

# FCC SAR TEST REPORT

**Test File No : F690501/RF-SAR002366**

<b>Equipment Under Test</b>	Module
<b>Model Name</b>	8260D2W
<b>Host Device</b>	Notebook PC
<b>Host Device Name</b>	NP740U5L
<b>Applicant</b>	Intel Mobile Communications
<b>Address of Applicant</b>	Intel Mobile Communications 100 Center Point Circle Suite 200 Columbia, SC 29210 USA
<b>FCC ID</b>	PD98260D2
<b>Exposure Category</b>	General Population/Uncontrolled Exposure
<b>Standards</b>	FCC 47 CFR Part 2 (2.1093) IEEE 1528, 2013 ANSI/IEEE C95.1, C95.3
<b>Date of Receipt</b>	2016-04-18
<b>Date of Test(s)</b>	2016-04-18 ~ 2016-04-24
<b>Date of Issue</b>	2016-05-12
<b>Test Result</b>	Refer to the Page 05

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

**Remarks:**

This report details the results of the testing carried out on one sample, the results contained in this test report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

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Report File No : F690501/RF-SAR002366

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Date of Issue : 2016-05-12

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-	May 12, 2016	Initial issue	-

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## 1 Testing Laboratory

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## 2 Details of Manufacturer

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## 3 Description of EUT(s)

<b>EUT Type</b>	Module		
<b>Model Name</b>	8260D2W		
<b>Host Device</b>	Notebook PC		
<b>Host Device Name</b>	NP740U5L		
<b>Serial Number</b>	0LP591ZH400026D		
<b>Mode of Operation</b>	WLAN, Bluetooth		
<b>Duty Cycle</b>	1 (WLAN, Bluetooth)		
<b>Body worn Accessory</b>	None		
<b>Tx Frequency Range</b>	2412 MHz ~ 2462 MHz (WLAN_802.11b/g/n) 5180 MHz ~ 5240 MHz, 5260 MHz ~ 5320 MHz (WLAN_802.11a/n/ac) 5500 MHz ~ 5700 MHz (WLAN_802.11a/n), 5500 MHz ~ 5720 MHz (WLAN_802.11ac) 5745 MHz ~ 5825 MHz (WLAN_802.11a/n/ac) 2402 MHz ~ 2480 MHz (Bluetooth)		
<b>Antenna Information</b>	Port	Main	Aux
	Manufacturer	Galtronics	Galtronics
	Type	PIFA	PIFA
	Main Antenna Gain (dBi)	Aux Antenna Gain (dBi)	
	2.40 GHz	3.20	2.40 GHz
	5.150 GHz ~ 5.350 GHz	3.62	5.150 GHz ~ 5.350 GHz
	5.470 GHz ~ 5.725 GHz	4.71	5.470 GHz ~ 5.725 GHz
	5.725 GHz ~ 5.850 GHz	4.88	5.725 GHz ~ 5.850 GHz
			4.51

## 4 The Highest Reported SAR Values

Equipment Class	Band	Highest Reported SAR 1g (W/kg)
<b>DTS</b>	2.4 GHz WLAN	1.00
<b>UNII</b>	5.8 GHz WLAN	0.71
<b>NII</b>	5.3 GHz WLAN	0.96
	5.6 GHz WLAN	0.80
<b>DSS</b>	Bluetooth	N/A
Simultaneous SAR per KDB 690783 D01v01r03		1.20

## 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 1528-2013 and the following published KDB procedures.

In additions;

<input checked="" type="checkbox"/>	<b>KDB 865664 D01v01r04</b>	<b>SAR Measurement Requirements for 100 MHz to 6 GHz</b>
<input checked="" type="checkbox"/>	<b>KDB 447498 D01v06</b>	<b>Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies</b>
<input type="checkbox"/>	KDB 447498 D02v02r01	SAR Measurement Procedures for USB Dongle Transmitters
<input checked="" type="checkbox"/>	<b>KDB 248227 D01v02r02</b>	<b>SAR Guidance For IEEE 802.11 (Wi-Fi) Transmitters</b>
<input type="checkbox"/>	KDB 615223 D01v01r01	802.16e/WiMax SAR Measurement Guidance
<input checked="" type="checkbox"/>	<b>KDB 616217 D04v01r02</b>	<b>SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers</b>
<input type="checkbox"/>	KDB 643646 D01v01r03	SAR Test Reduction Considerations for Occupational PTT Radios
<input type="checkbox"/>	KDB 648474 D03v01r04	Evaluation and Approval Considerations for Handsets with Specific Wireless Charging Battery Covers
<input type="checkbox"/>	KDB 648474 D04v01r03	SAR Evaluation Considerations for Wireless Handsets
<input type="checkbox"/>	KDB 680106 D01v02	RF Exposure Considerations for Low Power Consumer Wireless Power Transfer Applications
<input type="checkbox"/>	KDB 941225 D01v03r01	3G SAR Measurement Procedures
<input type="checkbox"/>	KDB 941225 D05v02r05	SAR Evaluation Considerations for LTE Devices
<input type="checkbox"/>	KDB 941225 D06v02r01	SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities
<input type="checkbox"/>	KDB 941225 D07v01r02	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 ( $\rho$ ). The equation description is as below:

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

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

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

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

Where: C is the specific heat capacity,  $\delta T$  is the temperature rise and  $\delta t$  is the exposure duration, or related to the electrical field in the tissue by

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

Where:  $\sigma$  is the conductivity of the tissue,  $\rho$  is the mass density of the tissue and E is the RMS electrical field strength.

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

### 7.3 Test Standards and Limits

According to FCC 47CFR §2.1093(d) The limits to be used for evaluation are based generally on criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate ("SAR") in Section 4.2 of "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," ANSI/IEEE C95.3-2003, Copyright 2003 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017. These criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements (NCRP) in "Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields," NCRP Report No. 86, Section 17.4.5. Copyright NCRP, 1986, Bethesda, Maryland 20814. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting

source. SAR values have been related to threshold levels for potential biological hazards. The criteria to be used are specified in paragraphs (d)(1) and (d)(2) of this section and shall apply for portable devices transmitting in the frequency range from 100 kHz to 6 GHz. Portable devices that transmit at frequencies above 6 GHz are to be evaluated in terms of the MPE limits specified in § 1.1310 of this chapter. Measurements and calculations to demonstrate compliance with MPE field strength or power density limits for devices operating above 6 GHz should be made at a minimum distance of 5 cm from the radiating source.

(1) Limits for Occupational/Controlled exposure: 0.4 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 8 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 20 W/kg, as averaged over any 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.

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

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

## 8 The SAR Measurement System

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

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

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

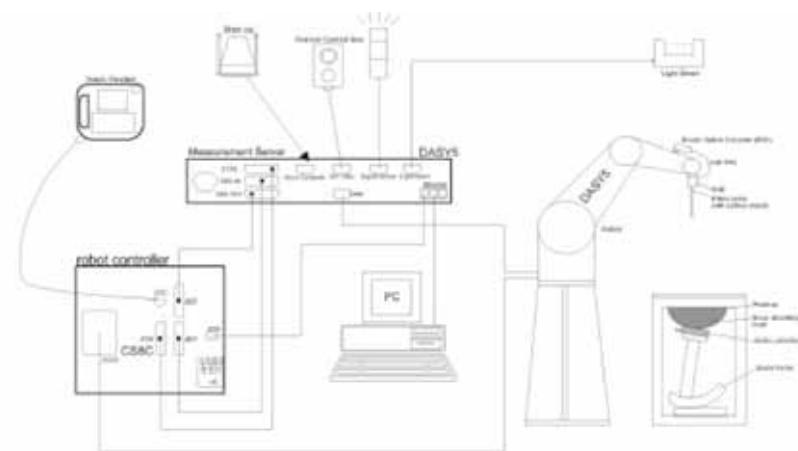


Fig a. The microwave circuit arrangement used for SAR system verification

- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 7.
- DASY 5 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The ELI phantom enabling testing flat usage.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing to validate the proper functioning of the system.

## 9 System Components

### 9.1 Probe

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



EX3DV4 E-Field Probe

**NOTE:**

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

### 9.2 ELI Phantom

<b>Construction</b>	: Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 <b>MHz</b> to 6 <b>GHz</b> . 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



ELI Phantom

<b>Shell Thickness</b>	: $2.0 \text{ mm} \pm 0.2 \text{ mm}$
<b>Dimensions</b>	: Major axis: 600 <b>mm</b> Minor axis: 400 <b>mm</b>

### 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).

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



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 1.4 mm. This distance cannot be smaller than the Distance of sensor calibration points to probe tip as defined in the probe properties.

#### Step 2 and 3: Area Scan & Zoom Scan Procedures

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

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

#### Step 4: Power drift measurement

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

< Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01r04 >

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

## 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  $\pm 10\%$  from the target SAR values. These tests were done at 2450 MHz, 5300 MHz, 5600 MHz, and 5800 MHz. The tests were conducted on the same days as the measurement of the DUT. The obtained results from the system accuracy verification are displayed in the table 1. (SAR values are normalized to 1W forward power delivered to the dipole). During the tests, the ambient temperature of the laboratory was in the range  $(22 \pm 2)^\circ\text{C}$ , the relative humidity was in the range  $(55 \pm 5)\%$  R.H and the liquid depth above the ear reference points was  $\geq 15\text{ cm} \pm 5\text{ mm}$  (frequency  $\leq 3\text{ GHz}$ ) or  $\geq 10\text{ cm} \pm 5\text{ mm}$  (frequency  $> 3\text{ GHz}$ ) in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.

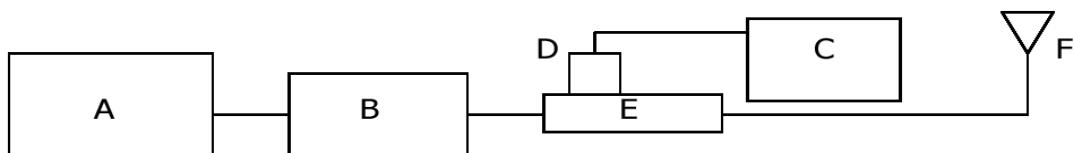


Fig 1. The microwave circuit arrangement used for SAR system verification

- 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  
Agilent Model E9327A Power Sensor
- E. KEYSIGHT Model 772D Dual Directional Coupler
- 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 SN:892	3862	2450 Body	51.40	5.37	53.70	4.47	2016-04-18	21.8
D5 GHz V2 SN:1106	3862	5300 Body	76.10	7.58	75.80	-0.39	2016-04-23	21.7
D5 GHz V2 SN:1106	3862	5600 Body	80.20	7.89	78.90	-1.62	2016-04-24	22.3
D5 GHz V2 SN:1106	3862	5800 Body	77.30	7.44	74.40	-3.75	2016-04-24	22.3

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 kHz - 6 GHz) by using a procedure detailed in Section V.

f (MHz)	Tissue type	Limits / Measured	Dielectric Parameters		
			Permittivity	Conductivity	Simulated Tissue Temp( )
2450	Body	Measured, 2016-04-18	52.94	1.99	21.8
		Target Tissue Body	52.70	1.95	
		<u>Deviation (%)</u>	<u>0.46</u>	<u>2.05</u>	
		Measured, 2016-04-18	52.97	1.99	
		<u>Deviation (%)</u>	<u>0.51</u>	<u>2.05</u>	
		Measured, 2016-04-18	52.96	1.99	
2412	Body	<u>Deviation (%)</u>	<u>0.49</u>	<u>2.05</u>	21.8
		Measured, 2016-04-23	49.20	5.40	
		Target Tissue Body	48.90	5.42	
		<u>Deviation (%)</u>	<u>0.61</u>	<u>-0.37</u>	
		Measured, 2016-04-23	49.21	5.39	21.7
		<u>Deviation (%)</u>	<u>0.63</u>	<u>-0.55</u>	
2462	Body	Measured, 2016-04-23	49.18	5.41	
		<u>Deviation (%)</u>	<u>0.57</u>	<u>-0.18</u>	
		Measured, 2016-04-24	49.37	5.81	
		Target Tissue Body	48.50	5.77	
		<u>Deviation (%)</u>	<u>1.79</u>	<u>0.69</u>	
		Measured, 2016-04-24	49.46	5.63	22.3
5300	Body	<u>Deviation (%)</u>	<u>1.98</u>	<u>-2.43</u>	
		Measured, 2016-04-24	49.32	5.97	
		<u>Deviation (%)</u>	<u>1.69</u>	<u>3.47</u>	
		Measured, 2016-04-24	49.19	6.16	
		Target Tissue Body	48.20	6.00	
		<u>Deviation (%)</u>	<u>2.05</u>	<u>2.67</u>	
5290	Body	Measured, 2016-04-24	49.21	6.12	22.3
		<u>Deviation (%)</u>	<u>2.10</u>	<u>2.00</u>	
		Measured, 2016-04-24	49.19	6.15	
		<u>Deviation (%)</u>	<u>2.05</u>	<u>2.50</u>	
		Measured, 2016-04-24	49.19	6.15	
		<u>Deviation (%)</u>	<u>2.05</u>	<u>2.50</u>	
5310	Body	Measured, 2016-04-24	49.19	6.15	22.3
		<u>Deviation (%)</u>	<u>2.05</u>	<u>2.50</u>	
		Measured, 2016-04-24	49.19	6.15	
		<u>Deviation (%)</u>	<u>2.05</u>	<u>2.50</u>	
		Measured, 2016-04-24	49.19	6.15	
		<u>Deviation (%)</u>	<u>2.05</u>	<u>2.50</u>	
5600	Body	Measured, 2016-04-24	49.19	6.15	22.3
		<u>Deviation (%)</u>	<u>2.05</u>	<u>2.50</u>	
		Measured, 2016-04-24	49.19	6.15	
		<u>Deviation (%)</u>	<u>2.05</u>	<u>2.50</u>	
		Measured, 2016-04-24	49.19	6.15	
		<u>Deviation (%)</u>	<u>2.05</u>	<u>2.50</u>	
5510	Body	Measured, 2016-04-24	49.19	6.15	22.3
		<u>Deviation (%)</u>	<u>2.05</u>	<u>2.50</u>	
		Measured, 2016-04-24	49.19	6.15	
		<u>Deviation (%)</u>	<u>2.05</u>	<u>2.50</u>	
		Measured, 2016-04-24	49.19	6.15	
		<u>Deviation (%)</u>	<u>2.05</u>	<u>2.50</u>	
5690	Body	Measured, 2016-04-24	49.19	6.15	22.3
		<u>Deviation (%)</u>	<u>2.05</u>	<u>2.50</u>	
		Measured, 2016-04-24	49.19	6.15	
		<u>Deviation (%)</u>	<u>2.05</u>	<u>2.50</u>	
		Measured, 2016-04-24	49.19	6.15	
		<u>Deviation (%)</u>	<u>2.05</u>	<u>2.50</u>	
5800	Body	Measured, 2016-04-24	49.19	6.15	22.3
		<u>Deviation (%)</u>	<u>2.05</u>	<u>2.50</u>	
		Measured, 2016-04-24	49.19	6.15	
		<u>Deviation (%)</u>	<u>2.05</u>	<u>2.50</u>	
		Measured, 2016-04-24	49.19	6.15	
		<u>Deviation (%)</u>	<u>2.05</u>	<u>2.50</u>	
5775	Body	Measured, 2016-04-24	49.19	6.15	22.3
		<u>Deviation (%)</u>	<u>2.10</u>	<u>2.00</u>	
		Measured, 2016-04-24	49.19	6.15	
		<u>Deviation (%)</u>	<u>2.10</u>	<u>2.00</u>	
		Measured, 2016-04-24	49.19	6.15	
		<u>Deviation (%)</u>	<u>2.10</u>	<u>2.00</u>	
5795	Body	Measured, 2016-04-24	49.19	6.15	22.3
		<u>Deviation (%)</u>	<u>2.10</u>	<u>2.00</u>	
		Measured, 2016-04-24	49.19	6.15	
		<u>Deviation (%)</u>	<u>2.10</u>	<u>2.00</u>	
		Measured, 2016-04-24	49.19	6.15	
		<u>Deviation (%)</u>	<u>2.10</u>	<u>2.00</u>	

The composition of the brain & muscle tissue simulating liquid

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

Ingredients (% by weight)	Frequency (MHz)									
	450		835		900		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.91	46.21	40.29	50.75	40.29	50.75	55.24	70.17	55.00	68.64
Salt (NaCl)	3.79	2.34	1.38	0.94	1.38	0.94	0.31	0.39	-	-
Sugar	56.93	51.17	57.90	-	57.90	-	-	-	-	-
HEC	0.25	0.15	0.24	0.10	0.24	0.10	-	-	-	-
Bactericide	0.12	0.08	0.18	-	0.18	-	-	-	-	-
Triton X-100	-	-	-	-	-	-	-	-	-	-
DGBE	-	-	-	-	-	-	44.45	70.17	45.00	31.37
Dielectric Constant	43.5	56.7	41.5	55.2	41.5	55.0	40.0	53.3	39.2	52.7
Conductivity (S/m)	0.87	0.94	0.90	0.97	0.97	1.05	1.40	1.52	1.80	1.95

Salt: 99 +% Pure Sodium Chloride

Sugar: 98 +% Pure Sucrose

Water: De-ionized, 16 MΩ<sup>+</sup> resistivity

HEC: Hydroxyethyl Cellulose

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

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

Simulating Liquids for 5 GHz, Manufactured by SPEAG

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

### 13. Test System Validation

Per FCC KDB 865664 D01v01r04, SAR system validation status should be documented to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the required tissue-equivalent media for system validation, according to the procedures outlined in IEEE 1528-2013 and FCC KDB 865664 D01v01r04. 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		
					Permitt ivity	Condu ctivity	Sensitivity	Probe Linearity	Probe Isotropy	Mod. Type	Duty Factor	PAR
2450	2015-10-12	3862	2450	Body	51.17	1.93	PASS	PASS	PASS	OFDM	N/A	PASS
5300	2015-10-12	3862	5300	Body	50.47	5.20	PASS	PASS	PASS	OFDM	N/A	PASS
5600	2015-10-12	3862	5600	Body	49.11	5.76	PASS	PASS	PASS	OFDM	N/A	PASS
5800	2015-10-12	3862	5800	Body	49.10	6.17	PASS	PASS	PASS	OFDM	N/A	PASS

< SAR System Validation Summary >

## 14 Instruments List

<b>Test Platform</b>	SPEAG DASY5 Professional				
<b>Location</b>	SGS Korea Co., Ltd. 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, E&E Lab				
<b>Manufacture</b>	SPEAG				
<b>Description</b>	SAR Test System (Frequency range 300 MHz – 6 GHz)				
<b>Software Reference</b>	DASY52: 52.8.8(1222) SEMCAD X: 14.6.10(7331)				
<b>Hardware Reference</b>					
Equipment	Type	Serial Number	Cal Date	Cal Interval	Cal Due
Robot	TX90X L	F12/5LPBA1/A/01	N/A	N/A	N/A
Phantom	ELI Phantom	TP-1200	N/A	N/A	N/A
Dielectric Assessment Kit	DAK-3.5	1228	2015-11-17	Annual	2016-11-17
Verification Dipole	D2450V2	892	2015-04-22	Biennial	2017-04-22
Verification Dipole	D5 GHz V2	1106	2015-05-22	Biennial	2017-05-22
DAE	DAE4	1430	2016-03-21	Annual	2017-03-21
E-Field Probe	EX3DV4	3862	2015-09-28	Annual	2016-09-28
Network Analyzer	E5071C	MY46111535	2015-06-22	Annual	2016-06-22
Power Meter	E4419B	GB43311125	2015-06-23	Annual	2016-06-23
Power Meter	E4419B	GB43311715	2015-06-23	Annual	2016-06-23
Power Sensor	E9300H	MY41495307	2015-06-25	Annual	2016-06-25
Power Sensor	E9300H	MY41495314	2015-06-25	Annual	2016-06-25
Power Sensor	E9327A	US40441371	2015-12-24	Annual	2016-12-24
Signal Generator	E8247C	MY43321024	2015-06-23	Annual	2016-06-23
Power Amplifier	2001-BBS3Q7ECK	1032 D/C 0336	2015-12-24	Annual	2016-12-24
Power Amplifier	2092-BBS5K8CAJ	1010	2015-06-26	Annual	2016-06-26
Dual Directional Coupler	772D	MY52180226	2015-08-25	Annual	2016-08-25
LP Filter	LA-30N	N/A	2015-07-01	Annual	2016-07-01
LP Filter	LA-60N	N/A	2015-07-01	Annual	2016-07-01
Attenuator	8491B	50566	2015-06-26	Annual	2016-06-26
Attenuator	05AS102-K20	A3	2015-12-23	Annual	2016-12-23
Attenuator	05AS102-K03	A1	2015-12-23	Annual	2016-12-23
Hygro-Thermometer	BJ5478	12091382-1	2015-06-26	Annual	2016-06-26
Digital Thermometer	DTM3000	3027	2015-06-26	Annual	2016-06-26
Spectrum Analyzer	E4445A	MY44020523	2015-06-23	Annual	2016-06-23

## 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 D01v06, 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 D01v06

### 17.1 SISO Maximum Output Power Specifications

Average power for Production (dB m)					
Mode	Data Rate	Channel	Normal/Maximum	Main	Aux
802.11b, g, n HT20	All Data Rates	All Channels	Maximum	<b>16.0</b>	<b>15.5</b>
			Normal	14.5	14.0
802.11n HT40	All Data Rates	3 Channel	Maximum	<b>16.0</b>	<b>15.0</b>
			Normal	14.5	13.5
		4 ~ 8 Channels	Maximum	<b>16.0</b>	<b>15.5</b>
			Normal	14.5	14.0
		9 Channel	Maximum	<b>15.0</b>	<b>14.5</b>
			Normal	13.5	13.0
Tune-up Tolerance: -1.5 dB / +1.5 dB					

<b>Average power for Production (dB m)</b>					
<b>Mode</b>	<b>Data Rate</b>	<b>Channel</b>	<b>Normal/Maximum</b>	<b>Main</b>	<b>Aux</b>
802.11a, n, ac HT20 / VHT20	All Data Rates	36 ~ 64 Channels	Maximum	<b>11.0</b>	<b>11.0</b>
			Normal	9.5	9.5
		100 ~ 140 Channels	Maximum	<b>10.5</b>	<b>10.5</b>
			Normal	9.0	9.0
		144 ~ 165 Channels	Maximum	<b>11.0</b>	<b>11.0</b>
			Normal	9.5	9.5
	All Data Rates	38 ~ 62 Channels	Maximum	<b>11.0</b>	<b>11.0</b>
			Normal	9.5	9.5
		102 ~ 142 Channels	Maximum	<b>10.5</b>	<b>10.5</b>
			Normal	9.0	9.0
		151 ~ 159 Channels	Maximum	<b>11.0</b>	<b>11.0</b>
			Normal	9.5	9.5
802.11ac VHT80	All Data Rates	42 ~ 58 Channels	Maximum	<b>11.0</b>	<b>11.0</b>
			Normal	9.5	9.5
		106 ~ 138 Channels	Maximum	<b>10.5</b>	<b>10.5</b>
			Normal	9.0	9.0
		155 Channels	Maximum	<b>11.0</b>	<b>11.0</b>
			Normal	9.5	9.5
Tune-up Tolerance: -1.5 dB / +1.5 dB					

## 17.2 MIMO Maximum Output Power Specifications

<b>Average power for Production (dB m)</b>						
<b>Mode</b>	<b>Data Rate</b>	<b>Channel</b>	<b>Normal/Maximum</b>	<b>Main</b>	<b>Aux</b>	
802.11n HT20	MCS0 ~ 7	All Channels	Maximum	<b>16.0</b>	<b>15.5</b>	
			Normal	14.5	14.0	
	MCS8 ~ 15		Maximum	<b>13.0</b>	<b>13.0</b>	
			Normal	11.5	11.5	
802.11n HT40	MCS0 ~ 7	3 Channel	Maximum	<b>16.0</b>	<b>15.0</b>	
			Normal	14.5	13.5	
		4 ~ 8 Channel	Maximum	<b>16.0</b>	<b>15.5</b>	
			Normal	14.5	14.0	
	MCS8 ~ 15	9 Channel	Maximum	<b>15.0</b>	<b>14.5</b>	
			Normal	13.5	13.0	
		3 ~ 8 Channel	Maximum	<b>13.0</b>	<b>13.0</b>	
			Normal	11.5	11.5	
Tune-up Tolerance: -1.5 dB / +1.5 dB						

<b>Average power for Production (dB m)</b>					
<b>Mode</b>	<b>Data Rate</b>	<b>Channel</b>	<b>Normal/Maximum</b>	<b>Main</b>	<b>Aux</b>
802.11n HT20	MCS0 ~ 7	36 ~ 64 Channels	Maximum	<b>11.0</b>	<b>11.0</b>
			Normal	9.5	9.5
		100 ~ 140 Channels	Maximum	<b>10.5</b>	<b>10.5</b>
			Normal	9.0	9.0
		144 ~ 165 Channels	Maximum	<b>11.0</b>	<b>11.0</b>
	MCS8 ~ 15		Normal	9.5	9.5
		36 ~ 64 Channels	Maximum	<b>8.5</b>	<b>8.5</b>
			Normal	7.0	7.0
		100 ~ 140 Channels	Maximum	<b>7.5</b>	<b>7.5</b>
			Normal	6.0	6.0
802.11n HT40	MCS0 ~ 7	144 ~ 165 Channels	Maximum	<b>8.0</b>	<b>8.0</b>
			Normal	6.5	6.5
	MCS8 ~ 15	38 ~ 62 Channels	Maximum	<b>11.0</b>	<b>11.0</b>
			Normal	9.5	9.5
		102 ~ 142 Channels	Maximum	<b>10.5</b>	<b>10.5</b>
	MCS8 ~ 15		Normal	9.0	9.0
		151 ~ 159 Channels	Maximum	<b>11.0</b>	<b>11.0</b>
			Normal	9.5	9.5
		38 ~ 62 Channels	Maximum	<b>8.5</b>	<b>8.5</b>
			Normal	7.0	7.0
802.11ac VHT20	All Data Rates	102 ~ 142 Channels	Maximum	<b>7.5</b>	<b>7.5</b>
			Normal	6.0	6.0
		151 ~ 159 Channels	Maximum	<b>8.0</b>	<b>8.0</b>
			Normal	6.5	6.5
		36 ~ 64 Channels	Maximum	<b>8.5</b>	<b>8.5</b>
802.11ac VHT40	All Data Rates		Normal	7.0	7.0
		100 ~ 140 Channels	Maximum	<b>7.5</b>	<b>7.5</b>
			Normal	6.0	6.0
		144 ~ 165 Channels	Maximum	<b>8.0</b>	<b>8.0</b>
			Normal	6.5	6.5
802.11ac VHT80	All Data Rates	38 ~ 62 Channels	Maximum	<b>8.5</b>	<b>8.5</b>
			Normal	7.0	7.0
		102 ~ 142 Channels	Maximum	<b>7.5</b>	<b>7.5</b>
			Normal	6.0	6.0
		151 ~ 159 Channels	Maximum	<b>8.0</b>	<b>8.0</b>
			Normal	6.5	6.5
		42 ~ 58 Channels	Maximum	<b>8.5</b>	<b>8.5</b>
			Normal	7.0	7.0
		106 ~ 138 Channels	Maximum	<b>7.5</b>	<b>7.5</b>
			Normal	6.0	6.0
		155 Channels	Maximum	<b>8.0</b>	<b>8.0</b>
			Normal	6.5	6.5
Tune-up Tolerance: -1.5 dB / +1.5 dB					

### 17.3 Bluetooth Maximum Output Power Specifications

Average power for Production (dBm)					
Mode	Normal/Maximum	GFSK	PI/4DQPSK	8DPSK	LE
Bluetooth	Maximum	<b>7.0</b>	<b>7.0</b>	<b>7.0</b>	<b>6.0</b>
	Normal	5.5	5.5	5.5	4.5
Tune-up Tolerance: -1.5 dB / +1.5 dB					

## 18 WLAN

### 18.1 General Device Setup

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

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. A periodic duty factor is required for current generation SAR systems to measure SAR. When 802.11 frame gaps are accounted for in the transmission, a maximum transmission duty factor of 92 – 96% is typically achievable in most test mode configurations. A minimum transmission duty factor of 85% is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. The reported SAR is scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

### 18.2 U-NII-1 and U-NII-2A

For devices that operate in both U-NII-1 and U-NII-2A bands, when the same maximum output power is specified for both bands, SAR measurement using OFDM SAR test procedures is not required for U-NII-1 unless the highest reported SAR for U-NII-2A is  $> 1.2 \text{ W/kg}$ . When different maximum output powers is not required unless the highest reported SAR for the U-NII band with the higher maximum output power, adjusted by the ratio of lower to higher specified maximum output power for the two bands, is  $> 1.2 \text{ W/kg}$ .

### 18.3 U-NII-2C and U-NII-3

The frequency range covered by U-NII-2C and U-NII-3 is 380 MHz (5.47 – 5.85 GHz), which requires a minimum of at least two SAR probe calibration frequency points to support SAR measurements.

When Terminal Doppler Weather Radar (TDWR) restriction applies, the channels at 5.60 – 5.65 GHz in U-NII-2C band must be disabled with acceptable mechanisms and documented in the equipment certification.

Unless band gap channels are permanently disabled, SAR must be considered for these channels.

When band gap channels are disabled, each band is tested independently according to the normally required OFDM SAR measurement and probe calibration frequency point requirements.

### 18.4 2.4 GHz SAR Test Requirements

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

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

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

#### **18.5 OFDM Transmission Mode and SAR Test Channel Selection**

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

#### **18.6 Initial Test Configuration Procedure**

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

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

#### **18.7 Subsequent Test Configuration Procedures**

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

## 19 RF Conducted Power Measurement

### WLAN 2.4 GHz

Mode	Freq. (MHz)	Ch. #	Rate	Average Power [dB m]		Average Power [dB m] Main + Aux
				Main	AUX	
802.11b	2412	1	1	15.41	15.38	-
	2437	6	1	15.36	15.44	-
	2462	11	1	15.50	15.48	-
802.11g	2412	1	6	-	-	-
	2437	6	6	-	-	-
	2462	11	6	-	-	-
802.11n HT20	2412	1	MCS0	-	-	-
	2437	6	MCS0	-	-	-
	2462	11	MCS0	-	-	-
802.11n HT40	2422	3	MCS0	-	-	-
	2437	6	MCS0	-	-	-
	2452	9	MCS0	-	-	-

### WLAN 5.2 GHz

Mode	Freq. (MHz)	Ch. #	Rate	Measured Power [dB m]		Measured Power [dB m] Main + Aux
				Main	AUX	
802.11a	5180	36	6	-	-	-
	5200	40	6	-	-	-
	5220	44	6	-	-	-
	5240	48	6	-	-	-
802.11n HT20	5180	36	MCS0	-	-	-
	5200	40	MCS0	-	-	-
	5220	44	MCS0	-	-	-
	5240	48	MCS0	-	-	-
802.11n HT40	5190	38	MCS0	-	-	-
	5230	46	MCS0	-	-	-
802.11ac VHT20	5180	36	MCS0	-	-	-
	5200	40	MCS0	-	-	-
	5220	44	MCS0	-	-	-
	5240	48	MCS0	-	-	-
802.11ac VHT40	5190	38	MCS0	-	-	-
	5230	46	MCS0	-	-	-
802.11ac VHT80	5210	42	MCS0	-	-	-

### WLAN 5.3 GHz

Mode	Freq. (MHz)	Ch. #	Rate	Measured Power [dB m]		Measured Power [dB m] Main + Aux
				Main	AUX	
802.11a	5260	52	6	-	-	-
	5280	56	6	-	-	-
	5300	60	6	-	-	-
	5320	64	6	-	-	-
802.11n HT20	5260	52	MCS0	-	-	-
	5280	56	MCS0	-	-	-
	5300	60	MCS0	-	-	-
	5320	64	MCS0	-	-	-
802.11n HT40	5270	54	MCS0	-	-	-
	5310	62	MCS0	-	-	-
802.11ac VHT20	5260	52	MCS0	-	-	-
	5280	56	MCS0	-	-	-
	5300	60	MCS0	-	-	-
	5320	64	MCS0	-	-	-
802.11ac VHT40	5270	54	MCS0	-	-	-
	5310	62	MCS0	-	-	-
802.11ac VHT80	5290	58	MCS0	9.95	10.00	-

### WLAN 5.6 GHz

Mode	Freq. (MHz)	Ch. #	Rate	Measured Power [dB m]		Measured Power [dB m] Main + Aux
				Main	AUX	
802.11a	5500	100	6	-	-	-
	5580	116	6	-	-	-
	5660	132	6	-	-	-
	5700	140	6	-	-	-
802.11n HT20	5500	100	MCS0	-	-	-
	5580	116	MCS0	-	-	-
	5660	132	MCS0	-	-	-
	5700	140	MCS0	-	-	-
802.11n HT40	5510	102	MCS0	-	-	-
	5550	110	MCS0	-	-	-
	5670	134	MCS0	-	-	-
802.11ac VHT20	5500	100	MCS0	-	-	-
	5580	116	MCS0	-	-	-
	5660	132	MCS0	-	-	-
	5720	144	MCS0	-	-	-
802.11ac VHT40	5510	102	MCS0	-	-	-
	5550	110	MCS0	-	-	-
	5670	134	MCS0	-	-	-
	5710	142	MCS0	-	-	-
802.11ac VHT80	5530	106	MCS0	10.42	10.36	-
	5690	138	MCS0	10.48	10.38	-

### WLAN 5.8 GHz

Mode	Freq. (MHz)	Ch. #	Rate	Measured Power [dB m]		Measured Power [dB m] Main + Aux
				Main	AUX	
802.11a	5745	149	6	-	-	-
	5785	157	6	-	-	-
	5825	165	6	-	-	-
802.11n HT20	5745	149	MCS0	-	-	-
	5785	157	MCS0	-	-	-
	5825	165	MCS0	-	-	-
802.11n HT40	5755	151	MCS0			
	5795	159	MCS0			
802.11ac VHT20	5745	149	MCS0	-	-	-
	5785	157	MCS0	-	-	-
	5825	165	MCS0	-	-	-
802.11ac VHT40	5755	151	MCS0	-	-	-
	5795	159	MCS0	-	-	-
802.11ac VHT80	5775	155	MCS0	10.98	10.99	-

### Bluetooth

Channel	Frequency (MHz)	GFSK (dB m)	4DPSK (dB m)	8DPSK (dB m)	LE (dB m)
Low	2402	6.17	6.14	6.15	5.71
Middle	2441	5.84	5.96	5.96	5.25
High	2480	6.10	6.08	6.06	5.53

Note. Justification for test configurations for WLAN per KDB Publication 248227 D01 Wi-Fi SAR v02r02:

1. Power measurements were performed for the transmission mode configuration with the highest maximum output power specified for production units.
2. For transmission modes with the same maximum output power specification, powers were measured for the largest channel bandwidth, lowest order modulation and lowest data rate.
3. For transmission modes with identical maximum specified output power, channel bandwidth, modulation and data rates, power measurements were required for all identical configurations.
4. For each transmission mode configuration, powers were measured for the highest and lowest channels; and at the mid-band channel(s) when there were at least 3 channels supported. For channels were measured.

## 20. Transmit Antenna Separation Distances

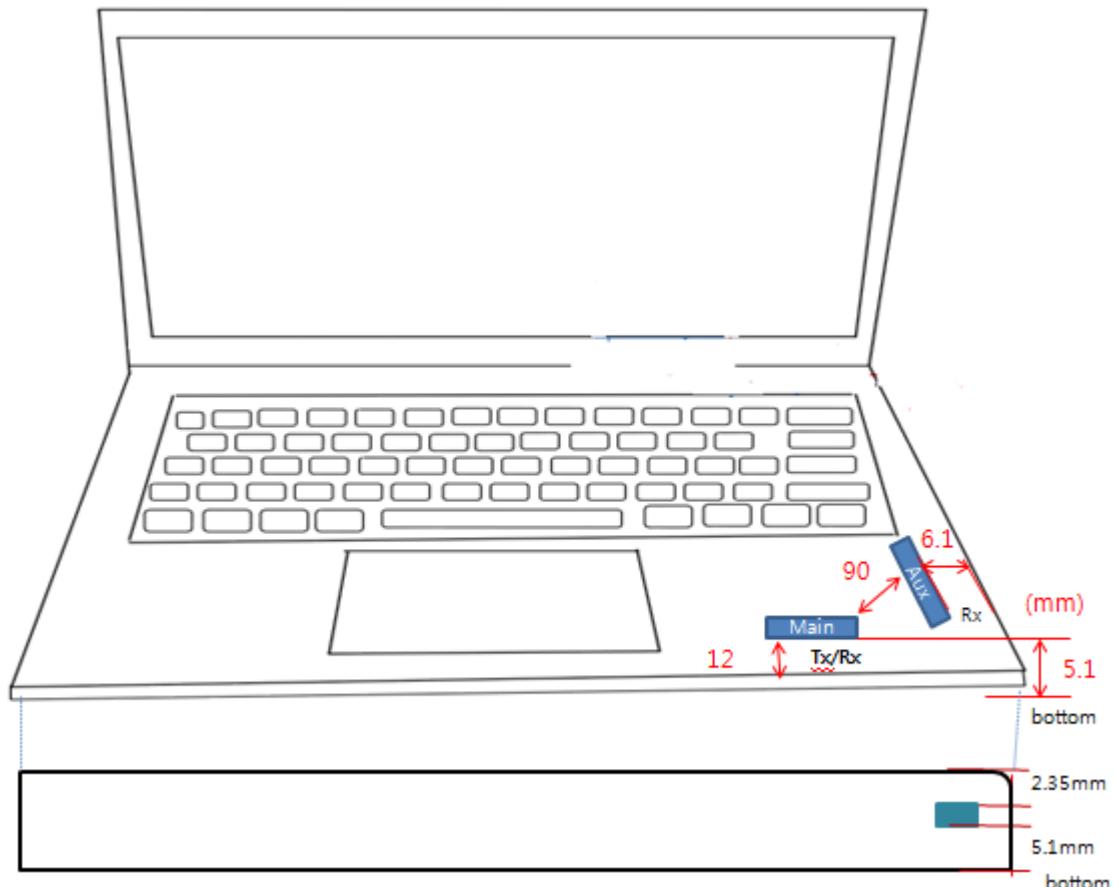
### 20.1 Notebook Device Type

Per FCC KDB 447498 D01v06, the SAR exclusion threshold for distances  $< 50 \text{ mm}$  is defined by the following equation:

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

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

Notebook Type Bluetooth SAR was not required:  $[5.01 / 5.1 * \sqrt{2.480}] = 1.55 < 3.0$



<The Distance information of Antenna to Edges of Notebook>

## 20.2 Tablet PC Device Type

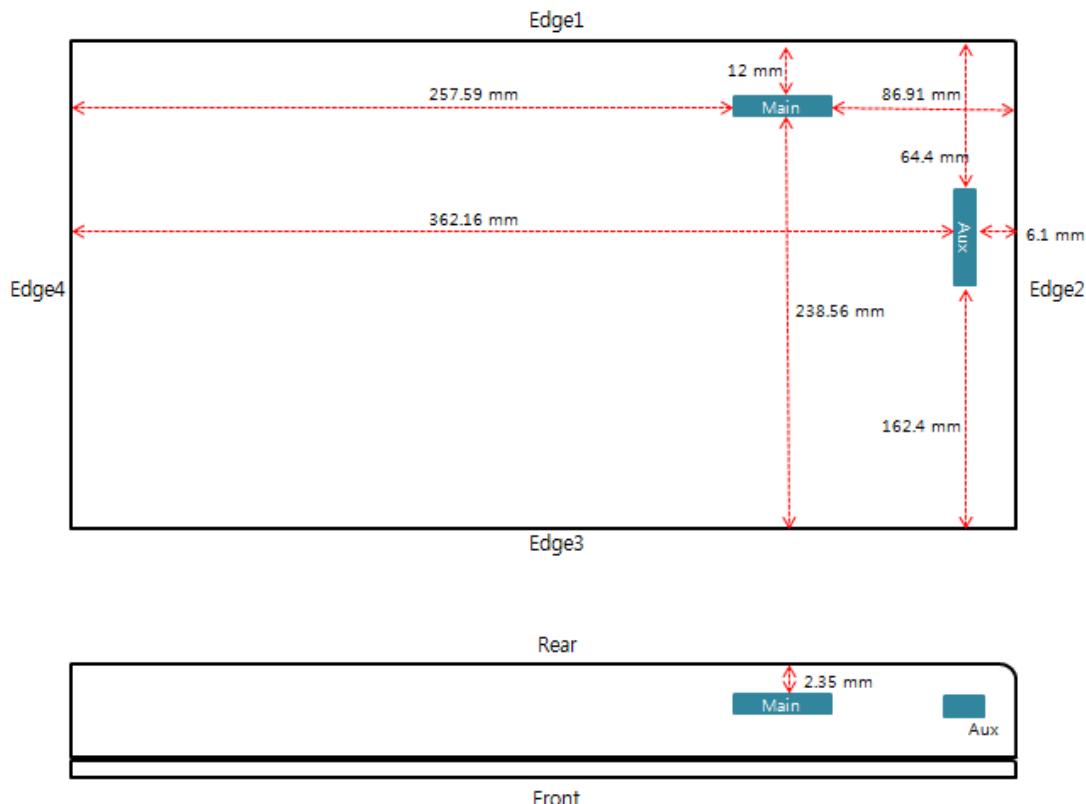
Based on the maximum tune-up tolerance limit of WLAN and Bluetooth, and the antenna to use separation distance, Table “EXEMPT” SAR was not required and Table “Measure” SAR was required.

Frequency (MHz)	Separation distances (mm)								SAR Exemption					
	dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
<b>WLAN Main Antenna</b>														
2462	16.00	40	2.35	12	86.91	238.56	257.59	N/A	12.55 Measure	5.23 Measure	EXEMPT	EXEMPT	EXEMPT	N/A
5320	11.00	13	2.35	12	86.91	238.56	257.59	N/A	6.00 Measure	EXEMPT	EXEMPT	EXEMPT	EXEMPT	N/A
5700	10.50	11	2.35	12	86.91	238.56	257.59	N/A	5.25 Measure	EXEMPT	EXEMPT	EXEMPT	EXEMPT	N/A
5825	11.00	13	2.35	12	86.91	238.56	257.59	N/A	6.28 Measure	EXEMPT	EXEMPT	EXEMPT	EXEMPT	N/A
<b>WLAN Aux Antenna</b>														
2462	15.50	35	2.35	64.4	6.1	162.4	362.16	N/A	10.98 Measure	EXEMPT	9.15 Measure	EXEMPT	EXEMPT	N/A
5320	11.00	13	2.35	64.4	6.1	162.4	362.16	N/A	6.00 Measure	EXEMPT	5.00 Measure	EXEMPT	EXEMPT	N/A
5700	10.50	11	2.35	64.4	6.1	162.4	362.16	N/A	5.25 Measure	EXEMPT	4.38 Measure	EXEMPT	EXEMPT	N/A
5825	11.00	13	2.35	64.4	6.1	162.4	362.16	N/A	6.28 Measure	EXEMPT	5.23 Measure	EXEMPT	EXEMPT	N/A
<b>Bluetooth Antenna</b>														
2480	7.00	5	2.35	64.4	6.1	162.4	362.16	N/A	EXEMPT	EXEMPT	EXEMPT	EXEMPT	EXEMPT	N/A

### Note

1. Maximum power is the source-based time-average power and represents the maximum RF output power among production units.
2. For distances < 5mm, a distance of 5mm is used to determine SAR exclusion and estimated SAR value.
3. Output power is the maximum rated power (including tune-up or manufacturing tolerances).
4. If the antenna separation distance is > 50mm then the value listed is the output power threshold, above which SAR measurement is required. For separation  $\leq$  50mm the value is the KDB 447498 D01v06 calculated value and must be less than 3 for SAR exemption.
5. Formulas round separation distance to nearest mm and power to nearest mW before calculating thresholds or exemption values.
6. SAR evaluation for the front surface of tablet display screens is generally not necessary according to 4.3 section of KDB 616217 D04 v01r02.

### Transmit Antenna Separation Distances (Tablet PC Type)



<The Distance information of Antenna to Edges of Tablet PC>

## 21. SAR Data Summary

### 21.1 Notebook Device Type

#### WLAN 2.45 GHz Body SAR

EUT Position	Mode	Traffic Channel		Power(dBm)			Peak SAR of Area Scan(W/kg)	1-g SAR (W/kg))		Scaling Factor (Power)		Scaling Factor (Duty cycle)	1-g Scaled SAR (W/kg)		Plot No	
		Frequency (MHz)	Channel	Conducted Power		Tune-Up Limit		Main	Aux	Main	Aux		Main	Aux		
				Main	Aux			Main	Aux	Main	Aux		Main	Aux		
Base	802.11b	2462	11	15.50	-	16.00	0.878	0.517	-	1.122	-	1.019	<b>0.591</b>	-	A5	
Base	802.11b	2462	11	-	15.48	15.50	0.713	-	0.437	-	1.005	1.019	-	0.447	-	

#### WLAN 5.3 GHz Body SAR

EUT Position	Mode	Traffic Channel		Power(dBm)			Peak SAR of Area Scan(W/kg)	1-g SAR (W/kg))		Scaling Factor (Power)		Scaling Factor (Duty cycle)	1-g Scaled SAR (W/kg)		Plot No	
		Frequency (MHz)	Channel	Conducted Power		Tune-Up Limit		Main	Aux	Main	Aux		Main	Aux		
				Main	Aux			Main	Aux	Main	Aux		Main	Aux		
Base	802.11ac VHT80	5290	58	9.95	-	11.00	3.010	0.693	-	1.274	-	1.091	<b>0.963</b>	-	A6	
Base	802.11ac VHT80	5290	58	-	10.00	11.00	1.300	-	0.561	-	1.259	1.088	-	0.768	-	

#### WLAN 5.6 GHz Body SAR

EUT Position	Mode	Traffic Channel		Power(dBm)			Peak SAR of Area Scan(W/kg)	1-g SAR (W/kg))		Scaling Factor (Power)		Scaling Factor (Duty cycle)	1-g Scaled SAR (W/kg)		Plot No	
		Frequency (MHz)	Channel	Conducted Power		Tune-Up Limit		Main	Aux	Main	Aux		Main	Aux		
				Main	Aux			Main	Aux	Main	Aux		Main	Aux		
Base	802.11ac VHT80	5530	106	10.42	-	10.50	1.541	0.715	-	1.019	-	1.091	<b>0.795</b>	-	A7	
Base	802.11ac VHT80	5690	138	10.48	-	10.50	1.640	0.646	-	1.005	-	1.091	0.708	-	-	
Base	802.11ac VHT80	5530	106		10.36	10.50	1.160	-	0.519	-	1.033	1.088	-	0.583	-	
Base	802.11ac VHT80	5690	138	-	10.38	10.50	1.900	-	0.503	-	1.028	1.088	-	0.563	-	

#### WLAN 5.8 GHz Body SAR

EUT Position	Mode	Traffic Channel		Power(dBm)			Peak SAR of Area Scan(W/kg)	1-g SAR (W/kg))		Scaling Factor (Power)		Scaling Factor (Duty cycle)	1-g Scaled SAR (W/kg)		Plot No	
		Frequency (MHz)	Channel	Conducted Power		Tune-Up Limit		Main	Aux	Main	Aux		Main	Aux		
				Main	Aux			Main	Aux	Main	Aux		Main	Aux		
Base	802.11ac VHT80	5775	155	10.98	-	11.00	1.110	0.451	-	1.005	-	1.091	0.494	-	-	
Base	802.11ac VHT80	5775	155	-	10.99	11.00	1.570	-	0.578	-	1.002	1.088	-	<b>0.630</b>	A8	

## 21.2 Tablet PC Device Type

### WLAN 2.45 GHz Body SAR

EUT Position	Mode	Traffic Channel		Power(dBm)		Peak SAR of Area Scan(W/kg)	1-g SAR (W/kg))		Scaling Factor (Power)		Scaling Factor (Duty cycle)	1-g Scaled SAR (W/kg)		Plot No	
		Frequency (MHz)	Channel	Conducted Power			Main	Aux	Main	Aux		Main	Aux		
				Main	Aux		Main	Aux	Main	Aux		Main	Aux		
Rear	802.11b	2462	11	15.50	-	16.00	0.234	0.134	-	1.122	-	1.019	0.153	-	
Edge1	802.11b	2462	11	15.50	-	16.00	1.270	0.698	-	1.122	-	1.019	0.798	-	
Rear	802.11b	2462	11	-	15.48	15.50	0.393	-	0.220	-	1.000	1.019	-	0.225	
Edge2	802.11b	2462	11	-	15.48	15.50	3.040	-	0.976	-	1.000	1.019	-	0.999	
Edge2	802.11b	2412	1	-	15.38	15.50	1.670	-	0.892	-	1.028	1.019	-	0.934	
Edge2	802.11b	2437	6	-	15.44	15.50	1.760	-	0.944	-	1.014	1.019	-	0.975	
<b>Repeated Test</b>															
Edge2	802.11b	2462	11	-	15.48	15.50	1.850	-	0.977	-	1.000	1.019	-	<b>1.000</b>	
														A9	

### WLAN 5.3 GHz Body SAR

EUT Position	Mode	Traffic Channel		Power(dBm)		Peak SAR of Area Scan(W/kg)	1-g SAR (W/kg))		Scaling Factor (Power)		Scaling Factor (Duty cycle)	1-g Scaled SAR (W/kg)		Plot No	
		Frequency (MHz)	Channel	Conducted Power			Main	Aux	Main	Aux		Main	Aux		
				Main	Aux		Main	Aux	Main	Aux		Main	Aux		
Rear	802.11ac VHT80	5290	58	9.95	-	11.00	0.155	0.041	-	1.274	-	1.091	0.057	-	
Rear	802.11ac VHT80	5290	58	-	10.00	11.00	0.240	-	0.081	-	1.259	1.088	-	0.111	
Edge2	802.11ac VHT80	5290	58	-	10.00	11.00	1.510	-	0.516	-	1.259	1.088	-	<b>0.707</b>	
														A10	

### WLAN 5.6 GHz Body SAR

EUT Position	Mode	Traffic Channel		Power(dBm)		Peak SAR of Area Scan(W/kg)	1-g SAR (W/kg))		Scaling Factor (Power)		Scaling Factor (Duty cycle)	1-g Scaled SAR (W/kg)		Plot No	
		Frequency (MHz)	Channel	Conducted Power			Main	Aux	Main	Aux		Main	Aux		
				Main	Aux		Main	Aux	Main	Aux		Main	Aux		
Rear	802.11ac VHT80	5690	138	10.48	-	10.50	0.239	0.073	-	1.005	-	1.091	0.080	-	
Rear	802.11ac VHT80	5690	138	-	10.38	10.50	0.302	-	0.093	-	1.028	1.088	-	0.104	
Edge2	802.11ac VHT80	5530	106	-	10.36	10.50	1.180	-	0.449	-	1.033	1.088	-	0.505	
Edge2	802.11ac VHT80	5690	138	-	10.38	10.50	1.670	-	0.520	-	1.028	1.088	-	<b>0.582</b>	
														A11	

### WLAN 5.8 GHz Body SAR

EUT Position	Mode	Traffic Channel		Power(dBm)		Peak SAR of Area Scan(W/kg)	1-g SAR (W/kg))		Scaling Factor (Power)		Scaling Factor (Duty cycle)	1-g Scaled SAR (W/kg)		Plot No	
		Frequency (MHz)	Channel	Conducted Power			Main	Aux	Main	Aux		Main	Aux		
				Main	Aux		Main	Aux	Main	Aux		Main	Aux		
Rear	802.11ac VHT80	5775	155	10.98	-	11.00	0.249	0.052	-	1.005	-	1.091	0.057	-	
Rear	802.11ac VHT80	5775	155	-	10.99	11.00	0.294	-	0.111	-	1.002	1.088	-	0.121	
Edge2	802.11ac VHT80	5775	155	-	10.99	11.00	2.020	-	0.653	-	1.002	1.088	-	<b>0.712</b>	
														A12	

**General Notes:**

1. The test data reported are the worst-case SAR values according to test procedures specified in FCC KDB Publication 616217 D04v01r02 and FCC KDB Publication 447498 D01v06.
2. Liquid tissue depth was at least 15 cm for all frequencies.
3. All modes of operation were investigated, and worst-case results are reported.
4. The EUT is tested 2<sup>nd</sup> hot-spot peak, if it is less than 2 dB below the highest peak.
5. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
6. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01v06.
7. Per FCC KDB 616217 D04v01r02 Section 4.3, SAR tests are required for the back surface and edges of the tablet with the tablet touching the phantom. The SAR Exclusion Threshold in FCC KDB 447498 D01v06 was applied to determined SAR test exclusion for adjacent edge configurations.

**WLAN Notes:**

1. Justification for test configurations for WLAN per KDB Publication 248227 D01v02r02 for 2.4GHz WIFI operations, the highest measured maximum output power channel for DSSS was selected for SAR measurement. SAR for OFDM modes (2.4GHz 802.11g/n) was not required due to the maximum allowed powers and the highest reported DSSS SAR.
2. Justification for test configurations for WLAN per KDB Publication 248227 D01v02r02 for 5GHz WIFI operations, the initial test configuration was selected according to the transmission mode with the highest maximum allowed powers. Other transmission modes were not investigated since the highest reported SAR for initial test configuration adjusted by the ratio of maximum output powers is less than 1.2W/kg.
3. When the maximum reported 1g averaged SAR is  $\leq 0.8$  W/kg, SAR testing on additional channels was not required. Otherwise, SAR for the next highest output power channel was required until the reported SAR result was  $\leq 1.20$  W/kg or all test channels were measured.
4. The device was configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools. The reported SAR was scaled to the 100% transmission duty factor to determine compliance.
5. WLAN transmission was verified using a spectrum analyzer.
6. When the same transmission mode configurations have the same maximum output power on the same channel for the 802.11 a/g/n/ac modes, the channel in the lower order/sequence 802.11 mode (i.e. a,g, n then ac) is selected.
7. When the specified maximum output power is the same for both UNII Band1 and UNII Band 2A, begin SAR measurement in UNII band 2A; and if the highest reported SAR for UNII band 2A is  $\leq 1.2$  W/kg, SAR is not required for UNII band1  $> 1.2$  W/kg, both bands should be tested independently for SAR.

## 22. SAR Measurement Variability

### 22.1 Measurement Variability

Per FCC KDB Publication 865664 D01v01r04, SAR measurement variability was assessed for each frequency band, which was determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media were required for SAR measurements in a frequency band, the variability measurement procedures were applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. These additional measurements were repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device was returned to ambient conditions (normal room temperature) with the battery fully charged before it was re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

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

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

EUT Position	Mode	Traffic Channel		Separation Distance (mm)	Measured 1g SAR (W/kg)	1 <sup>st</sup> Repeated 1g SAR(W/kg)	Ratio	2 <sup>nd</sup> Repeated 1g SAR(W/kg)	Ratio	3 <sup>rd</sup> Repeated 1g SAR(W/kg)	Ratio
		Frequency (MHz)	Channel								
Edge 2	WLAN 2.45 GHz	2462	11	0	0.976	0.977	1.00	N/A	N/A	N/A	N/A

### 22.2 Measurement Uncertainty

The measured SAR was  $< 1.5$  W/kg for all frequency bands. Therefore, per KDB Publication 865664 D01v01r04, the extended measurement uncertainty analysis per IEEE 1528-2013 was not required.

## 23. Simultaneous Multi-band Transmission Evaluation

### 23.1 Introduction

The following procedures adopted from FCC KDB Publication 447498 D01v06 are applicable to handsets with built-in unlicensed transmitters such as Bluetooth devices which may simultaneously transmit with the licensed transmitter.

### 23.2 The Simultaneous Transmission possibilities are listed as below

No	Capable TX Configuration	Body SAR
1	2.45 GHz Main Ant + Bluetooth Aux Ant	Yes
2	5 GHz Main Ant + Bluetooth Aux Ant	Yes

**Note:**

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

### 23.3 Simultaneous Transmission Procedures

This device contains transmitters that may operate simultaneously. Therefore simultaneous transmission analysis is required. Per FCC KDB 447498 D01v06 4.3.2, simultaneous transmission SAR test exclusion may be applied when the sum of the 1-g SAR for all the simultaneous transmitting antennas in a specific physical test configuration is 1.6 W/kg. When standalone SAR is not required to be measured per FCC KDB 447498 D01v06 4.3.2.b), the following equation must be used to estimate the standalone 1g and 10g SAR for simultaneous transmission involving that transmitter.

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

#### 23.3.1 Notebook Device Type

Device Type	Mode	Frequency [MHz]	Maximum Allowed Power [mW]	Separation Distance [mm]	Estimated SAR [W/kg]
Notebook	Bluetooth	2480	5.01	5.1	0.206

### Body SAR Simultaneous Transmission Analysis

Simultaneous TX	configuration	2.4 GHz Main Ant SAR(W/kg)	Bluetooth SAR (W/kg)	$\Sigma$ SAR (W/kg)
Body	Base	0.591	0.206	0.797
Simultaneous TX	configuration	5 GHz Main Ant SAR(W/kg)	Bluetooth SAR (W/kg)	$\Sigma$ SAR (W/kg)
Body	Base	0.963	0.206	1.169

**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.

### 23.3.2 Tablet PC Device Type

Frequency (MHz)	Output power		Separation distances (mm)						Estimated SAR Value					
	dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
<b>WLAN Main Antenna</b>														
2462	16.00	40	2.35	12	86.91	238.56	257.59	N/A	Measure	Measure	0.400	0.400	0.400	N/A
5320	11.00	13	2.35	12	86.91	238.56	257.59	N/A	Measure	0.333	0.400	0.400	0.400	N/A
5700	10.50	11	2.35	12	86.91	238.56	257.59	N/A	Measure	0.292	0.400	0.400	0.400	N/A
5825	11.00	13	2.35	12	86.91	238.56	257.59	N/A	Measure	0.349	0.400	0.400	0.400	N/A
<b>WLAN Aux Antenna</b>														
2462	15.50	35	2.35	64.4	6.1	162.4	362.16	N/A	Measure	0.400	Measure	0.400	0.400	N/A
5320	11.00	13	2.35	64.4	6.1	162.4	362.16	N/A	Measure	0.400	Measure	0.400	0.400	N/A
5700	10.50	11	2.35	64.4	6.1	162.4	362.16	N/A	Measure	0.400	Measure	0.400	0.400	N/A
5825	11.00	13	2.35	64.4	6.1	162.4	362.16	N/A	Measure	0.400	Measure	0.400	0.400	N/A
<b>Bluetooth Antenna</b>														
2480	7.00	5	2.35	64.4	6.1	162.4	362.16	N/A	0.210	0.400	0.175	0.400	0.400	N/A

### Body SAR Simultaneous Transmission Analysis

Simultaneous TX	configuration	2.4 GHz Main Ant SAR(W/kg)	Bluetooth SAR (W/kg)	$\sum$ SAR (W/kg)
Body	Rear	0.153	0.210	0.363
	Edge1	0.798	0.400	1.198
	configuration	5 GHz Main Ant SAR(W/kg)	Bluetooth SAR (W/kg)	$\sum$ SAR (W/kg)
	Rear	0.080	0.210	0.290

**Note:**

1. For distances < 5mm, a distance of 5mm is used to determine SAR exclusion and estimated SAR value.
2. Output power is the maximum rated power (including tune-up or manufacturing tolerances) and includes source-based averaging.
3. Formulas round separation distance to nearest mm and power to nearest mW before calculating estimated SAR or determining if SAR is excluded.
4. 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.

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## Appendix A.1 Verification Test Plots for 2450 MHz

Date: 2016-04-18

Test Laboratory : SGS Korea (Gunpo Laboratory)  
File Name: [2450MHz\\_Verification.d353.0](#)

Input Power : 100 mW

Ambient Temp : 22.9 °C Tissue Temp : 21.8 °C

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

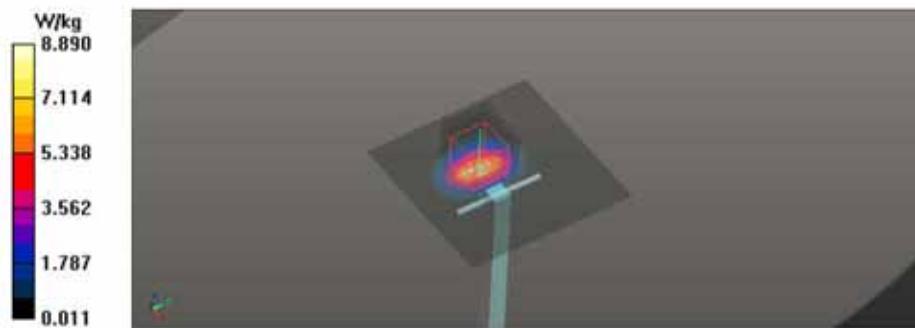
Communication System: UID 0, CW (0); Frequency: 2450 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.988$  S/m;  $\epsilon_r = 52.936$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(7.42, 7.42, 7.42); Calibrated: 2015-09-28;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1430; Calibrated: 2016-03-21
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1200
- DASY52 52.8.8(1222)SEMCAD X 14.6.10(7331)

**Verification/2450MHz Verification/Area Scan (101x101x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm  
Maximum value of SAR (interpolated) = 8.89 W/kg

**Verification/2450MHz Verification/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 45.68 V/m; Power Drift = 0.15 dB  
Peak SAR (extrapolated) = 10.5 W/kg  
**SAR(1 g) = 5.37 W/kg; SAR(10 g) = 2.56 W/kg**  
Maximum value of SAR (measured) = 8.71 W/kg



## Appendix A.2 Verification Test Plots for 5300 MHz

Date: 2016-04-23

Test Laboratory : SGS Korea (Gunpo Laboratory)  
File Name: [5300MHz\\_Verification.d3.53.0](#)

Input Power : 100 mW

Ambient Temp : 23.0 °C Tissue Temp : 21.7 °C

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1106**

Communication System: UID 0, CW (0); Frequency: 5300 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 5300$  MHz;  $\sigma = 5.401$  S/m;  $\epsilon_r = 49.204$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(4.1, 4.1, 4.1); Calibrated: 2015-09-28;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1430; Calibrated: 2016-03-21
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1200
- DASY52 52.8.8(1222)SEMCAD X 14.6.10(7331)

**Verification/5300MHz Verification/Area Scan (81x81x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm  
Maximum value of SAR (interpolated) = 15.7 W/kg

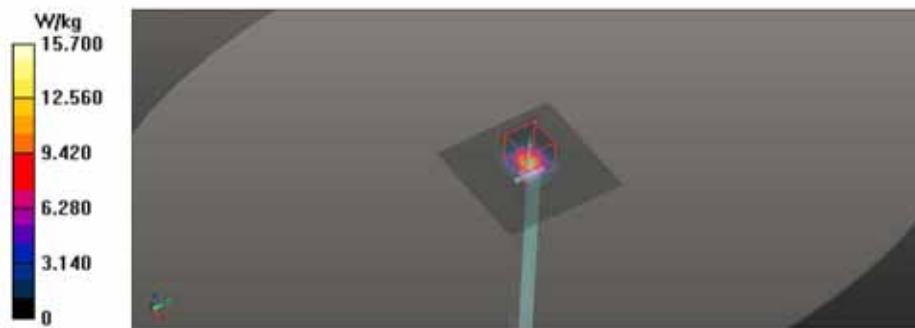
**Verification/5300MHz Verification/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 53.45 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 25.5 W/kg

SAR(1 g) = 7.58 W/kg; SAR(10 g) = 2.17 W/kg

Maximum value of SAR (measured) = 17.8 W/kg



### Appendix A.3 Verification Test Plots for 5600 MHz

Date: 2016-04-24

Test Laboratory : SGS Korea (Gunpo Laboratory)  
File Name: [5600MHz\\_Verification.d3z:0](#)

Input Power : 100 mW

Ambient Temp : 23.3 °C Tissue Temp : 22.3 °C

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1106**

Communication System: UID 0, CW (0); Frequency: 5600 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.811$  S/m;  $\epsilon_r = 49.374$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(3.75, 3.75, 3.75); Calibrated: 2015-09-28;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1430; Calibrated: 2016-03-21
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1200
- DASY52 52.8.8(1222)SEMCAD X 14.6.10(7331)

**Verification/5600MHz Verification/Area Scan (81x81x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm  
Maximum value of SAR (interpolated) = 17.8 W/kg

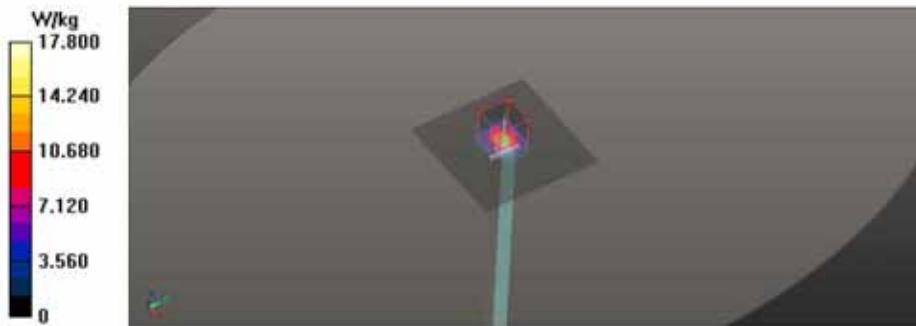
**Verification/5600MHz Verification/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 56.68 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 30.9 W/kg

**SAR(1 g) = 7.89 W/kg; SAR(10 g) = 2.2 W/kg**

Maximum value of SAR (measured) = 19.9 W/kg



## Appendix A.4 Verification Test Plots for 5800 MHz

Date: 2016-04-24

Test Laboratory : SGS Korea (Gunpo Laboratory)  
File Name: [5800MHz\\_Verification.d3z:0](#)

Input Power : 100 mW

Ambient Temp : 23.3 °C Tissue Temp : 22.3 °C

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1106**

Communication System: UID 0, CW (0); Frequency: 5800 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 5800$  MHz;  $\sigma = 6.157$  S/m;  $\epsilon_r = 49.185$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(3.82, 3.82, 3.82); Calibrated: 2015-09-28;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1430; Calibrated: 2016-03-21
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1200
- DASY52 52.8.8(1222)SEMCAD X 14.6.10(7331)

**Verification/5800MHz Verification/Area Scan (81x81x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm  
Maximum value of SAR (interpolated) = 17.3 W/kg

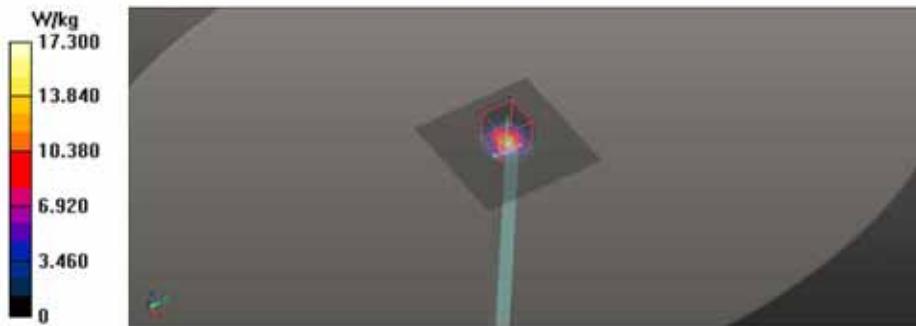
**Verification/5800MHz Verification/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 59.50 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 29.7 W/kg

**SAR(1 g) = 7.44 W/kg; SAR(10 g) = 2.09 W/kg**

Maximum value of SAR (measured) = 18.9 W/kg



## Appendix A.5 SAR Test Plots for WLAN 2450 MHz (Notebook Mode)

Date: 2016-04-18

Test Laboratory : SGS Korea (Gunpo Laboratory)  
File Name: [2.45GHz\\_WLAN\\_802.11b\\_Base\\_CH11\\_Main.da53:0](#)

Ambient Temp : 22.9 °C Tissue Temp : 21.8 °C

**DUT: NP740U5L; Type: Samsung Notebook; Serial: 0LP591ZH400026D**

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

Medium parameters used:  $f = 2462$  MHz;  $\sigma = 1.992$  S/m;  $\epsilon_r = 52.96$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(7.42, 7.42, 7.42); Calibrated: 2015-09-28;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1430; Calibrated: 2016-03-21
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1200
- DASY52 52.8.8(1222)SEMCAD X 14.6.10(7331)

**WLAN/2.45GHz\_WLAN\_802.11b\_Base\_CH11\_Main/Area Scan (131x131x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm  
Maximum value of SAR (interpolated) = 0.878 W/kg

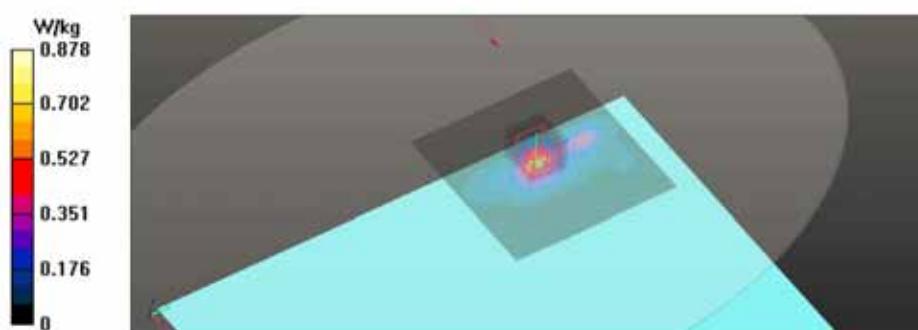
**WLAN/2.45GHz\_WLAN\_802.11b\_Base\_CH11\_Main/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 4.493 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 1.13 W/kg

**SAR(1 g) = 0.517 W/kg; SAR(10 g) = 0.224 W/kg**

Maximum value of SAR (measured) = 0.904 W/kg



## Appendix A.6 SAR Test Plots for WLAN 5.3GHz (Notebook Mode)

Date: 2016-04-23

Test Laboratory : SGS Korea (Gunpo Laboratory)  
File Name: [5.3GHz\\_WLAN\\_802.11ac\\_VHT80\\_Base\\_CH58\\_Main.d3s3.0](#)

Ambient Temp : 23.0 °C Tissue Temp : 21.7 °C

**DUT: NP740U5L; Type: Samsung Notebook; Serial: 0LP591ZH400026D**

Communication System: UID 0, 5GHz WLAN (0); Frequency: 5290 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5290$  MHz;  $\sigma = 5.386$  S/m;  $\epsilon_r = 49.214$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(4.1, 4.1, 4.1); Calibrated: 2015-09-28;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1430; Calibrated: 2016-03-21
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1200
- DASY52 52.8.8(1222)SEMCAD X 14.6.10(7331)

**WLAN/5.3GHz\_WLAN\_802.11ac\_VHT80\_Base\_CH58\_Main/Area Scan (131x131x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm  
Maximum value of SAR (interpolated) = 3.01 W/kg

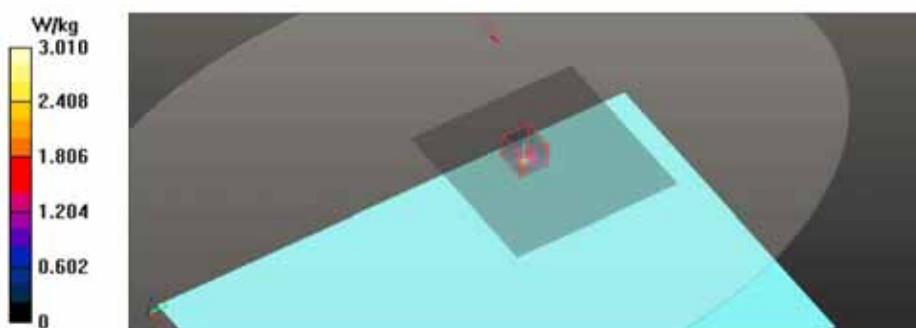
**WLAN/5.3GHz\_WLAN\_802.11ac\_VHT80\_Base\_CH58\_Main/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 6.087 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 2.62 W/kg

**SAR(1 g) = 0.693 W/kg; SAR(10 g) = 0.161 W/kg**

Maximum value of SAR (measured) = 1.71 W/kg



## Appendix A.7 SAR Test Plots for WLAN 5.6GHz (Notebook Mode)

Date: 2016-04-24

Test Laboratory : SGS Korea (Gunpo Laboratory)  
File Name: [5.6GHz\\_WLAN\\_802.11ac\\_VHT80\\_Base\\_CH106\\_Main.da53.0](#)

Ambient Temp : 23.3 °C Tissue Temp : 22.3 °C

**DUT: NP740U5L; Type: Samsung Notebook; Serial: 0LP591ZH400026D**

Communication System: UID 0, 5GHz WLAN (0); Frequency: 5530 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5530$  MHz;  $\sigma = 5.672$  S/m;  $\epsilon_r = 49.462$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(3.75, 3.75, 3.75); Calibrated: 2015-09-28;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1430; Calibrated: 2016-03-21
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1200
- DASY52 52.8.8(1222)SEMCAD X 14.6.10(7331)

**WLAN/5.6GHz\_WLAN\_802.11ac\_VHT80\_Base\_CH106\_Main/Area Scan (131x131x1): Interpolated grid:**

$dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 1.54 W/kg

**WLAN/5.6GHz\_WLAN\_802.11ac\_VHT80\_Base\_CH106\_Main/Zoom Scan (7x7x7)/Cube 0:**

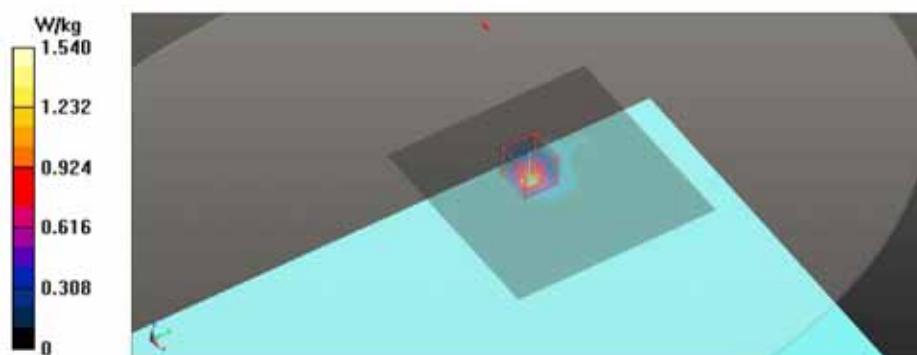
Measurement grid:  $dx=4$  mm,  $dy=4$  mm,  $dz=1.4$  mm

Reference Value = 16.69 V/m; Power Drift = -0.14 dB

Peak SAR (extrapolated) = 2.84 W/kg

**SAR(1 g) = 0.715 W/kg; SAR(10 g) = 0.217 W/kg**

Maximum value of SAR (measured) = 1.82 W/kg



## Appendix A.8 SAR Test Plots for WLAN 5.8GHz (Notebook Mode)

Date: 2016-04-24

Test Laboratory : SGS Korea (Gunpo Laboratory)  
File Name: [5.8GHz\\_WLAN\\_802.11ac\\_VHT80\\_Base\\_CH155\\_Aux.da53.0](#)

Ambient Temp : 23.3 °C Tissue Temp : 22.3 °C

**DUT: NP740U5L; Type: Samsung Notebook; Serial: 0LP591ZH400026D**

Communication System: UID 0, 5GHz WLAN (0); Frequency: 5775 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5775$  MHz;  $\sigma = 6.12$  S/m;  $\epsilon_r = 49.211$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(3.82, 3.82, 3.82); Calibrated: 2015-09-28;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1430; Calibrated: 2016-03-21
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1200
- DASY52 52.8.8(1222)SEMCAD X 14.6.10(7331)

**WLAN/5.8GHz\_WLAN\_802.11ac\_VHT80\_Base\_CH155\_Aux/Area Scan (131x111x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm  
Maximum value of SAR (interpolated) = 1.57 W/kg

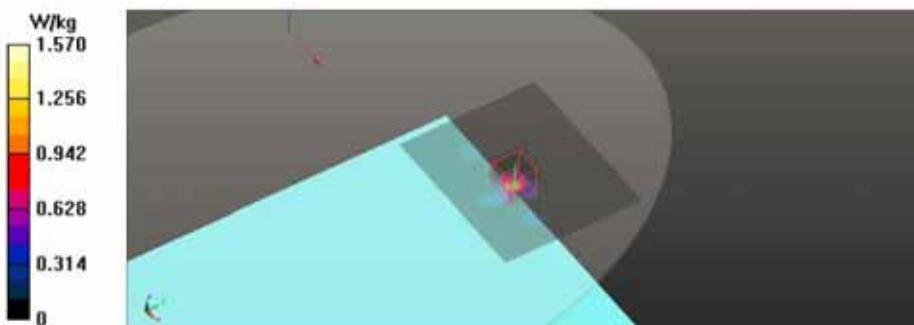
**WLAN/5.8GHz\_WLAN\_802.11ac\_VHT80\_Base\_CH155\_Aux/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 5.315 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 2.59 W/kg

**SAR(1 g) = 0.578 W/kg; SAR(10 g) = 0.134 W/kg**

Maximum value of SAR (measured) = 1.60 W/kg



## Appendix A.9 SAR Test Plots for WLAN 2450 MHz (Tablet Mode)

Date: 2016-04-18

Test Laboratory : SGS Korea (Gunpo Laboratory)  
File Name: [2.45GHz\\_WLAN\\_802.11b\\_Edge2\\_CH11\\_Aux\\_RepeatTest.da53:0](#)

Ambient Temp : 22.9 °C Tissue Temp : 21.8 °C

**DUT: NP740U5L; Type: Samsung Notebook; Serial: 0LP591ZH400026D**

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

Medium parameters used:  $f = 2462$  MHz;  $\sigma = 1.992$  S/m;  $\epsilon_r = 52.96$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(7.42, 7.42, 7.42); Calibrated: 2015-09-28;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1430; Calibrated: 2016-03-21
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1200
- DASY52 52.8.8(1222)SEMCAD X 14.6.10(7331)

**WLAN/2.45GHz\_WLAN\_802.11b\_Edge\_CH11\_Aux\_RepeatTest/Area Scan (91x131x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm  
Maximum value of SAR (interpolated) = 1.85 W/kg

**WLAN/2.45GHz\_WLAN\_802.11b\_Edge\_CH11\_Aux\_RepeatTest/Zoom Scan (7x8x7)/Cube 0:**

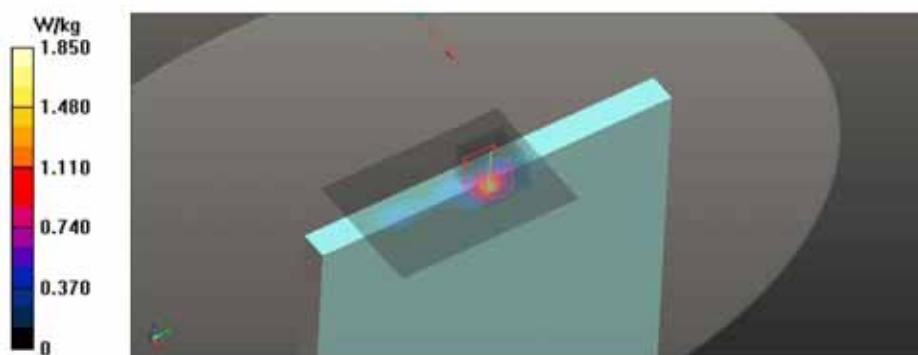
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 12.34 V/m; Power Drift = 0.14 dB

Peak SAR (extrapolated) = 2.37 W/kg

**SAR(1 g) = 0.977 W/kg; SAR(10 g) = 0.371 W/kg**

Maximum value of SAR (measured) = 1.87 W/kg



## Appendix A.10 SAR Test Plots for WLAN 5.3GHz (Tablet Mode)

Date: 2016-04-23

Test Laboratory : SGS Korea (Gunpo Laboratory)  
File Name: [5.3GHz\\_WLAN\\_802.11ac\\_VHT80\\_Edge2\\_CH58\\_Aux.da53:0](#)

Ambient Temp : 23.0 °C Tissue Temp : 21.7 °C

**DUT: NT740USL; Type: Samsung Notebook; Serial: 0LP591ZH400026D**

Communication System: UID 0, 5GHz WLAN (0); Frequency: 5290 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5290$  MHz;  $\sigma = 5.386$  S/m;  $\epsilon_r = 49.214$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(4.1, 4.1, 4.1); Calibrated: 2015-09-28;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1430; Calibrated: 2016-03-21
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1200
- DASY52 52.8.8(1222)SEMCAD X 14.6.10(7331)

**WLAN/5.3GHz\_WLAN\_802.11ac\_VHT80\_Edge2\_CH58\_Aux/Area Scan (91x131x1):** Interpolated grid:  
 $dx=1.000$  mm,  $dy=1.000$  mm  
Maximum value of SAR (interpolated) = 1.51 W/kg

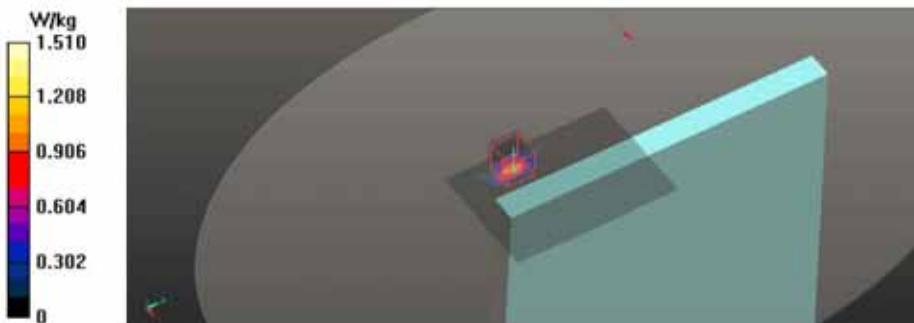
**WLAN/5.3GHz\_WLAN\_802.11ac\_VHT80\_Edge2\_CH58\_Aux/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=4$  mm,  $dy=4$  mm,  $dz=1.4$  mm

Reference Value = 6.538 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 1.88 W/kg

**SAR(1 g) = 0.516 W/kg; SAR(10 g) = 0.145 W/kg**

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



### Appendix A.11 SAR Test Plots for WLAN 5.6GHz (Tablet Mode)

Date: 2016-04-24

Test Laboratory : SGS Korea (Gunpo Laboratory)  
File Name: [5.6GHz\\_WLAN\\_802.11ac\\_VHT80\\_Edge2\\_CH138\\_Aux.da53:0](#)

Ambient Temp : 23.3 °C Tissue Temp : 22.3 °C

DUT: NT740U5L; Type: Samsung Notebook; Serial: 0LP591ZH400026D

Communication System: UID 0, 5GHz WLAN (0); Frequency: 5690 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5690$  MHz;  $\sigma = 5.974$  S/m;  $\epsilon_r = 49.315$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(3.75, 3.75, 3.75); Calibrated: 2015-09-28;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1430; Calibrated: 2016-03-21
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1200
- DASY52 52.8.8(1222)SEMCAD X 14.6.10(7331)

**WLAN/5.6GHz\_WLAN\_802.11ac\_VHT80\_Edge2\_CH138\_Aux/Area Scan (91x131x1):** Interpolated grid:

dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 1.67 W/kg

**WLAN/5.6GHz\_WLAN\_802.11ac\_VHT80\_Edge2\_CH138\_Aux/Zoom Scan (7x7x7)/Cube 0:**

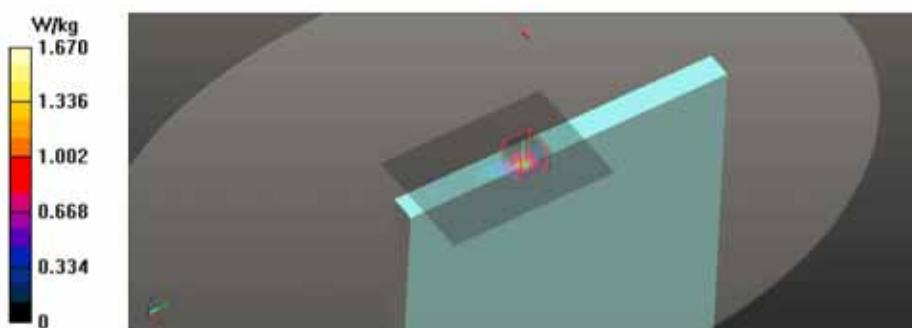
Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 6.388 V/m; Power Drift = -0.13 dB

Peak SAR (extrapolated) = 2.58 W/kg

**SAR(1 g) = 0.520 W/kg; SAR(10 g) = 0.136 W/kg**

Maximum value of SAR (measured) = 1.41 W/kg



### Appendix A.12 SAR Test Plots for WLAN 5.8GHz (Tablet Mode)

Date: 2016-04-24

Test Laboratory : SGS Korea (Gunpo Laboratory)  
File Name: [5.8GHz\\_WLAN\\_802.11ac\\_VHT80\\_Edge2\\_CH155\\_Aux.da53:0](#)

Ambient Temp : 23.3 °C Tissue Temp : 22.3 °C

**DUT: NP740U5L; Type: Samsung Notebook; Serial: 0LP591ZH400026D**

Communication System: UID 0, 5GHz WLAN (0); Frequency: 5775 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 5775$  MHz;  $\sigma = 6.12$  S/m;  $\epsilon_r = 49.211$ ;  $\rho = 1000$  kg/m<sup>3</sup>

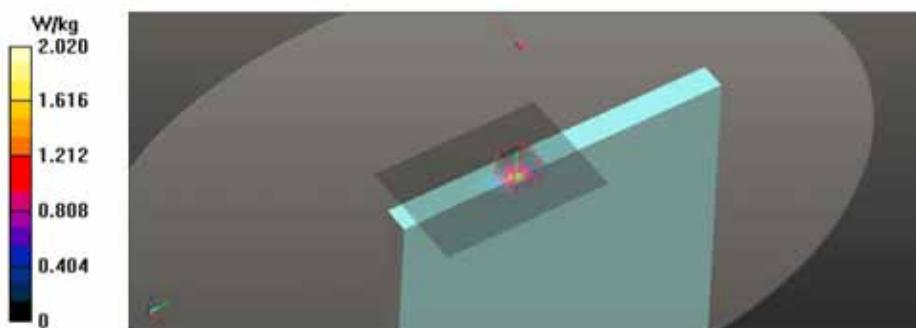
Phantom section: Flat Section

DASY52 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(3.82, 3.82, 3.82); Calibrated: 2015-09-28;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1430; Calibrated: 2016-03-21
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1200
- DASY52 52.8.8(1222)SEMCAD X 14.6.10(7331)

**WLAN/5.8GHz\_WLAN\_802.11ac\_VHT80\_Edge\_CH155\_Aux/Area Scan (91x131x1):** Interpolated grid:  
dx=1.000 mm, dy=1.000 mm  
Maximum value of SAR (interpolated) = 2.02 W/kg

**WLAN/5.8GHz\_WLAN\_802.11ac\_VHT80\_Edge\_CH155\_Aux/Zoom Scan (7x7x7)/Cube 0:** Measurement  
grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 5.957 V/m; Power Drift = -0.14 dB  
Peak SAR (extrapolated) = 2.79 W/kg  
**SAR(1 g) = 0.653 W/kg; SAR(10 g) = 0.172 W/kg**  
Maximum value of SAR (measured) = 1.74 W/kg



### Appendix B.1 Uncertainty Analysis DASY5 #2

Measurement uncertainty for 300 MHz to 6 GHz averaged over 1 gram

a	b	c	d	e = f(d,k)	f	g	h	i	k
							cxf/e	cxg/e	
Uncertainty Component	IEEE 1528	Tol	Prob.	Div.	Ci	Ci	1g	10g	Vi
	2013	(%)	Dist.		(1g)	(10g)	ui (%)	ui (%)	(Veef)
Probe calibration	E.2.1	6.55	N	1	1	1	6.55	6.55	$\infty$
Axial Isotropy	E.2.2	4.7	R	1.73	0.71	0.71	1.92	1.92	$\infty$
Hemispherical Isotropy	E.2.2	9.6	R	1.73	0.71	0.71	3.92	3.92	$\infty$
Boundary Effects	E.2.3	1	R	1.73	1	1	0.58	0.58	$\infty$
Modulation Response	E.2.5	2.4	R	1.73	1	1	1.39	1.39	$\infty$
Linearity	E.2.4	4.7	R	1.73	1	1	2.71	2.71	$\infty$
System Detection Limits	E.2.4	0.3	R	1.73	1	1	0.17	0.17	$\infty$
Reabout Electronics	E.2.6	0.3	N	1	1	1	0.30	0.30	$\infty$
Response Time	E.2.7	0.5	R	1.73	1	1	0.29	0.29	$\infty$
Integration Time	E.2.8	2.6	R	1.73	1	1	1.50	1.50	$\infty$
RF Ambient Noise	E.6.1	3	R	1.73	1	1	1.73	1.73	$\infty$
RF Ambient Reflections	E.6.1	3	R	1.73	1	1	1.73	1.73	$\infty$
Probe Positions	E.6.2	1.5	R	1.73	1	1	0.87	0.87	$\infty$
Probe Positioning	E.6.3	2.9	R	1.73	1	1	1.67	1.67	$\infty$
Max SAR evaluation	E.5	1	R	1.73	1	1	0.58	0.58	$\infty$
Test sample positioning	E.4.2	2.02/1.88	N	1	1	1	2.02	1.88	9
Device holder uncertainty	E.4.1	3.6	N	1	1	1	3.60	3.60	4
Output power variation -	E.2.9	5	R	1.73	1	1	2.89	2.89	$\infty$
SAR drift measurement									
Phantom uncertainty	E.3.1	4	R	1.73	1	1	2.31	2.31	$\infty$
Correcting SAR for deviations in permittivity and conductivity	E.3.2	1.2	R	1.73	1	0.84	0.69	0.58	$\infty$
Liquid conductivity-measurement	E.3.3	1.76	N	1	0.78	0.71	1.37	1.25	5
Liquid permittivity-measurement	E.3.3	1.72	N	1	0.23	0.26	0.39	0.45	4
Liquid conductivity-temperature	E.3.4	5.22	R	1.73	0.78	0.71	2.35	2.14	$\infty$
Liquid permittivity – temperature	E.3.4	0.84	R	1.73	0.23	0.26	0.11	0.13	$\infty$
Combined standard uncertainty				RSS			11.07	10.99	341/335
Expanded uncertainty				k=2			22.14	21.98	
(95% CONFIDENCE INTERVAL)									

**Appendix C.1 Calibration certificate for Probe(S/N 3862)**

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



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

Accreditation No.: SCS 0108

2015.10.8

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

Client SGS (Dymstec)

Certificate No: EX3-3862\_Sep15

**CALIBRATION CERTIFICATE**

Object

EX3DV4 - SN:3862

Calibration procedure(s)

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

Calibration date

September 28, 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  $(22 \pm 3)^\circ\text{C}$  and humidity < 70%.

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

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	01-Apr-15 (No. 217-02128)	Mar-16
Power sensor E4412A	MY41498087	01-Apr-15 (No. 217-02128)	Mar-16
Reference 3 dB Attenuator	SN: S5054 (3c)	01-Apr-15 (No. 217-02129)	Mar-16
Reference 20 dB Attenuator	SN: S5277 (20x)	01-Apr-15 (No. 217-02132)	Mar-16
Reference 30 dB Attenuator	SN: S5129 (30b)	01-Apr-15 (No. 217-02133)	Mar-16
Reference Probe ES30V2	SN: 3013	30-Dec-14 (No. ES3-3013_Dec14)	Dec-15
DAE4	SN: 660	14-Jan-15 (No. DAE4-660_Jan15)	Jan-16

Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

Calibrated by:	Name	Function	Signature
	Israe Elmouq	Laboratory Technician	
Approved by:	Katja Pekovic	Technical Manager	

Issued: September 30, 2015

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

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



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

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

Accreditation No.: SCS 0108

**Glossary:**

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

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Methods Applied and Interpretation of Parameters:**

- $NORM_{x,y,z}$ : Assessed for E-field polarization  $\theta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide).  $NORM_{x,y,z}$  are only intermediate values, i.e., the uncertainties of  $NORM_{x,y,z}$  does not affect the  $E^2$ -field uncertainty inside TSL (see below ConvF).
- $NORM(f,x,y,z) = NORM_{x,y,z} * frequency\_response$  (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- $DCPx,y,z$ : 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
- $A_{x,y,z}$ ;  $B_{x,y,z}$ ;  $C_{x,y,z}$ ;  $D_{x,y,z}$ ;  $VR_{x,y,z}$ ;  $A$ ,  $B$ ,  $C$ ,  $D$  are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters:** Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800$  MHz) and inside waveguide using analytical field distributions based on power measurements for  $f > 800$  MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to  $NORM_{x,y,z} * ConvF$  whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from  $\pm 50$  MHz to  $\pm 100$  MHz.
- Spherical Isotropy (3D deviation from isotropy):** in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset:** The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle:** The angle is assessed using the information gained by determining the  $NORM_{x,y,z}$  (no uncertainty required).

EX3DV4 – SN:3862

September 28, 2015

# Probe EX3DV4

## SN:3862

Manufactured: February 2, 2012  
Calibrated: September 28, 2015

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

EX3DV4- SN:3862

September 28, 2015

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

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	0.37	0.35	0.40	$\pm 10.1\%$
DCP (mV) <sup>B</sup>	105.6	101.3	98.9	

### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	158.9	$\pm 3.3\%$
		Y	0.0	0.0	1.0		148.1	
		Z	0.0	0.0	1.0		143.0	

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

<sup>A</sup> The uncertainties of Norm X,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 6).

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

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

EX3DV4- SN:3862

September 26, 2015

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

### Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) <sup>c</sup>	Relative Permittivity <sup>f</sup>	Conductivity (S/m) <sup>f</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>g</sup>	Depth <sup>g</sup> (mm)	Unc (k=2)
835	41.5	0.90	9.79	9.79	9.79	0.23	1.32	± 12.0 %
900	41.5	0.97	9.41	9.41	9.41	0.16	1.72	± 12.0 %
1750	40.1	1.37	8.31	8.31	8.31	0.34	0.85	± 12.0 %
1900	40.0	1.40	8.04	8.04	8.04	0.31	0.80	± 12.0 %
2300	39.5	1.67	7.66	7.66	7.66	0.25	1.00	± 12.0 %
2450	39.2	1.80	7.22	7.22	7.22	0.27	0.99	± 12.0 %
2600	39.0	1.96	7.10	7.10	7.10	0.25	1.13	± 12.0 %
5200	36.0	4.66	5.14	5.14	5.14	0.40	1.80	± 13.1 %
5300	35.9	4.76	4.94	4.94	4.94	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.70	4.70	4.70	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.39	4.39	4.39	0.45	1.80	± 13.1 %
5800	35.3	5.27	4.37	4.37	4.37	0.50	1.80	± 13.1 %

<sup>c</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 160 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

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

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

EX3DV4- SN:3862

September 28, 2015

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

### Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unc (k=2)
835	55.2	0.97	9.70	9.70	9.70	0.19	1.65	± 12.0 %
1750	53.4	1.49	8.02	8.02	8.02	0.38	0.85	± 12.0 %
1900	53.3	1.52	7.77	7.77	7.77	0.26	1.04	± 12.0 %
2450	52.7	1.95	7.42	7.42	7.42	0.30	0.95	± 12.0 %
2600	52.5	2.16	7.29	7.29	7.29	0.25	0.97	± 12.0 %
5200	49.0	5.30	4.32	4.32	4.32	0.50	1.90	± 13.1 %
5300	48.9	5.42	4.10	4.10	4.10	0.50	1.90	± 13.1 %
5600	48.5	5.77	3.75	3.75	3.75	0.50	1.90	± 13.1 %
5800	48.2	6.00	3.82	3.82	3.82	0.55	1.90	± 13.1 %

<sup>C</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

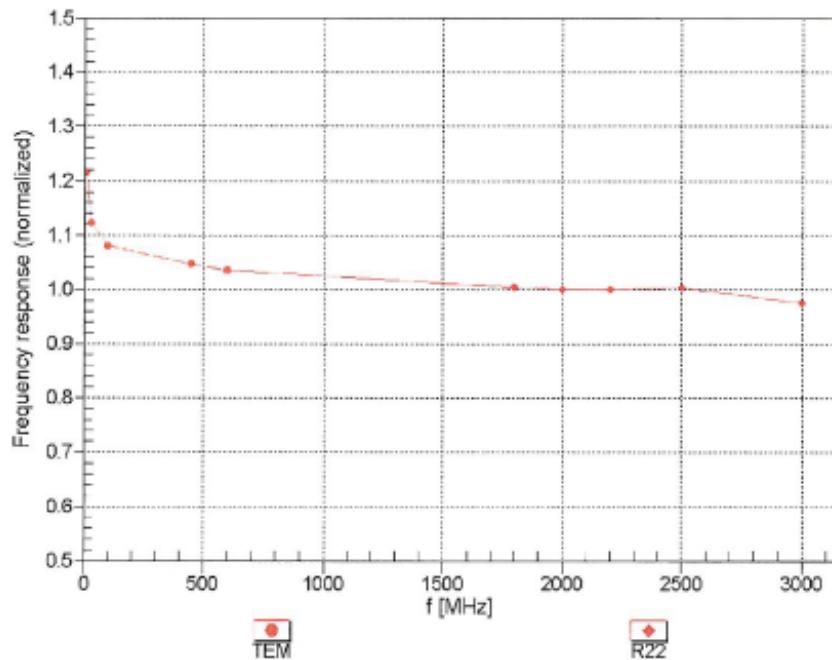
<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted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

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

EX3DV4-SN:3862

September 28, 2015

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

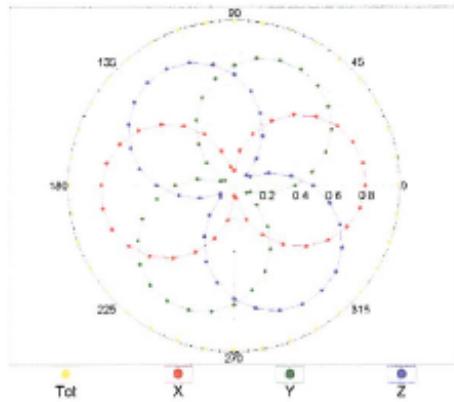
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

EX3DV4- SN:3862

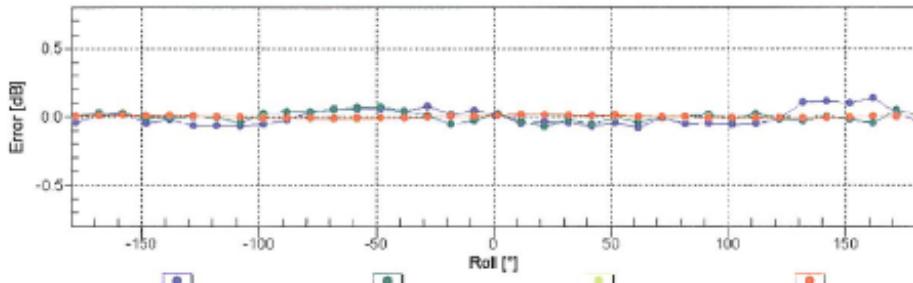
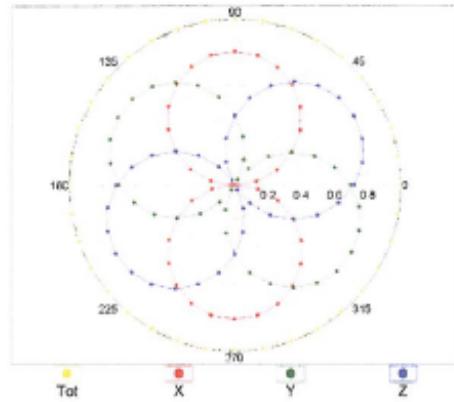
September 28, 2015

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

f=600 MHz, TEM



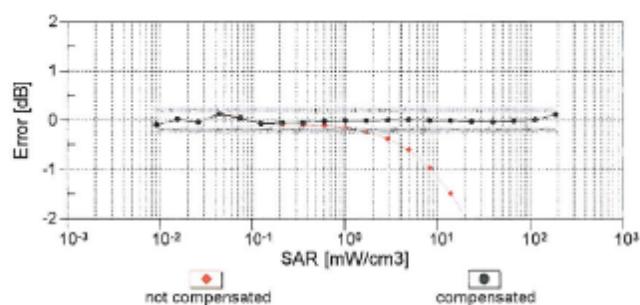
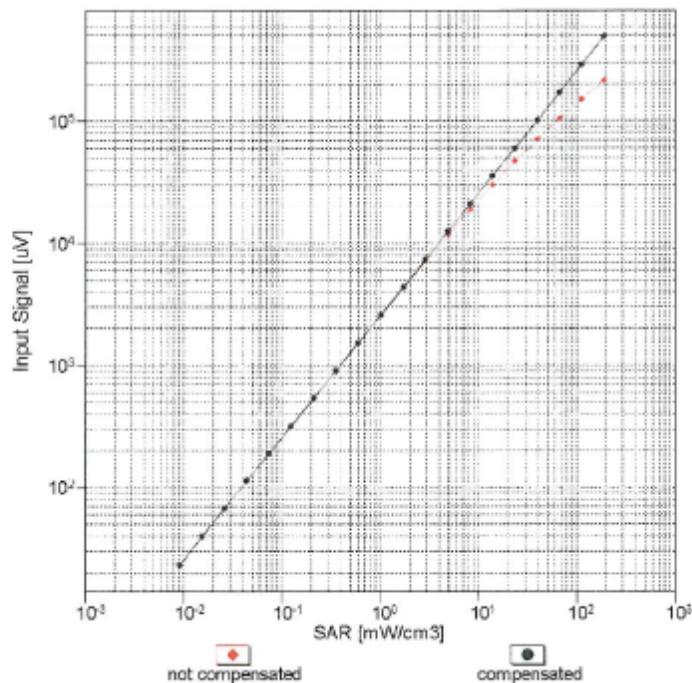
f=1800 MHz, R22



EX3DV4- SN:3862

September 28, 2015

**Dynamic Range f(SAR<sub>head</sub>)**  
(TEM cell , f<sub>eval</sub>= 1900 MHz)

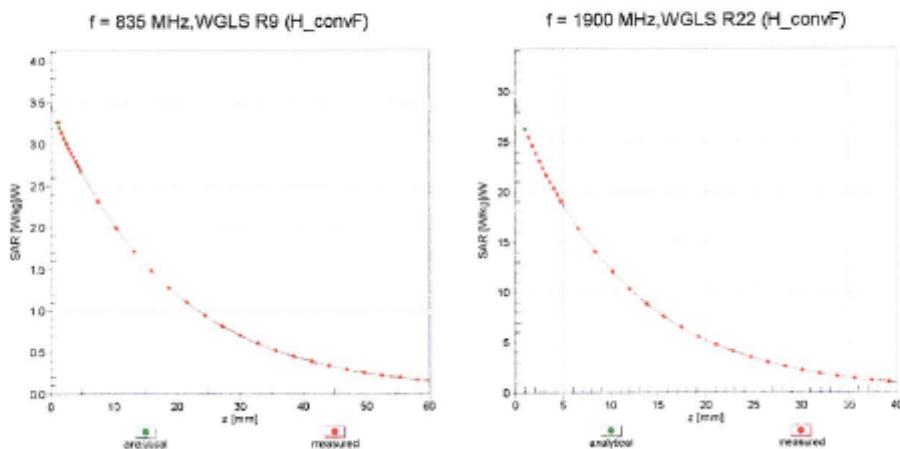


Uncertainty of Linearity Assessment:  $\pm 0.6\%$  (k=2)

EX3DV4- SN:3862

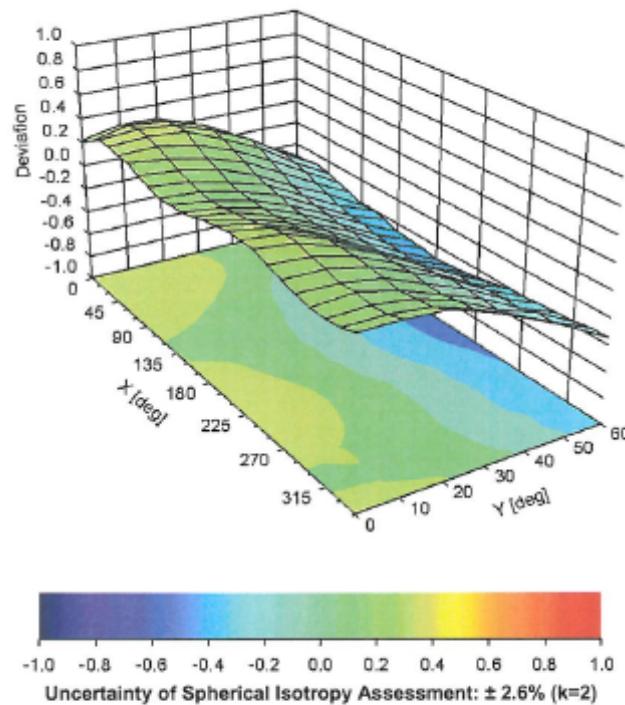
September 28, 2015

## Conversion Factor Assessment



## Deviation from Isotropy in Liquid

Error ( $\phi, \theta$ ),  $f = 900 \text{ MHz}$



EX3DV4- SN:3862

September 28, 2015

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

### **Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-28.2
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

## Appendix C.2 Calibration certificate for DAE

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



**S** Schweizerischer Kalibrierdienst  
**C** Service suisse d'étalementage  
**S** Servizio svizzero di taratura  
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The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**Client **SGS Korea (Dymstec)**Certificate No: **DAE4-1430\_Mar16**

### CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BM - SN: 1430**Calibration procedure(s) **QA CAL-06.v29**  
Calibration procedure for the data acquisition electronics (DAE)Calibration date: **March 21, 2016**

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 &lt; 70%.

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

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	09-Sep-15 (No:17153)	Sep-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	05-Jan-16 (in house check)	In house check: Jan-17
Calibrator Box V2.t	SE UMS 006 AA 1002	05-Jan-16 (in house check)	In house check: Jan-17

Calibrated by:	Name R. Mayoraz	Function Technician	Signature 
Approved by:	Fin Bomholt	Deputy Technical Manager	

Issued: March 22, 2016

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



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

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

Accreditation No.: **SCS 0108**

### Glossary

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

### Methods Applied and Interpretation of Parameters

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

#### DC Voltage Measurement

A/D - Converter Resolution nominal  
High Range: 1LSB =  $6.1\mu\text{V}$ , full range =  $-100...+300\text{ mV}$   
Low Range: 1LSB =  $61\text{nV}$ , full range =  $-1.....+3\text{mV}$   
DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	$404.000 \pm 0.02\% \text{ (k=2)}$	$404.187 \pm 0.02\% \text{ (k=2)}$	$404.021 \pm 0.02\% \text{ (k=2)}$
Low Range	$3.97417 \pm 1.50\% \text{ (k=2)}$	$3.99744 \pm 1.50\% \text{ (k=2)}$	$4.00834 \pm 1.50\% \text{ (k=2)}$

#### Connector Angle

Connector Angle to be used in DASY system	$253.5^\circ \pm 1^\circ$
---	---------------------------

**Appendix (Additional assessments outside the scope of SCS0108)****1. DC Voltage Linearity**

High Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	200031.18	-3.10	-0.00
Channel X + Input	20006.09	1.50	0.01
Channel X - Input	-20002.66	2.96	-0.01
Channel Y + Input	200031.68	-2.83	-0.00
Channel Y + Input	20003.18	-1.19	-0.01
Channel Y - Input	-20006.52	-0.80	0.00
Channel Z + Input	200032.65	-1.93	-0.00
Channel Z + Input	20003.81	-0.62	-0.00
Channel Z - Input	-20006.89	-1.13	0.01

Low Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	2001.13	0.13	0.01
Channel X + Input	201.16	0.11	0.06
Channel X - Input	-198.65	0.31	-0.16
Channel Y + Input	2001.05	0.23	0.01
Channel Y + Input	200.42	-0.37	-0.18
Channel Y - Input	-199.70	-0.49	0.24
Channel Z + Input	2000.72	-0.04	-0.00
Channel Z + Input	199.57	-1.12	-0.56
Channel Z - Input	-201.13	-1.93	0.97

**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	2.96	1.45
	-200	-0.55	-2.01
Channel Y	200	-20.53	-20.60
	-200	20.12	19.64
Channel Z	200	-17.81	-18.51
	-200	16.71	15.91

**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	-	2.07	-3.93
Channel Y	200	7.81	-	3.01
Channel Z	200	10.13	5.46	-

**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	16018	16873
Channel Y	16237	13845
Channel Z	15847	17732

**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	0.72	-0.09	2.25	0.40
Channel Y	-1.21	-1.99	0.25	0.37
Channel Z	-1.07	-1.88	-0.08	0.43

**6. Input Offset Current**

Nominal Input circuitry offset current on all channels: &lt;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)**

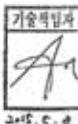
Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	-0.01	-8	-9

### 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  
**S** Servizio svizzero di taratura  
**S** Swiss Calibration Service

Accreditation No.: **SCS 0108**

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

Client **SGS (Dymstec)**Certificate No: **D2450V2-892\_Apr15**

### CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 892**Calibration procedure(s) **QA CAL-05.v9**  
Calibration procedure for dipole validation kits above 700 MHzCalibration date: **April 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  $(22 \pm 3)^\circ\text{C}$  and humidity  $< 70\%$ .

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

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US372927B3	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41082317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (20k)	01-Apr-15 (No. 217-02131)	Mar-16
Type-N mismatch combination	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02134)	Mar-16
Reference Probe ES3DV3	SN: 3205	30-Dec-14 (No. ES3-3205_Dec14)	Dec-15
DAE4	SN: 601	18-Aug-14 (No. DAE4-601_Aug14)	Aug-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-14)	In house check: Oct-15

Calibrated by: Name **Michael Weber** Function **Laboratory Technician** Signature Approved by: Name **Katja Pokovic** Function **Technical Manager** Signature 

Issued: April 23, 2015

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

Certificate No: **D2450V2-892\_Apr15**

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Report File No : **F690501/RF-SAR002366**Date of Issue : **2016-05-12**(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>.)

RTT5041-76(2015.10.01) (2)

A4 (210mm x 297mm)

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



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

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

Accreditation No.: **SCS 0108****Glossary:**

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

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Additional Documentation:**

- DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

**Measurement Conditions**

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

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	37.6 ± 6 %	1.82 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Head TSL**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.0 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	6.09 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.1 W/kg ± 16.5 % (k=2)

**Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	50.6 ± 6 %	2.02 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Body TSL**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	51.4 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	6.10 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.0 W/kg ± 16.5 % (k=2)

**Appendix (Additional assessments outside the scope of SCS 0108)**

**Antenna Parameters with Head TSL**

Impedance, transformed to feed point	54.4 $\Omega$ + 2.3 $j\Omega$
Return Loss	- 26.5 dB

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	49.9 $\Omega$ + 3.7 $j\Omega$
Return Loss	- 28.5 dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.162 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	October 06, 2011

**DASY5 Validation Report for Head TSL**

Date: 22.04.2015

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.82$  S/m;  $\epsilon_r = 37.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.54, 4.54, 4.54); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- 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:**

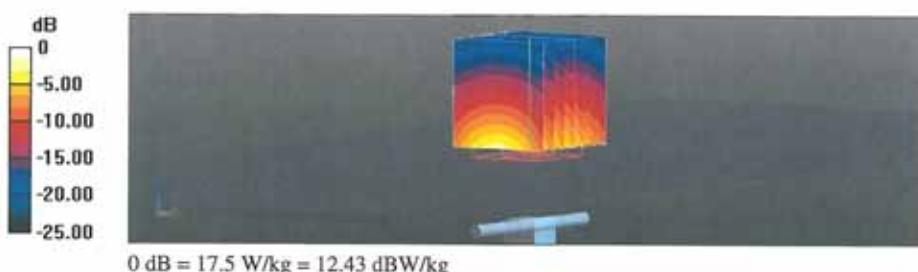
Measurement grid: dx=5mm, dy=5mm, dz=5mm

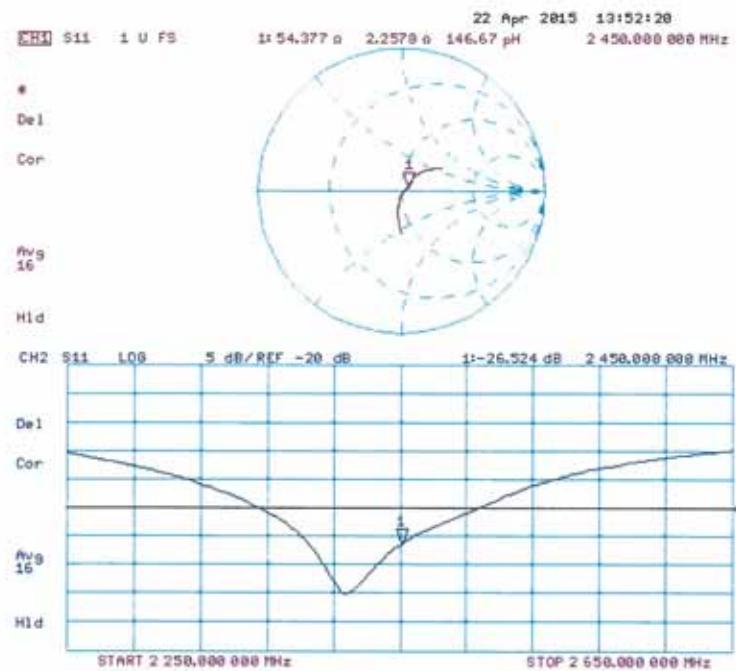
Reference Value = 101.4 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 27.5 W/kg

SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.09 W/kg

Maximum value of SAR (measured) = 17.5 W/kg



**Impedance Measurement Plot for Head TSL**

**DASY5 Validation Report for Body TSL**

Date: 22.04.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 892**Communication System: UID 0 - CW; Frequency: 2450 MHz  
Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.02$  S/m;  $\epsilon_r = 50.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.32, 4.32, 4.32); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

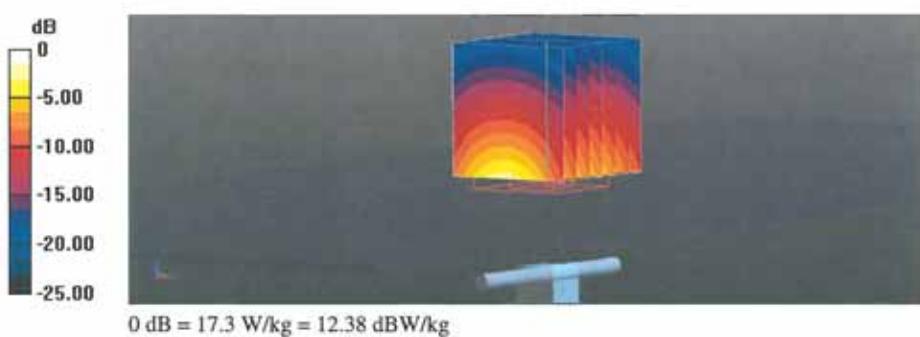
Measurement grid: dx=5mm, dy=5mm, dz=5mm

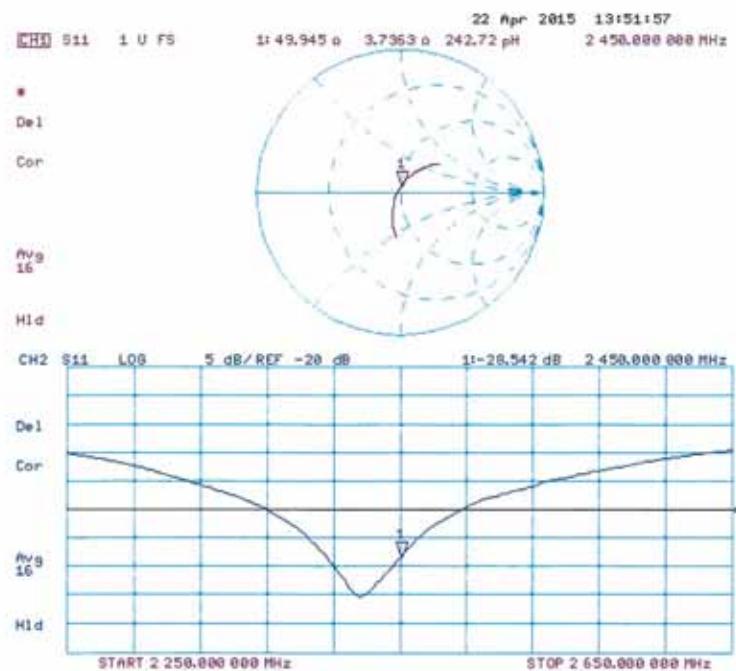
Reference Value = 95.49 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 27.4 W/kg

SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.1 W/kg

Maximum value of SAR (measured) = 17.3 W/kg



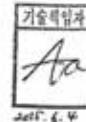
**Impedance Measurement Plot for Body TSL**

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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**Client **SGS (Dymstec)**Certificate No: **D5GHzV2-1106\_May15**

## CALIBRATION CERTIFICATE

Object	D5GHzV2 - SN: 1106
Calibration procedure(s)	QA CAL-22.v2 Calibration procedure for dipole validation kits between 3-6 GHz
Calibration date:	May 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  $(22 \pm 3)^\circ\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (20k)	01-Apr-15 (No. 217-02131)	Mar-16
Type-N mismatch combination	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02134)	Mar-16
Reference Probe EX3DV4	SN: 3503	30-Dec-14 (No. EX3-3503_Dec14)	Dec-15
DAE4	SN: 601	18-Aug-14 (No. DAE4-601_Aug14)	Aug-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-14)	In house check: Oct-15

Calibrated by:	Name Michael Weber	Function Laboratory Technician	Signature 
Approved by:	Katja Pokovic	Technical Manager	

Issued: May 22, 2015

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Certificate No: D5GHzV2-1106\_May15

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

Accreditation No.: **SCS 0108****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.

<b>DASY Version</b>	DASY5	V52.8.8
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Modular Flat Phantom V5.0	
<b>Distance Dipole Center - TSL</b>	10 mm	with Spacer
<b>Zoom Scan Resolution</b>	$dx, dy = 4.0 \text{ mm}, dz = 1.4 \text{ mm}$	Graded Ratio = 1.4 (Z direction)
<b>Frequency</b>	5200 MHz $\pm 1 \text{ MHz}$ 5300 MHz $\pm 1 \text{ MHz}$ 5500 MHz $\pm 1 \text{ MHz}$ 5600 MHz $\pm 1 \text{ MHz}$ 5800 MHz $\pm 1 \text{ MHz}$	

**Head TSL parameters at 5200 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	36.0	4.66 mho/m
<b>Measured Head TSL parameters</b>	(22.0 $\pm$ 0.2) °C	34.4 $\pm$ 6 %	4.45 mho/m $\pm$ 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

**SAR result with Head TSL at 5200 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.08 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.0 W/kg $\pm$ 19.9 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (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	22.8 W/kg $\pm$ 19.5 % (k=2)

**Head TSL parameters at 5300 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	35.9	4.76 mho/m
<b>Measured Head TSL parameters</b>	(22.0 ± 0.2) °C	34.3 ± 6 %	4.54 mho/m ± 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

**SAR result with Head TSL at 5300 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	83.1 W / kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.42 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.9 W/kg ± 19.5 % (k=2)

**Head TSL parameters at 5500 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	35.6	4.96 mho/m
<b>Measured Head TSL parameters</b>	(22.0 ± 0.2) °C	34.0 ± 6 %	4.73 mho/m ± 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

**SAR result with Head TSL at 5500 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	82.7 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.6 W/kg ± 19.5 % (k=2)

**Head TSL parameters at 5600 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	35.5	5.07 mho/m
<b>Measured Head TSL parameters</b>	(22.0 ± 0.2) °C	33.9 ± 6 %	4.83 mho/m ± 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

**SAR result with Head TSL at 5600 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	82.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.4 W/kg ± 19.5 % (k=2)

**Head TSL parameters at 5800 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	35.3	5.27 mho/m
<b>Measured Head TSL parameters</b>	(22.0 ± 0.2) °C	33.6 ± 6 %	5.03 mho/m ± 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

**SAR result with Head TSL at 5800 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.05 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.5 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.7 W/kg ± 19.5 % (k=2)

**Body TSL parameters at 5200 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	49.0	5.30 mho/m
<b>Measured Body TSL parameters</b>	(22.0 ± 0.2) °C	47.3 ± 6 %	5.43 mho/m ± 6 %
<b>Body TSL temperature change during test</b>	< 0.5 °C	---	---

**SAR result with Body TSL at 5200 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.51 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	74.6 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	Condition	
SAR measured	100 mW input power	2.10 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.8 W/kg ± 19.5 % (k=2)

**Body TSL parameters at 5300 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	48.9	5.42 mho/m
<b>Measured Body TSL parameters</b>	(22.0 ± 0.2) °C	47.1 ± 6 %	5.56 mho/m ± 6 %
<b>Body TSL temperature change during test</b>	< 0.5 °C	---	---

**SAR result with Body TSL at 5300 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.66 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	76.1 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	Condition	
SAR measured	100 mW input power	2.14 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.2 W/kg ± 19.5 % (k=2)

**Body TSL parameters at 5600 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	48.5	5.77 mho/m
<b>Measured Body TSL parameters</b>	(22.0 ± 0.2) °C	46.6 ± 6 %	5.96 mho/m ± 6 %
<b>Body TSL temperature change during test</b>	< 0.5 °C	---	---

**SAR result with Body TSL at 5600 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.07 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	80.2 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	Condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	22.2 W/kg ± 19.5 % (k=2)

**Body TSL parameters at 5800 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	48.2	6.00 mho/m
<b>Measured Body TSL parameters</b>	(22.0 ± 0.2) °C	46.3 ± 6 %	6.23 mho/m ± 6 %
<b>Body TSL temperature change during test</b>	< 0.5 °C	---	---

**SAR result with Body TSL at 5800 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.78 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	77.3 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	Condition	
SAR measured	100 mW input power	2.15 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.3 W/kg ± 19.5 % (k=2)

**Appendix (Additional assessments outside the scope of SCS 0108)****Antenna Parameters with Head TSL at 5200 MHz**

Impedance, transformed to feed point	49.7 $\Omega$ - 10.0 $j\Omega$
Return Loss	- 20.0 dB

**Antenna Parameters with Head TSL at 5300 MHz**

Impedance, transformed to feed point	50.9 $\Omega$ - 3.9 $j\Omega$
Return Loss	- 27.9 dB

**Antenna Parameters with Head TSL at 5500 MHz**

Impedance, transformed to feed point	48.5 $\Omega$ - 4.3 $j\Omega$
Return Loss	- 26.7 dB

**Antenna Parameters with Head TSL at 5600 MHz**

Impedance, transformed to feed point	55.1 $\Omega$ - 5.9 $j\Omega$
Return Loss	- 22.7 dB

**Antenna Parameters with Head TSL at 5800 MHz**

Impedance, transformed to feed point	54.1 $\Omega$ - 0.4 $j\Omega$
Return Loss	- 28.1 dB

**Antenna Parameters with Body TSL at 5200 MHz**

Impedance, transformed to feed point	50.0 $\Omega$ - 8.5 $j\Omega$
Return Loss	- 21.4 dB

**Antenna Parameters with Body TSL at 5300 MHz**

Impedance, transformed to feed point	50.9 $\Omega$ - 3.1 $j\Omega$
Return Loss	- 30.0 dB

**Antenna Parameters with Body TSL at 5600 MHz**

Impedance, transformed to feed point	55.5 $\Omega$ - 4.3 $j\Omega$
Return Loss	- 23.6 dB

**Antenna Parameters with Body TSL at 5800 MHz**

Impedance, transformed to feed point	54.5 $\Omega$ + 1.0 $j\Omega$
Return Loss	- 27.0 dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.198 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

**Additional EUT Data**

Manufactured by	SPEAG
Manufactured on	March 11, 2011

### **DASY5 Validation Report for Head TSL**

Date: 22.05.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1106**

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz  
Medium parameters used:  $f = 5200 \text{ MHz}$ ;  $\sigma = 4.45 \text{ S/m}$ ;  $\epsilon_r = 34.4$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used:  $f = 5300 \text{ MHz}$ ;  $\sigma = 4.54 \text{ S/m}$ ;  $\epsilon_r = 34.3$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used:  $f = 5500 \text{ MHz}$ ;  $\sigma = 4.73 \text{ S/m}$ ;  $\epsilon_r = 34$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used:  $f = 5600 \text{ MHz}$ ;  $\sigma = 4.83 \text{ S/m}$ ;  $\epsilon_r = 33.9$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used:  $f = 5800 \text{ MHz}$ ;  $\sigma = 5.03 \text{ S/m}$ ;  $\epsilon_r = 33.6$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.51, 5.51, 5.51); Calibrated: 30.12.2014, ConvF(5.21, 5.21, 5.21); Calibrated: 30.12.2014, ConvF(5.12, 5.12, 5.12); Calibrated: 30.12.2014, ConvF(4.92, 4.92, 4.92); Calibrated: 30.12.2014, ConvF(4.9, 4.9, 4.9); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- 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:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 66.79 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 29.3 W/kg

SAR(1 g) = 8.08 W/kg; SAR(10 g) = 2.31 W/kg

Maximum value of SAR (measured) = 18.2 W/kg

#### **Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:**

Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 67.17 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 31.1 W/kg

SAR(1 g) = 8.4 W/kg; SAR(10 g) = 2.42 W/kg

Maximum value of SAR (measured) = 19.6 W/kg

#### **Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:**

Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 65.76 V/m; Power Drift = 0.02 dB

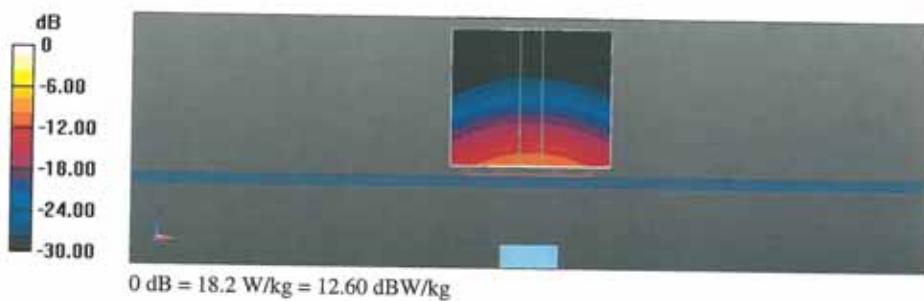
Peak SAR (extrapolated) = 32.5 W/kg

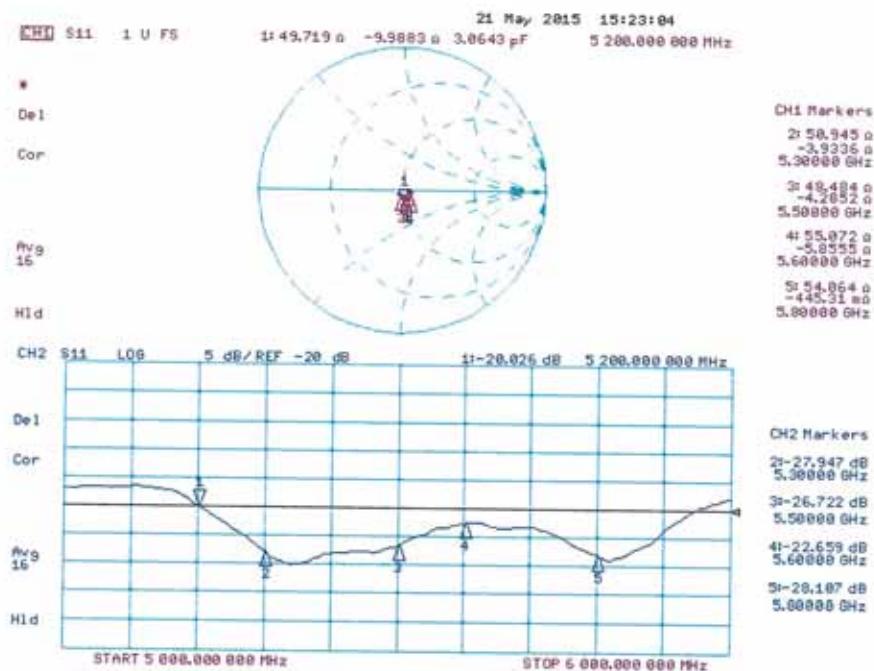
SAR(1 g) = 8.37 W/kg; SAR(10 g) = 2.4 W/kg

Maximum value of SAR (measured) = 20.0 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 = 65.47 V/m; Power Drift = 0.03 dB  
Peak SAR (extrapolated) = 32.3 W/kg  
SAR(1 g) = 8.3 W/kg; SAR(10 g) = 2.37 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 = 63.69 V/m; Power Drift = -0.01 dB  
Peak SAR (extrapolated) = 32.3 W/kg  
SAR(1 g) = 8.05 W/kg; SAR(10 g) = 2.3 W/kg  
Maximum value of SAR (measured) = 19.5 W/kg



**Impedance Measurement Plot for Head TSL**

## **DASY5 Validation Report for Body TSL**

Date: 21.05.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1106**

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz

Medium parameters used:  $f = 5200 \text{ MHz}$ ;  $\sigma = 5.43 \text{ S/m}$ ;  $\epsilon_r = 47.3$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used:  $f = 5300 \text{ MHz}$ ;  $\sigma = 5.56 \text{ S/m}$ ;  $\epsilon_r = 47.1$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used:  $f = 5600 \text{ MHz}$ ;  $\sigma = 5.96 \text{ S/m}$ ;  $\epsilon_r = 46.6$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used:  $f = 5800 \text{ MHz}$ ;  $\sigma = 6.23 \text{ S/m}$ ;  $\epsilon_r = 46.3$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.95, 4.95, 4.95); Calibrated: 30.12.2014, ConvF(4.78, 4.78, 4.78); Calibrated: 30.12.2014, ConvF(4.35, 4.35, 4.35); Calibrated: 30.12.2014, ConvF(4.32, 4.32, 4.32); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- 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:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 59.44 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 29.5 W/kg

SAR(1 g) = 7.51 W/kg; SAR(10 g) = 2.1 W/kg

Maximum value of SAR (measured) = 18.0 W/kg

**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 59.13 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 30.9 W/kg

SAR(1 g) = 7.66 W/kg; SAR(10 g) = 2.14 W/kg

Maximum value of SAR (measured) = 18.6 W/kg

**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

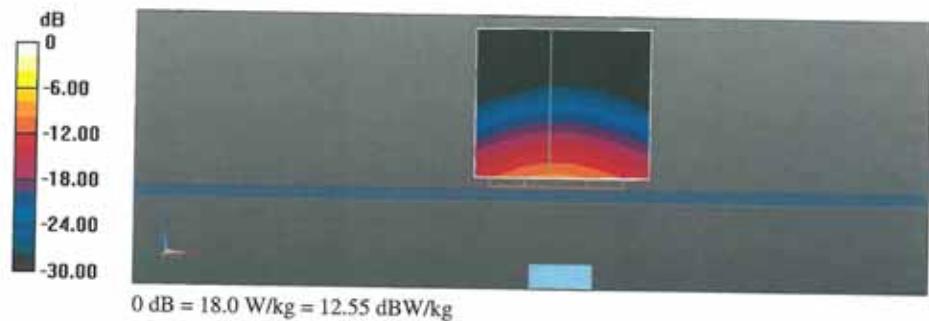
Reference Value = 59.00 V/m; Power Drift = 0.03 dB

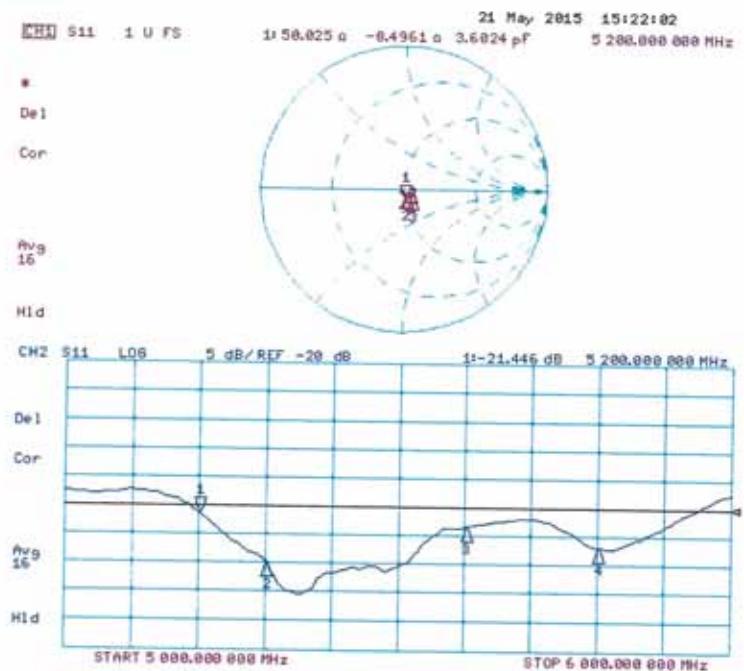
Peak SAR (extrapolated) = 35.2 W/kg

SAR(1 g) = 8.07 W/kg; SAR(10 g) = 2.24 W/kg

Maximum value of SAR (measured) = 20.1 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 = 56.85 V/m; Power Drift = 0.02 dB  
Peak SAR (extrapolated) = 36.1 W/kg  
SAR(1 g) = 7.78 W/kg; SAR(10 g) = 2.15 W/kg  
Maximum value of SAR (measured) = 19.7 W/kg



**Impedance Measurement Plot for Body TSL****-THE END-**