FCC SAR TEST REPORT

Test File No : F690501/RF-SAR002264

Equipment Under Test	SAMSUNG NOTEBOOK
Model No.	NFA455
Host PC Name	NP500R5H
Applicant	Samsung Electronics Co., Ltd.
Address of Applicant	129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, Korea 443-742
FCC ID	A3LNFA455
Device Category	Laptop Device
Exposure Category	General Population/Uncontrolled Exposure
Standards	FCC 47 CFR Part 2 (2.1093) IEEE 1528, 2003 ANSI/IEEE C95.1, C95.3
Date of Test(s)	2015-03-06~ 2015-04-03
Date of Issue	2015-04-06

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

Remarks:

Report prepared by /
Changhyun Song
Test Engineer

Approved by /
Jongwon Ma
Technical Manager

Revision history

Revision	Date of issue	Revisions	Revised By
-	April 06, 2015	Initial issue	-

Contents

1 Testing Laboratory 4
2 Details of Manufacturer 4
3 Description of EUT(s) 4
4 The Highest Reported SAR Values 4
5 Test Methodology 5
6 Test Environment 5
7 Specific Absorption Rate (SAR) 6
7.1 Introduction 6
7.2 SAR Definition 6
7.3 Test Standards and Limits 6
8 The SAR Measurement System 8
9 System Components 9
9.1 Probe 9
9.2 ELI Phantom 9
9.3 Device Holder 10
10 SAR Measurement Procedures 11
10.1 Normal SAR Measurement Procedure 11
11 SAR System Verification 13
12 Tissue Simulant Fluid for the Frequency Band 14
13 Test System Validation 16
14 Instruments List 17
15 FCC Power Measurement Procedures 18
16 Measured and Reported SAR 18
17 Maximum Output Power Specifications 18
18 RF Conducted Power 20
18.1 SAR Test Configuration 24
18.2 SAR Test Exclusions Applied 25
19 SAR Data Summary 26
20 SAR Measurement Variability 28
20.1 Measurement Variability 28
20.2 Measurement Uncertainty 28
21 Simultaneous Multi-band Transmission Evaluation 29
21.1 Introduction 29
21.2 Body SAR Simultaneous Transmission Analysis 29
21.3 The Simultaneous Transmission possibilities are listed as below 29
29
22. Appendixes List 30
Appendixes A.1 31
Appendixes A.2 33
Appendixes A.3 34
Appendixes A.4 35
Appendixes A.5 36
Appendixes A.6 37
Appendixes A.7 38
Appendixes A.8 40
Appendixes A.9 42
Appendixes A.10 46
Appendixes A.11 47
Appendixes B.1 48
Appendixes C.1 50
Appendixes C.2 61
Appendixes C.3 66
END 89

1 Testing Laboratory

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

2 Details of Manufacturer

Applicant	Samsung Electronics Co., Ltd.
Address	129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, Korea 443-742
Contact Person	Seo, Beom Hee
E-Mile	Ally.seo@samsung.com
Phone No.	+82+31-8062-4313

3 Description of EUT(s)

EUT Type	SAMSUNG NOTEBOOK
Model No.	NFA455
Host PC Name	NP500R5H
Serial Number	0GMY91HG100086K
Mode of Operation	WLAN, Bluetooth
Duty Cycle	1 (WLAN)
Body worn Accessory	None
Tx Frequency Range	2412 ㎒ ~ 2462 ㎒ (WLAN_11b/g/n) 5180 ㎒ ~ 5240 ㎒, 5260 ㎒ ~ 5320 ㎒ (WLAN_11a/n/ac) 5500 ㎒ ~ 5700 ㎒, 5745 ㎒ ~ 5825 ㎒ (WLAN_11a/n/ac) 2402 ㎒ ~ 2480 ㎒ (Bluetooth)

Antenna Information

Port	Main	Aux
Manufacturer	Wistron Neweb Corporation	Wistron Neweb Corporation
Type	PIFA	PIFA

Frequency	Main Antenna Gain (dBi)	Aux Antenna Gain (dBi)
2.40 GHz	0.69	1.10
5.150 GHz ~ 5.350 GHz	1.85	-
5.470 GHz ~ 5.725 GHz	2.86	-
5.725 GHz ~ 5.850 GHz	0.99	-

4 The Highest Reported SAR Values

Equipment Class	Band	Highest Reported SAR 1g (W/kg)
DTS	2.4 ㎓ WLAN	0.729
UNII	5.8 ㎓ WLAN	0.388
NII	5.2 ㎓ WLAN	0.337
	5.3 ㎓ WLAN	0.392
	5.6 ㎓ WLAN	0.790
DSS	Bluetooth	0.058
Simultaneous SAR per KDB 690783 D01v01r03		0.859

5 Test Methodology

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

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

In additions;

☒	**KDB 865664 D01v01r03**	**SAR Measurement Requirements for 100 MHz to 6 GHz**
☒	**KDB 447498 D01v05r02**	**Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies**
☐	KDB 447498 D02v02	SAR Measurement Procedures for USB Dongle Transmitters
☒	**KDB 248227 D01v01r02**	**SAR Measurement Procedures for 802.11a,b,g Transmitters**
☐	KDB 615223 D01v01	802.16e/WiMax SAR Measurement Guidance
☒	**KDB 616217 D04v01r01**	**SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers**
☐	KDB 643646 D01v01r01	SAR Test Reduction Considerations for Occupational PTT Radios
☐	KDB 648474 D03v01r02	Evaluation and Approval Considerations for Handsets with Specific Wireless Charging Battery Covers
☐	KDB 648474 D04v01r02	SAR Evaluation Considerations for Wireless Handsets
☐	KDB 680106 D01v02	RF Exposure Considerations for Low Power Consumer Wireless Power Transfer Applications
☐	KDB 941225 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. 3-1. This SAR Measurement System uses a Computer-controlled 3-D stepper motor system (SPEAG DASY 4 professional system). The model 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 DASY 4 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.

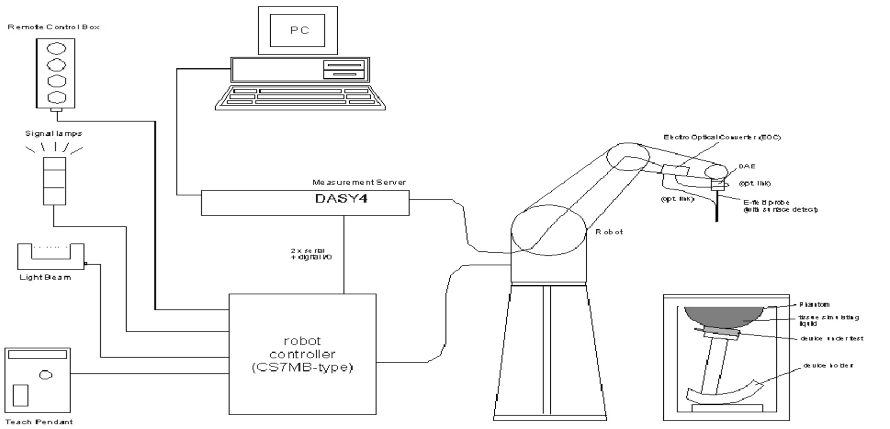


Fig 3-1. The microwave circuit arrangement used for SAR system Validation

- 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
- DASY 4 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The ELI phantom enabling testing body worn usage.
- The device holder for handheld mobile phones.
- 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%

Construction : Symmetrical design with triangular core.
Built-in shielding against static charges.
PEEK enclosure material (resistant to organic solvents, e.g., DGBE)

NOTE:

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

9.2 ELI Phantom

ELI Phantom

Construction : Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 ㎒ to 6 ㎓. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.

ELI V5.0 has the same shell geometry and is manufactured from the same material as ELI4, but has reinforced top structure

Shell Thickness : 2.0 mm ± 0.2 mm

Dimensions : Major axis: 600 ㎜
Minor axis: 400 ㎜

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

Construction: : Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (a.q.. laptops, Cameras, etc.). It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioned.

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 ㎜. 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 SAR System Verification

The microwave circuit arrangement for system verification is sketched in Fig. 1. The daily system accuracy verification occurs within the flat section of the ELI 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 2450 ㎒ and 5200 ㎒, 5300 ㎒, 5600 ㎒, 5800 ㎒. 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.

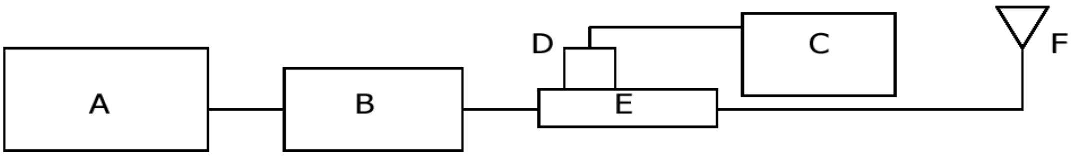


Fig 1. The microwave circuit arrangement used for SAR system verification

A. Agilent Model E8247C Signal Generator
B. EMPOWER Model 2001-BBS3Q7ECK Amplifier
EMPOWER Model 2092-BBS5K8CAJ 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	Target SAR 1 g from Calibration Certificate (1 W)	Measured SAR 1 g (0.1 W)	Normalized SAR 1 g (1 W)	Deviation (%)	Date	Liquid Temp. (°C)
D2450V2 S/N: 734	3791	2450 ㎒ Body	49.8 W/kg	5.06	50.6	**1.64**	2015-03-06	22.1
D2450V2 S/N: 734	3791	2450 ㎒ Body	49.8 W/kg	5.17	51.7	**3.82**	2015-04-03	22.3
D5 ㎓ V2 S/N: 1130	3791	5200 ㎒ Body	76.1 W/kg	7.99	79.9	**4.99**	2015-03-09	22.6
D5 ㎓ V2 S/N: 1130	3791	5300 ㎒ Body	78.4 W/kg	8.11	81.1	**3.44**	2015-03-09	22.6
D5 ㎓ V2 S/N: 1130	3791	5600 ㎒ Body	83.0 W/kg	8.84	88.4	**6.51**	2015-03-10	21.9
D5 ㎓ V2 S/N: 1130	3791	5800 ㎒ Body	77.6 W/kg	7.78	77.8	**0.26**	2015-03-10	21.9

Table1. Results system verification

12. 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(℃)
2 450	Body	Measured, 2015-03-06	53.2	1.92	22.1
		Target Tissue	*52.7*	*1.95*	
		Deviation (%)	**0.95**	**-2.05**	
2 412		Measured, 2015-03-06	53.4	1.87	
		Deviation (%)	**1.33**	**-4.10**	
2 462		Measured, 2015-03-06	53.2	1.94	
		Deviation (%)	**0.95**	**-0.51**	
2 450	Body	Measured, 2015-04-03	54.8	1.98	22.3
		Target Tissue	*52.7*	*1.95*	
		Deviation (%)	**3.98**	**1.54**	
2 402		Measured, 2015-04-03	55.0	2.00	
		Deviation (%)	**4.36**	**2.56**	
2 480		Measured, 2015-04-03	54.6	2.00	
		Deviation (%)	**3.61**	**2.56**	
5 200	Body	Measured, 2015-03-09	48.3	5.09	22.6
		Target Tissue	*49.0*	*5.30*	
		Deviation (%)	**-1.43**	**-3.96**	
5 180		Measured, 2015-03-09	48.4	5.07	
		Deviation (%)	**-1.22**	**-4.34**	
5 240		Measured, 2015-03-09	48.2	5.16	
		Deviation (%)	**-1.63**	**-2.64**	
5 300	Body	Measured, 2015-03-09	48.1	5.24	22.6
		Target Tissue	*48.9*	*5.42*	
		Deviation (%)	**-1.64**	**-3.32**	
5 260		Measured, 2015-03-09	48.2	5.19	
		Deviation (%)	**-1.43**	**-4.24**	
5 320		Measured, 2015-03-09	48.0	5.27	
		Deviation (%)	**-1.84**	**-2.77**	
5 600	Body	Measured, 2015-03-10	50.1	5.76	21.9
		Target Tissue	*48.5*	*5.77*	
		Deviation (%)	**2.45**	**-0.17**	
5 520		Measured, 2015-03-10	49.6	5.56	
		Deviation (%)	**1.43**	**-3.64**	
5 690		Measured, 2015-03-10	50.3	5.93	
		Deviation (%)	**3.71**	**2.77**	
5 800	Body	Measured, 2015-03-10	50.4	6.13	21.9
		Target Tissue	*48.2*	*6.00*	
		Deviation (%)	**4.56**	**2.17**	
5 745		Measured, 2015-03-10	50.4	6.06	
		Deviation (%)	**4.56**	**1.00**	
5 805		Measured, 2015-03-10	50.4	6.14	
		Deviation (%)	**4.56**	**2.33**	

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

Salt: 99 $^{+}$% Pure Sodium Chloride   Sugar: 98 $^{+}$% Pure Sucrose

Water: De-ionized, 16 MΩ^{+} resistivity   HEC: Hydroxyethyl Cellulose

DGBE: 99 $^{+}$% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]

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

Simulating Liquids for 5 ㎓, Manufactured by SPEAG

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

13. 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
2450	2014-06-24	3791	2450	Body	51.57	1.89	PASS	PASS	PASS	OFDM	N/A	PASS
5200	2014-06-23	3791	5200	Body	49.46	5.13	PASS	PASS	PASS	OFDM	N/A	PASS
5300	2014-06-23	3791	5300	Body	48.21	5.24	PASS	PASS	PASS	OFDM	N/A	PASS
5600	2014-06-24	3791	5600	Body	46.34	5.90	PASS	PASS	PASS	OFDM	N/A	PASS
5800	2014-06-24	3791	5800	Body	46.01	6.21	PASS	PASS	PASS	OFDM	N/A	PASS

< SAR System Validation Summary>

14 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	ELI Phantom	TP-1169	N/A	N/A	N/A
Verification Dipole	D2450V2	734	2014-05-20	Biennial	2016-05-20
Verification Dipole	D5GHzV2	1130	2014-05-22	Biennial	2016-05-22
DAE	DAE3	567	2015-01-22	Annual	2016-01-22
E-Field Probe	EX3DV4	3791	2014-05-21	Annual	2015-05-21
Dielectric Assessment Kit	DAK-3.5	1107	2015-01-27	Annual	2016-01-27
Network Analyzer	E5071C	MY46111535	2014-07-04	Annual	2015-07-04
Power Meter	E4419B	GB43311715	2014-06-25	Annual	2015-06-25
Signal Generator	E8247C	MY43321024	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
Power Amplifier	2092-BBS5K8CAJ	1010	2014-06-27	Annual	2015-06-27
Directional Bridge	86205A	MY31402302	2014-07-03	Annual	2015-07-03
LP Filter	LA-30N	N/A	2014-07-01	Annual	2015-07-01
LP Filter	LA-60N	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	2014-03-28	Annual	2015-03-24
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

15 FCC Power Measurement Procedures

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.

16 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.

17 Maximum Output Power Specifications

This device operates using the following maximum output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498 D01v05r02.

Average power for Production (dB m)			
Mode	**Channel**	**Normal/Maximum**	**Main**
802.11b	All channel	Maximum	**18.5**
		Normal	17.0
802.11g	All channel	Maximum	**18.0**
		Normal	16.5
802.11n HT20	All channel	Maximum	**18.0**
		Normal	16.5
802.11n HT40	All channel	Maximum	**18.0**
		Normal	16.5
Tune-up Tolerance: -1.5 dB / + 1.5 dB			

Average power for Production (dB m)			
Mode	**Channel**	**Normal/Maximum**	**Main**
802.11a	All Channel	Maximum	**15.0**
		Normal	13.0
802.11n HT20	All Channel	Maximum	**15.0**
		Normal	13.0
802.11n HT40	All Channel	Maximum	**15.0**
		Normal	13.0
802.11ac VHT20	All Channel	Maximum	**15.0**
		Normal	13.0
802.11ac VHT40	All Channel	Maximum	**15.0**
		Normal	13.0
802.11ac VHT80	All Channel	Maximum	**15.0**
		Normal	13.0
Tune-up Tolerance: -2.0 dB / + 2.0 dB			

Average power for Production (dBm)					
Mode	**Normal/Maximum**	**GFSK**	**PI/4DQPSK**	**8DPSK**	**LE**
Bluetooth	Maximum	**10.5**	**7.0**	**7.0**	**3.5**
	Normal	8.5	5.0	5.0	1.5
Tune-up Tolerance: -2.0 dB / + 2.0 dB					

18 RF Conducted Power Measurement

WLAN 2.4 ㎓

Mode	Freq. (㎒)	Ch. #	Rate	Measured Power [dB m]
				Main
802.11b	2412	1	1	18.39
	2437	6	1	17.99
	2462	11	1	18.09
802.11g	2412	1	6	17.40
	2437	6	6	17.91
	2462	11	6	17.09
802.11n HT20	2412	1	MCS0	17.08
	2437	6	MCS0	17.64
	2462	11	MCS0	17.80
802.11n HT40	2422	3	MCS0	17.71
	2437	6	MCS0	17.13
	2452	9	MCS0	17.23

WLAN 5.2 ㎓

Mode	Freq. (㎒)	Ch. #	Rate	Measured Power [dB m]
				Main
802.11a	5180	36	6	14.92
	5200	40	6	14.90
	5220	44	6	14.65
	5240	48	6	14.83
802.11n HT20	5180	36	MCS0	14.75
	5200	40	MCS0	14.67
	5220	44	MCS0	14.55
	5240	48	MCS0	14.49
802.11n HT40	5190	38	MCS0	14.93
	5230	46	MCS0	14.87
802.11ac VTH20	5180	36	MCS0	14.74
	5200	40	MCS0	14.68
	5220	44	MCS0	14.61
	5240	48	MCS0	14.60
802.11ac VTH40	5190	38	MCS0	14.84
	5230	46	MCS0	14.73
802.11ac VTH80	5210	42	MCS0	14.65

WLAN 5.3 ㎓

Mode	Freq. (㎒)	Ch. #	Rate	Measured Power [㏈ m]
				Main
802.11a	5260	52	6	14.83
	5280	56	6	14.80
	5300	60	6	14.75
	5320	64	6	14.87
802.11n HT20	5260	52	MCS0	14.22
	5280	56	MCS0	14.74
	5300	60	MCS0	14.52
	5320	64	MCS0	14.59
802.11n HT40	5270	54	MCS0	14.62
	5310	62	MCS0	14.27
802.11ac VTH20	5260	52	MCS0	14.30
	5280	56	MCS0	14.82
	5300	60	MCS0	14.59
	5320	64	MCS0	14.62
802.11ac VTH40	5270	54	MCS0	14.64
	5310	62	MCS0	14.25
802.11ac VTH80	5290	58	MCS0	14.76

WLAN 5.6 ㎓

Mode	Freq. (㎒)	Ch. #	Rate	Measured Power [㏈ m] Main
802.11a	5500	100	6	14.47
	5520	104	6	14.65
	5540	108	6	14.51
	5560	112	6	14.64
	5580	116	6	14.71
	5660	132	6	14.52
	5680	136	6	14.80
	5700	140	6	14.74
802.11n HT20	5500	100	MCS0	14.27
	5520	104	MCS0	14.19
	5540	108	MCS0	14.38
	5560	112	MCS0	14.49
	5580	116	MCS0	14.65
	5680	136	MCS0	14.89
	5700	140	MCS0	14.76
802.11n HT40	5510	102	MCS0	14.70
	5550	110	MCS0	14.48
	5670	134	MCS0	14.28
802.11ac VTH20	5500	100	MCS0	14.67
	5520	104	MCS0	14.88
	5540	108	MCS0	14.83
	5560	112	MCS0	14.77
	5580	116	MCS0	14.92
	5680	136	MCS0	14.83
	5700	140	MCS0	14.82
802.11ac VTH40	5510	102	MCS0	14.95
	5550	110	MCS0	14.73
	5670	134	MCS0	14.78
	5710	142	MCS0	14.32
802.11ac VTH80	5530	106	MCS0	14.60
	5690	138	MCS0	14.22

WLAN 5.8 ㎓

Mode	Freq. (㎒)	Ch. #	Rate	Measured Power [dB m]
				Main
802.11a	5745	149	6	14.92
	5765	153	6	14.90
	5785	157	6	14.58
	5805	161	6	14.55
	5825	165	6	14.63
802.11n HT20	5745	149	MCS0	14.53
	5765	153	MCS0	14.85
	5785	157	MCS0	14.22
	5805	161	MCS0	14.43
	5825	165	MCS0	14.32
802.11n HT40	5755	151	MCS0	14.20
	5795	159	MCS0	14.83
802.11ac VTH20	5745	149	MCS0	14.53
	5765	153	MCS0	14.70
	5785	157	MCS0	14.37
	5805	161	MCS0	14.40
	5825	165	MCS0	14.35
802.11ac VTH40	5755	151	MCS0	14.21
	5795	159	MCS0	14.81
802.11ac VTH80	5775	155	MCS0	14.07

Bluetooth

Channel	Frequency (㎒)	GFSK (dB m)	4DPSK (dB m)	8DPSK (dB m)	LE (dB m)
Low	2402	9.75	6.59	6.56	-0.46
Middle	2441	9.69	6.55	6.53	0.06
High	2480	9.50	6.33	6.36	0.46

18.1 SAR Test Configuration

IEEE 802.11 Transmitters

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

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

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

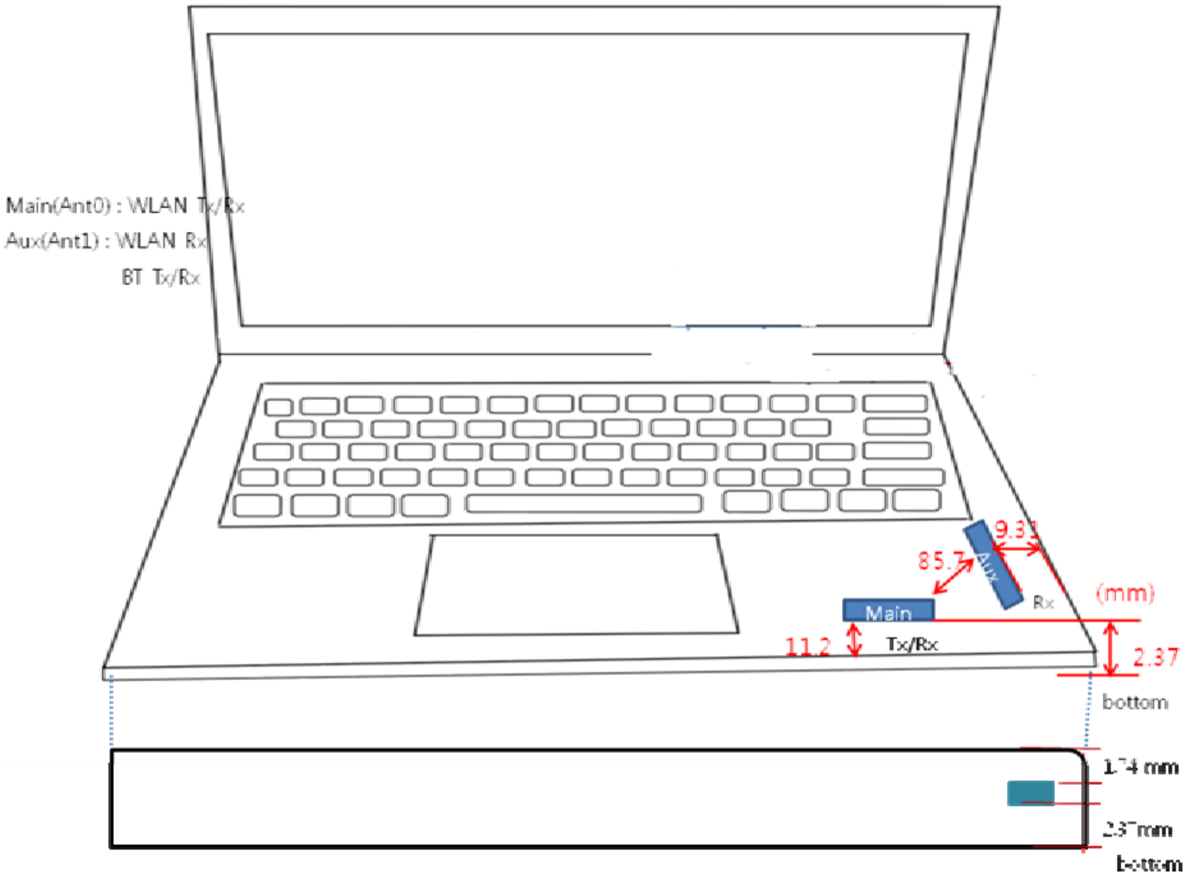
18.2 SAR Test Exclusions Applied

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

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

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

<u>Bluetooth LE SAR was not required</u>: [3.5/5 * √2.480] = 1.10＜3.0



<The Distance information of Antenna to Edges of EUT>

19 SAR Data Summary

WLAN 2.4 GHz Body SAR

Test Mode	Antenna (Chain)	EUT Position	Traffic Channel		Distance (㎜)	Power(dBm)		1-g SAR (W/kg)		1 g SAR Limits (W/kg)
			Frequency (㎒)	Channel		Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
802.11b	Main	Base	2412	1	0	18.39	18.50	0.711	**0.729**	1.6

WLAN 5.2 GHz Body SAR

Test Mode	Antenna (Chain)	EUT Position	Traffic Channel		Distance (㎜)	Power(dBm)		1-g SAR (W/kg)		1 g SAR Limits (W/kg)
			Frequency (㎒)	Channel		Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
802.11a	Main	Base	5180	36	0	14.92	15.00	0.335	**0.337**	1.6
802.11ac			5210	42	0	14.65	15.00	0.267	0.289	

WLAN 5.3 GHz Body SAR

Test Mode	Antenna (Chain)	EUT Position	Traffic Channel		Distance (㎜)	Power(dBm)		1-g SAR (W/kg)		1 g SAR Limits (W/kg)
			Frequency (㎒)	Channel		Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
802.11a	Main	Base	5320	64	0	14.87	15.00	0.387	**0.392**	1.6
802.11ac		Base	5290	58	0	14.76	15.00	0.315	0.333	

WLAN 5.6 GHz Body SAR

Test Mode	Antenna (Chain)	EUT Position	Traffic Channel		Distance (㎜)	Power(dBm)		1-g SAR (W/kg)		1 g SAR Limits (W/kg)
			Frequency (㎒)	Channel		Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
802.11a	Main	Base	5520	104	0	14.65	15.00	0.480	0.520	1.6
		Base	5580	116	0	14.71	15.00	0.586	0.626	
		Base	5680	136	0	14.80	15.00	0.754	**0.790**	
802.11ac		Base	5690	138	0	14.41	15.00	0.610	0.699	

WLAN 5.8 GHz Body SAR

Test Mode	Antenna (Chain)	EUT Position	Traffic Channel		Distance (㎜)	Power(dBm)		1-g SAR (W/kg)		1 g SAR Limits (W/kg)
			Frequency (㎒)	Channel		Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
802.11a	Main	Base	5745	149	0	14.92	15.00	0.381	**0.388**	1.6
802.11ac		Base	5775	155	0	14.07	15.00	0.289	0.358	

Bluetooth Body SAR

Test Mode	Antenna (Chain)	EUT Position	Traffic Channel		Distance (㎜)	Power(dBm)		1-g SAR (W/kg)		1 g SAR Limits (W/kg)
			Frequency (㎒)	Channel		Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
Bluetooth	Aux	Base	2402	0	0	9.75	10.5	0.058	**0.069**	1.6

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 D01v01r03 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.

WLAN Notes:

1. For 2.4 GHz, justification for reduced test configuration for WIFI channels per KDB Publication 248227 and April 2010 FCC/TCB Meeting Notes: Highest average RF output power channel for the lowest data rate were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11g/n) were not investigated since the average output powers were not greater than 0.25 ㏈ than that of the corresponding channel in the lowest data rate IEEE 802.11b modes.
2. For 5 GHz, justification for reduced test configuration for WIFI channels per KDB Publication 248227 and April 2010 FCC/TCB Meeting Notes: Highest average RF output power channel for the lowest data rate were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11n HT20 MHz and HT40, VHT20, VHT40) were not investigated since the average output powers were not greater than 0.25 ㏈ than that of the corresponding channel in the lowest data rate IEEE 802.11a modes
3. For 802.11ac SAR evaluation for each frequency band, 802.11ac VHT80 will verified at the worst case found in 802.11a SAR testing.
4. Since the maximum extrapolated peak SAR of the zoom scan for the maximum output channel was ≤ 1.6 W/kg and the reported 1g averaged SAR was < 0.8 W/kg, SAR testing on other default channels was not required.
5. According to KDB248227 D01v01, when the maximum average output channel in each frequency band is not include in the “default test channels”, the maximum average output power channel should be tested instead of an adjacent “default test channels”.
6. According to KDB447498 D01v05r02 the 1-g SAR for the highest output channel is less than 0.4 W/kg, where the transmission band corresponding to all channels is ≥ 200 ㎒, testing for the other channels is not required.
7. WLAN transmission was verified using a spectrum analyzer.

20 SAR Measurement Variability

20.1 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

20.2 Measurement Uncertainty

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

21 Simultaneous Multi-band Transmission Evaluation

21.1 Introduction

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

21.2 The Simultaneous Transmission possibilities are listed as below

No	Capable TX Configuration	Body SAR
1	2.45 GHz Main Ant + Bluetooth Aux	Yes

Note:

- The simultaneous transmission possibilities are listed as below.
- Bluetooth Aux share the same antenna and cannot transmit simultaneously.

21.3 Body SAR Simultaneous Transmission Analysis

Simultaneous TX	configuration	2.4 GHz Main Ant	Bluetooth SAR (W/kg)	∑SAR (W/kg)
Body	Base	0.729	0.069	0.798
Simultaneous TX	configuration	5 GHz Main Ant SAR	Bluetooth SAR (W/kg)	∑SAR (W/kg)
Body	Base	0.790	0.069	0.859

Note:

- 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 2450MHz A.2 Verification Test Plots for 5200 MHz A.3 Verification Test Plots for 5300 MHz A.4 Verification Test Plots for 5600 MHz A.5 Verification Test Plots for 5800 MHz A.6 SAR Test Plots for WLAN 2450 MHz A.7 SAR Test Plots for WLAN 5200 MHz A.8 SAR Test Plots for WLAN 5300 MHz A.9 SAR Test Plots for WLAN 5600 MHz A.10 SAR Test Plots for WLAN 5800 MHz A.11 SAR Test Plots for Bluetooth
Appendix B	B.1 Uncertainty Analysis
Appendix C	C.1 Calibration certificate for Probe C.2 Calibration certificate for DAE C.3 Calibration certificate for Dipole

Appendix A.1 Verification Test Plots for 2450 MHz

Date: 2015-03-06

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

Input Power : 100 mW

Ambient Temp : 22.9 ℃ Tissue Temp : 22.1 ℃

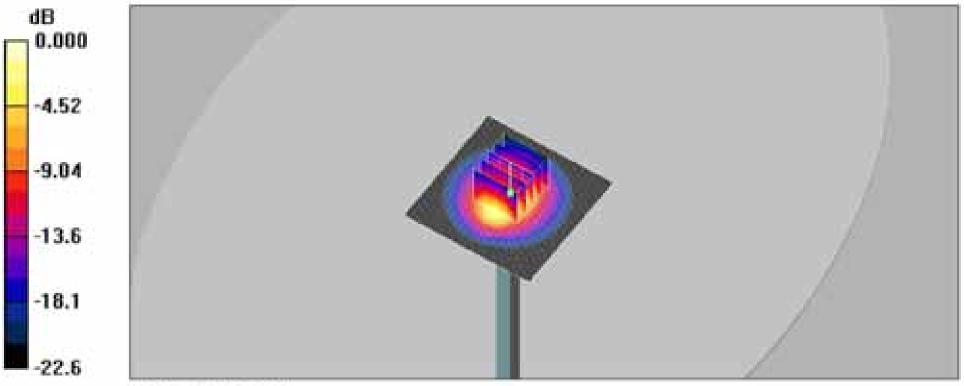
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:734
Program Name: Verification

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.92 mho/m; ε_r = 53.2; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(6.65, 6.65, 6.65); Calibrated: 2014-05-21
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

2450MHz Verification/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 7.89 mW/g

2450MHz Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 64.1 V/m; Power Drift = -0.115 dB
Peak SAR (extrapolated) = 10.2 W/kg
SAR(1 g) = 5.06 mW/g; SAR(10 g) = 2.38 mW/g
Maximum value of SAR (measured) = 7.42 mW/g



0 dB = 7.42mW/g

Appendix A.1 Verification Test Plots for 2450 MHz

Date: 2015-04-03

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

Input Power : 100 mW

Ambient Temp : 23.8 ℃ Tissue Temp : 22.3 ℃

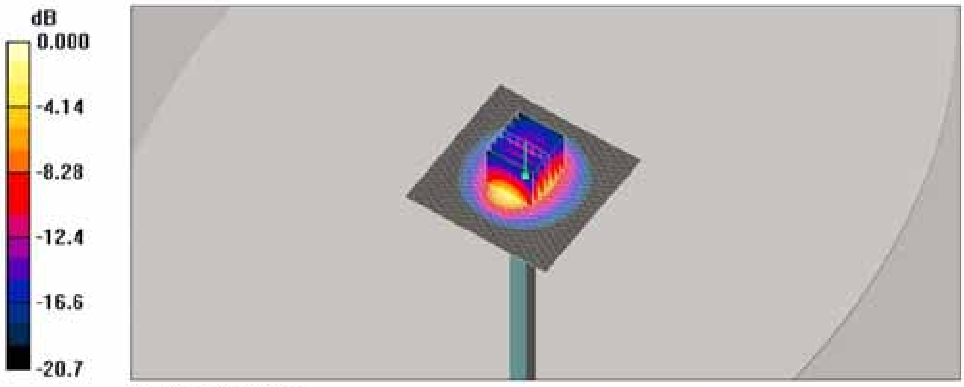
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:734
Program Name: Verification

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.98 mho/m; ε_r = 54.8; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(6.65, 6.65, 6.65); Calibrated: 2014-05-21
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- 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) = 7.97 mW/g

2450MHz Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 63.2 V/m; Power Drift = -0.005 dB
Peak SAR (extrapolated) = 10.4 W/kg
SAR(1 g) = 5.17 mW/g; SAR(10 g) = 2.43 mW/g
Maximum value of SAR (measured) = 7.81 mW/g



0 dB = 7.81mW/g

Appendix A.2 Verification Test Plots for 5200 MHz

Date: 2015-03-09

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 5200MHz Verification.da4

Ambient Temp : 23.3 ℃ Tissue Temp : 22.6 ℃

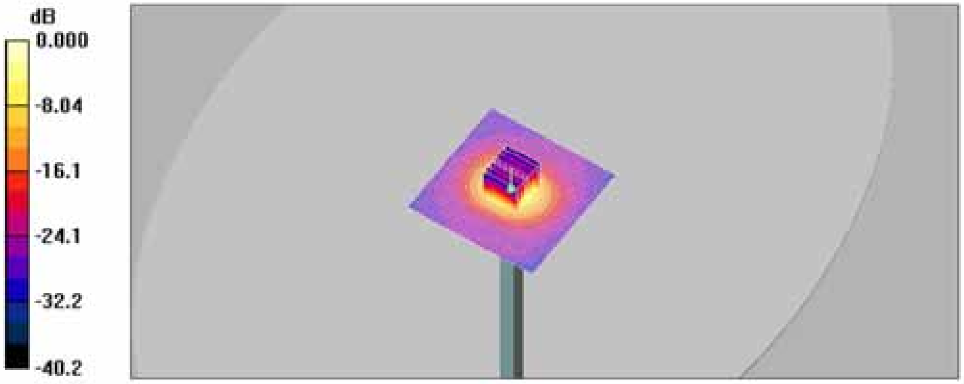
DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1130
Program Name: Verification

Communication System: CW; Frequency: 5200 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5200 MHz; σ = 5.09 mho/m; ε_r = 48.3; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(4.36, 4.36, 4.36); Calibrated: 2014-05-21
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

5.2GHz Verification/Area Scan (91x91x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 16.5 mW/g

5.2GHz Verification/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 60.9 V/m; Power Drift = -0.056 dB
Peak SAR (extrapolated) = 31.6 W/kg
SAR(1 g) = 7.99 mW/g; SAR(10 g) = 2.3 mW/g
Maximum value of SAR (measured) = 16.1 mW/g



0 dB = 16.1mW/g

Appendix A.3 Verification Test Plots for 5300 MHz

Date: 2015-03-09

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 5300MHz Verification.da4

Input Power : 100 mW

Ambient Temp : 23.3 ℃ Tissue Temp : 22.6 ℃

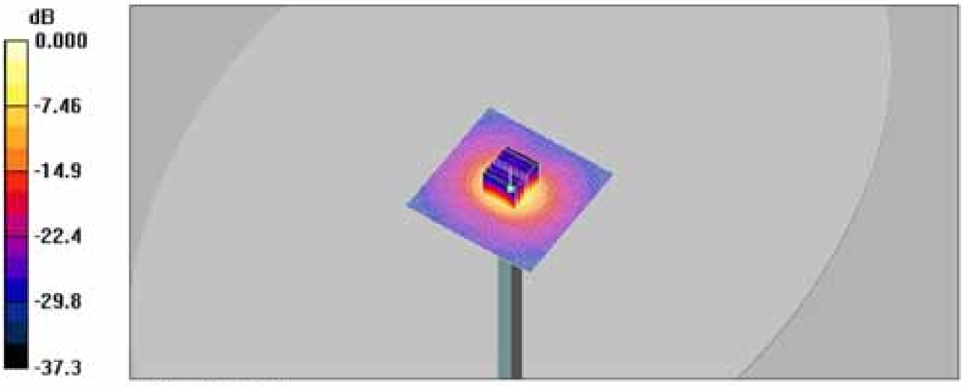
DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1130
Program Name: Verification

Communication System: CW; Frequency: 5300 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5300 MHz; σ = 5.24 mho/m; ε_r = 48.1; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(4.15, 4.15, 4.15); Calibrated: 2014-05-21
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

5.3GHz Verification/Area Scan (91x91x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 16.8 mW/g

5.3GHz Verification/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 61.7 V/m; Power Drift = -0.144 dB
Peak SAR (extrapolated) = 34.4 W/kg
SAR(1 g) = 8.11 mW/g; SAR(10 g) = 2.3 mW/g
Maximum value of SAR (measured) = 17.0 mW/g



0 dB = 17.0mW/g

Appendix A.4 Verification Test Plots for 5600 MHz

Date: 2015-03-10

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 5600MHz Verification.da4

Input Power : 100 mW

Ambient Temp : 22.7 ℃ Tissue Temp : 21.9 ℃

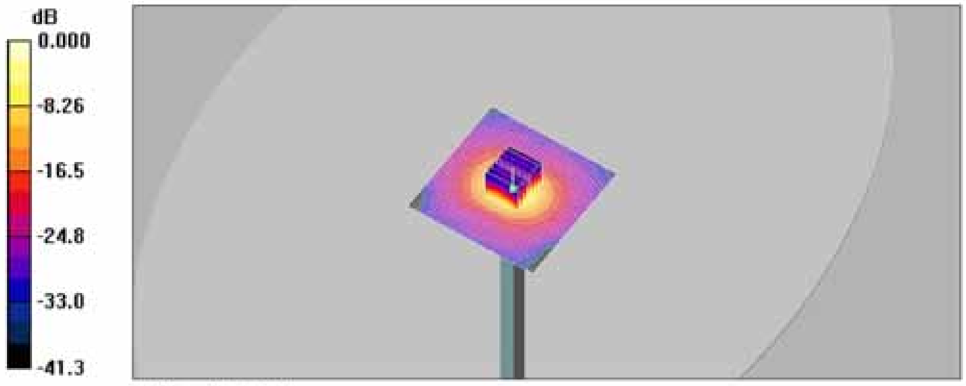
DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1130
Program Name: Verification

Communication System: CW; Frequency: 5600 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5600 MHz; σ = 5.76 mho/m; ε_r = 50.1; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(3.79, 3.79, 3.79); Calibrated: 2014-05-21
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

5.6GHz Verification/Area Scan (91x91x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 18.9 mW/g

5.6GHz Verification/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 62.7 V/m; Power Drift = -0.011 dB
Peak SAR (extrapolated) = 38.8 W/kg
SAR(1 g) = 8.84 mW/g; SAR(10 g) = 2.47 mW/g
Maximum value of SAR (measured) = 18.6 mW/g



0 dB = 18.6mW/g

Appendix A.5 Verification Test Plots for 5800 MHz

Date: 2015-03-10

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 5800MHz Verification.da4

Input Power : 100 mW

Ambient Temp : 22.7 ℃ Tissue Temp : 21.9 ℃

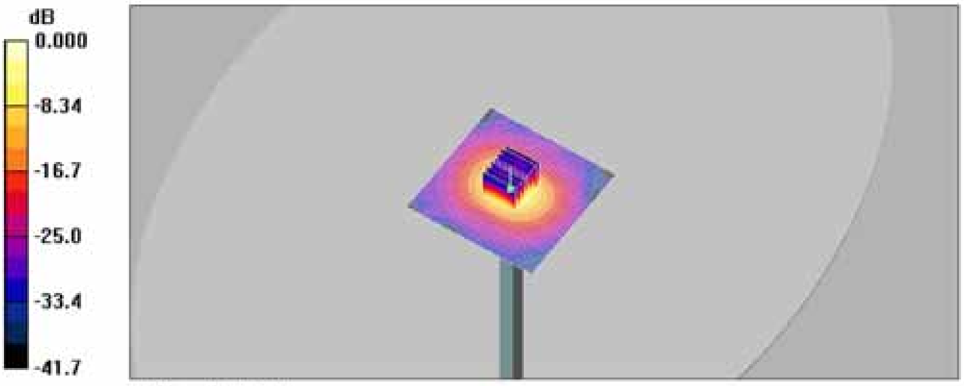
DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1130
Program Name: Verification

Communication System: CW; Frequency: 5800 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5800 MHz; σ = 6.13 mho/m; ε_r = 50.4; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(4.09, 4.09, 4.09); Calibrated: 2014-05-21
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

5.8GHz Verification/Area Scan (91x91x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 16.5 mW/g

5.8GHz Verification/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 56.5 V/m; Power Drift = -0.033 dB
Peak SAR (extrapolated) = 34.3 W/kg
SAR(1 g) = 7.78 mW/g; SAR(10 g) = 2.18 mW/g
Maximum value of SAR (measured) = 16.7 mW/g



0 dB = 16.7mW/g

Appendix A.6 SAR Test Plots for WLAN 2.45GHz

Date: 2015-03-06

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: WLAN_802.11b_1Mbps_Base_CH1.da4

Ambient Temp : 22.9 ℃ Tissue Temp : 22.1 ℃

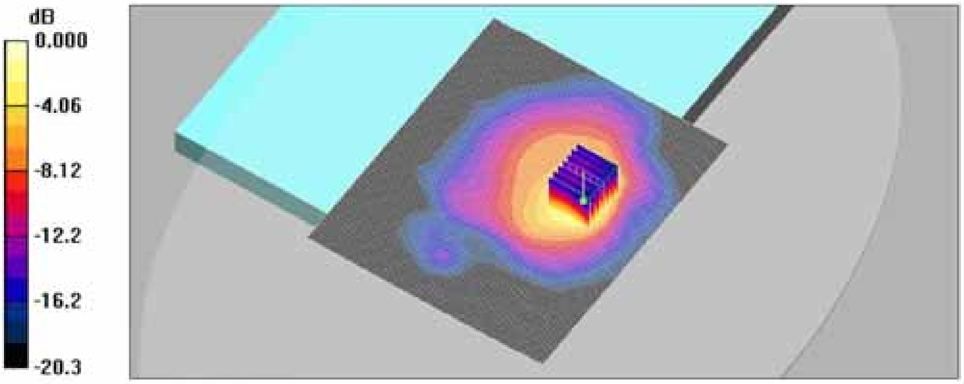
DUT: NP500R5H; Type: Samsung Notebook; Serial: 0GMY91HG100086K
Program Name: Body

Communication System: 2.45GHz; Frequency: 2412 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2412 MHz; σ = 1.87 mho/m; ε_r = 53.4; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(6.65, 6.65, 6.65); Calibrated: 2014-05-21
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_802.11b_1Mbps_Base_CH1/Area Scan (171x201x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.01 mW/g

WLAN_802.11b_1Mbps_Base_CH1/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 9.76 V/m; Power Drift = -0.075 dB
Peak SAR (extrapolated) = 1.34 W/kg
SAR(1 g) = 0.711 mW/g; SAR(10 g) = 0.379 mW/g
Maximum value of SAR (measured) = 1.02 mW/g



0 dB = 1.02mW/g

Appendix A.7 SAR Test Plots for WLAN 5.2GHz

Date: 2015-03-09

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: WLAN_802.11a_6Mbps_Base_CH36.da4

Ambient Temp : 23.3 ℃ Tissue Temp : 22.6 ℃

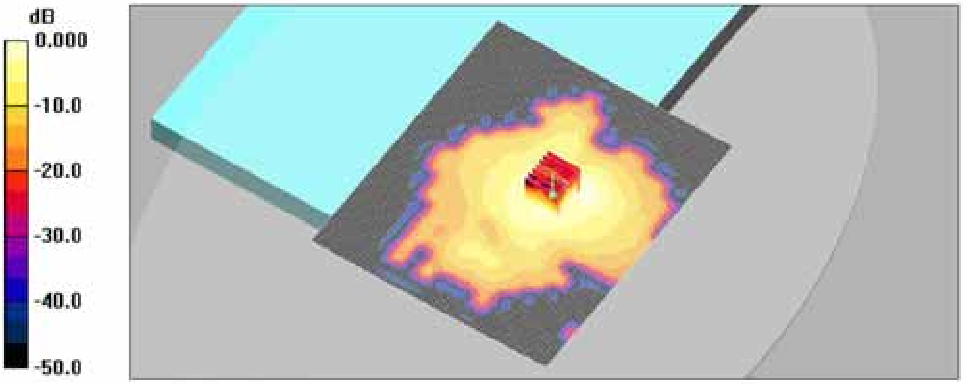
DUT: NP500R5H; Type: Samsung Notebook; Serial: 0GMY91HG100086K
Program Name: Body

Communication System: 5GHz; Frequency: 5180 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5180 MHz; σ = 5.07 mho/m; ε_r = 48.4; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(4.36, 4.36, 4.36); Calibrated: 2014-05-21
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_802.11a_6Mbps_Base_CH36/Area Scan (171x201x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.611 mW/g

WLAN_802.11a_6Mbps_Base_CH36/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 4.29 V/m; Power Drift = 0.096 dB
Peak SAR (extrapolated) = 1.23 W/kg
SAR(1 g) = 0.335 mW/g; SAR(10 g) = 0.129 mW/g
Maximum value of SAR (measured) = 0.607 mW/g



0 dB = 0.607mW/g

Date: 2015-03-09

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: WLAN_802.11ac_VHT80_MCS0_Base_CH42.da4

Ambient Temp : 23.3 ℃ Tissue Temp : 22.6 ℃

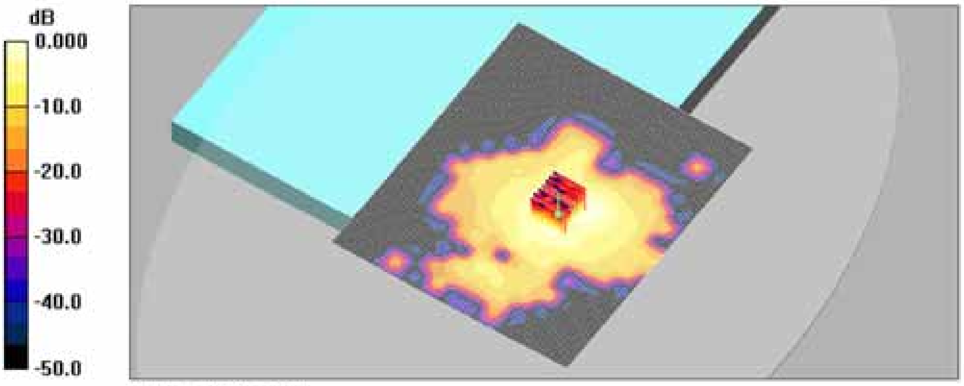
DUT: NP500R5H; Type: Samsung Notebook; Serial: 0GMY91HG100086K
Program Name: Body

Communication System: 5GHz; Frequency: 5210 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5210 MHz; σ = 5.11 mho/m; ε_r = 48.3; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(4.36, 4.36, 4.36); Calibrated: 2014-05-21
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_802.11ac_VHT80_MCS0_Base_CH42/Area Scan (171x201x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.481 mW/g

WLAN_802.11ac_VHT80_MCS0_Base_CH42/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 4.86 V/m; Power Drift = 0.075 dB
Peak SAR (extrapolated) = 0.978 W/kg
SAR(1 g) = 0.267 mW/g; SAR(10 g) = 0.102 mW/g
Maximum value of SAR (measured) = 0.482 mW/g



0 dB = 0.482mW/g

Appendix A.8 SAR Test Plots for WLAN 5.3GHz

Date: 2015-03-09

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: WLAN_802.11a_6Mbps_Base_CH64.da4

Ambient Temp : 23.3 ℃ Tissue Temp : 22.6 ℃

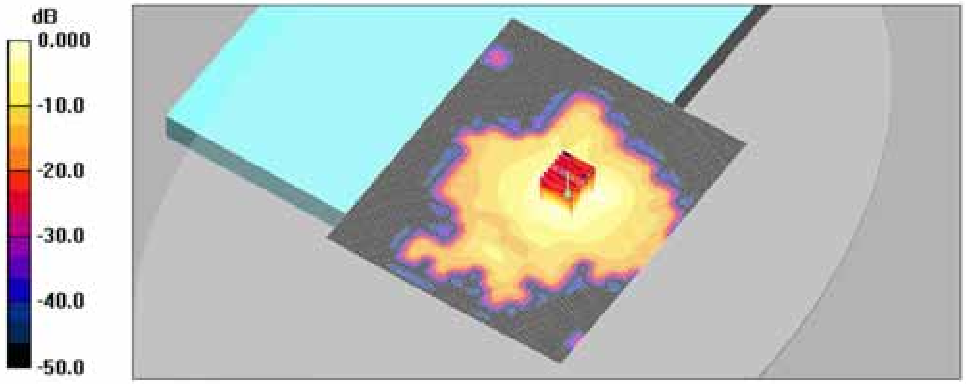
DUT: NP500R5H; Type: Samsung Notebook; Serial: 0GMY91HG100086K
Program Name: Body

Communication System: 5GHz; Frequency: 5320 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5320 MHz; σ = 5.27 mho/m; ε_r = 48; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(4.15, 4.15, 4.15); Calibrated: 2014-05-21
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_802.11a_6Mbps_Base_CH64/Area Scan (171x201x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.710 mW/g

WLAN_802.11a_6Mbps_Base_CH64/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 4.46 V/m; Power Drift = 0.165 dB
Peak SAR (extrapolated) = 1.43 W/kg
SAR(1 g) = 0.387 mW/g; SAR(10 g) = 0.145 mW/g
Maximum value of SAR (measured) = 0.716 mW/g



0 dB = 0.716mW/g

Date: 2015-03-09

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: WLAN_802.11ac_VHT80_MCS0_Base_CH58.da4

Ambient Temp : 23.3 ℃ Tissue Temp : 22.6 ℃

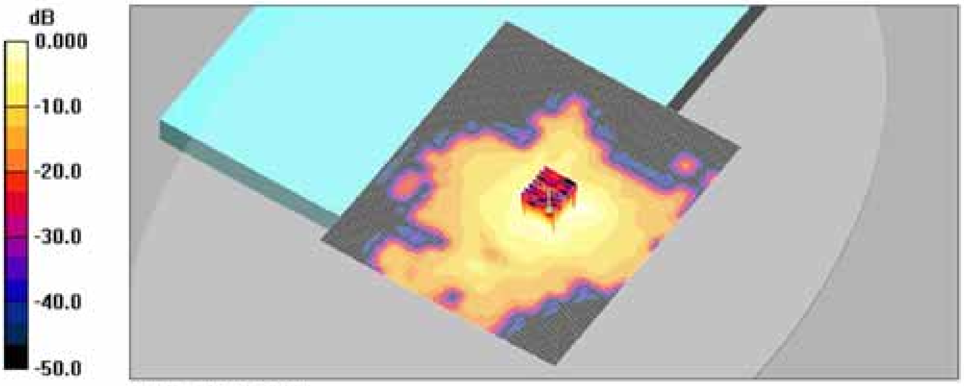
DUT: NP500R5H; Type: Samsung Notebook; Serial: 0GMY91HG100086K
Program Name: Body

Communication System: 5GHz; Frequency: 5290 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5290 MHz; σ = 5.23 mho/m; ε_r = 48.1; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(4.15, 4.15, 4.15); Calibrated: 2014-05-21
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_802.11ac_VHT80_MCS0_Base_CH58/Area Scan (171x201x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.567 mW/g

WLAN_802.11ac_VHT80_MCS0_Base_CH58/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 5.27 V/m; Power Drift = -0.168 dB
Peak SAR (extrapolated) = 1.18 W/kg
SAR(1 g) = 0.315 mW/g; SAR(10 g) = 0.118 mW/g
Maximum value of SAR (measured) = 0.583 mW/g



0 dB = 0.583mW/g

Appendix A.9 SAR Test Plots for WLAN 5.6GHz

Date: 2015-03-10

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: WLAN_802.11a_6Mbps_Base_CH104.da4

Ambient Temp : 22.7 ℃ Tissue Temp : 21.9 ℃

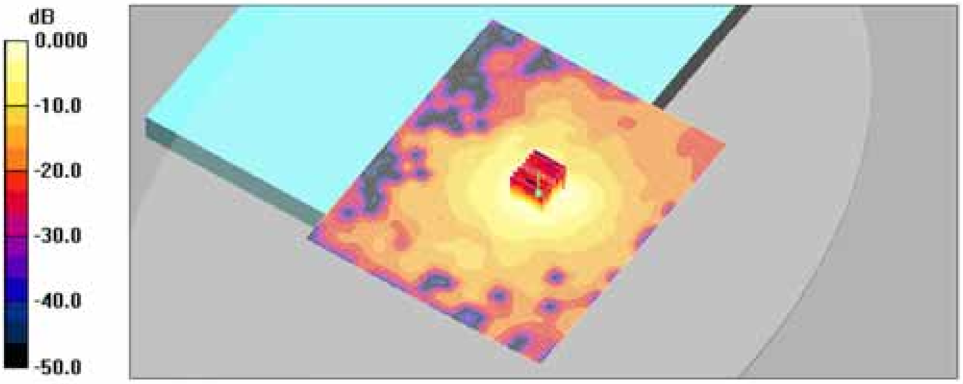
DUT: NP500R5H; Type: Samsung Notebook; Serial: 0GMY91HG100086K
Program Name: Body

Communication System: 5GHz; Frequency: 5520 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5520 MHz; σ = 5.56 mho/m; ε_r = 49.6; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(3.9, 3.9, 3.9); Calibrated: 2014-05-21
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_802.11a_6Mbps_Base_CH104/Area Scan (171x201x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.858 mW/g

WLAN_802.11a_6Mbps_Base_CH104/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 5.55 V/m; Power Drift = 0.015 dB
Peak SAR (extrapolated) = 1.79 W/kg
SAR(1 g) = 0.480 mW/g; SAR(10 g) = 0.181 mW/g
Maximum value of SAR (measured) = 0.900 mW/g



0 dB = 0.900mW/g

Date: 2015-03-10

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: WLAN_802.11a_6Mbps_Base_CH116.da4

Ambient Temp : 22.7 ℃ Tissue Temp : 21.9 ℃

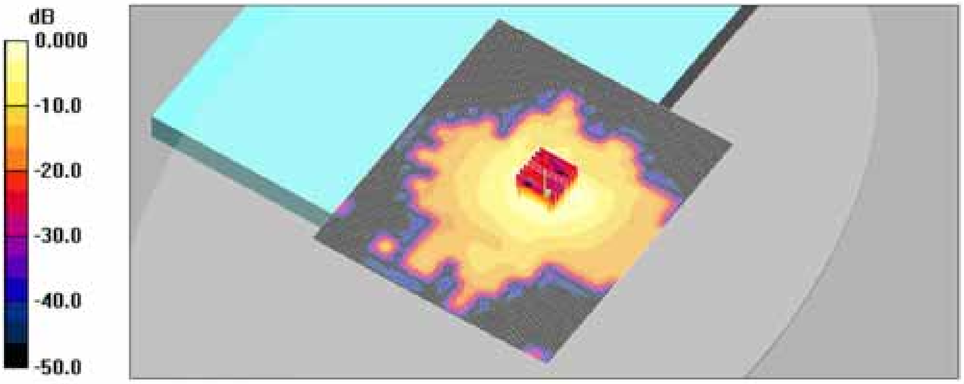
DUT: NP500R5H; Type: Samsung Notebook; Serial: 0GMY91HG100086K
Program Name: Body

Communication System: 5GHz; Frequency: 5580 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5580 MHz; σ = 5.71 mho/m; ε_r = 50; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(3.79, 3.79, 3.79); Calibrated: 2014-05-21
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_802.11a_6Mbps_Base_CH116/Area Scan (171x201x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.07 mW/g

WLAN_802.11a_6Mbps_Base_CH116/Zoom Scan (8x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 5.45 V/m; Power Drift = -0.115 dB
Peak SAR (extrapolated) = 2.33 W/kg
SAR(1 g) = 0.586 mW/g; SAR(10 g) = 0.218 mW/g
Maximum value of SAR (measured) = 1.09 mW/g



0 dB = 1.09mW/g

Date: 2015-03-10

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: WLAN_802.11a_6Mbps_Base_CH136.da4

Ambient Temp : 22.7 ℃ Tissue Temp : 21.9 ℃

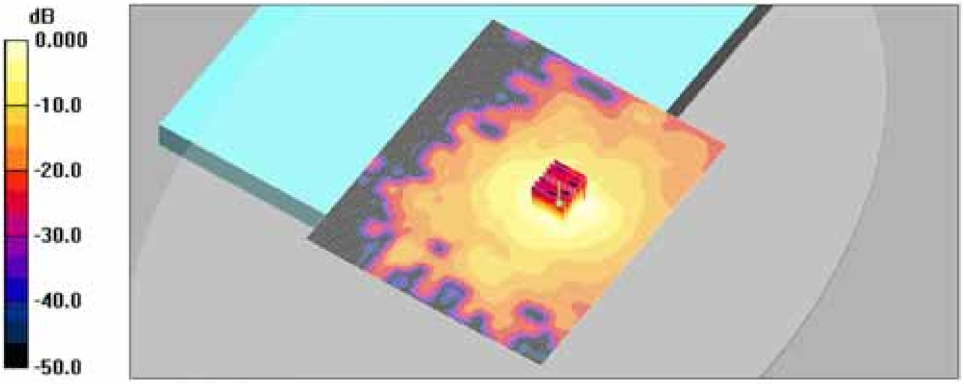
DUT: NP500R5H; Type: Samsung Notebook; Serial: 0GMY91HG100086K
Program Name: Body

Communication System: 5GHz; Frequency: 5680 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5680 MHz; σ = 5.91 mho/m; ε_r = 50.3; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(3.79, 3.79, 3.79); Calibrated: 2014-05-21
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_802.11a_6Mbps_Base_CH136/Area Scan (171x201x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.44 mW/g

WLAN_802.11a_6Mbps_Base_CH136/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 5.68 V/m; Power Drift = -0.054 dB
Peak SAR (extrapolated) = 3.03 W/kg
SAR(1 g) = 0.754 mW/g; SAR(10 g) = 0.284 mW/g
Maximum value of SAR (measured) = 1.43 mW/g



0 dB = 1.43mW/g

Date: 2015-03-10

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: WLAN_802.11ac_VHT80_MCS0_Base_CH138.da4

Ambient Temp : 22.7 ℃ Tissue Temp : 21.9 ℃

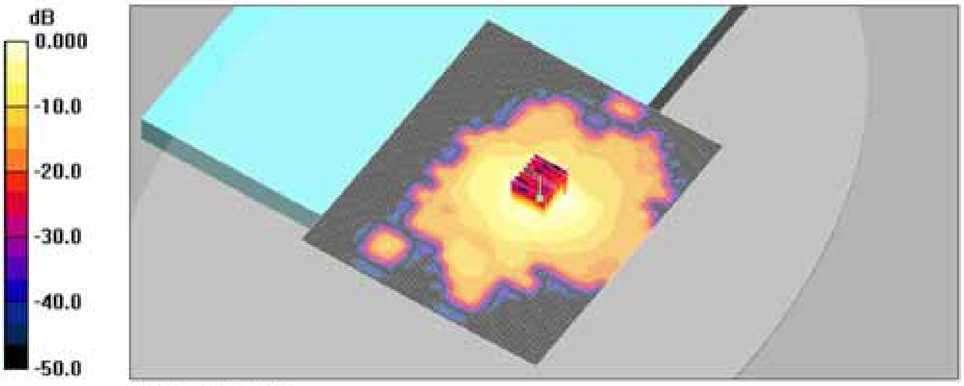
DUT: NP500R5H; Type: Samsung Notebook; Serial: 0GMY91HG100086K
Program Name: Body

Communication System: 5GHz; Frequency: 5690 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5690 MHz; σ = 5.93 mho/m; ε_r = 50.3; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(3.79, 3.79, 3.79); Calibrated: 2014-05-21
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_802.11ac_VHT80_MCS0_Base_CH138/Area Scan (171x201x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.16 mW/g

WLAN_802.11ac_VHT80_MCS0_Base_CH138/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 5.31 V/m; Power Drift = 0.023 dB
Peak SAR (extrapolated) = 2.48 W/kg
SAR(1 g) = 0.610 mW/g; SAR(10 g) = 0.231 mW/g
Maximum value of SAR (measured) = 1.16 mW/g



0 dB = 1.16mW/g

Appendix A.10 SAR Test Plots for WLAN 5.8GHz

Date: 2015-03-10

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: WLAN_802.11a_6Mbps_Base_CH149.da4

Ambient Temp : 22.7 ℃ Tissue Temp : 21.9 ℃

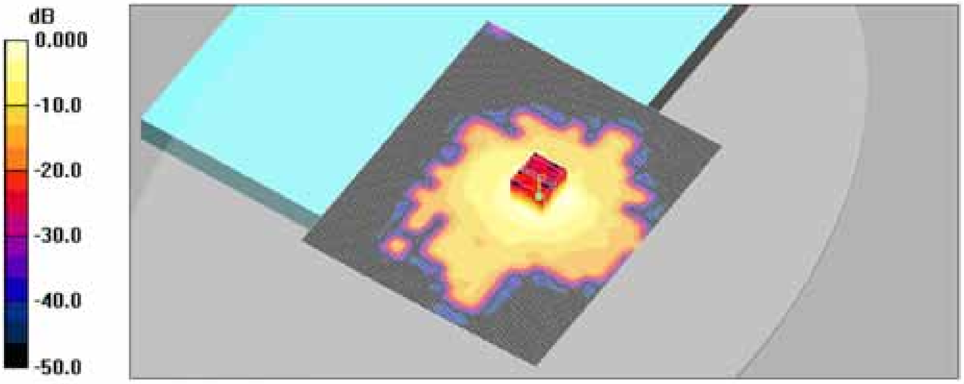
DUT: NP500R5H; Type: Samsung Notebook; Serial: 0GMY91HG100086K
Program Name: Body

Communication System: 5GHz; Frequency: 5745 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5745 MHz; σ = 6.06 mho/m; ε_r = 50.4; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(4.09, 4.09, 4.09); Calibrated: 2014-05-21
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_802.11a_6Mbps_Base_CH149/Area Scan (171x201x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.701 mW/g

WLAN_802.11a_6Mbps_Base_CH149/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 4.39 V/m; Power Drift = 0.182 dB
Peak SAR (extrapolated) = 1.47 W/kg
SAR(1 g) = 0.381 mW/g; SAR(10 g) = 0.143 mW/g
Maximum value of SAR (measured) = 0.713 mW/g



0 dB = 0.713mW/g

Date: 2015-03-10

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: WLAN_802.11ac_VHT80_MCS0_Base_CH155.da4

Ambient Temp : 22.7 ℃ Tissue Temp : 21.9 ℃

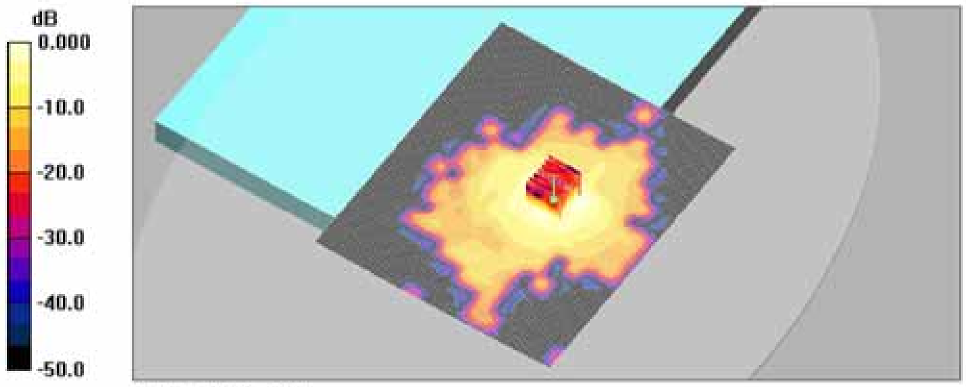
DUT: NP500R5H; Type: Samsung Notebook; Serial: 0GMY91HG100086K
Program Name: Body

Communication System: 5GHz; Frequency: 5775 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5775 MHz; σ = 6.1 mho/m; ε_r = 50.4; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(4.09, 4.09, 4.09); Calibrated: 2014-05-21
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_802.11ac_VHT80_MCS0_Base_CH155/Area Scan (171x201x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.573 mW/g

WLAN_802.11ac_VHT80_MCS0_Base_CH155/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 3.97 V/m; Power Drift = 0.180 dB
Peak SAR (extrapolated) = 1.14 W/kg
SAR(1 g) = 0.289 mW/g; SAR(10 g) = 0.107 mW/g
Maximum value of SAR (measured) = 0.561 mW/g



0 dB = 0.561mW/g

Appendix A.11 SAR Test Plots for Bluetooth

Date: 2015-04-03

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: Bluetooth_Base_CH0.da4

Ambient Temp : 23.8 ℃ Tissue Temp : 22.3 ℃

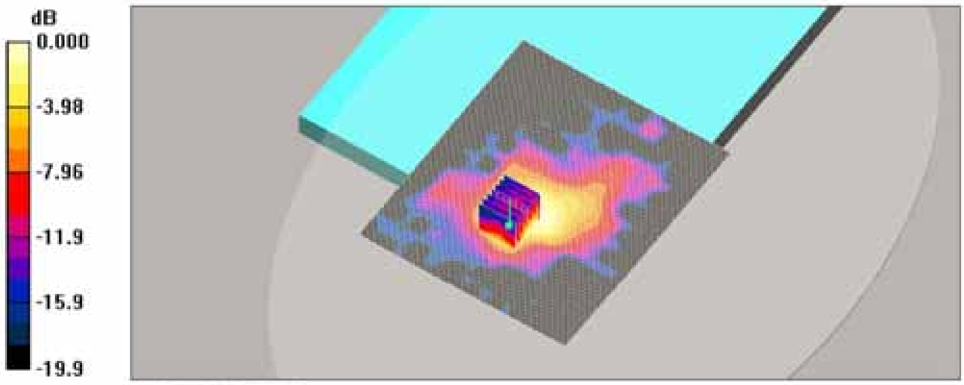
DUT: NP500R5H; Type: Samsung Notebook; Serial: 0GMY91HG100086K
Program Name: Body

Communication System: 2.45GHz; Frequency: 2402 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2402 MHz; σ = 2 mho/m; ε_r = 55; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(6.65, 6.65, 6.65); Calibrated: 2014-05-21
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2015-01-22
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Bluetooth_Base_CH0/Area Scan (171x201x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.079 mW/g

Bluetooth_Base_CH0/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 2.61 V/m; Power Drift = -0.053 dB
Peak SAR (extrapolated) = 0.104 W/kg
SAR(1 g) = 0.058 mW/g; SAR(10 g) = 0.030 mW/g
Maximum value of SAR (measured) = 0.083 mW/g



0 dB = 0.083mW/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 (95% CONFIDENCE INTERVAL)				K=2		**21.66**	

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

a	b	c	d	e = f(d,k)	g	i = cxg/e	k
Uncertainty Component	Section in IEEE 1528	Tol (%)	Prob . Dist.	Div.	Ci (1g)	1g ui (%)	Vi (Veff)
Probe calibration	E.2.1	6.55	N	1	1	6.55	∞
Axial isotropy	E.2.2	4.7	R	1.73	0.71	1.92	∞
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	6.1	R	1.73	1	3.52	∞
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		11.46	355
Expanded uncertainty (95% CONFIDENCE INTERVAL)				K=2		**22.92**	

Appendix C.1 Calibration certificate for Probe(S/N 3791)

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

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

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

Accreditation No.: **SCS 108**

기술책임자
2014. 6. 2

Client **SGS (Dymstec)**

Certificate No: **EX3-3791_May14**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3791
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:	May 21, 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 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-13 (No. ES3-3013_Dec13)	Dec-14
DAE4	SN: 660	13-Dec-13 (No. DAE4-660_Dec13)	Dec-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

Issued: May 22, 2014

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

Certificate No: EX3-3791_May14 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 108**

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:3791

Manufactured: February 18, 2011
Calibrated: May 21, 2014

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3791

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (μV/(V/m)^2)[A]	0.55	0.53	0.53	± 10.1 %
DCP (mV)[B]	105.4	100.4	102.3	

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	142.2	±3.5 %
		Y	0.0	0.0	1.0		144.8	
		Z	0.0	0.0	1.0		146.3	

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:3791

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	8.98	8.98	8.98	0.23	1.47	± 12.0 %
900	41.5	0.97	8.82	8.82	8.82	0.41	0.85	± 12.0 %
1750	40.1	1.37	7.71	7.71	7.71	0.32	0.92	± 12.0 %
1900	40.0	1.40	7.36	7.36	7.36	0.71	0.61	± 12.0 %
2450	39.2	1.80	6.63	6.63	6.63	0.62	0.65	± 12.0 %
2600	39.0	1.96	6.41	6.41	6.41	0.39	0.83	± 12.0 %
5200	36.0	4.66	4.83	4.83	4.83	0.40	1.80	± 13.1 %
5300	35.9	4.76	4.62	4.62	4.62	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.57	4.57	4.57	0.45	1.80	± 13.1 %
5600	35.5	5.07	4.36	4.36	4.36	0.45	1.80	± 13.1 %
5800	35.3	5.27	4.46	4.46	4.46	0.45	1.80	± 13.1 %

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

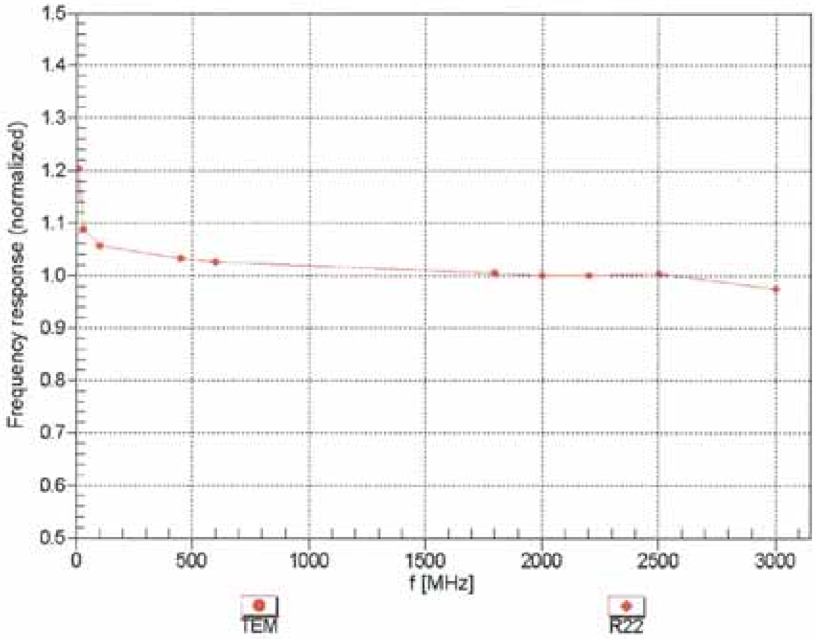
DASY/EASY - Parameters of Probe: EX3DV4 - SN:3791

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	8.63	8.63	8.63	0.60	0.76	± 12.0 %
1750	53.4	1.49	7.38	7.38	7.38	0.67	0.66	± 12.0 %
1900	53.3	1.52	7.04	7.04	7.04	0.33	0.96	± 12.0 %
2450	52.7	1.95	6.65	6.65	6.65	0.80	0.58	± 12.0 %
2600	52.5	2.16	6.36	6.36	6.36	0.80	0.50	± 12.0 %
5200	49.0	5.30	4.36	4.36	4.36	0.40	1.90	± 13.1 %
5300	48.9	5.42	4.15	4.15	4.15	0.40	1.90	± 13.1 %
5500	48.6	5.65	3.90	3.90	3.90	0.50	1.90	± 13.1 %
5600	48.5	5.77	3.79	3.79	3.79	0.45	1.90	± 13.1 %
5800	48.2	6.00	4.09	4.09	4.09	0.50	1.90	± 13.1 %

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

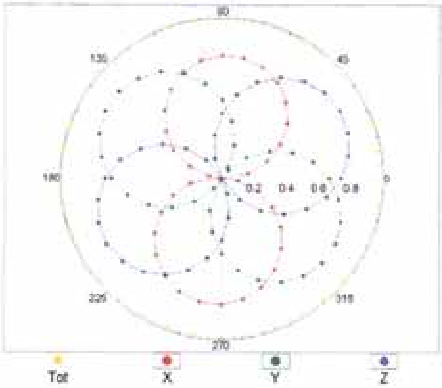
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



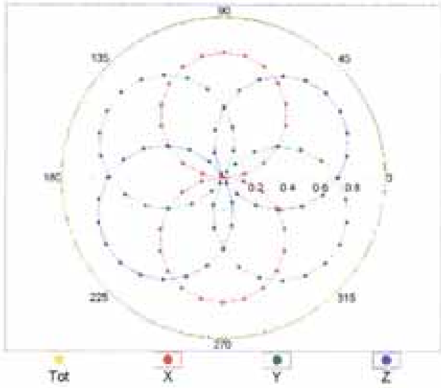
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

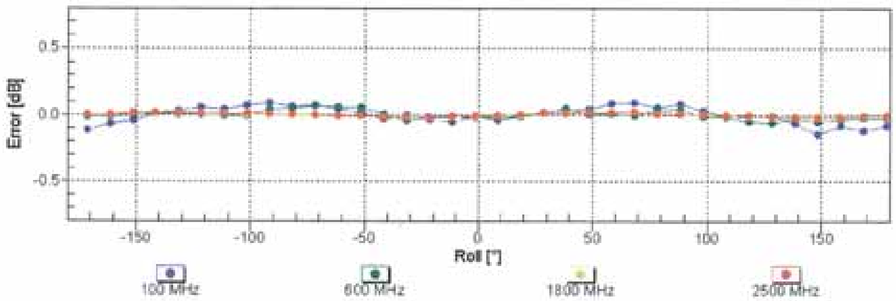
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



f=1800 MHz,R22

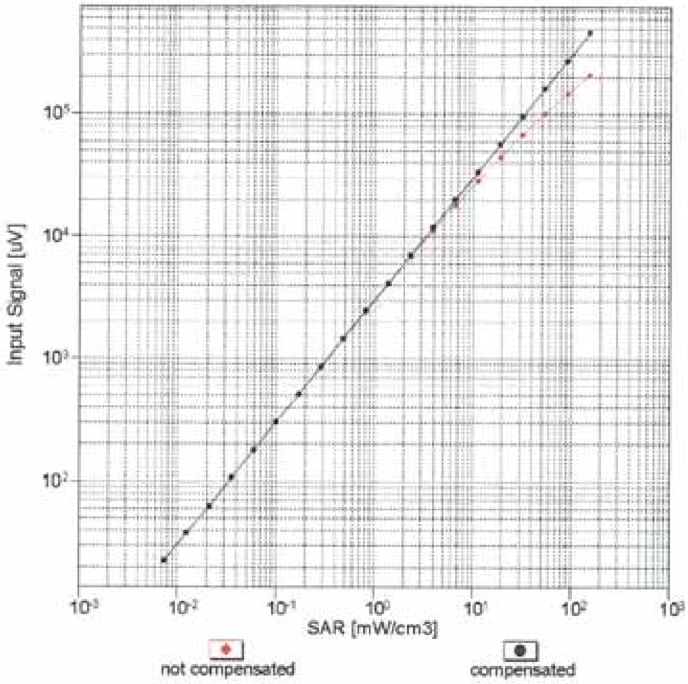


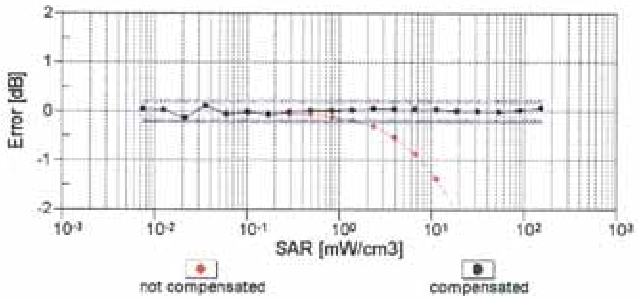


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR_{head})

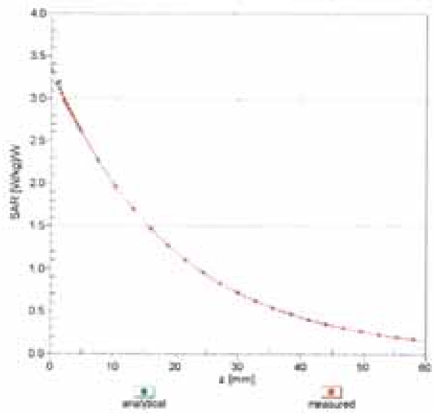
(TEM cell , f_{eval}= 1900 MHz)

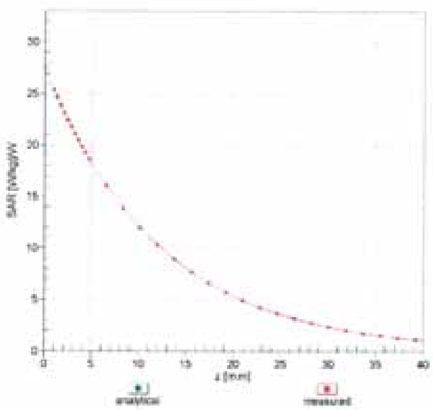




Uncertainty of Linearity Assessment: ± 0.6% (k=2)

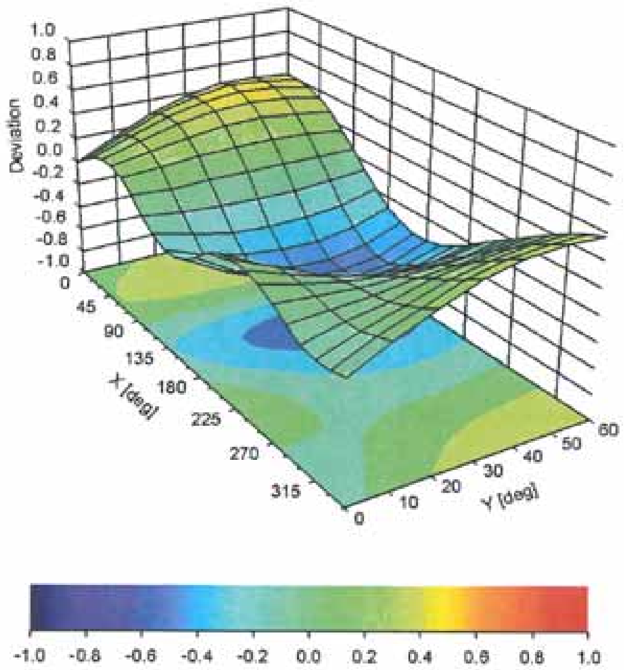
Conversion Factor Assessment





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:3791

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-111.6
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm

Appendix C.2 Calibration certificate for DAE

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

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

Certificate No: DAE3-567_Jan15 Page 1 of 5

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	-

Certificate No: DAE3-567_Jan15 Page 4 of 5

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.3 Calibration certificate for Dipole

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

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

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

Accreditation No.: SCS 108

기술책임자

Client SGS (Dymstec)

Certificate No: D2450V2-734_May14 2014. 6. 2

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

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

Certificate No: D2450V2-734_May14 Page 1 of 8

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

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

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

Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

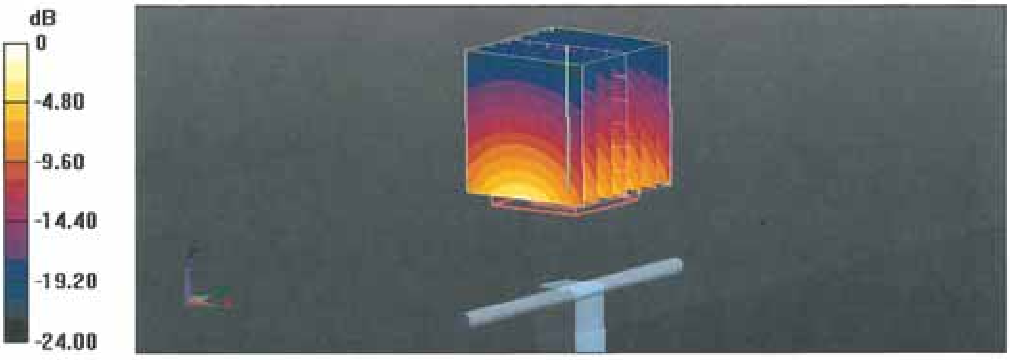
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.83 S/m; ε_r = 38.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

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)

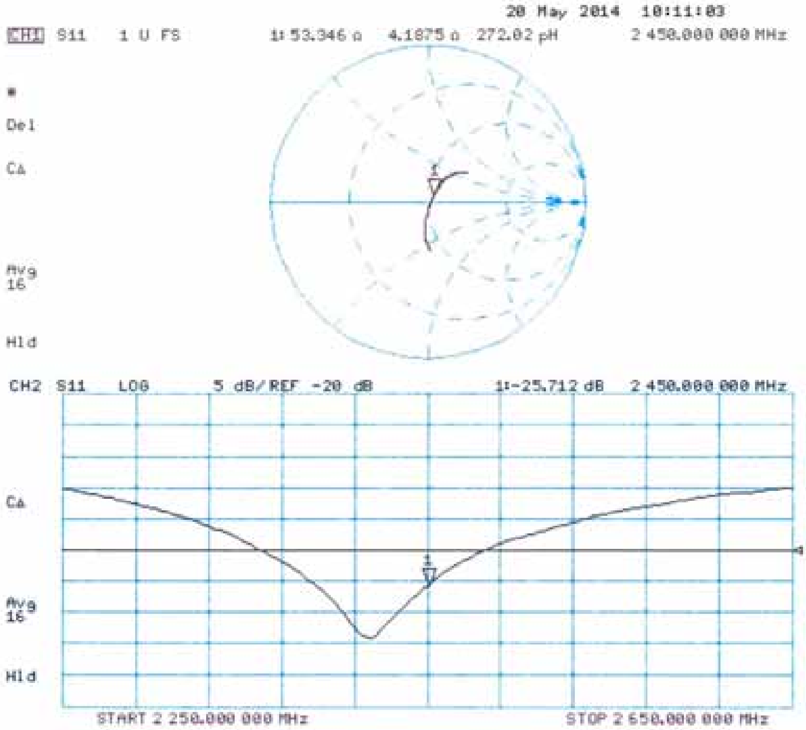
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

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

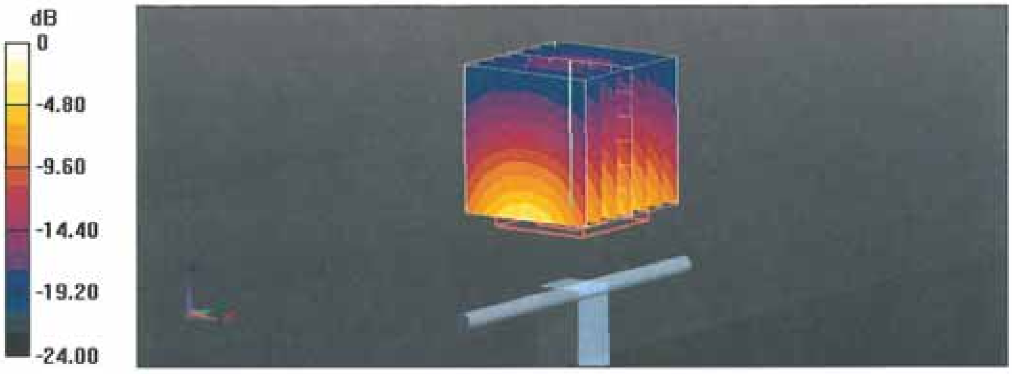
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 734

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)

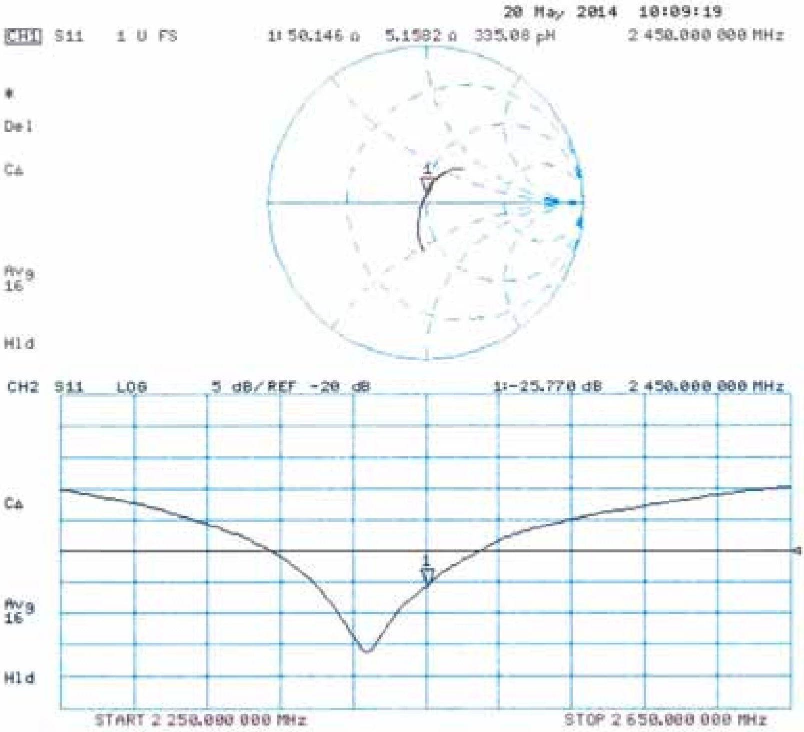
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 94.69 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 27.0 W/kg
SAR(1 g) = 12.8 W/kg; SAR(10 g) = 5.9 W/kg
Maximum value of SAR (measured) = 17.1 W/kg



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



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

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

기술책임자
2014.6.2

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

Accreditation No.: **SCS 108**

Client **SGS (Dymstec)**

Certificate No: **D5GHzV2-1130_May14**

CALIBRATION CERTIFICATE

Object	D5GHzV2 - SN: 1130
Calibration procedure(s)	QA CAL-22.v2 Calibration procedure for dipole validation kits between 3-6 GHz
Calibration date:	May 22, 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 EX3DV4	SN: 3503	30-Dec-13 (No. EX3-3503_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:	Israe El-Naouq	Laboratory Technician	Israe El-Naouq
Approved by:	Katja Pokovic	Technical Manager	

Issued: May 22, 2014

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

Certificate No: D5GHzV2-1130_May14 Page 1 of 16

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

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

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

Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEC 62209-2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation, and Procedures"; Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", March 2010
b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"
c) 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

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 V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz ± 1 MHz 5300 MHz ± 1 MHz 5500 MHz ± 1 MHz 5600 MHz ± 1 MHz 5800 MHz ± 1 MHz	

Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.5 ± 6 %	4.55 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.97 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**79.4 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.6 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.0 ± 6 %	4.96 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.59 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**85.6 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.44 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.3 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.7 ± 6 %	5.18 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.13 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**81.0 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.0 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.0 ± 6 %	5.44 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.67 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**76.1 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.13 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.1 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.42 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.8 ± 6 %	5.59 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5300 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.90 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**78.4 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.21 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.9 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.6	5.65 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.5 ± 6 %	5.85 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5500 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.24 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**81.8 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.28 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**22.6 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.4 ± 6 %	5.98 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.36 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**83.0 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.31 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**22.9 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.0 ± 6 %	6.27 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.82 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**77.6 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.16 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.4 W/kg ± 19.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	51.2 Ω - 9.8 jΩ
Return Loss	- 20.3 dB

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	52.1 Ω - 4.2 jΩ
Return Loss	- 26.8 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	52.5 Ω - 4.3 jΩ
Return Loss	- 26.3 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	56.7 Ω - 3.8 jΩ
Return Loss	- 22.8 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	56.1 Ω - 1.9 jΩ
Return Loss	- 24.4 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	55.7 Ω + 6.8 jΩ
Return Loss	- 21.5 dB

Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	52.0 Ω + 3.3 jΩ
Return Loss	- 28.4 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	51.6 Ω + 3.0 jΩ
Return Loss	- 29.4 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	50.3 Ω + 7.5 jΩ
Return Loss	- 22.6 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	49.1 Ω + 6.2 jΩ
Return Loss	- 24.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.205 ns

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	September 08, 2011

DASY5 Validation Report for Head TSL

Date: 22.05.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1130

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 4.55 S/m; ε_r = 35.5; ρ = 1000 kg/m^3 , Medium parameters used: f = 5300 MHz; σ = 4.66 S/m; ε_r = 35.4; ρ = 1000 kg/m^3 , Medium parameters used: f = 5500 MHz; σ = 4.86 S/m; ε_r = 35.1; ρ = 1000 kg/m^3 , Medium parameters used: f = 5600 MHz; σ = 4.96 S/m; ε_r = 35; ρ = 1000 kg/m^3 , Medium parameters used: f = 5800 MHz; σ = 5.18 S/m; ε_r = 34.7; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.52, 5.52, 5.52); Calibrated: 30.12.2013, ConvF(5.2, 5.2, 5.2); Calibrated: 30.12.2013, ConvF(5.01, 5.01, 5.01); Calibrated: 30.12.2013, ConvF(4.86, 4.86, 4.86); Calibrated: 30.12.2013, ConvF(4.91, 4.91, 4.91); Calibrated: 30.12.2013;
- Sensor-Surface: 1.4mm (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)

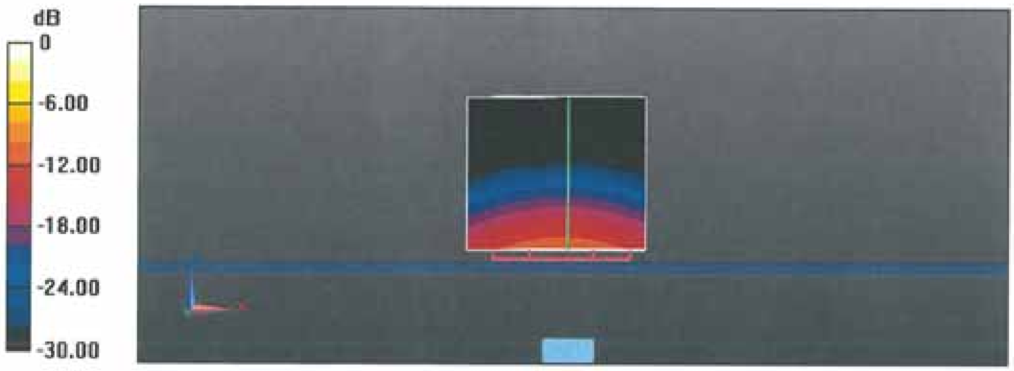
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 64.34 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 28.7 W/kg
SAR(1 g) = 7.97 W/kg; SAR(10 g) = 2.27 W/kg
Maximum value of SAR (measured) = 18.6 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 66.92 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 31.4 W/kg
SAR(1 g) = 8.5 W/kg; SAR(10 g) = 2.44 W/kg
Maximum value of SAR (measured) = 20.1 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 66.08 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 33.5 W/kg
SAR(1 g) = 8.61 W/kg; SAR(10 g) = 2.46 W/kg
Maximum value of SAR (measured) = 21.0 W/kg

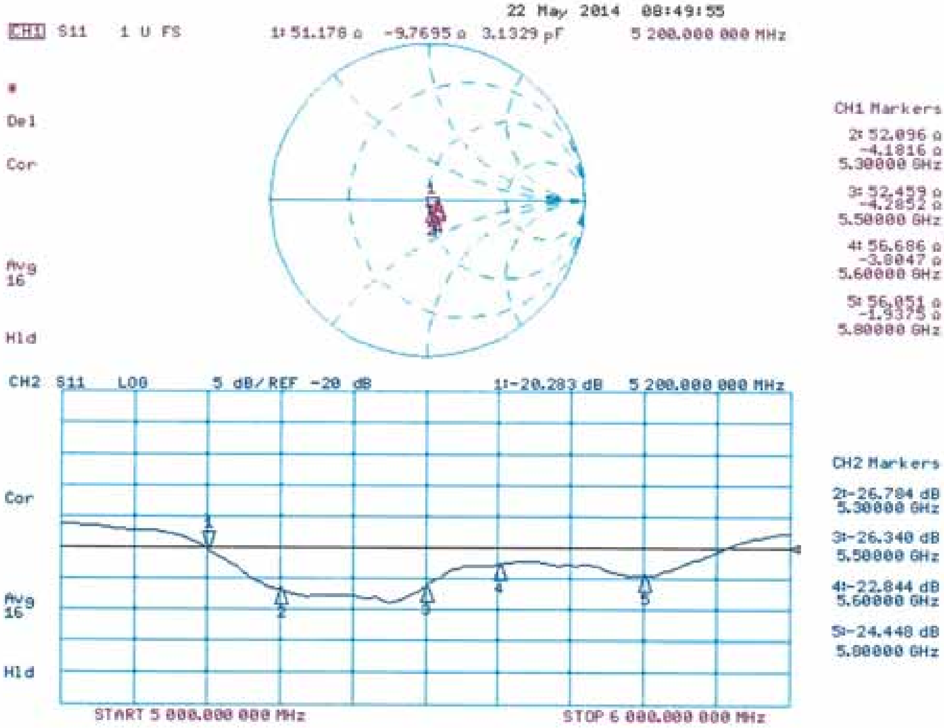
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 65.82 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 33.8 W/kg
SAR(1 g) = 8.59 W/kg; SAR(10 g) = 2.44 W/kg
Maximum value of SAR (measured) = 21.1 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.19 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 33.3 W/kg
SAR(1 g) = 8.13 W/kg; SAR(10 g) = 2.31 W/kg



0 dB = 20.1 W/kg = 13.03 dBW/kg

Impedance Measurement Plot for Head TSL



Certificate No: D5GHzV2-1130_May14 Page 13 of 16

DASY5 Validation Report for Body TSL

Date: 21.05.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1130

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 5.44 S/m; ε_r = 47; ρ = 1000 kg/m^3 , Medium parameters used: f = 5300 MHz; σ = 5.59 S/m; ε_r = 46.8; ρ = 1000 kg/m^3 , Medium parameters used: f = 5500 MHz; σ = 5.85 S/m; ε_r = 46.5; ρ = 1000 kg/m^3 , Medium parameters used: f = 5600 MHz; σ = 5.98 S/m; ε_r = 46.4; ρ = 1000 kg/m^3 , Medium parameters used: f = 5800 MHz; σ = 6.27 S/m; ε_r = 46; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.01, 5.01, 5.01); Calibrated: 30.12.2013, ConvF(4.76, 4.76, 4.76); Calibrated: 30.12.2013, ConvF(4.52, 4.52, 4.52); Calibrated: 30.12.2013, ConvF(4.3, 4.3, 4.3); Calibrated: 30.12.2013, ConvF(4.47, 4.47, 4.47); Calibrated: 30.12.2013;
- Sensor-Surface: 1.4mm (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)

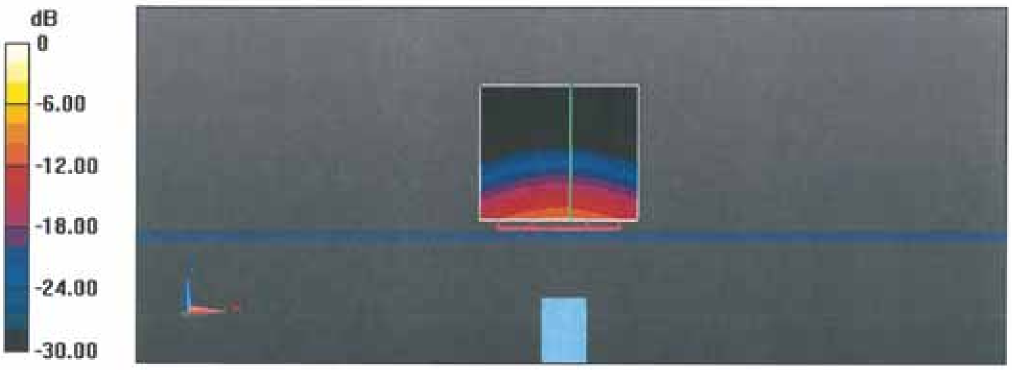
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.37 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 30.4 W/kg
SAR(1 g) = 7.67 W/kg; SAR(10 g) = 2.13 W/kg
Maximum value of SAR (measured) = 17.8 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.51 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 32.1 W/kg
SAR(1 g) = 7.9 W/kg; SAR(10 g) = 2.21 W/kg
Maximum value of SAR (measured) = 18.5 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.52 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 35.5 W/kg
SAR(1 g) = 8.24 W/kg; SAR(10 g) = 2.28 W/kg
Maximum value of SAR (measured) = 19.8 W/kg

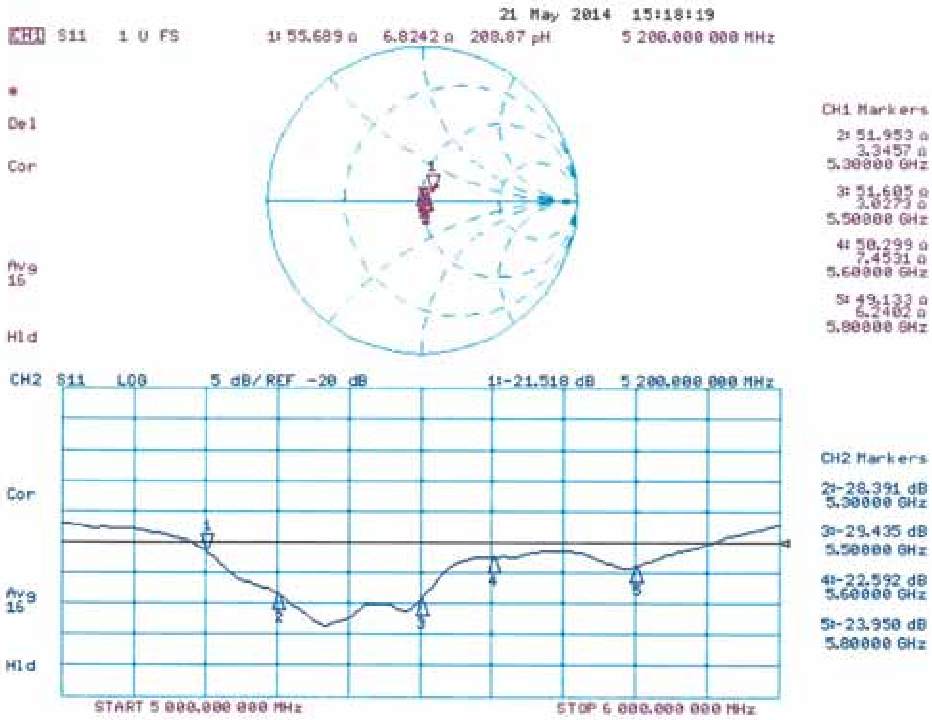
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.41 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 37.1 W/kg
SAR(1 g) = 8.36 W/kg; SAR(10 g) = 2.31 W/kg
Maximum value of SAR (measured) = 20.2 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 56.24 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 36.6 W/kg
SAR(1 g) = 7.82 W/kg; SAR(10 g) = 2.16 W/kg
Maximum value of SAR (measured) = 19.2 W/kg



0 dB = 19.2 W/kg = 12.83 dBW/kg

Impedance Measurement Plot for Body TSL



Certificate No: D5GHzV2-1130_May14 Page 16 of 16

-THE END-