# FCC SAR TEST REPORT

**Test File No : F690501/RF-SAR002392**

| | |
|---|---|
| **Equipment Under Test** | Module |
| **Model Name** | 8265D2W |
| **Host Device** | NOTEBOOK PC |
| **Host Device Name** | NP900X3N |
| **Applicant** | Intel Mobile Communications |
| **Address of Applicant** | Intel Mobile Communications 100 Center Point Circle Suite 200 Columbia, SC 29210 USA |
| **FCC ID** | PD98265D2 |
| **Exposure Category** | General Population/Uncontrolled Exposure |
| **Standards** | FCC 47 CFR Part 2 (2.1093)<br>IEEE 1528, 2013<br>ANSI/IEEE C95.1, C95.3 |
| **Date of Receipt** | 2016-10-04 |
| **Date of Test(s)** | 2016-10-14 ~ 2016-10-17 |
| **Date of Issue** | 2016-11-02 |
| **Test Result** | Refer to the Page 05 |

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

**Remarks:**



**Report prepared by /**
**Matthew Park**
**Test Engineer**

**Approved by /**
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**Technical Manager**

## Revision history

| Revision | Date of issue | Revisions | Revised By |
|---|---|---|---|
| - | November 02,2016 | Initial issue | - |

**Contents**

## 1 Testing Laboratory

| | |
|---|---|
| **Company Name** | SGS Korea Co., Ltd. (Gunpo Laboratory) |
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## 2 Details of Manufacturer

| | |
|---|---|
| **Applicant** | Intel Mobile Communications |
| **Address** | Intel Mobile Communications 100 Center Point Circle Suite 200 Columbia, SC 29210 USA |
| **Email** | steven.c.hackett@intel.com |
| **Phone No.** | 803-216-2344 |

## 3 Description of EUT(s)

| | |
|---|---|
| **Equipment Under Test** | Module |
| **Model Name** | 8265D2W |
| **Host Device** | NOTEBOOK PC |
| **Host Device Name** | NP900X3N |
| **Mode of Operation** | WLAN, Bluetooth |
| **Duty Cycle** | 1 (WLAN) / 1.307 (Bluetooth) |
| **Body worn Accessory** | None |
| **Tx Frequency Range** | 2412 ‘ ~ 2462 ‘ (WLAN_802.11b/g/n)<br>5180 ‘ ~ 5240 ‘ , 5260 ‘ ~ 5320 ‘ (WLAN_802.11a/n/ac)<br>5500 ‘ ~ 5700 ‘ (WLAN_802.11a)<br>5500 ‘ ~ 5725 ‘ (WLAN_802.11n/ac)<br>5745 ‘ ~ 5825 ‘ (WLAN_802.11a/n/ac)<br>2402 ‘ ~ 2480 ‘ (Bluetooth) |

**Antenna Information**

| Port | Main | Aux |
|---|---|---|
| Manufacturer | Galtronics | Galtronics |
| Type | PIFA | PIFA |

| Main Antenna Gain (dBi) | | Aux Antenna Gain (dBi) | |
|---|---|---|---|
| 2.40 GHz ~ 2.50GHz | 1.61 | 2.40 GHz ~ 2.50GHz | 1.67 |
| 5.150 GHz ~ 5.350 GHz | 3.48 | 5.150 GHz ~ 5.350 GHz | 3.55 |
| 5.470 GHz ~ 5.725 GHz | 2.06 | 5.470 GHz ~ 5.725 GHz | 3.66 |
| 5.725 GHz ~ 5.850 GHz | 1.97 | 5.725 GHz ~ 5.850 GHz | 1.97 |

## 4 The Highest Reported SAR Values

| Equipment Class | Band | Highest Reported SAR 1g (W/kg) |
|---|---|---|
| DTS | 2.4 ? WLAN | 0.90 |
| UNII | 5.8 ? WLAN | 1.05 |
| NII | 5.2 ? WLAN | 0.96 |
| | 5.6 ? WLAN | 1.08 |
| DSS | Bluetooth | 0.24 |
| Simultaneous SAR per KDB 690783 D01v01r03 | | 1.32 |

## 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;

| | | |
|---|---|---|
| ☒ | **KDB 865664 D01v01r04** | **SAR Measurement Requirements for 100 MHz to 6 GHz** |
| ☒ | **KDB 447498 D01v06** | **Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies** |
| ☐ | KDB 447498 D02v02r01 | SAR Measurement Procedures for USB Dongle Transmitters |
| ☒ | **KDB 248227 D01v02r02** | **SAR Guidance For IEEE 802.11 (Wi-Fi) Transmitters** |
| ☐ | KDB 615223 D01v01r01 | 802.16e/WiMax SAR Measurement Guidance |
| ☒ | **KDB 616217 D04v01r02** | **SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers** |
| ☐ | KDB 643646 D01v01r03 | SAR Test Reduction Considerations for Occupational PTT Radios |
| ☐ | KDB 648474 D03v01r04 | Evaluation and Approval Considerations for Handsets with Specific Wireless Charging Battery Covers |
| ☐ | KDB 648474 D04v01r03 | SAR Evaluation Considerations for Wireless Handsets |
| ☐ | KDB 680106 D01v02 | RF Exposure Considerations for Low Power Consumer Wireless Power Transfer Applications |
| ☐ | KDB 941225 D01v03r01 | 3G SAR Measurement Procedures |
| ☐ | KDB 941225 D05v02r05 | SAR Evaluation Considerations for LTE Devices |
| ☐ | KDB 941225 D06v02r01 | SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities |
| ☐ | 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 | : <À 2°C |
| Ambient noise & Reflection | : < 0.012 W/kg |

# 7 Specific Absorption Rate (SAR)

## 7.1 Introduction

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

## 7.2 SAR Definition

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

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

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

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

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

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

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

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

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

## 7.3 Test Standards and Limits

According to FCC 47CFR §2.1093(d) The limits to be used for evaluation are based generally on criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate ("SAR") in Section 4.2 of "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 ʾ to 300 ˀ ," ANSI/IEEE C95.3–2003, Copyright 2003 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017. These criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements (NCRP) in "Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields," NCRP Report No. 86, Section 17.4.5. Copyright NCRP, 1986, Bethesda, Maryland 20814. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards. The criteria to be used are specified in paragraphs (d)(1) and (d)(2) of this section and shall apply for portable devices transmitting in the frequency range from 100 ’ to 6 ? . Portable devices that transmit at frequencies above 6 ? are to be evaluated in terms of the MPE limits specified in § 1.1310 of this chapter. Measurements and calculations to demonstrate compliance with MPE field strength or power density limits for devices operating above 6 ? should be made at a minimum distance of 5 cm from the radiating source.

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

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

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

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 4 professional system). The model EX3DV4 field probe is used to determine the internal electric fields. The SAR can be obtained from the equation SAR= $\sigma$ ($|Ei|^2$)/ $\rho$ where $\sigma$ and $\rho$ are the conductivity and mass density of the tissue-simulant.

The DASY 4 system for performing compliance tests consists of the following items:

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

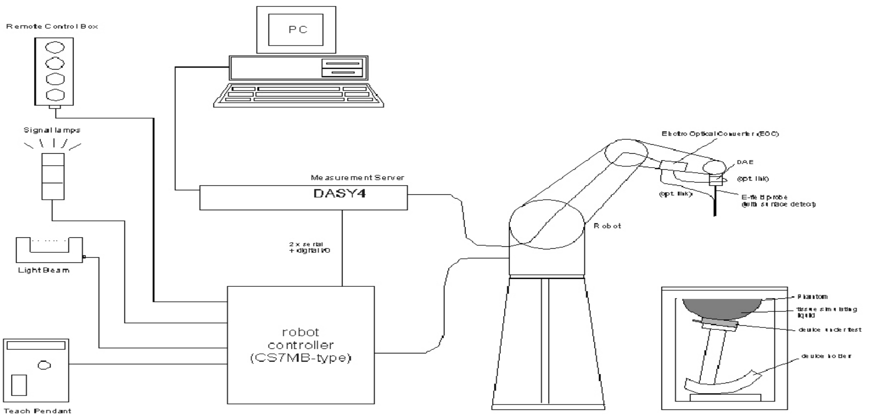



Fig a. The microwave circuit arrangement used for SAR system verification

- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows XP
- DASY 4 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM 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

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

| | | |
|---|---|---|
| Construction | : | Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 ʾ to 6 ʿ. 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.<br><br>ELI V5.0 has the same shell geometry and is manufactured from the same material as ELI4, but has reinforced top structure |
| Shell Thickness | : | 2.0 mm ± 0.2 mm |
| Dimensions | : | Major axis: 600 ʒ<br>Minor axis: 400 ʒ |


ELI Phantom

## 9.3 Device Holder

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

Device Holder

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

Device Holder

# 10 SAR Measurement Procedures

## 10.1 Normal SAR Measurement Procedure

**Step 1: Power Reference Measurement**

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The Minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 1.4 ʖ. 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 >

| | | | ≤ 3 GHz | > 3 GHz |
|---|---|---|---|---|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | | | 5 ± 1 mm | ½·δ·ln(2) ± 0.5 mm |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location | | | 30° ± 1° | 20° ± 1° |
| Maximum area scan spatial resolution: $\Delta x_{Area}$, $\Delta y_{Area}$ | | | ≤ 2 GHz: ≤ 15 mm<br>2 – 3 GHz: ≤ 12 mm | 3 – 4 GHz: ≤ 12 mm<br>4 – 6 GHz: ≤ 10 mm |
| | | | When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ 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: $\Delta x_{Zoom}$, $\Delta y_{Zoom}$ | | | ≤ 2 GHz: ≤ 8 mm<br>2 – 3 GHz: ≤ 5 mm* | 3 – 4 GHz: ≤ 5 mm*<br>4 – 6 GHz: ≤ 4 mm* |
| Maximum zoom scan spatial resolution, normal to phantom surface | uniform grid: $\Delta z_{Zoom}(n)$ | | ≤ 5 mm | 3 – 4 GHz: ≤ 4 mm<br>4 – 5 GHz: ≤ 3 mm<br>5 – 6 GHz: ≤ 2 mm |
| | graded grid | $\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface | ≤ 4 mm | 3 – 4 GHz: ≤ 3 mm<br>4 – 5 GHz: ≤ 2.5 mm<br>5 – 6 GHz: ≤ 2 mm |
| | | $\Delta z_{Zoom}(n>1)$: between subsequent points | ≤ 1.5·$\Delta z_{Zoom}(n-1)$ | |
| Minimum zoom scan volume | x, y, z | | ≥ 30 mm | 3 – 4 GHz: ≥ 28 mm<br>4 – 5 GHz: ≥ 25 mm<br>5 – 6 GHz: ≥ 22 mm |

Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.

* When zoom scan is required and the *reported* SAR from the area scan based *1-g SAR estimation* procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

## 11 SAR System Verification

The microwave circuit arrangement for system verification is sketched in Fig. 1. The daily system accuracy verification occurs within the flat section of the ELI phantom. A SAR measurement was performed to see if the measured SAR was within +/- 10% from the target SAR values. These tests were done at 2450 ’, 5200 ’, 5600 ’ and 5800 ’. The tests were conducted on the same days as the measurement of the DUT. The obtained results from the system accuracy verification are displayed in the table 1. (SAR values are normalized to 1W forward power delivered to the dipole). During the tests, the ambient temperature of the laboratory was in the range (22 ± 2) ° C, the relative humidity was in the range (55 ± 5) % R.H and the liquid depth above the ear reference points was ≥ 15 cm ± 5 mm (frequency ≤ 3 GHz) or ≥ 10 cm ± 5 mm (frequency > 3 G Hz)in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.

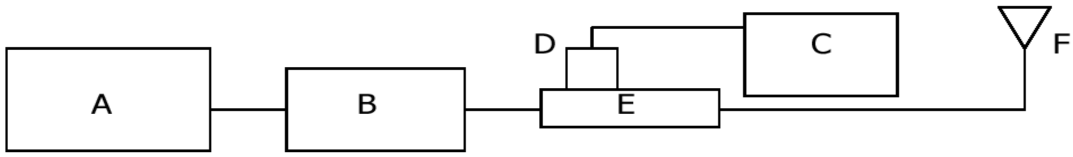



Fig. 1. The microwave circuit arrangement used for SAR system verification

A. Agilent Model E8247C Signal Generator
B. EMPOWER Model 2001-BBS3Q7ECK Amplifier
   EMPOWER Model 2092-BBS5K8CAJ Amplifier
C. Agilent Model E4419B Power Meter
D. Agilent Model 9300H Power Sensor
   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:734 | 3791 | 2450 Body | 49.50 | 4.87 | 48.70 | -1.62 | 2016-10-17 | 21.7 |
| D5 ? V2 SN:1130 | 3791 | 5200 Body | 73.50 | 7.56 | 75.60 | 2.86 | 2016-10-14 | 22.0 |
| D5 ? V2 SN:1130 | 3791 | 5600 Body | 78.90 | 7.92 | 79.20 | 0.38 | 2016-10-15 | 22.0 |
| D5 ? V2 SN:1130 | 3791 | 5800 Body | 76.00 | 7.63 | 76.30 | 0.39 | 2016-10-15 | 22.0 |

Table1. Results system verification

## 12 Tissue Simulant Fluid for the Frequency Band

The dielectric properties for this simulant fluid were measured by using the Speag Model DAK-3.5 Dielectric Probe in conjunction with Agilent E5071C Network Analyzer(300 ’ - 6 ˀ ) by using a procedure detailed in Section V.

| f ( ’ ) | Tissue type | Limits / Measured | Dielectric Parameters | | |
|---|---|---|---|---|---|
| | | | **Permittivity** | **Conductivity** | **Simulated Tissue Temp(Ë)** |
| 2450 | Body | Measured, 2016-10-17 | 51.1 | 1.93 | 21.7 |
| | | *Target Tissue Body* | *52.7* | *1.95* | |
| | | **Deviation (%)** | **-3.04** | **-1.03** | |
| 2412 | | Measured, 2016-10-17 | 51.2 | 1.88 | |
| | | **Deviation (%)** | **-2.85** | **-3.59** | |
| 2462 | | Measured, 2016-10-17 | 51.0 | 1.94 | |
| | | **Deviation (%)** | **-3.23** | **-0.51** | |
| 5200 | Body | Measured, 2016-10-14 | 48.8 | 5.07 | 22.0 |
| | | *Target Tissue Body* | *49.0* | *5.30* | |
| | | **Deviation (%)** | **-0.41** | **-4.34** | |
| 5210 | | Measured, 2016-10-14 | 48.8 | 5.09 | |
| | | **Deviation (%)** | **-0.41** | **-3.96** | |
| 5600 | Body | Measured, 2016-10-15 | 46.7 | 5.80 | 22.0 |
| | | *Target Tissue Body* | *48.5* | *5.77* | |
| | | **Deviation (%)** | **-3.71** | **0.52** | |
| 5530 | | Measured, 2016-10-15 | 47.0 | 5.72 | |
| | | **Deviation (%)** | **-3.09** | **-0.87** | |
| 5690 | | Measured, 2016-10-15 | 46.5 | 5.90 | |
| | | **Deviation (%)** | **-4.12** | **2.25** | |
| 5800 | Body | Measured, 2016-10-15 | 46.3 | 6.05 | 22.0 |
| | | *Target Tissue Body* | *48.2* | *6.00* | |
| | | **Deviation (%)** | **-3.94** | **0.83** | |
| 5775 | | Measured, 2016-10-15 | 46.4 | 6.02 | |
| | | **Deviation (%)** | **-3.73** | **0.33** | |

The composition of the brain & muscle tissue simulating liquid

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

| Ingredients (% by weight) | Frequency ( ’ ) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 450 | | 835 | | 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 M$\Omega^{+}$ resistivity

HEC: Hydroxyethyl Cellulose

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

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

Simulating Liquids for 5 ‘ , Manufactured by SPEAG

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

## 13 Instruments List

| **Test Platform** | SPEAG DASY4 Professional | | | | |
|---|---|---|---|---|---|
| **Location** | SGS Korea Co., Ltd. 4, Ls-ro 182beon-gil, Gyeonggi-do, E&E Lab | | | | |
| **Manufacture** | SPEAG | | | | |
| **Description** | SAR Test System (Frequency range 300 ’ – 6 ‘ ) | | | | |
| **Software Reference** | DASY4: V4.7 Build 80<br>SEMCAD: V1.8 Build 186 | | | | |
| **Hardware Reference** | | | | | |
| **Equipment** | **Type** | **Serial Number** | **Cal Date** | **Cal Interval** | **Cal Due** |
| Robot | RX90BL | F03/5W05A1/A/01 | N/A | N/A | N/A |
| Phantom | ELI Phantom | TP-1169 | N/A | N/A | N/A |
| Verification Dipole | D2450V2 | 734 | 2016-05-24 | Biennial | 2018-05-24 |
| Verification Dipole | D5 ? V2 | 1130 | 2016-05-23 | Biennial | 2018-05-23 |
| Dielectric Assessment Kit | DAK-3.5 | 1228 | 2015-11-17 | Annual | 2016-11-17 |
| DAE | DAE3 | 567 | 2016-01-26 | Annual | 2017-01-26 |
| E-Field Probe | EX3DV4 | 3791 | 2016-05-31 | Annual | 2017-05-31 |
| Network Analyzer | E5071C | MY46111535 | 2016-05-24 | Annual | 2017-05-24 |
| Power Meter | E4419B | GB43311125 | 2016-06-20 | Annual | 2017-06-20 |
| Power Meter | E4419B | GB43311715 | 2016-06-20 | Annual | 2017-06-20 |
| Power Sensor | E9300H | MY41495307 | 2016-06-21 | Annual | 2017-06-21 |
| Power Sensor | E9300H | MY41495314 | 2016-06-11 | Annual | 2017-06-11 |
| Power Sensor | E9327A | US40441371 | 2015-12-24 | Annual | 2016-12-24 |
| Signal Generator | E8247C | MY43321024 | 2016-06-20 | Annual | 2017-06-20 |
| Power Amplifier | 2001-BBS3Q7ECK | 1032 D/C 0336 | 2015-12-21 | Annual | 2016-12-21 |
| Power Amplifier | 2092-BBS5K8CAJ | 1010 | 2016-06-21 | Annual | 2017-06-21 |
| Dual Directional Coupler | 772D | MY52180226 | 2016-06-21 | Annual | 2017-06-21 |
| LP Filter | LA-30N | N/A | 2016-06-21 | Annual | 2017-06-21 |
| LP Filter | LA-60N | N/A | 2016-06-21 | Annual | 2017-06-21 |
| Attenuator | 05AS102-K03 | A1 | 2015-12-23 | Annual | 2016-12-23 |
| Attenuator | 05AS102-K20 | A3 | 2015-12-23 | Annual | 2016-12-23 |
| Attenuator | 05AS102-K20 | A4 | 2015-12-23 | Annual | 2016-12-23 |
| Digital Hygro-Thermometer | HTC-1 | 14032782-1 | 2016-03-22 | Annual | 2017-03-22 |
| Digital Thermometer | DTM3000 | 3027 | 2016-06-22 | Annual | 2017-06-22 |
| Spectrum Analyzer | E4445A | MY44020523 | 2016-06-20 | Annual | 2017-06-20 |

## 14 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.

## 15 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.

# 16 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

## 16.1 Maximum Output Power Specifications

| Average power for Production (㏈ m) | | | | | |
|---|---|---|---|---|---|
| **Mode** | **Data Rate** | **Channel** | **Normal/Maximum** | **Main** | **Aux** |
| 802.11b, g, n HT20 / HT40 | All Data Rates | All Channels | Maximum | **16.5** | **16.5** |
| | | | Normal | 15.0 | 15.0 |
| Tune-up Tolerance: -1.5 dB / +1.5 dB | | | | | |

| Average power for Production (㏈ m) | | | | | |
|---|---|---|---|---|---|
| **Mode** | **Data Rate** | **Channel** | **Normal/Maximum** | **Main** | **Aux** |
| 802.11a, n, ac HT20 / VHT20 | All Data Rates | 36 ~ 64 Channels | Maximum | **13.5** | **13.5** |
| | | | Normal | 12.0 | 12.0 |
| | | 100 ~ 116 Channels | Maximum | **13.5** | **13.5** |
| | | | Normal | 12.0 | 12.0 |
| | | 132 ~ 140 Channels | Maximum | **13.5** | **13.5** |
| | | | Normal | 12.0 | 12.0 |
| | | 144 ~ 165 Channels | Maximum | **14.0** | **14.0** |
| | | | Normal | 12.5 | 12.5 |
| 802.11n, ac HT40 / VHT40 | All Data Rates | 38 ~ 62 Channels | Maximum | **13.5** | **13.5** |
| | | | Normal | 12.0 | 12.0 |
| | | 102 ~ 142 Channel | Maximum | **13.5** | **13.5** |
| | | | Normal | 12.0 | 12.0 |
| | | 151 ~ 159 Channels | Maximum | **14.0** | **14.0** |
| | | | Normal | 12.5 | 12.5 |
| 802.11ac VHT80 | All Data Rates | 42 Channel | Maximum | **13.5** | **13.5** |
| | | | Normal | 12.0 | 12.0 |
| | | 58 Channels | Maximum | **12.5** | **12.5** |
| | | | Normal | 11.0 | 11.0 |
| | | 106 ~ 138 Channel | Maximum | **13.5** | **13.5** |
| | | | Normal | 12.0 | 12.0 |
| | | 155 Channel | Maximum | **14.0** | **14.0** |
| | | | Normal | 12.5 | 12.5 |
| Tune-up Tolerance: -1.5 dB / +1.5 dB | | | | | |

## 16.2 Bluetooth Maximum Output Power Specifications

| Average power for Production (dBm) | | | | | |
|---|---|---|---|---|---|
| **Mode** | **Normal/Maximum** | **GFSK** | **PI/4DQPSK** | **8DPSK** | **LE** |
| Bluetooth | Maximum | **11.5** | **8.0** | **7.0** | **7.0** |
| | Normal | 9.5 | 6.0 | 5.0 | 5.0 |
| Tune-up Tolerance: -2.0 dB / +2.0 dB | | | | | |

# 17 WLAN

## 17.1 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.

## 17.2 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 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 W/kg.

## 17.3 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.

## 17.4 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 ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.
2) When the reported SAR is > 0.8 W/kg, SAR is required for that position using the next highest measured output power channel; i.e., all channels require testing.

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

### 17.5 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 congigurations; for example, 802.11a, 802.11n and 802.11ac or 802.11g and 802.11n with the same channel bandwith, modulation and data rate etc., the lower order 802.11 mode i.e., 802.11a, then 802.11n and 802.11ac or 802.11g then 802.11n, is used for SAR measurement. When maximum output power are the same for multiple test channels, either according to the default or additional power measurement requirements, SAR is measured using the channel closest to the middle of the frequency band or aggregated band. When thereare multiple channels with the same maximum output power, SAR is measured using the higher number channel.

### 17.6 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 ≤ 0.8 W/kg, no additional measurements on other test channels are required. Otherwise, SAR is evaluated using the subsequent highest average RF output channel until the reported SAR result is ≤ 1.2 W/kg or all channels are measured. When there are multiple untested channels having the same subsequent highest average RF output power, the channel with higher frequency from the lowest 802.11 mode is considered for SAR measurements

### 17.7 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 ≤ 1.2 W/kg, no additional SAR tests for the subsequent test configurations are required.

## 18 RF Conducted Power Measurement

### WLAN 2.4 ?

| Mode | Freq. ( ' ) | Ch. # | Rate | Average Power [㏈ m] | |
|---|---|---|---|---|---|
| | | | | Main | AUX |
| 802.11b | 2412 | 1 | 1 | 16.47 | 16.48 |
| | 2437 | 6 | 1 | 16.46 | 16.44 |
| | 2462 | 11 | 1 | 16.49 | 16.50 |
| 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 ?

| Mode | Freq. ( ' ) | Ch. # | Rate | Measured Power [㏈ m] | |
|---|---|---|---|---|---|
| | | | | 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 | 13.30 | 13.26 |

**WLAN 5.3 ?**

| Mode | Freq. ( ˀ ) | Ch. # | Rate | Measured Power [ʤ m] | |
|---|---|---|---|---|---|
| | | | | 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 | - | - |

**WLAN 5.6 ?**

| Mode | Freq. ( ' ) | Ch. # | Rate | Measured Power [㏈m] | |
|---|---|---|---|---|---|
| | | | | 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 | - | - |
| | 5720 | 144 | MCS0 | - | - |
| 802.11n HT40 | 5510 | 102 | MCS0 | - | - |
| | 5550 | 110 | MCS0 | - | - |
| | 5670 | 134 | MCS0 | - | - |
| | 5710 | 142 | 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 | 13.47 | 13.43 |
| | 5690 | 138 | MCS0 | 13.43 | 13.46 |

**WLAN 5.8 ㎓**

| Mode | Freq. (㎒) | Ch. # | Rate | Measured Power [㏈m] | |
|---|---|---|---|---|---|
| | | | | 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 | 13.91 | 14.00 |

**Bluetooth**

| Channel | Frequency (㎒) | GFSK (㏈m) | 4DPSK (㏈m) | 8DPSK (㏈m) | LE (㏈m) |
|---|---|---|---|---|---|
| Low | 2402 | 9.85 | 6.60 | 5.63 | 3.47 |
| Middle | 2441 | 11.05 | 7.51 | 6.57 | 3.45 |
| High | 2480 | 9.40 | 6.03 | 5.14 | 3.41 |

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

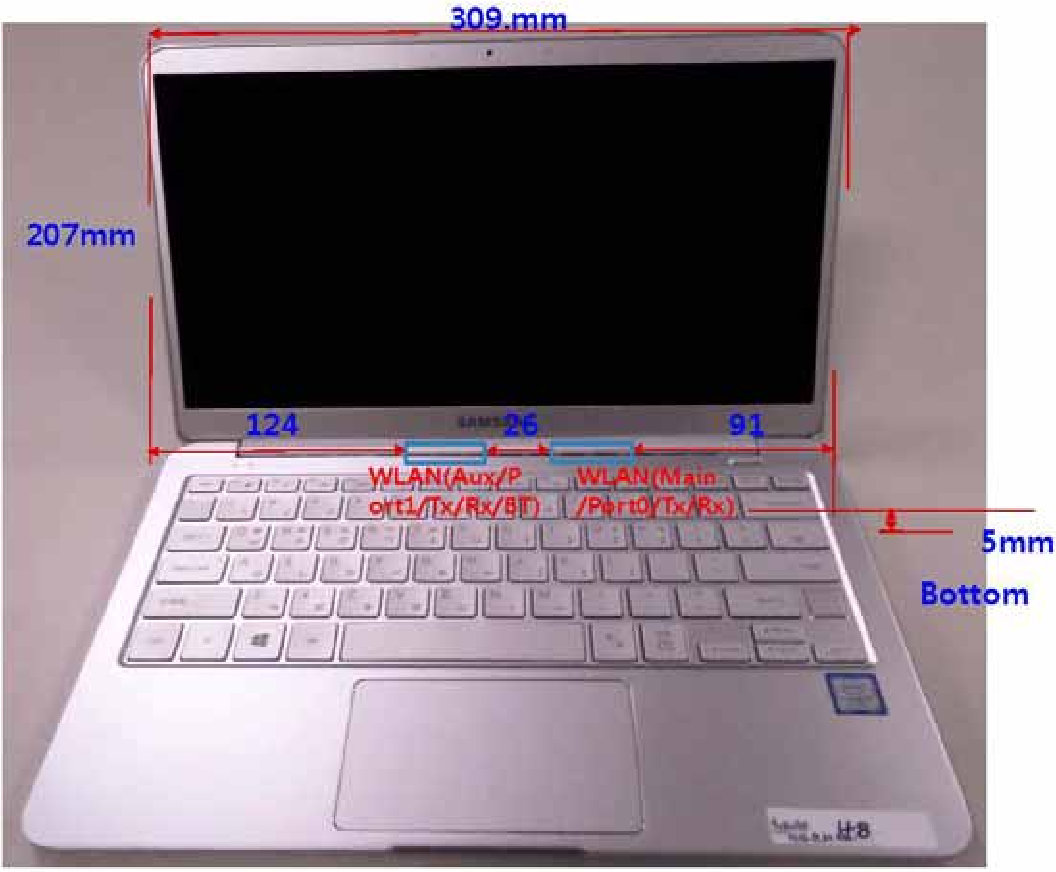
1. Power measurements were performed for the transmission mode configuration with the highest maximum output power specified for production units.

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.

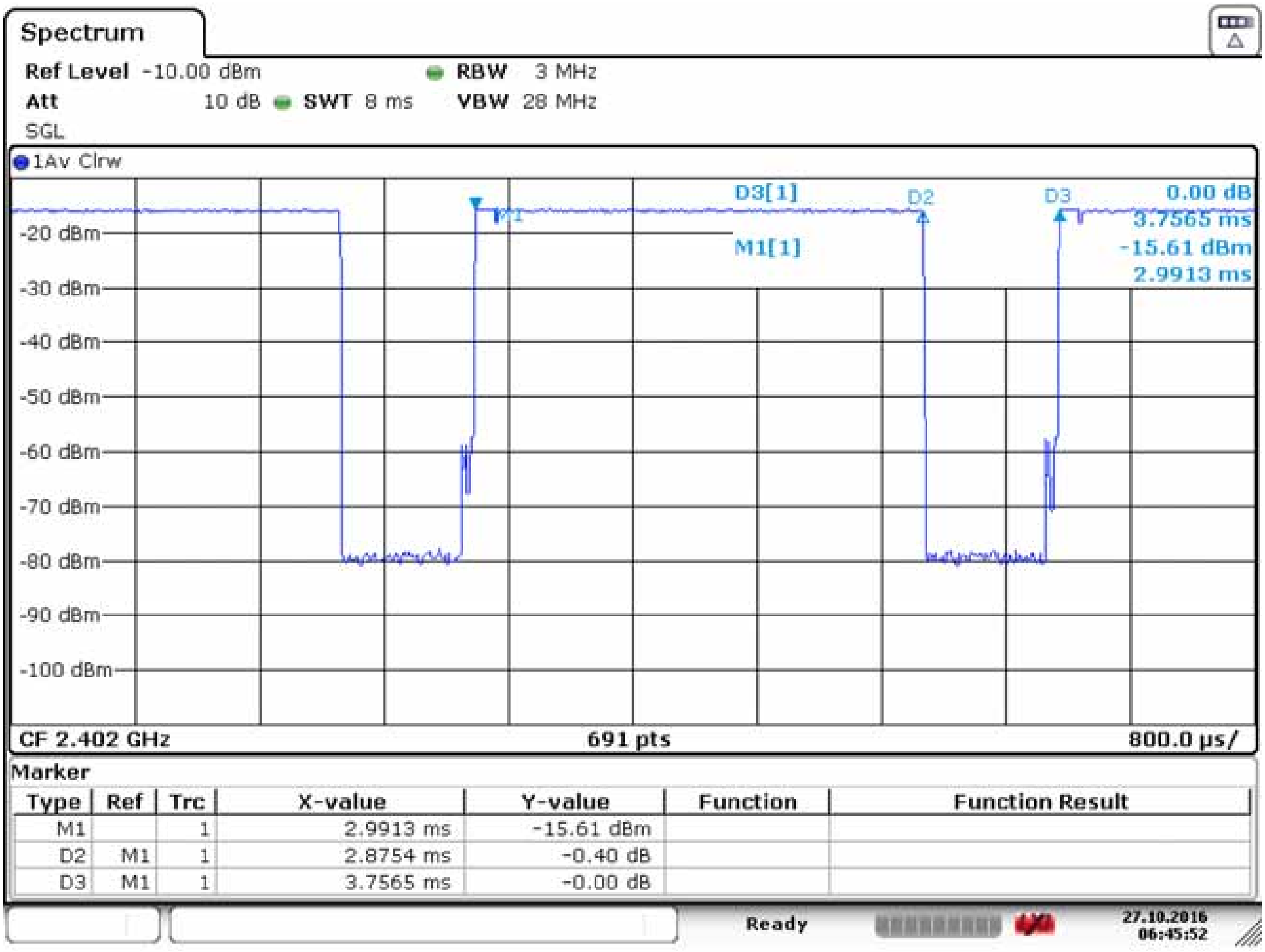
4. For each transmission mode configuration, powers were measured for the highest and lowest channels; and at the mid-band channel(s) when there were at least 3 channels supported. For channels were measured.

## 19. Transmit Antenna Separation Distances




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

## 20. Bluetooth Duty Cycle used for SAR Testing




Date: 27.OCT.2016 06:45:52

**Bluetooth Duty cycle measurement**

$T_{on}$ = 2.87 ms

$T_{on}$+ $T_{off}$ = 3.75 ms

Duty Cycle = ($T_{on}$ / $T_{on}$+ $T_{off}$) x 100

76.5 % = (2.87 / 3.75) x 100

Bluetooth Duty cycle: **76.5 %**

SAR Crest Factor = 100 / 76.5 = 1.3071

# 21. SAR Data Summary

## 21.1 Notebook Device Type

### WLAN 2.45 GHz Body SAR

| EUT Position | Mode | Traffic Channel: Frequency ( ' ) | Traffic Channel: Channel | Power(dBm) Conducted Power: Main | Power(dBm) Conducted Power: Aux | Power(dBm): Tune-Up Limit | Peak SAR of Area Scan(W/kg) | 1-g SAR (W/kg): Main | 1-g SAR (W/kg): Aux | Scaling Factor (Power): Main | Scaling Factor (Power): Aux | Scaling Factor (Duty cycle) | 1-g Scaled SAR (W/kg): Main | 1-g Scaled SAR (W/kg): Aux | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Base | 802.11b | 2412 | 1 | 16.47 | - | 16.50 | 1.510 | 0.845 | - | 1.007 | - | 1.013 | 0.862 | - | - |
| Base | 802.11b | 2412 | 1 | - | 16.48 | 16.50 | 1.430 | - | 0.835 | - | 1.005 | 1.013 | - | 0.850 | - |
| Base | 802.11b | 2437 | 6 | 16.46 | - | 16.50 | 1.550 | 0.836 | - | 1.009 | - | 1.013 | 0.855 | - | - |
| Base | 802.11b | 2437 | 6 | - | 16.44 | 16.50 | 1.290 | - | 0.835 | - | 1.014 | 1.013 | - | 0.858 | - |
| Base | 802.11b | 2462 | 11 | 16.49 | - | 16.50 | 1.640 | 0.885 | - | 1.002 | - | 1.013 | **0.899** | - | A5 |
| Base | 802.11b | 2462 | 11 | - | 16.50 | 16.50 | 1.690 | - | 0.850 | - | 1.000 | 1.013 | - | **0.861** | A6 |
| **Repeated Test** | | | | | | | | | | | | | | | |
| Base | 802.11b | 2462 | 11 | 16.49 | - | 16.50 | 1.630 | 0.879 | - | 1.002 | - | 1.013 | 0.892 | - | - |
| Base | 802.11b | 2462 | 11 | - | 16.50 | 16.50 | 1.480 | - | 0.827 | - | 1.000 | 1.013 | - | 0.838 | - |

### WLAN 5.2 GHz Body SAR

| EUT Position | Mode | Traffic Channel: Frequency ( ' ) | Traffic Channel: Channel | Power(dBm) Conducted Power: Main | Power(dBm) Conducted Power: Aux | Power(dBm): Tune-Up Limit | Peak SAR of Area Scan(W/kg) | 1-g SAR (W/kg): Main | 1-g SAR (W/kg): Aux | Scaling Factor (Power): Main | Scaling Factor (Power): Aux | Scaling Factor (Duty cycle) | 1-g Scaled SAR (W/kg): Main | 1-g Scaled SAR (W/kg): Aux | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Base | 802.11ac VHT80 | 5210.0 | 42 | 13.30 | - | 13.50 | 2.080 | 0.854 | - | 1.047 | - | 1.074 | **0.960** | - | A7 |
| Base | 802.11ac VHT80 | 5210.0 | 42 | - | 13.26 | 13.50 | 1.020 | - | 0.502 | - | 1.057 | 1.063 | - | **0.564** | A8 |
| **Repeated Test** | | | | | | | | | | | | | | | |
| Base | 802.11ac VHT80 | 5210.0 | 42 | 13.30 | - | 13.50 | 2.100 | 0.825 | - | 1.047 | - | 1.074 | 0.928 | - | - |

### WLAN 5.6 GHz Body SAR

| EUT Position | Mode | Traffic Channel: Frequency ( ' ) | Traffic Channel: Channel | Power(dBm) Conducted Power: Main | Power(dBm) Conducted Power: Aux | Power(dBm): Tune-Up Limit | Peak SAR of Area Scan(W/kg) | 1-g SAR (W/kg): Main | 1-g SAR (W/kg): Aux | Scaling Factor (Power): Main | Scaling Factor (Power): Aux | Scaling Factor (Duty cycle) | 1-g Scaled SAR (W/kg): Main | 1-g Scaled SAR (W/kg): Aux | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Base | 802.11ac VHT80 | 5530.0 | 106 | 13.47 | - | 13.50 | 2.070 | 1.000 | - | 1.007 | - | 1.074 | **1.081** | - | A9 |
| Base | 802.11ac VHT80 | 5530.0 | 106 | - | 13.43 | 13.50 | 1.540 | - | 0.809 | - | 1.016 | 1.063 | - | **0.874** | A10 |
| Base | 802.11ac VHT80 | 5690.0 | 138 | 13.43 | - | 13.50 | 1.910 | 0.928 | - | 1.016 | - | 1.074 | 1.013 | - | - |
| Base | 802.11ac VHT80 | 5690.0 | 138 | - | 13.46 | 13.50 | 1.540 | - | 0.804 | - | 1.009 | 1.063 | - | 0.863 | - |
| **Repeated Test** | | | | | | | | | | | | | | | |
| Base | 802.11ac VHT80 | 5530.0 | 106 | 13.47 | - | 13.50 | 2.120 | 0.981 | - | 1.007 | - | 1.074 | 1.061 | - | - |
| Base | 802.11ac VHT80 | 5530.0 | 106 | - | 13.43 | 13.50 | 1.530 | - | 0.802 | - | 1.016 | 1.063 | - | 0.866 | - |

## 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 ( ' ) | Channel | Conducted Power | | Tune-Up Limit | | | | | | | | | |
| | | | | Main | Aux | | | Main | Aux | Main | Aux | | Main | Aux | |
| Base | 802.11ac VHT80 | 5775.0 | 155 | 13.91 | - | 14.00 | 2.200 | 0.915 | - | 1.021 | - | 1.074 | 1.003 | - | - |
| Base | 802.11ac VHT80 | 5775.0 | 155 | - | 14.00 | 14.00 | 1.510 | - | 0.779 | - | 1.000 | 1.063 | - | **0.828** | A12 |
| **Repeated Test** | | | | | | | | | | | | | | | |
| Base | 802.11ac VHT80 | 5775.0 | 155 | 13.91 | - | 14.00 | 2.110 | 0.953 | - | 1.021 | - | 1.074 | **1.045** | - | A11 |

## Bluetooth 2.45GHz Body SAR

| EUT Position | Mode | Traffic Channel | | Power(dBm) | | Peak SAR of Area Scan(W/kg) | 1-g SAR (W/kg) | Scaling Factor (Power) | 1-g Scaled SAR (W/kg) | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Frequency ( ' ) | Channel | Conducted Power | Tune-Up Limit | | | | | |
| Base | DH5 | 2441.0 | 39 | 11.05 | 11.50 | 0.342 | 0.214 | 1.109 | 0.237 | A13 |

**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$^{nd}$ 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 ≤ 0.8 W/kg, SAR testing on additional channels was not required. Otherwise, SAR for the next highest output power channel was required until the reported SAR result was ≤ 1.20 W/kg or all test channels were measured.
4. The device was configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools. The reported SAR was scaled to the 100% transmission duty factor to determine compliance.
5. WLAN transmission was verified using a spectrum analyzer.
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 ≤ 1.2W/kg, SAR is not required for UNII band1 > 1.2W/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 ≥ 0.80 W/kg, the measurement was repeated once.**

2. A second repeated measurement was preformed only if the ratio of largest to smallest SAR for the original and first repeated measurements was > 1.20 or when the original or repeated measurement was ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).

3. A third repeated measurement was performed only if the original, first or second repeated measurement was ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

4. Repeated measurements are not required when the original highest measured SAR is < 0.80 W/kg

| EUT Position | Mode | Traffic Channel | | Separation Distance (mm) | Measured 1g SAR (W/kg) | 1st Repeated 1g SAR(W/kg) | Ratio |
|---|---|---|---|---|---|---|---|
| | | Frequency (MHz) | Channel | | | | |
| Base | WLAN 2.45 GHz | 2462 | 11 | 0 | 0.885 | 0.879 | 0.99 |
| Base | WLAN 2.45 GHz | 2462 | 11 | 0 | 0.850 | 0.827 | 0.97 |
| Base | WLAN 5 GHz | 5210 | 42 | 0 | 0.854 | 0.825 | 0.97 |
| Base | WLAN 5 GHz | 5530 | 106 | 0 | 1.000 | 0.981 | 0.98 |
| Base | WLAN 5 GHz | 5530 | 106 | 0 | 0.809 | 0.802 | 0.99 |
| Base | WLAN 5 GHz | 5775 | 155 | 0 | 0.915 | 0.953 | 1.04 |

## 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 | Operation |
|---|---|---|
| 1 | WLAN 2.4 GHz Main Ant + WLAN 5 GHz Aux Ant | Yes |
| 2 | WLAN 2.4 GHz Main Ant + Bluetooth Aux Ant | Yes |
| 3 | WLAN 5 GHz Main Ant + Bluetooth Aux Ant | Yes |

**Note**:

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

## 23.3 Notebook Body SAR Simultaneous Transmission Analysis

| Simultaneous TX | configuration | Main Ant SAR(W/kg) | Aux Ant SAR(W/kg) | ∑SAR (W/kg) |
|---|---|---|---|---|
| WLAN 2.4 GHz | Base | 0.899 | 0.861 | **1.760** |
| WLAN 5.2 GHz | Base | 0.960 | 0.564 | 1.524 |
| WLAN 5.6 GHz | Base | 1.081 | 0.874 | **1.955** |
| WLAN 5.8 GHz | Base | 1.045 | 0.828 | **1.873** |
| WLAN + Bluetooth | configuration | 2.4 GHz Main Ant SAR(W/kg) | Bluetooth Aux Ant SAR (W/kg) | ∑SAR (W/kg) |
| | Base | 0.899 | 0.237 | 1.136 |
| | configuration | 5 GHz Main Ant SAR(W/kg) | Bluetooth Aux Ant SAR (W/kg) | ∑SAR (W/kg) |
| | Base | 1.081 | 0.237 | 1.318 |

## 23.4 SPLSR Evaluation and Analysis

FCC KDB Publication 447498 D01v06, when the sum of the standalone transmitters is more than 1.6 W/kg, the SAR sum to peak locations can be analyzed to determine SAR distribution overlaps. When the SAR peak to location ratio for each pair of antennas is ≤ 0.04, simultaneous SAR evaluation is not required. The distance between the transmitters was calculated using the following formal.

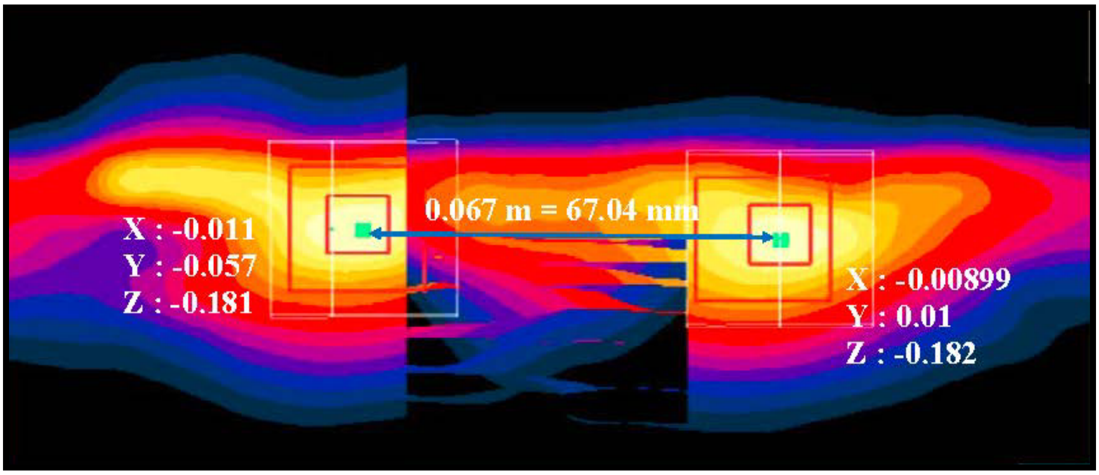
$$\text{Distance} = R_i = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2}$$

$$\text{SPLS Ratio} = \frac{(SAR_1 + SAR_2)^{1.5}}{R_i}$$

### Notebook Body SAR Peak Location Separation Ratio (SPLSR)

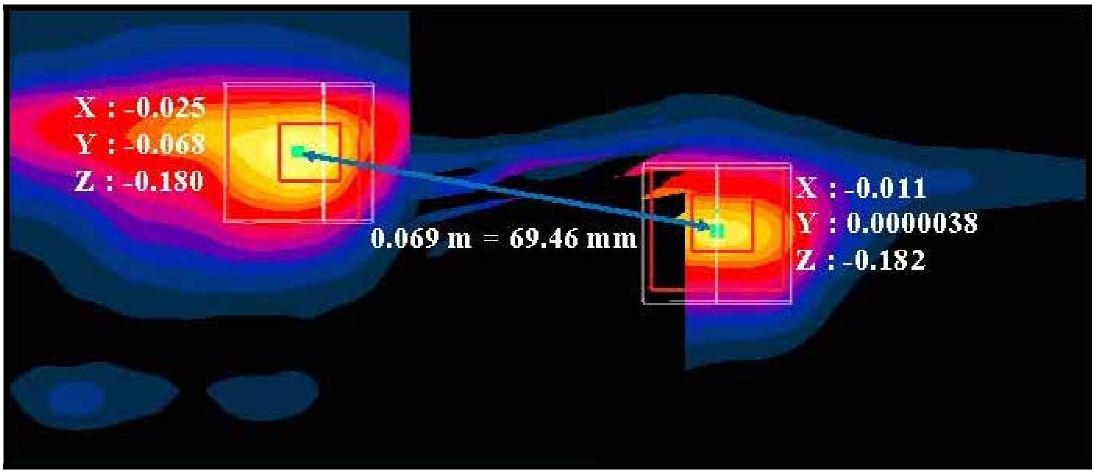
| Simultaneous Tx | Position | Man Ant | Aux Ant | ∑SAR (W/kg) | Calculated Distance (mm) | SPLSR (≤0.04) | Volume Scan | Page No |
|---|---|---|---|---|---|---|---|---|
| WLAN 2.4 GHz | Base | 0.899 | 0.861 | 1.760 | 67.04 | 0.035 | No | - |
| WLAN 5.6 GHz | Base | 1.081 | 0.874 | 1.955 | 69.46 | 0.039 | No | - |
| WLAN 5.8 GHz | Base | 1.045 | 0.828 | 1.873 | 65.04 | 0.039 | No | - |

## Notebook (Base) 2.4 GHz (WLAN Main Ant + WLAN Aux Ant)



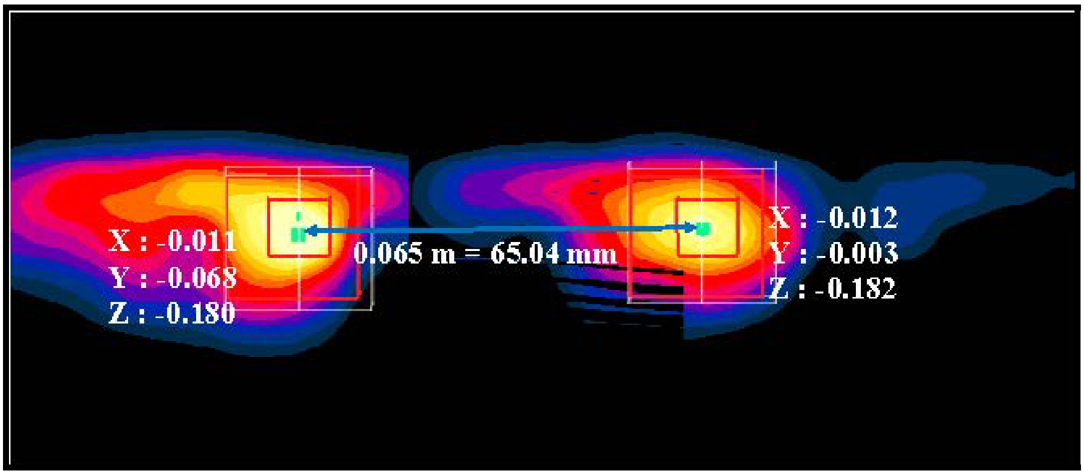

| WLAN Main Ant | | | WLAN Aux Ant | | | $R_i$ | | ∑SAR (W/kg) | SPLSR (≤0.04) | Volume Scan SAR [W/kg] | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|---|
| X, m | Y, m | Z, m | X, m | Y, m | Z, m | m | mm | | | | |
| -0.011 | -0.057 | -0.181 | -0.00899 | 0.01 | -0.182 | 0.067 | 67.04 | 1.760 | 0.035 | - | - |

## Notebook (Base) 5.6 GHz (WLAN Main Ant + WLAN Aux Ant)




| WLAN Main Ant | | | WLAN Aux Ant | | | $R_i$ | | ∑SAR (W/kg) | SPLSR (≤0.04) | Volume Scan SAR [W/kg] | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|---|
| X, m | Y, m | Z, m | X, m | Y, m | Z, m | m | mm | | | | |
| -0.025 | -0.068 | -0.18 | -0.011 | 0.0000038 | -0.182 | 0.069 | 69.46 | 1.955 | 0.039 | - | - |

## Notebook (Base) 5.8 GHz (WLAN Main Ant + WLAN Aux Ant)




| WLAN Main Ant | | | WLAN Aux Ant | | | $R_i$ | | ∑SAR (W/kg) | SPLSR (≤0.04) | Volume Scan SAR [W/kg] | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|---|
| X, m | Y, m | Z, m | X, m | Y, m | Z, m | m | mm | | | | |
| -0.011 | -0.068 | -0.18 | -0.012 | -0.003 | -0.182 | 0.065 | 65.04 | 1.873 | 0.039 | - | - |

# Appendixes List

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

Date: 2016-10-17

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

Input Power : 100 mW

Ambient Temp : 22.6 ℃ Tissue Temp : 21.7 ℃

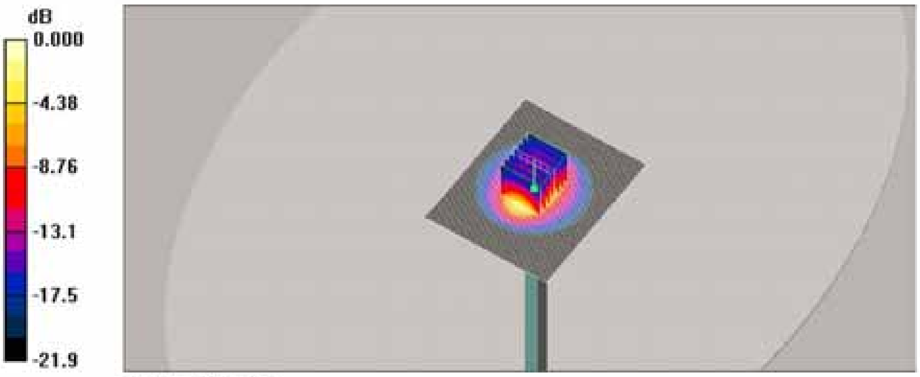
**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:734**
**Program Name: 2450MHz Verification**

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.93 mho/m; $\varepsilon_r$ = 51.1; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(6.63, 6.63, 6.63); Calibrated: 2016-05-31
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2016-01-26
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**2450MHz Verification/Area Scan (91x111x1):** Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 8.39 mW/g

**2450MHz Verification/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 66.2 V/m; Power Drift = -0.013 dB
Peak SAR (extrapolated) = 10.1 W/kg
**SAR(1 g) = 4.87 mW/g; SAR(10 g) = 2.26 mW/g**
Maximum value of SAR (measured) = 8.14 mW/g




0 dB = 8.14mW/g

**Appendix A.2 Verification Test Plots for 5200 MHz**

Date: 2016-10-14

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

Input Power : 100 mW

Ambient Temp : 22.9 ℃ Tissue Temp : 22.0 ℃

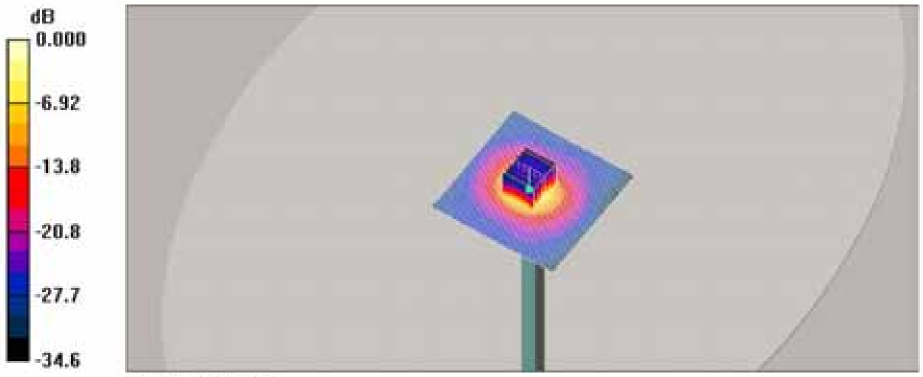
**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1130**
**Program Name: Verification**

Communication System: CW; Frequency: 5200 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5200 MHz; $\sigma$ = 5.07 mho/m; $\varepsilon_r$ = 48.8; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(4.31, 4.31, 4.31); Calibrated: 2016-05-31
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2016-01-26
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**5200MHz Verification/Area Scan (91x91x1):** Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 18.7 mW/g

**5200MHz Verification/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 65.8 V/m; Power Drift = -0.031 dB
Peak SAR (extrapolated) = 29.5 W/kg
**SAR(1 g) = 7.56 mW/g; SAR(10 g) = 2.19 mW/g**
Maximum value of SAR (measured) = 18.5 mW/g




0 dB = 18.5mW/g

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

Date: 2016-10-15

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

Input Power : 100 mW

Ambient Temp : 22.7 ℃ Tissue Temp : 22.0 ℃

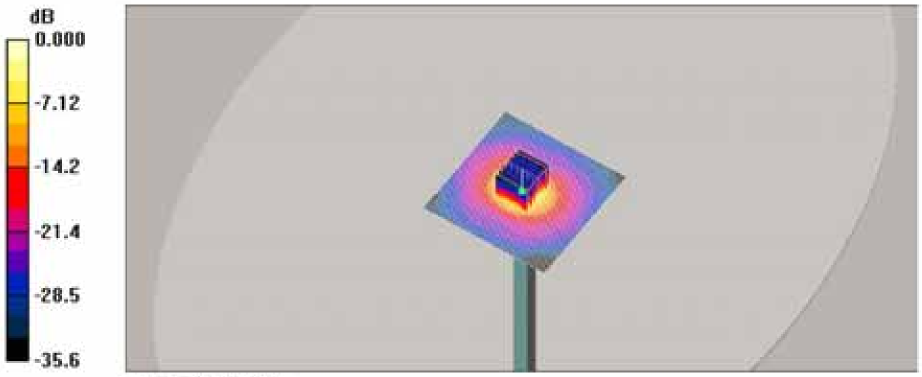
**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1130**
**Program Name: Verification**

Communication System: CW; Frequency: 5600 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5600 MHz; σ = 5.8 mho/m; $\varepsilon_r$ = 46.7; ρ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(3.57, 3.57, 3.57); Calibrated: 2016-05-31
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2016-01-26
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**5600MHz Verification/Area Scan (91x91x1):** Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 21.6 mW/g

**5600MHz Verification/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 66.6 V/m; Power Drift = -0.068 dB
Peak SAR (extrapolated) = 32.2 W/kg
**SAR(1 g) = 7.92 mW/g; SAR(10 g) = 2.23 mW/g**
Maximum value of SAR (measured) = 20.0 mW/g




0 dB = 20.0mW/g

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

Date: 2016-10-15

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

Input Power : 100 mW

Ambient Temp : 22.7 ℃ Tissue Temp : 22.0 ℃

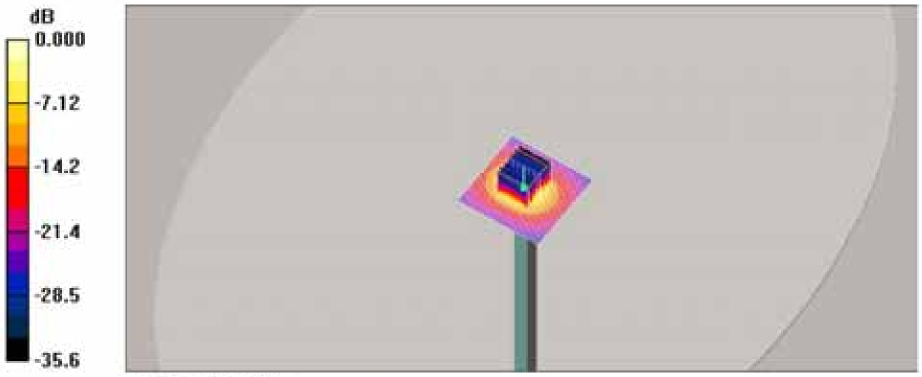
**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1130**
**Program Name: Verification**

Communication System: CW; Frequency: 5800 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5800 MHz; $\sigma$ = 6.05 mho/m; $\varepsilon_r$ = 46.3; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(3.89, 3.89, 3.89); Calibrated: 2016-05-31
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2016-01-26
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**5800MHz Verification/Area Scan (61x61x1):** Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 19.7 mW/g

**5800MHz Verification/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.2 V/m; Power Drift = -0.031 dB
Peak SAR (extrapolated) = 32.5 W/kg
**SAR(1 g) = 7.63 mW/g; SAR(10 g) = 2.17 mW/g**
Maximum value of SAR (measured) = 19.5 mW/g




0 dB = 19.5mW/g

**Appendix A.5 SAR Test Plots for WLAN 2450 MHz Main**

Date: 2016-10-17

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 2.45GHz_WLAN_802.11b_Base_CH11_Main.da4

Ambient Temp : 22.6 ℃ Tissue Temp : 21.7 ℃

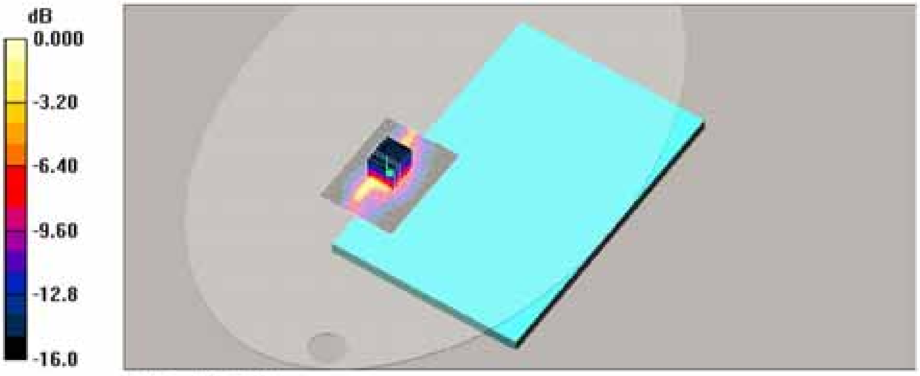
**DUT: NP900X3N; Type: SAMSUNG Notebook; Serial: 0NFN91ZH800005F**
**Program Name: Body**

Communication System: 2.45GHz; Frequency: 2462 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2462 MHz; $\sigma$ = 1.94 mho/m; $\varepsilon_r$ = 51; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(6.63, 6.63, 6.63); Calibrated: 2016-05-31
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2016-01-26
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**2.45GHz_WLAN_802.11b_Base_CH11_Main/Area Scan (81x111x1):** Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.64 mW/g

**2.45GHz_WLAN_802.11b_Base_CH11_Main/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 5.23 V/m; Power Drift = -0.148 dB
Peak SAR (extrapolated) = 2.10 W/kg
**SAR(1 g) = 0.885 mW/g; SAR(10 g) = 0.395 mW/g**
Maximum value of SAR (measured) = 1.59 mW/g




0 dB = 1.59mW/g

**Appendix A.6 SAR Test Plots for WLAN 2450 MHz Aux**

Date: 2016-10-17

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 2.45GHz_WLAN_802.11b_Base_CH11_Aux.da4

Ambient Temp : 22.6 ℃ Tissue Temp : 21.7 ℃

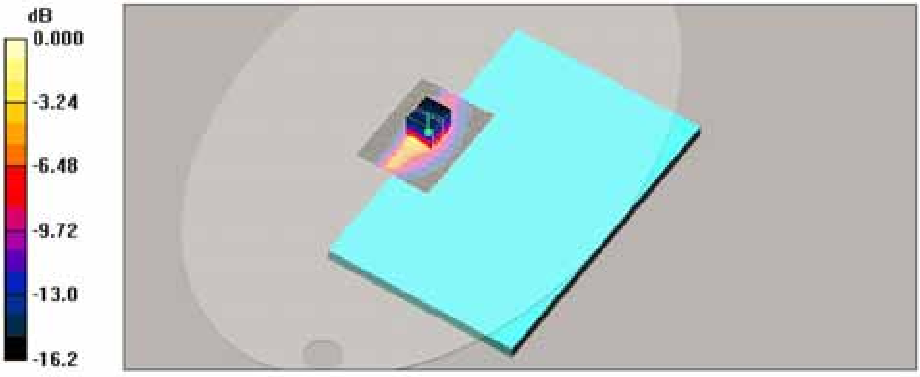
**DUT: NP900X3N; Type: SAMSUNG Notebook; Serial: 0NFN91ZH800005F**
**Program Name: Body**

Communication System: 2.45GHz; Frequency: 2462 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2462 MHz; σ = 1.94 mho/m; $\varepsilon_r$ = 51; ρ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(6.63, 6.63, 6.63); Calibrated: 2016-05-31
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2016-01-26
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**2.45GHz_WLAN_802.11b_Base_CH11_Aux/Area Scan (81x111x1):** Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.69 mW/g

**2.45GHz_WLAN_802.11b_Base_CH11_Aux/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 18.5 V/m; Power Drift = 0.020 dB
Peak SAR (extrapolated) = 2.39 W/kg
**SAR(1 g) = 0.850 mW/g; SAR(10 g) = 0.387 mW/g**
Maximum value of SAR (measured) = 1.65 mW/g




0 dB = 1.65mW/g

**Appendix A.7 SAR Test Plots for WLAN 5.2GHz Main**

Date: 2016-10-14

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 5.2GHz_WLAN_802.11ac_VHT80_Base_CH42.da4

Ambient Temp : 22.9 ℃ Tissue Temp : 22.0 ℃

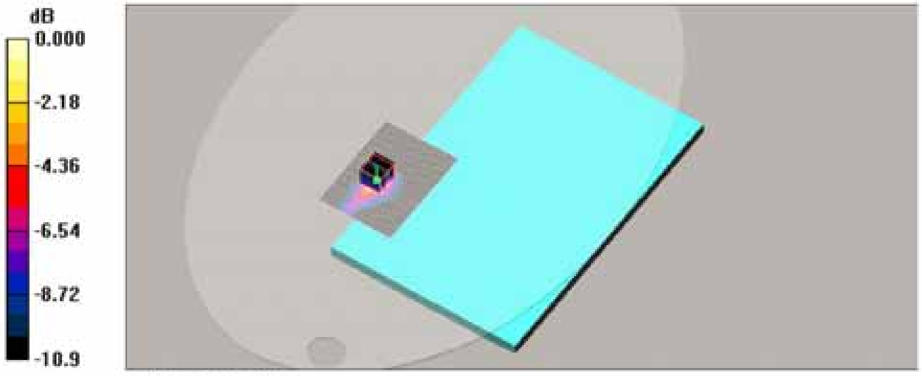
**DUT: NP900X3N; Type: SAMSUNG Notebook; Serial: 0NFN91ZH800005F**
**Program Name: Body**

Communication System: 5GHz; Frequency: 5210 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5210 MHz; $\sigma$ = 5.09 mho/m; $\varepsilon_r$ = 48.8; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(4.31, 4.31, 4.31); Calibrated: 2016-05-31
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2016-01-26
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**5.2GHz_WLAN_802.11ac_VHT80_Base_CH42_Main/Area Scan (81x111x1):** Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 2.08 mW/g

**5.2GHz_WLAN_802.11ac_VHT80_Base_CH42_Main/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 5.05 V/m; Power Drift = 0.043 dB
Peak SAR (extrapolated) = 3.48 W/kg
**SAR(1 g) = 0.854 mW/g; SAR(10 g) = 0.375 mW/g**
Maximum value of SAR (measured) = 2.01 mW/g



0 dB = 2.01mW/g

**Appendix A.8 SAR Test Plots for WLAN 5.2GHz Aux**

Date: 2016-10-14

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 5.2GHz_WLAN_802.11ac_VHT80_Base_CH42_Aux.da4

Ambient Temp : 22.9 ℃ Tissue Temp : 22.0 ℃

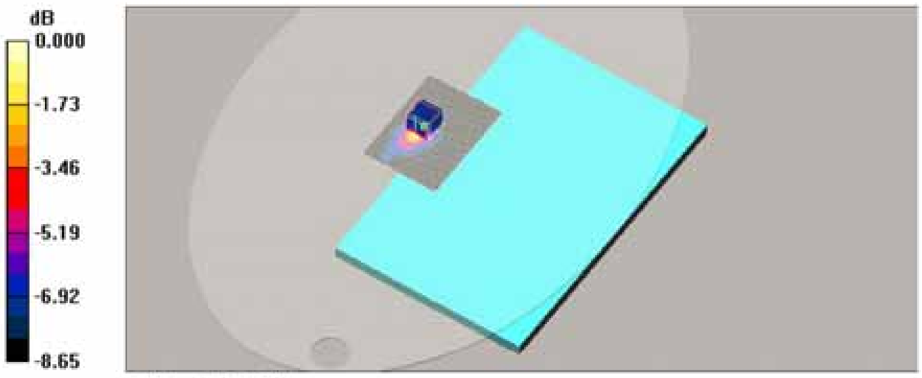
**DUT: NP900X3N; Type: SAMSUNG Notebook; Serial: 0NFN91ZH800005F**
**Program Name: Body**

Communication System: 5GHz; Frequency: 5210 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5210 MHz; $\sigma$ = 5.09 mho/m; $\varepsilon_r$ = 48.8; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(4.31, 4.31, 4.31); Calibrated: 2016-05-31
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2016-01-26
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**5.2GHz_WLAN_802.11ac_VHT80_Base_CH42_Aux/Area Scan (81x111x1):** Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.02 mW/g

**5.2GHz_WLAN_802.11ac_VHT80_Base_CH42_Aux/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 6.70 V/m; Power Drift = 0.046 dB
Peak SAR (extrapolated) = 1.66 W/kg
**SAR(1 g) = 0.502 mW/g; SAR(10 g) = 0.264 mW/g**
Maximum value of SAR (measured) = 0.951 mW/g




0 dB = 0.951mW/g

**Appendix A.9 SAR Test Plots for WLAN 5.6GHz Main**

Date: 2016-10-15

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 5.6GHz_WLAN_802.11ac_VHT80_Base_CH106_Main.da4

Ambient Temp : 22.7 ℃ Tissue Temp : 22.0 ℃

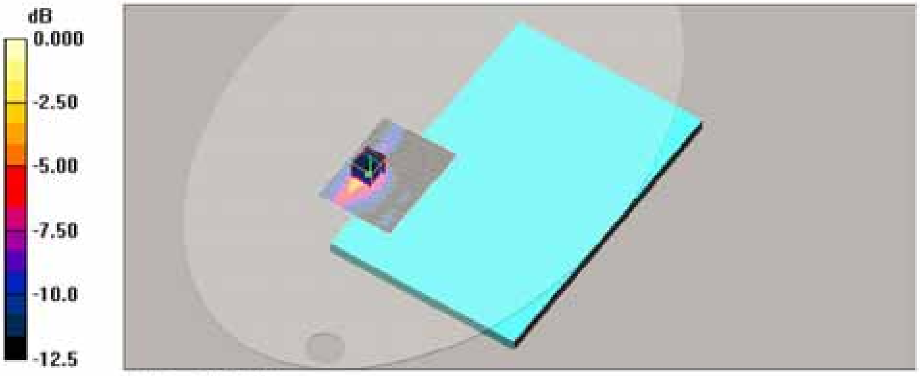
**DUT: NP900X3N; Type: SAMSUNG Notebook; Serial: 0NFN91ZH800005F**
**Program Name: Body**

Communication System: 5GHz; Frequency: 5530 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5530 MHz; $\sigma$ = 5.72 mho/m; $\varepsilon_r$ = 47; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(3.57, 3.57, 3.57); Calibrated: 2016-05-31
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2016-01-26
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**5.6GHz_WLAN_802.11ac_VHT80_Base_CH106_Main/Area Scan (81x111x1):** Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 2.07 mW/g

**5.6GHz_WLAN_802.11ac_VHT80_Base_CH106_Main/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 4.59 V/m; Power Drift = 0.001 dB
Peak SAR (extrapolated) = 4.38 W/kg
**SAR(1 g) = 1 mW/g; SAR(10 g) = 0.410 mW/g**
Maximum value of SAR (measured) = 2.45 mW/g




0 dB = 2.45mW/g

**Appendix A.10 SAR Test Plots for WLAN 5.6GHz Aux**

Date: 2016-10-15

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 5.6GHz_WLAN_802.11ac_VHT80_Base_CH106_Aux.da4

Ambient Temp : 22.7 ℃ Tissue Temp : 22.0 ℃

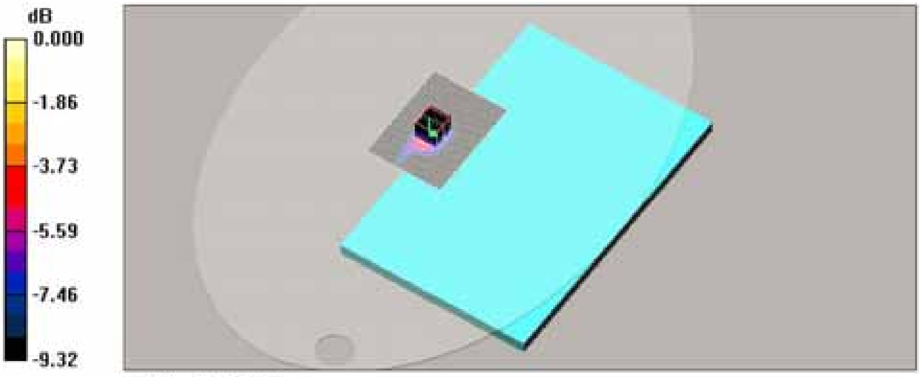
**DUT: NP900X3N; Type: SAMSUNG Notebook; Serial: 0NFN91ZH800005F**
**Program Name: Body**

Communication System: 5GHz; Frequency: 5530 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5530 MHz; $\sigma$ = 5.72 mho/m; $\varepsilon_r$ = 47; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(3.57, 3.57, 3.57); Calibrated: 2016-05-31
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2016-01-26
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**5.6GHz_WLAN_802.11ac_VHT80_Base_CH106_Aux/Area Scan (81x111x1):** Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.54 mW/g

**5.6GHz_WLAN_802.11ac_VHT80_Base_CH106_Aux/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 10.5 V/m; Power Drift = -0.079 dB
Peak SAR (extrapolated) = 3.05 W/kg
**SAR(1 g) = 0.809 mW/g; SAR(10 g) = 0.390 mW/g**
Maximum value of SAR (measured) = 1.72 mW/g




0 dB = 1.72mW/g

**Appendix A.11 SAR Test Plots for WLAN 5.8GHz Main**

Date: 2016-10-15

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 5.8GHz_WLAN_802.11ac_VHT80_Base_CH155_Main_Repeated Test.da4

Ambient Temp : 22.7 ℃ Tissue Temp : 22.0 ℃

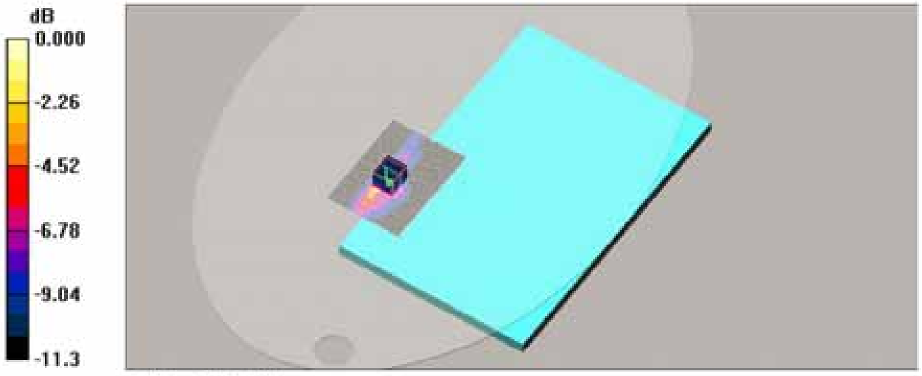
**DUT: NP900X3N; Type: SAMSUNG Notebook; Serial: 0NFN91ZH800005F**
**Program Name: Body**

Communication System: 5GHz; Frequency: 5775 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5775 MHz; $\sigma$ = 6.02 mho/m; $\varepsilon_r$ = 46.4; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(3.89, 3.89, 3.89); Calibrated: 2016-05-31
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2016-01-26
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**5.8GHz_WLAN_802.11ac_VHT80_Base_CH155_Main_Repeated Test/Area Scan (81x111x1):**
Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 2.11 mW/g

**5.8GHz_WLAN_802.11ac_VHT80_Base_CH155_Main_Repeated Test/Zoom Scan (7x7x7)/Cube 0:**
Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 5.22 V/m; Power Drift = 0.027 dB
Peak SAR (extrapolated) = 5.53 W/kg
**SAR(1 g) = 0.953 mW/g; SAR(10 g) = 0.420 mW/g**
Maximum value of SAR (measured) = 2.16 mW/g




0 dB = 2.16mW/g

**Appendix A.12 SAR Test Plots for WLAN 5.8GHz Aux**

Date: 2016-10-15

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 5.8GHz_WLAN_802.11ac_VHT80_Base_CH155_Aux.da4

Ambient Temp : 22.7 ℃ Tissue Temp : 22.0 ℃

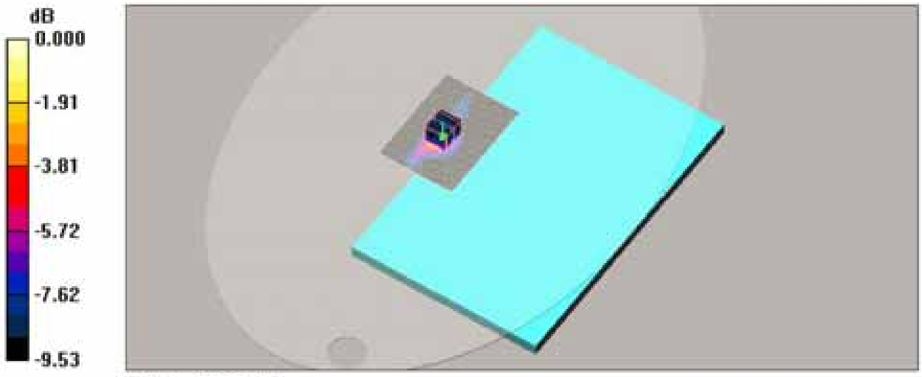
**DUT: NP900X3N; Type: SAMSUNG Notebook; Serial: 0NFN91ZH800005F**
**Program Name: Body**

Communication System: 5GHz; Frequency: 5775 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5775 MHz; $\sigma$ = 6.02 mho/m; $\varepsilon_r$ = 46.4; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(3.89, 3.89, 3.89); Calibrated: 2016-05-31
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2016-01-26
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**5.8GHz_WLAN_802.11ac_VHT80_Base_CH155_Aux/Area Scan (81x111x1):** Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.51 mW/g

**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 = 9.99 V/m; Power Drift = 0.049 dB
Peak SAR (extrapolated) = 3.12 W/kg
**SAR(1 g) = 0.779 mW/g; SAR(10 g) = 0.380 mW/g**
Maximum value of SAR (measured) = 1.66 mW/g



0 dB = 1.66mW/g

**Appendix A.13 SAR Test Plots for Bluetooth**

Date: 2016-10-17

Test Laboratory: SGS Korea (Gunpo Laboratory)
File Name: 2.45GHz_Bluetooth_Base_CH2441.da4

Ambient Temp : 22.6 ℃ Tissue Temp : 21.7 ℃

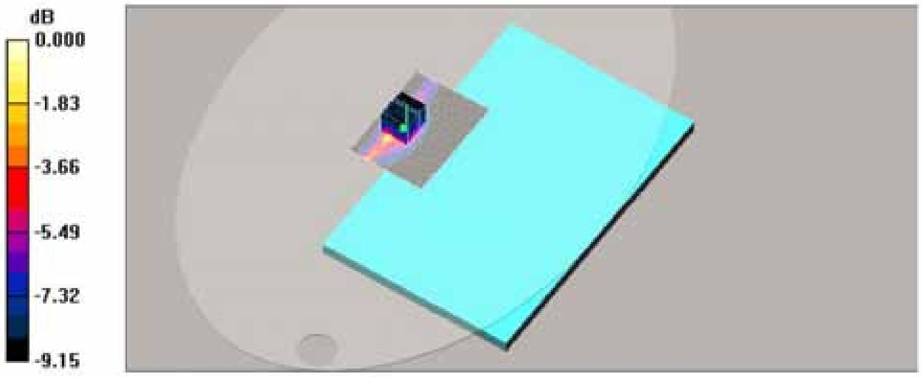
**DUT: NP900X3N; Type: SAMSUNG Notebook; Serial: 0NFN91ZH800005F**
**Program Name: Body**

Communication System: Bluetooth; Frequency: 2441 MHz;Duty Cycle: 1:1.307
Medium parameters used: f = 2441 MHz; σ = 1.92 mho/m; $\varepsilon_r$ = 51.1; ρ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3791; ConvF(6.63, 6.63, 6.63); Calibrated: 2016-05-31
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2016-01-26
- Phantom: ELI v4.0 Phamtom TP:1169; Type: ELI v4.0 Phamtom; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**2.45GHz_Bluetooth_Base_CH2441/Area Scan (81x111x1):** Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.329 mW/g

**2.45GHz_Bluetooth_Base_CH2441/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 5.28 V/m; Power Drift = 0.045 dB
Peak SAR (extrapolated) = 0.494 W/kg
**SAR(1 g) = 0.214 mW/g; SAR(10 g) = 0.116 mW/g**
Maximum value of SAR (measured) = 0.364 mW/g



0 dB = 0.364mW/g

**Appendix B.1 Uncertainty Analysis DASY4**

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

| a | b | c | d | e = f(d,k) | f | g | h cxf/e | i cxg/e | k |
|---|---|---|---|---|---|---|---|---|---|
| Uncertainty Component | IEEE 1528 2013 | Tol (%) | Prob . Dist. | Div. | Ci (1g) | Ci (10g) | 1g ui (%) | 10g ui (%) | Vi (Veff) |
| Probe calibration | E.2.1 | 6.55 | N | 1 | 1 | 1 | 6.55 | 6.55 | ∞ |
| Axial Isotropy | E.2.2 | 4.7 | R | 1.73 | 0.71 | 0.71 | 1.92 | 1.92 | ∞ |
| Hemispherical Isotropy | E.2.2 | 9.6 | R | 1.73 | 0.71 | 0.71 | 3.92 | 3.92 | ∞ |
| Boundary Effects | E.2.3 | 1 | R | 1.73 | 1 | 1 | 0.58 | 0.58 | ∞ |
| Modulation Response | E.2.5 | 2.4 | R | 1.73 | 1 | 1 | 1.39 | 1.39 | ∞ |
| Linearity | E.2.4 | 4.7 | R | 1.73 | 1 | 1 | 2.71 | 2.71 | ∞ |
| System Detection Limits | E.2.4 | 0.3 | R | 1.73 | 1 | 1 | 0.17 | 0.17 | ∞ |
| Reabout Electronics | E.2.6 | 0.3 | N | 1 | 1 | 1 | 0.30 | 0.30 | ∞ |
| Response Time | E.2.7 | 0.5 | R | 1.73 | 1 | 1 | 0.29 | 0.29 | ∞ |
| Integration Time | E.2.8 | 2.6 | R | 1.73 | 1 | 1 | 1.50 | 1.50 | ∞ |
| RF Ambient Noise | E.6.1 | 3 | R | 1.73 | 1 | 1 | 1.73 | 1.73 | ∞ |
| RF Ambient Reflections | E.6.1 | 3 | R | 1.73 | 1 | 1 | 1.73 | 1.73 | ∞ |
| Probe Positiones | E.6.2 | 1.5 | R | 1.73 | 1 | 1 | 0.87 | 0.87 | ∞ |
| Probe Positioning | E.6.3 | 2.9 | R | 1.73 | 1 | 1 | 1.67 | 1.67 | ∞ |
| Max SAR evaluation | E.5 | 1 | R | 1.73 | 1 | 1 | 0.58 | 0.58 | ∞ |
| Test sample positioning | E.4.2 | 2.06/1.97 | N | 1 | 1 | 1 | 2.06 | 1.97 | 9 |
| Device holder uncertainty | E.4.1 | 3.6 | N | 1 | 1 | 1 | 3.60 | 3.60 | 4 |
| Output power variation - SAR drift measurement | E.2.9 | 5 | R | 1.73 | 1 | 1 | 2.89 | 2.89 | ∞ |
| Phantom uncertainty | E.3.1 | 4 | R | 1.73 | 1 | 1 | 2.31 | 2.31 | ∞ |
| Correcting SAR for deviations in permittivity and conductivity | E.3.2 | 1.2 | R | 1.73 | 1 | 0.84 | 0.69 | 0.58 | ∞ |
| 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 | ∞ |
| Liquid permittivity – temperature | E.3.4 | 0.84 | R | 1.73 | 0.23 | 0.26 | 0.11 | 0.13 | ∞ |
| Combined standard uncertainty | | | | RSS | | | 11.08 | 11.01 | 341/335 |
| Expanded uncertainty (95% CONFIDENCE INTERVAL) | | | | k=2 | | | 22.16 | 22.02 | |

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

기술 책임자

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

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

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

Accreditation No.: **SCS 0108**

Client **SGS Korea (Dymstec)**

Certificate No: **EX3-3791_May16**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | EX3DV4 - SN:3791 |
| Calibration procedure(s) | QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6<br>Calibration procedure for dosimetric E-field probes |
| Calibration date: | May 31, 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 < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter NRP | SN: 104778 | 06-Apr-16 (No. 217-02288/02289) | Apr-17 |
| Power sensor NRP-Z91 | SN: 103244 | 06-Apr-16 (No. 217-02288) | Apr-17 |
| Power sensor NRP-Z91 | SN: 103245 | 06-Apr-16 (No. 217-02289) | Apr-17 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 05-Apr-16 (No. 217-02293) | Apr-17 |
| Reference Probe ES3DV2 | SN: 3013 | 31-Dec-15 (No. ES3-3013_Dec15) | Dec-16 |
| DAE4 | SN: 660 | 23-Dec-15 (No. DAE4-660_Dec15) | Dec-16 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| Power meter E4419B | SN: GB41293874 | 06-Apr-16 (No. 217-02285/02284) | In house check: Jun-16 |
| Power sensor E4412A | SN: MY41498087 | 06-Apr-16 (No. 217-02285) | In house check: Jun-16 |
| Power sensor E4412A | SN: 000110210 | 06-Apr-16 (No. 217-02284) | In house check: Jun-16 |
| RF generator HP 8648C | SN: US3642U01700 | 04-Aug-99 (in house check Apr-13) | In house check: Jun-16 |
| Network Analyzer HP 8753E | SN: US37390585 | 18-Oct-01 (in house check Oct-15) | In house check: Oct-16 |

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

Issued: June 1, 2016

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

Certificate No: EX3-3791_May16 Page 1 of 11

Calibration Laboratory of
Schmid & Partner
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Accreditation No.: SCS 0108

## Glossary:

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

## Calibration is Performed According to the Following Standards:

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

## Methods Applied and Interpretation of Parameters:

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

# Probe EX3DV4

## SN:3791

Manufactured: February 18, 2011
Calibrated: May 31, 2016

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

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

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm ($\mu V/(V/m)^2$)[A] | 0.55 | 0.54 | 0.54 | ± 10.1 % |
| DCP (mV)[B] | 99.1 | 96.3 | 100.3 | |

## Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB$\sqrt{\mu V}$ | C | D dB | VR mV | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 143.1 | ±1.9 % |
| | | Y | 0.0 | 0.0 | 1.0 | | 146.4 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 147.8 | |

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

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

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

## Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unc (k=2) |
|---|---|---|---|---|---|---|---|---|
| 835 | 41.5 | 0.90 | 8.63 | 8.63 | 8.63 | 0.45 | 0.86 | ± 12.0 % |
| 900 | 41.5 | 0.97 | 8.45 | 8.45 | 8.45 | 0.26 | 1.21 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 7.48 | 7.48 | 7.48 | 0.36 | 0.80 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 7.19 | 7.19 | 7.19 | 0.43 | 0.80 | ± 12.0 % |
| 2300 | 39.5 | 1.67 | 6.81 | 6.81 | 6.81 | 0.39 | 0.80 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 6.54 | 6.54 | 6.54 | 0.42 | 0.80 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 6.34 | 6.34 | 6.34 | 0.35 | 0.91 | ± 12.0 % |
| 5200 | 36.0 | 4.66 | 4.97 | 4.97 | 4.97 | 0.35 | 1.80 | ± 13.1 % |
| 5300 | 35.9 | 4.76 | 4.69 | 4.69 | 4.69 | 0.35 | 1.80 | ± 13.1 % |
| 5500 | 35.6 | 4.96 | 4.60 | 4.60 | 4.60 | 0.40 | 1.80 | ± 13.1 % |
| 5600 | 35.5 | 5.07 | 4.42 | 4.42 | 4.42 | 0.40 | 1.80 | ± 13.1 % |
| 5800 | 35.3 | 5.27 | 4.40 | 4.40 | 4.40 | 0.45 | 1.80 | ± 13.1 % |

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters ($\varepsilon$ 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 ($\varepsilon$ and $\sigma$) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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

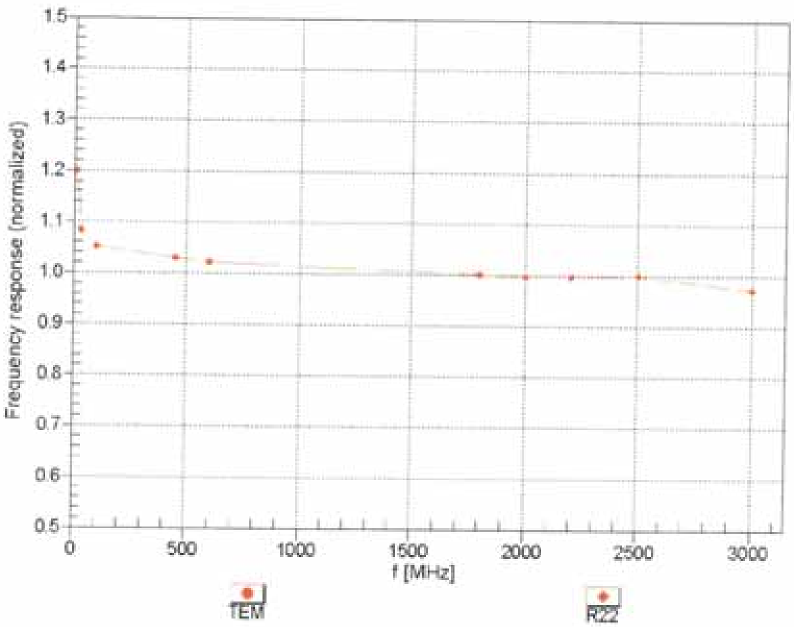
## Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unc (k=2) |
|---|---|---|---|---|---|---|---|---|
| 835 | 55.2 | 0.97 | 8.64 | 8.64 | 8.64 | 0.53 | 0.80 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 7.20 | 7.20 | 7.20 | 0.41 | 0.80 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 6.96 | 6.96 | 6.96 | 0.47 | 0.80 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 6.63 | 6.63 | 6.63 | 0.41 | 0.80 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 6.43 | 6.43 | 6.43 | 0.30 | 0.80 | ± 12.0 % |
| 5200 | 49.0 | 5.30 | 4.31 | 4.31 | 4.31 | 0.45 | 1.90 | ± 13.1 % |
| 5300 | 48.9 | 5.42 | 4.00 | 4.00 | 4.00 | 0.50 | 1.90 | ± 13.1 % |
| 5600 | 48.5 | 5.77 | 3.57 | 3.57 | 3.57 | 0.55 | 1.90 | ± 13.1 % |
| 5800 | 48.2 | 6.00 | 3.89 | 3.89 | 3.89 | 0.55 | 1.90 | ± 13.1 % |

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

## Frequency Response of E-Field

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

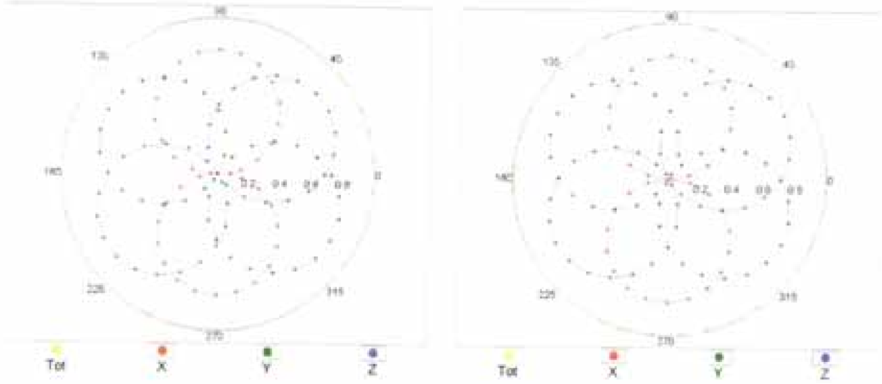


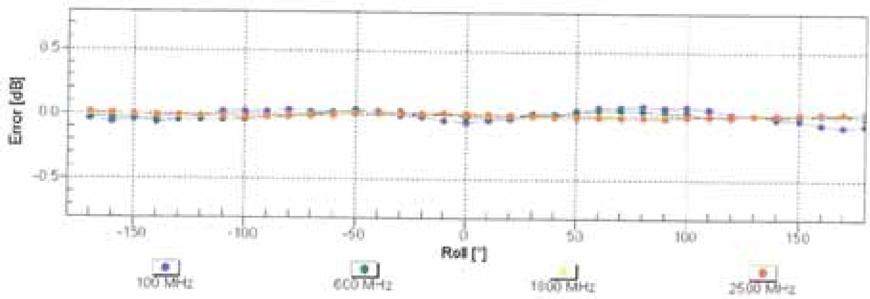

**Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)**

EX3DV4– SN:3791 May 31, 2016

## Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM f=1800 MHz,R22



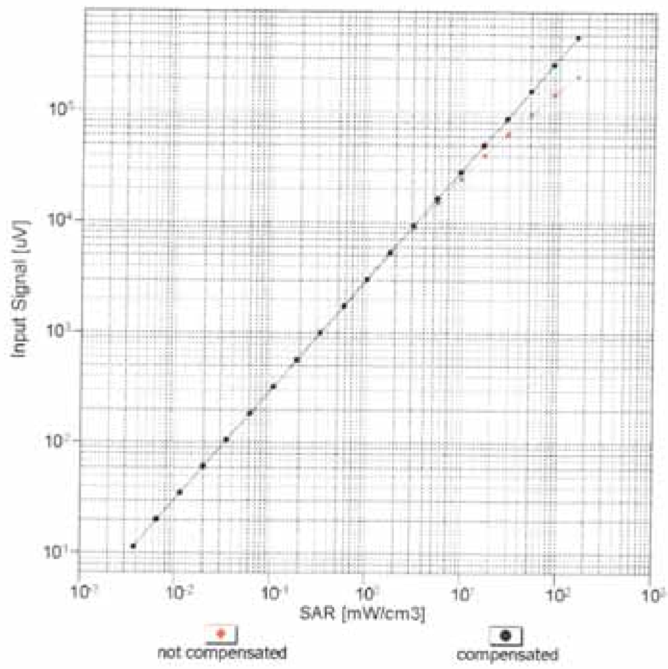



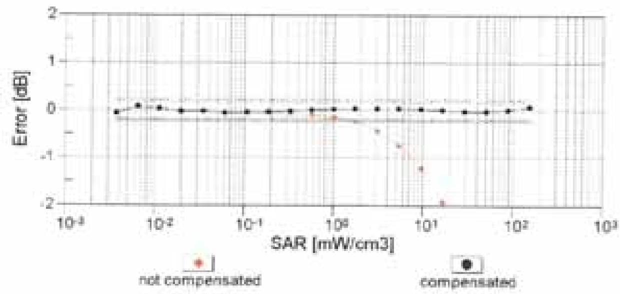

**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

Certificate No: EX3-3791_May16 Page 8 of 11

# Dynamic Range f($SAR_{head}$)

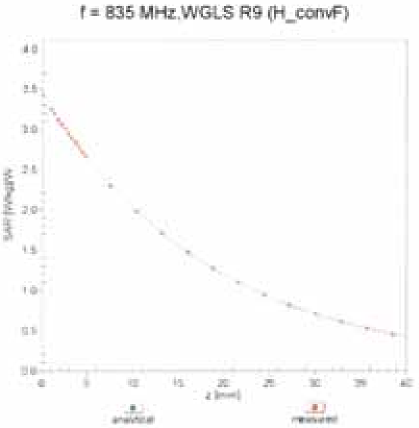
**(TEM cell , $f_{eval}$= 1900 MHz)**

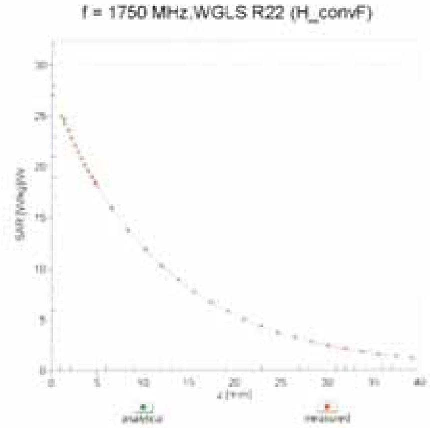



**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

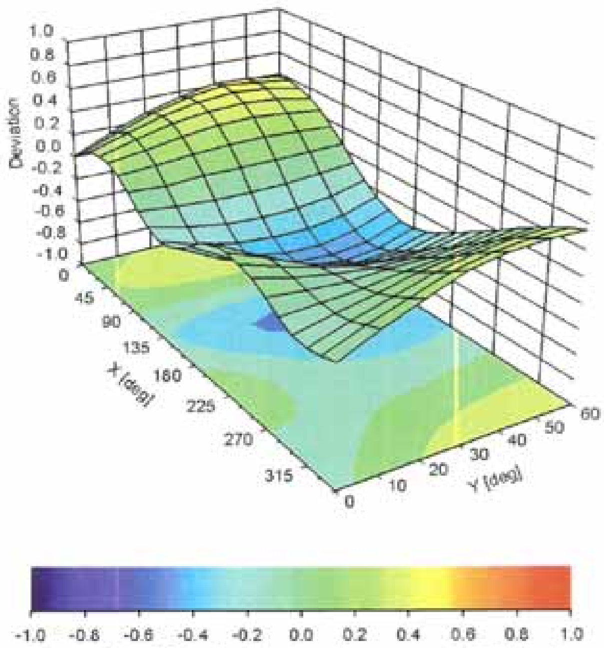
# Conversion Factor Assessment




# Deviation from Isotropy in Liquid

**Error (ϕ, ϑ), f = 900 MHz**




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

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

## Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 69.9 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 9 mm |
| Tip Diameter | 2.5 mm |
| Probe Tip to Sensor X Calibration Point | 1 mm |
| Probe Tip to Sensor Y Calibration Point | 1 mm |
| Probe Tip to Sensor Z Calibration Point | 1 mm |
| Recommended Measurement Distance from Surface | 1.4 mm |

**Appendix C.2 Calibration certificate for DAE**

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

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

Accreditation No.: **SCS 0108**

Client **SGS-Korea (Dymstec)**

Certificate No: **DAE3-567_Jan16**

# CALIBRATION CERTIFICATE

Object: DAE3 - SD 000 D03 AA - SN: 567

Calibration procedure(s): QA CAL-06.v29
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: January 26, 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 < 70%.

Calibration Equipment used (M&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 V2.1 | SE UMS 006 AA 1002 | 05-Jan-16 (in house check) | In house check: Jan-17 |

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

Issued: January 26, 2016

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

Certificate No: DAE3-567_Jan16 Page 1 of 5

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Accreditation No.: **SCS 0108**

## Glossary

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

## Methods Applied and Interpretation of Parameters

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

## DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1µV , full range = -100…+300 mV

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

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

| Calibration Factors | X | Y | Z |
|---|---|---|---|
| **High Range** | 404.722 ± 0.02% (k=2) | 404.468 ± 0.02% (k=2) | 404.559 ± 0.02% (k=2) |
| **Low Range** | 3.95717 ± 1.50% (k=2) | 3.97236 ± 1.50% (k=2) | 3.96088 ± 1.50% (k=2) |

## Connector Angle

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

## Appendix (Additional assessments outside the scope of SCS0108)

### 1. DC Voltage Linearity

| High Range | | Reading (μV) | Difference (μV) | Error (%) |
|---|---|---|---|---|
| Channel X | + Input | 200039.44 | 3.95 | 0.00 |
| Channel X | + Input | 20010.09 | 5.51 | 0.03 |
| Channel X | - Input | -20001.95 | 3.63 | -0.02 |
| Channel Y | + Input | 200038.39 | 2.75 | 0.00 |
| Channel Y | + Input | 20005.77 | 1.25 | 0.01 |
| Channel Y | - Input | -20003.83 | 1.96 | -0.01 |
| Channel Z | + Input | 200039.05 | 3.88 | 0.00 |
| Channel Z | + Input | 20003.12 | -1.30 | -0.01 |
| Channel Z | - Input | -20003.03 | 2.76 | -0.01 |

| Low Range | | Reading (μV) | Difference (μV) | Error (%) |
|---|---|---|---|---|
| Channel X | + Input | 2000.42 | -0.37 | -0.02 |
| Channel X | + Input | 201.05 | 0.32 | 0.16 |
| Channel X | - Input | -198.92 | 0.27 | -0.14 |
| Channel Y | + Input | 2000.80 | 0.06 | 0.00 |
| Channel Y | + Input | 200.66 | 0.09 | 0.05 |
| Channel Y | - Input | -199.98 | -0.69 | 0.35 |
| Channel Z | + Input | 2000.80 | 0.20 | 0.01 |
| Channel Z | + Input | 199.37 | -1.24 | -0.62 |
| Channel Z | - Input | -200.58 | -1.23 | 0.62 |

### 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 | 2.74 | 1.36 |
| | - 200 | -0.60 | -2.08 |
| Channel Y | 200 | 0.66 | -0.06 |
| | - 200 | -0.78 | -1.16 |
| Channel Z | 200 | 3.85 | 3.52 |
| | - 200 | -6.05 | -6.27 |

### 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 | - | -0.96 | -3.39 |
| Channel Y | 200 | 8.03 | - | -0.22 |
| Channel Z | 200 | 5.75 | 5.98 | - |

## 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 | 16274 | 16202 |
| Channel Y | 16146 | 13920 |
| Channel Z | 15961 | 15010 |

## 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 | 0.97 | -0.59 | 2.15 | 0.50 |
| Channel Y | 0.06 | -1.18 | 1.26 | 0.47 |
| Channel Z | -0.20 | -1.36 | 0.89 | 0.44 |

## 6. Input Offset Current

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

## 7. Input Resistance (Typical values for information)

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

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

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

## 9. Power Consumption (Typical values for information)

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

**Appendix C.3 Calibration certificate for Dipole**

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

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**S** Swiss Calibration Service

기술 책임자

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Accreditation No.: **SCS 0108**

Client **SGS Korea (Dymstec)**

Certificate No: **D2450V2-734_May16**

## CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D2450V2 - SN:734 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | May 24, 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 < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter NRP | SN: 104778 | 06-Apr-16 (No. 217-02288/02289) | Apr-17 |
| Power sensor NRP-Z91 | SN: 103244 | 06-Apr-16 (No. 217-02288) | Apr-17 |
| Power sensor NRP-Z91 | SN: 103245 | 06-Apr-16 (No. 217-02289) | Apr-17 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 05-Apr-16 (No. 217-02292) | Apr-17 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 05-Apr-16 (No. 217-02295) | Apr-17 |
| Reference Probe EX3DV4 | SN: 7349 | 31-Dec-15 (No. EX3-7349_Dec15) | Dec-16 |
| DAE4 | SN: 601 | 30-Dec-15 (No. DAE4-601_Dec15) | Dec-16 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power meter EPM-442A | SN: GB37480704 | 07-Oct-15 (No. 217-02222) | In house check: Oct-16 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (No. 217-02222) | In house check: Oct-16 |
| Power sensor HP 8481A | SN: MY41092317 | 07-Oct-15 (No. 217-02223) | In house check: Oct-16 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Jun-15) | In house check: Oct-16 |
| Network Analyzer HP 8753E | SN: US37390585 | 18-Oct-01 (in house check Oct-15) | In house check: Oct-16 |

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

Issued: May 25, 2016

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Certificate No: D2450V2-734_May16 Page 1 of 8

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

**Additional Documentation:**

e) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

## Measurement Conditions

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

| | | |
|---|---|---|
| **DASY Version** | DASY5 | V52.8.8 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 2450 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 39.2 | 1.80 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 38.6 ± 6 % | 1.87 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 12.8 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **50.1 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.92 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **23.4 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 | 52.6 ± 6 % | 2.02 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 12.6 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **49.5 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.90 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **23.4 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 | 54.6 Ω + 5.0 jΩ |
| Return Loss | - 23.7 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 50.7 Ω + 7.2 jΩ |
| Return Loss | - 22.9 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.152 ns |

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

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

### Additional EUT Data

| | |
|---|---|
| Manufactured by | SPEAG |
| Manufactured on | May 07, 2003 |

**DASY5 Validation Report for Head TSL**

Date: 24.05.2016

Test Laboratory: SPEAG, Zurich, Switzerland

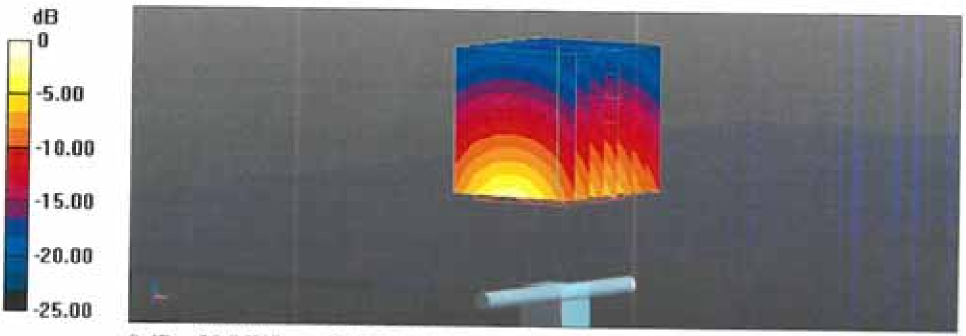
**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 734**

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.87 S/m; $\varepsilon_r$ = 38.6; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

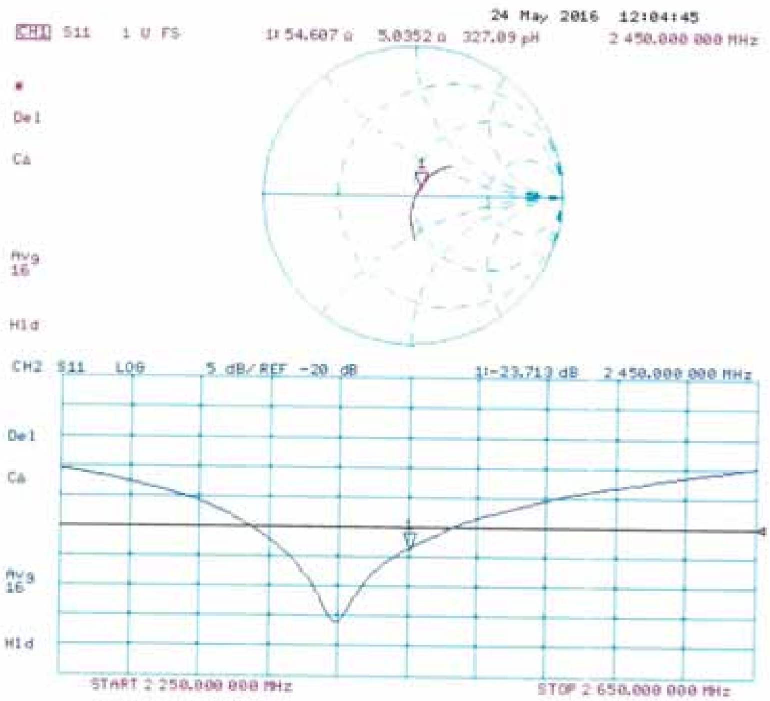
- Probe: EX3DV4 - SN7349; ConvF(7.76, 7.76, 7.76); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

**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 = 111.0 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 25.8 W/kg
**SAR(1 g) = 12.8 W/kg; SAR(10 g) = 5.92 W/kg**
Maximum value of SAR (measured) = 20.8 W/kg




0 dB = 20.8 W/kg = 13.18 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 24.05.2016

Test Laboratory: SPEAG, Zurich, Switzerland

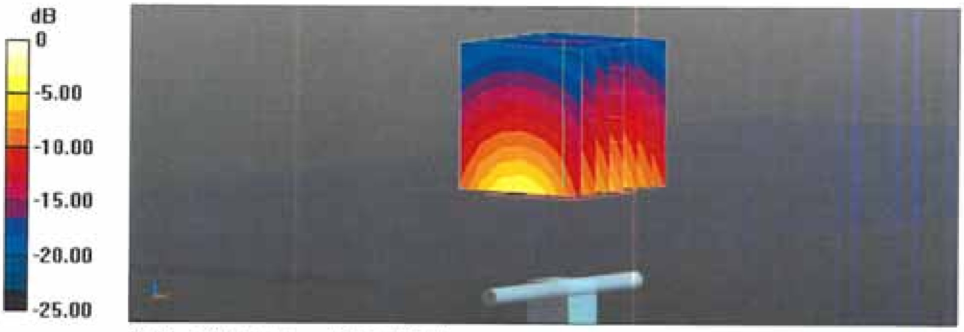
**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 734**

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 2.02 S/m; $\varepsilon_r$ = 52.6; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.79, 7.79, 7.79); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

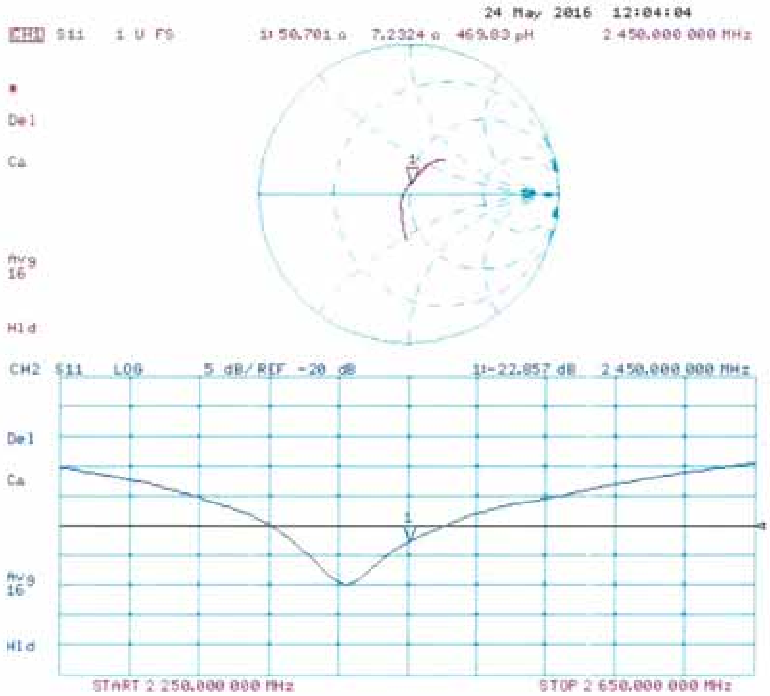
**Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:**
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 105.2 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 25.2 W/kg
**SAR(1 g) = 12.6 W/kg; SAR(10 g) = 5.9 W/kg**
Maximum value of SAR (measured) = 20.6 W/kg




0 dB = 20.6 W/kg = 13.14 dBW/kg

Certificate No: D2450V2-734_May16 Page 7 of 8

**Impedance Measurement Plot for Body TSL**




Certificate No: D2450V2-734_May16 Page 8 of 8

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

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Swiss Calibration Service

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

Accreditation No.: **SCS 0108**

Client **SGS Korea (Dymstec)**

Certificate No: **D5GHzV2-1130_May16**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D5GHzV2 - SN: 1130 |
| Calibration procedure(s) | QA CAL-22.v2<br>Calibration procedure for dipole validation kits between 3-6 GHz |
| Calibration date: | May 23, 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 < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter NRP | SN: 104778 | 06-Apr-16 (No. 217-02288/02289) | Apr-17 |
| Power sensor NRP-Z91 | SN: 103244 | 06-Apr-16 (No. 217-02288) | Apr-17 |
| Power sensor NRP-Z91 | SN: 103245 | 06-Apr-16 (No. 217-02289) | Apr-17 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 05-Apr-16 (No. 217-02292) | Apr-17 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 05-Apr-16 (No. 217-02295) | Apr-17 |
| Reference Probe EX3DV4 | SN: 3503 | 31-Dec-15 (No. EX3-3503_Dec15) | Dec-16 |
| DAE4 | SN: 601 | 30-Dec-15 (No. DAE4-601_Dec15) | Dec-16 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power meter EPM-442A | SN: GB37480704 | 07-Oct-15 (No. 217-02222) | In house check: Oct-16 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (No. 217-02222) | In house check: Oct-16 |
| Power sensor HP 8481A | SN: MY41092317 | 07-Oct-15 (No. 217-02223) | In house check: Oct-16 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Jun-15) | In house check: Oct-16 |
| Network Analyzer HP 8753E | SN: US37390585 | 18-Oct-01 (in house check Oct-15) | In house check: Oct-16 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Michael Weber | Laboratory Technician | M.Weber |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: May 25, 2016

**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**

**Glossary:**

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

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

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-2, "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
c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Additional Documentation:**

d) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

## Measurement Conditions

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

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

## Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 36.0 | 4.66 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 34.8 ± 6 % | 4.52 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL at 5200 MHz

| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.63 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **75.7 W/kg ± 19.9 % (k=2)** |

| SAR averaged over 10 cm³ (10 g) of Head TSL | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.21 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **21.9 W/kg ± 19.5 % (k=2)** |

## Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 35.9 | 4.76 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 34.7 ± 6 % | 4.61 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL at 5300 MHz

| **SAR averaged over 1 $cm^3$ (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 | **79.9 W / kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.34 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **23.2 W/kg ± 19.5 % (k=2)** |

## Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 35.6 | 4.96 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 34.4 ± 6 % | 4.81 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL at 5500 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 8.01 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **79.4 W/kg ± 19.9 % (k=2)** |

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

## Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 35.5 | 5.07 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 34.3 ± 6 % | 4.91 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL at 5600 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 8.15 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **80.8 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.34 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **23.2 W/kg ± 19.5 % (k=2)** |

## Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 35.3 | 5.27 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 34.0 ± 6 % | 5.12 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL at 5800 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.74 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **76.7 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.20 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **21.8 W/kg ± 19.5 % (k=2)** |

## Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

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

## SAR result with Body TSL at 5200 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.40 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **73.5 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.09 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **20.7 W/kg ± 19.5 % (k=2)** |

## Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

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

## SAR result with Body TSL at 5300 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.69 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **76.4 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.17 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **21.5 W/kg ± 19.5 % (k=2)** |

## Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 48.6 | 5.65 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 46.7 ± 6 % | 5.83 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL at 5500 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.93 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **78.8 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.23 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **22.1 W/kg ± 19.5 % (k=2)** |

## Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 48.5 | 5.77 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 46.5 ± 6 % | 5.97 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL at 5600 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.95 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **78.9 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.24 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 |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 48.2 | 6.00 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 46.2 ± 6 % | 6.26 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL at 5800 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.65 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **76.0 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.14 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **21.2 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 | 51.5 Ω - 10.0 jΩ |
| Return Loss | - 20.0 dB |

### Antenna Parameters with Head TSL at 5300 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 52.1 Ω - 4.5 jΩ |
| Return Loss | - 26.3 dB |

### Antenna Parameters with Head TSL at 5500 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 51.7 Ω - 5.6 jΩ |
| Return Loss | - 24.8 dB |

### Antenna Parameters with Head TSL at 5600 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 56.2 Ω - 3.2 jΩ |
| Return Loss | - 23.7 dB |

### Antenna Parameters with Head TSL at 5800 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 54.7 Ω - 2.6 jΩ |
| Return Loss | - 25.8 dB |

### Antenna Parameters with Body TSL at 5200 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 51.4 Ω - 8.9 jΩ |
| Return Loss | - 21.0 dB |

### Antenna Parameters with Body TSL at 5300 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 50.9 Ω - 3.1 jΩ |
| Return Loss | - 29.9 dB |

### Antenna Parameters with Body TSL at 5500 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 52.5 Ω - 4.1 jΩ |
| Return Loss | - 26.6 dB |

## Antenna Parameters with Body TSL at 5600 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 57.9 Ω - 1.4 jΩ |
| Return Loss | - 22.6 dB |

## Antenna Parameters with Body TSL at 5800 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 56.5 Ω - 1.1 jΩ |
| Return Loss | - 24.2 dB |

## General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.205 ns |

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

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

## Additional EUT Data

| | |
|---|---|
| Manufactured by | SPEAG |
| Manufactured on | September 08, 2011 |

## DASY5 Validation Report for Head TSL

Date: 23.05.2016

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1130**

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; $\sigma$ = 4.52 S/m; $\varepsilon_r$ = 34.8; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5300 MHz; $\sigma$ = 4.61 S/m; $\varepsilon_r$ = 34.7; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5500 MHz; $\sigma$ = 4.81 S/m; $\varepsilon_r$ = 34.4; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5600 MHz; $\sigma$ = 4.91 S/m; $\varepsilon_r$ = 34.3; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5800 MHz; $\sigma$ = 5.12 S/m; $\varepsilon_r$ = 34; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.59, 5.59, 5.59); Calibrated: 31.12.2015, ConvF(5.25, 5.25, 5.25); Calibrated: 31.12.2015, ConvF(5.18, 5.18, 5.18); Calibrated: 31.12.2015, ConvF(4.99, 4.99, 4.99); Calibrated: 31.12.2015, ConvF(4.95, 4.95, 4.95); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

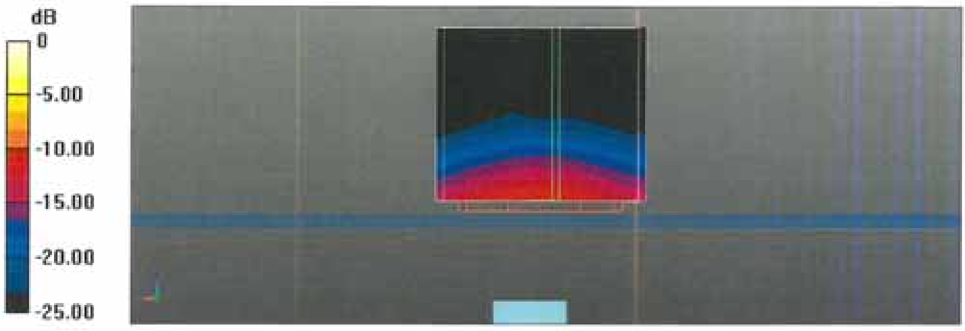
**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 71.75 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 27.6 W/kg
**SAR(1 g) = 7.63 W/kg; SAR(10 g) = 2.21 W/kg**
Maximum value of SAR (measured) = 17.7 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 73.16 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 30.1 W/kg
**SAR(1 g) = 8.05 W/kg; SAR(10 g) = 2.34 W/kg**
Maximum value of SAR (measured) = 18.8 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 70.23 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 31.5 W/kg
**SAR(1 g) = 8.01 W/kg; SAR(10 g) = 2.31 W/kg**
Maximum value of SAR (measured) = 18.9 W/kg

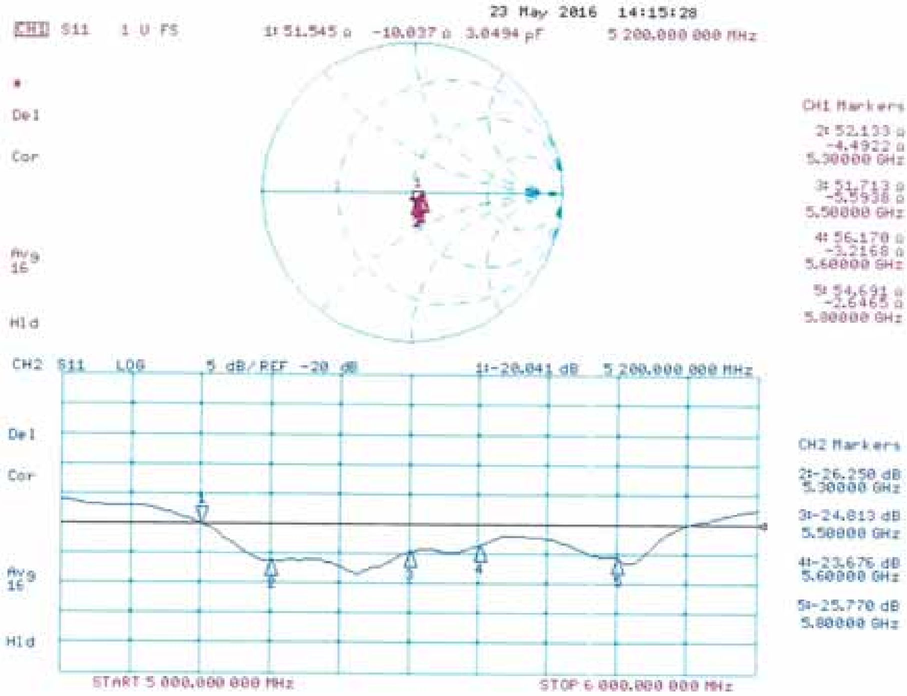
**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 72.60 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 31.9 W/kg
**SAR(1 g) = 8.15 W/kg; SAR(10 g) = 2.34 W/kg**
Maximum value of SAR (measured) = 19.5 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 = 69.86 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 31.8 W/kg
**SAR(1 g) = 7.74 W/kg; SAR(10 g) = 2.2 W/kg**
Maximum value of SAR (measured) = 19.5 W/kg




0 dB = 18.8 W/kg = 12.74 dBW/kg

**Impedance Measurement Plot for Head TSL**



**DASY5 Validation Report for Body TSL**

Date: 20.05.2016

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1130**

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; $\sigma$ = 5.43 S/m; $\varepsilon_r$ = 47.3; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5300 MHz; $\sigma$ = 5.56 S/m; $\varepsilon_r$ = 47.1; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5500 MHz; $\sigma$ = 5.83 S/m; $\varepsilon_r$ = 46.7; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5600 MHz; $\sigma$ = 5.97 S/m; $\varepsilon_r$ = 46.5; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5800 MHz; $\sigma$ = 6.26 S/m; $\varepsilon_r$ = 46.2; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.99, 4.99, 4.99); Calibrated: 31.12.2015, ConvF(4.75, 4.75, 4.75); Calibrated: 31.12.2015, ConvF(4.4, 4.4, 4.4); Calibrated: 31.12.2015, ConvF(4.35, 4.35, 4.35); Calibrated: 31.12.2015, ConvF(4.27, 4.27, 4.27); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

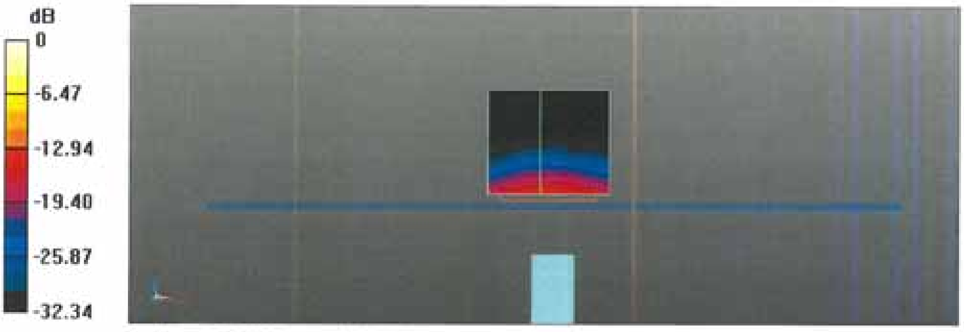
**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 66.11 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 27.3 W/kg
**SAR(1 g) = 7.4 W/kg; SAR(10 g) = 2.09 W/kg**
Maximum value of SAR (measured) = 16.7 W/kg

**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 67.08 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 29.1 W/kg
**SAR(1 g) = 7.69 W/kg; SAR(10 g) = 2.17 W/kg**
Maximum value of SAR (measured) = 17.6 W/kg

**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 67.44 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 31.9 W/kg
**SAR(1 g) = 7.93 W/kg; SAR(10 g) = 2.23 W/kg**
Maximum value of SAR (measured) = 18.6 W/kg

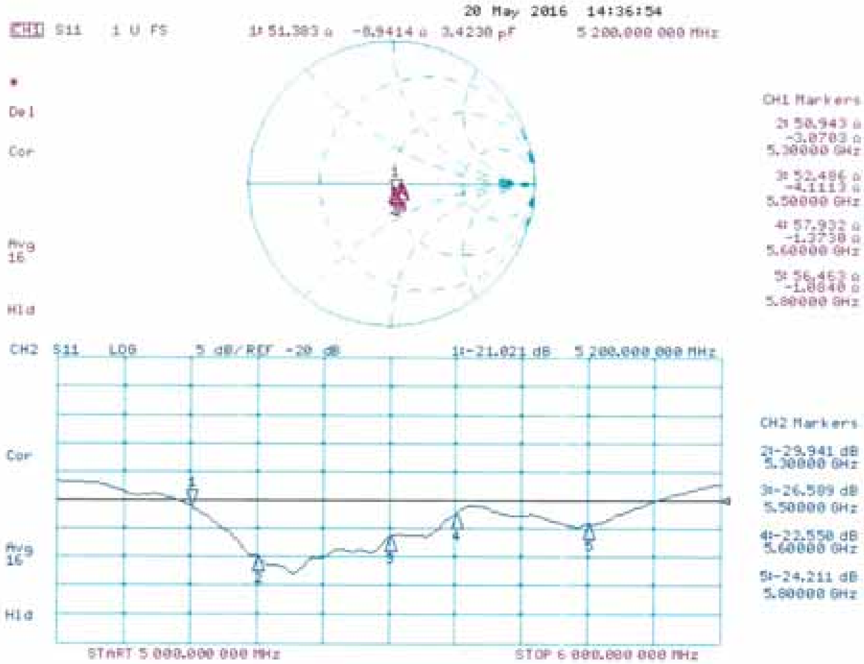
**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 67.01 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 32.6 W/kg
**SAR(1 g) = 7.95 W/kg; SAR(10 g) = 2.24 W/kg**
Maximum value of SAR (measured) = 18.7 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 = 64.61 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 33.2 W/kg
**SAR(1 g) = 7.65 W/kg; SAR(10 g) = 2.14 W/kg**
Maximum value of SAR (measured) = 18.3 W/kg



0 dB = 16.7 W/kg = 12.23 dBW/kg

### Impedance Measurement Plot for Body TSL

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