



FCC SAR Test Report

Report No. : SA130109C08

Applicant : ASUSTeK Computer Inc

Address : 4F., NO. 150, LI-TE RD. PEITOU, TAIPEI, 112 TAIWAN

Product : Notebook PC

FCC ID : MSQPU500C

Brand : ASUS

Model No. : PU500C,PRO500C,E500C

Standards : FCC 47 CFR Part 2 (2.1093) / IEEE C95.1:1991 / IEEE 1528:2003
 FCC OET Bulletin 65 Supplement C (Edition 01-01)
 KDB 248227 D01 v01r02 / KDB 447498 D01 v05 / KDB 616217 D04 v01

Date of Testing : Jan. 29, 2013 ~ Jan. 31, 2013

CERTIFICATION: The above equipment have been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch - Taiwan HwaYa Lab**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's SAR characteristics under the conditions specified in this report. It should not be reproduced except in full, without the written approval of our laboratory. The client should not use it to claim product certification, approval, or endorsement by TAF or any government agencies.

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Release Control Record

| Issue No. | Reason for Change | Date Issued |
|-----------|-------------------|---------------|
| R01 | Initial release | Feb. 18, 2013 |
| | | |
| | | |



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1. Summary of Maximum SAR Value

| Equipment Class | Mode | Highest Reported Body SAR _{1g} (0 cm Gap) (W/kg) |
|---------------------------------------|-----------|---|
| DTS | 2.4G WLAN | 0.29 |
| | 5.8G WLAN | 0.32 |
| NII | 5.2G WLAN | 0.33 |
| | 5.3G WLAN | 0.28 |
| | 5.5G WLAN | 0.59 |
| DSS | Bluetooth | N/A |
| Highest Simultaneous Transmission SAR | | Body (W/kg) |
| DTS+DSS | | 0.53 |
| NII+DSS | | 0.79 |

Note:

1. The SAR limit (**Head & Body: SAR_{1g} 1.6 W/kg, Extremity: SAR_{10g} 4.0 W/kg**) for general population / uncontrolled exposure is specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1991.

2. Description of Equipment Under Test

| | |
|--|---|
| EUT Type | Notebook PC |
| FCC ID | MSQPU500C |
| Brand Name | ASUS |
| Model Name | PU500C,PRO500C,E500C |
| Tx Frequency Bands (Unit: MHz) | WLAN : 2400 ~ 2483.5, 5150 ~ 5350, 5470 ~ 5725, 5725 ~ 5850 Bluetooth : 2400 ~ 2483.5 |
| Uplink Modulations | 802.11b : DSSS 802.11a/g/n : OFDM Bluetooth : GFSK |
| Maximum Tune-up Conducted Power (Unit: dBm) | 802.11b : 15.5 802.11g : 15.5 802.11n HT20 (2.4GHz) : 19.0 802.11n HT40 (2.4GHz) : 15.5 802.11a : 14.5 802.11n HT20 (5GHz) : 16.8 802.11n HT40 (5GHz) : 16.8 Bluetooth : 8.0 |
| Antenna Type | Fixed Internal Antenna |
| EUT Stage | Identical Prototype |

Note:

1. The above EUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.
2. The details related to antennas used in this EUT are listed as below.

| Vendor | Brand | Model | Antenna Type | | Connector | Gain(dBi) | |
|--------|-------|------------------|--------------|------|----------------|-------------|-------------|
| | | | | | | 2.4GHz Band | 5.0GHz Band |
| 1 | ACON | APP6P-700769 | Ant-0 | PIFA | I-PEX & Hirose | 1.01 | 1.27 |
| | | | Ant-1 | PIFA | I-PEX & Hirose | 1.53 | 2.28 |
| 2 | INPAQ | WA-F-LBLB-04-005 | Ant-0 | PIFA | I-PEX MHF | 1.02 | 0.39 |
| | | | Ant-1 | PIFA | I-PEX MHF | 1.30 | 1.06 |

3. SAR Measurement System

3.1 Definition of Specific Absorption Rate (SAR)

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.

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

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

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

SAR measurement can be related to the electrical field in the tissue by

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

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

3.2 SPEAG DASY System

DASY system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY4/5 software defined. The DASY software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC.

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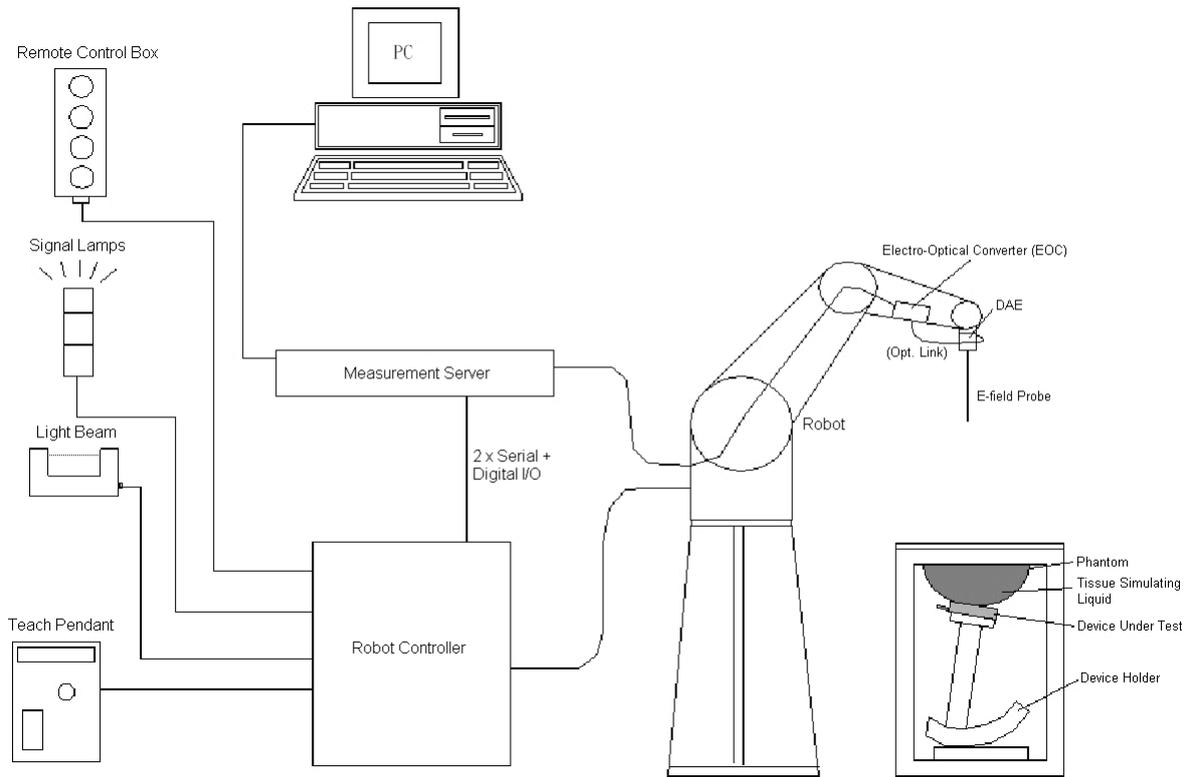


Fig-3.1 DASY System Setup

3.2.1 Robot

The DASY system uses the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY4: CS7MB; DASY5: CS8c) from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability ± 0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)



Fig-3.2 DASY4



Fig-3.3 DASY5

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3.2.2 Probes

The SAR measurement is conducted with the dosimetric probe. The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency.

| | | |
|----------------------|--|---|
| Model | EX3DV4 |  |
| Construction | Symmetrical design with triangular core. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE). | |
| Frequency | 10 MHz to 6 GHz Linearity: ± 0.2 dB | |
| Directivity | ± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis) | |
| Dynamic Range | 10 μ W/g to 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 μ W/g) | |
| Dimensions | Overall length: 337 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm | |

| | | |
|----------------------|---|--|
| Model | ES3DV3 |  |
| Construction | Symmetrical design with triangular core. Interleaved sensors. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE). | |
| Frequency | 10 MHz to 4 GHz Linearity: ± 0.2 dB | |
| Directivity | ± 0.2 dB in HSL (rotation around probe axis) ± 0.3 dB in tissue material (rotation normal to probe axis) | |
| Dynamic Range | 5 μ W/g to 100 mW/g Linearity: ± 0.2 dB | |
| Dimensions | Overall length: 337 mm (Tip: 20 mm) Tip diameter: 3.9 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.0 mm | |

3.2.3 Data Acquisition Electronics (DAE)

| | | |
|-----------------------------|--|---|
| Model | DAE3, DAE4 |  |
| Construction | Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY4/5 embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop. | |
| Measurement Range | -100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV) | |
| Input Offset Voltage | < 5 μ V (with auto zero) | |
| Input Bias Current | < 50 fA | |
| Dimensions | 60 x 60 x 68 mm | |

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3.2.4 Phantoms

| | | |
|------------------------|---|---|
| Model | Twin SAM |  |
| Construction | The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot. | |
| Material | Vinylester, glass fiber reinforced (VE-GF) | |
| Shell Thickness | 2 ± 0.2 mm (6 ± 0.2 mm at ear point) | |
| Dimensions | Length: 1000 mm Width: 500 mm Height: adjustable feet | |
| Filling Volume | approx. 25 liters | |

| | | |
|------------------------|---|--|
| Model | ELI |  |
| Construction | Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. 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. | |
| Material | Vinylester, glass fiber reinforced (VE-GF) | |
| Shell Thickness | 2.0 ± 0.2 mm (bottom plate) | |
| Dimensions | Major axis: 600 mm Minor axis: 400 mm | |
| Filling Volume | approx. 30 liters | |

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3.2.5 Device Holder

| | | |
|---------------------|---|---|
| Model | Mounting Device |  |
| Construction | In combination with the Twin SAM Phantom or ELI4, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to IEC, IEEE, FCC or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat). | |
| Material | POM | |

| | | |
|---------------------|---|---|
| Model | Laptop Extensions Kit |  |
| Construction | Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.). It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner. | |
| Material | POM, Acrylic glass, Foam | |

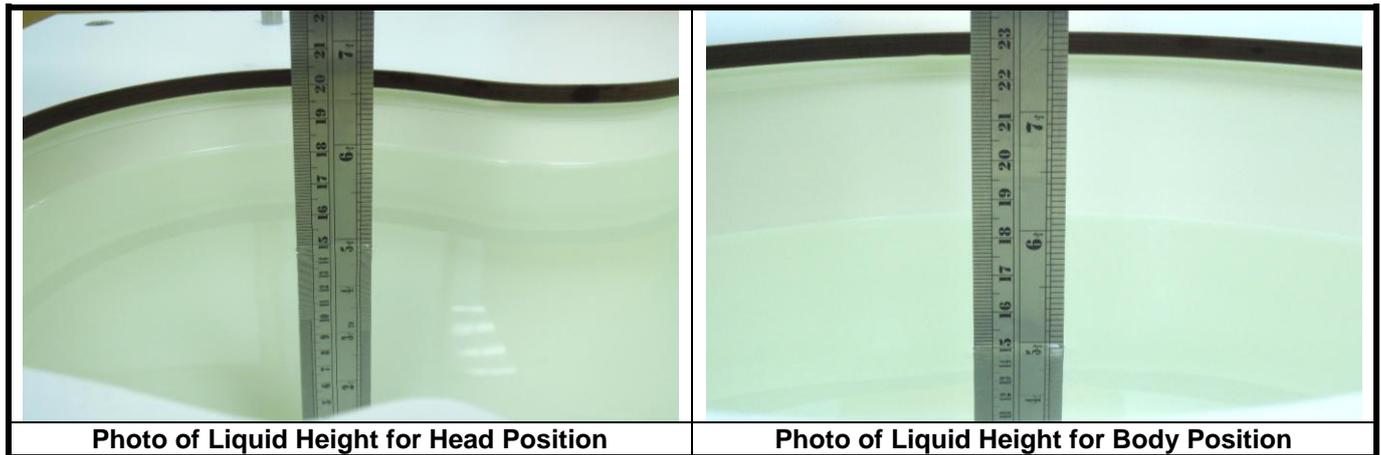
3.2.6 System Validation Dipoles

| | | |
|-------------------------|--|---|
| Model | D-Serial |  |
| Construction | Symmetrical dipole with 1/4 balun. Enables measurement of feed point impedance with NWA. Matched for use near flat phantoms filled with tissue simulating solutions. | |
| Frequency | 750 MHz to 5800 MHz | |
| Return Loss | > 20 dB | |
| Power Capability | > 100 W (f < 1GHz), > 40 W (f > 1GHz) | |

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3.2.7 Tissue Simulating Liquids

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5% are listed in Table-3.1.



The dielectric properties of the head tissue simulating liquids are defined in IEEE 1528 and FCC OET 65 Supplement C Appendix C. For the body tissue simulating liquids, the dielectric properties are defined in FCC OET 65 Supplement C Appendix C. The dielectric properties of the tissue simulating liquids were verified prior to the SAR evaluation using an Agilent 85070D Dielectric Probe Kit and an Agilent Network Analyzer.

Table-3.1 Targets of Tissue Simulating Liquid

| Frequency (MHz) | Target Permittivity | Range of $\pm 5\%$ | Target Conductivity | Range of $\pm 5\%$ |
|-----------------|---------------------|--------------------|---------------------|--------------------|
| For Body | | | | |
| 2450 | 52.7 | 50.1 ~ 55.3 | 1.95 | 1.85 ~ 2.05 |
| 5200 | 49.0 | 46.6 ~ 51.5 | 5.30 | 5.04 ~ 5.57 |
| 5300 | 48.9 | 46.5 ~ 51.3 | 5.42 | 5.15 ~ 5.69 |
| 5600 | 48.5 | 46.1 ~ 50.9 | 5.77 | 5.48 ~ 6.06 |
| 5800 | 48.2 | 45.8 ~ 50.6 | 6.00 | 5.70 ~ 6.30 |

The following table gives the recipes for tissue simulating liquids.

Table-3.2 Recipes of Tissue Simulating Liquid

| Tissue Type | Bactericide | DGBE | HEC | NaCl | Sucrose | Triton X-100 | Water | Diethylene Glycol Mono-hexylether |
|-------------|-------------|------|-----|------|---------|--------------|-------|-----------------------------------|
| B2450 | - | 31.4 | - | 0.1 | - | - | 68.5 | - |
| B5G | - | - | - | - | - | 10.7 | 78.6 | 10.7 |

3.3 SAR System Verification

The system check verifies that the system operates within its specifications. It is performed daily or before every SAR measurement. The system check uses normal SAR measurements in the flat section of the phantom with a matched dipole at a specified distance. The system verification setup is shown as below.

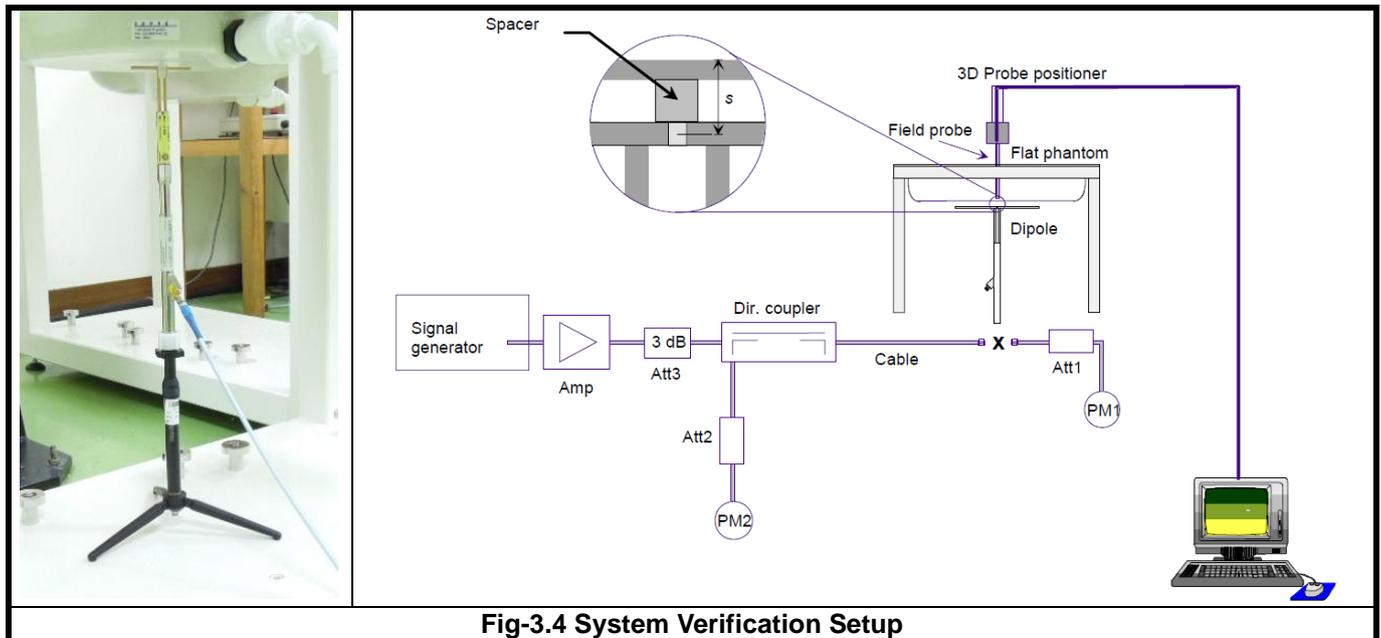


Fig-3.4 System Verification Setup

The validation dipole is placed beneath the flat phantom with the specific spacer in place. The distance spacer is touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The power meter PM1 measures the forward power at the location of the system check dipole connector. The signal generator is adjusted for the desired forward power (250 mW is used for 700 MHz to 3 GHz, 100 mW is used for 3.5 GHz to 6 GHz) at the dipole connector and the power meter PM2 is read at that level. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at power meter PM2.

After system check testing, the SAR result will be normalized to 1W forward input power and compared with the reference SAR value derived from validation dipole certificate report. The deviation of system check should be within 10 %.

3.4 SAR Measurement Procedure

According to the SAR test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

- (a) Power reference measurement
- (b) Area scan
- (c) Zoom scan
- (d) Power drift measurement

The SAR measurement procedures for each of test conditions are as follows:

- (a) Make EUT to transmit maximum output power
- (b) Measure conducted output power through RF cable
- (c) Place the EUT in the specific position of phantom
- (d) Perform SAR testing steps on the DASY system
- (e) Record the SAR value

3.4.1 Area & Zoom Scan Procedure

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g. According to KDB 865664D01v01, the resolution for Area and Zoom scan is specified in the table below.

| Items | <= 2 GHz | 2-3 GHz | 3-4 GHz | 4-5 GHz | 5-6 GHz |
|---------------------------------------|----------|----------|----------|----------|----------|
| Area Scan ($\Delta x, \Delta y$) | <= 15 mm | <= 12 mm | <= 12 mm | <= 10 mm | <= 10 mm |
| Zoom Scan ($\Delta x, \Delta y$) | <= 8 mm | <= 5 mm | <= 5 mm | <= 4 mm | <= 4 mm |
| Zoom Scan (Δz) | <= 5 mm | <= 5 mm | <= 4 mm | <= 3 mm | <= 2 mm |
| Zoom Scan Volume | >= 30 mm | >= 30 mm | >= 28 mm | >= 25 mm | >= 22 mm |

Note:

When zoom scan is required and report SAR is <= 1.4 W/kg, the zoom scan resolution of $\Delta x / \Delta y$ (2-3GHz: <= 8 mm, 3-4GHz: <= 7 mm, 4-6GHz: <= 5 mm) may be applied.

3.4.2 Volume Scan Procedure

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

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3.4.3 Power Drift Monitoring

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In DASY measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in dB. If the power drift more than 5%, the SAR will be retested.

3.4.4 Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1g and 10g, as well as for user-specific masses. The DASY software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

The base for the evaluation is a "cube" measurement. The measured volume must include the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.

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 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

- (a) Extraction of the measured data (grid and values) from the Zoom Scan
- (b) Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
- (c) Generation of a high-resolution mesh within the measured volume
- (d) Interpolation of all measured values from the measurement grid to the high-resolution grid
- (e) Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
- (f) Calculation of the averaged SAR within masses of 1g and 10g

3.4.5 SAR Averaged Methods

In DASY, the interpolation and extrapolation are both based on the modified Quadratic Shepard's method. The interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5 mm.

4. SAR Measurement Evaluation

4.1 EUT Configuration and Setting

For WLAN SAR testing, the EUT has installed WLAN engineering testing software which can provide continuous transmitting RF signal. According to KDB 248227 D01, WLAN SAR should be tested at the lowest data rate, and testing at higher data rate is not required when the maximum average output power is less than 1/4 dB higher than those measured at the lowest data rate. Since the WLAN power at the lowest data rate has the highest output power, WLAN SAR for this device was performed at the lowest data rate as set in 1 Mbps for 802.11b, 6 Mbps for 802.11a, and MCS0 for 802.11n. This RF signal utilized in SAR measurement has almost 100% duty cycle and the duty factor is 1 for WLAN SAR testing.

4.2 EUT Testing Position

According to KDB 447498, SAR testing for laptop PC is required for the bottom surface. This EUT was tested in the base of EUT directly against the flat phantom.

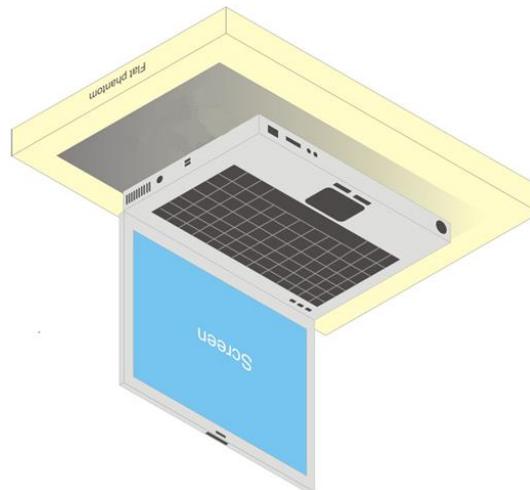


Fig-4.1 Illustration for Laptop Setup

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According to KDB 447498 D01v05, the SAR test exclusion condition is based on source-based time-averaged maximum conducted output power, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions. The SAR exclusion threshold is determined by the following formula.

1. For the test separation distance ≤ 50 mm

$$\frac{\text{Max. Tune up Power}_{(mW)}}{\text{Min. Test Separation Distance}_{(mm)}} \times \sqrt{f_{(GHz)}} \leq 3.0$$

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

2. For the test separation distance > 50 mm, and the frequency at 100 MHz to 1500 MHz

$$\left[(\text{Threshold at 50 mm in Step 1}) + (\text{Test Separation Distance} - 50 \text{ mm}) \times \left(\frac{f_{(MHz)}}{150} \right) \right]_{(mW)}$$

3. For the test separation distance > 50 mm, and the frequency at > 1500 MHz to 6 GHz

$$[(\text{Threshold at 50 mm in Step 1}) + (\text{Test Separation Distance} - 50 \text{ mm}) \times 10]_{(mW)}$$

| Mode | Max. Tune-up Power (dBm) | Max. Tune-up Power (mW) | Body | | |
|------|--------------------------|-------------------------|----------------------|--------------------------|-------------|
| | | | Ant. to Surface (mm) | Exclusion Threshold (mW) | SAR Tested? |
| BT | 8.0 | 6 | 7.5 | 14 | No |



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4.3 Tissue Verification

The measuring results for tissue simulating liquid are shown as below.

| Test Date | Tissue Type | Frequency (MHz) | Liquid Temp. (°C) | Measured Conductivity (σ) | Measured Permittivity (ε _r) | Target Conductivity (σ) | Target Permittivity (ε _r) | Conductivity Deviation (%) | Permittivity Deviation (%) |
|---------------|-------------|-----------------|-------------------|---------------------------|---|-------------------------|---------------------------------------|----------------------------|----------------------------|
| Jan. 31, 2013 | Body | 2450 | 20.5 | 2.006 | 52.889 | 1.95 | 52.7 | 2.87 | 0.36 |
| Jan. 29, 2013 | Body | 5200 | 20.1 | 5.212 | 51.041 | 5.30 | 49.0 | -1.66 | 4.17 |
| Jan. 29, 2013 | Body | 5300 | 20.1 | 5.377 | 50.94 | 5.42 | 48.9 | -0.79 | 4.17 |
| Jan. 29, 2013 | Body | 5600 | 20.1 | 5.906 | 50.367 | 5.77 | 48.5 | 2.36 | 3.85 |
| Jan. 30, 2013 | Body | 5800 | 20.2 | 6.127 | 47.81 | 6.00 | 48.2 | 2.12 | -0.81 |

Note:

The dielectric properties of the tissue simulating liquid must be measured within 24 hours before the SAR testing and within ±5% of the target values. Liquid temperature during the SAR testing must be within ±2 °C.

4.4 System Validation

The SAR measurement system was validated according to procedures in KDB 865664 D01v01. The validation status in tabulated summary is as below.

| Test Date | Probe S/N | Calibration Point | | Measured Conductivity (σ) | Measured Permittivity (ε _r) | Validation for CW | | | Validation for Modulation | | |
|---------------|-----------|-------------------|------|---------------------------|---|-------------------|-----------------|----------------|---------------------------|-------------|------|
| | | | | | | Sensitivity Range | Probe Linearity | Probe Isotropy | Modulation Type | Duty Factor | PAR |
| Jan. 31, 2013 | 3650 | Body | 2450 | 2.006 | 52.889 | Pass | Pass | Pass | OFDM | N/A | Pass |
| Jan. 29, 2013 | 3650 | Body | 5200 | 5.212 | 51.041 | Pass | Pass | Pass | OFDM | N/A | Pass |
| Jan. 29, 2013 | 3650 | Body | 5300 | 5.377 | 50.94 | Pass | Pass | Pass | OFDM | N/A | Pass |
| Jan. 29, 2013 | 3650 | Body | 5600 | 5.906 | 50.367 | Pass | Pass | Pass | OFDM | N/A | Pass |
| Jan. 30, 2013 | 3650 | Body | 5800 | 6.127 | 47.81 | Pass | Pass | Pass | OFDM | N/A | Pass |

4.5 System Verification

The measuring result for system verification is tabulated as below.

| Test Date | Mode | Frequency (MHz) | 1W Target SAR-1g (W/kg) | Measured SAR-1g (W/kg) | Normalized to 1W SAR-1g (W/kg) | Deviation (%) | Dipole S/N | Probe S/N | DAE S/N |
|---------------|------|-----------------|-------------------------|------------------------|--------------------------------|---------------|------------|-----------|---------|
| Jan. 31, 2013 | Body | 2450 | 50.00 | 12.5 | 50.00 | 0.00 | 735 | 3650 | 1277 |
| Jan. 29, 2013 | Body | 5200 | 73.00 | 7.83 | 78.30 | 7.26 | 1019 | 3650 | 1277 |
| Jan. 29, 2013 | Body | 5300 | 74.60 | 7.67 | 76.70 | 2.82 | 1019 | 3650 | 1277 |
| Jan. 29, 2013 | Body | 5600 | 79.90 | 8.46 | 84.60 | 5.88 | 1019 | 3650 | 1277 |
| Jan. 30, 2013 | Body | 5800 | 73.40 | 7.67 | 76.70 | 4.50 | 1019 | 3650 | 1277 |

Note:

Comparing to the reference SAR value provided by SPEAG, the validation data should be within its specification of 10 %. The result indicates the system check can meet the variation criterion and the plots can be referred to Appendix A of this report.



FCC SAR Test Report

4.6 Maximum Output Power

4.6.1 Nominal Conducted Power

The nominal conducted power (Unit: dBm) including tune-up tolerance is shown as below.

| Mode | 2.4G WLAN | 5.2G WLAN | 5.3G WLAN | 5.5G WLAN | 5.8G WLAN |
|--------------|-----------|-----------|-----------|-----------|-----------|
| 802.11b | 15.5 | N/A | N/A | N/A | N/A |
| 802.11g | 15.5 | N/A | N/A | N/A | N/A |
| 802.11a | N/A | 14.5 | 14.5 | 14.5 | 14.5 |
| 802.11n HT20 | 19.0 | 16.5 | 16.8 | 16.5 | 16.5 |
| 802.11n HT40 | 15.5 | 16.5 | 16.5 | 16.8 | 16.5 |

| Mode | Bluetooth |
|------|-----------|
| All | 8.0 |

4.6.2 Measured Conducted Power Result

The measuring conducted power (Unit: dBm) is shown as below.

| Band | 802.11b | | | 802.11g | | |
|-----------------------|---------|-------|-------|---------|-------|-------|
| | Channel | 1 | 6 | 11 | 1 | 6 |
| Frequency (MHz) | 2412 | 2437 | 2462 | 2412 | 2437 | 2462 |
| Average Power (Ant-0) | 15.13 | 15.33 | 15.11 | 12.23 | 15.29 | 12.26 |

| Band | 802.11n (HT20) | | | 802.11n (HT40) | | |
|-------------------------------|----------------|-------|-------|----------------|-------|-------|
| | Channel | 1 | 6 | 11 | 3 | 6 |
| Frequency (MHz) | 2412 | 2437 | 2462 | 2422 | 2437 | 2452 |
| Average Power (Ant-0) | 12.24 | 15.92 | 11.73 | 8.84 | 12.77 | 9.27 |
| Average Power (Ant-0 + Ant-1) | 15.00 | 18.84 | 14.68 | 11.63 | 15.38 | 11.89 |

| Band | 802.11a | | | | | | | |
|-----------------------|---------|-------|-------|-------|-------|-------|-------|-------|
| | Channel | 36 | 40 | 44 | 48 | 52 | 56 | 60 |
| Frequency (MHz) | 5180 | 5200 | 5220 | 5240 | 5260 | 5280 | 5300 | 5320 |
| Average Power (Ant-0) | 14.32 | 14.47 | 14.40 | 14.37 | 14.15 | 14.28 | 14.25 | 14.22 |

| Band | 802.11a | | | | | | | |
|-----------------------|---------|-------|-------|-------|-------|-------|-------|-------|
| | Channel | 100 | 104 | 108 | 112 | 116 | 132 | 136 |
| Frequency (MHz) | 5500 | 5520 | 5540 | 5560 | 5580 | 5660 | 5680 | 5700 |
| Average Power (Ant-0) | 14.47 | 14.30 | 14.14 | 14.36 | 14.15 | 14.19 | 14.20 | 14.39 |

| Band | 802.11a | | | | | | | |
|-----------------------|---------|-------|-------|-------|-------|-----|---|---|
| | Channel | 149 | 153 | 157 | 161 | 165 | - | - |
| Frequency (MHz) | 5745 | 5765 | 5785 | 5805 | 5825 | - | - | - |
| Average Power (Ant-0) | 14.28 | 14.42 | 14.25 | 14.41 | 14.26 | - | - | - |



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| Band | 802.11n (HT20) | | | | | | | |
|-------------------------------|----------------|-------|-------|-------|-------|-------|-------|-------|
| Channel | 36 | 40 | 44 | 48 | 52 | 56 | 60 | 64 |
| Frequency (MHz) | 5180 | 5200 | 5220 | 5240 | 5260 | 5280 | 5300 | 5320 |
| Average Power (Ant-0) | 13.35 | 13.48 | 13.10 | 13.19 | 13.63 | 13.50 | 13.65 | 13.80 |
| Average Power (Ant-0 + Ant-1) | 16.25 | 16.31 | 16.20 | 16.19 | 16.59 | 16.54 | 16.76 | 16.77 |

| Band | 802.11n (HT20) | | | | | | | |
|-------------------------------|----------------|-------|-------|-------|-------|-------|-------|-------|
| Channel | 100 | 104 | 108 | 112 | 116 | 132 | 136 | 140 |
| Frequency (MHz) | 5500 | 5520 | 5540 | 5560 | 5580 | 5660 | 5680 | 5700 |
| Average Power (Ant-0) | 13.32 | 13.58 | 13.41 | 13.21 | 13.25 | 13.28 | 13.22 | 13.21 |
| Average Power (Ant-0 + Ant-1) | 16.38 | 16.37 | 16.47 | 16.38 | 16.25 | 16.26 | 16.18 | 16.35 |

| Band | 802.11n (HT20) | | | | | | | |
|-------------------------------|----------------|-------|-------|-------|-------|---|---|---|
| Channel | 149 | 153 | 157 | 161 | 165 | - | - | - |
| Frequency (MHz) | 5745 | 5765 | 5785 | 5805 | 5825 | - | - | - |
| Average Power (Ant-0) | 13.17 | 13.41 | 13.38 | 13.52 | 13.47 | - | - | - |
| Average Power (Ant-0 + Ant-1) | 16.32 | 16.48 | 16.41 | 16.48 | 16.41 | - | - | - |

| Band | 802.11n (HT40) | | | | | | | |
|-------------------------------|----------------|-------|-------|-------|-------|-------|-------|-------|
| Channel | 38 | 46 | 54 | 62 | 102 | 134 | 151 | 159 |
| Frequency (MHz) | 5190 | 5230 | 5270 | 5310 | 5510 | 5670 | 5755 | 5795 |
| Average Power (Ant-0) | 10.55 | 13.88 | 13.46 | 10.94 | 13.52 | 13.22 | 13.51 | 13.32 |
| Average Power (Ant-0 + Ant-1) | 13.49 | 16.50 | 16.50 | 13.92 | 16.71 | 16.26 | 16.50 | 16.31 |



FCC SAR Test Report

4.7 SAR Testing Results

4.7.1 SAR Results for Body (Test Separation Distance is 0 cm)

| Plot No. | Band | Mode | Test Position | Separation Distance (cm) | Ch. | Ant. Vendor | Tx Antenna | Max. Tune-up Power (dBm) | Measured Conducted Power (dBm) | Scaling Factor | Power Drift (dB) | Measured SAR-1g (W/kg) | Scaled SAR-1g (W/kg) |
|----------|---------|------|---------------|--------------------------|-----|-------------|------------|--------------------------|--------------------------------|----------------|------------------|------------------------|----------------------|
| | 802.11b | - | Bottom | 0 | 6 | 1 | 0 | 15.5 | 15.33 | 1.04 | 0.012 | 0.094 | 0.10 |
| | 802.11n | HT20 | Bottom | 0 | 6 | 1 | 0+1 | 19.0 | 18.84 | 1.04 | 0 | 0.233 | 0.24 |
| | 802.11b | - | Bottom | 0 | 6 | 2 | 0 | 15.5 | 15.33 | 1.04 | 0.013 | 0.207 | 0.22 |
| 131 | 802.11n | HT20 | Bottom | 0 | 6 | 2 | 0+1 | 19.0 | 18.84 | 1.04 | -0.01 | 0.279 | 0.29 |
| 109 | 802.11a | - | Bottom | 0 | 153 | 1 | 0 | 14.5 | 14.42 | 1.02 | -0.03 | 0.315 | 0.32 |
| | 802.11n | HT40 | Bottom | 0 | 151 | 1 | 0+1 | 16.5 | 16.50 | 1.00 | 0.001 | 0.295 | 0.30 |
| | 802.11a | - | Bottom | 0 | 153 | 2 | 0 | 14.5 | 14.42 | 1.02 | 0 | 0.19 | 0.19 |
| | 802.11n | HT40 | Bottom | 0 | 151 | 2 | 0+1 | 16.5 | 16.50 | 1.00 | 0.01 | 0.164 | 0.16 |
| | 802.11a | - | Bottom | 0 | 40 | 1 | 0 | 14.5 | 14.47 | 1.01 | 0.001 | 0.201 | 0.20 |
| | 802.11n | HT40 | Bottom | 0 | 46 | 1 | 0+1 | 16.5 | 16.50 | 1.00 | 0.02 | 0.078 | 0.08 |
| 123 | 802.11a | - | Bottom | 0 | 40 | 2 | 0 | 14.5 | 14.47 | 1.01 | 0.005 | 0.33 | 0.33 |
| | 802.11n | HT40 | Bottom | 0 | 46 | 2 | 0+1 | 16.5 | 16.50 | 1.00 | 0 | 0.157 | 0.16 |
| | 802.11a | - | Bottom | 0 | 56 | 1 | 0 | 14.5 | 14.28 | 1.05 | 0.019 | 0.243 | 0.26 |
| | 802.11n | HT20 | Bottom | 0 | 64 | 1 | 0+1 | 16.8 | 16.77 | 1.01 | 0.01 | 0.163 | 0.16 |
| 125 | 802.11a | - | Bottom | 0 | 56 | 2 | 0 | 14.5 | 14.28 | 1.05 | 0.001 | 0.265 | 0.28 |
| | 802.11n | HT20 | Bottom | 0 | 64 | 2 | 0+1 | 16.8 | 16.77 | 1.01 | 0 | 0.181 | 0.18 |
| 107 | 802.11a | - | Bottom | 0 | 100 | 1 | 0 | 14.5 | 14.47 | 1.01 | 0.1 | 0.58 | 0.59 |
| | 802.11n | HT40 | Bottom | 0 | 102 | 1 | 0+1 | 16.8 | 16.71 | 1.02 | 0.001 | 0.296 | 0.30 |
| | 802.11a | - | Bottom | 0 | 100 | 2 | 0 | 14.5 | 14.47 | 1.01 | 0.03 | 0.169 | 0.17 |
| | 802.11n | HT40 | Bottom | 0 | 102 | 2 | 0+1 | 16.8 | 16.71 | 1.02 | 0.001 | 0.091 | 0.09 |

Note:

- SAR is performed on the highest power channel. When the reported SAR value of highest power channel is ≤ 0.8 W/kg, SAR testing for optional channel is not required.
- SAR testing for 802.11g/n is not required because its maximum power is less than 1/4 dB higher than 802.11b.
- SAR testing for 802.11n is not required when its maximum power is less than 1/4 dB higher than 802.11a.

4.7.2 SAR Measurement Variability

According to KDB 865664 D01v01, SAR measurement variability was assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. Alternatively, if the highest measured SAR for both head and body tissue-equivalent media are ≤ 1.45 W/kg and the ratio of these highest SAR values, i.e., largest divided by smallest value, is ≤ 1.10 , the highest SAR configuration for either head or body tissue-equivalent medium may be used to perform the repeated measurement. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

Since all the measured SAR are less than 0.8 W/kg, the repeated measurement is not required.

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4.7.3 Simultaneous Multi-band Transmission Evaluation

<Estimated SAR Calculation>

According to KDB 447498 D01v05, when standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR was estimated according to following to determine simultaneous transmission SAR test exclusion.

$$\text{Estimated SAR} = \frac{\text{Max. Tune up Power}_{(mW)}}{\text{Min. Test Separation Distance}_{(mm)}} \times \frac{\sqrt{f_{(GHz)}}}{7.5}$$

If the minimum test separation distance is < 5 mm, a distance of 5 mm is used for estimated SAR calculation. When the test separation distance is > 50 mm, the 0.4 W/kg is used for SAR-1g.

| Mode / Band | Frequency (GHz) | Max. Tune-up Power (dBm) | Test Position | Separation Distance (mm) | Estimated SAR (W/kg) |
|-------------|-----------------|--------------------------|---------------|--------------------------|----------------------|
| Bluetooth | 2.48 | 8.0 | Body | 7.5 | 0.2 |

<SAR Summation Analysis>

Simultaneous transmission SAR test exclusion is determined for each operating configuration and exposure condition according to the reported standalone SAR of each applicable simultaneous transmitting antenna. When the sum of SAR_{1g} of all simultaneously transmitting antennas in an operating mode and exposure condition combination is within the SAR limit (SAR_{1g} 1.6 W/kg), the simultaneous transmission SAR is not required. When the sum of SAR_{1g} is greater than the SAR limit (SAR_{1g} 1.6 W/kg), SAR test exclusion is determined by the SPLSR.

| No. | Conditions (SAR1 + SAR2) | Exposure Condition | Test Position | Max. SAR1 | Max. SAR2 | SAR Summation | SPLSR |
|-----|-----------------------------|--------------------|---------------|-----------|-----------|---------------|-------|
| 1 | WLAN (DTS) + BT (DSS) | Body | Bottom | 0.32 | 0.2 | 0.52 | N/A |
| 2 | WLAN (NII) + BT (DSS) | Body | Bottom | 0.59 | 0.2 | 0.79 | N/A |

Test Engineer : Ulysses Liu, and Willy Chang



5. Calibration of Test Equipment

| Equipment | Manufacturer | Model | SN | Cal. Date | Cal. Interval |
|------------------------------|--------------|----------------|------------|---------------|---------------|
| System Validation Kit | SPEAG | D2450V2 | 735 | Jun. 15, 2012 | Annual |
| System Validation Kit | SPEAG | D5GHzV2 | 1019 | Nov. 16, 2012 | Annual |
| Dosimetric E-Field Probe | SPEAG | EX3DV4 | 3650 | Oct. 26, 2012 | Annual |
| Data Acquisition Electronics | SPEAG | DAE4 | 1277 | Jul. 19, 2012 | Annual |
| ELI Phantom | SPEAG | QDOVA001B | TP-1039 | N/A | N/A |
| ENA Series Network Analyzer | Agilent | E5071C | MY46214281 | May 14, 2012 | Annual |
| MXG Analog Signal Generator | Agilent | N5181A | MY50143868 | May 06, 2012 | Annual |
| Power Meter | Anritsu | ML2495A | 1218009 | May 07, 2012 | Annual |
| Power Sensor | Anritsu | MA2411B | 1207252 | May 07, 2012 | Annual |
| EXA Spectrum Analyzer | Agilent | N9010A | MY52100136 | Apr. 23, 2012 | Annual |
| Dielectric Probe Kit | Agilent | 85070D | E2-020018 | May 14, 2012 | Annual |
| Thermometer | YFE | YF-160A | 110600361 | Feb. 21, 2012 | Annual |
| Directional Coupler | Woken | 0110A05602O-10 | 11122702 | Apr. 19, 2012 | Annual |
| Power Amplifier | AR | 5S1G4 | 0339656 | Apr. 23, 2012 | Annual |
| Power Amplifier | Mini-Circuit | ZVE-8G | 001000422 | Apr. 23, 2012 | Annual |
| Attenuator | Woken | 00800A1G01L-03 | N/A | Apr. 19, 2012 | Annual |

6. Measurement Uncertainty

| Error Description | Uncertainty Value (±%) | Probability Distribution | Divisor | C _i (1g) | Standard Uncertainty (1g) | V _i |
|--------------------------------------|------------------------|--------------------------|---------|---------------------|---------------------------|----------------|
| Measurement System | | | | | | |
| Probe Calibration | 6.0 | Normal | 1 | 1 | ± 6.0 % | ∞ |
| Axial Isotropy | 4.7 | Rectangular | √3 | 0.7 | ± 1.9 % | ∞ |
| Hemispherical Isotropy | 9.6 | Rectangular | √3 | 0.7 | ± 3.9 % | ∞ |
| Boundary Effects | 1.0 | Rectangular | √3 | 1 | ± 0.6 % | ∞ |
| Linearity | 4.7 | Rectangular | √3 | 1 | ± 2.7 % | ∞ |
| System Detection Limits | 1.0 | Rectangular | √3 | 1 | ± 0.6 % | ∞ |
| Readout Electronics | 0.6 | Normal | 1 | 1 | ± 0.6 % | ∞ |
| Response Time | 0.0 | Rectangular | √3 | 1 | ± 0.0 % | ∞ |
| Integration Time | 1.7 | Rectangular | √3 | 1 | ± 1.0 % | ∞ |
| RF Ambient Noise | 3.0 | Rectangular | √3 | 1 | ± 1.7 % | ∞ |
| RF Ambient Reflections | 3.0 | Rectangular | √3 | 1 | ± 1.7 % | ∞ |
| Probe Positioner | 0.5 | Rectangular | √3 | 1 | ± 0.3 % | ∞ |
| Probe Positioning | 2.9 | Rectangular | √3 | 1 | ± 1.7 % | ∞ |
| Max. SAR Eval. | 2.3 | Rectangular | √3 | 1 | ± 1.3 % | ∞ |
| Test Sample Related | | | | | | |
| Device Positioning | 3.9 | Normal | 1 | 1 | ± 3.9 % | 31 |
| Device Holder | 2.7 | Normal | 1 | 1 | ± 2.7 % | 19 |
| Power Drift | 5.0 | Rectangular | √3 | 1 | ± 2.9 % | ∞ |
| Phantom and Setup | | | | | | |
| Phantom Uncertainty | 4.0 | Rectangular | √3 | 1 | ± 2.3 % | ∞ |
| Liquid Conductivity (Target) | 5.0 | Rectangular | √3 | 0.64 | ± 1.8 % | ∞ |
| Liquid Conductivity (Meas.) | 5.0 | Normal | 1 | 0.64 | ± 3.2 % | 29 |
| Liquid Permittivity (Target) | 5.0 | Rectangular | √3 | 0.6 | ± 1.7 % | ∞ |
| Liquid Permittivity (Meas.) | 5.0 | Normal | 1 | 0.6 | ± 3.0 % | 29 |
| Combined Standard Uncertainty | | | | | ± 11.7 % | |
| Expanded Uncertainty (K=2) | | | | | ± 23.4 % | |

Uncertainty budget for frequency range 300 MHz to 3 GHz



FCC SAR Test Report

| Error Description | Uncertainty Value (±%) | Probability Distribution | Divisor | Ci (1g) | Standard Uncertainty (1g) | Vi |
|--------------------------------------|------------------------|--------------------------|---------|---------|---------------------------|----|
| Measurement System | | | | | | |
| Probe Calibration | 6.55 | Normal | 1 | 1 | ± 6.55 % | ∞ |
| Axial Isotropy | 4.7 | Rectangular | √3 | 0.7 | ± 1.9 % | ∞ |
| Hemispherical Isotropy | 9.6 | Rectangular | √3 | 0.7 | ± 3.9 % | ∞ |
| Boundary Effects | 2.0 | Rectangular | √3 | 1 | ± 1.2 % | ∞ |
| Linearity | 4.7 | Rectangular | √3 | 1 | ± 2.7 % | ∞ |
| System Detection Limits | 1.0 | Rectangular | √3 | 1 | ± 0.6 % | ∞ |
| Readout Electronics | 0.3 | Normal | 1 | 1 | ± 0.3 % | ∞ |
| Response Time | 0.8 | Rectangular | √3 | 1 | ± 0.5 % | ∞ |
| Integration Time | 2.6 | Rectangular | √3 | 1 | ± 1.5 % | ∞ |
| RF Ambient Noise | 3.0 | Rectangular | √3 | 1 | ± 1.7 % | ∞ |
| RF Ambient Reflections | 3.0 | Rectangular | √3 | 1 | ± 1.7 % | ∞ |
| Probe Positioner | 0.8 | Rectangular | √3 | 1 | ± 0.5 % | ∞ |
| Probe Positioning | 9.9 | Rectangular | √3 | 1 | ± 5.7 % | ∞ |
| Max. SAR Eval. | 4.0 | Rectangular | √3 | 1 | ± 2.3 % | ∞ |
| Test Sample Related | | | | | | |
| Device Positioning | 3.9 | Normal | 1 | 1 | ± 3.9 % | 31 |
| Device Holder | 2.7 | Normal | 1 | 1 | ± 2.7 % | 19 |
| Power Drift | 5.0 | Rectangular | √3 | 1 | ± 2.9 % | ∞ |
| Phantom and Setup | | | | | | |
| Phantom Uncertainty | 4.0 | Rectangular | √3 | 1 | ± 2.3 % | ∞ |
| Liquid Conductivity (Target) | 5.0 | Rectangular | √3 | 0.64 | ± 1.8 % | ∞ |
| Liquid Conductivity (Meas.) | 5.0 | Normal | 1 | 0.64 | ± 3.2 % | 30 |
| Liquid Permittivity (Target) | 5.0 | Rectangular | √3 | 0.6 | ± 1.7 % | ∞ |
| Liquid Permittivity (Meas.) | 5.0 | Normal | 1 | 0.6 | ± 3.0 % | 30 |
| Combined Standard Uncertainty | | | | | ± 13.4 % | |
| Expanded Uncertainty (K=2) | | | | | ± 26.8 % | |

Uncertainty budget for frequency range 3 GHz to 6 GHz



7. Information on the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

Taiwan HwaYa EMC/RF/Safety/Telecom Lab:

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The road map of all our labs can be found in our web site also.

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Appendix A. SAR Plots of System Verification

The plots for system verification are shown as follows.

System Check_B2450_130131

DUT: Dipole 2450 MHz; Type: D2450V2; SN: 735

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: B2450_0131 Medium parameters used: $f = 2450$ MHz; $\sigma = 2.006$ S/m; $\epsilon_r = 52.889$; $\rho = 1000$ kg/m³

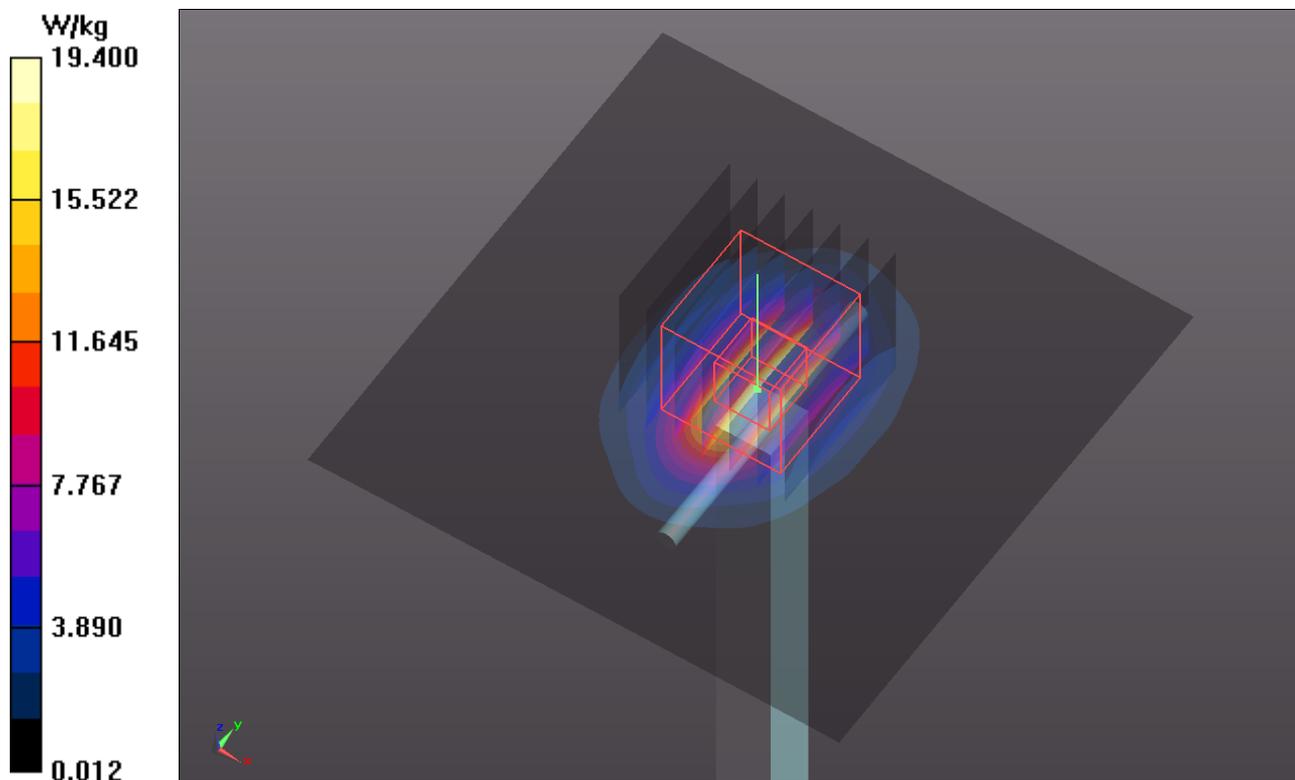
Ambient Temperature : 21.6 °C ; Liquid Temperature : 20.5 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3650; ConvF(6.6, 6.6, 6.6); Calibrated: 2012/10/26;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2012/07/19
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1039
- Measurement SW: DASY52, Version 52.8 (3); SEMCAD X Version 14.6.8 (7028)

Pin=250mW/Area Scan (81x81x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 19.4 W/kg

Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 98.490 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 26.8 W/kg
SAR(1 g) = 12.5 W/kg; SAR(10 g) = 5.72 W/kg
Maximum value of SAR (measured) = 19.4 W/kg



System Check_B5200_130129

DUT: Dipole 5 GHz; Type: D5GHzV2; SN: 1019

Communication System: CW; Frequency: 5200 MHz; Duty Cycle: 1:1

Medium: B5G_0129 Medium parameters used: $f = 5200$ MHz; $\sigma = 5.212$ S/m; $\epsilon_r = 51.041$; $\rho = 1000$ kg/m³

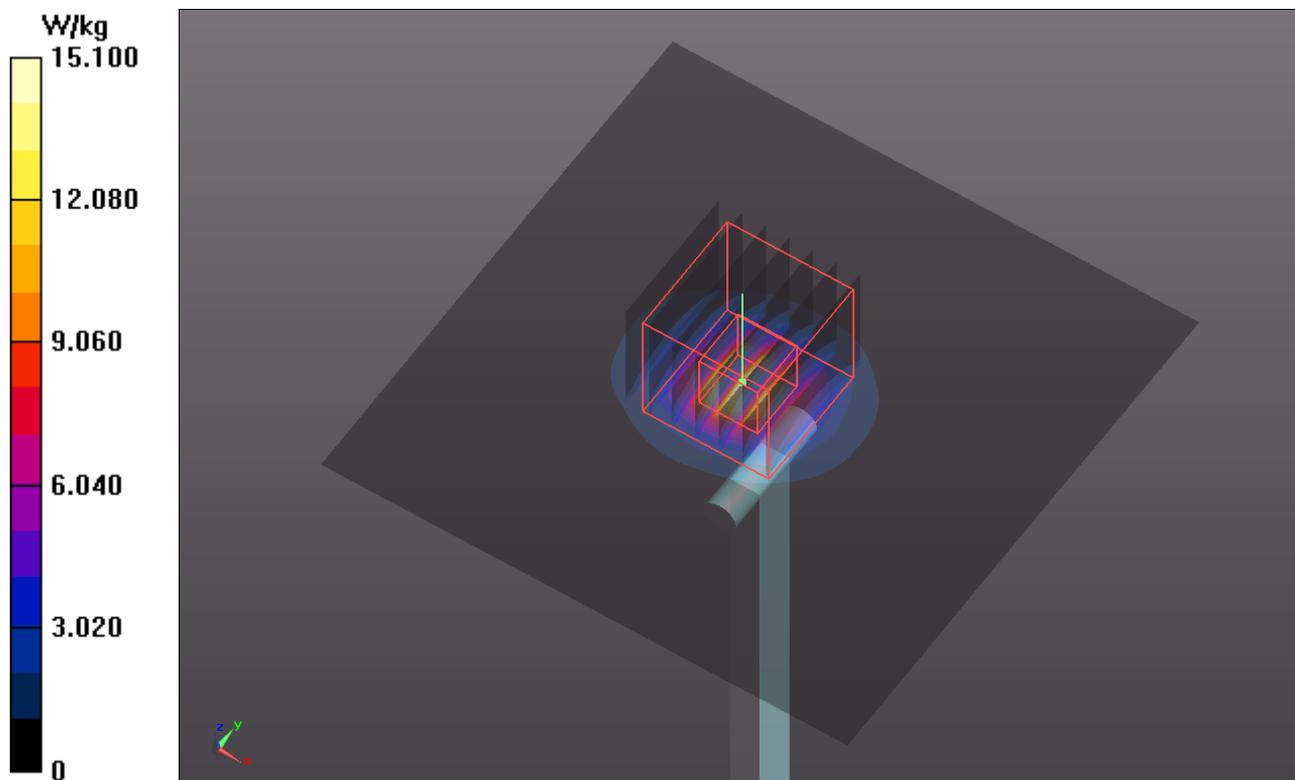
Ambient Temperature : 21.3 °C ; Liquid Temperature : 20.1 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3650; ConvF(4.34, 4.34, 4.34); Calibrated: 2012/10/26;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2012/07/19
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1039
- Measurement SW: DASY52, Version 52.8 (3); SEMCAD X Version 14.6.8 (7028)

Pin=100mW/Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 15.1 W/kg

Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 59.402 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 30.5 W/kg
SAR(1 g) = 7.83 W/kg; SAR(10 g) = 2.23 W/kg
Maximum value of SAR (measured) = 16.2 W/kg



System Check_B5300_130129

DUT: Dipole 5 GHz; Type: D5GHzV2; SN: 1019

Communication System: CW; Frequency: 5300 MHz; Duty Cycle: 1:1

Medium: B5G_0129 Medium parameters used: $f = 5300$ MHz; $\sigma = 5.377$ mho/m; $\epsilon_r = 50.94$; $\rho = 1000$ kg/m³

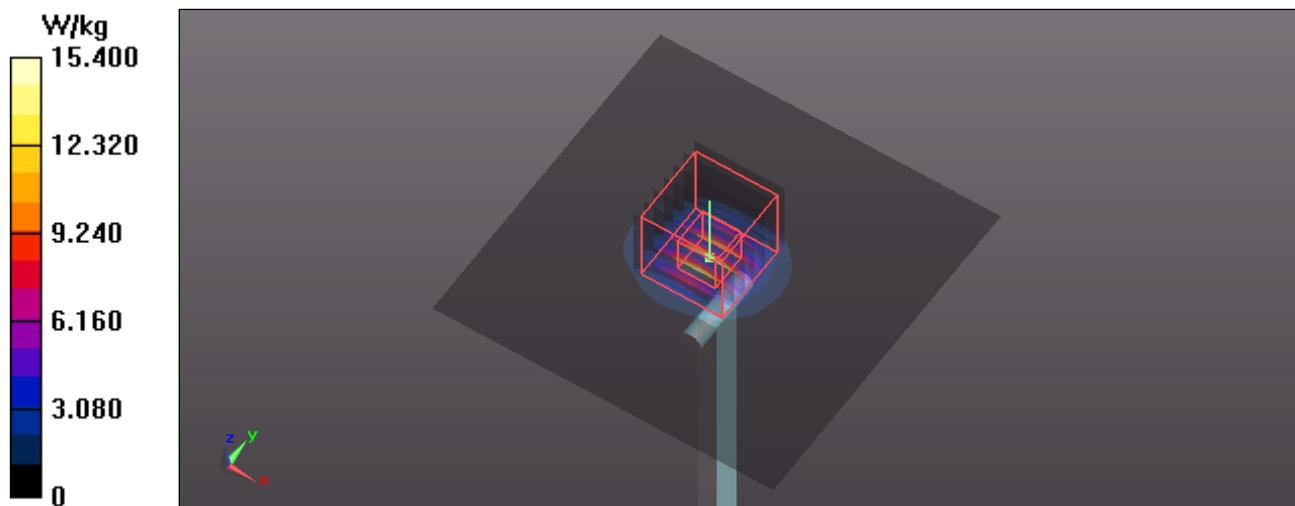
Ambient Temperature : 21.3 °C; Liquid Temperature : 20.1 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3650; ConvF(4.18, 4.18, 4.18); Calibrated: 2012/10/26;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2012/07/19
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1039
- Measurement SW: DASY52, Version 52.8 (3); SEMCAD X Version 14.6.8 (7028)

Pin=100mW/Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 15.4 W/kg

Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 58.329 V/m; Power Drift = 0.16 dB
Peak SAR (extrapolated) = 30.3 W/kg
SAR(1 g) = 7.67 W/kg; SAR(10 g) = 2.19 W/kg
Maximum value of SAR (measured) = 19.5 W/kg



System Check_B5600_130129

DUT: Dipole 5 GHz; Type: D5GHzV2; SN: 1019

Communication System: CW; Frequency: 5600 MHz; Duty Cycle: 1:1

Medium: B5G_0129 Medium parameters used: $f = 5600$ MHz; $\sigma = 5.906$ S/m; $\epsilon_r = 50.367$; $\rho = 1000$ kg/m³

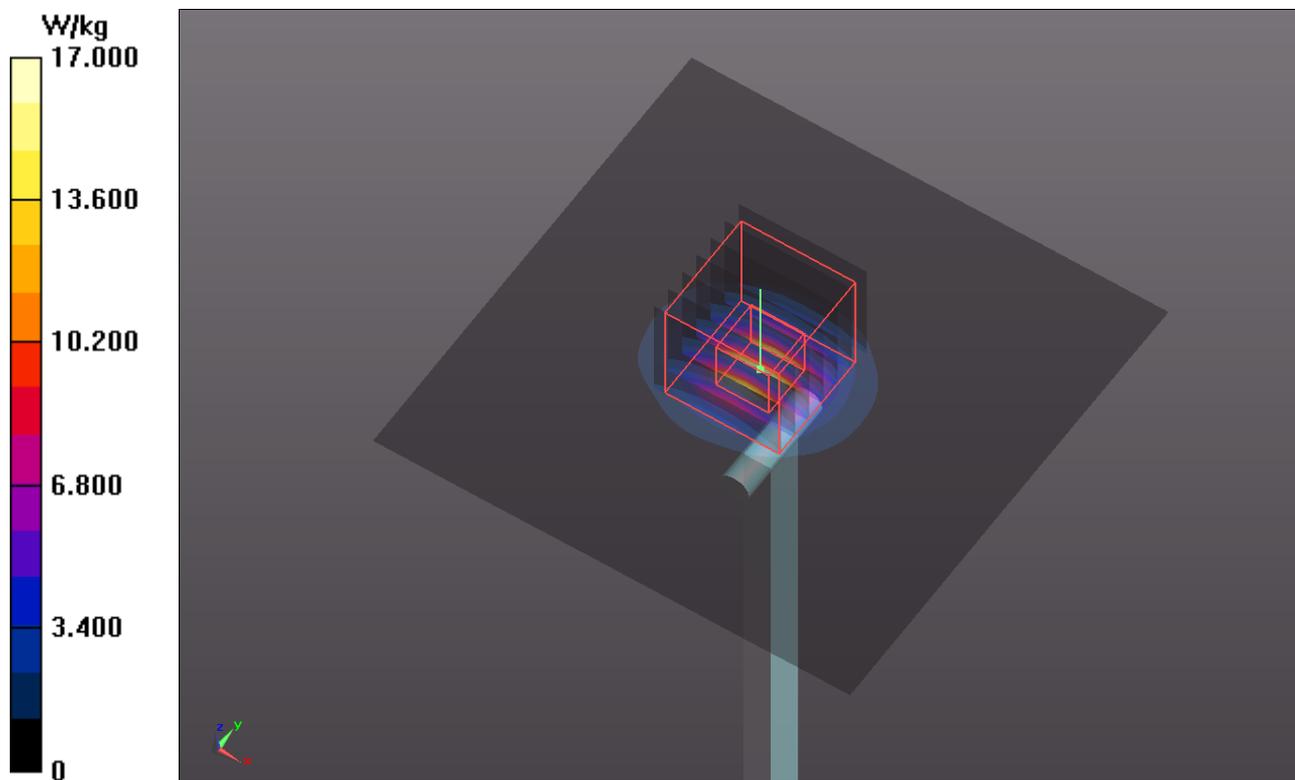
Ambient Temperature : 21.3 °C ; Liquid Temperature : 20.1 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3650; ConvF(3.53, 3.53, 3.53); Calibrated: 2012/10/26;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2012/07/19
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1039
- Measurement SW: DASY52, Version 52.8 (3); SEMCAD X Version 14.6.8 (7028)

Pin=100mW/Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 17.0 W/kg

Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 60.449 V/m; Power Drift = 0.10 dB
Peak SAR (extrapolated) = 32.8 W/kg
SAR(1 g) = 8.46 W/kg; SAR(10 g) = 2.4 W/kg
Maximum value of SAR (measured) = 18.0 W/kg



System Check_B5800_130130

DUT: Dipole 5 GHz; Type: D5GHzV2; SN: 1019

Communication System: CW; Frequency: 5800 MHz; Duty Cycle: 1:1

Medium: B5G_0130 Medium parameters used: $f = 5800$ MHz; $\sigma = 6.127$ mho/m; $\epsilon_r = 47.81$; $\rho = 1000$ kg/m³

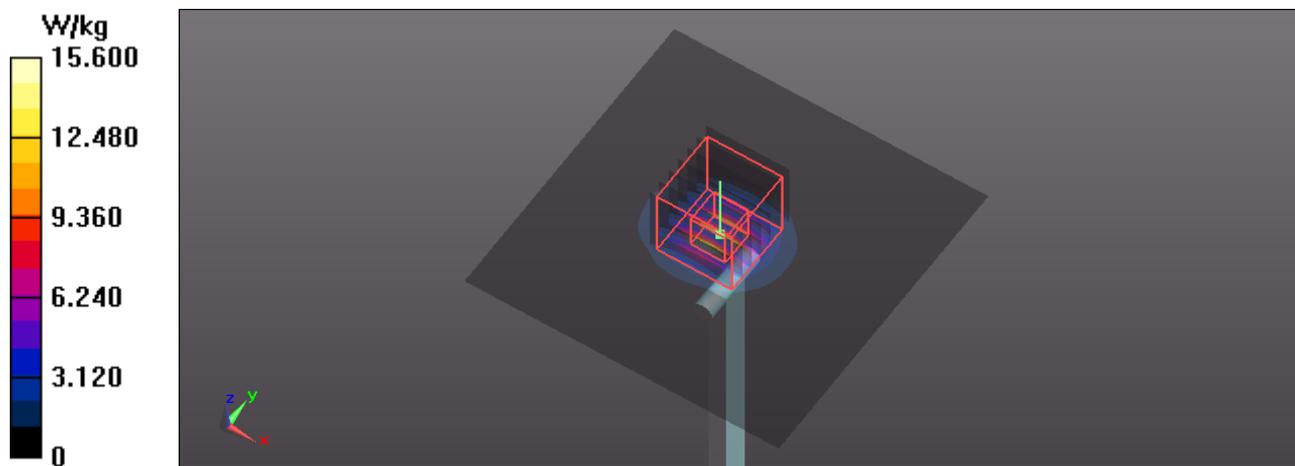
Ambient Temperature : 21.2 °C; Liquid Temperature : 20.2 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3650; ConvF(3.94, 3.94, 3.94); Calibrated: 2012/10/26;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2012/07/19
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1039
- Measurement SW: DASY52, Version 52.8 (3); SEMCAD X Version 14.6.8 (7028)

Pin=100mW/Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 15.6 W/kg

Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 56.307 V/m; Power Drift = 0.10 dB
Peak SAR (extrapolated) = 31.4 W/kg
SAR(1 g) = 7.67 W/kg; SAR(10 g) = 2.17 W/kg
Maximum value of SAR (measured) = 16.4 W/kg





Appendix B. SAR Plots of SAR Measurement

The SAR plots for highest measured SAR and measured SAR > 1.5 W/kg are shown as follows.

P131 802.11n_HT20_Bottom_0cm_Ch6_Ant 0+1_Ant Vendor2

DUT: 130109C16

Communication System: WLAN_2.4G; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium: B2450_0131 Medium parameters used: $f = 2437$ MHz; $\sigma = 1.987$ S/m; $\epsilon_r = 52.936$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.6 °C ; Liquid Temperature : 20.5 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3650; ConvF(6.6, 6.6, 6.6); Calibrated: 2012/10/26;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2012/07/19
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1039
- Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.8 (7028)

Ch6/Area Scan (71x351x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 0.657 W/kg

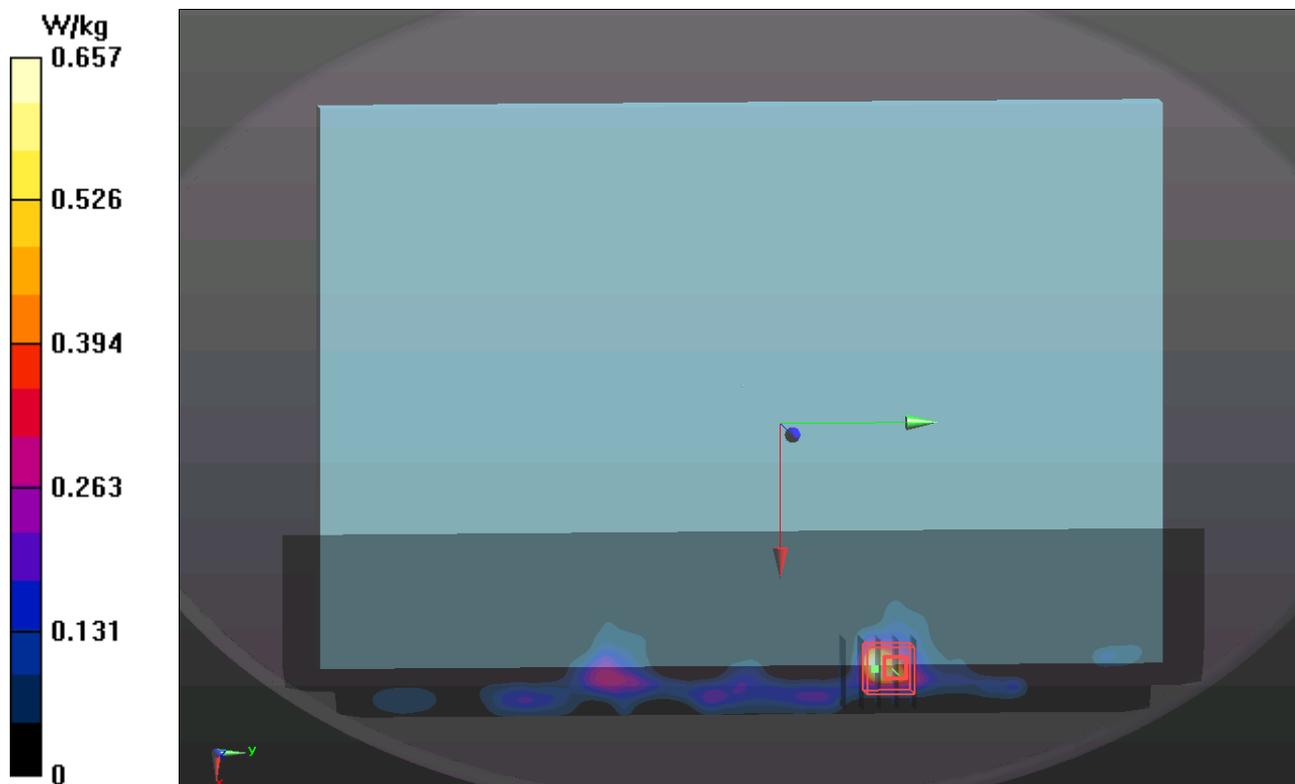
Ch6/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 0.117 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 0.632 W/kg

SAR(1 g) = 0.279 W/kg; SAR(10 g) = 0.119 W/kg

Maximum value of SAR (measured) = 0.466 W/kg



P123 802.11a_Bottom_0cm_Ch40_Ant 0_Ant Vendor2

DUT: 130109C16

Communication System: WLAN_5G; Frequency: 5200 MHz; Duty Cycle: 1:1

Medium: B5G_0129 Medium parameters used: $f = 5200$ MHz; $\sigma = 5.212$ S/m; $\epsilon_r = 51.041$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.3°C; Liquid Temperature : 20.1 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3650; ConvF(4.34, 4.34, 4.34); Calibrated: 2012/10/26;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2012/07/19
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1039
- Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.8 (7028)

Ch40/Area Scan (101x421x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.640 W/kg

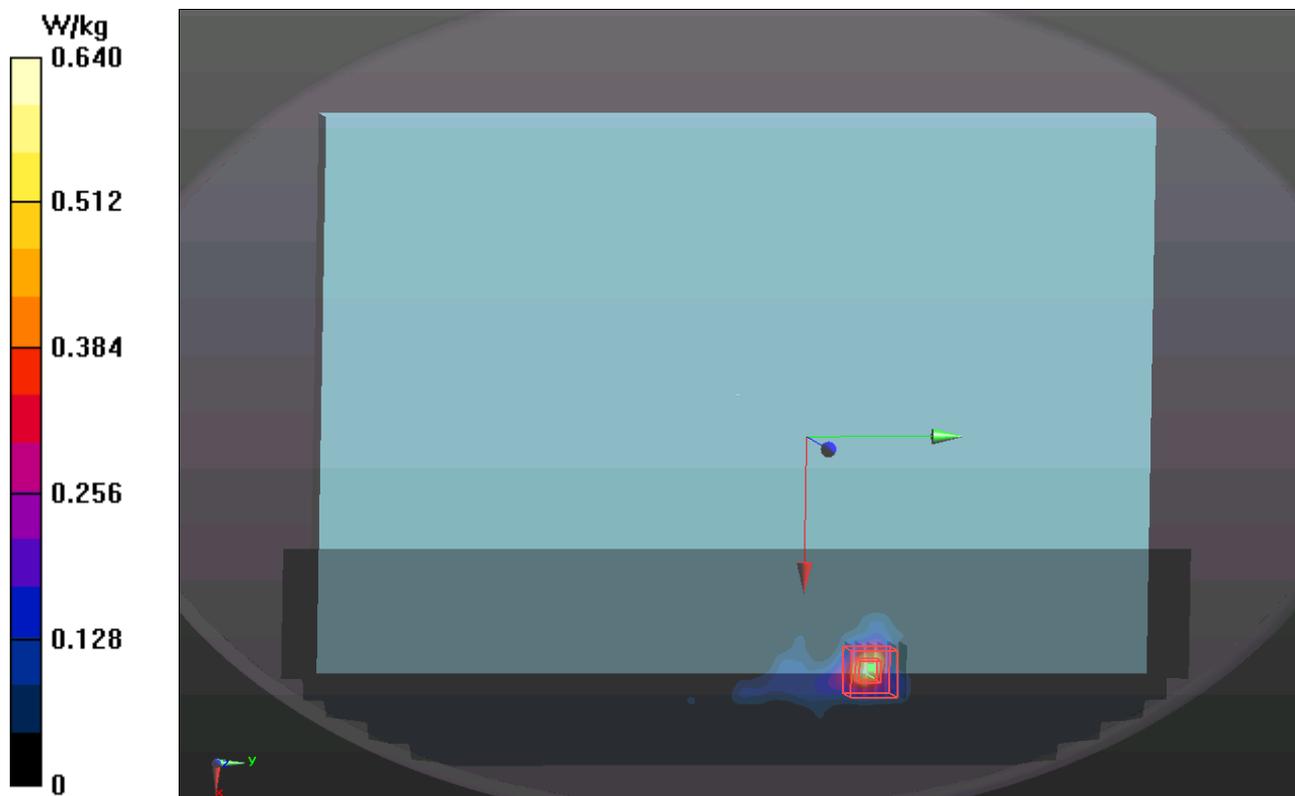
Ch40/Zoom Scan (6x6x12)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=2mm

Reference Value = 0 V/m; Power Drift = 0.005 dB

Peak SAR (extrapolated) = 1.29 W/kg

SAR(1 g) = 0.330 W/kg; SAR(10 g) = 0.090 W/kg

Maximum value of SAR (measured) = 0.638 W/kg



P125 802.11a_Bottom_0cm_Ch56_Ant 0_Ant Vendor2

DUT: 130109C16

Communication System: WLAN_5G; Frequency: 5280 MHz; Duty Cycle: 1:1

Medium: B5G_0129 Medium parameters used: $f = 5280$ MHz; $\sigma = 5.349$ S/m; $\epsilon_r = 50.976$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.3°C; Liquid Temperature : 20.1 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3650; ConvF(4.18, 4.18, 4.18); Calibrated: 2012/10/26;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2012/07/19
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1039
- Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.8 (7028)

Ch56/Area Scan (101x421x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.649 W/kg

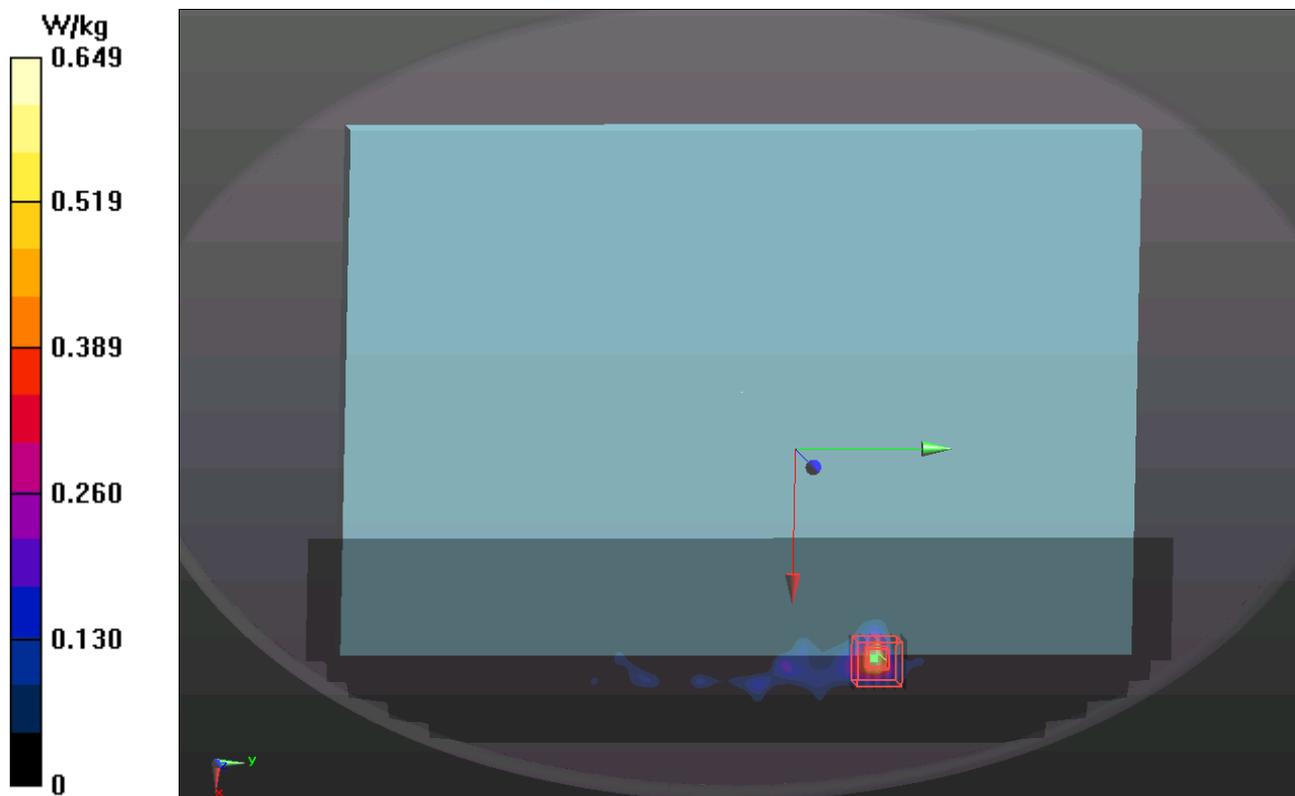
Ch56/Zoom Scan (6x6x12)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=2mm

Reference Value = 0 V/m; Power Drift = 0.001 dB

Peak SAR (extrapolated) = 0.948 W/kg

SAR(1 g) = 0.265 W/kg; SAR(10 g) = 0.073 W/kg

Maximum value of SAR (measured) = 0.529 W/kg



P107 802.11a_Bottom_0cm_Ch100_Ant 0_Ant Vendor1

DUT: 130109C16

Communication System: WLAN_5G; Frequency: 5500 MHz; Duty Cycle: 1:1

Medium: B5G_0129 Medium parameters used: $f = 5500$ MHz; $\sigma = 5.734$ S/m; $\epsilon_r = 50.612$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.3°C; Liquid Temperature : 20.1 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3650; ConvF(3.82, 3.82, 3.82); Calibrated: 2012/10/26;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2012/07/19
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1039
- Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.8 (7028)

Ch100/Area Scan (101x421x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 1.33 W/kg

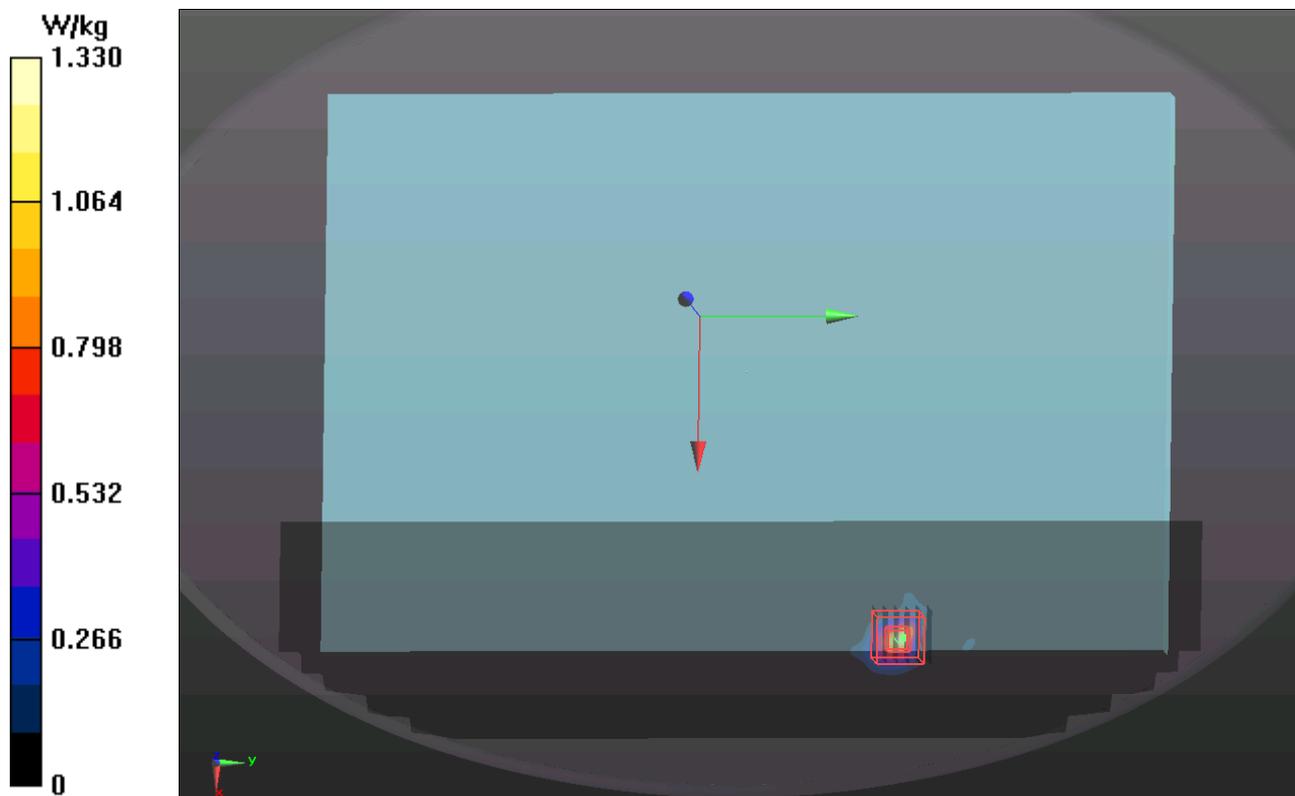
Ch100/Zoom Scan (6x6x12)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=2mm

Reference Value = 0 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 2.34 W/kg

SAR(1 g) = 0.580 W/kg; SAR(10 g) = 0.139 W/kg

Maximum value of SAR (measured) = 1.21 W/kg



P109 802.11a_Bottom_0cm_Ch153_Ant 0_Ant Vendor1

DUT: 130109C16

Communication System: WLAN_5G; Frequency: 5765 MHz; Duty Cycle: 1:1

Medium: B5G_0130 Medium parameters used: $f = 5765$ MHz; $\sigma = 6.033$ S/m; $\epsilon_r = 48.057$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.2°C; Liquid Temperature : 20.2 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3650; ConvF(3.94, 3.94, 3.94); Calibrated: 2012/10/26;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2012/07/19
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1039
- Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.8 (7028)

Ch153/Area Scan (101x421x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.708 W/kg

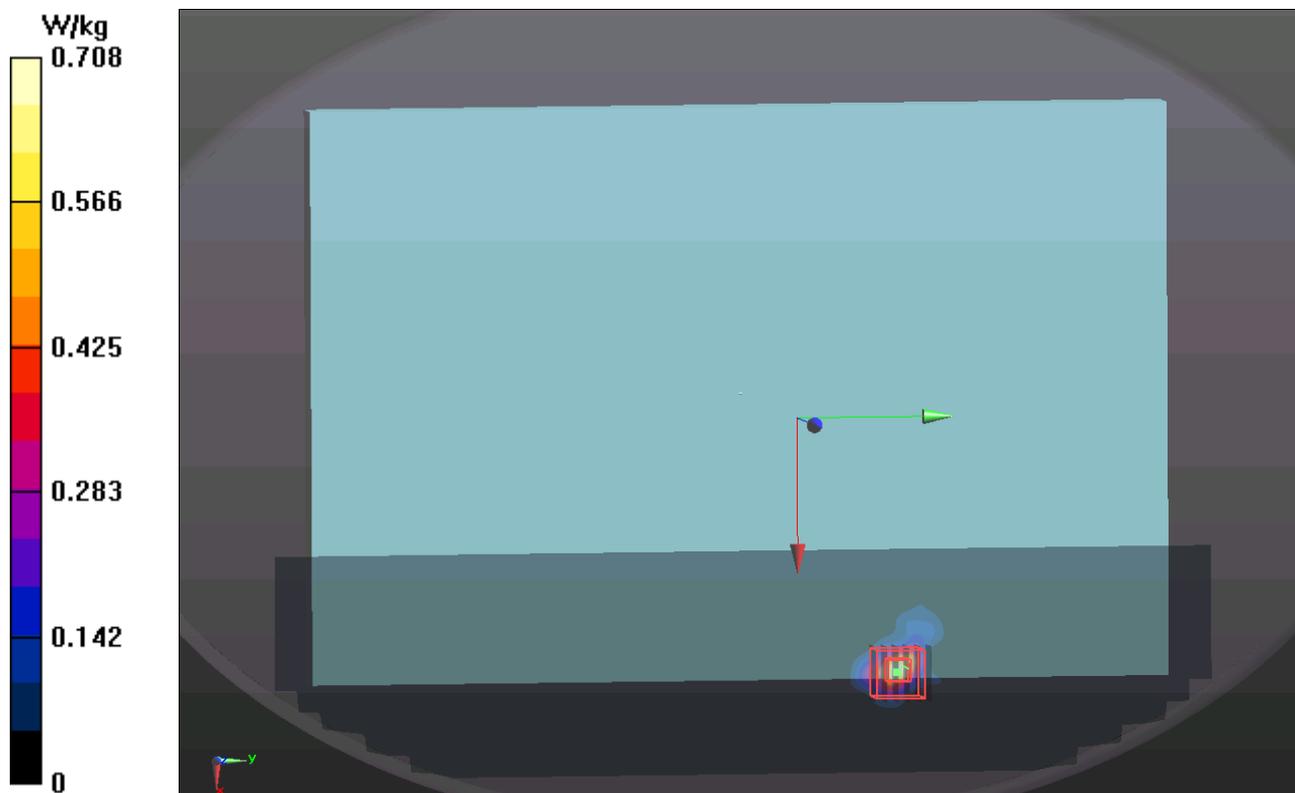
Ch153/Zoom Scan (6x6x12)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=2mm

Reference Value = 1.170 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 1.85 W/kg

SAR(1 g) = 0.315 W/kg; SAR(10 g) = 0.083 W/kg

Maximum value of SAR (measured) = 0.697 W/kg





Appendix C. Calibration Certificate for Probe and Dipole

The SPEAG calibration certificates are shown as follows.



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

Accreditation No.: **SCS 108**

Client **Auden**

Certificate No: **D2450V2-735_Jun12**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 735**

Calibration procedure(s) **QA CAL-05.v8
Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **June 15, 2012**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter EPM-442A | GB37480704 | 05-Oct-11 (No. 217-01451) | Oct-12 |
| Power sensor HP 8481A | US37292783 | 05-Oct-11 (No. 217-01451) | Oct-12 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 27-Mar-12 (No. 217-01530) | Apr-13 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 27-Mar-12 (No. 217-01533) | Apr-13 |
| Reference Probe ES3DV3 | SN: 3205 | 30-Dec-11 (No. ES3-3205_Dec11) | Dec-12 |
| DAE4 | SN: 601 | 04-Jul-11 (No. DAE4-601_Jul11) | Jul-12 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power sensor HP 8481A | MY41092317 | 18-Oct-02 (in house check Oct-11) | In house check: Oct-13 |
| RF generator R&S SMT-06 | 100005 | 04-Aug-99 (in house check Oct-11) | In house check: Oct-13 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-11) | In house check: Oct-12 |

Calibrated by: **Name** Claudio Leubler **Function** Laboratory Technician

Signature

Approved by: **Name** Katja Pokovic **Function** Technical Manager

Issued: June 18, 2012

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



Accredited by the Swiss Accreditation Service (SAS)

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

Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

| | | |
|-------------------------------------|------------------------|-------------|
| DASY Version | DASY5 | V52.8.1 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Modular Flat Phantom | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 2450 MHz \pm 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|---------------------|----------------|----------------------|
| Nominal Head TSL parameters | 22.0 °C | 39.2 | 1.80 mho/m |
| Measured Head TSL parameters | (22.0 \pm 0.2) °C | 38.9 \pm 6 % | 1.86 mho/m \pm 6 % |
| Head TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Head TSL

| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 13.4 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 52.7 mW / g \pm 17.0 % (k=2) |

| SAR averaged over 10 cm³ (10 g) of Head TSL | condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 6.27 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 24.8 mW / g \pm 16.5 % (k=2) |

Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|---------------------|----------------|----------------------|
| Nominal Body TSL parameters | 22.0 °C | 52.7 | 1.95 mho/m |
| Measured Body TSL parameters | (22.0 \pm 0.2) °C | 51.6 \pm 6 % | 2.01 mho/m \pm 6 % |
| Body TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Body TSL

| SAR averaged over 1 cm³ (1 g) of Body TSL | Condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 12.9 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 50.6 mW / g \pm 17.0 % (k=2) |

| SAR averaged over 10 cm³ (10 g) of Body TSL | condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 6.03 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 23.9 mW / g \pm 16.5 % (k=2) |

Appendix

Antenna Parameters with Head TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 54.6 Ω + 4.5 j Ω |
| Return Loss | - 24.3 dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 50.4 Ω + 5.9 j Ω |
| Return Loss | - 24.5 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.153 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: 15.06.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 735

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.86$ mho/m; $\epsilon_r = 38.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.45, 4.45, 4.45); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

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

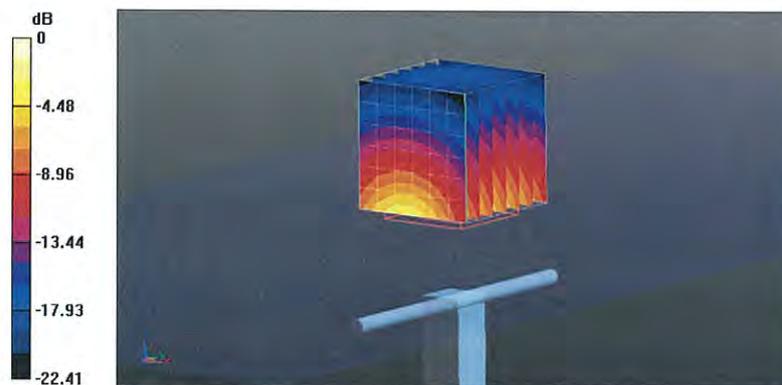
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 99.721 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 27.562 mW/g

SAR(1 g) = 13.4 mW/g; SAR(10 g) = 6.27 mW/g

Maximum value of SAR (measured) = 17.1 mW/g

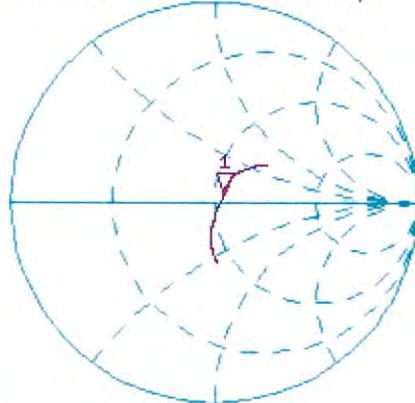


0 dB = 17.1 mW/g = 24.66 dB mW/g

Impedance Measurement Plot for Head TSL

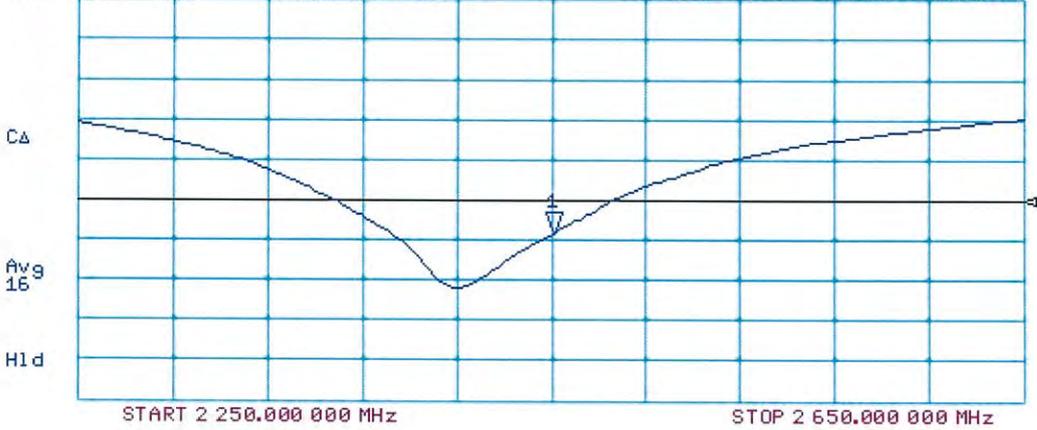
15 Jun 2012 10:55:28
[CH1] S11 1 U FS 1: 54.559 Ω 4.4883 Ω 291.56 pF 2 450.000 000 MHz

*
De1
C Δ



Avg
16
H1 d

CH2 S11 LOG 5 dB/REF -20 dB 1:-24.273 dB 2 450.000 000 MHz



DASY5 Validation Report for Body TSL

Date: 14.06.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 735

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.01$ mho/m; $\epsilon_r = 51.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.26, 4.26, 4.26); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

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

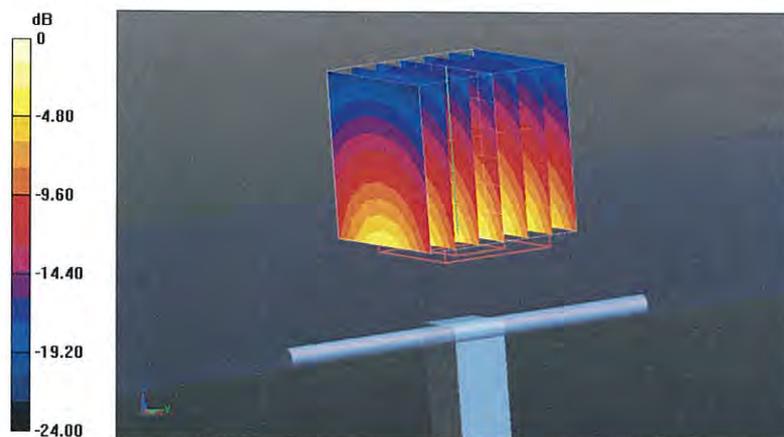
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.125 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 26.372 mW/g

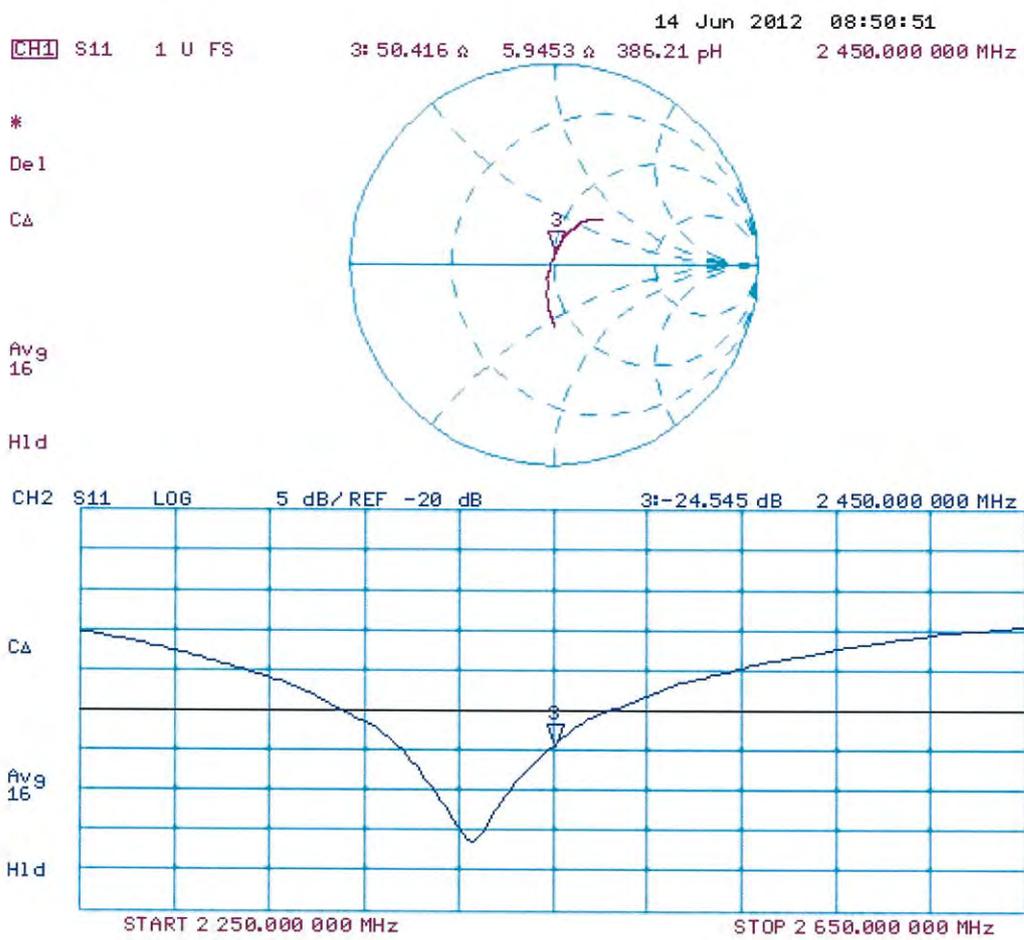
SAR(1 g) = 12.9 mW/g; SAR(10 g) = 6.03 mW/g

Maximum value of SAR (measured) = 16.9 mW/g



0 dB = 16.9 mW/g = 24.56 dB mW/g

Impedance Measurement Plot for Body TSL





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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **B.V. ADT (Auden)**

Certificate No: **D5GHzV2-1019_Nov12**

CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN: 1019**

Calibration procedure(s) **QA CAL-22.v1
Calibration procedure for dipole validation kits between 3-6 GHz**

Calibration date: **November 16, 2012**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|-----------------------------|--------------------|--------------------------------|-----------------------|
| Power meter EPM-442A | GB37480704 | 01-Nov-12 (No. 217-01640) | Oct-13 |
| Power sensor HP 8481A | US37292783 | 01-Nov-12 (No. 217-01640) | Oct-13 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 27-Mar-12 (No. 217-01530) | Apr-13 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 27-Mar-12 (No. 217-01533) | Apr-13 |
| Reference Probe EX3DV4 | SN: 3503 | 30-Dec-11 (No. EX3-3503_Dec11) | Dec-12 |
| DAE4 | SN: 601 | 27-Jun-12 (No. DAE4-601_Jun12) | Jun-13 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---------------------------|------------------|-----------------------------------|------------------------|
| Power sensor HP 8481A | MY41092317 | 18-Oct-02 (in house check Oct-11) | In house check: Oct-13 |
| RF generator R&S SMT-06 | 100005 | 04-Aug-99 (in house check Oct-11) | In house check: Oct-13 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

Calibrated by: **Israe El-Naouq** Name: **Israe El-Naouq** Function: **Laboratory Technician**

Approved by: **Katja Pokovic** Name: **Katja Pokovic** Function: **Technical Manager**

Signature

Issued: November 16, 2012

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Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

- a) IEC 62209-2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation, and Procedures"; Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", March 2010
- b) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

Additional Documentation:

- c) 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 | V52.8.3 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Modular Flat Phantom V5.0 | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy = 4.0 mm, dz = 1.4 mm | Graded Ratio = 1.4 (Z direction) |
| Frequency | 5200 MHz ± 1 MHz 5300 MHz ± 1 MHz 5600 MHz ± 1 MHz 5800 MHz ± 1 MHz | |

Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 36.0 | 4.66 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 34.8 ± 6 % | 4.53 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 | 7.96 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 79.0 W/kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm³ (10 g) of Head TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 2.27 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 22.5 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 % | 4.63 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Head TSL at 5300 MHz

| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
|---|--------------------|-----------------------------------|
| SAR measured | 100 mW input power | 8.28 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 82.2 W / kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm³ (10 g) of Head TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 2.37 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 23.5 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 | 34.2 ± 6 % | 4.93 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 | 8.46 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 83.8 W/kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 2.41 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 23.8 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 % | 5.15 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 | 7.96 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 78.9 W/kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 2.26 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 22.4 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 | 46.8 ± 6 % | 5.35 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 | 7.37 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 73.0 W/kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 2.07 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 20.5 W/kg ± 19.5 % (k=2) |

Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Body TSL parameters | 22.0 °C | 48.9 | 5.42 mho/m |
| Measured Body TSL parameters | (22.0 ± 0.2) °C | 46.7 ± 6 % | 5.47 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 | 7.53 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 74.6 W/kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 2.12 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 21.0 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 | 46.2 ± 6 % | 5.86 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Body TSL at 5600 MHz

| SAR averaged over 1 cm ³ (1 g) of Body TSL | Condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 8.06 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 79.9 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 | 22.1 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 | 45.9 ± 6 % | 6.13 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 | 7.41 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 73.4 W/kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 2.06 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 20.4 W/kg ± 19.5 % (k=2) |

Appendix

Antenna Parameters with Head TSL at 5200 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 52.1 Ω - 7.8 j Ω |
| Return Loss | - 22.0 dB |

Antenna Parameters with Head TSL at 5300 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 52.6 Ω - 1.5 j Ω |
| Return Loss | - 30.7 dB |

Antenna Parameters with Head TSL at 5600 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 56.6 Ω - 2.1 j Ω |
| Return Loss | - 23.7 dB |

Antenna Parameters with Head TSL at 5800 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 56.3 Ω + 1.7 j Ω |
| Return Loss | - 24.3 dB |

Antenna Parameters with Body TSL at 5200 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 52.7 Ω - 7.8 j Ω |
| Return Loss | - 22.0 dB |

Antenna Parameters with Body TSL at 5300 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 53.2 Ω - 0.3 j Ω |
| Return Loss | - 30.1 dB |

Antenna Parameters with Body TSL at 5600 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 57.1 Ω - 1.0 j Ω |
| Return Loss | - 23.5 dB |

Antenna Parameters with Body TSL at 5800 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 57.6 Ω + 2.9 j Ω |
| Return Loss | - 22.4 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.204 ns |
|----------------------------------|----------|

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

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

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

Additional EUT Data

| | |
|-----------------|-------------------|
| Manufactured by | SPEAG |
| Manufactured on | February 05, 2004 |

DASY5 Validation Report for Head TSL

Date: 16.11.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1019

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

Medium parameters used: $f = 5200$ MHz; $\sigma = 4.53$ mho/m; $\epsilon_r = 34.8$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5300$ MHz; $\sigma = 4.63$ mho/m; $\epsilon_r = 34.7$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 4.93$ mho/m; $\epsilon_r = 34.2$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 5.15$ mho/m; $\epsilon_r = 34$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.41, 5.41, 5.41); Calibrated: 30.12.2011, ConvF(5.1, 5.1, 5.1); Calibrated: 30.12.2011, ConvF(4.76, 4.76, 4.76); Calibrated: 30.12.2011, ConvF(4.81, 4.81, 4.81); Calibrated: 30.12.2011;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.3(988); SEMCAD X 14.6.7(6848)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 64.098 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 29.6 W/kg

SAR(1 g) = 7.96 W/kg; SAR(10 g) = 2.27 W/kg

Maximum value of SAR (measured) = 18.5 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 = 64.859 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 31.3 W/kg

SAR(1 g) = 8.28 W/kg; SAR(10 g) = 2.37 W/kg

Maximum value of SAR (measured) = 19.4 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

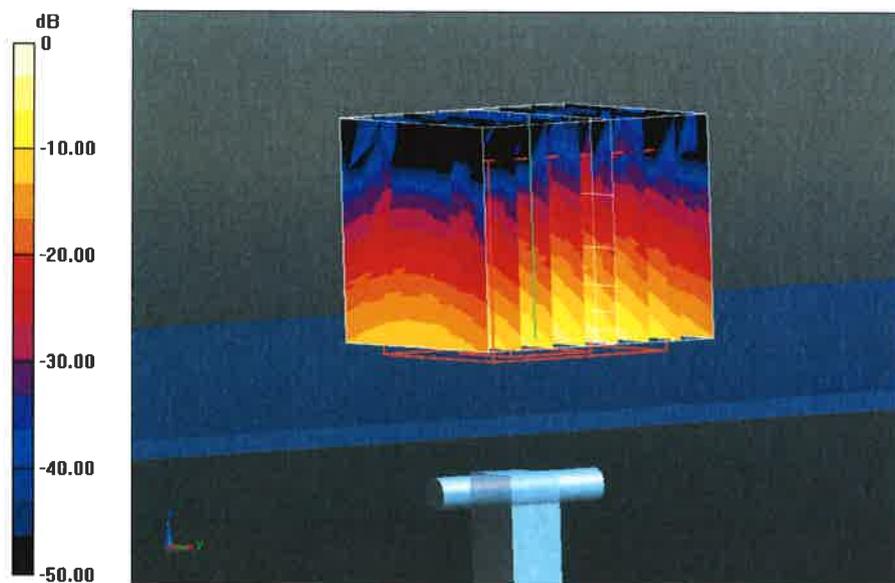
Reference Value = 64.163 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 33.6 W/kg

SAR(1 g) = 8.46 W/kg; SAR(10 g) = 2.41 W/kg

Maximum value of SAR (measured) = 20.3 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 = 60.898 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 33.1 W/kg
SAR(1 g) = 7.96 W/kg; SAR(10 g) = 2.26 W/kg
Maximum value of SAR (measured) = 19.5 W/kg



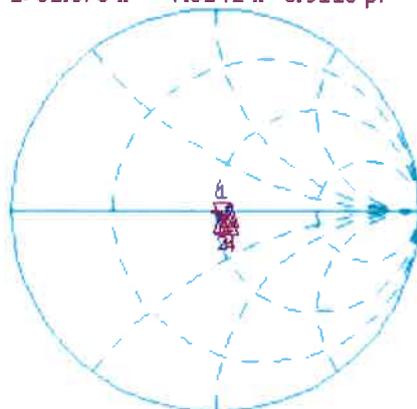
0 dB = 19.5 W/kg = 12.90 dBW/kg

Impedance Measurement Plot for Head TSL

16 Nov 2012 17:30:41

CH1 S11 1 U FS 1: 52.078 Ω -7.8242 Ω 3.9118 pF 5 200.000 000 MHz

*
De1
Cor
Avg 16
H1d



CH1 Markers
2: 52.619 Ω
-1.4551 Ω
5.30000 GHz
4: 56.619 Ω
-2.1328 Ω
5.60000 GHz
5: 56.289 Ω
1.6992 Ω
5.80000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 1: -22.033 dB 5 200.000 000 MHz

Cor
Avg 16
H1d



CH2 Markers
2: -30.687 dB
5.30000 GHz
4: -23.714 dB
5.60000 GHz
5: -24.254 dB
5.80000 GHz

START 5 000.000 000 MHz STOP 6 000.000 000 MHz

DASY5 Validation Report for Body TSL

Date: 14.11.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1019

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

Medium parameters used: $f = 5200$ MHz; $\sigma = 5.35$ mho/m; $\epsilon_r = 46.8$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5300$ MHz; $\sigma = 5.47$ mho/m; $\epsilon_r = 46.7$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 5.86$ mho/m; $\epsilon_r = 46.2$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 6.13$ mho/m; $\epsilon_r = 45.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.91, 4.91, 4.91); Calibrated: 30.12.2011, ConvF(4.67, 4.67, 4.67); Calibrated: 30.12.2011, ConvF(4.22, 4.22, 4.22); Calibrated: 30.12.2011, ConvF(4.38, 4.38, 4.38); Calibrated: 30.12.2011;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.3(988); SEMCAD X 14.6.7(6848)

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 = 58.457 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 29.3 W/kg

SAR(1 g) = 7.37 W/kg; SAR(10 g) = 2.07 W/kg

Maximum value of SAR (measured) = 17.4 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 = 58.382 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 30.4 W/kg

SAR(1 g) = 7.53 W/kg; SAR(10 g) = 2.12 W/kg

Maximum value of SAR (measured) = 17.9 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

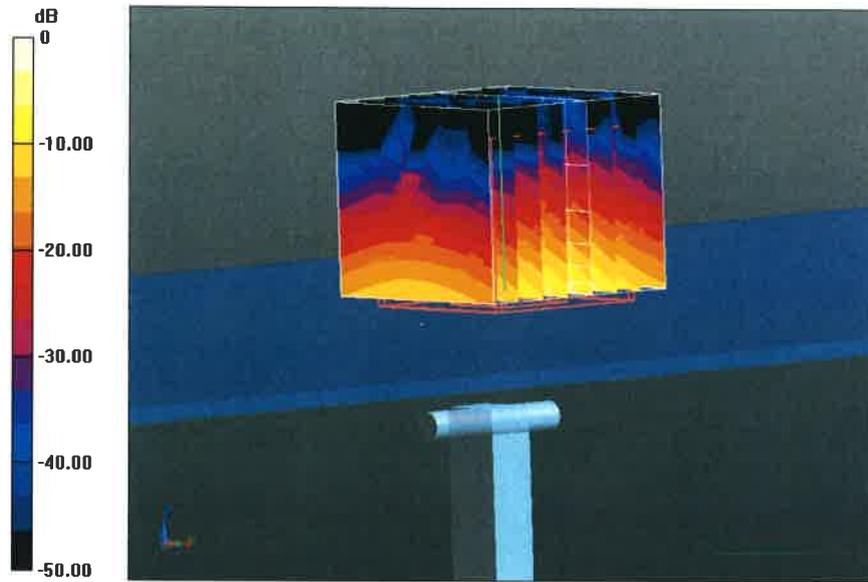
Reference Value = 58.712 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 35.9 W/kg

SAR(1 g) = 8.06 W/kg; SAR(10 g) = 2.24 W/kg

Maximum value of SAR (measured) = 19.9 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 = 54.869 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 34.7 W/kg
SAR(1 g) = 7.41 W/kg; SAR(10 g) = 2.06 W/kg
Maximum value of SAR (measured) = 18.4 W/kg

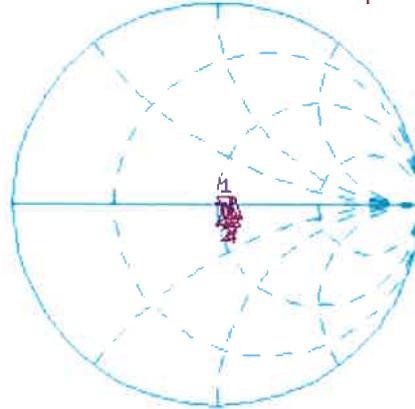


Impedance Measurement Plot for Body TSL

14 Nov 2012 10:21:29

CH1 S11 1 U FS 1: 52.654 Ω -7.7520 Ω 3.9483 pF 5 200.000 000 MHz

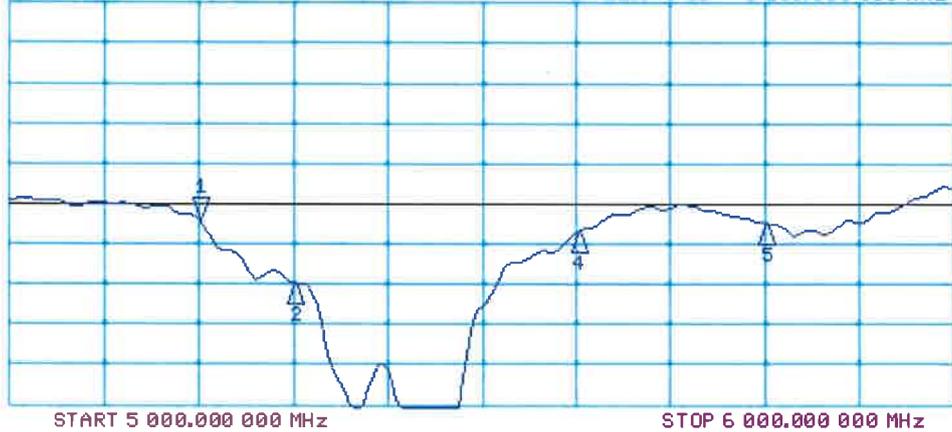
*
De1
Cor
Avg
16
H1d



CH1 Markers
2: 53.219 Ω
-275.39 m Ω
5.30000 GHz
4: 57.076 Ω
-1.0098 Ω
5.60000 GHz
5: 57.600 Ω
2.9238 Ω
5.80000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 1: -21.979 dB 5 200.000 000 MHz

Cor
Avg
16
H1d



CH2 Markers
2: -30.081 dB
5.30000 GHz
4: -23.508 dB
5.60000 GHz
5: -22.424 dB
5.80000 GHz



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **B.V.ADT (Auden)**

Certificate No: **EX3-3650_Oct12**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3650**

Calibration procedure(s) **QA CAL-01.v8, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4
Calibration procedure for dosimetric E-field probes**

Calibration date: **October 26, 2012**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B | GB41293874 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Power sensor E4412A | MY41498087 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 27-Mar-12 (No. 217-01531) | Apr-13 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 27-Mar-12 (No. 217-01529) | Apr-13 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 27-Mar-12 (No. 217-01532) | Apr-13 |
| Reference Probe ES3DV2 | SN: 3013 | 29-Dec-11 (No. ES3-3013_Dec11) | Dec-12 |
| DAE4 | SN: 660 | 20-Jun-12 (No. DAE4-660_Jun12) | Jun-13 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-11) | In house check: Apr-13 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

| | Name | Function | Signature |
|---|----------------|-----------------------|--------------------------|
| Calibrated by: | Jeton Kastrati | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |
| | | | Issued: October 26, 2012 |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. | | | |



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Accreditation No.: **SCS 108**

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Glossary:

| | |
|--------------------------|--|
| TSL | tissue simulating liquid |
| NORM _{x,y,z} | sensitivity in free space |
| ConvF | sensitivity in TSL / NORM _{x,y,z} |
| DCP | diode compression point |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A, B, C | modulation dependent linearization parameters |
| Polarization ϕ | ϕ rotation around probe axis |
| Polarization ϑ | ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis |

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

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

Probe EX3DV4

SN:3650

Manufactured: March 18, 2008
Calibrated: October 26, 2012

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3650

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|----------|----------|----------|-----------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 0.36 | 0.38 | 0.45 | ± 10.1 % |
| DCP (mV) ^B | 94.2 | 103.5 | 98.5 | |

Modulation Calibration Parameters

| UID | Communication System Name | PAR | | A dB | B dB | C dB | VR mV | Unc ^E (k=2) |
|-----|---------------------------|------|---|---------|---------|---------|----------|---------------------------|
| 0 | CW | 0.00 | X | 0.0 | 0.0 | 1.0 | 135.1 | ±3.3 % |
| | | | Y | 0.0 | 0.0 | 1.0 | 173.8 | |
| | | | Z | 0.0 | 0.0 | 1.0 | 152.5 | |

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

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

^B Numerical linearization parameter: uncertainty not required.

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3650

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 | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 41.9 | 0.89 | 9.15 | 9.15 | 9.15 | 0.16 | 1.66 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 8.89 | 8.89 | 8.89 | 0.15 | 1.72 | ± 12.0 % |
| 900 | 41.5 | 0.97 | 8.82 | 8.82 | 8.82 | 0.31 | 0.91 | ± 12.0 % |
| 1450 | 40.5 | 1.20 | 8.10 | 8.10 | 8.10 | 0.35 | 1.03 | ± 12.0 % |
| 1640 | 40.3 | 1.29 | 8.28 | 8.28 | 8.28 | 0.29 | 0.97 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 8.07 | 8.07 | 8.07 | 0.50 | 0.77 | ± 12.0 % |
| 1810 | 40.0 | 1.40 | 7.76 | 7.76 | 7.76 | 0.34 | 0.85 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 7.61 | 7.61 | 7.61 | 0.33 | 0.89 | ± 12.0 % |
| 2300 | 39.5 | 1.67 | 7.16 | 7.16 | 7.16 | 0.52 | 0.69 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 6.69 | 6.69 | 6.69 | 0.51 | 0.74 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 6.49 | 6.49 | 6.49 | 0.32 | 1.04 | ± 12.0 % |
| 3500 | 37.9 | 2.91 | 6.46 | 6.46 | 6.46 | 0.33 | 1.32 | ± 13.1 % |
| 5200 | 36.0 | 4.66 | 5.14 | 5.14 | 5.14 | 0.35 | 1.80 | ± 13.1 % |
| 5300 | 35.9 | 4.76 | 4.83 | 4.83 | 4.83 | 0.40 | 1.80 | ± 13.1 % |
| 5500 | 35.6 | 4.96 | 4.50 | 4.50 | 4.50 | 0.45 | 1.80 | ± 13.1 % |
| 5600 | 35.5 | 5.07 | 4.22 | 4.22 | 4.22 | 0.50 | 1.80 | ± 13.1 % |
| 5800 | 35.3 | 5.27 | 4.34 | 4.34 | 4.34 | 0.50 | 1.80 | ± 13.1 % |

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

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3650

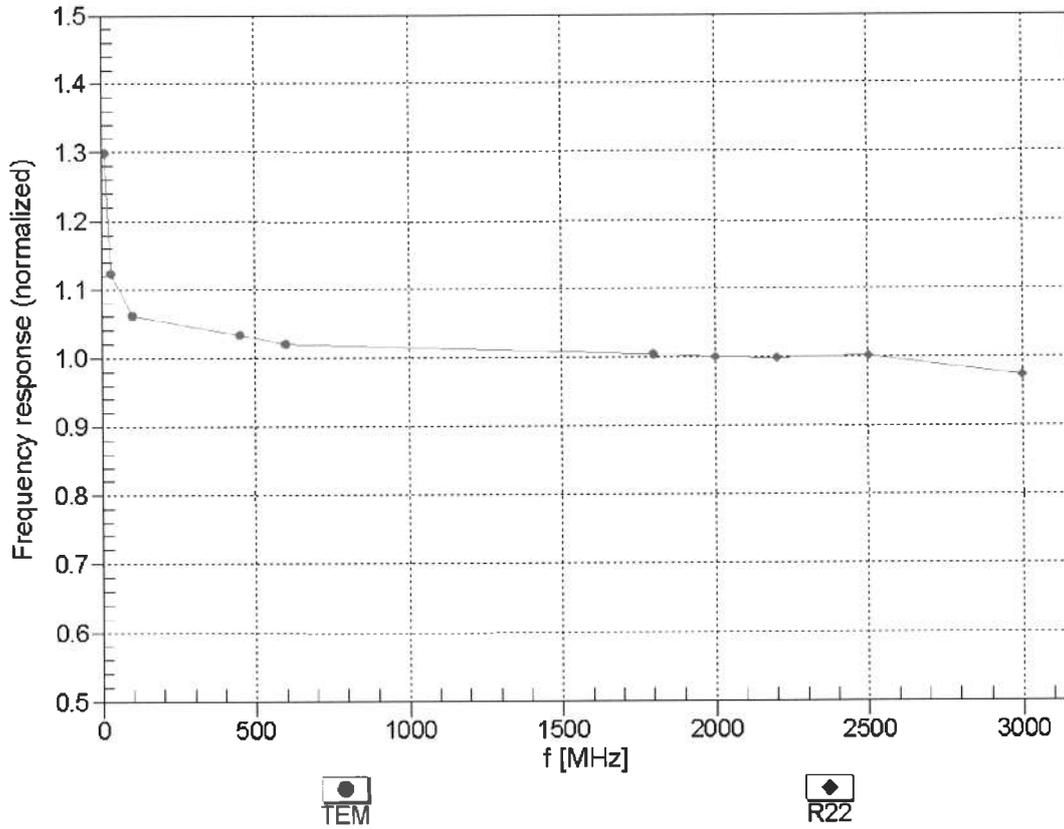
Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 55.5 | 0.96 | 9.22 | 9.22 | 9.22 | 0.57 | 0.72 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 9.06 | 9.06 | 9.06 | 0.54 | 0.75 | ± 12.0 % |
| 900 | 55.0 | 1.05 | 8.87 | 8.87 | 8.87 | 0.36 | 0.93 | ± 12.0 % |
| 1450 | 54.0 | 1.30 | 7.90 | 7.90 | 7.90 | 0.17 | 1.92 | ± 12.0 % |
| 1640 | 53.8 | 1.40 | 7.98 | 7.98 | 7.98 | 0.76 | 0.70 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 7.31 | 7.31 | 7.31 | 0.50 | 0.77 | ± 12.0 % |
| 1810 | 53.3 | 1.52 | 7.10 | 7.10 | 7.10 | 0.40 | 0.84 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 6.94 | 6.94 | 6.94 | 0.29 | 1.04 | ± 12.0 % |
| 2300 | 52.9 | 1.81 | 6.83 | 6.83 | 6.83 | 0.80 | 0.59 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 6.60 | 6.60 | 6.60 | 0.80 | 0.50 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 6.36 | 6.36 | 6.36 | 0.80 | 0.50 | ± 12.0 % |
| 3500 | 51.3 | 3.31 | 6.00 | 6.00 | 6.00 | 0.21 | 2.72 | ± 13.1 % |
| 5200 | 49.0 | 5.30 | 4.34 | 4.34 | 4.34 | 0.50 | 1.90 | ± 13.1 % |
| 5300 | 48.9 | 5.42 | 4.18 | 4.18 | 4.18 | 0.50 | 1.90 | ± 13.1 % |
| 5500 | 48.6 | 5.65 | 3.82 | 3.82 | 3.82 | 0.55 | 1.90 | ± 13.1 % |
| 5600 | 48.5 | 5.77 | 3.53 | 3.53 | 3.53 | 0.63 | 1.90 | ± 13.1 % |
| 5800 | 48.2 | 6.00 | 3.94 | 3.94 | 3.94 | 0.60 | 1.90 | ± 13.1 % |

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

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

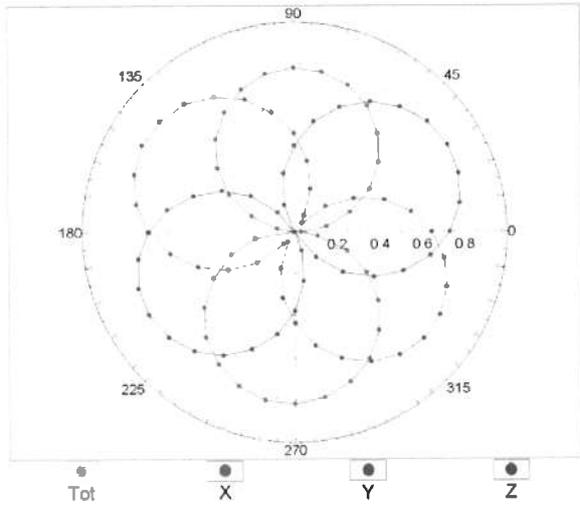
Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



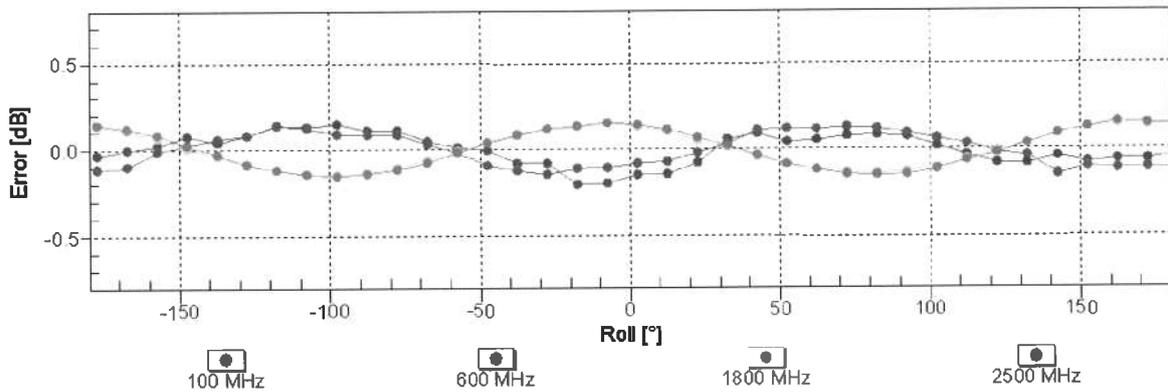
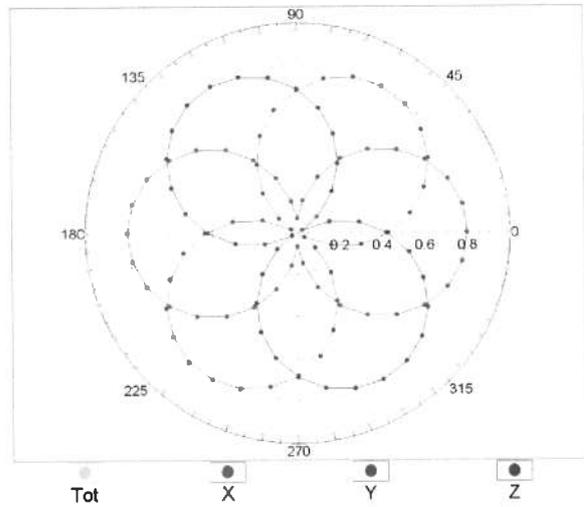
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz,TEM

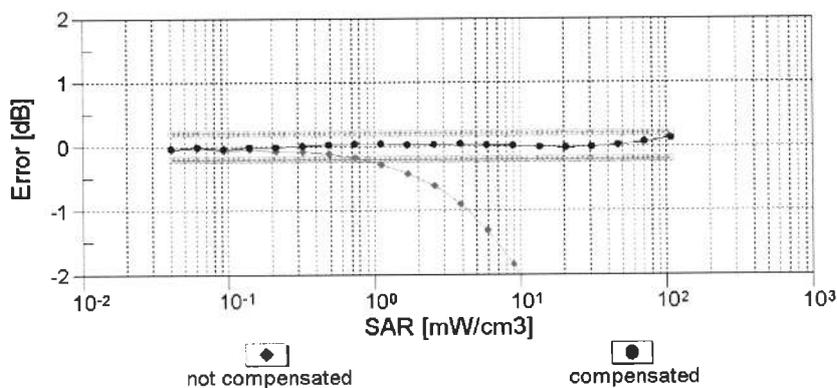
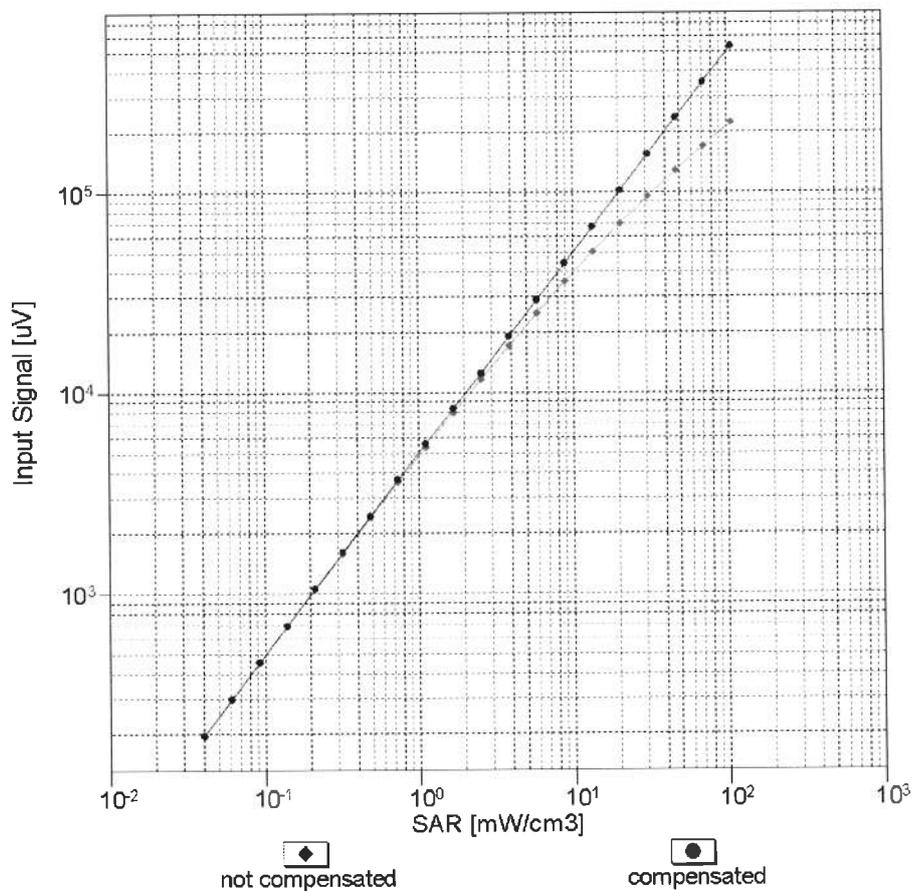


f=1800 MHz,R22



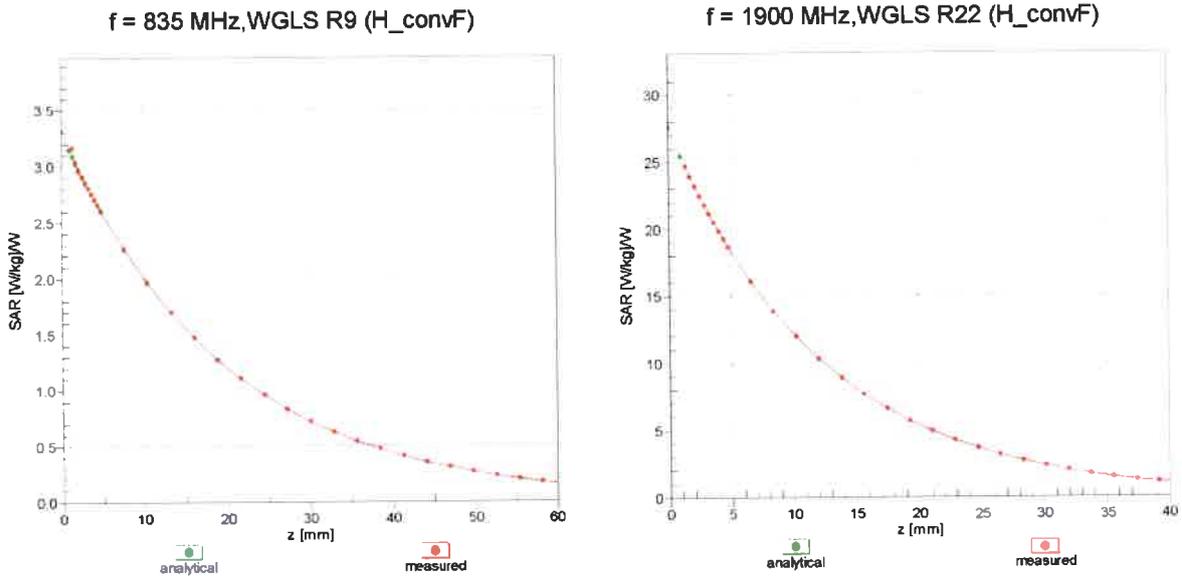
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

Dynamic Range f(SAR_{head}) (TEM cell , f = 900 MHz)

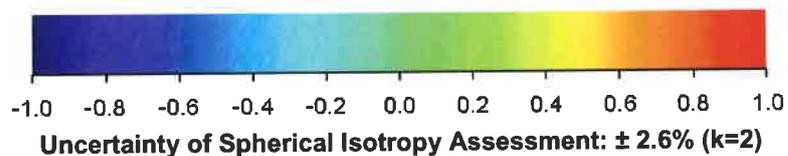
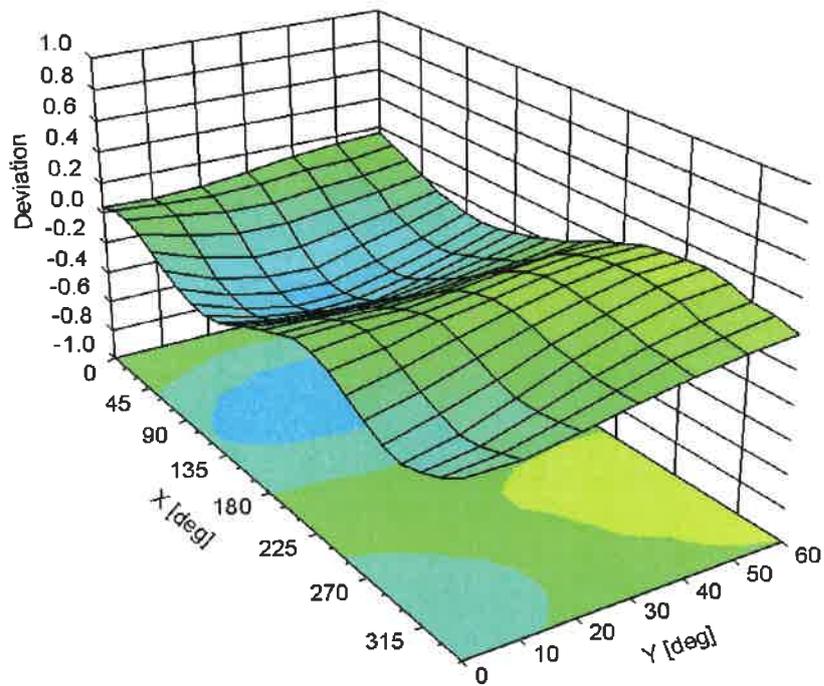


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, ϑ), f = 900 MHz



DASY/EASY - Parameters of Probe: EX3DV4 - SN:3650

Other Probe Parameters

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | -17.5 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 9 mm |
| Tip Diameter | 2.5 mm |
| Probe Tip to Sensor X Calibration Point | 1 mm |
| Probe Tip to Sensor Y Calibration Point | 1 mm |
| Probe Tip to Sensor Z Calibration Point | 1 mm |
| Recommended Measurement Distance from Surface | 2 mm |