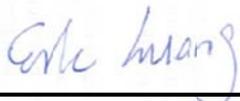


FCC SAR Test Report

APPLICANT : ZTE CORPORATION
EQUIPMENT : WiFi Ufi
BRAND NAME : ZTE
MODEL NAME : MF97W
FCC ID : SRQ-MF97W
STANDARD : FCC 47 CFR Part 2 (2.1093)
ANSI/IEEE C95.1-1992
IEEE 1528-2003

We, SPORTON INTERNATIONAL (KUNSHAN) INC., would like to declare that the tested sample has been evaluated in accordance with the procedures and had been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL (KUNSHAN) INC., the test report shall not be reproduced except in full.



Reviewed by: Eric Huang / Deputy Manager



Approved by: Jones Tsai / Manager



SPORTON INTERNATIONAL (KUNSHAN) INC.
No. 3-2, PingXiang Road, Kunshan, Jiangsu Province, P.R.C.



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Appendix C. DASYS Calibration Certificate

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1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for **ZTE CORPORATION, WiFi Ufi, MF97W** are as follows.

| Equipment Class | Frequency Band | Operating Mode | Highest SAR Summary |
|------------------|------------------|-------------------------------|-----------------------------|
| | | | Body 1g SAR (W/kg) Gap(1cm) |
| DTS | WLAN 2.4GHz Band | Data | 0.20 |
| NII | WLAN 5.2GHz Band | Data | 0.33 |
| | WLAN 5.8GHz Band | Data | 0.31 |
| Date of Testing: | | Sep. 14, 2014 ~ Sep. 17, 2014 | |

This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg) specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2003.

2. Administration Data

| Testing Laboratory | |
|---------------------------|--|
| Test Site | SPORTON INTERNATIONAL (KUNSHAN) INC. |
| Test Site Location | No. 3-2, PingXiang Road, Kunshan, Jiangsu Province, P.R.C. TEL: +86-0512-5790-0158 FAX: +86-0512-5790-0958 |

| Applicant | |
|---------------------|---|
| Company Name | ZTE CORPORATION |
| Address | ZTE Plaza, Keji Road South, Hi-Tech Industrial Park, Nanshan District, Shenzhen, Guangdong, 518057, P. R. China |

| Manufacturer | |
|---------------------|---|
| Company Name | ZTE CORPORATION |
| Address | ZTE Plaza, Keji Road South, Hi-Tech Industrial Park, Nanshan District, Shenzhen, Guangdong, 518057, P. R. China |

3. Guidance Standard

The Specific Absorption Rate (SAR) testing specification, method, and procedure for this device is in accordance with the following standards:

- FCC 47 CFR Part 2 (2.1093)
- ANSI/IEEE C95.1-1992
- IEEE 1528-2003
- FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r03
- FCC KDB 865664 D02 SAR Reporting v01r01
- FCC KDB 447498 D01 General RF Exposure Guidance v05r02
- FCC KDB 248227 D01 SAR meas for 802 11abg v01r02
- FCC KDB 941225 D06 Hotspot Mode SAR v01r01



4. Equipment Under Test (EUT)

4.1 General Information

| Product Feature & Specification | |
|---|---|
| Equipment Name | WiFi Ufi |
| Brand Name | ZTE |
| Model Name | MF97W |
| FCC ID | SRQ-MF97W |
| Wireless Technology and Frequency Range | WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz WLAN 5.8GHz Band: 5745 MHz ~ 5825 MHz Bluetooth: 2402 MHz ~ 2480 MHz |
| Mode | •802.11a/b/g/n HT20/HT40 •Bluetooth v3.0+EDR, Bluetooth v4.0 LE |
| HW Version | xs9B |
| SW Version | MF97WV1.0.0B01 |
| EUT Stage | Identical Prototype |
| Remark: | |
| <ol style="list-style-type: none"> 1. The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description. 2. This device 2.4GHz WLAN supports hotspot operation, and 5.8GHz WLAN supports WiFi Direct (GC/GO), and 5.2GHz supports WiFi Direct (GC only). 3. This device has no voice function. | |



4.2 Maximum Tune-up Limit

| Mode | | Maximum Average Power (dBm) | | |
|-------------------|--------------------|-----------------------------|--------------|-----|
| 2.4GHz | 802.11b | Chain Port 0 | 16.0 | |
| | | Chain Port 1 | 16.5 | |
| | 802.11g | Chain Port 0 | 11.0 | |
| | | Chain Port 1 | 11.0 | |
| | 802.11n HT20 | Chain Port 0 | 10.5 | |
| | | Chain Port 1 | 10.5 | |
| | | Chain Port 0+1 | 10.5 | |
| | 802.11n HT40 | Chain Port 0 | 9.5 | |
| | | Chain Port 1 | 10.0 | |
| | | Chain Port 0+1 | 10.5 | |
| | 5.2GHz | 802.11a | Chain Port 0 | 9.5 |
| | | | Chain Port 1 | 8.5 |
| 802.11n HT20 | | Chain Port 0 | 8.5 | |
| | | Chain Port 1 | 9.0 | |
| | | Chain Port 0+1 | 11.5 | |
| 802.11n HT40 | | Chain Port 0 | 8.5 | |
| | | Chain Port 1 | 8.0 | |
| | | Chain Port 0+1 | 12.0 | |
| 5.8GHz | | 802.11a | Chain Port 0 | 9.5 |
| | Chain Port 1 | | 9.0 | |
| | 802.11n HT20 | Chain Port 0 | 8.0 | |
| | | Chain Port 1 | 9.0 | |
| | | Chain Port 0+1 | 12.0 | |
| | 802.11n HT40 | Chain Port 0 | 8.5 | |
| | | Chain Port 1 | 9.0 | |
| | | Chain Port 0+1 | 11.5 | |
| | Bluetooth v3.0+EDR | | 0 | |
| Bluetooth v4.0 LE | | 0.5 | | |



5. RF Exposure Limits

5.1 Uncontrolled Environment

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

5.2 Controlled Environment

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. The exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

Limits for Occupational/Controlled Exposure (W/kg)

| Whole-Body | Partial-Body | Hands, Wrists, Feet and Ankles |
|------------|--------------|--------------------------------|
| 0.4 | 8.0 | 20.0 |

Limits for General Population/Uncontrolled Exposure (W/kg)

| Whole-Body | Partial-Body | Hands, Wrists, Feet and Ankles |
|------------|--------------|--------------------------------|
| 0.08 | 1.6 | 4.0 |

1. Whole-Body SAR is averaged over the entire body, partial-body SAR is averaged over any 1gram of tissue defined as a tissue volume in the shape of a cube. SAR for hands, wrists, feet and ankles is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

6. Specific Absorption Rate (SAR)

6.1 Introduction

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

6.2 SAR Definition

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

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

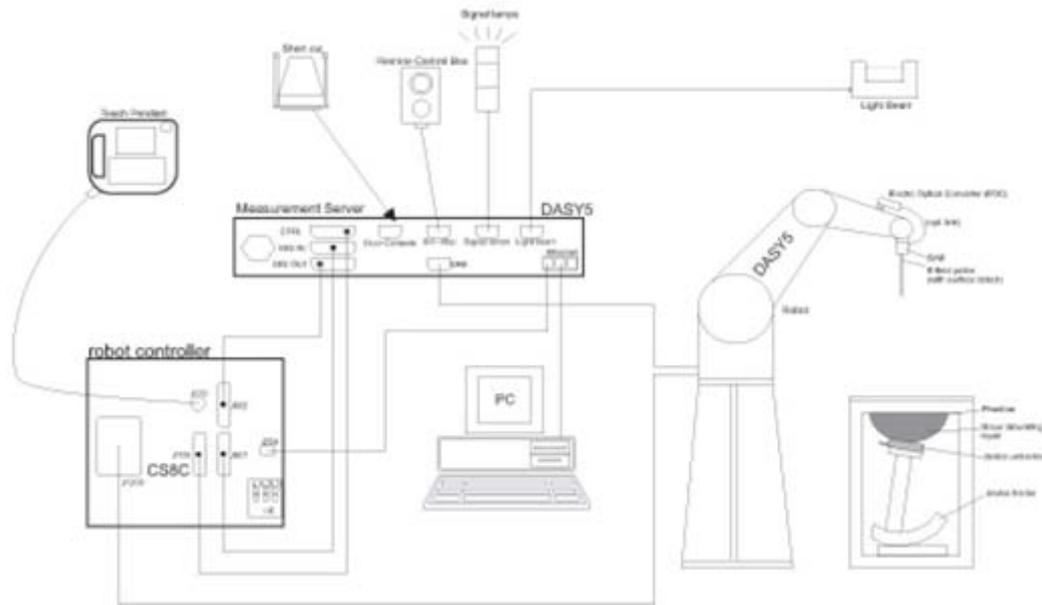
SAR is expressed in units of Watts per kilogram (W/kg)

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

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

7. System Description and Setup

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



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

8. Measurement Procedures

The measurement procedures are as follows:

<Conducted power measurement>

- (a) For WLAN/BT power measurement, use engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power in each supported wireless interface and frequency band
- (b) Connect EUT RF port through RF cable to the power meter, and measure WLAN/BT output power

<SAR measurement>

- (a) Use base station simulator to configure EUT transmission in radiated connection, and engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power, in the highest power channel.
- (b) Place the EUT in the positions as Appendix D demonstrates.
- (c) Set scan area, grid size and other setting on the DASY software.
- (d) Measure SAR results for the highest power channel on each testing position.
- (e) Find out the largest SAR result on these testing positions of each band
- (f) Measure SAR results for other channels in worst SAR testing position if the reported SAR of highest power channel is larger than 0.8 W/kg

According to the 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

8.1 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

8.2 Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

8.3 Area Scan

The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum found in the scanned area, within a range of the global maximum. The range (in dB0 is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan), if only one zoom scan follows the area scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of zoom scans has to be increased accordingly.

Area scan parameters extracted from FCC KDB 865664 D01v01r03 SAR measurement 100 MHz to 6 GHz.

| | ≤ 3 GHz | > 3 GHz |
|--|---|--|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | 5 ± 1 mm | ½ · δ · ln(2) ± 0.5 mm |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location | 30° ± 1° | 20° ± 1° |
| Maximum area scan spatial resolution: Δx _{Area} , Δy _{Area} | ≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm | 3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm |
| | When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device. | |

8.4 Zoom Scan

Zoom scans are used assess the peak spatial SAR values within a cubic averaging volume containing 1 gram and 10 gram of simulated tissue. The zoom scan measures points (refer to table below) within a cube shoes base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the zoom scan evaluates the averaged SAR for 1 gram and 10 gram and displays these values next to the job's label.

Zoom scan parameters extracted from FCC KDB 865664 D01v01r03 SAR measurement 100 MHz to 6 GHz.

| | | ≤ 3 GHz | > 3 GHz | |
|--|------------------------------------|--|---|--|
| Maximum zoom scan spatial resolution: $\Delta x_{Zoom}, \Delta y_{Zoom}$ | | ≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm* | 3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm* | |
| Maximum zoom scan spatial resolution, normal to phantom surface | uniform grid: $\Delta z_{Zoom}(n)$ | ≤ 5 mm | 3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm | |
| | graded grid | $\Delta z_{Zoom}(1)$: between 1 st two points closest to phantom surface | ≤ 4 mm | 3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm |
| | | $\Delta z_{Zoom}(n>1)$: between subsequent points | $\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$ | |
| Minimum zoom scan volume | x, y, z | ≥ 30 mm | 3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm | |
| Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details. * When zoom scan is required and the <i>reported</i> SAR from the <i>area scan based 1-g SAR estimation</i> procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz. | | | | |

8.5 Volume Scan Procedures

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.

8.6 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 drifts more than 5%, the SAR will be retested.



9. Test Equipment List

| Manufacturer | Name of Equipment | Type/Model | Serial Number | Calibration | |
|---------------|---------------------------------|---------------|---------------|---------------|---------------|
| | | | | Last Cal. | Due Date |
| SPEAG | 2450MHz System Validation Kit | D2450V2 | 924 | Nov. 13, 2013 | Nov. 12, 2014 |
| SPEAG | 5000MHz System Validation Kit | D5000V2 | 1006 | Sep. 23, 2013 | Sep. 22, 2014 |
| SPEAG | Data Acquisition Electronics | DAE4 | 1210 | May 19, 2014 | May 18, 2015 |
| SPEAG | Dosimetric E-Field Probe | EX3DV4 | 3857 | May 23, 2014 | May 22, 2015 |
| SPEAG | ELI4 Phantom | QD OVA 001 BB | 1479 | NCR | NCR |
| SPEAG | ELI4 Phantom | QD OVA 001 BB | 1477 | NCR | NCR |
| SPEAG | Phone Positioner | N/A | N/A | NCR | NCR |
| Agilent | Wireless Communication Test Set | E5515C | MY52102706 | May 03, 2014 | May 02, 2015 |
| Agilent | ENA Series Network Analyzer | E5071C | MY46111157 | May 04, 2014 | May 03, 2015 |
| Agilent | Dielectric Probe Kit | 85070E | MY44300475 | NCR | NCR |
| Agilent | Signal Generator | N5181A | MY50145381 | Jan. 04, 2014 | Jan. 03, 2015 |
| Anritsu | Power Sensor | MA2411B | 0917070 | Feb. 27, 2014 | Feb. 26, 2015 |
| Anritsu | Power Meter | ML2495A | 1005002 | Feb. 27, 2014 | Feb. 26, 2015 |
| ARRA | Power Divider | A3200-2 | N/A | NA | NA |
| R&S | Spectrum Analyzer | FSP7 | 101045 | Dec. 30, 2013 | Dec. 29, 2014 |
| Agilent | Dual Directional Coupler | 778D | 50422 | Note1 | |
| Woken | Attenuator 1 | WK0602-XX | N/A | Note1 | |
| PE | Attenuator 2 | PE7005-10 | N/A | Note1 | |
| PE | Attenuator 3 | PE7005- 3 | N/A | Note1 | |
| AR | Power Amplifier | 5S1G4M2 | 0328767 | Note1 | |
| Mini-Circuits | Power Amplifier | ZVE-3W | 162601250 | Note1 | |
| Mini-Circuits | Power Amplifier | ZHL-42W+ | 13440021344 | Note1 | |

General Note:

1. Prior to system verification and validation, the path loss from the signal generator to the system check source and the power meter, which includes the amplifier, cable, attenuator and directional coupler, was measured by the network analyzer. The reading of the power meter was offset by the path loss difference between the path to the power meter and the path to the system check source to monitor the actual power level fed to the system check source.
2. Referring to KDB 865664 D01v01r03, the dipole calibration interval can be extended to 3 years with justification. The dipoles are also not physically damaged, or repaired during the interval.
3. The justification data of dipole can be found in appendix C. The return loss is < -20dB, within 20% of prior calibration, the impedance is within 5 ohm of prior calibration.

10. System Verification

10.1 Tissue Verification

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

| Frequency (MHz) | Water (%) | Sugar (%) | Cellulose (%) | Salt (%) | Preventol (%) | DGBE (%) | Conductivity (σ) | Permittivity (ϵ_r) |
|-----------------|-----------|-----------|---------------|----------|---------------|----------|---------------------------|-------------------------------|
| For Body | | | | | | | | |
| 2450 | 68.6 | 0 | 0 | 0 | 0 | 31.4 | 1.95 | 52.7 |

Simulating Liquid for 5GHz, Manufactured by SPEAG

| Ingredients | (% by weight) |
|--------------------|---------------|
| Water | 64~78% |
| Mineral oil | 11~18% |
| Emulsifiers | 9~15% |
| Additives and Salt | 2~3% |

<Tissue Dielectric Parameter Check Results>

| Frequency (MHz) | Tissue Type | Liquid Temp. (°C) | Conductivity (σ) | Permittivity (ϵ_r) | Conductivity Target (σ) | Permittivity Target (ϵ_r) | Delta (σ) (%) | Delta (ϵ_r) (%) | Limit (%) | Date |
|-----------------|-------------|-------------------|---------------------------|-------------------------------|----------------------------------|--------------------------------------|------------------------|----------------------------|-----------|---------------|
| 2450 | Body | 22.6 | 1.933 | 51.278 | 1.95 | 52.70 | -0.87 | -2.70 | ±5 | Sep. 14, 2014 |
| 5200 | Body | 22.8 | 5.297 | 49.185 | 5.30 | 49.00 | -0.06 | 0.38 | ±5 | Sep. 17, 2014 |
| 5800 | Body | 22.8 | 6.127 | 47.784 | 6.00 | 48.20 | 2.12 | -0.86 | ±5 | Sep. 17, 2014 |

10.2 System Performance Check Results

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10 %. Below table shows the target SAR and measured SAR after normalized to 1W input power. The table below indicates the system performance check can meet the variation criterion and the plots can be referred to Appendix A of this report.

| Date | Frequency (MHz) | Tissue Type | Input Power (mW) | Dipole S/N | Probe S/N | DAE S/N | Measured SAR (W/kg) | Targeted SAR (W/kg) | Normalized SAR (W/kg) | Deviation (%) |
|---------------|-----------------|-------------|------------------|------------|-----------|---------|---------------------|---------------------|-----------------------|---------------|
| Sep. 14, 2014 | 2450 | Body | 250 | 924 | 3857 | 1210 | 12.80 | 50.20 | 51.2 | 1.99 |
| Sep. 17, 2014 | 5200 | Body | 100 | 1006 | 3857 | 1210 | 7.21 | 71.50 | 72.1 | 0.84 |
| Sep. 17, 2014 | 5800 | Body | 100 | 1006 | 3857 | 1210 | 7.08 | 72.30 | 70.8 | -2.07 |

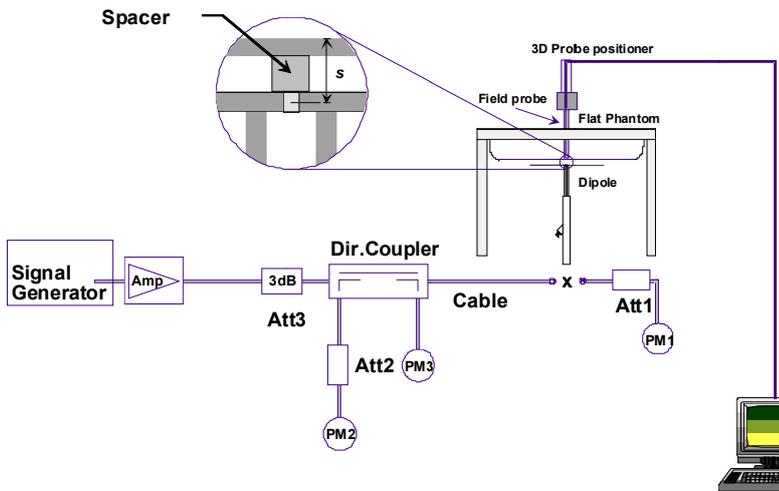


Fig 8.3.1 System Performance Check Setup



Fig 8.3.2 Setup Photo



11. RF Exposure Positions

11.1 Body Position

- (a) To position the device parallel to the phantom surface with all sides and either keypad up or down.
- (b) To adjust the device parallel to the flat phantom.
- (c) To adjust the distance between the device and the flat phantom to 1 cm.

<EUT Setup Photos>

Please refer to Appendix D for the test setup photos.



12. Conducted RF Output Power (Unit: dBm)

<WLAN Conducted Power>

General Note:

1. Per KDB 248227, SAR for MIMO was measured with both transmitting simultaneously and was evaluated in dependently of SISO operation.
2. For 2.4GHz SISO WLAN SAR testing, highest average RF output power channel for the lowest data rate for 802.11b were selected for SAR evaluation. 802.11g/n HT20/HT40 were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of 802.11b mode.
3. For 2.4 GHz MIMO, 802.11n-HT20MHz/n-HT40MHz maximum power including turn-up power were low and complied SAR test exclusion, so SAR can be excluded.
4. For 5.2 GHz SISO WLAN SAR testing, 802.11a/n -HT20/HT40 SAR test can be excluded , only 802.11MIMO SAR was selected for WLAN 5.2G SAR evaluation.
5. For 5.2GHz MIMO SAR testing, 802.11an-HT20MHz were evaluated, 802.11n-HT40 verified the worst position of 802.11n-HT20, for 802.11n-HT40 maximum power is more than 0.25 dB higher than 802.11n-HT20.
6. For 5.8 GHz SISO WLAN SAR testing, 802.11a/n -HT20/HT40 SAR test can be excluded , only 802.11MIMO SAR was selected for WLAN 5.8G SAR evaluation.
7. For 5.8 GHz MIMO WLAN SAR testing, 802.11an-HT20MHz were evaluated, 802.11n-HT40 SAR can be excluded for maximum power is not more than 0.25 dB higher than 802.11n-HT20.



<WLAN 2.4GHz>

| WLAN 2.4GHz 802.11b Average Power (dBm) | | | | | | | | Tune up Limit (dBm) |
|---|-----------------|------------|-----------------|---------------------|-------|---------|--------|---------------------|
| Power vs. Channel | | | | Power vs. Data Rate | | | | |
| Channel | Frequency (MHz) | Chain Port | Data Rate 1Mbps | Channel | 2Mbps | 5.5Mbps | 11Mbps | |
| CH 01 | 2412 | 0 | 15.01 | CH 06 | 15.75 | 15.52 | 15.50 | 16.0 |
| CH 06 | 2437 | 0 | 15.84 | | | | | |
| CH 11 | 2462 | 0 | 15.56 | | | | | |
| CH 01 | 2412 | 1 | 15.42 | CH 06 | 15.88 | 15.37 | 15.42 | 16.5 |
| CH 06 | 2437 | 1 | 15.91 | | | | | |
| CH 11 | 2462 | 1 | 15.38 | | | | | |

| WLAN 2.4GHz 802.11g Average Power (dBm) | | | | | | | | | | | | Tune up Limit (dBm) |
|---|-----------------|------------|-----------------|---------------------|-------|--------|--------|--------|--------|--------|--------|---------------------|
| Power vs. Channel | | | | Power vs. Data Rate | | | | | | | | |
| Channel | Frequency (MHz) | Chain Port | Data Rate 6Mbps | Channel | 9Mbps | 12Mbps | 18Mbps | 24Mbps | 36Mbps | 48Mbps | 54Mbps | |
| CH 01 | 2412 | 0 | 10.13 | CH 06 | 10.54 | 10.51 | 10.56 | 10.48 | 10.50 | 10.51 | 10.49 | 11.0 |
| CH 06 | 2437 | 0 | 10.58 | | | | | | | | | |
| CH 11 | 2462 | 0 | 10.38 | | | | | | | | | |
| CH 01 | 2412 | 1 | 9.69 | CH 06 | 10.33 | 10.28 | 10.31 | 10.30 | 10.34 | 10.37 | 10.33 | 11.0 |
| CH 06 | 2437 | 1 | 10.39 | | | | | | | | | |
| CH 11 | 2462 | 1 | 9.71 | | | | | | | | | |

| WLAN 2.4GHz 802.11n HT20 Average Power (dBm) | | | | | | | | | | | | Tune up Limit (dBm) |
|--|-----------------|------------|-------------------|---------------------|------|------|------|------|------|------|------|---------------------|
| Power vs. Channel | | | | Power vs. MCS Index | | | | | | | | |
| Channel | Frequency (MHz) | Chain Port | MCS Index MCS0 | Channel | MCS1 | MCS2 | MCS3 | MCS4 | MCS5 | MCS6 | MCS7 | |
| CH 01 | 2412 | 0 | 9.23 | CH 06 | 9.89 | 9.91 | 9.86 | 9.90 | 9.85 | 9.89 | 9.90 | 10.5 |
| CH 06 | 2437 | 0 | 9.93 | | | | | | | | | |
| CH 11 | 2462 | 0 | 9.87 | | | | | | | | | |
| CH 01 | 2412 | 1 | 9.73 | CH 06 | 9.84 | 9.79 | 9.75 | 9.84 | 9.81 | 9.71 | 9.76 | 10.5 |
| CH 06 | 2437 | 1 | 9.89 | | | | | | | | | |
| CH 11 | 2462 | 1 | 9.82 | | | | | | | | | |
| Channel | Frequency (MHz) | Chain Port | MCS Index MCS0 | Channel | MCS1 | MCS2 | MCS3 | MCS4 | MCS5 | MCS6 | MCS7 | Tune up Limit (dBm) |
| CH 01 | 2412 | 0+1 | 9.12 | CH 06 | 9.69 | 9.63 | 9.66 | 9.67 | 9.21 | 9.65 | 9.64 | 10.5 |
| CH 06 | 2437 | 0+1 | 9.94 | | | | | | | | | |
| CH 11 | 2462 | 0+1 | 8.96 | | | | | | | | | |

| WLAN 2.4GHz 802.11n HT40 Average Power (dBm) | | | | | | | | | | | | Tune up Limit (dBm) |
|--|-----------------|------------|-------------------|---------------------|------|------|------|------|------|------|------|---------------------|
| Power vs. Channel | | | | Power vs. MCS Index | | | | | | | | |
| Channel | Frequency (MHz) | Chain Port | MCS Index MCS0 | Channel | MCS1 | MCS2 | MCS3 | MCS4 | MCS5 | MCS6 | MCS7 | |
| CH 03 | 2422 | 0 | 8.70 | CH 09 | 9.08 | 9.06 | 9.01 | 9.04 | 9.07 | 9.09 | 9.06 | 9.5 |
| CH 06 | 2437 | 0 | 8.87 | | | | | | | | | |
| CH 09 | 2452 | 0 | 9.10 | | | | | | | | | |
| CH 03 | 2422 | 1 | 9.34 | CH 09 | 9.08 | 9.11 | 9.30 | 9.36 | 9.27 | 9.31 | 9.35 | 10.0 |
| CH 06 | 2437 | 1 | 9.30 | | | | | | | | | |
| CH 09 | 2452 | 1 | 9.38 | | | | | | | | | |
| Channel | Frequency (MHz) | Chain Port | MCS Index MCS0 | Channel | MCS1 | MCS2 | MCS3 | MCS4 | MCS5 | MCS6 | MCS7 | Tune up Limit (dBm) |
| CH 03 | 2422 | 0+1 | 9.81 | CH 06 | 9.96 | 9.93 | 9.91 | 9.97 | 9.94 | 9.95 | 9.94 | 10.5 |
| CH 06 | 2437 | 0+1 | 9.90 | | | | | | | | | |
| CH 09 | 2452 | 0+1 | 9.79 | | | | | | | | | |



<5GHz WLAN>

| WLAN 5GHz 802.11a Average Power (dBm) | | | | | | | | | | | | |
|---------------------------------------|-----------------|------------|-----------------|---------------------|-------|--------|--------|--------|--------|--------|--------|---------------------|
| Power vs. Channel | | | | Power vs. Data Rate | | | | | | | | Tune up Limit (dBm) |
| Channel | Frequency (MHz) | Chain Port | Data Rate 6Mbps | Channel | 9Mbps | 12Mbps | 18Mbps | 24Mbps | 36Mbps | 48Mbps | 54Mbps | |
| CH 36 | 5180 | 0 | 9.31 | CH 36 | 9.14 | 9.20 | 9.19 | 9.18 | 9.15 | 9.23 | 9.27 | 9.5 |
| CH 40 | 5200 | 0 | 9.26 | | | | | | | | | |
| CH 44 | 5220 | 0 | 9.17 | | | | | | | | | |
| CH 48 | 5240 | 0 | 9.10 | | | | | | | | | |
| CH 149 | 5745 | 0 | 8.95 | CH 157 | 9.10 | 9.03 | 9.08 | 9.12 | 9.11 | 9.12 | 9.13 | 9.5 |
| CH 153 | 5765 | 0 | 8.94 | | | | | | | | | |
| CH 157 | 5785 | 0 | 9.14 | | | | | | | | | |
| CH 161 | 5805 | 0 | 8.70 | | | | | | | | | |
| CH 165 | 5825 | 0 | 9.00 | | | | | | | | | |
| CH 36 | 5180 | 1 | 7.71 | CH 48 | 8.10 | 8.08 | 8.20 | 8.11 | 8.28 | 8.17 | 8.06 | 8.5 |
| CH 40 | 5200 | 1 | 7.96 | | | | | | | | | |
| CH 44 | 5220 | 1 | 7.93 | | | | | | | | | |
| CH 48 | 5240 | 1 | 8.37 | | | | | | | | | |
| CH 149 | 5745 | 1 | 8.84 | CH 157 | 8.73 | 8.74 | 8.82 | 8.83 | 8.82 | 8.83 | 8.82 | 9.0 |
| CH 153 | 5765 | 1 | 8.71 | | | | | | | | | |
| CH 157 | 5785 | 1 | 8.85 | | | | | | | | | |
| CH 161 | 5805 | 1 | 8.33 | | | | | | | | | |
| CH 165 | 5825 | 1 | 8.20 | | | | | | | | | |



| WLAN 5GHz 802.11n HT20 Average Power (dBm) | | | | | | | | | | | | |
|--|-----------------|------------|-------------------|---------------------|-------|-------|-------|-------|-------|-------|-------|---------------------|
| Power vs. Channel | | | | Power vs. MCS Index | | | | | | | | Tune up Limit (dBm) |
| Channel | Frequency (MHz) | Chain Port | MCS Index MCS0 | Channel | MCS1 | MCS2 | MCS3 | MCS4 | MCS5 | MCS6 | MCS7 | |
| CH 36 | 5180 | 0 | 8.35 | CH 36 | 8.33 | 8.30 | 8.28 | 8.31 | 8.31 | 8.33 | 8.30 | 8.5 |
| CH 40 | 5200 | 0 | 8.26 | | | | | | | | | |
| CH 44 | 5220 | 0 | 8.23 | | | | | | | | | |
| CH 48 | 5240 | 0 | 8.14 | | | | | | | | | |
| CH 149 | 5745 | 0 | 7.52 | CH 157 | 7.73 | 7.65 | 7.63 | 7.78 | 7.79 | 7.75 | 7.63 | 8.0 |
| CH 153 | 5765 | 0 | 7.56 | | | | | | | | | |
| CH 157 | 5785 | 0 | 7.80 | | | | | | | | | |
| CH 161 | 5805 | 0 | 7.41 | | | | | | | | | |
| CH 165 | 5825 | 0 | 7.63 | | | | | | | | | |
| CH 36 | 5180 | 1 | 8.31 | CH 48 | 8.70 | 8.69 | 8.75 | 8.73 | 8.74 | 8.74 | 8.75 | 9.0 |
| CH 40 | 5200 | 1 | 8.28 | | | | | | | | | |
| CH 44 | 5220 | 1 | 8.55 | | | | | | | | | |
| CH 48 | 5240 | 1 | 8.77 | | | | | | | | | |
| CH 149 | 5745 | 1 | 8.17 | CH 157 | 8.38 | 8.39 | 8.39 | 8.38 | 8.43 | 8.45 | 8.44 | 9.0 |
| CH 153 | 5765 | 1 | 8.12 | | | | | | | | | |
| CH 157 | 5785 | 1 | 8.47 | | | | | | | | | |
| CH 161 | 5805 | 1 | 7.90 | | | | | | | | | |
| CH 165 | 5825 | 1 | 7.57 | | | | | | | | | |
| Channel | Frequency (MHz) | Chain Port | MCS Index MCS0 | Channel | MCS1 | MCS2 | MCS3 | MCS4 | MCS5 | MCS6 | MCS7 | Tune up Limit (dBm) |
| CH 36 | 5180 | 0+1 | 10.81 | CH 48 | 10.94 | 10.98 | 11.04 | 11.12 | 11.11 | 11.08 | 11.00 | 11.5 |
| CH 40 | 5200 | 0+1 | 10.88 | | | | | | | | | |
| CH 44 | 5220 | 0+1 | 11.02 | | | | | | | | | |
| CH 48 | 5240 | 0+1 | 11.13 | | | | | | | | | |
| CH 149 | 5745 | 0+1 | 11.42 | CH 157 | 11.49 | 11.54 | 11.55 | 11.54 | 11.49 | 11.55 | 11.55 | 12.0 |
| CH 153 | 5765 | 0+1 | 11.36 | | | | | | | | | |
| CH 157 | 5785 | 0+1 | 11.56 | | | | | | | | | |
| CH 161 | 5805 | 0+1 | 11.05 | | | | | | | | | |
| CH 165 | 5825 | 0+1 | 11.16 | | | | | | | | | |



| WLAN 5GHz 802.11n HT40 Average Power (dBm) | | | | | | | | | | | | Tune up Limit (dBm) |
|--|-----------------|------------|-------------------|---------------------|-------|-------|-------|-------|-------|-------|-------|---------------------|
| Power vs. Channel | | | | Power vs. MCS Index | | | | | | | | |
| Channel | Frequency (MHz) | Chain Port | MCS Index MCS0 | Channel | MCS1 | MCS2 | MCS3 | MCS4 | MCS5 | MCS6 | MCS7 | Tune up Limit (dBm) |
| CH 38 | 5190 | 0 | 8.23 | CH 38 | 8.21 | 8.22 | 8.17 | 8.16 | 8.19 | 8.20 | 8.21 | |
| CH 46 | 5230 | 0 | 8.13 | CH 151 | 8.24 | 8.28 | 8.11 | 8.19 | 8.17 | 8.22 | 8.27 | 8.5 |
| CH 151 | 5755 | 0 | 8.30 | | | | | | | | | |
| CH 159 | 5795 | 0 | 8.13 | CH 46 | 7.64 | 7.46 | 7.64 | 7.57 | 7.65 | 7.49 | 7.73 | 8.0 |
| CH 38 | 5190 | 1 | 7.59 | | | | | | | | | |
| CH 46 | 5230 | 1 | 7.75 | CH 151 | 8.33 | 8.36 | 8.28 | 8.35 | 8.33 | 8.37 | 8.38 | 9.0 |
| CH 151 | 5755 | 1 | 8.39 | | | | | | | | | |
| CH 159 | 5795 | 1 | 8.18 | CH 38 | 11.41 | 11.45 | 11.39 | 11.30 | 11.27 | 11.37 | 11.37 | 12.0 |
| Channel | Frequency (MHz) | Chain Port | MCS Index MCS0 | | | | | | | | | |
| CH 38 | 5190 | 0+1 | 11.46 | CH 151 | 11.01 | 11.01 | 11.02 | 10.95 | 10.87 | 10.86 | 10.88 | 11.5 |
| CH 46 | 5230 | 0+1 | 11.39 | | | | | | | | | |
| CH 151 | 5755 | 0+1 | 11.14 | | | | | | | | | |
| CH 159 | 5795 | 0+1 | 10.97 | | | | | | | | | |

13. Exclusions Applied

For Bluetooth:

| Mode Band | Average power(dBm) | |
|------------------|--------------------|-------------------|
| | Bluetooth v3.0+EDR | Bluetooth v4.0 LE |
| 2.4GHz Bluetooth | 0 | 0.5 |

| Bluetooth Max Power (dBm) | Separation Distance (mm) | Frequency (GHz) | exclusion thresholds |
|---------------------------|--------------------------|-----------------|----------------------|
| 0.5 | 10 | 2.48 | 0.2 |

For WLAN 2.4G:

| Mode Band | Average power(dBm) | |
|-------------|--------------------|--|
| | MIMO | |
| 2.4GHz WLAN | 10.5 | |

| Max Power (dBm) | Separation Distance (mm) | Frequency (GHz) | exclusion thresholds |
|-----------------|--------------------------|-----------------|----------------------|
| 10.5 | 10 | 2.62 | 1.8 |

For WLAN 5.2G:

| Mode Band | Average power(dBm) | |
|-------------|--------------------|--|
| | 5.2G SISO | |
| 5.2GHz WLAN | 9.5 | |

| Max Power (dBm) | Separation Distance (mm) | Frequency (GHz) | exclusion thresholds |
|-----------------|--------------------------|-----------------|----------------------|
| 9.5 | 10 | 5.25 | 2.1 |

For WLAN 5.8G:

| Mode Band | Average power(dBm) | |
|-------------|--------------------|--|
| | 5.8G SISO | |
| 5.8GHz WLAN | 9.5 | |

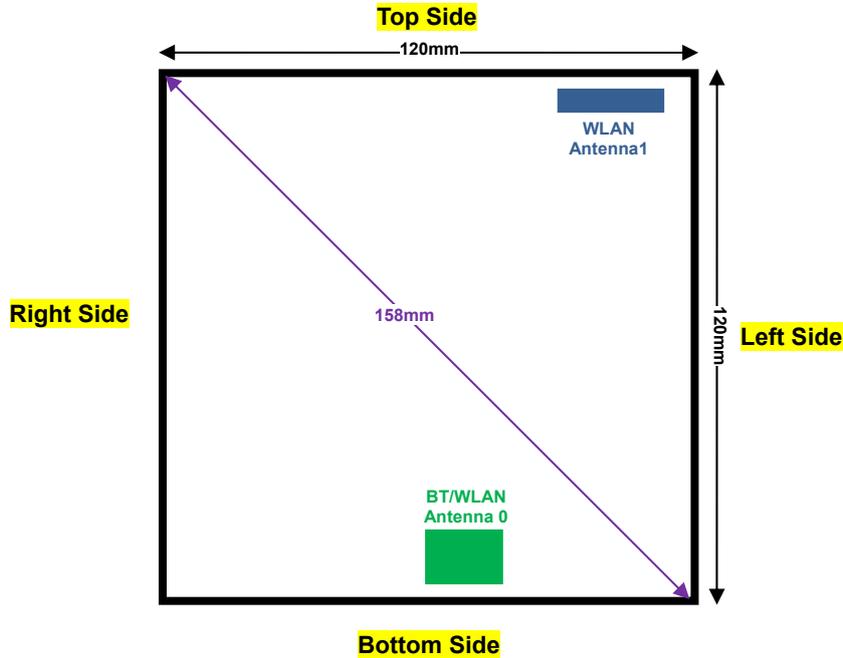
| Max Power (dBm) | Separation Distance (mm) | Frequency (GHz) | exclusion thresholds |
|-----------------|--------------------------|-----------------|----------------------|
| 9.5 | 10 | 5.85 | 2.2 |

Note:

- Per KDB 447498 D01v05r02, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤ 50 mm are determined by:

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$$
 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR
 - f(GHz) is the RF channel transmit frequency in GHz
 - Power and distance are rounded to the nearest mW and mm before calculation
 - The result is rounded to one decimal place for comparison
- Per KDB 447498 D01v05r02, above radio frequency band test exclusion threshold are all ≤ 3, SAR testing are not required.

14. Antenna Location



<Transmission configuration>

| Wireless Interface | SISO Mode | | MIMO Mode |
|-------------------------------|----------------------|----------------------|------------------------|
| | Antenna 0 <Tx/Rx> | Antenna 1 <Tx/Rx> | Antenna 0+1 <Tx/Rx> |
| BT & WLAN 2.4GHz 802.11b/g | yes | yes | |
| WLAN 2.4GHz 802.11n HT20/HT40 | yes | yes | yes |
| WLAN 5GHz 802.11a | yes | yes | |
| WLAN 5GHz 802.11n HT20/HT40 | yes | yes | yes |

| Distance of the Antenna to the EUT surface/edge | | | | | | |
|---|--------|--------|----------|-------------|------------|-----------|
| Antennas | Back | Front | Top Side | Bottom Side | Right Side | Left Side |
| BT & WLAN Antenna 0 | ≤ 25mm | ≤ 25mm | 107mm | ≤ 25mm | 57mm | 49mm |
| WLAN Antenna 1 | ≤ 25mm | ≤ 25mm | ≤ 25mm | 115mm | 101mm | ≤ 25mm |

| Positions for SAR tests; Hotspot mode | | | | | | |
|---------------------------------------|------|-------|----------|-------------|------------|-----------|
| Antennas | Back | Front | Top Side | Bottom Side | Right Side | Left Side |
| BT & WLAN Antenna 0 | Yes | Yes | No | Yes | No | No |
| WLAN Antenna 1 | Yes | Yes | Yes | No | No | Yes |

General Note:

Referring to KDB 941225 D06 v01r01, when the overall device length and width are ≥ 9cm*5cm, the test distance is 10 mm. SAR must be measured for all sides and surfaces with a transmitting antenna located within 25mm from that surface or edge.



15. SAR Test Results

General Note:

1. Per KDB 447498 D01v05r02, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
 - a. Tune-up scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.
 - b. For SAR testing of WLAN signal with non-100% duty cycle, the measured SAR is scaled-up by the duty cycle scaling factor which is equal to "1/(duty cycle)"
 - c. Reported SAR(W/kg)= Measured SAR(W/kg)* Duty Cycle scaling factor * Tune-up scaling factor
2. Per KDB 447498 D01v05r02, for each exposure position, testing of other required channels within the operating mode of a frequency band is not required when the *reported* 1-g or 10-g SAR for the mid-band or highest output power channel is:
 - ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
 - ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
 - ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz
3. This device 2.4GHz WLAN supports Hotspot operation, 5.8GHz WLAN supports WiFi Direct (Group Client / Group Owner), and 5.2GHz supports WiFi Direct (Group Client only).
4. Per KDB 865664 D01v01r03, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥ 0.8 W/kg.



15.1 Body SAR

<DTS WLAN SAR>

| Plot No. | Band | Mode | Test Position | Gap (cm) | Ant. | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Tune-up Scaling Factor | Duty Cycle % | Duty Cycle Scaling Factor | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|----------|-------------|---------------|---------------|----------|------|-----|-------------|---------------------|---------------------|------------------------|--------------|---------------------------|------------------|------------------------|------------------------|
| | WLAN 2.4GHz | 802.11b 1Mbps | Front | 1 | 0 | 6 | 2437 | 15.84 | 16 | 1.038 | 100 | 1.000 | -0.085 | 0.062 | 0.064 |
| | WLAN 2.4GHz | 802.11b 1Mbps | Back | 1 | 0 | 6 | 2437 | 15.84 | 16 | 1.038 | 100 | 1.000 | -0.05 | 0.098 | 0.102 |
| | WLAN 2.4GHz | 802.11b 1Mbps | Bottom side | 1 | 0 | 6 | 2437 | 15.84 | 16 | 1.038 | 100 | 1.000 | 0.13 | 0.135 | 0.140 |
| | WLAN 2.4GHz | 802.11b 1Mbps | Front | 1 | 1 | 6 | 2437 | 15.91 | 16.5 | 1.146 | 100 | 1.000 | -0.16 | 0.061 | 0.070 |
| | WLAN 2.4GHz | 802.11b 1Mbps | Back | 1 | 1 | 6 | 2437 | 15.91 | 16.5 | 1.146 | 100 | 1.000 | -0.19 | 0.089 | 0.102 |
| #01 | WLAN 2.4GHz | 802.11b 1Mbps | Left side | 1 | 1 | 6 | 2437 | 15.91 | 16.5 | 1.146 | 100 | 1.000 | -0.02 | 0.176 | 0.202 |
| | WLAN 2.4GHz | 802.11b 1Mbps | Top side | 1 | 1 | 6 | 2437 | 15.91 | 16.5 | 1.146 | 100 | 1.000 | -0.07 | 0.072 | 0.082 |

<UNII WLAN SAR>

| Plot No. | Band | Mode | Test Position | Gap (cm) | Ant. | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Tune-up Scaling Factor | Duty Cycle % | Duty Cycle Scaling Factor | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|----------|-------------|-------------------|---------------|----------|---------|-----|-------------|---------------------|---------------------|------------------------|--------------|---------------------------|------------------|------------------------|------------------------|
| | WLAN 5.2GHz | 802.11n HT20 MCS0 | Front | 1 | Ant 0+1 | 48 | 5240 | 11.13 | 11.5 | 1.089 | 90.52 | 1.110 | -0.05 | 0.055 | 0.066 |
| | WLAN 5.2GHz | 802.11n HT20 MCS0 | Back | 1 | Ant 0+1 | 48 | 5240 | 11.13 | 11.5 | 1.089 | 90.52 | 1.110 | 0.01 | 0.114 | 0.137 |
| | WLAN 5.2GHz | 802.11n HT20 MCS0 | Left side | 1 | Ant 0+1 | 48 | 5240 | 11.13 | 11.5 | 1.089 | 90.52 | 1.110 | -0.04 | 0.065 | 0.078 |
| | WLAN 5.2GHz | 802.11n HT20 MCS0 | Top side | 1 | Ant 0+1 | 48 | 5240 | 11.13 | 11.5 | 1.089 | 90.52 | 1.110 | -0.06 | 0.147 | 0.177 |
| | WLAN 5.2GHz | 802.11n HT20 MCS0 | Bottom side | 1 | Ant 0+1 | 48 | 5240 | 11.13 | 11.5 | 1.089 | 90.52 | 1.110 | 0.02 | 0.216 | 0.260 |
| #02 | WLAN 5.2GHz | 802.11n HT40 MCS0 | Bottom side | 1 | Ant 0+1 | 38 | 5190 | 11.46 | 12.0 | 1.132 | 83.00 | 1.210 | -0.02 | 0.243 | 0.332 |
| | WLAN 5.8GHz | 802.11n HT20 MCS0 | Front | 1 | Ant 1 | 157 | 5785 | 11.56 | 12 | 1.107 | 90.52 | 1.110 | -0.09 | 0.089 | 0.109 |
| | WLAN 5.8GHz | 802.11n HT20 MCS0 | Back | 1 | Ant 1 | 157 | 5785 | 11.56 | 12 | 1.107 | 90.52 | 1.110 | -0.07 | 0.221 | 0.270 |
| | WLAN 5.8GHz | 802.11n HT20 MCS0 | Left side | 1 | Ant 1 | 157 | 5785 | 11.56 | 12 | 1.107 | 90.52 | 1.110 | -0.01 | 0.018 | 0.022 |
| | WLAN 5.8GHz | 802.11n HT20 MCS0 | Top side | 1 | Ant 0+1 | 157 | 5785 | 11.56 | 12 | 1.107 | 90.52 | 1.110 | 0.03 | 0.074 | 0.090 |
| #03 | WLAN 5.8GHz | 802.11n HT20 MCS0 | Bottom side | 1 | Ant 0+1 | 157 | 5785 | 11.56 | 12 | 1.107 | 90.52 | 1.110 | -0.01 | 0.251 | 0.307 |



16. Simultaneous Transmission Analysis

| NO. | Simultaneous Transmission Configurations |
|-----|--|
| 1. | None |

General Note:

- 1. This device 2.4GHz WLAN supports hotspot operation, 5.8GHz WLAN supports hotspot /WiFi Direct (GC/GO) and 5.2GHz supports WiFi Direct (GC only).
- 2. EUT will choose either WLAN 2.4GHz or WLAN 5GHz according to the network signal condition; therefore, they will not transmit simultaneously.
- 3. Bluetooth and WLAN Antenna 0 share the same antenna, and cannot transmit simultaneously. And Bluetooth also cannot transmit simultaneously with WLAN Antenna 1.

Test Engineer : Fulu Hu

17. Uncertainty Assessment

The component of uncertainty may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainty by the statistical analysis of a series of observations is termed a Type A evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance.

A Type A evaluation of standard uncertainty may be based on any valid statistical method for treating data. This includes calculating the standard deviation of the mean of a series of independent observations; using the method of least squares to fit a curve to the data in order to estimate the parameter of the curve and their standard deviations; or carrying out an analysis of variance in order to identify and quantify random effects in certain kinds of measurement.

A type B evaluation of standard uncertainty is typically based on scientific judgment using all of the relevant information available. These may include previous measurement data, experience, and knowledge of the behavior and properties of relevant materials and instruments, manufacture’s specification, data provided in calibration reports and uncertainties assigned to reference data taken from handbooks. Broadly speaking, the uncertainty is either obtained from an outdoor source or obtained from an assumed distribution, such as the normal distribution, rectangular or triangular distributions indicated in table below.

| Uncertainty Distributions | Normal | Rectangular | Triangular | U-Shape |
|------------------------------------|--------------------|-------------|------------|---------|
| Multi-plying Factor ^(a) | 1/k ^(b) | 1/√3 | 1/√6 | 1/√2 |

(a) standard uncertainty is determined as the product of the multiplying factor and the estimated range of variations in the measured quantity

(b) κ is the coverage factor

Table 17.1. Standard Uncertainty for Assumed Distribution

The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type B evaluation using the usual “root-sum-squares” (RSS) methods of combining standard deviations by taking the positive square root of the estimated variances.

Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. Typically, the coverage factor ranges from 2 to 3. Using a coverage factor allows the true value of a measured quantity to be specified with a defined probability within the specified uncertainty range. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %. The DASY uncertainty Budget is shown in the following tables.

| Error Description | Uncertainty Value (±%) | Probability Distribution | Divisor | Ci (1g) | Ci (10g) | Standard Uncertainty (1g) | Standard Uncertainty (10g) |
|--------------------------------------|------------------------|--------------------------|---------|---------|----------|---------------------------|----------------------------|
| Measurement System | | | | | | | |
| Probe Calibration | 6.0 | Normal | 1 | 1 | 1 | ± 6.0 % | ± 6.0 % |
| Axial Isotropy | 4.7 | Rectangular | √3 | 0.7 | 0.7 | ± 1.9 % | ± 1.9 % |
| Hemispherical Isotropy | 9.6 | Rectangular | √3 | 0.7 | 0.7 | ± 3.9 % | ± 3.9 % |
| Boundary Effects | 1.0 | Rectangular | √3 | 1 | 1 | ± 0.6 % | ± 0.6 % |
| Linearity | 4.7 | Rectangular | √3 | 1 | 1 | ± 2.7 % | ± 2.7 % |
| System Detection Limits | 1.0 | Rectangular | √3 | 1 | 1 | ± 0.6 % | ± 0.6 % |
| Readout Electronics | 0.3 | Normal | 1 | 1 | 1 | ± 0.3 % | ± 0.3 % |
| Response Time | 0.8 | Rectangular | √3 | 1 | 1 | ± 0.5 % | ± 0.5 % |
| Integration Time | 2.6 | Rectangular | √3 | 1 | 1 | ± 1.5 % | ± 1.5 % |
| RF Ambient Noise | 3.0 | Rectangular | √3 | 1 | 1 | ± 1.7 % | ± 1.7 % |
| RF Ambient Reflections | 3.0 | Rectangular | √3 | 1 | 1 | ± 1.7 % | ± 1.7 % |
| Probe Positioner | 0.4 | Rectangular | √3 | 1 | 1 | ± 0.2 % | ± 0.2 % |
| Probe Positioning | 2.9 | Rectangular | √3 | 1 | 1 | ± 1.7 % | ± 1.7 % |
| Max. SAR Eval. | 1.0 | Rectangular | √3 | 1 | 1 | ± 0.6 % | ± 0.6 % |
| Test Sample Related | | | | | | | |
| Device Positioning | 2.9 | Normal | 1 | 1 | 1 | ± 2.9 % | ± 2.9 % |
| Device Holder | 3.6 | Normal | 1 | 1 | 1 | ± 3.6 % | ± 3.6 % |
| Power Drift | 5.0 | Rectangular | √3 | 1 | 1 | ± 2.9 % | ± 2.9 % |
| Phantom and Setup | | | | | | | |
| Phantom Uncertainty | 4.0 | Rectangular | √3 | 1 | 1 | ± 2.3 % | ± 2.3 % |
| Liquid Conductivity (Target) | 5.0 | Rectangular | √3 | 0.64 | 0.43 | ± 1.8 % | ± 1.2 % |
| Liquid Conductivity (Meas.) | 2.5 | Normal | 1 | 0.64 | 0.43 | ± 1.6 % | ± 1.1 % |
| Liquid Permittivity (Target) | 5.0 | Rectangular | √3 | 0.6 | 0.49 | ± 1.7 % | ± 1.4 % |
| Liquid Permittivity (Meas.) | 2.5 | Normal | 1 | 0.6 | 0.49 | ± 1.5 % | ± 1.2 % |
| Combined Standard Uncertainty | | | | | | ± 11.0 % | ± 10.8 % |
| Coverage Factor for 95 % | | | | | | K=2 | |
| Expanded Uncertainty | | | | | | ± 22.0 % | ± 21.5 % |

Table 17.2. Uncertainty Budget for frequency range 300 MHz to 3 GHz

| Error Description | Uncertainty Value (±%) | Probability Distribution | Divisor | Ci (1g) | Ci (10g) | Standard Uncertainty (1g) | Standard Uncertainty (10g) |
|--------------------------------------|------------------------|--------------------------|---------|---------|----------|---------------------------|----------------------------|
| Measurement System | | | | | | | |
| Probe Calibration | 6.55 | Normal | 1 | 1 | 1 | ± 6.55 % | ± 6.55 % |
| Axial Isotropy | 4.7 | Rectangular | √3 | 0.7 | 0.7 | ± 1.9 % | ± 1.9 % |
| Hemispherical Isotropy | 9.6 | Rectangular | √3 | 0.7 | 0.7 | ± 3.9 % | ± 3.9 % |
| Boundary Effects | 2.0 | Rectangular | √3 | 1 | 1 | ± 1.2 % | ± 1.2 % |
| Linearity | 4.7 | Rectangular | √3 | 1 | 1 | ± 2.7 % | ± 2.7 % |
| System Detection Limits | 1.0 | Rectangular | √3 | 1 | 1 | ± 0.6 % | ± 0.6 % |
| Readout Electronics | 0.3 | Normal | 1 | 1 | 1 | ± 0.3 % | ± 0.3 % |
| Response Time | 0.8 | Rectangular | √3 | 1 | 1 | ± 0.5 % | ± 0.5 % |
| Integration Time | 2.6 | Rectangular | √3 | 1 | 1 | ± 1.5 % | ± 1.5 % |
| RF Ambient Noise | 3.0 | Rectangular | √3 | 1 | 1 | ± 1.7 % | ± 1.7 % |
| RF Ambient Reflections | 3.0 | Rectangular | √3 | 1 | 1 | ± 1.7 % | ± 1.7 % |
| Probe Positioner | 0.8 | Rectangular | √3 | 1 | 1 | ± 0.5 % | ± 0.5 % |
| Probe Positioning | 9.9 | Rectangular | √3 | 1 | 1 | ± 5.7 % | ± 5.7 % |
| Max. SAR Eval. | 4.0 | Rectangular | √3 | 1 | 1 | ± 2.3 % | ± 2.3 % |
| Test Sample Related | | | | | | | |
| Device Positioning | 2.9 | Normal | 1 | 1 | 1 | ± 2.9 % | ± 2.9 % |
| Device Holder | 3.6 | Normal | 1 | 1 | 1 | ± 3.6 % | ± 3.6 % |
| Power Drift | 5.0 | Rectangular | √3 | 1 | 1 | ± 2.9 % | ± 2.9 % |
| Phantom and Setup | | | | | | | |
| Phantom Uncertainty | 4.0 | Rectangular | √3 | 1 | 1 | ± 2.3 % | ± 2.3 % |
| Liquid Conductivity (Target) | 5.0 | Rectangular | √3 | 0.64 | 0.43 | ± 1.8 % | ± 1.2 % |
| Liquid Conductivity (Meas.) | 2.5 | Normal | 1 | 0.64 | 0.43 | ± 1.6 % | ± 1.1 % |
| Liquid Permittivity (Target) | 5.0 | Rectangular | √3 | 0.6 | 0.49 | ± 1.7 % | ± 1.4 % |
| Liquid Permittivity (Meas.) | 2.5 | Normal | 1 | 0.6 | 0.49 | ± 1.5 % | ± 1.2 % |
| Combined Standard Uncertainty | | | | | | ± 12.8 % | ± 12.6 % |
| Coverage Factor for 95 % | | | | | | K=2 | |
| Expanded Uncertainty | | | | | | ± 25.6 % | ± 25.2 % |

Table 17.3. Uncertainty Budget for frequency range 3 GHz to 6 GHz



18. References

- [1] FCC 47 CFR Part 2 "Frequency Allocations and Radio Treaty Matters; General Rules and Regulations"
- [2] ANSI/IEEE Std. C95.1-1992, "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz", September 1992
- [3] IEEE Std. 1528-2003, "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- [4] SPEAG DASY System Handbook
- [5] FCC KDB 248227 D01 v01r02, "SAR Measurement Procedures for 802.11 a/b/g Transmitters", May 2007
- [6] FCC KDB 447498 D01 v05r02, "Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies", Feb 2014
- [7] FCC KDB 941225 D06 v01r01, "SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities", May 2013.
- [8] FCC KDB 865664 D01 v01r03, "SAR Measurement Requirements for 100 MHz to 6 GHz", Feb 2014.
- [9] FCC KDB 865664 D02 v01r01, "RF Exposure Compliance Reporting and Documentation Considerations" May 2013.



Appendix A. Plots of System Performance Check

The plots are shown as follows.

System Check_Body_2450MHz_140914

DUT: D2450V2 - SN:924

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

Medium: MSL_2450_140914 Medium parameters used: $f = 2450$ MHz; $\sigma = 1.933$ mho/m; $\epsilon_r =$

51.278 ; $\rho = 1000$ kg/m³

Ambient Temperature : 23.3 °C ; Liquid Temperature : 22.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3857; ConvF(7.14, 7.14, 7.14); Calibrated: 2014.05.23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM1; Type: SAM; Serial: TP-1479
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Pin=250mW/Area Scan (81x81x1): Measurement grid: dx=12mm, dy=12mm

Maximum value of SAR (interpolated) = 19.542 mW/g

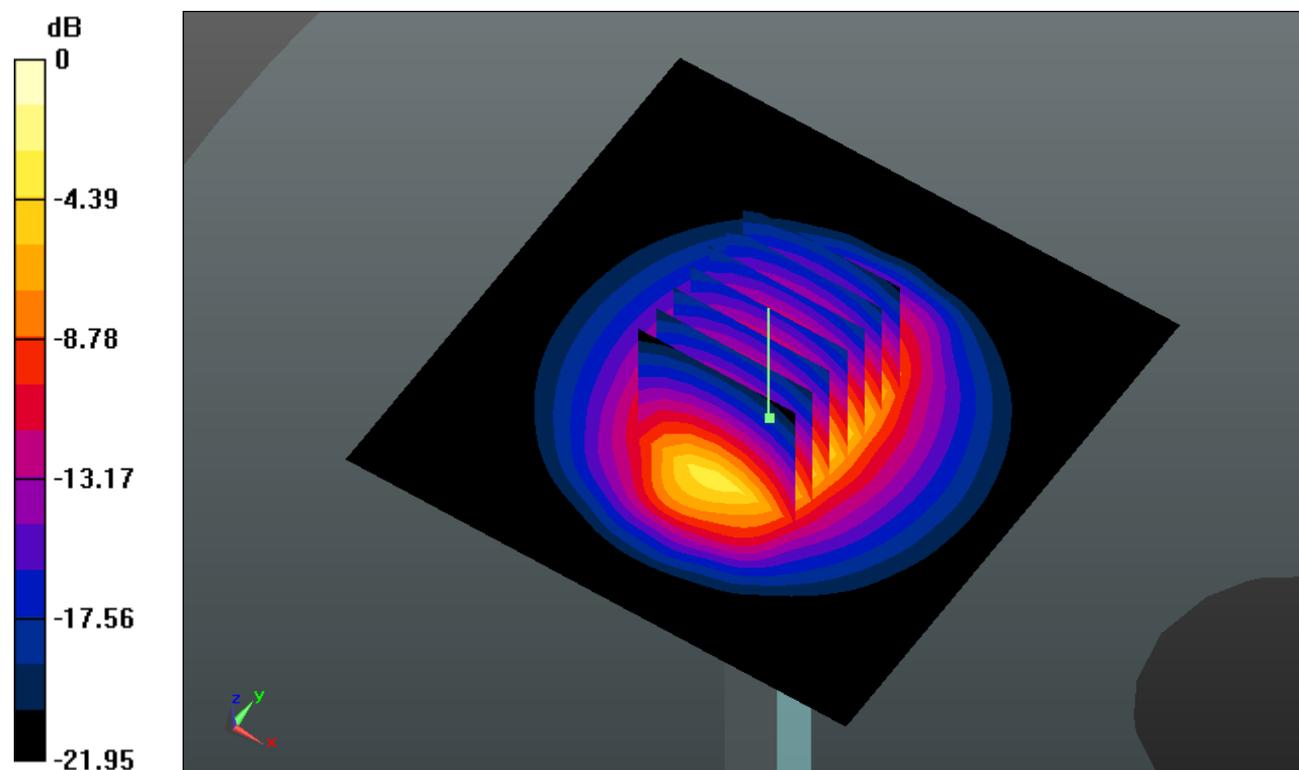
Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 87.416 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 26.454 W/kg

SAR(1 g) = 12.8 mW/g; SAR(10 g) = 5.91 mW/g

Maximum value of SAR (measured) = 19.605 mW/g



0 dB = 19.600mW/g

System Check_Body_5200MHz_140917

DUT: D5GHzV2-SN:1006

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

Medium: MSL_5000_140917 Medium parameters used: $f = 5200$ MHz; $\sigma = 5.297$ mho/m; $\epsilon_r =$

49.185; $\rho = 1000$ kg/m³

Ambient Temperature : 23.2 °C ; Liquid Temperature : 22.8 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3857; ConvF(4.54, 4.54, 4.54); Calibrated: 2014.05.23
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM2; Type: SAM; Serial: TP-1477
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Pin=100mW/Area Scan (71x71x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 16.995 mW/g

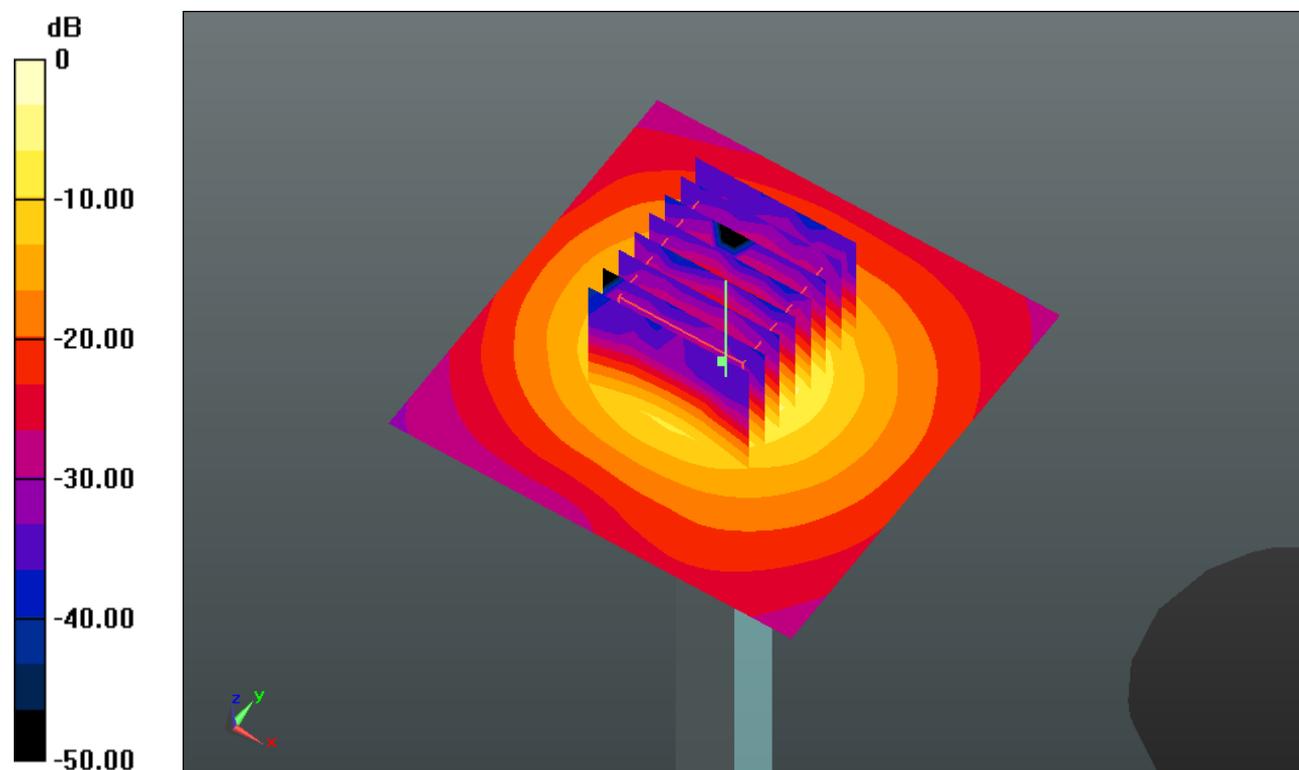
Pin=100mW/Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 40.232 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 29.936 W/kg

SAR(1 g) = 7.21 mW/g; SAR(10 g) = 2.02 mW/g

Maximum value of SAR (measured) = 16.849 mW/g



0 dB = 16.850mW/g

System Check_Body_5800MHz_140917

DUT: D5GHzV2-SN:1006

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

Medium: MSL_5000_140917 Medium parameters used: $f = 5800 \text{ MHz}$; $\sigma = 6.127 \text{ mho/m}$; $\epsilon_r =$

47.784 ; $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature : $23.2 \text{ }^\circ\text{C}$; Liquid Temperature : $22.8 \text{ }^\circ\text{C}$

DASY5 Configuration:

- Probe: EX3DV4 - SN3857; ConvF(4.21, 4.21, 4.21); Calibrated: 2014.05.23
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM2; Type: SAM; Serial: TP-1477
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Pin=100mW/Area Scan (71x71x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

Maximum value of SAR (interpolated) = 17.667 mW/g

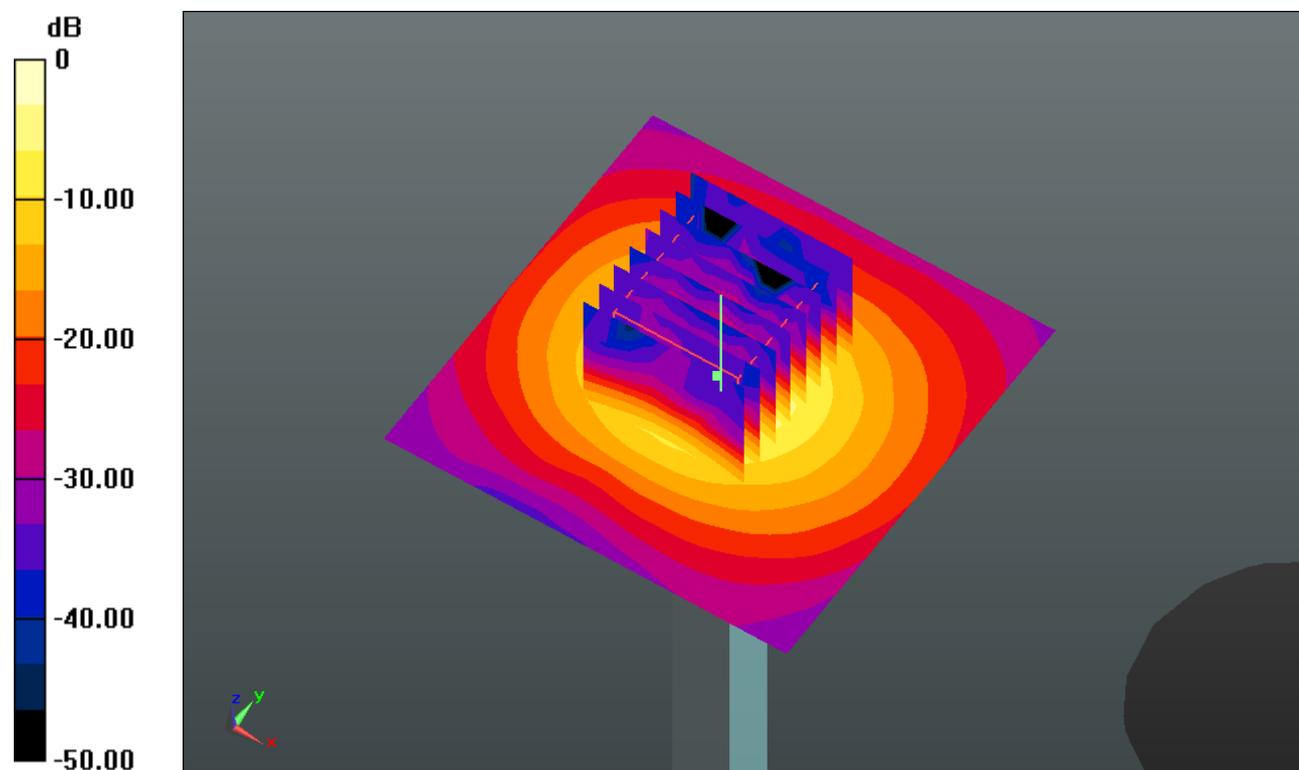
Pin=100mW/Zoom Scan (8x8x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$

Reference Value = 36.719 V/m ; Power Drift = -0.0087 dB

Peak SAR (extrapolated) = 32.163 W/kg

SAR(1 g) = 7.08 mW/g ; SAR(10 g) = 1.97 mW/g

Maximum value of SAR (measured) = 17.317 mW/g



0 dB = 17.320mW/g



Appendix B. Plots of High SAR Measurement

The plots are shown as follows.

#01WLAN 2.4GHz_802.11b 1Mbps_Left Side_1.0cm_Ch6_Ant.1

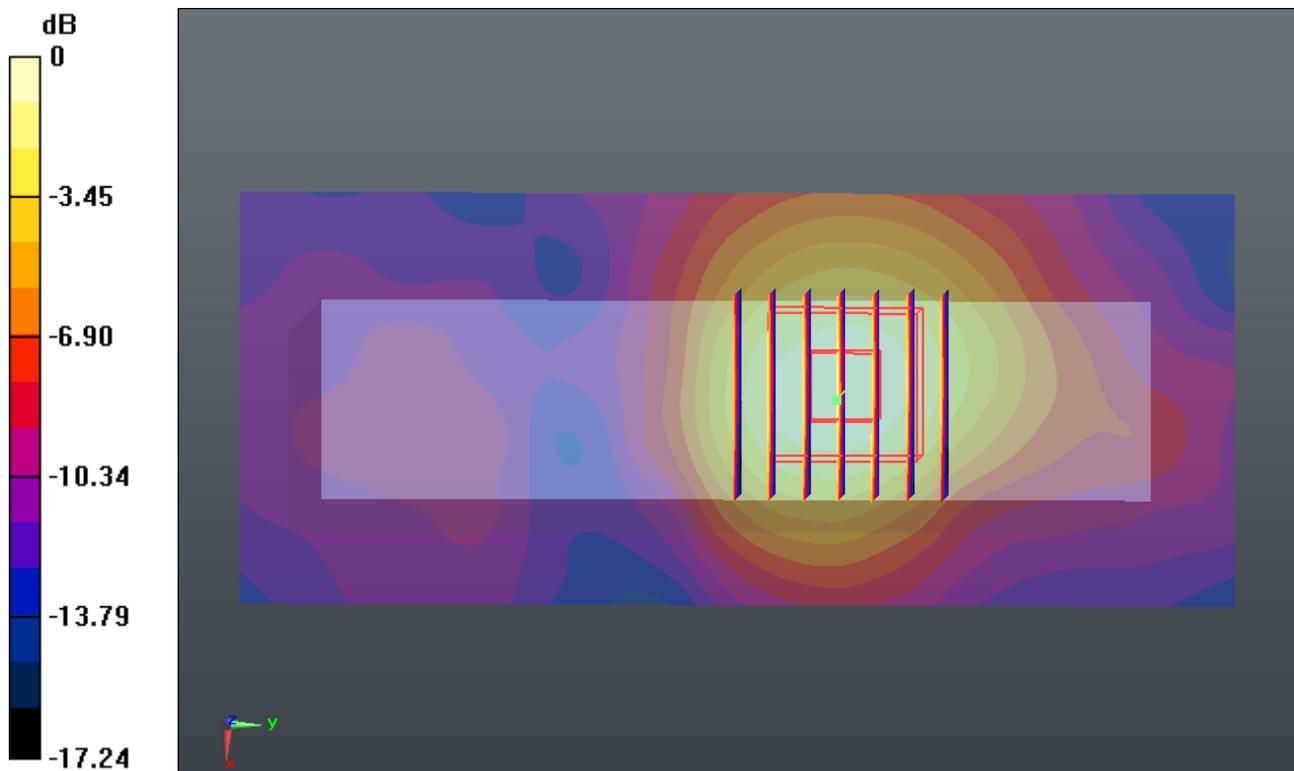
Communication System: WIFI (0); Frequency: 2437 MHz; Duty Cycle: 1:1
Medium: MSL_2450_140914 Medium parameters used: $f = 2437$ MHz; $\sigma = 1.915$ mho/m; $\epsilon_r = 51.338$; $\rho = 1000$ kg/m³
Ambient Temperature : 23.3 °C ; Liquid Temperature : 22.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3857; ConvF(7.14, 7.14, 7.14); Calibrated: 2014.05.23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM1; Type: SAM; Serial: TP-1479
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Ch6/Area Scan (51x121x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (interpolated) = 0.256 mW/g

Ch6/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 7.575 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 0.320 W/kg
SAR(1 g) = 0.176 mW/g; SAR(10 g) = 0.095 mW/g
Maximum value of SAR (measured) = 0.248 mW/g



0 dB = 0.250mW/g

#02 WLAN 5.2GHz_802.11n HT40 MCS0_Bottom Side_1.0cm_Ch38_Ant.0+1

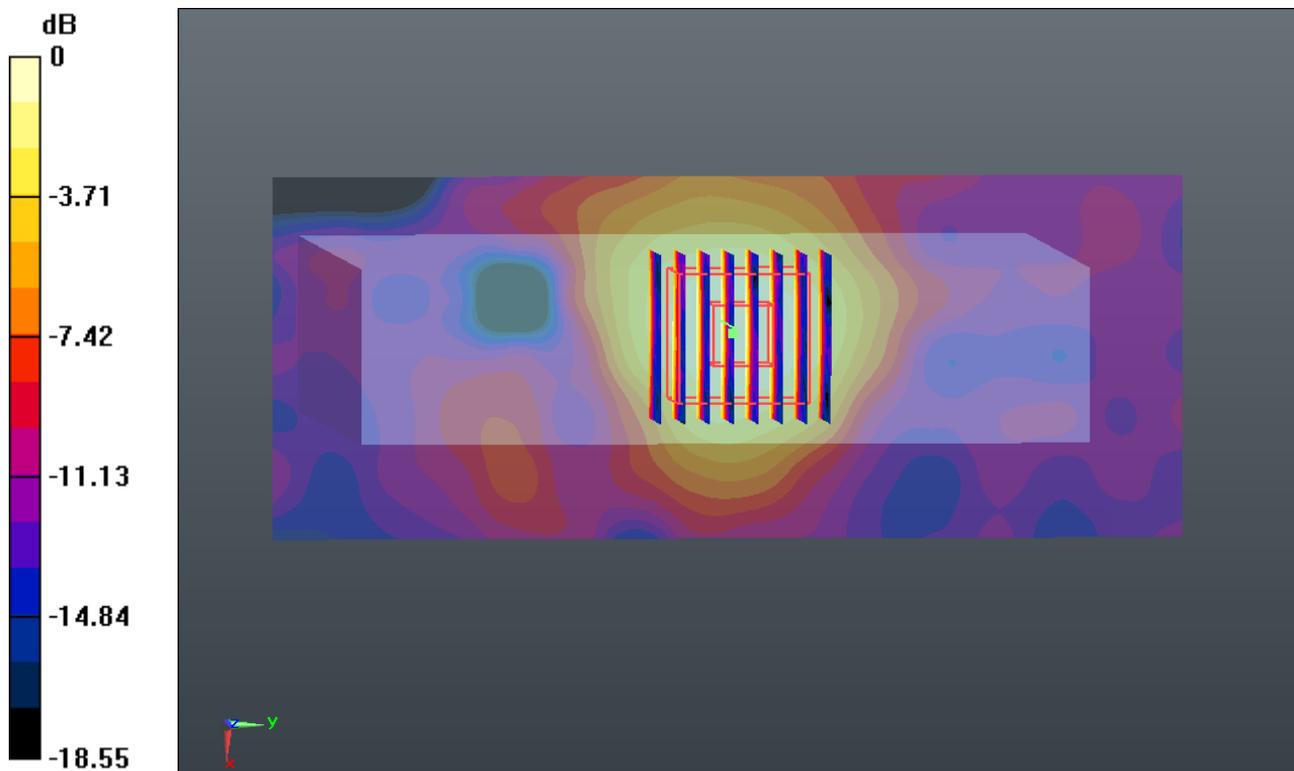
Communication System: WIFI (0); Frequency: 5190 MHz; Duty Cycle: 1:1.21
Medium: MSL_5000_140917 Medium parameters used: $f = 5190$ MHz; $\sigma = 5.283$ mho/m; $\epsilon_r = 49.207$; $\rho = 1000$ kg/m³
Ambient Temperature : 23.2 °C ; Liquid Temperature : 22.8 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3857; ConvF(4.54, 4.54, 4.54); Calibrated: 2014.05.23
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM2; Type: SAM; Serial: TP-1477
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Ch38/Area Scan (61x151x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.470 mW/g

Ch38/Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 7.167 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 0.602 W/kg
SAR(1 g) = 0.243 mW/g; SAR(10 g) = 0.108 mW/g
Maximum value of SAR (measured) = 0.442 mW/g



0 dB = 0.440mW/g

#03 WLAN 5.8GHz_802.11n HT20 MCS0_Bottom Side_1.0cm_Ch157_Ant.0+1

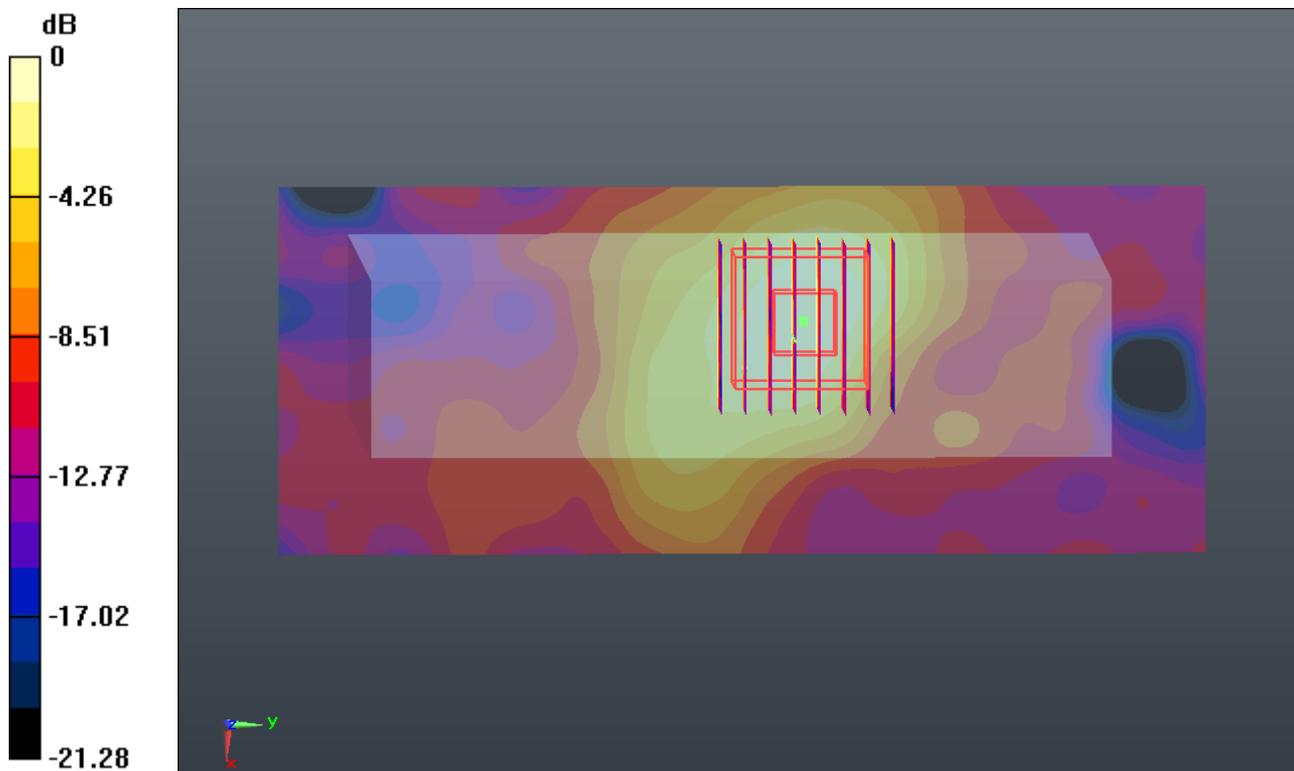
Communication System: WIFI (0); Frequency: 5785 MHz; Duty Cycle: 1:1.11
Medium: MSL_5000_140917 Medium parameters used: $f = 5785$ MHz; $\sigma = 6.11$ mho/m; $\epsilon_r = 47.844$; $\rho = 1000$ kg/m³
Ambient Temperature : 23.2 °C ; Liquid Temperature : 22.8 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3857; ConvF(4.21, 4.21, 4.21); Calibrated: 2014.05.23
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM2; Type: SAM; Serial: TP-1477
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Ch157/Area Scan (61x151x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.517 mW/g

Ch157/Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 5.924 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 0.669 W/kg
SAR(1 g) = 0.251 mW/g; SAR(10 g) = 0.112 mW/g
Maximum value of SAR (measured) = 0.483 mW/g



0 dB = 0.480mW/g



Appendix C. DASYS Calibration Certificate

The DASYS calibration certificates are shown as follows.



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

Accreditation No.: **SCS 108**

Client **Sporton-TW (Auden)**

Certificate No: **D2450V2-924_Nov13**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 924**

Calibration procedure(s) **QA CAL-05.v9
Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **November 13, 2013**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter EPM-442A | GB37480704 | 09-Oct-13 (No. 217-01827) | Oct-14 |
| Power sensor HP 8481A | US37292783 | 09-Oct-13 (No. 217-01827) | Oct-14 |
| Power sensor HP 8481A | MY41092317 | 09-Oct-13 (No. 217-01828) | Oct-14 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 04-Apr-13 (No. 217-01736) | Apr-14 |
| Type-N mismatch combination | SN: 5047.3 / 06327 | 04-Apr-13 (No. 217-01739) | Apr-14 |
| Reference Probe ES3DV3 | SN: 3205 | 28-Dec-12 (No. ES3-3205_Dec12) | Dec-13 |
| DAE4 | SN: 601 | 25-Apr-13 (No. DAE4-601_Apr13) | Apr-14 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| RF generator R&S SMT-06 | 100005 | 04-Aug-99 (in house check Oct-13) | In house check: Oct-15 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-13) | In house check: Oct-14 |

| | Name | Function | Signature |
|----------------|----------------|-----------------------|-----------|
| Calibrated by: | Israe El-Naouq | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: November 13, 2013

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



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

| | | |
|-------------------------------------|------------------------|-------------|
| DASY Version | DASY5 | V52.8.7 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Modular Flat Phantom | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 2450 MHz ± 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 39.2 | 1.80 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 39.7 ± 6 % | 1.84 mho/m ± 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 | 13.2 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 52.4 W/kg ± 17.0 % (k=2) |

| SAR averaged over 10 cm³ (10 g) of Head TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 250 mW input power | 6.08 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 24.2 W/kg ± 16.5 % (k=2) |

Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|-----------------|--------------|------------------|
| Nominal Body TSL parameters | 22.0 °C | 52.7 | 1.95 mho/m |
| Measured Body TSL parameters | (22.0 ± 0.2) °C | 52.1 ± 6 % | 2.02 mho/m ± 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 | 12.8 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 50.2 W/kg ± 17.0 % (k=2) |

| SAR averaged over 10 cm³ (10 g) of Body TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 250 mW input power | 5.92 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 23.4 W/kg ± 16.5 % (k=2) |

Appendix

Antenna Parameters with Head TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 53.1 Ω + 2.6 j Ω |
| Return Loss | - 28.2 dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 49.6 Ω + 4.3 j Ω |
| Return Loss | - 27.3 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.154 ns |
|----------------------------------|----------|

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

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

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

Additional EUT Data

| | |
|-----------------|--------------------|
| Manufactured by | SPEAG |
| Manufactured on | September 26, 2013 |

DASY5 Validation Report for Head TSL

Date: 13.11.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 924

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.84$ S/m; $\epsilon_r = 39.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.52, 4.52, 4.52); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

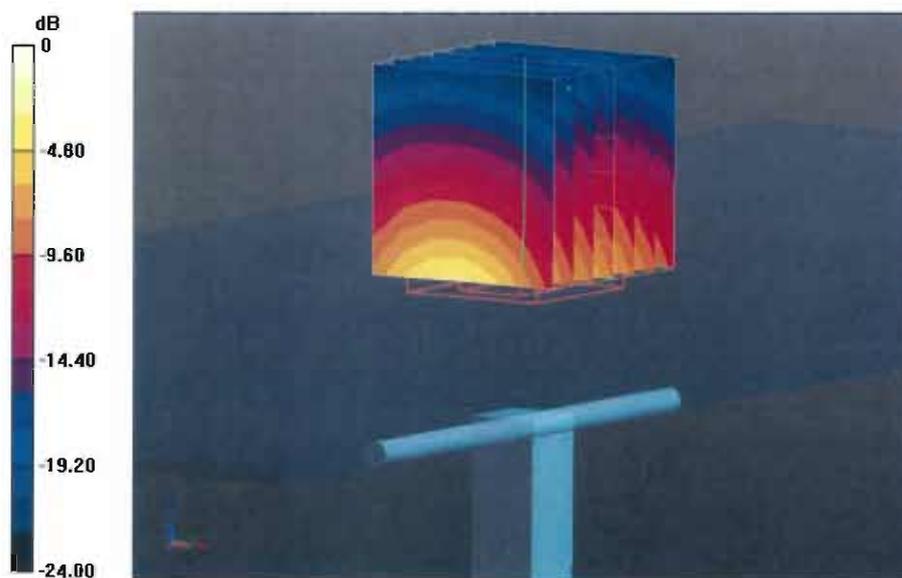
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.75 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 27.5 W/kg

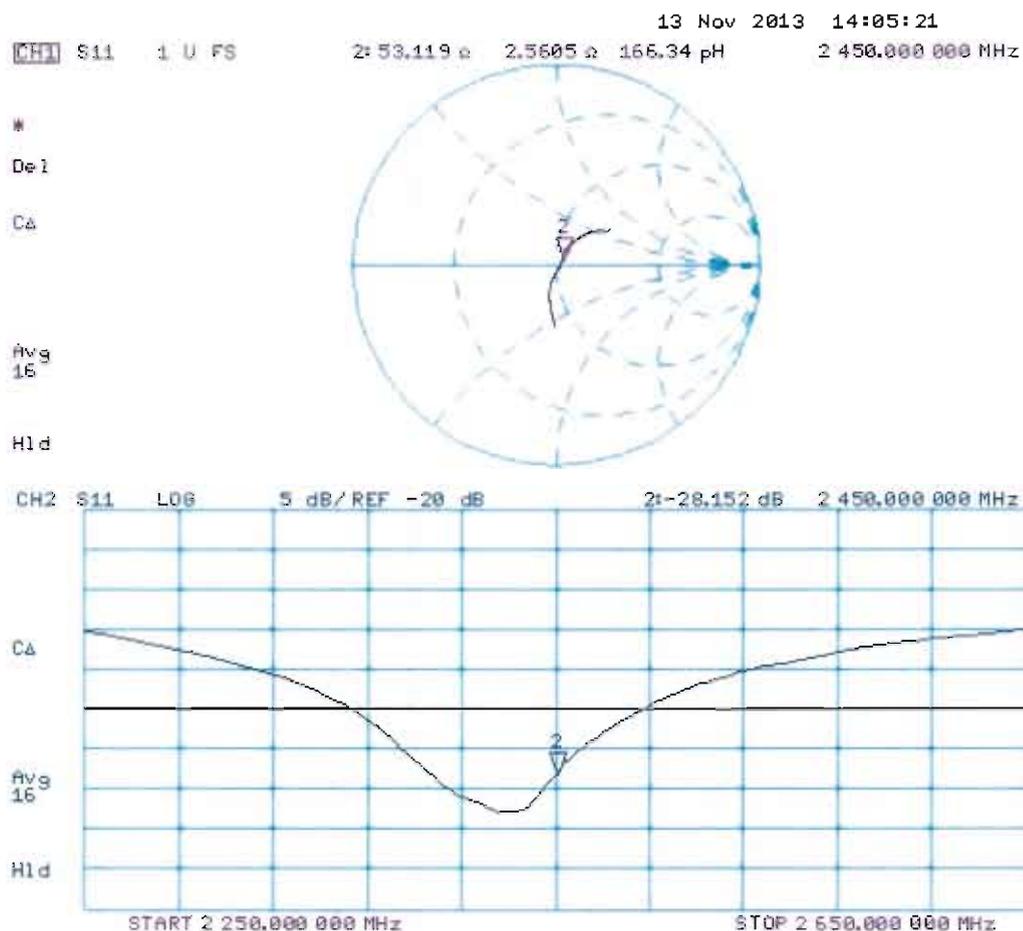
SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.08 W/kg

Maximum value of SAR (measured) = 16.7 W/kg



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

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 13.11.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 924

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.02$ S/m; $\epsilon_r = 52.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.42, 4.42, 4.42); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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 = 93.726 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 26.8 W/kg

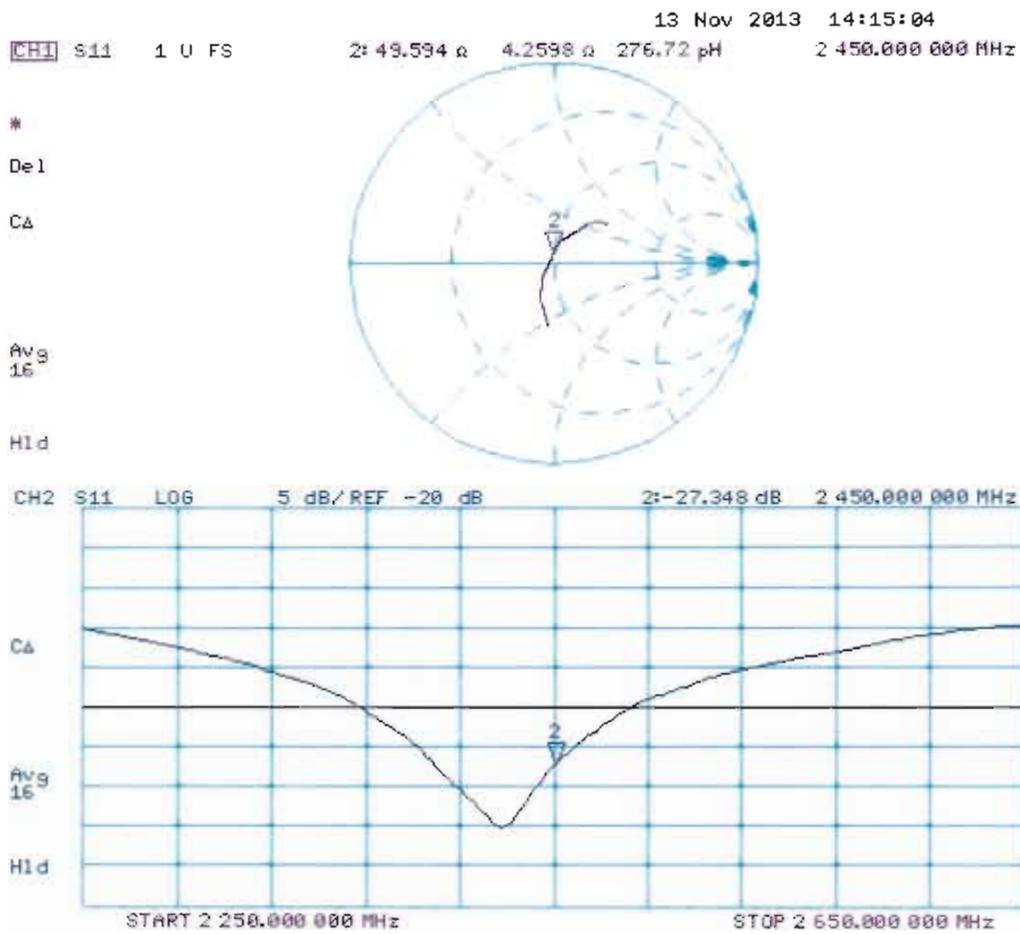
SAR(1 g) = 12.8 W/kg; SAR(10 g) = 5.92 W/kg

Maximum value of SAR (measured) = 16.8 W/kg



0 dB = 16.8 W/kg = 12.25 dBW/kg

Impedance Measurement Plot for Body TSL





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

Accreditation No.: **SCS 108**

Client **Sporton-TW (Auden)**

Certificate No: **D5GHzV2-1006_Sep13**

CALIBRATION CERTIFICATE

Object: **D5GHzV2 - SN: 1006**

Calibration procedure(s): **QA CAL-22.v2
Calibration procedure for dipole validation kits between 3-6 GHz**

Calibration date: **September 23, 2013**

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) | 04-Apr-13 (No. 217-01736) | Apr-14 |
| Type-N mismatch combination | SN: 5047.3 / 06327 | 04-Apr-13 (No. 217-01739) | Apr-14 |
| Reference Probe EX3DV4 | SN: 3503 | 28-Dec-12 (No. EX3-3503_Dec12) | Dec-13 |
| DAE4 | SN: 601 | 25-Apr-13 (No. DAE4-601_Apr13) | Apr-14 |
| 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 |

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

Issued: September 24, 2013

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:

- 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

| | | |
|-------------------------------------|--|----------------------------------|
| DASY Version | DASY5 | V52.8.7 |
| 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 | 35.8 ± 6 % | 4.48 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 | 7.68 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 76.6 W/kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm³ (10 g) of Head TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 2.20 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 21.9 W/kg ± 19.5 % (k=2) |

Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 35.9 | 4.76 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 35.6 ± 6 % | 4.62 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Head TSL at 5300 MHz

| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
|---|--------------------|-----------------------------------|
| SAR measured | 100 mW input power | 8.06 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 80.4 W / kg ± 19.9 % (k=2) |

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

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 35.5 | 5.07 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 35.2 ± 6 % | 4.86 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 | 8.02 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 79.9 W/kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 2.28 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 22.7 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 | 35.0 ± 6 % | 5.07 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 | 7.66 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 76.3 W/kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 2.17 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 21.6 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 | 48.3 ± 6 % | 5.36 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 | 7.17 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 71.5 W/kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 1.99 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 19.8 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 | 48.1 ± 6 % | 5.56 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Body TSL at 5300 MHz

| SAR averaged over 1 cm ³ (1 g) of Body TSL | Condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 7.54 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 75.2 W/kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 2.11 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 | 47.6 ± 6 % | 5.88 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Body TSL at 5600 MHz

| SAR averaged over 1 cm ³ (1 g) of Body TSL | Condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 7.80 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 77.8 W/kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 2.16 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 21.5 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 | 47.3 ± 6 % | 6.17 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 | 7.25 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 72.3 W/kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 2.00 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 19.9 W/kg ± 19.5 % (k=2) |

Appendix

Antenna Parameters with Head TSL at 5200 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 52.5 Ω - 8.7 j Ω |
| Return Loss | - 21.1 dB |

Antenna Parameters with Head TSL at 5300 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 57.1 Ω - 2.8 j Ω |
| Return Loss | - 22.9 dB |

Antenna Parameters with Head TSL at 5600 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 56.6 Ω - 5.6 j Ω |
| Return Loss | - 21.9 dB |

Antenna Parameters with Head TSL at 5800 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 56.2 Ω + 5.1 j Ω |
| Return Loss | - 22.4 dB |

Antenna Parameters with Body TSL at 5200 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 51.8 Ω - 9.3 j Ω |
| Return Loss | - 20.6 dB |

Antenna Parameters with Body TSL at 5300 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 56.0 Ω + 0.5 j Ω |
| Return Loss | - 25.0 dB |

Antenna Parameters with Body TSL at 5600 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 56.6 Ω - 3.7 j Ω |
| Return Loss | - 22.9 dB |

Antenna Parameters with Body TSL at 5800 MHz

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 59.2 Ω + 8.2 j Ω |
| Return Loss | - 18.9 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.200 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 | August 28, 2003 |

DASY5 Validation Report for Head TSL

Date: 23.09.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1006

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

Medium parameters used: $f = 5200$ MHz; $\sigma = 4.48$ S/m; $\epsilon_r = 35.8$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5300$ MHz; $\sigma = 4.62$ S/m; $\epsilon_r = 35.6$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 4.86$ S/m; $\epsilon_r = 35.2$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 5.07$ S/m; $\epsilon_r = 35$; $\rho = 1000$ 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: 28.12.2012, ConvF(5.1, 5.1, 5.1); Calibrated: 28.12.2012, ConvF(4.76, 4.76, 4.76); Calibrated: 28.12.2012, ConvF(4.81, 4.81, 4.81); Calibrated: 28.12.2012;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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 = 63.982 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 27.9 W/kg

SAR(1 g) = 7.68 W/kg; SAR(10 g) = 2.2 W/kg

Maximum value of SAR (measured) = 17.8 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 = 64.816 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 29.8 W/kg

SAR(1 g) = 8.06 W/kg; SAR(10 g) = 2.31 W/kg

Maximum value of SAR (measured) = 19.0 W/kg

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

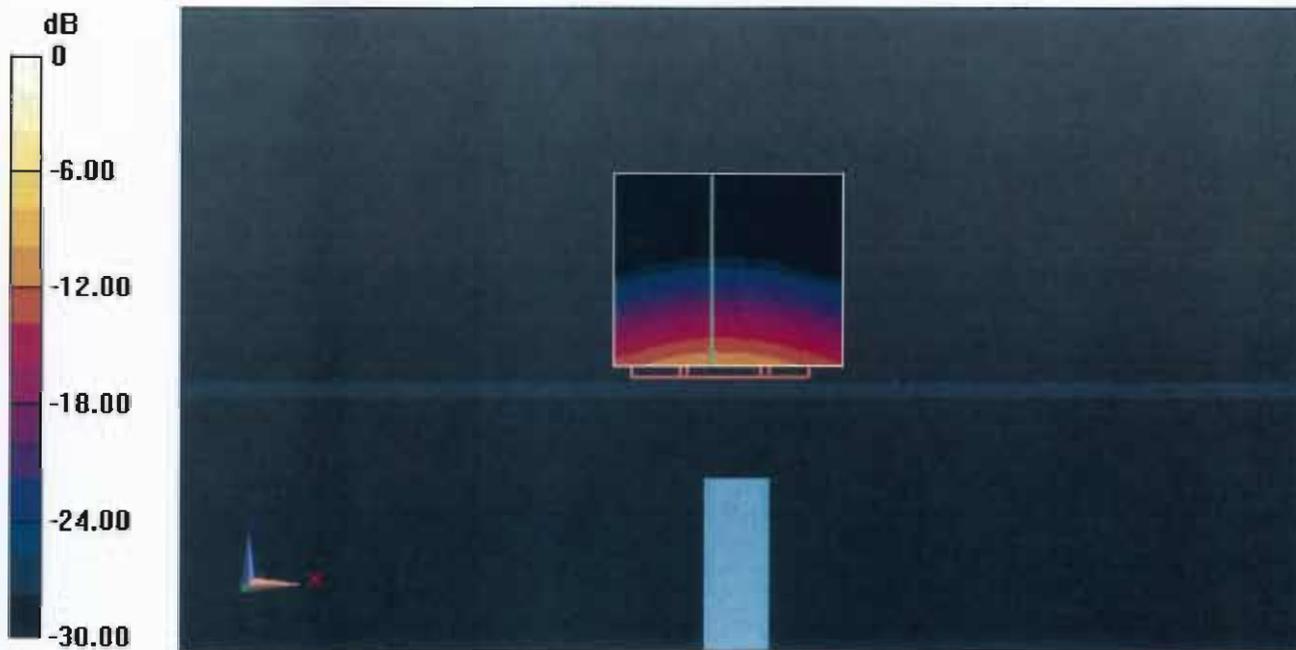
Reference Value = 63.442 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 31.2 W/kg

SAR(1 g) = 8.02 W/kg; SAR(10 g) = 2.28 W/kg

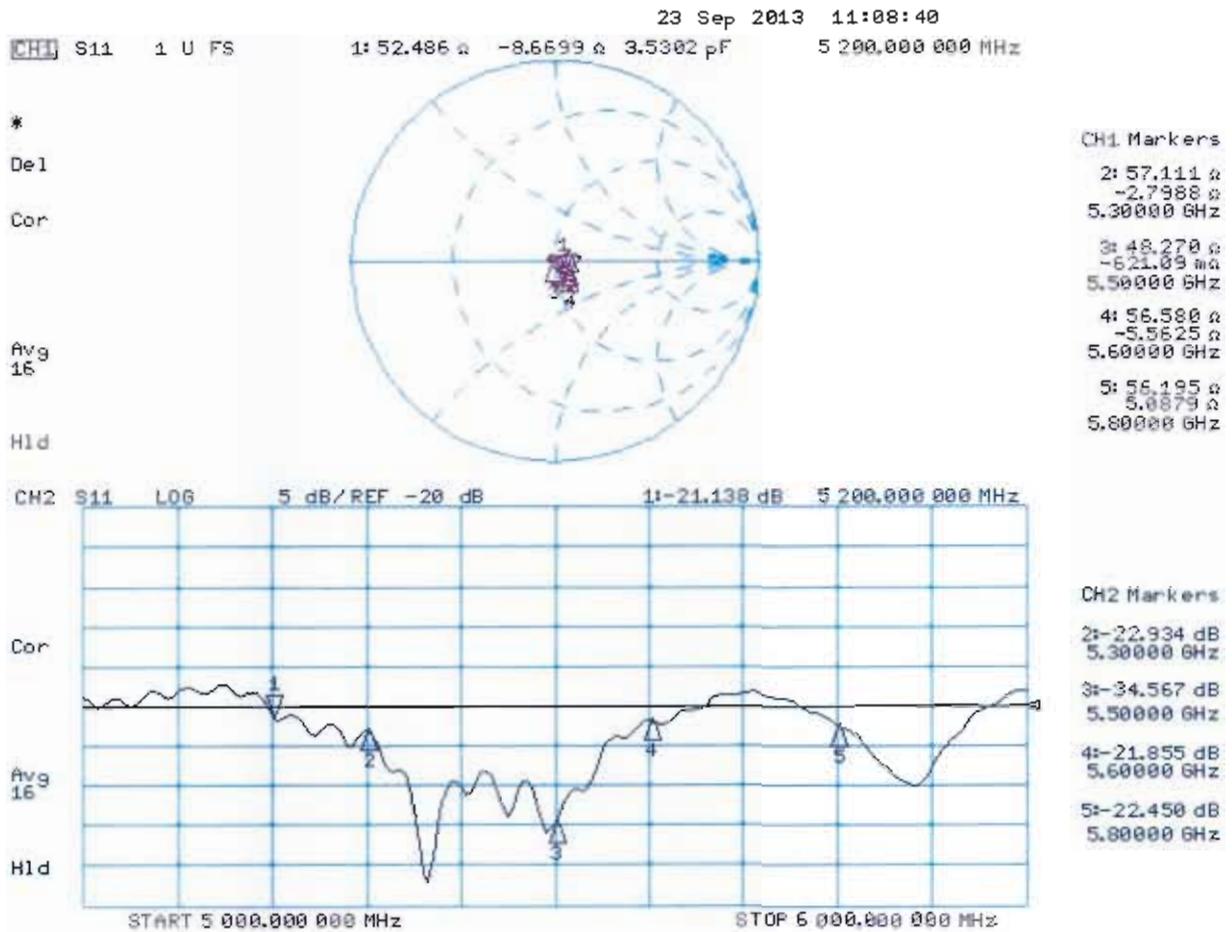
Maximum value of SAR (measured) = 19.3 W/kg

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 = 61.293 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 31.2 W/kg
SAR(1 g) = 7.66 W/kg; SAR(10 g) = 2.17 W/kg
Maximum value of SAR (measured) = 18.7 W/kg



0 dB = 18.7 W/kg = 12.72 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 20.09.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1006

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

Medium parameters used: $f = 5200$ MHz; $\sigma = 5.36$ S/m; $\epsilon_r = 48.3$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5300$ MHz; $\sigma = 5.56$ S/m; $\epsilon_r = 48.1$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 5.88$ S/m; $\epsilon_r = 47.6$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 6.17$ S/m; $\epsilon_r = 47.3$; $\rho = 1000$ 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: 28.12.2012, ConvF(4.67, 4.67, 4.67); Calibrated: 28.12.2012, ConvF(4.22, 4.22, 4.22); Calibrated: 28.12.2012, ConvF(4.38, 4.38, 4.38); Calibrated: 28.12.2012;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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 = 58.601 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 28.0 W/kg

SAR(1 g) = 7.17 W/kg; SAR(10 g) = 1.99 W/kg

Maximum value of SAR (measured) = 17.2 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 = 58.846 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 30.2 W/kg

SAR(1 g) = 7.54 W/kg; SAR(10 g) = 2.11 W/kg

Maximum value of SAR (measured) = 18.3 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

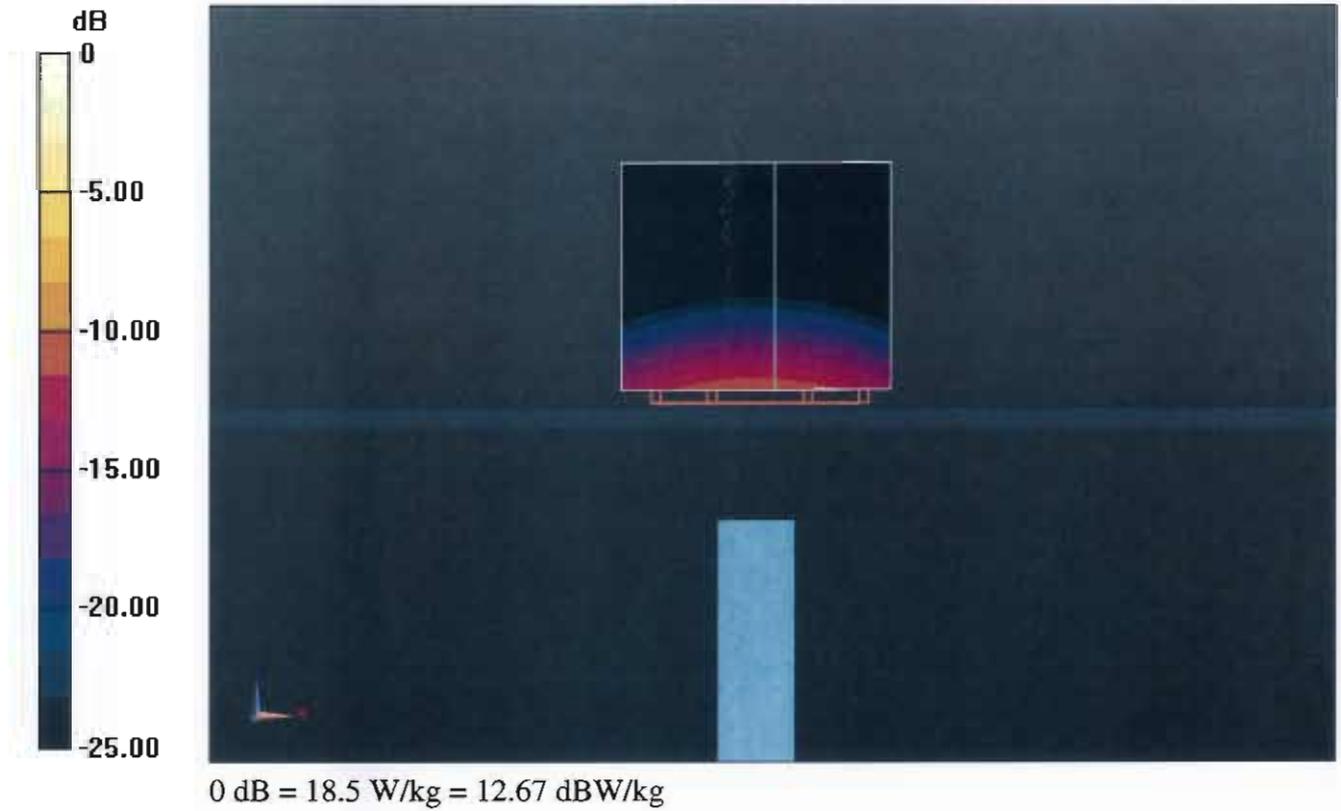
Reference Value = 58.294 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 34.4 W/kg

SAR(1 g) = 7.8 W/kg; SAR(10 g) = 2.16 W/kg

Maximum value of SAR (measured) = 19.6 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 = 54.918 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 33.5 W/kg
SAR(1 g) = 7.25 W/kg; SAR(10 g) = 2 W/kg
Maximum value of SAR (measured) = 18.5 W/kg



Impedance Measurement Plot for Body TSL

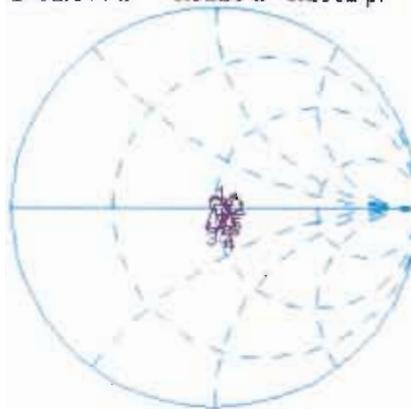
20 Sep 2013 12:15:50

CH1 S11 1 U FS

1: 51.844 Ω -3.3223 Ω 3.2832 pF

5 200.000 000 MHz

De1
Cor
Avg
16
H1 d



CH1 Markers

- 2: 55.957 Ω
- 3: 8.5313 Ω
- 5: 3.0000 GHz
- 3: 48.036 Ω
- 107.42 Ω
- 5: 5.0000 GHz
- 4: 56.619 Ω
- 3.7383 Ω
- 5: 5.6000 GHz
- 5: 59.219 Ω
- 8.2482 Ω
- 5: 5.8000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 1: -20.636 dB 5 200.000 000 MHz

Cor
Avg
16
H1 d



CH2 Markers

- 2: -24.963 dB
- 5: 3.0000 GHz
- 3: -34.184 dB
- 5: 5.5000 GHz
- 4: -22.938 dB
- 5: 5.6000 GHz
- 5: -18.946 dB
- 5: 5.8000 GHz

IMPORTANT NOTICE

USAGE OF THE DAE 4

The DAE unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE. Special attention shall be given to the following points:

Battery Exchange: The battery cover of the DAE4 unit is closed using a screw, over tightening the screw may cause the threads inside the DAE to wear out.

Shipping of the DAE: Before shipping the DAE to SPEAG for calibration, remove the batteries and pack the DAE in an antistatic bag. This antistatic bag shall then be packed into a larger box or container which protects the DAE from impacts during transportation. The package shall be marked to indicate that a fragile instrument is inside.

E-Stop Failures: Touch detection may be malfunctioning due to broken magnets in the E-stop. Rough handling of the E-stop may lead to damage of these magnets. Touch and collision errors are often caused by dust and dirt accumulated in the E-stop. To prevent E-stop failure, the customer shall always mount the probe to the DAE carefully and keep the DAE unit in a non-dusty environment if not used for measurements.

Repair: Minor repairs are performed at no extra cost during the annual calibration. However, SPEAG reserves the right to charge for any repair especially if rough unprofessional handling caused the defect.

DASY Configuration Files: Since the exact values of the DAE input resistances, as measured during the calibration procedure of a DAE unit, are not used by the DASY software, a nominal value of 200 MOhm is given in the corresponding configuration file.

Important Note:

Warranty and calibration is void if the DAE unit is disassembled partly or fully by the Customer.

Important Note:

Never attempt to grease or oil the E-stop assembly. Cleaning and readjusting of the E-stop assembly is allowed by certified SPEAG personnel only and is part of the annual calibration procedure.

Important Note:

To prevent damage of the DAE probe connector pins, use great care when installing the probe to the DAE. Carefully connect the probe with the connector notch oriented in the mating position. Avoid any rotational movement of the probe body versus the DAE while turning the locking nut of the connector. The same care shall be used when disconnecting the probe from the DAE.

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



S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **Sporton-CN (Auden)**

Certificate No: **DAE4-1210_May14**

CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BM - SN: 1210**

Calibration procedure(s) **QA CAL-06.v26
Calibration procedure for the data acquisition electronics (DAE)**

Calibration date: **May 19, 2014**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|-------------------------------|--------------------|----------------------------|------------------------|
| Keithley Multimeter Type 2001 | SN: 0810278 | 01-Oct-13 (No:13976) | Oct-14 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Auto DAE Calibration Unit | SE UWS 053 AA 1001 | 07-Jan-14 (in house check) | In house check: Jan-15 |
| Calibrator Box V2.1 | SE UMS 006 AA 1002 | 07-Jan-14 (in house check) | In house check: Jan-15 |

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

Issued: May 20, 2014

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



Glossary

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

Methods Applied and Interpretation of Parameters

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

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1 μ V, full range = -100...+300 mV

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

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

| Calibration Factors | X | Y | Z |
|---------------------|---------------------------|---------------------------|---------------------------|
| High Range | 404.126 \pm 0.02% (k=2) | 404.956 \pm 0.02% (k=2) | 405.065 \pm 0.02% (k=2) |
| Low Range | 4.00002 \pm 1.50% (k=2) | 3.98327 \pm 1.50% (k=2) | 4.00021 \pm 1.50% (k=2) |

Connector Angle

| | |
|---|-------------------------------------|
| Connector Angle to be used in DASY system | 123.5 $^{\circ}$ \pm 1 $^{\circ}$ |
|---|-------------------------------------|

Appendix

1. DC Voltage Linearity

| High Range | Reading (μV) | Difference (μV) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 199993.16 | -3.08 | -0.00 |
| Channel X + Input | 20001.58 | 0.86 | 0.00 |
| Channel X - Input | -19997.88 | 2.96 | -0.01 |
| Channel Y + Input | 199997.46 | 1.25 | 0.00 |
| Channel Y + Input | 20001.02 | 0.31 | 0.00 |
| Channel Y - Input | -20000.67 | 0.41 | -0.00 |
| Channel Z + Input | 199997.96 | 1.16 | 0.00 |
| Channel Z + Input | 20000.22 | -0.47 | -0.00 |
| Channel Z - Input | -20000.31 | 0.71 | -0.00 |

| Low Range | Reading (μV) | Difference (μV) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 2001.44 | 0.40 | 0.02 |
| Channel X + Input | 201.65 | 0.25 | 0.12 |
| Channel X - Input | -198.86 | -0.60 | 0.30 |
| Channel Y + Input | 2001.05 | 0.10 | 0.01 |
| Channel Y + Input | 200.89 | -0.51 | -0.25 |
| Channel Y - Input | -198.70 | -0.35 | 0.18 |
| Channel Z + Input | 2001.15 | 0.23 | 0.01 |
| Channel Z + Input | 200.32 | -1.08 | -0.54 |
| Channel Z - Input | -199.61 | -1.14 | 0.57 |

2. Common mode sensitivity

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

| | Common mode Input Voltage (mV) | High Range Average Reading (μV) | Low Range Average Reading (μV) |
|-----------|--------------------------------|--|---|
| Channel X | 200 | -5.19 | -7.07 |
| | - 200 | 7.82 | 6.50 |
| Channel Y | 200 | -3.56 | -3.90 |
| | - 200 | 4.19 | 4.35 |
| Channel Z | 200 | 12.21 | 11.95 |
| | - 200 | -14.51 | -14.28 |

3. Channel separation

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

| | Input Voltage (mV) | Channel X (μV) | Channel Y (μV) | Channel Z (μV) |
|-----------|--------------------|-----------------------------|-----------------------------|-----------------------------|
| Channel X | 200 | - | 1.78 | -3.94 |
| Channel Y | 200 | 8.13 | - | 2.67 |
| Channel Z | 200 | 9.14 | 6.43 | - |

4. AD-Converter Values with inputs shorted

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

| | High Range (LSB) | Low Range (LSB) |
|-----------|------------------|-----------------|
| Channel X | 15954 | 15797 |
| Channel Y | 15962 | 16451 |
| Channel Z | 15874 | 16936 |

5. Input Offset Measurement

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

Input 10M Ω

| | Average (μ V) | min. Offset (μ V) | max. Offset (μ V) | Std. Deviation (μ V) |
|-----------|--------------------|------------------------|------------------------|---------------------------|
| Channel X | -0.85 | -1.82 | -0.15 | 0.34 |
| Channel Y | -0.27 | -1.81 | 0.54 | 0.39 |
| Channel Z | -0.30 | -1.29 | 0.94 | 0.43 |

6. Input Offset Current

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

7. Input Resistance (Typical values for information)

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

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

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

9. Power Consumption (Typical values for information)

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

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Accreditation No.: **SCS 108**

Client **Sporton-CN (Auden)**

Certificate No: **EX3-3857_May14**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3857**

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

Calibration date: **May 23, 2014**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^{\circ}\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B | GB41293874 | 03-Apr-14 (No. 217-01911) | Apr-15 |
| Power sensor E4412A | MY41498087 | 03-Apr-14 (No. 217-01911) | Apr-15 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 03-Apr-14 (No. 217-01915) | Apr-15 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 03-Apr-14 (No. 217-01919) | Apr-15 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 03-Apr-14 (No. 217-01920) | Apr-15 |
| Reference Probe ES3DV2 | SN: 3013 | 30-Dec-13 (No. ES3-3013_Dec13) | Dec-14 |
| DAE4 | SN: 660 | 13-Dec-13 (No. DAE4-660_Dec13) | Dec-14 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-13) | In house check: Apr-16 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-13) | In house check: Oct-14 |

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

Issued: May 23, 2014

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Accreditation No.: **SCS 108**

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, D | modulation dependent linearization parameters |
| Polarization φ | φ rotation around probe axis |
| Polarization θ | θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., θ = 0 is normal to probe axis |
| Connector Angle | information used in DASY system to align probe sensor X to the robot coordinate system |

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

- **NORM_{x,y,z}**: Assessed for E-field polarization θ = 0 (f ≤ 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 E²-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}; D_{x,y,z}; VR_{x,y,z}**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- **ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 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.
- **Connector Angle**: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).

Probe EX3DV4

SN:3857

Manufactured: January 23, 2012
Calibrated: May 23, 2014

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3857

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|----------|----------|----------|--------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 0.18 | 0.44 | 0.46 | $\pm 10.1\%$ |
| DCP (mV) ^B | 94.2 | 98.6 | 99.4 | |

Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB $\sqrt{\mu\text{V}}$ | C | D dB | VR mV | Unc ^E (k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 132.0 | $\pm 3.8\%$ |
| | | Y | 0.0 | 0.0 | 1.0 | | 149.4 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 149.1 | |

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

^A The uncertainties of NormX,Y,Z do not affect the E^2 -field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3857

Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha ^G | Depth (mm) ^G | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750 | 41.9 | 0.89 | 9.92 | 9.92 | 9.92 | 0.44 | 0.82 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 9.41 | 9.41 | 9.41 | 0.30 | 1.01 | ± 12.0 % |
| 900 | 41.5 | 0.97 | 9.20 | 9.20 | 9.20 | 0.80 | 0.50 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 8.55 | 8.55 | 8.55 | 0.80 | 0.59 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 8.40 | 8.40 | 8.40 | 0.69 | 0.65 | ± 12.0 % |
| 2000 | 40.0 | 1.40 | 8.31 | 8.31 | 8.31 | 0.77 | 0.56 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 7.48 | 7.48 | 7.48 | 0.78 | 0.58 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 7.30 | 7.30 | 7.30 | 0.42 | 0.87 | ± 12.0 % |
| 5200 | 36.0 | 4.66 | 5.35 | 5.35 | 5.35 | 0.30 | 1.80 | ± 13.1 % |
| 5300 | 35.9 | 4.76 | 5.12 | 5.12 | 5.12 | 0.30 | 1.80 | ± 13.1 % |
| 5500 | 35.6 | 4.96 | 4.99 | 4.99 | 4.99 | 0.35 | 1.80 | ± 13.1 % |
| 5600 | 35.5 | 5.07 | 4.56 | 4.56 | 4.56 | 0.45 | 1.80 | ± 13.1 % |
| 5800 | 35.3 | 5.27 | 4.79 | 4.79 | 4.79 | 0.40 | 1.80 | ± 13.1 % |

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3857

Calibration Parameter Determined in Body Tissue Simulating Media

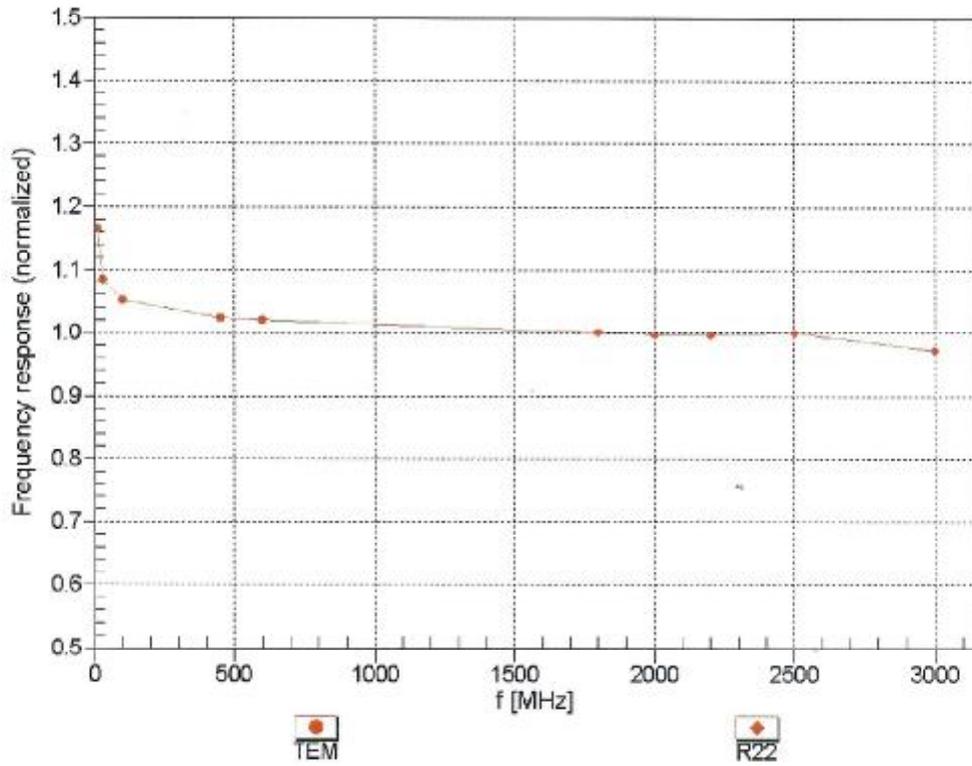
| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha ^G | Depth ^G (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750 | 55.5 | 0.96 | 9.46 | 9.46 | 9.46 | 0.47 | 0.84 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 9.31 | 9.31 | 9.31 | 0.31 | 1.06 | ± 12.0 % |
| 900 | 55.0 | 1.05 | 9.13 | 9.13 | 9.13 | 0.80 | 0.61 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 7.89 | 7.89 | 7.89 | 0.80 | 0.60 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 7.56 | 7.56 | 7.56 | 0.59 | 0.71 | ± 12.0 % |
| 2000 | 53.3 | 1.52 | 7.73 | 7.73 | 7.73 | 0.29 | 1.00 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 7.14 | 7.14 | 7.14 | 0.76 | 0.57 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 6.82 | 6.82 | 6.82 | 0.73 | 0.61 | ± 12.0 % |
| 5200 | 49.0 | 5.30 | 4.54 | 4.54 | 4.54 | 0.40 | 1.90 | ± 13.1 % |
| 5300 | 48.9 | 5.42 | 4.37 | 4.37 | 4.37 | 0.40 | 1.90 | ± 13.1 % |
| 5500 | 48.6 | 5.65 | 4.15 | 4.15 | 4.15 | 0.40 | 1.90 | ± 13.1 % |
| 5600 | 48.5 | 5.77 | 3.98 | 3.98 | 3.98 | 0.40 | 1.90 | ± 13.1 % |
| 5800 | 48.2 | 6.00 | 4.21 | 4.21 | 4.21 | 0.50 | 1.90 | ± 13.1 % |

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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

^G Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-8 GHz at any distance larger than half the probe tip diameter from the boundary.

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

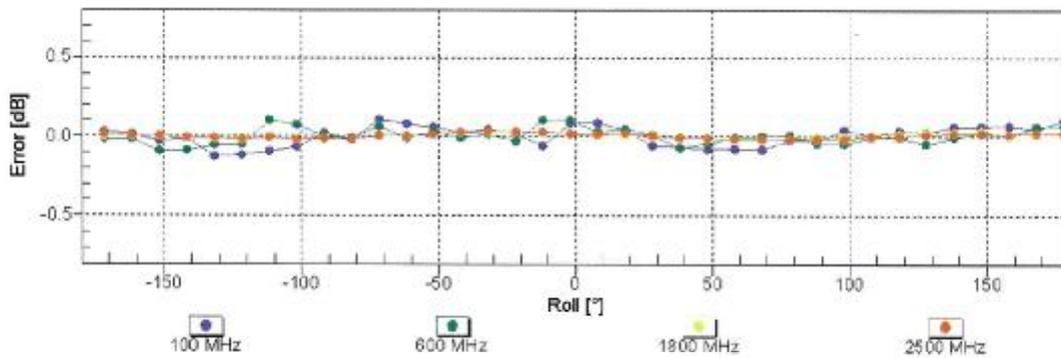
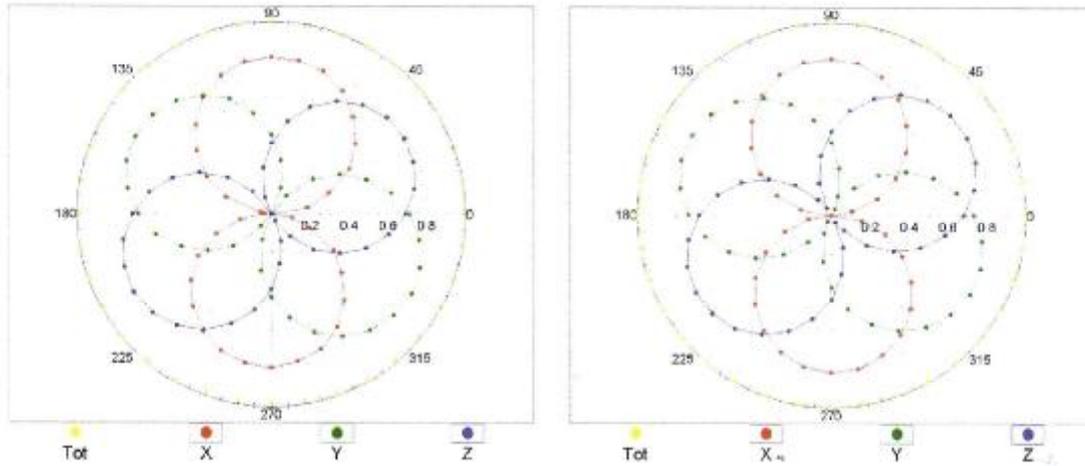


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

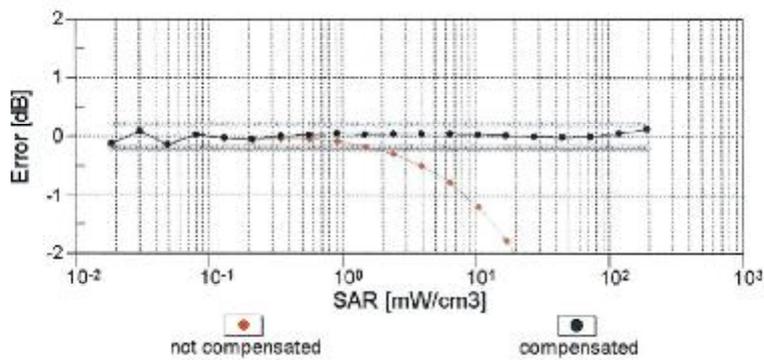
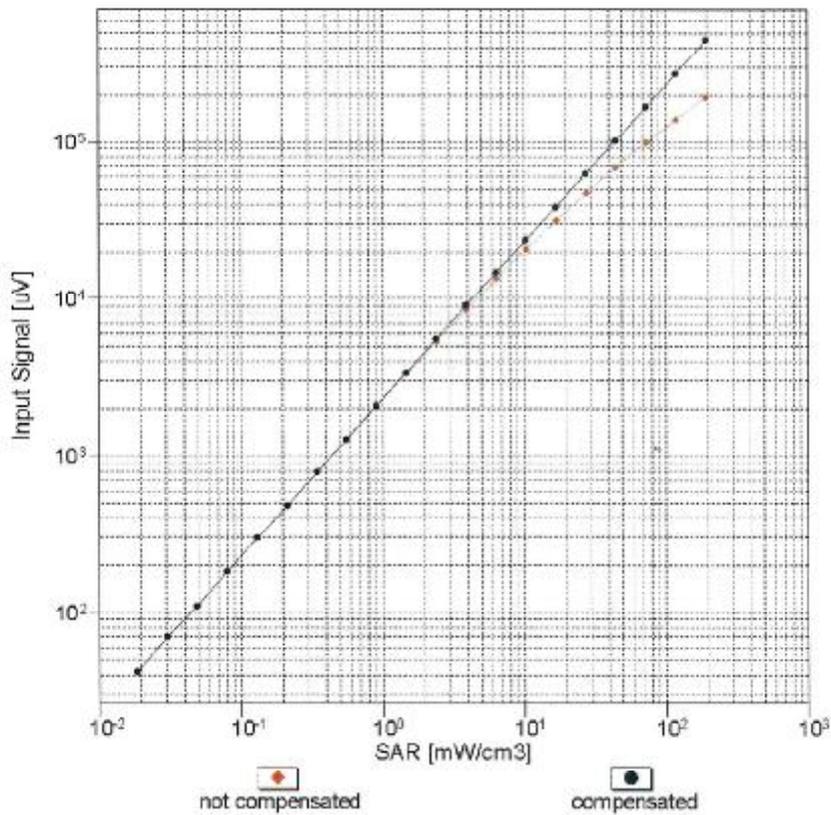
f=600 MHz, TEM

f=1800 MHz, R22



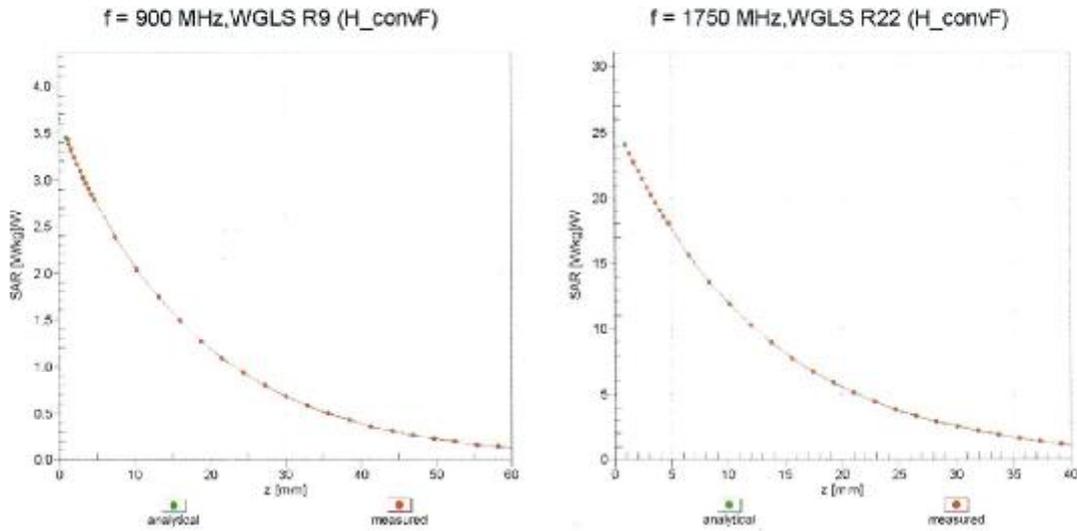
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

Dynamic Range f(SAR_{head}) (TEM cell , f_{eval}= 1900 MHz)

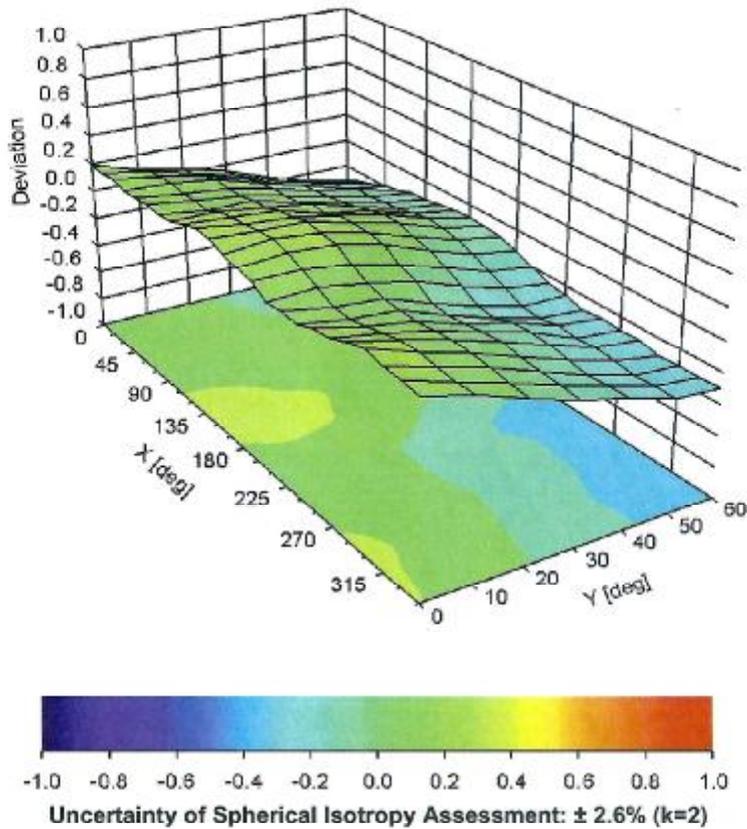


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment



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



DASY/EASY - Parameters of Probe: EX3DV4 - SN:3857**Other Probe Parameters**

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | -41.9 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 9 mm |
| Tip Diameter | 2.5 mm |
| Probe Tip to Sensor X Calibration Point | 1 mm |
| Probe Tip to Sensor Y Calibration Point | 1 mm |
| Probe Tip to Sensor Z Calibration Point | 1 mm |
| Recommended Measurement Distance from Surface | 2 mm |