address of Applicant	1000 Sylvan Avenue, Englewood Cliffs, NJ07632
FCC ID	ZNFH540T
Exposure Category	General Population/Uncontrolled Exposure
Standards	FCC 47 CFR Part 2 (2.1093) IEEE 1528, 2013 ANSI/IEEE C95.1, C95.3
Date of Test(s)	2015-04-20 ~ 2015-05-20
Date of Issue	2015-05-20

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

Remarks:

Report prepared by /
Chnaghyun Song
Test Engineer

Approved by /
Jongwon Ma
Technical Manager

Revision history

Revision	Date of issue	Revisions	Revised By
-	May 15, 2015	Initial issue	-
A1	May 20, 2015	The probe was changed in order to measure WLAN SAR re-tested.	Chnaghyun Song

Contents

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
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2. Details of Manufacturer

Applicant	LG Electronics MobileComm U.S.A., Inc.
Address	1000 Sylvan Avenue, Englewood Cliffs, NJ07632
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/WCDMA Phone with WLAN, Bluetooth
Model	LG-H540T
Alternative Model	LGH540T, H540T, LG-H540t, LGH540t, H540t, LG-H540, H540, LGH540, LG-H542, H542, LGH542
Serial Number	412KPZK784445
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, Bluetooth)
Body worn Accessory	None
Tx Frequency Range	GSM850 (824.2 MHz ~ 848.8 MHz) GSM1900 (1850.2 MHz ~ 1909.8 MHz) WCDMA 850 (826.4 MHz ~ 846.6 MHz) WCDMA 1900 (1852.4 MHz ~ 1907.6 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	Extremity
PCE	GSM/GPRS850	824.2 ~ 848.8	0.30	0.51	0.61	N/A
PCE	GSM/GPRS1900	1850.2 ~ 1909.8	0.38	0.35	0.59	N/A
PCE	WCDMA 850	826.4 ~ 846.6	0.39	0.71	0.71	N/A
PCE	WCDMA 1900	1852.4 ~ 1907.6	0.53	0.95	0.95	N/A
DTS	2.4 GHz WLAN	2412.0 ~ 2462.0	0.40	0.13	0.13	N/A
DSS	Bluetooth	2402.0 ~ 2480.0	N/A	N/A	N/A	N/A
Simultaneous SAR per KDB 690783 D01v01r03			0.93	1.08	1.08	N/A

5. Test Methodology

ANSI C95.1–2005: 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 1528-2013 & 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 D01v02**	**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 D01v03**	**3G SAR Measurement Procedures**
☐	**KDB 941225 D05v02r03**	**SAR Evaluation Considerations for LTE Devices**
☒	**KDB 941225 D06v02**	**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:

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

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

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

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

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

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

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 ㎑ to 300 ㎓,” 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 ㎑ to 6 ㎓. Portable devices that transmit at frequencies above 6 ㎓ 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 ㎓ 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 DASY4 professional system). The model ET3DV6 and EX3DV4 field probe is used to determine the internal electric fields. The SAR can be obtained from the equation SAR= σ ($|Ei|^2$)/ ρ where σ and ρ are the conductivity and mass density of the tissue-simulant.

The DASY4 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Staubli RX 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.

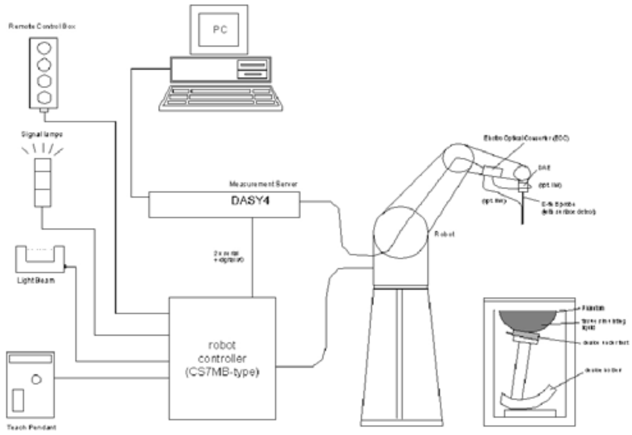


Fig a. The microwave circuit arrangement used for SAR system verification

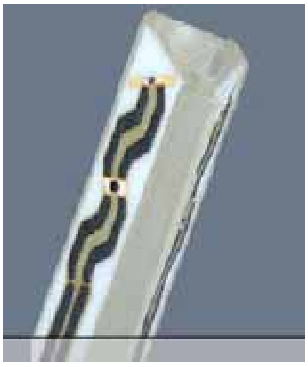
- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is 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 Windows XP.
- DASY4 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


EX3DV4 E-Field 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 ㎒ to 6 ㎓; Linearity: ± 0.2 ㏈ (30 ㎒ to 6 ㎓)
Directivity	:	± 0.3 ㏈ in HSL (rotation around probe axis) ± 0.5 ㏈ in tissue material (rotation normal to probe axis)
Dynamic Range	:	10μW/g to > 100 m W/g; Linearity: ± 0.2 ㏈(noise: typically < 1 μW/g)
Dimensions	:	Overall length: 337 ㎜ (Tip length: 20 ㎜) Tip diameter: 2.5 ㎜ (Body diameter: 12 ㎜) Distance from probe tip to dipole centers: 1 ㎜
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 ㎓ with precision of better 30%


ET3DV6 E-Field Probe

Construction	:	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g. glycol).
Calibration	:	In air from 10 ㎒ to 2.5 ㎓ In brain simulating tissue (accuracy ± 8 %)
Frequency	:	10 ㎒ to >6 ㎓; Linearity: ±0.2 ㏈ (30 ㎒ to 3 ㎓)
Directivity	:	±0.2 ㏈ in brain tissue (rotation around probe axis) ±0.4 ㏈ in brain tissue (rotation normal to probe axis)
Dynamic Range	:	5 μW/g to >100 mW/g; Linearity: ±0.2 ㏈
Dimensions	:	Overall length: 330 mm Tip length: 16 mm Body diameter: 12 mm Tip diameter: 6.8 mm Distance from probe tip to dipole centers: 2.7 mm
Application	:	General dosimetry up to 3 ㎓ Compliance tests of mobile phone

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 ㎜ ± 0.1 ㎜
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 2/4 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 >

<table>
<tr><td colspan="3"></td><td>≤ 3 GHz</td><td>> 3 GHz</td></tr>
<tr><td colspan="3">Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5 ± 1 mm</td><td>½·δ·ln(2) ± 0.5 mm</td></tr>
<tr><td colspan="3">Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30° ± 1°</td><td>20° ± 1°</td></tr>
<tr><td colspan="3" rowspan="2">Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}</td><td>≤ 2 GHz: ≤ 15 mm
2 – 3 GHz: ≤ 12 mm</td><td>3 – 4 GHz: ≤ 12 mm
4 – 6 GHz: ≤ 10 mm</td></tr>
<tr><td colspan="2">When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}</td><td>≤ 2 GHz: ≤ 8 mm
2 – 3 GHz: ≤ 5 mm*</td><td>3 – 4 GHz: ≤ 5 mm*
4 – 6 GHz: ≤ 4 mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">uniform grid: $\Delta z_{Zoom}(n)$</td><td>≤ 5 mm</td><td>3 – 4 GHz: ≤ 4 mm
4 – 5 GHz: ≤ 3 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface</td><td>≤ 4 mm</td><td>3 – 4 GHz: ≤ 3 mm
4 – 5 GHz: ≤ 2.5 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td>$\Delta z_{Zoom}(n>1)$: between subsequent points</td><td colspan="2">$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">x, y, z</td><td>≥ 30 mm</td><td>3 – 4 GHz: ≥ 28 mm
4 – 5 GHz: ≥ 25 mm
5 – 6 GHz: ≥ 22 mm</td></tr>
<tr><td colspan="5">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 1-g SAR estimation procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.</td></tr>
</table>

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.

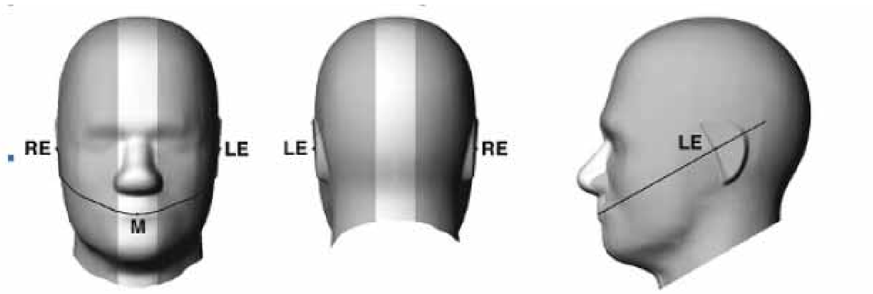


Fig 2 Front, back and side view of SAM Twin Phantom

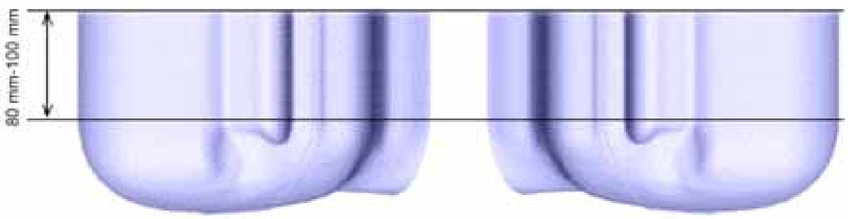


Fig 3 Sagittally bisected phantom with extended perimeter (shown placed on its side as used for device SAR tests)

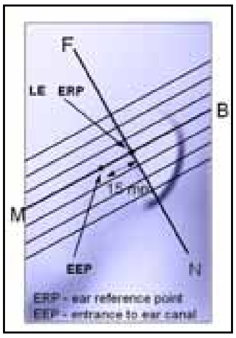


Fig 4 Close-up side view of ERP

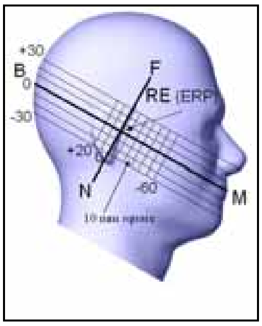


Fig 5 Side view of the phantom showing relevant markings

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 than 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 it's 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.

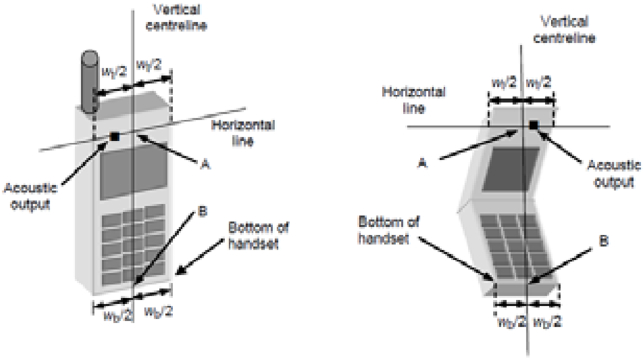


Fig 6 Handset Vertical Center & Horizontal Line Reference Points

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 ymmetrical 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

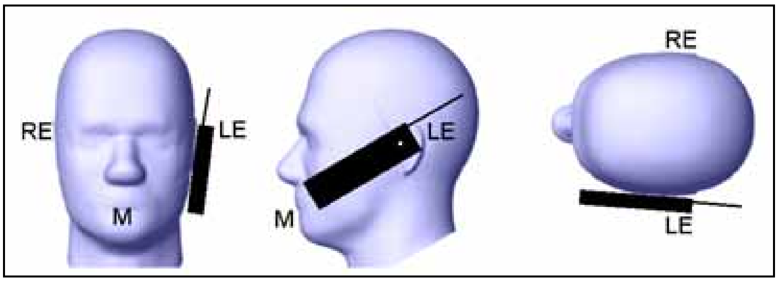


Fig 7 Cheek/Touch position of the wireless device on the left side of SAM

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).

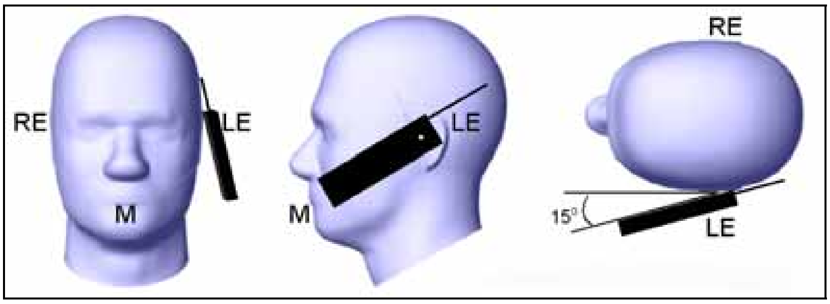


Fig 8 Ear/15˚ Tilt position of the wireless device on the left side of SAM

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 v02 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.

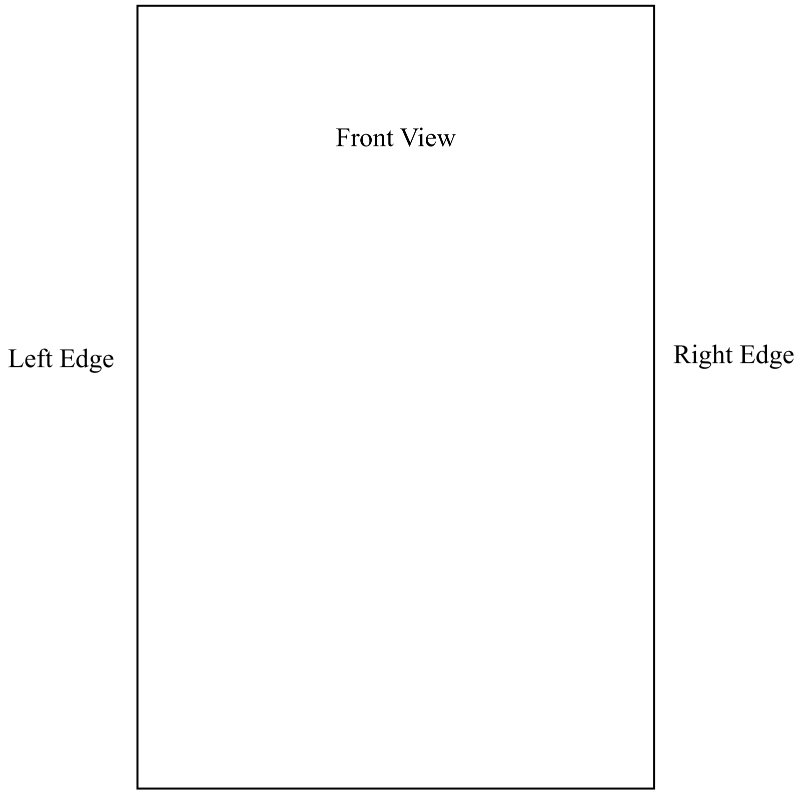
When the user enables the personal wireless router functions for the handset, actual operations include simultaneous transmission of both the WLAN transmitter and another licensed transmitter. Both transmitters often do not transmit at the same transmitting frequency and thus cannot be evaluated for 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 Extremity Exposure Configurations

Devices that are designed or intended for use on extremities or mainly operated in extremity only exposure conditions; i.e., hands, wrists, feet and ankles, may require extremity SAR evaluation. When the device also operates in close proximity to the user`s body, SAR compliance for the body is also required. The 1g body and 10g extremity SAR Exclusion thresholds found in KDB Publication 447498 D01v05 should be applied to determine SAR test requirements.

For smart phones with a display diagonal dimension > 15.0 cm or an overall diagonal dimension > 16.0 cm that provide similar mobile web access and multimedia support found in mini- tablets or UMPC mini-tablets that support voice calls next to the ear, the phablets procedures outlined in KDB Publication 648474 D04v01r02 should be applied to evaluate SAR compliance. A device marketed as phablets, regardless of form factors and operating characteristics must be tested as a phablets to determine SAR compliance. In addition to the normally required head and body-worn accessory SAR test procedures required for handsets, the UMPC mini-tablet procedures must also be applied to test the SAR of all surfaces and edges with an antenna ≤ 2.5 cm from that surface or edge, in direct contact with the phantom, for 10g SAR. The UMPC mini-tablet 1g SAR at 5 mm is not required. When hotspot mode applies, 10g SAR is required only for the surfaces and edges with hotspot mode 1g SAR scaled up to maximum output power tolerance > 1.2 W/kg.

11.8 DUT Antenna Locations



Note: Exact antenna dimensions and separation distances are shown in the "Antenna Location_ZNFH540T" in the FCC Filing

11.9 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	Yes	No	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 D06v02 guidance, page 2 and FCC KDB 648474 D04v01r01. 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 +/- 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 ± 2) ° C, the relative humidity was in the range (55 ± 5) % R.H and the liquid depth above the ear reference points was ≥ 15 cm ± 5 mm (frequency ≤ 3 GHz) or ≥ 10 cm ± 5 mm (frequency > 3 G Hz)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.

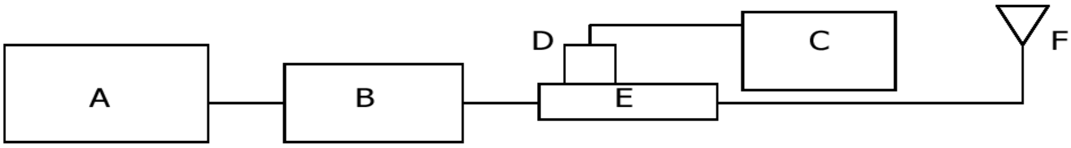


Fig 9. The microwave circuit arrangement used for SAR system verification

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:490	1782	835 Head	9.07	5.90	8.96	5.90	**-1.21**	**0.00**	2015-04-23	22.4
D835V2 SN:490	1782	835 Body	9.49	6.20	9.44	6.30	**-0.53**	**1.61**	2015-04-23	22.6
D1900V2 SN:5d033	1782	1900 Head	40.3	21.1	40.3	21.9	**0.00**	**3.79**	2015-04-20	22.2
D1900V2 SN:5d033	1782	1900 Body	40.6	21.3	40.8	22.5	**0.49**	**5.63**	2015-04-20	21.9
D2450V2 SN:734	3986	2450 Head	52.2	24.3	53.8	24.7	**3.07**	**1.65**	2015-05-20	22.3
D2450V2 SN:734	3986	2450 Body	49.8	23.2	52.9	25.0	**6.22**	**7.76**	2015-05-20	22.3

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 Network Analyzer(300 ㎑ - 6 ㎓) by using a procedure detailed in Section V.

f (㎒)	Tissue type	Limits / Measured	Dielectric Parameters		
			Permittivity	Conductivity	Simulated Tissue Temp(℃)
835	Head	Measured, 2015-04-23	42.0	0.89	22.4
		Target Tissue Head	*41.5*	*0.90*	
		Deviation (%)	**1.20**	**-1.11**	
835	Body	Measured, 2015-04-23	54.6	0.96	22.6
		Target Tissue Body	*55.2*	*0.97*	
		Deviation (%)	**-1.09**	**-1.03**	
1900	Head	Measured, 2015-04-20	38.4	1.40	22.2
		Target Tissue Head	*40.0*	*1.40*	
		Deviation (%)	**-4.00**	**0.00**	
1900	Body	Measured, 2015-04-20	54.3	1.55	21.9
		Target Tissue Body	*53.3*	*1.52*	
		Deviation (%)	**1.88**	**1.97**	
2450	Head	Measured, 2015-05-20	39.7	1.79	22.3
		Target Tissue Head	*39.2*	*1.80*	
		Deviation (%)	**1.28**	**-0.56**	
2450	Body	Measured, 2015-05-20	53.2	1.94	22.3
		Target Tissue Body	*52.7*	*1.95*	
		Deviation (%)	**0.95**	**-0.51**	

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 (㎒)					
	835		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body
Water	41.45	52.4	54.9	40.4	62.7	73.2
Salt (NaCl)	1.45	1.4	0.18	0.5	0.5	0.04
Sugar	56.0	45.0	0.0	58.0	0.0	0.0
HEC	1.0	1.0	0.0	1.0	0.0	0.0
Bactericide	0.1	0.1	0.0	0.1	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	42.54	56.1	39.9	54.0	39.8	52.5
Conductivity (S/m)	0.91	0.95	1.42	1.45	1.78	1.98

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 ㎓, 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 1528-2013 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		
					Permittivity	Conductivity	Sensitivity	Probe Linearity	Probe Isotropy	Mod. Type	Duty Factor	PAR
835	2015-04-13	1782	835	Head	43.0	0.91	PASS	PASS	PASS	GMSK	PASS	N/A
835	2015-04-13	1782	835	Body	56.1	0.95	PASS	PASS	PASS	GMSK	PASS	N/A
1900	2015-04-10	1782	1900	Head	39.9	1.35	PASS	PASS	PASS	GMSK	PASS	N/A
1900	2015-04-10	1782	1900	Body	52.6	1.54	PASS	PASS	PASS	GMSK	PASS	N/A
2450	2015-04-14	3986	2450	Head	39.4	1.77	PASS	PASS	PASS	OFDM	N/A	PASS
2450	2015-04-14	3986	2450	Body	53.0	1.88	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 Platform	SPEAG DASY4 Professional
Location	SGS Korea Co., Ltd. 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, E&E Lab
Manufacture	SPEAG
Description	SAR Test System (Frequency range 300 MHz – 6 GHz)
Software Reference	DASY4: V4.7 Build 80 SEMCAD: V1.8 Build 186

Hardware Reference

Equipment	Type	Serial Number	Cal Date	Cal Interval	Cal Due
Robot	RX90B L	F03/5W05A1/A/01	N/A	N/A	N/A
Phantom	SAM Phantom	TP-1300	N/A	N/A	N/A
Phantom	SAM Phantom	TP-1645	N/A	N/A	N/A
Dielectric Assessment Kit	DAK-3.5	1107	2015-01-27	Annual	2016-01-27
Verification Dipole	D835V2	490	2014-05-16	Biennial	2016-05-16
Verification Dipole	D1900V2	5d033	2014-05-19	Biennial	2016-05-19
Verification Dipole	D2450V2	734	2014-05-20	Biennial	2016-05-20
DAE	DAE3	567	2015-01-22	Annual	2016-01-22
E-Field Probe	ET3DV6	1782	2015-02-24	Annual	2016-02-24
E-Field Probe	EX3DV4	3986	2015-03-25	Annual	2016-03-25
Network Analyzer	E5071C	MY46111535	2014-07-04	Annual	2015-07-04
Power Meter	E4419B	GB43311715	2014-06-25	Annual	2015-06-25
Signal Generator	E4421B	MY43350132	2014-06-25	Annual	2015-06-25
Power Sensor	E9300H	MY41495307	2014-07-02	Annual	2015-07-02
		MY41495314	2014-07-02	Annual	2015-07-02
Power Amplifier	2001-BBS3Q7ECK	1032 D/C 0336	2014-12-24	Annual	2015-12-24
Directional Bridge	86205A	MY31402302	2014-07-03	Annual	2015-07-03
LP Filter	LA-15N	N/A	2014-07-01	Annual	2015-07-01
LP Filter	LA-30N	N/A	2014-07-01	Annual	2015-07-01
Attenuator	8491B	50566	2014-07-01	Annual	2015-07-01
Hygro-Thermometer	HTC-1	14032782-1	2015-03-24	Annual	2016-03-24
Digital Thermometer	DTM3000	3027	2014-07-02	Annual	2015-07-02
Spectrum Analyzer	E4445A	MY44020523	2014-06-25	Annual	2015-06-25
Communication Tester	CMU200	109456	2014-06-30	Annual	2015-06-30

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 Data (GMSK)**			
		GSM	1 slot	2 slot	3 slot	4 slot
GSM850	**Maximum**	**33.7**	**33.7**	**31.7**	**29.7**	**28.2**
	Nominal	33.2	33.2	31.2	29.2	27.7
PCS1900	**Maximum**	**30.7**	**30.7**	**28.7**	**26.7**	**25.2**
	Nominal	30.2	30.2	28.2	26.2	24.7
Mode / Band		**Frame Average GMSK (dBm)**				
		Voice	**GPRS Data (GMSK)**			
		GSM	1 slot	2 slot	3 slot	4 slot
GSM850	**Maximum**	**24.67**	**24.67**	**25.68**	**25.44**	**25.19**
	Nominal	24.17	24.17	25.18	24.94	24.69
PCS1900	**Maximum**	**21.67**	**21.67**	**22.68**	**22.44**	**22.19**
	Nominal	21.17	21.17	22.18	21.94	21.69
Tune-up Tolerance: -1.5 dB / + 0.5 dB						

Mode / Band		Modulated Average (dBm)				
		3GPP WCDMA	3GPP HSDPA			
		Rel. 99	Rel. 5			
		RMC/AMR	Subtest 1	Subtest 2	Subtest 3	Subtest 4
WCDMA850	**Maximum**	**24.7**	**23.7**	**23.7**	**23.2**	**23.2**
	Nominal	24.2	23.2	23.2	22.7	22.7
WCDMA1900	**Maximum**	**23.7**	**22.7**	**22.7**	**22.2**	**22.2**
	Nominal	23.2	22.2	22.2	21.7	21.7
Tune-up Tolerance: -1.5 dB / + 0.5 dB						

Note: This device supports HSUPA but the manufacturer only declares on the tune-up procedure that the HSUPA transmitter`s power will not exceed the R99 maximum transmit power in devices based on Qualcomm`s HSPA chipset solution.

Average power for Production (dBm)					
Mode	Nominal & Maximum	b	g	n	
2.4 ㎓ WLAN	**Maximum**	**15.5**	**12.5**	**12.0**	
	Nominal	14.5	11.5	11.0	
Mode	Nominal & Maximum	GFSK	DPSK	8DPSK	LE
Bluetooth	**Maximum**	**7.5**	**5.5**	**5.5**	**0.0**
	Nominal	6.5	4.5	4.5	-1.0
Tune-up Tolerance: -1.0 dB / + 1.0 dB					

19. RF Conducted Power Measurement

The device in GSM, WCDMA, and LTE was controlled by using a Communication tester. The EUT was set to maximum power level during all tests. The DASY4 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(㎒)	Burst -Conducted Average Power(㏈ m)				
			Voice	GPRS Data (GMSK)			
			GSM	1 Slot	2 Slot	3 Slot	4 Slot
GSM 850	128	824.2	33.54	33.56	31.54	29.45	27.97
	190	836.6	33.67	33.69	31.66	29.58	28.10
	251	848.8	33.69	33.70	31.68	29.65	28.19
PCS 1900	512	1850.2	30.27	30.20	28.29	26.26	24.79
	661	1880.0	30.31	30.32	28.35	26.32	24.89
	810	1909.8	30.32	30.33	28.39	26.37	24.94

GSM	Channel	Frequency(㎒)	Frame -Conducted Average Power(㏈ m)				
			Voice	GPRS Data (GMSK)			
			GSM	1 Slot	2 Slot	3 Slot	4 Slot
GSM 850	128	824.2	24.51	24.53	**25.52**	25.19	24.96
	190	836.6	24.64	24.66	**25.64**	25.32	25.09
	251	848.8	24.66	24.67	**25.66**	25.39	25.18
PCS 1900	512	1850.2	21.24	21.17	**22.27**	22.00	21.78
	661	1880.0	21.28	21.29	**22.33**	22.06	21.88
	810	1909.8	21.29	21.30	**22.37**	22.11	21.93

Note

1. 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.
2. 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.
3. GPRS/EDGE (GMSK) output powers were measured with coding scheme setting of 1 (CS1) on the base station simulator. CS1 was configured to measure GPRS output power measurements and SAR to ensure GMSK modulation in the signal. Our investigation has shown that CS1 – CS4 settings do not have any impact on the output levels or modulation in the GPRS modes.

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 Mode.

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.

Table 1

Sub-test	β_c	β_d	β_d *(SF)*	β_c/β_d	β_{hs} $^{(1)}$	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: Δ_{ACK}, Δ_{NACK} and Δ_{CQI} = 8 ⇔ $A_{hs} = \beta_{hs}/\beta_c = 30/15$ ⇔ $\beta_{hs} = 30/15 * \beta_c$
Note 2: CM = 1 for β_c/β_d =12/15, β_{hs}/β_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 β_c = 11/15 and β_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.

Table 2

Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	β_{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	β_{ed1}: 47/15 β_{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 Δ_{CQI} = 8 ⇔ $A_{hs} = \beta_{hs}/\beta_c = 30/15$ ⇔ $\beta_{hs} = 30/15 * \beta_c$.
Note 2: CM = 1 for β_c/β_d =12/15, β_{hs}/β_c=24/15. For all other combinations of DPDCH, DPCCH, HS- DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference.
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 β_c = 10/15 and β_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 β_c = 14/15 and β_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} cannot be set directly; it is set by Absolute Grant Value.

19.2.7 WCDMA Conducted Power

3GPP Release Version	Mode	3GPP 34.121 Subtest	Cellular Band (dBm)					
	Channel		4132	4183	4233	9262	9400	9538
99	WCDMA	12.2 kbps RMC	24.28	24.54	24.51	23.60	23.45	23.35
5	HSDPA	Subtest 1	23.57	23.51	23.41	22.55	22.41	22.20
5		Subtest 2	23.52	23.47	23.49	22.47	22.44	22.19
5		Subtest 3	22.93	22.98	22.83	22.09	21.96	21.75
5		Subtest 4	22.99	22.72	22.76	22.08	21.95	21.72
6	HSUPA	Subtest 1	21.46	21.47	21.40	20.64	20.74	20.53
6		Subtest 2	21.37	21.44	21.35	20.61	20.55	20.33
6		Subtest 3	22.40	22.36	22.01	21.64	21.53	21.31
6		Subtest 4	20.92	20.81	20.94	20.19	20.02	19.84
6		Subtest 5	21.50	21.54	21.42	20.62	20.54	20.32

Note

- WCDMA SAR was tested under RMC 12.2 kbps with HSPA inactive per KDB Publication 941225 D01v03. HSPA SAR was not required since the average output power of the HSPA subtests was not more than 0.25 dB higher than the RMC level and SAR was less than 1.2 W/kg
- This device supports HSUPA but the manufacturer only declares on the tune-up procedure that the HSUPA transmitter`s power will not exceed the R99 maximum transmit power in devices based on Qualcomm`s HSPA chipset solution.

19.3 WLAN

19.3.1 General Device Setup

The 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.

A periodic duty factor is required for current generation SAR systems to measure SAR. When 802.11 frame gaps are accounted for in the transmission, a maximum transmission duty factor of 92 – 96% is typically achievable in most test mode configurations. A minimum transmission duty factor of 85% is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. The reported SAR is scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

19.3.2 Initial Position Procedure

For exposure conditions with multiple, such as handset operating next to the ear, devices with hotspot mode or UMPC mini-tablet, procedures for initial test position can be applied. Using the transmission mode determined by the DSSS procedure or initial test configuration, area scans are measured for all positions in an exposure condition. The test position with the highest extrapolated (peak) SAR is used as the initial test position. When reported SAR for the initial test position is ≤ 0.4 W/kg, no additional testing for the remaining test positions is required. Otherwise, SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR result is ≤ 0.8 W/kg or all test positions are measured.

19.3.3 2.4 GHz SAR Test Requirements

SAR is measured for 2.4 GHz 802.11b DSSS using either the fixed test position or, when applicable, the initial test position procedure. SAR test reduction is determined according to the following.

1) When the reported SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.
2) When the reported SAR is > 0.8 W/kg, SAR is required for that position using the next highest measured output power channel; i.e., all channels require testing.

2.4 GHz 802.11g/n OFDM are additionally evaluated for SAR if highest reported SAR for 802.11b, adjusted by the ratio of the OFDM to DSSS specified maximum output power, is > 1.2 W/kg. When SAR is required for OFDM modes in 2.4 GHz band, the Initial Test Configuration Procedures should be followed.

19.3.4 OFDM Transmission Mode and SAR Test Channel Selection

For the 2.4 GHz and 5 GHz band, when the same maximum output power was specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration with the largest channel bandwidth, lowest order modulation and lowest data rate. When the maximum output power of a channel is the same for equivalent OFDM congigurations; for example, 802.11a, 802.11n and 802.11ac or 802.11g and 802.11n with the same channel bandwith, modulation and data rate etc., the lower order 802.11 mode i.e., 802.11a, then 802.11n and 802.11ac or 802.11g then 802.11n, is used for SAR measurement. When maximum output power are the same for multiple test channels, either according to the default or additional power measurement requirements, SAR is measured using the channel closest to the middle of the frequency band or aggregated band. When thereare multiple channels with the same maximum output power, SAR is measured using the higher number channel.

19.3.5 Initial Test Configuration Procedure

For OFDM, in both 2.4 and 5 GHz bands, an initial test configuration is determined for each frequency band and aggregated band, according to the transmission mode with the highest maximum output power specified for SAR measurements. When the same maximum output power is specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration(s) with the largest channel bandwidth, lowest order modulation, and lowest data rate. If the average RF output powers of the highest identical transmission modes are within 0.25 dB of each other, mid channel of the transmission mode with highest average RF output power is the initial test channel. Otherwise, the channel of the transmission mode with the highest average RF output conducted power will be the initial test configuration.

When the reported SAR is ≤ 0.8 W/kg, no additional measurements on other test channels are required. Otherwise, SAR is evaluated using the subsequent highest average RF output channel until the reported SAR result is ≤ 1.2 W/kg or all channels are measured. When there are multiple untested channels having the same subsequent highest average RF output power, the channel with higher frequency from the lowest 802.11 mode is considered for SAR measurements

19.3.6 Subsequent Test Configuration Procedures

For OFDM configurations in each frequency band and aggregated band, SAR is evaluated for initial test configuration using the fixed test position or the initial test position procedure. When the highest reported SAR (for the initial test configuration), adjusted by the ratio of the specified maximum output power of the subsequent test configuration to initial test configuration, is ≤ 1.2 W/kg, no additional SAR tests for the subsequent test configurations are required.

19.3.7 WLAN and Bluetooth Conducted Powers

IEEE 802.11b Average RF Power

Mode	Frequency	Channel	802.11b (2.4 GHz) Conducted Power (dBm)
			Data Rate (Mbps)
802.11b	2412	1	13.91
	2437	6	15.08
	2462	11	13.92

Justification for test configurations for WLAN per KDB Publication 248227 D01v02:

- Power measurements were performed for the transmission mode configuration with the highest maximum output power specified for production units.
- For transmission mode with the same maximum output power specification, powers were measured for the largest channel bandwidth, lowest order modulation and lowest data rate.
- For transmission mode configuration, powers were measured for the highest and lowest channels; and at the mid-band channel when there were at least 3 channels supported. For configurations with multiple mid-band channels, due to an even number of channels, both channels were measured.

Bluetooth

Channel	Frequency (MHz)	GFSK (dBm)	PI/4DQPSK (dBm)	8DPSK (dBm)	LE (dBm)
Low	2402	5.72	4.43	4.35	-1.53
Middle	2441	7.04	4.84	4.78	-0.99
High	2480	6.53	4.48	4.44	-0.63

20. SAR Test Exclusions Applied

Per FCC KDB 447498 D01v05r02, the 1g SAR exclusion threshold for distances < 50 ㎜ 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 [MHz]	Maximum Allowed Power [mW]	Separation Distance [mm]	≤ 3.0
Bluetooth	2480	6	5	1.89
Bluetooth LE	2480	1	5	0.31

Based on the maximum tune-up tolerance limit of Bluetooth the antenna to use separation distance, Bluetooth SAR was not required [(6/5)*√2.480] = 1.89 < 3.0.

Bluetooth LE SAR was not required [(1/5)*√2.480] = 0.31 < 3.0.

Per FCC KDB 447498 D01v05r02, the 10g SAR exclusion threshold for distances < 50 ㎜ is defined by the following equation:

$$\frac{\text{Max Power of Channel (mW)}}{\text{Test Separation Distance (mm)}} * \sqrt{\text{Frequency(GHz)}} \leq 7.5$$

Mode	Frequency [MHz]	Maximum Allowed Power [mW]	Separation Distance [mm]	≤ 7.5
Bluetooth	2480	6	5	1.89
Bluetooth LE	2480	1	5	0.31

Based on the maximum tune-up tolerance limit of Bluetooth the antenna to use separation distance, Extremity Bluetooth SAR was not required [(6/5)*√2.480] = 1.89 < 7.5.

Extremity Bluetooth LE SAR was not required [(1/5)*√2.480] = 0.31 < 7.5.

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	33.67	33.70	0.251	0.253	-
	Tilt		Standard	836.6	190	33.67	33.70	0.143	0.144	-
Left	Touch		Standard	836.6	190	33.67	33.70	0.245	0.247	-
	Tilt		Standard	836.6	190	33.67	33.70	0.156	0.157	-
Right	Touch	GPRS 2TX	Standard	836.6	190	31.66	31.70	**0.299**	**0.302**	7
	Tilt		Standard	836.6	190	31.66	31.70	0.172	0.174	-
Left	Touch		Standard	836.6	190	31.66	31.70	0.293	0.296	-
	Tilt		Standard	836.6	190	31.66	31.70	0.189	0.191	-
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	30.31	30.70	0.178	0.195	-
	Tilt		Standard	1880.0	661	30.31	30.70	0.137	0.150	-
Left	Touch		Standard	1880.0	661	30.31	30.70	0.227	0.248	-
	Tilt		Standard	1880.0	661	30.31	30.70	0.123	0.135	-
Right	Touch	GPRS 2TX	Standard	1880.0	661	28.35	28.70	0.271	0.294	-
	Tilt		Standard	1880.0	661	28.35	28.70	0.217	0.235	-
Left	Touch		Standard	1880.0	661	28.35	28.70	**0.350**	**0.379**	10
	Tilt		Standard	1880.0	661	28.35	28.70	0.193	0.209	-
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	23.45	23.70	0.421	0.446	-
	Tilt		Standard	1880.0	9400	23.45	23.70	0.302	0.320	-
Left	Touch		Standard	1880.0	9400	23.45	23.70	**0.499**	**0.529**	13
	Tilt		Standard	1880.0	9400	23.45	23.70	0.273	0.289	-
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	24.54	24.70	**0.375**	**0.389**	15
	Tilt		Standard	836.6	4183	24.54	24.70	0.213	0.221	-
Left	Touch		Standard	836.6	4183	24.54	24.70	0.373	0.387	-
	Tilt		Standard	836.6	4183	24.54	24.70	0.236	0.245	-
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	Traffic Channel		Duty cycle (%)	Power(dBm)		Peak SAR of Area Scan(W/kg)	1-g SAR (W/kg))	Scaling Factor (Power)	Scaling Factor (Duty cycle)	1-g Scaled SAR (W/kg)	Plot No
			Frequency (㎒)	Channel		Measured Power	Tune-Up Limit						
Right	Touch	802.11b	2437.0	6	99	15.08	15.50	0.532	**0.361**	1.102	1.010	**0.402**	17
	Tilt		2437.0	6	99	15.08	15.50	0.391	0.254	1.102	1.010	0.283	-
Left	Touch		2437.0	6	99	15.08	15.50	0.207	0.151	1.102	1.010	0.168	-
	Tilt		2437.0	6	99	15.08	15.50	0.227	0.162	1.102	1.010	0.180	-
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	33.67	33.70	**0.510**	**0.514**	8
Rear	GSM1900	Standard	1880.0	661	10	30.31	30.70	**0.321**	**0.351**	11
Rear	WCDMA II	Standard	1880.0	9400	10	23.45	23.70	**0.896**	**0.949**	14
Rear	WCDMA V	Standard	836.6	4183	10	24.54	24.70	**0.687**	**0.713**	16
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	Traffic Channel		Separation Distance (mm)	Duty cycle (%)	Power(dBm)		Peak SAR of Area Scan(W/kg)	1-g SAR (W/kg))	Scaling Factor (Power)	Scaling Factor (Duty cycle)	1-g Scaled SAR (W/kg)	Plot No
		Frequency (㎒)	Channel			Measured Power	Tune-Up Limit						
Rear	802.11b	2437.0	6	10	99	15.08	15.50	0.179	**0.119**	1.102	1.010	**0.132**	18
ANSI / IEEE C95.1 1992 – Safety Limit Spatial Peak Uncontrolled Exposure / General Population						Head 1.6 W/kg (mW/g) Averaged over 1 gram							

21.3 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	31.66	31.70	0.353	0.356	-
Rear		Standard	836.6	190	10	31.66	31.70	**0.601**	**0.607**	9
Right Edge		Standard	836.6	190	10	31.66	31.70	0.378	0.381	-
Left Edge		Standard	836.6	190	10	31.66	31.70	0.273	0.276	-
Bottom		Standard	836.6	190	10	31.66	31.70	0.063	0.064	-
ANSI / IEEE C95.1 1992 – Safety Limit Spatial Peak Uncontrolled Exposure / General Population					Body 1.6 W/kg (mW/g) Averaged over 1 gram					

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	28.35	28.70	0.500	0.542	-
Rear		Standard	1880.0	661	10	28.35	28.70	**0.543**	**0.589**	12
Right Edge		Standard	1880.0	661	10	28.35	28.70	0.521	0.565	-
Left Edge		Standard	1880.0	661	10	28.35	28.70	0.339	0.367	-
Bottom		Standard	1880.0	661	10	28.35	28.70	0.446	0.483	-
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	23.45	23.70	0.722	0.765	-
Rear		Standard	1880.0	9400	10	23.45	23.70	0.880	0.932	-
Right Edge		Standard	1880.0	9400	10	23.45	23.70	0.488	0.517	-
Left Edge		Standard	1880.0	9400	10	23.45	23.70	0.761	0.806	-
Bottom		Standard	1880.0	9400	10	23.45	23.70	0.640	0.678	-
Rear		Standard	1852.4	9262	10	23.60	23.70	0.875	0.895	-
Rear		Standard	1907.6	9538	10	23.35	23.70	0.830	0.900	-
Repeated test										
Rear	RMC	Standard	1880.0	9400	10	23.45	23.70	**0.896**	**0.949**	14
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	24.54	24.70	0.447	0.464	-
Rear		Standard	836.6	4183	10	24.54	24.70	**0.687**	**0.713**	16
Right Edge		Standard	836.6	4183	10	24.54	24.70	0.450	0.467	-
Left Edge		Standard	836.6	4183	10	24.54	24.70	0.326	0.338	-
Bottom		Standard	836.6	4183	10	24.54	24.70	0.088	0.091	-
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	Traffic Channel		Separation Distance (mm)	Duty cycle (%)	Power(dBm)		Peak SAR of Area Scan(W/kg)	1-g SAR (W/kg))	Scaling Factor (Power)	Scaling Factor (Duty cycle)	1-g Scaled SAR (W/kg)	Plot No
		Frequency (㎒)	Channel			Measured Power	Tune-Up Limit						
Front	802.11b	2437.0	6	10	99	15.08	15.50	0.100	-	-	-	-	-
Rear		2437.0	6	10	99	15.08	15.50	0.179	**0.119**	1.102	1.010	**0.132**	18
Left Edge		2437.0	6	10	99	15.08	15.50	0.099	-	-	-	-	-
Top		2437.0	6	10	99	15.08	15.50	0.074	-	-	-	-	-
ANSI / IEEE C95.1 1992 – Safety Limit Spatial Peak Uncontrolled Exposure / General Population						Head 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 1528-2013, 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.
9. During SAR Testing for the Wireless Router conditions per FCC KDB Publication 941225 D06v02, the actual Portable Hotspot operation (with actual simultaneous transmission of a transmitter with WIFI) was not activated.
10. Per FCC KDB Publication 648474 D04v01r01, this device is considered a "phablet" since the diagonal dimension is > 160 mm. Therefore, extremity SAR tests are required when wireless router mode does not apply of if wireless router 1g SAR > 1.2 W/kg when scaled to maximum output power.

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 D01v03: 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 > $^1/_2$ 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 D01v03. 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 > $^1/_2$ dB, instead of the middle channel, the highest output power channel must be used

WLAN Notes

1. For held-to-ear hotspot operations, the initial test position procedures were applied. The test position with the highest extrapolated peak SAR will be used as the initial test position. When reported SAR for the initial test position is ≤ 0.4 W/kg, no additional testing for the remaining test positions was required. Otherwise, SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR result is ≤ 0.8 W/kg or all test positions are measured.
2. Justification for test configurations for WLAN per KDB Publication 248227 D01v02 for 2.4 GHz WIFI single transmission chain operations, the highest measured maximum output power channel for DSSS was selected for SAR measurement. SAR for OFDM modes (2.4 GHz 802.11g/n) was not required due to the maximum allowed powers and the highest reported DSSS SAR.
3. When the maximum reported 1g averaged SAR is ≤ 0.8 W/kg, SAR testing on additional channels was not required. Otherwise, SAR for the next highest output power channel was required until the reported SAR result was ≤ 1.20 W/kg or all test channels were measured.
4. The device was configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools. The reported SAR was scaled to the 100% transmission duty factor to determine compliance.
5. 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 preformed 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 (~ 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)	1st Repeated 1g SAR(W/kg)	Ratio	2st Repeated 1g SAR(W/kg)	Ratio	3st Repeated 1g SAR(W/kg)	Ratio
		Frequency (MHz)	Channel								
Front	GPRS 2Tx	836.6	190	10	0.880	0.896	1.02	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 1528-2013 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 and 10g SAR for simultaneous transmission involving that transmitter.

$$\text{Estimated SAR} = \frac{\sqrt{\text{Frequency (GHz)}}}{7.5} * \frac{\text{Max Power of Channel (mW)}}{\text{Test Separation Distance (mm)}}$$

Mode	Frequency [MHz]	Maximum Allowed Power [mW]	Separation Distance [mm]	Estimated SAR [W/kg]
Bluetooth	2480	6	5	0.252
Bluetooth	2480	6	10	0.126

$$\text{Estimated SAR} = \frac{\sqrt{\text{Frequency (GHz)}}}{18.75} * \frac{\text{Max Power of Channel (mW)}}{\text{Test Separation Distance (mm)}}$$

Mode	Frequency [MHz]	Maximum Allowed Power [mW]	Separation Distance [mm]	Estimated SAR [W/kg]
Bluetooth	2480	6	5	0.101

23.3 Simultaneous Transmission Scenarios

No	Capable Transmit Configuration	Head	Body-Worn	Wireless Router	Extremity
1	GSM 850 Voice + WLAN 2.4 GHz	Yes	Yes	N/A	N/A
2	GSM 1900 Voice + WLAN 2.4 GHz	Yes	Yes	N/A	N/A
5	GSM 850 Voice + Bluetooth	Yes	Yes	N/A	N/A
6	GSM 1900 Voice + Bluetooth	Yes	Yes	N/A	N/A
7	GPRS 850 + WLAN 2.4 GHz	Yes	Yes	Yes	N/A
8	GPRS 1900 + WLAN 2.4 GHz	Yes	Yes	Yes	N/A
11	GPRS 850 + Bluetooth	Yes	Yes	N/A	N/A
12	GPRS 1900 + Bluetooth	Yes	Yes	N/A	N/A
13	WCDMA 850 + WLAN 2.4 GHz	Yes	Yes	Yes	N/A
15	WCDMA 850 + Bluetooth	Yes	Yes	N/A	N/A
16	WCDMA 1900 + WLAN 2.4 GHz	Yes	Yes	Yes	N/A
18	WCDMA 1900 + Bluetooth	Yes	Yes	N/A	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	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN (W/kg)	∑SAR (W/kg)
Head SAR	GSM850	0.302	0.402	0.704
	GSM1900	0.379	0.402	0.781
	WCDMA II	0.529	0.402	0.931
	WCDMA V	0.389	0.402	0.791

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

Simultaneous TX	Mode	2G/3G SAR (W/kg)	Bluetooth (W/kg)	∑SAR (W/kg)
Head SAR	GSM850	0.302	0.252	0.554
	GSM1900	0.379	0.252	0.631
	WCDMA II	0.529	0.252	0.781
	WCDMA V	0.389	0.252	0.641

23.5 Body-Worn SAR Simultaneous Transmission Analysis

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

Simultaneous TX	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN (W/kg)	∑SAR (W/kg)
Body-Worn SAR	GSM850	0.514	0.132	0.646
	GSM1900	0.351	0.132	0.483
	WCDMA II	0.949	0.132	1.081
	WCDMA V	0.713	0.132	0.845

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

Simultaneous TX	Mode	2G/3G SAR (W/kg)	Bluetooth (W/kg)	∑SAR (W/kg)
Body-Worn SAR	GSM850	0.514	0.126	0.640
	GSM1900	0.351	0.126	0.477
	WCDMA II	0.949	0.126	1.075
	WCDMA V	0.713	0.126	0.839

23.6 Hotspot SAR Simultaneous Transmission Analysis

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

Simultaneous TX	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN (W/kg)	∑SAR (W/kg)
Hotspot SAR	GSM850	0.607	0.132	0.739
	GSM1900	0.589	0.132	0.721
	WCDMA II	0.949	0.132	1.081
	WCDMA V	0.713	0.132	0.845

Note

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.

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) A.3 Verification Test Plots for 2450 MHz (Plots No 5,6) A.4 SAR Test Plots for GSM850 Band (Plots No 7, 8, 9) A.5 SAR Test Plots for GSM1900 Band (Plots No 10, 11, 12) A.6 SAR Test Plots for WCDMA Band II (Plots No 13, 14) A.7 SAR Test Plots for WCDMA Band V (Plots No 15, 16) A.8 SAR Test Plots for WLAN 2.4 GHz (Plots No 17, 18)
Appendix B	B.1 Uncertainty Analysis
Appendix C	C.1 Calibration certificate for Probe (SN: 1782) C.2 Calibration certificate for Probe (SN: 3986) C.3 Calibration certificate for DAE C.4 Calibration certificate for Dipole

Appendix A.1 Verification Test Plots for 835 MHz_Head

Date: 2015-04-23

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 835MHz Head Verification.da4

Input Power : 100 mW

Ambient Temp : 23.5 ℃ Tissue Temp : 22.4 ℃

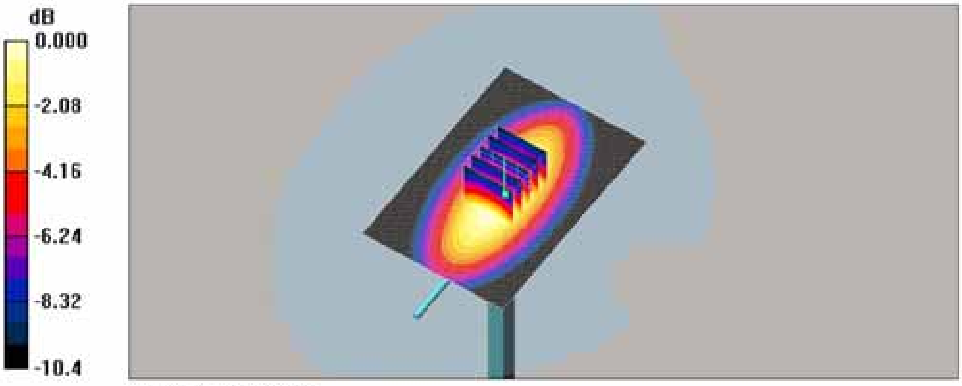
DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:490
Program Name: Verification

Communication System: CW; Frequency: 835 MHz;Duty Cycle: 1:1
Medium parameters used: f = 835 MHz; σ = 0.888 mho/m; ε_r = 42; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1782; ConvF(6.25, 6.25, 6.25); Calibrated: 2015-02-24
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: SAM Phantom_TP-1300; Type: SAM Phantom; Serial: TP-1300
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

835MHz_Verification/Area Scan (61x91x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.975 mW/g

835MHz_Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 34.1 V/m; Power Drift = -0.009 dB
Peak SAR (extrapolated) = 1.30 W/kg
SAR(1 g) = 0.896 mW/g; SAR(10 g) = 0.590 mW/g
Maximum value of SAR (measured) = 0.967 mW/g



0 dB = 0.967mW/g

Appendix A.1 Verification Test Plots for 835 MHz_Body

Date: 2015-04-23

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 835MHz Body Verification.da4

Input power : 100 mW

Ambient Temp : 23.5 ℃ Tissue Temp : 22.6 ℃

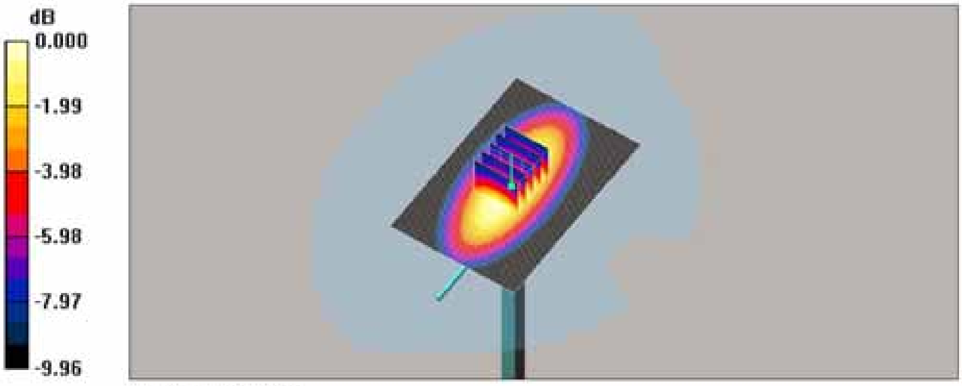
DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:490
Program Name: Verification

Communication System: CW; Frequency: 835 MHz;Duty Cycle: 1:1
Medium parameters used: f = 835 MHz; σ = 0.955 mho/m; ε_r = 54.6; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1782; ConvF(5.97, 5.97, 5.97); Calibrated: 2015-02-24
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: SAM Phantom TP-1645; Type: SAM Phantom; Serial: TP-1645
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

835MHz_Verification/Area Scan (61x91x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 1.03 mW/g

835MHz_Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 34.3 V/m; Power Drift = -0.027 dB
Peak SAR (extrapolated) = 1.32 W/kg
SAR(1 g) = 0.944 mW/g; SAR(10 g) = 0.630 mW/g
Maximum value of SAR (measured) = 1.02 mW/g



0 dB = 1.02mW/g

Appendix A.2 Verification Test Plots for 1900 MHz_Head

Date: 2015-04-20

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 1900MHz Head Verification.da4

Input Power : 100 mW

Ambient Temp : 23.0 ℃ Tissue Temp : 22.2 ℃

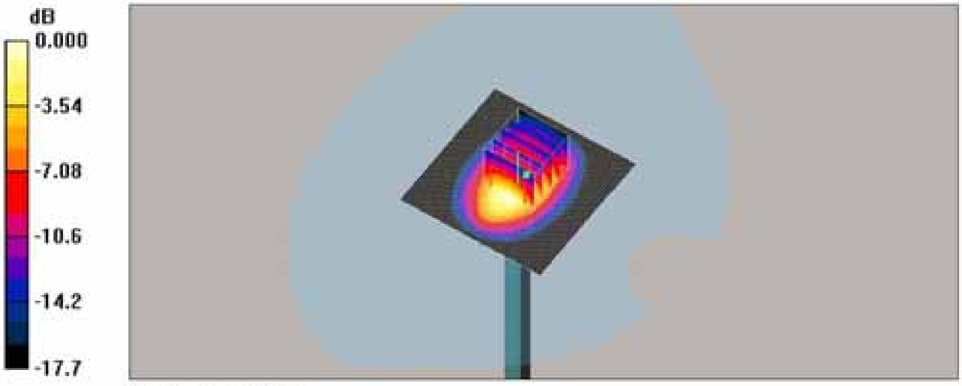
DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d033
Program Name: Verification

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium parameters used: f = 1900 MHz; σ = 1.4 mho/m; ε_r = 38.4; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1782; ConvF(5.11, 5.11, 5.11); Calibrated: 2015-02-24
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: SAM Phantom_TP-1300; Type: SAM Phantom; Serial: TP-1300
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

1900MHz Verification/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 4.81 mW/g

1900MHz Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 60.5 V/m; Power Drift = 0.000 dB
Peak SAR (extrapolated) = 6.60 W/kg
SAR(1 g) = 4.03 mW/g; SAR(10 g) = 2.19 mW/g
Maximum value of SAR (measured) = 4.51 mW/g



0 dB = 4.51mW/g

Appendix A.2 Verification Test Plots for 1900 MHz_Body

Date: 2015-04-20

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 1900MHz Body Verification.da4

Input Power : 100 mW

Ambient Temp : 22.9 ℃ Tissue Temp : 21.9 ℃

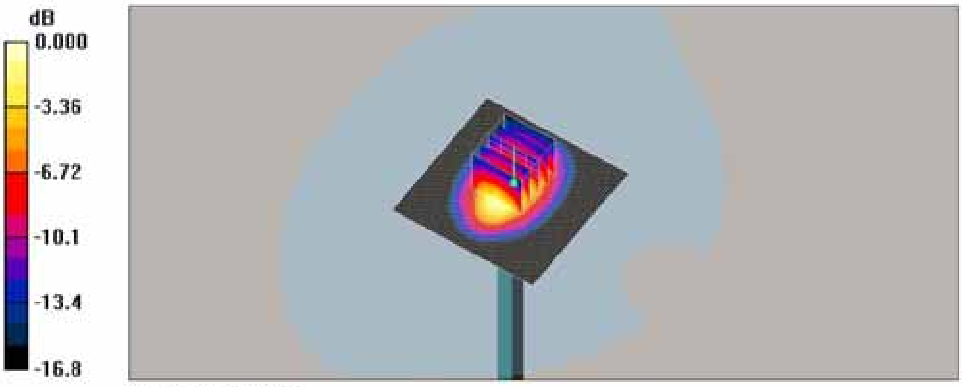
DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d033
Program Name: Verification

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium parameters used: f = 1900 MHz; σ = 1.55 mho/m; ε_r = 54.3; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1782; ConvF(4.67, 4.67, 4.67); Calibrated: 2015-02-24
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: SAM Phantom TP-1645; Type: SAM Phantom; Serial: TP-1645
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

1900MHz Verification/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 4.93 mW/g

1900MHz Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 58.4 V/m; Power Drift = -0.018 dB
Peak SAR (extrapolated) = 6.33 W/kg
SAR(1 g) = 4.08 mW/g; SAR(10 g) = 2.25 mW/g
Maximum value of SAR (measured) = 4.53 mW/g



0 dB = 4.53mW/g

Appendix A.3 Verification Test Plots for 2450 MHz_Head

Date: 2015-05-20

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 2450MHz Head Verification.da4

Input Power : 100 mW

Ambient Temp : 23.1 ℃ Tissue Temp : 22.3 ℃

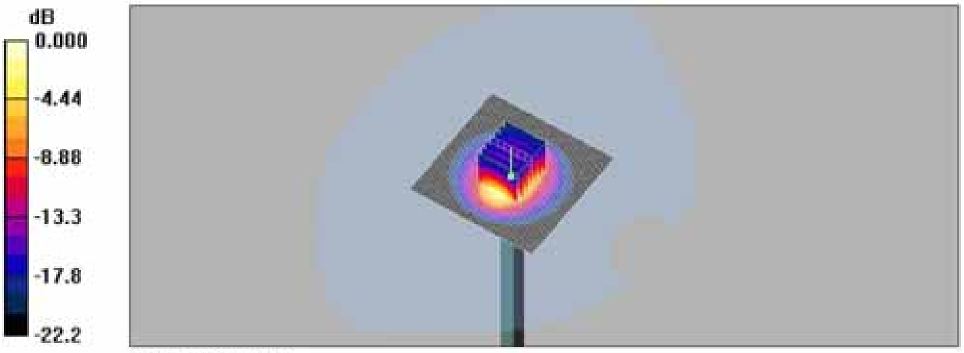
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:734
Program Name: Verification

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.79 mho/m; ε_r = 39.7; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3986; ConvF(7.86, 7.86, 7.86); Calibrated: 2015-03-25
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: SAM Phantom_TP-1300; Type: SAM Phantom; Serial: TP-1300
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

2450MHz Verification/Area Scan (91x91x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 8.40 mW/g

2450MHz Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 68.3 V/m; Power Drift = -0.044 dB
Peak SAR (extrapolated) = 11.3 W/kg
SAR(1 g) = 5.38 mW/g; SAR(10 g) = 2.47 mW/g
Maximum value of SAR (measured) = 8.37 mW/g



0 dB = 8.37mW/g

Appendix A.3 Verification Test Plots for 2450 MHz_Body

Date: 2015-05-20

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 2450MHz Body Verification.da4

Input Power : 100 mW

Ambient Temp : 23.1 ℃ Tissue Temp : 22.3 ℃

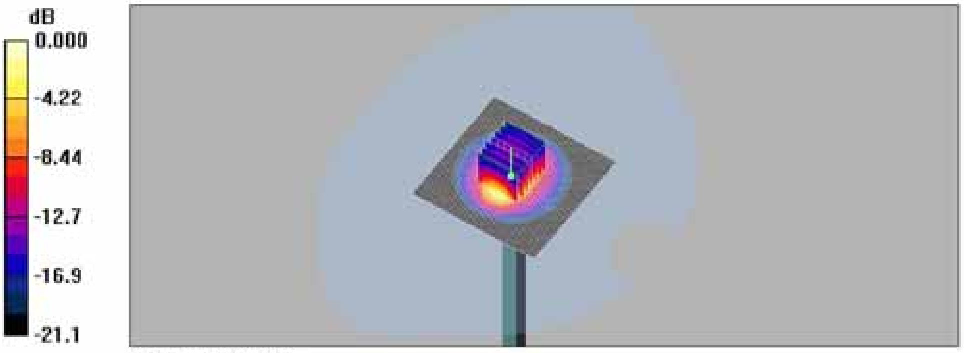
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:734
Program Name: Verification

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.94 mho/m; ε_r = 53.2; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3986; ConvF(7.62, 7.62, 7.62); Calibrated: 2015-03-25
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: SAM Phantom TP-1645; Type: SAM Phantom; Serial: TP-1645
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

2450MHz Verification/Area Scan (91x91x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 8.28 mW/g

2450MHz Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 63.6 V/m; Power Drift = -0.060 dB
Peak SAR (extrapolated) = 10.5 W/kg
SAR(1 g) = 5.29 mW/g; SAR(10 g) = 2.5 mW/g
Maximum value of SAR (measured) = 7.99 mW/g



0 dB = 7.99mW/g

Appendix A.4 SAR Test Plots for GSM850 Band (Head SAR)

Date: 2015-04-23

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: GPRS850_Right Touch_CH190_2TX.da4

Ambient Temp : 23.5 ℃ Tissue Temp : 22.4 ℃

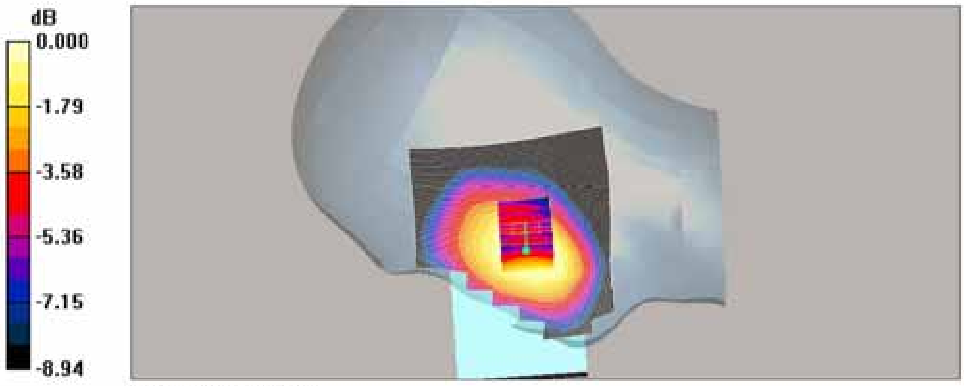
DUT: LG-H540T; Type: Cellular/PCS GSM/WCDMA Phone with WLAN, Bluetooth; Serial: 412KPZK784445
Program Name: Head

Communication System: GPRS850 2TX; Frequency: 836.6 MHz;Duty Cycle: 1:4.15
Medium parameters used: f = 837 MHz; σ = 0.891 mho/m; ε_r = 42; ρ = 1000 kg/m^3
Phantom section: Right Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1782; ConvF(6.25, 6.25, 6.25); Calibrated: 2015-02-24
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: SAM Phantom_TP-1300; Type: SAM Phantom; Serial: TP-1300
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

GPRS850_Right Touch_CH190_2TX/Area Scan (81x101x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.313 mW/g

GPRS850_Right Touch_CH190_2TX/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 6.50 V/m; Power Drift = -0.037 dB
Peak SAR (extrapolated) = 0.367 W/kg
SAR(1 g) = 0.299 mW/g; SAR(10 g) = 0.232 mW/g
Maximum value of SAR (measured) = 0.311 mW/g



0 dB = 0.311mW/g

Appendix A.4 SAR Test Plots for GSM850 Band (Body-Worn SAR)

Date: 2015-04-23

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: GSM850_Rear_CH190.da4

Ambient Temp : 23.5 ℃ Tissue Temp : 22.6 ℃

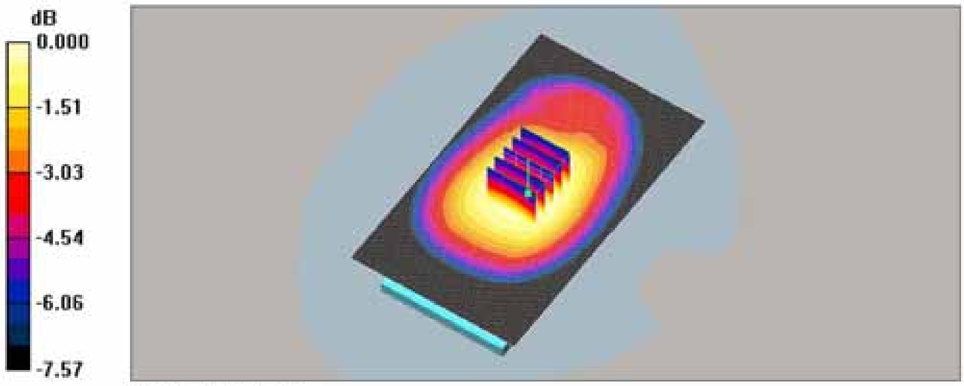
DUT: LG-H540T; Type: Cellular/PCS GSM/WCDMA Phone with WLAN, Bluetooth; Serial: 412KPZK784445
Program Name: Body

Communication System: GSM850; Frequency: 836.6 MHz;Duty Cycle: 1:8.3
Medium parameters used: f = 837 MHz; σ = 0.958 mho/m; ε_r = 54.6; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1782; ConvF(5.97, 5.97, 5.97); Calibrated: 2015-02-24
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: SAM Phantom TP-1645; Type: SAM Phantom; Serial: TP-1645
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

GSM850_Rear_CH190/Area Scan (71x121x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.531 mW/g

GSM850_Rear_CH190/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 24.6 V/m; Power Drift = -0.018 dB
Peak SAR (extrapolated) = 0.605 W/kg
SAR(1 g) = 0.510 mW/g; SAR(10 g) = 0.396 mW/g
Maximum value of SAR (measured) = 0.538 mW/g



0 dB = 0.538mW/g

Appendix A.4 SAR Test Plots for GSM850 Band (Hotspot SAR)

Date: 2015-04-23

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: GPRS850_Rear_CH190_2TX.da4

Ambient Temp : 23.5 ℃ Tissue Temp : 22.6 ℃

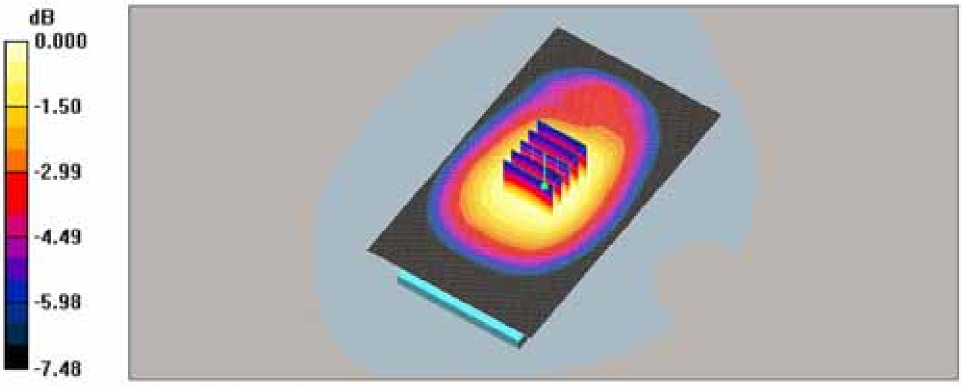
DUT: LG-H540T; Type: Cellular/PCS GSM/WCDMA Phone with WLAN, Bluetooth; Serial: 412KPZK784445
Program Name: Body

Communication System: GPRS850 2TX; Frequency: 836.6 MHz;Duty Cycle: 1:4.15
Medium parameters used: f = 837 MHz; σ = 0.958 mho/m; ε_r = 54.6; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1782; ConvF(5.97, 5.97, 5.97); Calibrated: 2015-02-24
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: SAM Phantom TP-1645; Type: SAM Phantom; Serial: TP-1645
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

GPRS850_Rear_CH190_2TX/Area Scan (71x121x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.634 mW/g

GPRS850_Rear_CH190_2TX/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 26.7 V/m; Power Drift = -0.038 dB
Peak SAR (extrapolated) = 0.726 W/kg
SAR(1 g) = 0.601 mW/g; SAR(10 g) = 0.469 mW/g
Maximum value of SAR (measured) = 0.632 mW/g



0 dB = 0.632mW/g

Appendix A.5 SAR Test Plots for GSM1900 Band (Head SAR)

Date: 2015-04-20

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: GPRS1900_Left Touch_CH661_2TX.da4

Ambient Temp : 23.0 ℃ Tissue Temp : 22.2 ℃

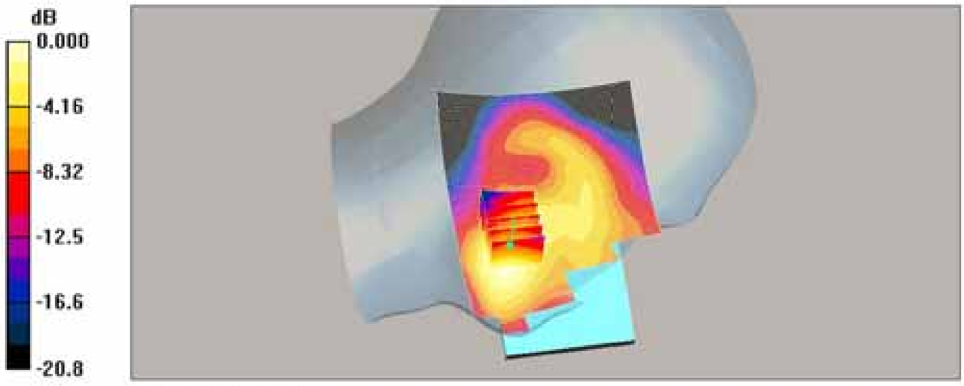
DUT: LG-H540T; Type: Cellular/PCS GSM/WCDMA Phone with WLAN, Bluetooth; Serial: 412KPZK784445
Program Name: Head

Communication System: GPRS1900 2TX; Frequency: 1880 MHz;Duty Cycle: 1:4.15
Medium parameters used: f = 1880 MHz; σ = 1.37 mho/m; ε_r = 38.5; ρ = 1000 kg/m^3
Phantom section: Left Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1782; ConvF(5.11, 5.11, 5.11); Calibrated: 2015-02-24
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: SAM Phantom_TP-1300; Type: SAM Phantom; Serial: TP-1300
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

GPRS1900_Left Touch_CH661_2TX/Area Scan (81x111x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.398 mW/g

GPRS1900_Left Touch_CH661_2TX/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 7.43 V/m; Power Drift = 0.009 dB
Peak SAR (extrapolated) = 0.501 W/kg
SAR(1 g) = 0.350 mW/g; SAR(10 g) = 0.226 mW/g
Maximum value of SAR (measured) = 0.369 mW/g



0 dB = 0.369mW/g

Appendix A.5 SAR Test Plots for GSM1900 Band (Body-Worn SAR)

Date: 2015-04-20

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: GSM1900_Rear_CH661.da4

Ambient Temp : 22.9 ℃ Tissue Temp : 21.9 ℃

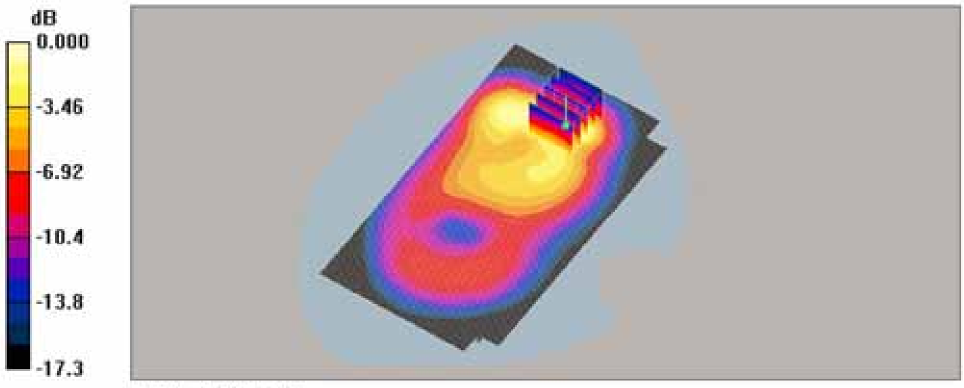
DUT: LG-H540T; Type: Cellular/PCS GSM/WCDMA Phone with WLAN, Bluetooth; Serial: 412KPZK784445
Program Name: Body

Communication System: GSM1900; Frequency: 1880 MHz;Duty Cycle: 1:8.3
Medium parameters used: f = 1880 MHz; σ = 1.53 mho/m; ε_r = 54.4; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1782; ConvF(4.67, 4.67, 4.67); Calibrated: 2015-02-24
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: SAM Phantom TP-1645; Type: SAM Phantom; Serial: TP-1645
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

GSM1900_Rear_CH661/Area Scan (81x141x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.359 mW/g

GSM1900_Rear_CH661/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 8.66 V/m; Power Drift = 0.013 dB
Peak SAR (extrapolated) = 0.549 W/kg
SAR(1 g) = 0.321 mW/g; SAR(10 g) = 0.173 mW/g
Maximum value of SAR (measured) = 0.365 mW/g



0 dB = 0.365mW/g

Appendix A.5 SAR Test Plots for GSM1900 Band (Hotspot SAR)

Date: 2015-04-20

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: GPRS1900_Rear_CH661_2TX.da4

Ambient Temp : 22.9 ℃ Tissue Temp : 21.9 ℃

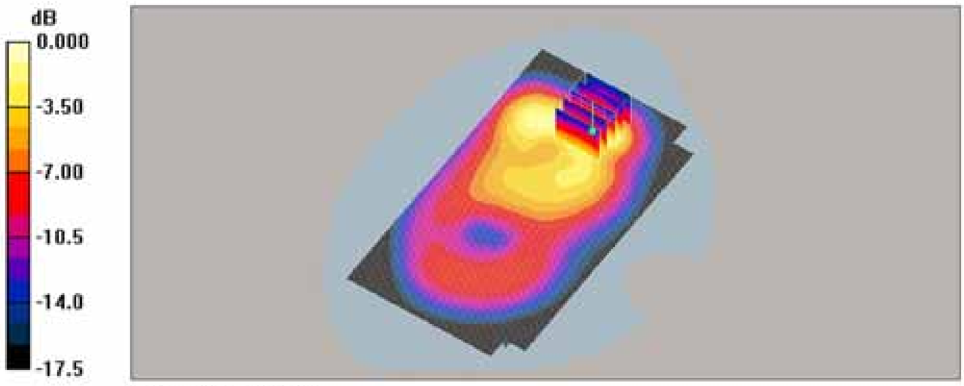
DUT: LG-H540T; Type: Cellular/PCS GSM/WCDMA Phone with WLAN, Bluetooth; Serial: 412KPZK784445
Program Name: Body

Communication System: GPRS1900 2TX; Frequency: 1880 MHz;Duty Cycle: 1:4.15
Medium parameters used: f = 1880 MHz; σ = 1.53 mho/m; ε_r = 54.4; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1782; ConvF(4.67, 4.67, 4.67); Calibrated: 2015-02-24
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: SAM Phantom TP-1645; Type: SAM Phantom; Serial: TP-1645
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

GPRS1900_Rear_CH661_2TX/Area Scan (81x141x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.621 mW/g

GPRS1900_Rear_CH661_2TX/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 11.3 V/m; Power Drift = -0.036 dB
Peak SAR (extrapolated) = 0.923 W/kg
SAR(1 g) = 0.543 mW/g; SAR(10 g) = 0.293 mW/g
Maximum value of SAR (measured) = 0.621 mW/g



0 dB = 0.621mW/g

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

Date: 2015-04-20

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: WCDMA II_Left Touch_CH9400.da4

Ambient Temp : 23.0 ℃ Tissue Temp : 22.2 ℃

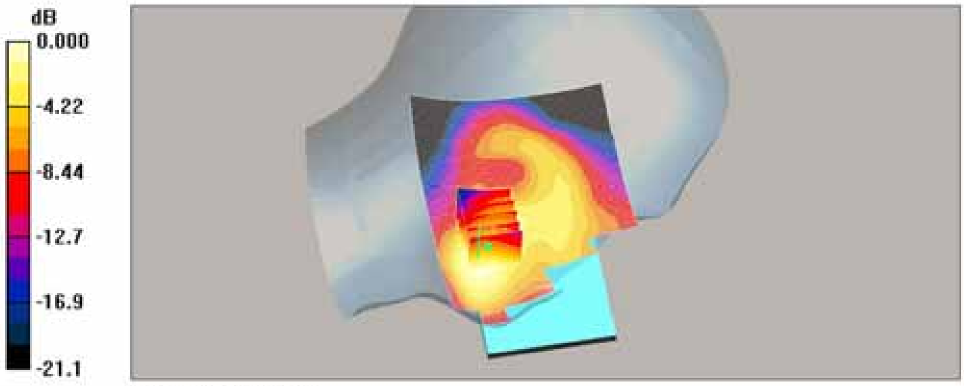
DUT: LG-H540T; Type: Cellular/PCS GSM/WCDMA Phone with WLAN, Bluetooth; Serial: 412KPZK784445
Program Name: Head

Communication System: WCDMA II; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium parameters used: f = 1880 MHz; σ = 1.37 mho/m; ε_r = 38.5; ρ = 1000 kg/m^3
Phantom section: Left Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1782; ConvF(5.11, 5.11, 5.11); Calibrated: 2015-02-24
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: SAM Phantom_TP-1300; Type: SAM Phantom; Serial: TP-1300
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WCDMA II_Left Touch_CH9400/Area Scan (81x111x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.561 mW/g

WCDMA II_Left Touch_CH9400/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 9.28 V/m; Power Drift = -0.007 dB
Peak SAR (extrapolated) = 0.701 W/kg
SAR(1 g) = 0.499 mW/g; SAR(10 g) = 0.326 mW/g
Maximum value of SAR (measured) = 0.521 mW/g



0 dB = 0.521mW/g

Appendix A.6 SAR Test Plots for WCDMA Band II (Body-Worn and Hotspot SAR)

Date: 2015-04-20

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: WCDMA II_Rear_CH9400_Repeated Test.da4

Ambient Temp : 22.9 ℃ Tissue Temp : 21.9 ℃

DUT: LG-H540T; Type: Cellular/PCS GSM/WCDMA Phone with WLAN, Bluetooth; Serial: 412KPZK784445
Program Name: Body

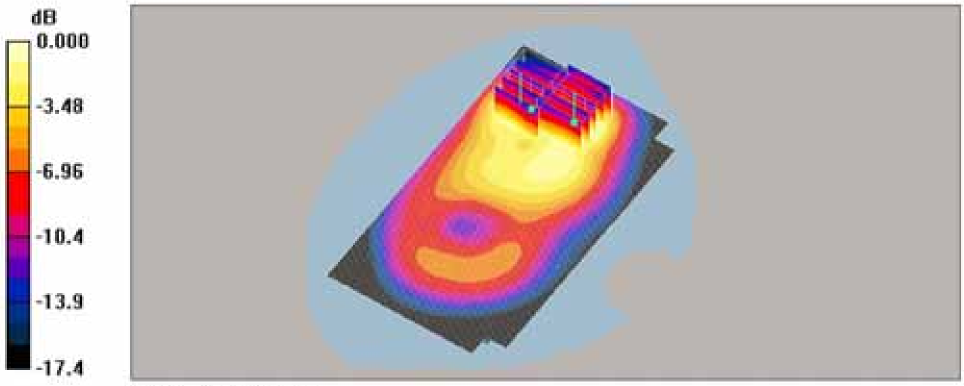
Communication System: WCDMA II; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium parameters used: f = 1880 MHz; σ = 1.53 mho/m; ε_r = 54.4; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1782; ConvF(4.67, 4.67, 4.67); Calibrated: 2015-02-24
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: SAM Phantom TP-1645; Type: SAM Phantom; Serial: TP-1645
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WCDMA II_Rear_CH9400_Repeated Test/Area Scan (81x141x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 1.05 mW/g

WCDMA II_Rear_CH9400_Repeated Test/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 12.3 V/m; Power Drift = -0.010 dB
Peak SAR (extrapolated) = 1.58 W/kg
SAR(1 g) = 0.896 mW/g; SAR(10 g) = 0.470 mW/g
Maximum value of SAR (measured) = 1.03 mW/g

WCDMA II_Rear_CH9400_Repeated Test/Zoom Scan (5x5x7)/Cube 1: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 12.3 V/m; Power Drift = -0.010 dB
Peak SAR (extrapolated) = 1.06 W/kg
SAR(1 g) = 0.645 mW/g; SAR(10 g) = 0.372 mW/g
Maximum value of SAR (measured) = 0.697 mW/g



0 dB = 0.697mW/g

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

Date: 2015-04-23

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: WCDMA V_Right Touch_CH4183.da4

Ambient Temp : 23.5 ℃ Tissue Temp : 22.4 ℃

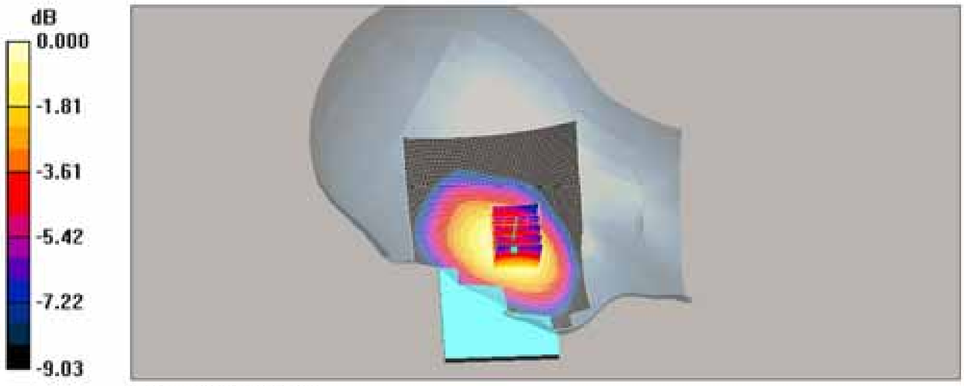
DUT: LG-H540T; Type: Cellular/PCS GSM/WCDMA Phone with WLAN, Bluetooth; Serial: 412KPZK784445
Program Name: Head

Communication System: WCDMA V; Frequency: 836.6 MHz;Duty Cycle: 1:1
Medium parameters used: f = 837 MHz; σ = 0.891 mho/m; ε_r = 42; ρ = 1000 kg/m^3
Phantom section: Right Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1782; ConvF(6.25, 6.25, 6.25); Calibrated: 2015-02-24
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: SAM Phantom_TP-1300; Type: SAM Phantom; Serial: TP-1300
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WCDMA V_Right Touch_CH4183/Area Scan (81x111x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.397 mW/g

WCDMA V_Right Touch_CH4183/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 7.09 V/m; Power Drift = -0.064 dB
Peak SAR (extrapolated) = 0.459 W/kg
SAR(1 g) = 0.375 mW/g; SAR(10 g) = 0.288 mW/g
Maximum value of SAR (measured) = 0.391 mW/g



0 dB = 0.391mW/g

Appendix A.7 SAR Test Plots for WCDMA Band V (Body-Worn and Hotspot SAR)

Date: 2015-04-23

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: WCDMA V_Rear_CH4183.da4

Ambient Temp : 23.5 ℃ Tissue Temp : 22.6 ℃

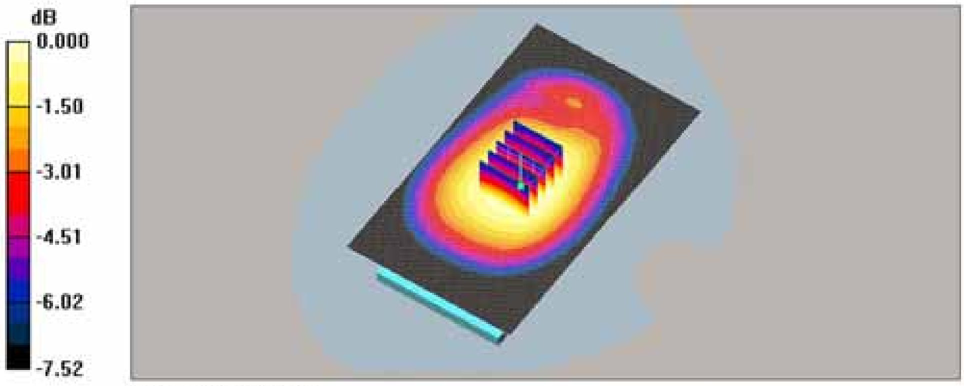
DUT: LG-H540T; Type: Cellular/PCS GSM/WCDMA Phone with WLAN, Bluetooth; Serial: 412KPZK784445
Program Name: Body

Communication System: WCDMA V; Frequency: 836.6 MHz;Duty Cycle: 1:1
Medium parameters used: f = 837 MHz; σ = 0.958 mho/m; ε_r = 54.6; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1782; ConvF(5.97, 5.97, 5.97); Calibrated: 2015-02-24
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: SAM Phantom TP-1645; Type: SAM Phantom; Serial: TP-1645
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WCDMA V_Rear_CH4183/Area Scan (71x121x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.724 mW/g

WCDMA V_Rear_CH4183/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 28.6 V/m; Power Drift = -0.013 dB
Peak SAR (extrapolated) = 0.809 W/kg
SAR(1 g) = 0.687 mW/g; SAR(10 g) = 0.536 mW/g
Maximum value of SAR (measured) = 0.719 mW/g



0 dB = 0.719mW/g

Appendix A.8 SAR Test Plots for WLAN 2.4 GHz Band (Head SAR)

Date: 2015-05-20

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: WLAN_802.11b_1Mbps_Right Touch_CH6.da4

Ambient Temp : 23.1 ℃ Tissue Temp : 22.3 ℃

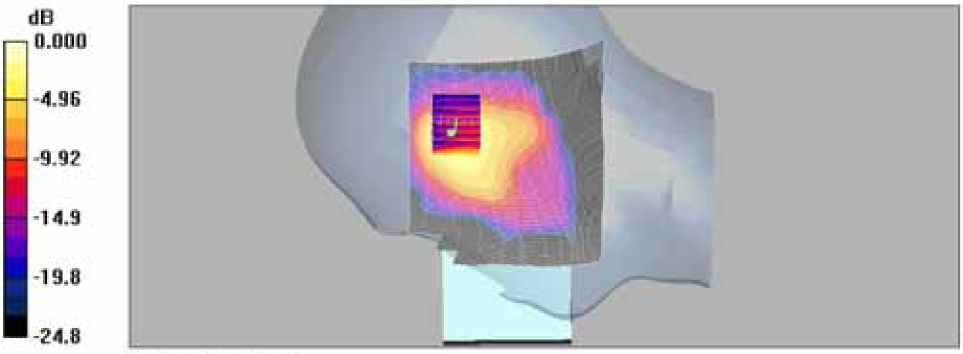
DUT: LG-H540T; Type: Cellular/PCS GSM/WCDMA Phone with WLAN, Bluetooth; Serial: 412KPZK784445
Program Name: Head

Communication System: 2.45GHz; Frequency: 2437 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2437 MHz; σ = 1.78 mho/m; ε_r = 39.8; ρ = 1000 kg/m^3
Phantom section: Right Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3986; ConvF(7.86, 7.86, 7.86); Calibrated: 2015-03-25
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: SAM Phantom_TP-1300; Type: SAM Phantom; Serial: TP-1300
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_802.11b_1Mbps_Right Touch_CH6/Area Scan (121x141x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.532 mW/g

WLAN_802.11b_1Mbps_Right Touch_CH6/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 7.89 V/m; Power Drift = 0.026 dB
Peak SAR (extrapolated) = 0.713 W/kg
SAR(1 g) = 0.361 mW/g; SAR(10 g) = 0.178 mW/g
Maximum value of SAR (measured) = 0.528 mW/g



0 dB = 0.528mW/g

Appendix A.8 SAR Test Plots for WLAN 2.4 GHz Band (Body-Worn and Hotspot SAR)

Date: 2015-05-20

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: WLAN_802.11b_1Mbps_Rear_CH6.da4

Ambient Temp : 23.1 ℃ Tissue Temp : 22.3 ℃

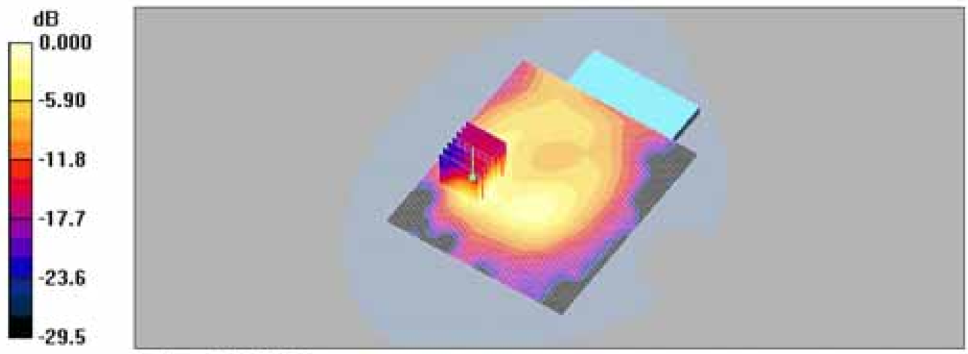
DUT: LG-H540T; Type: Cellular/PCS GSM/WCDMA Phone with WLAN, Bluetooth; Serial: 412KPZK784445
Program Name: Body

Communication System: 2.45GHz; Frequency: 2437 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2437 MHz; σ = 1.93 mho/m; ε_r = 53.2; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3986; ConvF(7.62, 7.62, 7.62); Calibrated: 2015-03-25
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: SAM Phantom TP-1645; Type: SAM Phantom; Serial: TP-1645
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_802.11b_1Mbps_Rear_CH6/Area Scan (131x151x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.179 mW/g

WLAN_802.11b_1Mbps_Rear_CH6/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 5.59 V/m; Power Drift = -0.042 dB
Peak SAR (extrapolated) = 0.255 W/kg
SAR(1 g) = 0.119 mW/g; SAR(10 g) = 0.057 mW/g
Maximum value of SAR (measured) = 0.183 mW/g



0 dB = 0.183mW/g

Appendix B.1 Uncertainty Analysis DASY4 #1

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 IEEE 1528	Tol (%)	Prob . Dist.	Div.	Ci (1g)	1g ui (%)	Vi (Veff)
Probe calibration	E.2.1	6.0	N	1	1	6.00	∞
Axial isotropy	E.2.2	4.7	R	1.73	0.71	1.92	∞
Hemispherical isotropy	E.2.2	9.6	R	1.73	0.71	3.92	∞
Boundary effect	E.2.3	1.0	R	1.73	1	0.58	∞
Linearity	E.2.4	4.7	R	1.73	1	2.71	∞
System detection limit	E.2.5	0.3	R	1.73	1	0.14	∞
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	3.0	R	1.73	1	1.73	∞
RF ambient Condition - reflections	E.6.1	3.0	R	1.73	1	1.73	∞
Probe Positiones	E.6.2	1.5	R	1.73	1	0.87	∞
Probe Positioning	E.6.3	2.9	R	1.73	1	1.67	∞
Max. SAR evaluation	E.5.2	1.0	R	1.73	1	0.58	∞
Test sample positioning	E.4.2	2.8	N	1	1	2.78	9
Device holder uncertainty	E.4.1	3.6	N	1	1	3.60	4
Output power variation -SAR drift measurement	6.6.3	5.0	R	1.73	1	2.89	∞
Phantom uncertainty	E.3.1	4.0	R	1.73	1	2.31	∞
Liquid conductivity - deviation from target values	E.3.2	5.0	R	1.73	0.64	1.85	∞
Liquid conductivity - measurement uncertainty	E.3.2	1.6	N	1	0.64	1.00	5
Liquid permittivity - deviation from target values	E.3.3	5.0	R	1.73	0.6	1.73	∞
Liquid permittivity - measurement uncertainty	E.3.3	1.2	N	1	0.6	0.75	4
Combined standard uncertainty				RSS		10.83	283
Expanded uncertainty				K=2		**21.66**	

Appendix C.1 Calibration certificate for Probe (SN: 1782)

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

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

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

Accreditation No.: **SCS 0108**

Client **SGS (Dymstec)**

Certificate No: **ET3-1782_Feb15**

CALIBRATION CERTIFICATE

Object: ET3DV6 - SN:1782

Calibration procedure(s): QA CAL-01.v9, QA CAL-12.v9, QA CAL-23.v5, QA CAL-25.v6
Calibration procedure for dosimetric E-field probes

Calibration date: February 24, 2015

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

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°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	03-Apr-14 (No. 217-01911)	Apr-15
Power sensor E4412A	MY41498087	03-Apr-14 (No. 217-01911)	Apr-15
Reference 3 dB Attenuator	SN: S5054 (3c)	03-Apr-14 (No. 217-01915)	Apr-15
Reference 20 dB Attenuator	SN: S5277 (20x)	03-Apr-14 (No. 217-01919)	Apr-15
Reference 30 dB Attenuator	SN: S5129 (30b)	03-Apr-14 (No. 217-01920)	Apr-15
Reference Probe ES3DV2	SN: 3013	30-Dec-14 (No. ES3-3013_Dec14)	Dec-15
DAE4	SN: 660	14-Jan-15 (No. DAE4-660_Jan15)	Jan-16
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-14)	In house check: Oct-15

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

Issued: February 25, 2015

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
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 0108**

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E^2-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,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 ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

Probe ET3DV6

SN:1782

Manufactured: April 15, 2003
Calibrated: February 24, 2015

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

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1782

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	2.09	1.64	1.91	± 10.1 %
DCP (mV)[B]	96.5	99.0	97.0	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	240.9	±3.8 %
		Y	0.0	0.0	1.0		249.3	
		Z	0.0	0.0	1.0		227.8	

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

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

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1782

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)
150	52.3	0.76	8.16	8.16	8.16	0.15	2.50	± 13.3 %
300	45.3	0.87	8.05	8.05	8.05	0.22	2.20	± 13.3 %
450	43.5	0.87	7.29	7.29	7.29	0.25	2.90	± 13.3 %
600	42.7	0.88	7.23	7.23	7.23	0.00	1.00	± 13.3 %
750	41.9	0.89	6.52	6.52	6.52	0.28	3.00	± 12.0 %
835	41.5	0.90	6.25	6.25	6.25	0.35	2.55	± 12.0 %
900	41.5	0.97	6.15	6.15	6.15	0.33	2.65	± 12.0 %
1640	40.3	1.29	5.63	5.63	5.63	0.80	2.09	± 12.0 %
1810	40.0	1.40	5.21	5.21	5.21	0.75	2.30	± 12.0 %
1900	40.0	1.40	5.11	5.11	5.11	0.80	2.09	± 12.0 %
2450	39.2	1.80	4.53	4.53	4.53	0.80	1.79	± 12.0 %

[C] Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[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.

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1782

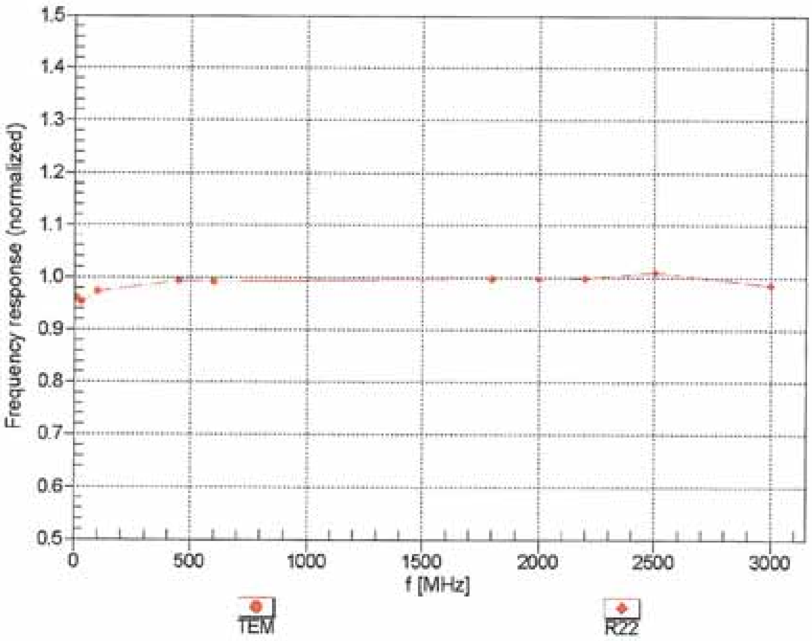
Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
300	58.2	0.92	7.46	7.46	7.46	0.19	2.20	± 13.3 %
450	56.7	0.94	7.32	7.32	7.32	0.20	2.10	± 13.3 %
750	55.5	0.96	6.02	6.02	6.02	0.35	2.61	± 12.0 %
835	55.2	0.97	5.97	5.97	5.97	0.31	2.94	± 12.0 %
1900	53.3	1.52	4.67	4.67	4.67	0.80	2.48	± 12.0 %
2450	52.7	1.95	4.12	4.12	4.12	0.80	1.32	± 12.0 %

[C] Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[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.

Frequency Response of E-Field

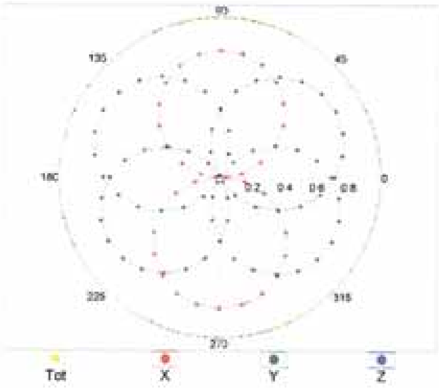
(TEM-Cell:ifi110 EXX, Waveguide: R22)



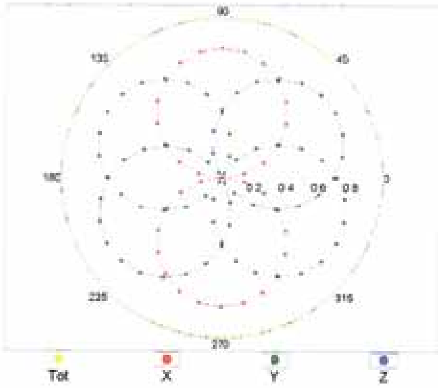
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

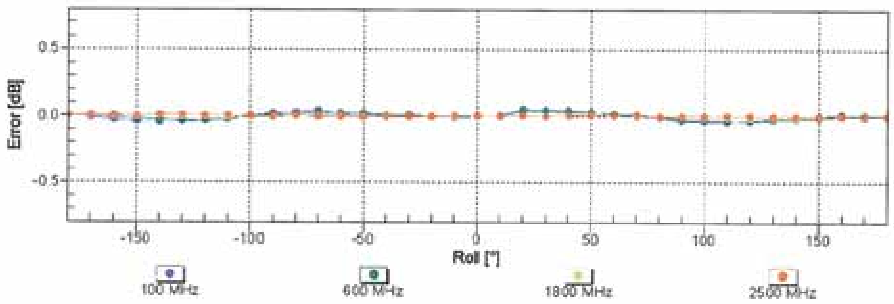
Receiving Pattern (ϕ), $\vartheta = 0°$

f=600 MHz,TEM



f=1800 MHz,R22

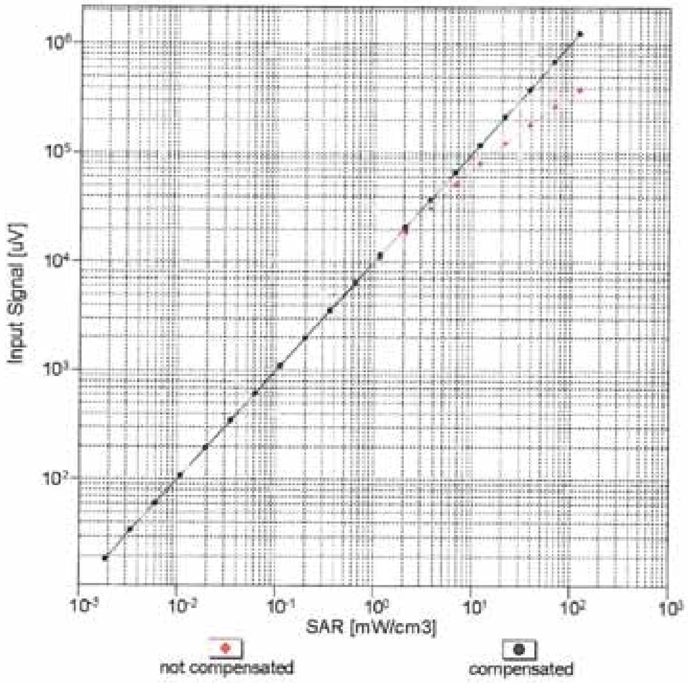


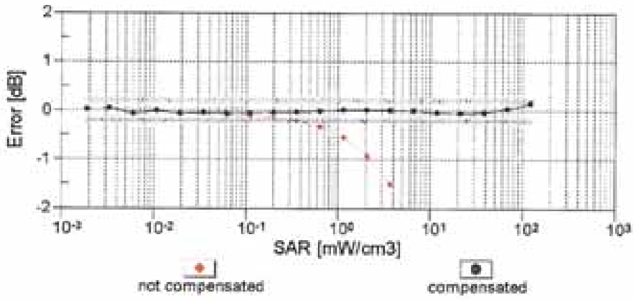


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR_{head})

(TEM cell , f_{eval}= 1900 MHz)

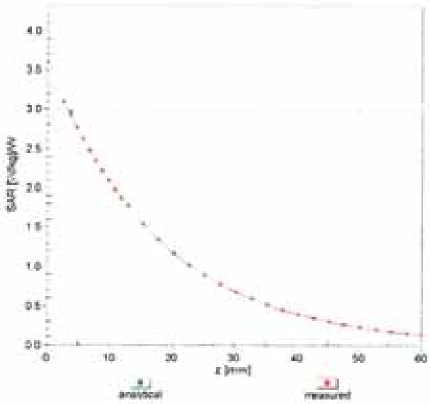




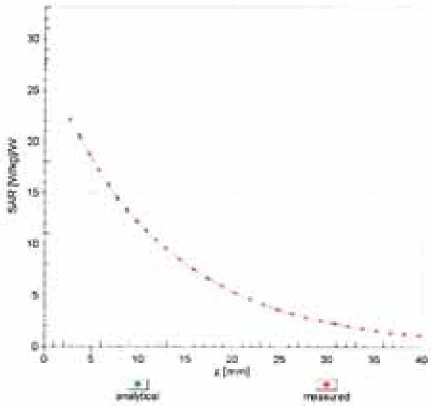
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment

f = 900 MHz,WGLS R9 (H_convF)

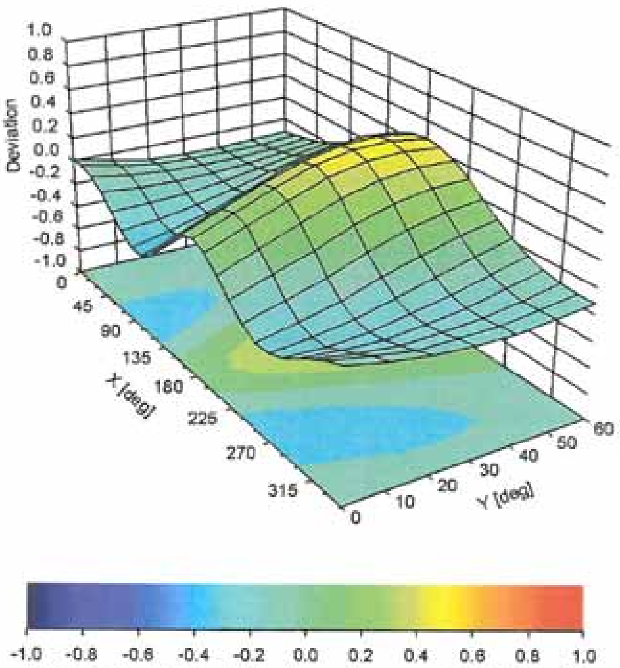


f = 1810 MHz,WGLS R22 (H_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1782

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-129.9
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	6.8 mm
Probe Tip to Sensor X Calibration Point	2.7 mm
Probe Tip to Sensor Y Calibration Point	2.7 mm
Probe Tip to Sensor Z Calibration Point	2.7 mm
Recommended Measurement Distance from Surface	4 mm

Appendix C.2 Calibration certificate for Probe (SN: 3986)

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

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

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

Accreditation No.: SCS 0108

Client SGS (Dymstec)

Certificate No: EX3-3986_Mar15

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:3986

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: March 25, 2015

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

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°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	03-Apr-14 (No. 217-01911)	Apr-15
Power sensor E4412A	MY41498087	03-Apr-14 (No. 217-01911)	Apr-15
Reference 3 dB Attenuator	SN: S5054 (3c)	03-Apr-14 (No. 217-01915)	Apr-15
Reference 20 dB Attenuator	SN: S5277 (20x)	03-Apr-14 (No. 217-01919)	Apr-15
Reference 30 dB Attenuator	SN: S5129 (30b)	03-Apr-14 (No. 217-01920)	Apr-15
Reference Probe ES3DV2	SN: 3013	30-Dec-14 (No. ES3-3013_Dec14)	Dec-15
DAE4	SN: 660	14-Jan-15 (No. DAE4-660_Jan15)	Jan-16
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-14)	In house check: Oct-15

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 26, 2015

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

Certificate No: EX3-3986_Mar15 Page 1 of 11

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

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

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

Accreditation No.: **SCS 0108**

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E^2-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,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 ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy):* in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset:* The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle:* The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

Probe EX3DV4

SN:3986

Manufactured: November 11, 2013
Calibrated: March 25, 2015

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3986

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.53	0.53	0.49	± 10.1 %
DCP (mV)[B]	100.8	97.7	101.2	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	144.2	±3.3 %
		Y	0.0	0.0	1.0		140.9	
		Z	0.0	0.0	1.0		133.3	

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

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3986

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	10.46	10.46	10.46	0.31	1.10	± 12.0 %
900	41.5	0.97	10.13	10.13	10.13	0.26	1.28	± 12.0 %
1750	40.1	1.37	8.81	8.81	8.81	0.39	0.82	± 12.0 %
1900	40.0	1.40	8.52	8.52	8.52	0.29	0.80	± 12.0 %
2300	39.5	1.67	8.19	8.19	8.19	0.25	0.80	± 12.0 %
2450	39.2	1.80	7.86	7.86	7.86	0.31	0.85	± 12.0 %
2600	39.0	1.96	7.61	7.61	7.61	0.25	1.02	± 12.0 %
5200	36.0	4.66	5.52	5.52	5.52	0.30	1.80	± 13.1 %
5300	35.9	4.76	5.23	5.23	5.23	0.30	1.80	± 13.1 %
5500	35.6	4.96	5.09	5.09	5.09	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.87	4.87	4.87	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.84	4.84	4.84	0.40	1.80	± 13.1 %

[C] Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[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.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3986

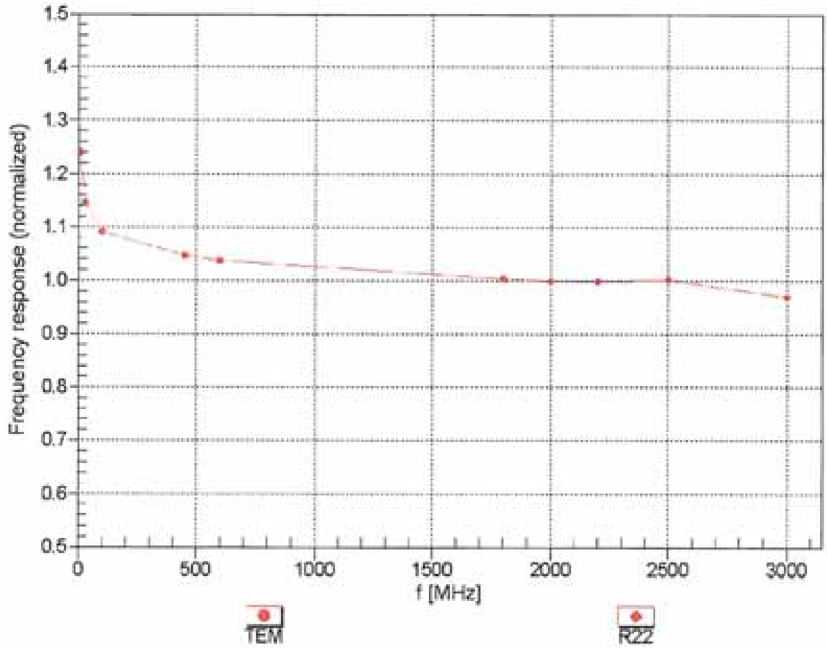
Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
835	55.2	0.97	10.27	10.27	10.27	0.25	1.19	± 12.0 %
1750	53.4	1.49	8.46	8.46	8.46	0.35	0.97	± 12.0 %
1900	53.3	1.52	8.21	8.21	8.21	0.40	0.83	± 12.0 %
2450	52.7	1.95	7.62	7.62	7.62	0.25	0.95	± 12.0 %
2600	52.5	2.16	7.32	7.32	7.32	0.24	0.95	± 12.0 %
5200	49.0	5.30	4.78	4.78	4.78	0.40	1.90	± 13.1 %
5300	48.9	5.42	4.54	4.54	4.54	0.40	1.90	± 13.1 %
5600	48.5	5.77	4.01	4.01	4.01	0.55	1.90	± 13.1 %
5800	48.2	6.00	4.15	4.15	4.15	0.55	1.90	± 13.1 %

[C] Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[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.

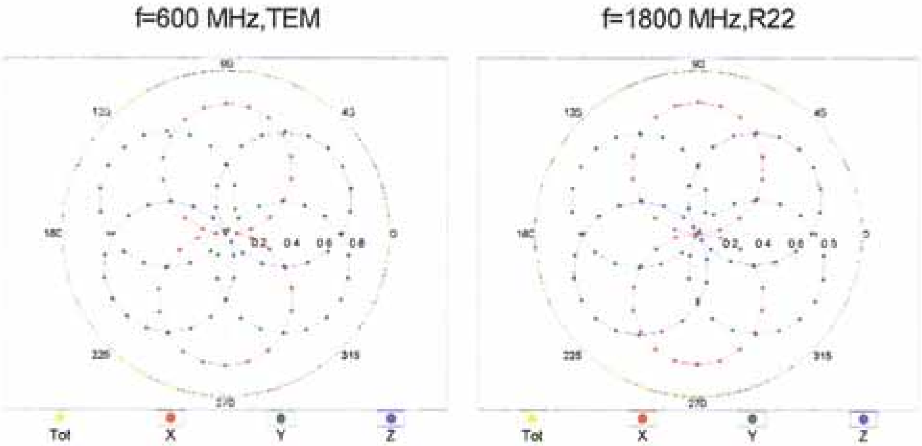
Frequency Response of E-Field

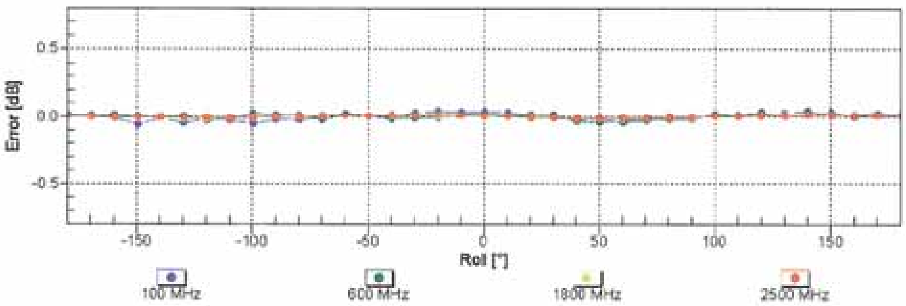
(TEM-Cell:ifi110 EXX, Waveguide: R22)



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

Receiving Pattern (ϕ), ϑ = 0°

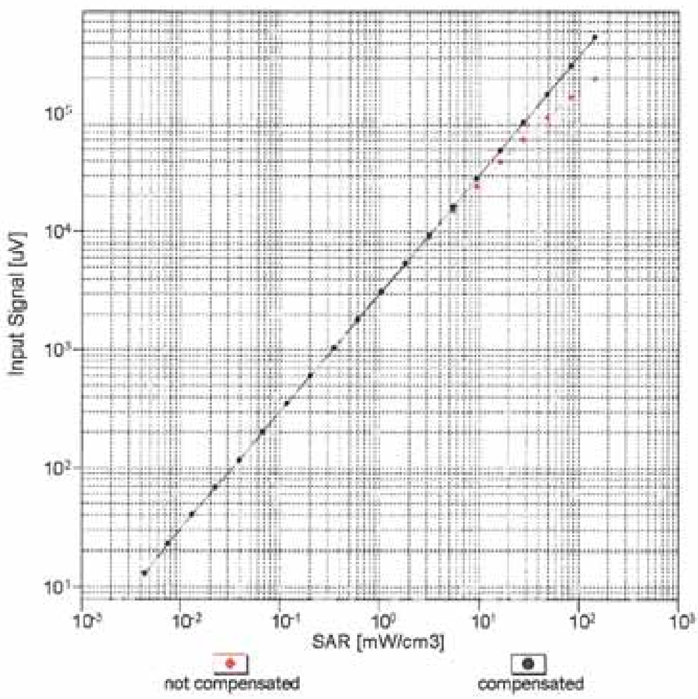


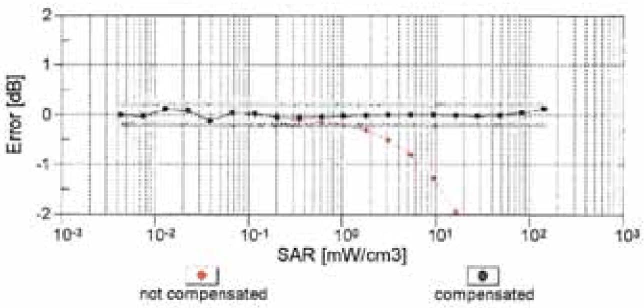


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR_{head})

(TEM cell , f_{eval}= 1900 MHz)



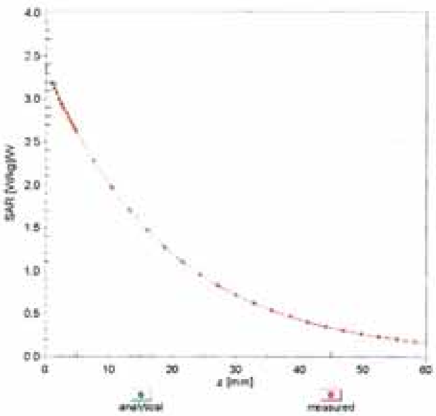


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

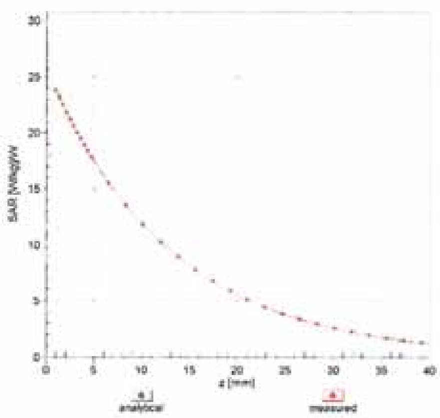
EX3DV4– SN:3986 March 25, 2015

Conversion Factor Assessment

f = 900 MHz,WGLS R9 (H_convF)

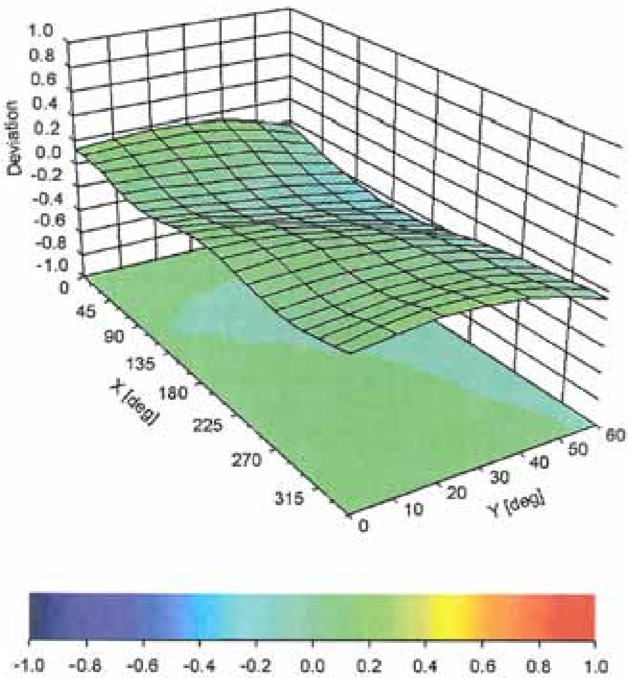


f = 1750 MHz,WGLS R22 (H_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3986

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-49.7
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	1.4 mm

Appendix C.3 Calibration certificate for DAE

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

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

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

Accreditation No.: **SCS 0108**

Client **SGS (Dymstec)**

Certificate No: **DAE3-567_Jan15**

CALIBRATION CERTIFICATE

Object	DAE3 - SD 000 D03 AA - SN: 567
Calibration procedure(s)	QA CAL-06.v29 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	January 22, 2015

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

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°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	03-Oct-14 (No:15573)	Oct-15
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	06-Jan-15 (in house check)	In house check: Jan-16
Calibrator Box V2.1	SE UMS 006 AA 1002	06-Jan-15 (in house check)	In house check: Jan-16

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Technician	
Approved by:	Fin Bomholt	Deputy Technical Manager	

Issued: January 22, 2015

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

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 = 6.1μV , 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	404.725 ± 0.02% (k=2)	404.466 ± 0.02% (k=2)	404.570 ± 0.02% (k=2)
Low Range	3.95751 ± 1.50% (k=2)	3.97188 ± 1.50% (k=2)	3.96085 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	5.0 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	200036.68	1.35	0.00
Channel X	+ Input	20006.89	3.53	0.02
Channel X	- Input	-20002.06	4.52	-0.02
Channel Y	+ Input	200035.89	0.85	0.00
Channel Y	+ Input	20003.43	0.09	0.00
Channel Y	- Input	-20005.71	1.01	-0.01
Channel Z	+ Input	200040.18	5.12	0.00
Channel Z	+ Input	20002.47	-0.89	-0.00
Channel Z	- Input	-20004.30	2.36	-0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	1999.70	-0.12	-0.01
Channel X	+ Input	199.72	-0.18	-0.09
Channel X	- Input	-199.94	0.16	-0.08
Channel Y	+ Input	1999.76	0.03	0.00
Channel Y	+ Input	199.48	-0.10	-0.05
Channel Y	- Input	-201.06	-0.82	0.41
Channel Z	+ Input	1999.91	0.25	0.01
Channel Z	+ Input	198.43	-1.22	-0.61
Channel Z	- Input	-201.33	-1.08	0.54

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 (μV)	Low Range Average Reading (μV)
Channel X	200	2.38	1.03
	- 200	0.01	-1.81
Channel Y	200	-1.57	-1.77
	- 200	0.56	0.40
Channel Z	200	4.02	3.58
	- 200	-6.01	-6.06

3. Channel separation

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

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	-1.38	-3.91
Channel Y	200	8.57	-	-0.48
Channel Z	200	5.30	6.61	-

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	16275	16253
Channel Y	16156	14849
Channel Z	15960	14831

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	0.76	-0.43	2.68	0.50
Channel Y	0.04	-1.11	1.19	0.40
Channel Z	-0.43	-1.53	0.53	0.38

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.4 Calibration certificate for Dipole

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

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

기술책임자 2014.6.2

Client **SGS (Dymstec)**

Certificate No: **D835V2-490_May14**

CALIBRATION CERTIFICATE

Object	D835V2 - SN: 490
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	May 16, 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
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	30-Apr-14 (No. DAE4-601_Apr14)	Apr-15

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

Issued: May 20, 2014

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

Certificate No: D835V2-490_May14 Page 1 of 8

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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**

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 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 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	V52.8.8
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 ± 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 ± 0.2) °C	40.2 ± 6 %	0.94 mho/m ± 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	2.36 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**9.07 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.52 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**5.90 W/kg ± 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 ± 0.2) °C	56.6 ± 6 %	1.02 mho/m ± 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	2.45 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**9.49 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.59 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**6.20 W/kg ± 16.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.9 Ω - 2.9 jΩ
Return Loss	- 30.4 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.3 Ω - 5.0 jΩ
Return Loss	- 22.9 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.392 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	May 19, 2003

DASY5 Validation Report for Head TSL

Date: 16.05.2014

Test Laboratory: SPEAG, Zurich, Switzerland

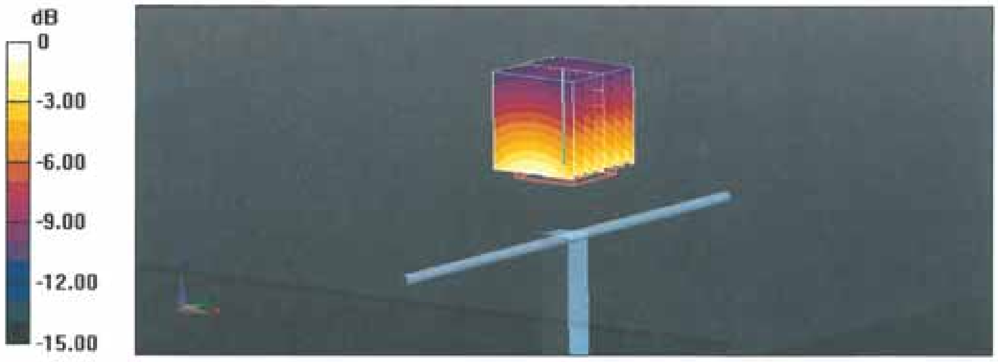
DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 490

Communication System: UID 0 - CW; Frequency: 835 MHz
Medium parameters used: f = 835 MHz; $\sigma = 0.94$ S/m; $\varepsilon_r = 40.2$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

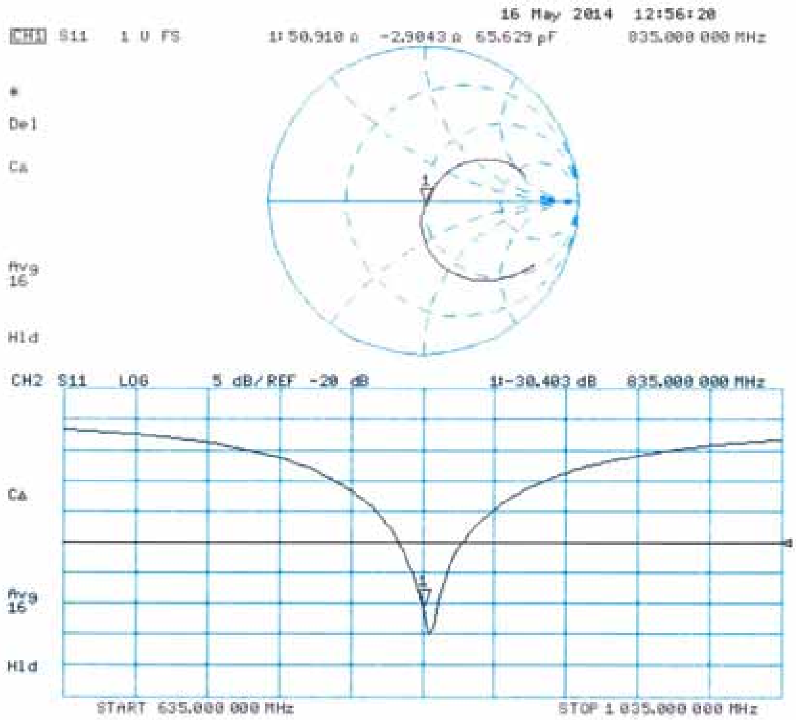
- Probe: ES3DV3 - SN3205; ConvF(6.22, 6.22, 6.22); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 56.09 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 3.57 W/kg
SAR(1 g) = 2.36 W/kg; SAR(10 g) = 1.52 W/kg
Maximum value of SAR (measured) = 2.78 W/kg



0 dB = 2.78 W/kg = 4.44 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 15.05.2014

Test Laboratory: SPEAG, Zurich, Switzerland

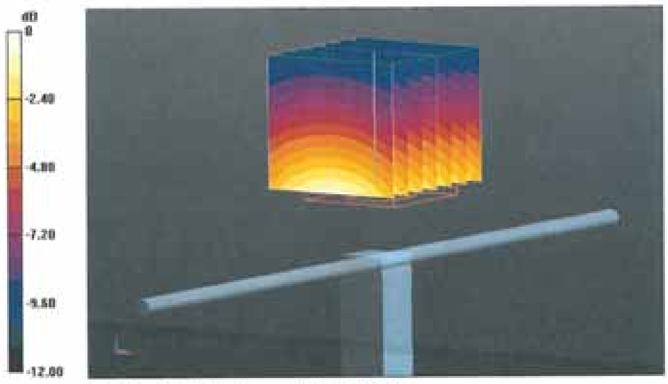
DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 490

Communication System: UID 0 - CW; Frequency: 835 MHz
Medium parameters used: f = 835 MHz; σ = 1.02 S/m; ε_r = 56.6; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

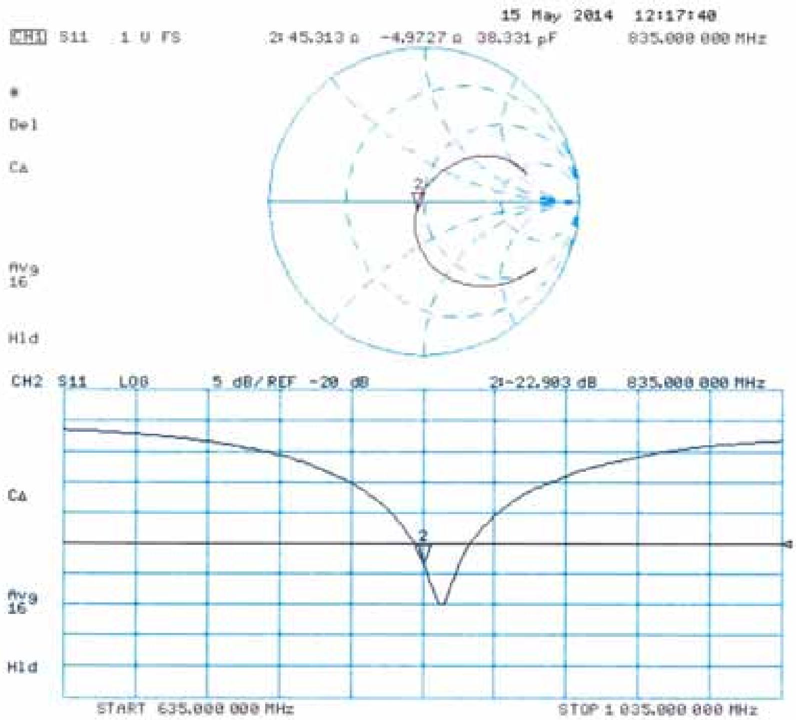
- Probe: ES3DV3 - SN3205; ConvF(6.09, 6.09, 6.09); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 55.12 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 3.64 W/kg
SAR(1 g) = 2.45 W/kg; SAR(10 g) = 1.59 W/kg
Maximum value of SAR (measured) = 2.87 W/kg



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

Impedance Measurement Plot for Body TSL



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Accreditation No.: SCS 108

Client: SGS (Dymstec)

Certificate No: D1900V2-5d033_May14

CALIBRATION CERTIFICATE

Object	D1900V2 - SN: 5d033
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
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
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	30-Apr-14 (No. DAE4-601_Apr14)	Apr-15

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: May 19, 2014

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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 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 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	V52.8.8
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 ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.3 ± 6 %	1.37 mho/m ± 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	9.99 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**40.3 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**21.1 W/kg ± 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 ± 0.2) °C	52.5 ± 6 %	1.50 mho/m ± 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	10.1 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**40.6 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.32 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.3 W/kg ± 16.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.9 Ω + 1.5 jΩ
Return Loss	- 32.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.6 Ω + 1.9 jΩ
Return Loss	- 30.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.204 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	March 17, 2003

DASY5 Validation Report for Head TSL

Date: 19.05.2014

Test Laboratory: SPEAG, Zurich, Switzerland

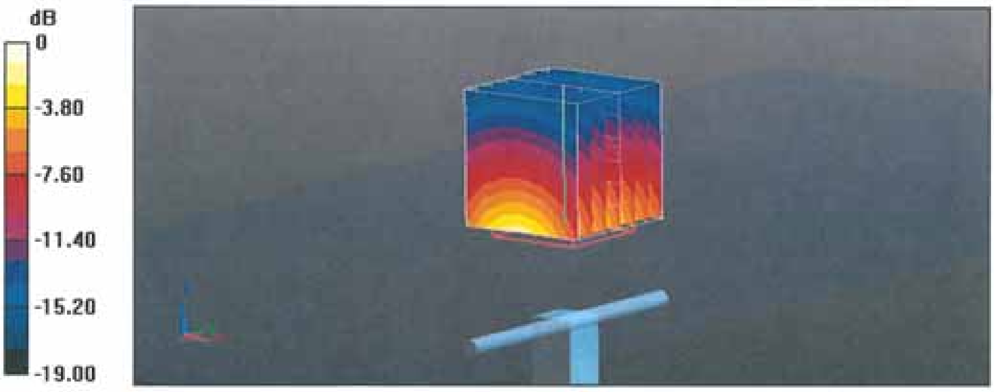
DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d033

Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; σ = 1.37 S/m; ε_r = 39.3; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

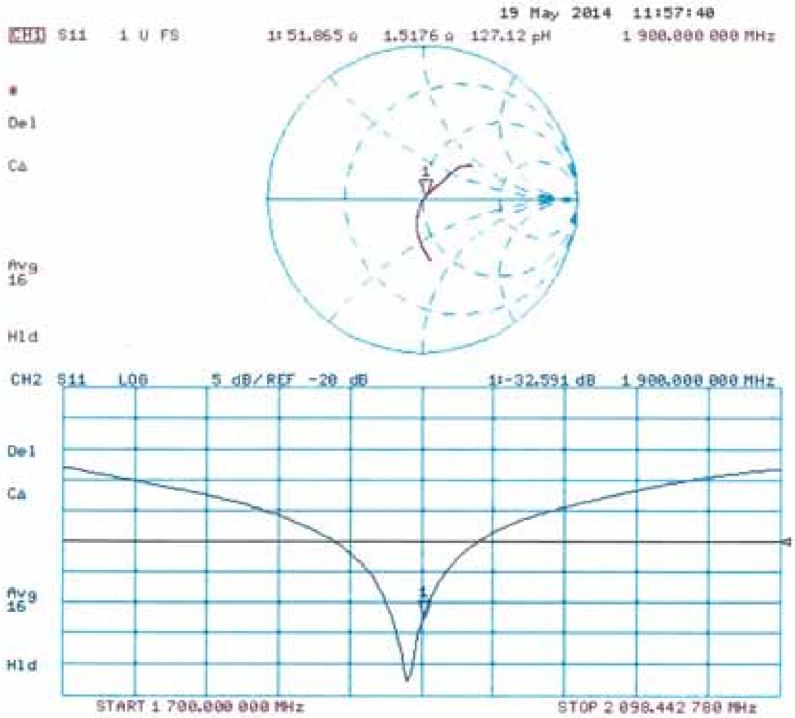
- Probe: ES3DV3 - SN3205; ConvF(5.06, 5.06, 5.06); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 98.44 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 18.3 W/kg
SAR(1 g) = 9.99 W/kg; SAR(10 g) = 5.24 W/kg
Maximum value of SAR (measured) = 12.6 W/kg



0 dB = 12.6 W/kg = 11.00 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 16.05.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d033

Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; σ = 1.5 S/m; ε_r = 52.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

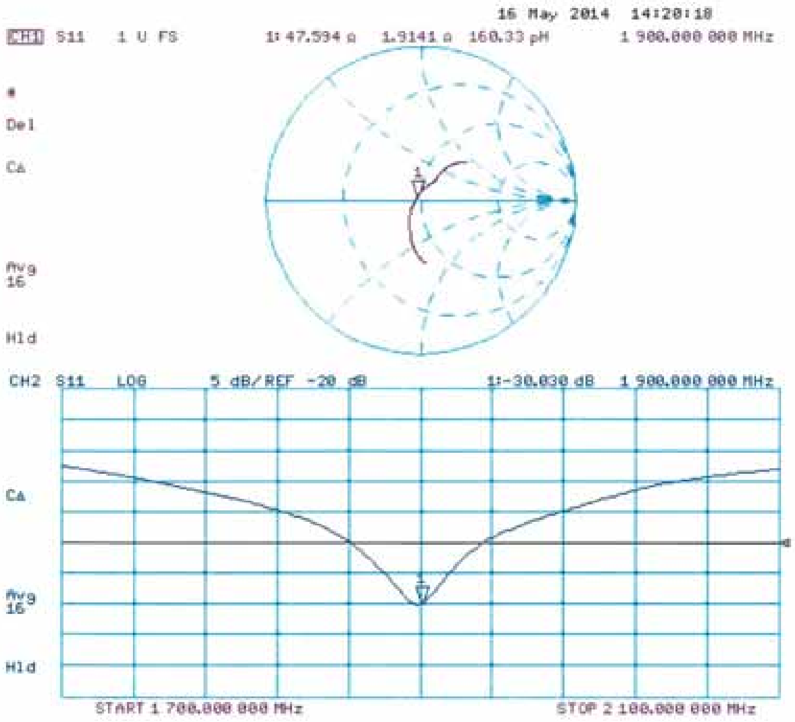
DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.76, 4.76, 4.76); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 95.47 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 17.5 W/kg
SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.32 W/kg
Maximum value of SAR (measured) = 12.6 W/kg

0 dB = 12.6 W/kg = 11.00 dBW/kg

Impedance Measurement Plot for Body TSL



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

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Accreditation No.: SCS 108

기술책임자

2014. 6. 2

Client SGS (Dymstec)

Certificate No: D2450V2-734_May14

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 734
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	May 20, 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
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	30-Apr-14 (No. DAE4-601_Apr14)	Apr-15

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

Issued: May 21, 2014

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 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 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	V52.8.8
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 ± 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 ± 0.2) °C	38.5 ± 6 %	1.83 mho/m ± 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	**52.2 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.11 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.3 W/kg ± 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 ± 0.2) °C	50.8 ± 6 %	2.03 mho/m ± 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	12.8 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**49.8 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.90 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**23.2 W/kg ± 16.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.3 Ω + 4.2 jΩ
Return Loss	- 25.7 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.1 Ω + 5.2 jΩ
Return Loss	- 25.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.152 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	May 07, 2003

DASY5 Validation Report for Head TSL

Date: 20.05.2014

Test Laboratory: SPEAG, Zurich, Switzerland

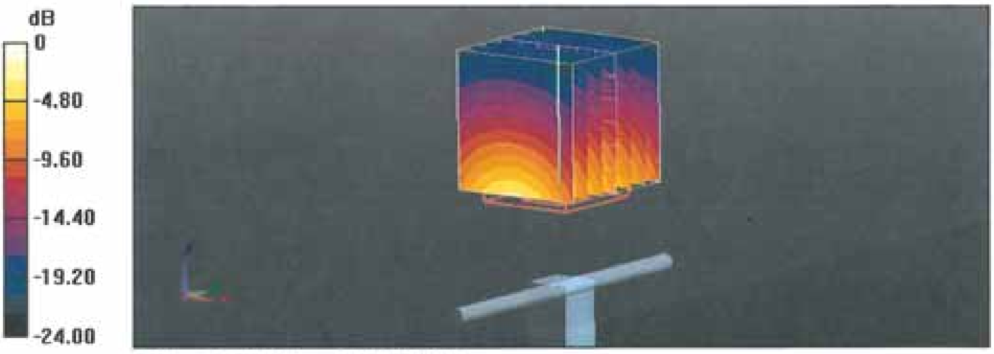
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 734

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.83 S/m; ε_r = 38.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

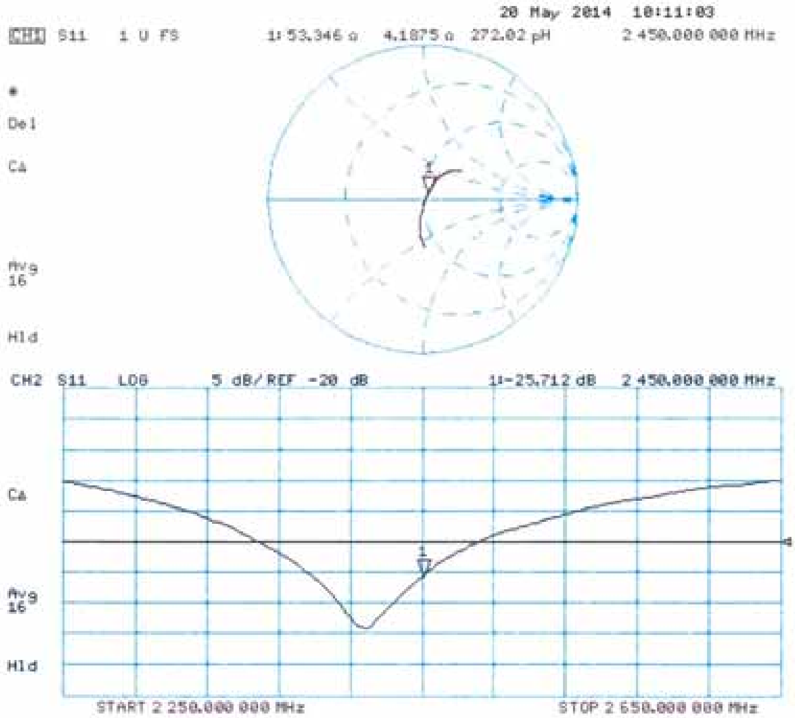
- Probe: ES3DV3 - SN3205; ConvF(4.53, 4.53, 4.53); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 101.3 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 27.4 W/kg
SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.11 W/kg
Maximum value of SAR (measured) = 17.4 W/kg



0 dB = 17.4 W/kg = 12.41 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 20.05.2014

Test Laboratory: SPEAG, Zurich, Switzerland

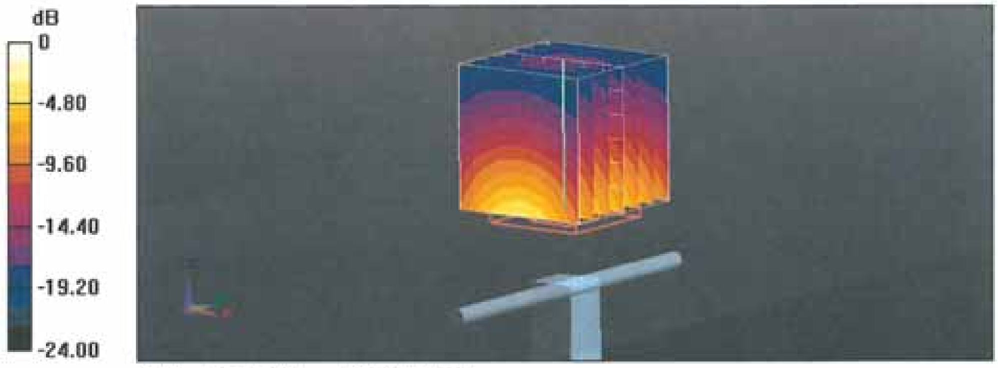
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 734

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.03 S/m; ε_r = 50.8; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.35, 4.35, 4.35); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

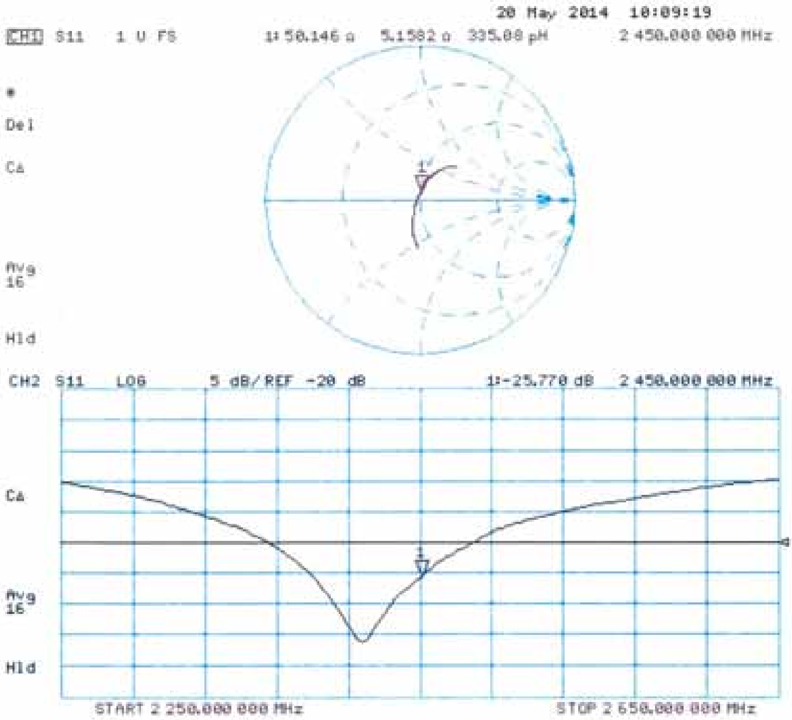
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 94.69 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 27.0 W/kg
SAR(1 g) = 12.8 W/kg; SAR(10 g) = 5.9 W/kg
Maximum value of SAR (measured) = 17.1 W/kg



0 dB = 17.1 W/kg = 12.33 dBW/kg

Certificate No: D2450V2-734_May14 Page 7 of 8

Impedance Measurement Plot for Body TSL



-THE END-