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# SAR EVALUATION REPORT

**Applicant Name:**
Samsung Electronics, Co. Ltd.
129, Samsung-ro, Maetan Dong,
Yeongtong-gu, Suwon-si,
Gyeonggi-do, 443-742, Republic of Korea

**Date of Testing:**
02/20/13 - 03/04/13
**Test Site/Location:**
PCTEST Lab, Columbia, MD, USA
**Document Serial No.:**
0Y1302280367-R1.A3L

**FCC ID:** **A3LGTN5110**

**APPLICANT:** **SAMSUNG ELECTRONICS, CO. LTD.**

**DUT Type:** Portable Tablet
**Application Type:** Class II Permissive Change
**FCC Rule Part(s):** CFR §2.1093
**Model(s):** GT-N5110
**Serial Number:** R31D20MH56R
**Permissive Change(s):** See FCC Change Document
**Date of Original Certification:** 01/25/2013

| Equipment Class | Band & Mode | Tx Frequency | Measured Conducted Power [dBm] | SAR 1 gm Body (W/kg) |
|---|---|---|---|---|
| DTS | 2.4 GHz WLAN | 2412 - 2462 MHz | 16.21 | 1.08 |
| DTS | Bluetooth LE | 2402 - 2480 MHz | 7.03 | N/A |
| DTS | 5.8 GHz WLAN | 5745 - 5825 MHz | 8.67 | 0.48 |
| UNII | 5.2 GHz WLAN | 5180 - 5240 MHz | 8.23 | 0.15 |
| UNII | 5.3 GHz WLAN | 5260 - 5320 MHz | 8.31 | 0.25 |
| UNII | 5.5 GHz WLAN | 5500 - 5700 MHz | 8.76 | 1.06 |
| DSS | Bluetooth | 2402 - 2480 MHz | 11.25 | 0.15 |

Note: Powers in the above table represent output powers for the SAR test configurations and may not represent the highest output powers for all configurations for each mode.

Note: This revised test report (S/N: 0Y1302280367-R1.A3L) supersedes and replaces the previously issued test report on the same subject DUT for the same type of testing indicated. Please discard or destroy the previously issued test report(s) and dispose of accordingly.

This wireless portable device has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE C95.1-1992 and has been tested in accordance with the measurement procedures specified in Section 1.7 of this report; for North American frequency bands only.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them. Test results reported herein relate only to the item(s) tested.

Randy Ortanez
President

ilac-MRA
ACCREDITED
TESTING LABORATORY
CERTIFICATE #2041.01


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# 1 DEVICE UNDER TEST

## 1.1 Device Overview

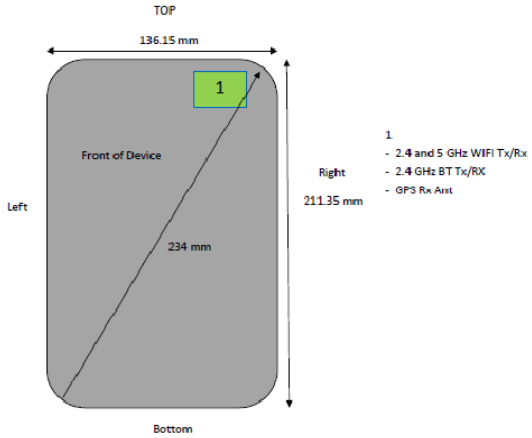
| Band & Mode | Operating Modes | Tx Frequency |
|---|---|---|
| 2.4 GHz WLAN | Data | 2412 - 2462 MHz |
| 5.8 GHz WLAN | Data | 5745 - 5825 MHz |
| 5.2 GHz WLAN | Data | 5180 - 5240 MHz |
| 5.3 GHz WLAN | Data | 5260 - 5320 MHz |
| 5.5 GHz WLAN | Data | 5500 - 5700 MHz |
| Bluetooth | Data | 2402 - 2480 MHz |

## 1.2 Nominal and Maximum Output Power Specifications

This device operates using the following maximum and nominal output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498 D01v05.

| Mode / Band | | Modulated Average (dBm) |
|---|---|---|
| IEEE 802.11b (2.4 GHz) | Maximum | **16.5** |
| | Nominal | **16.0** |
| IEEE 802.11g (2.4 GHz) | Maximum | **12.0** |
| | Nominal | **11.5** |
| IEEE 802.11n (2.4 GHz) | Maximum | **11.0** |
| | Nominal | **10.5** |
| IEEE 802.11a (5 GHz) | Maximum | **9.0** |
| | Nominal | **8.5** |
| IEEE 802.11n (5.2 and 5.3 GHz) | Maximum | **8.5** |
| | Nominal | **8.0** |
| IEEE 802.11n (5.5 and 5.8 GHz) | Maximum | **8.0** |
| | Nominal | **7.5** |
| Bluetooth | Maximum | **11.5** |
| | Nominal | **11.0** |
| Bluetooth LE | Maximum | **7.5** |
| | Nominal | **7.0** |

## 1.3 DUT Antenna Locations




Note: Specific antenna dimensions and separation distances are shown in the antenna distance document.

**Figure 1-1**
**DUT Antenna Locations**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## 1.4 Simultaneous Transmission Capabilities

There are no simultaneous transmission capabilities on this device; therefore, no simultaneous transmission was required to be evaluated.

## 1.5 Power Reduction for SAR

There is no power reduction used for any band/mode implemented in this device for SAR purposes.

## 1.6 SAR Test Exclusions Applied

**WIFI/BT**

2.4 GHz WLAN and 5 GHz WLAN and Bluetooth share the same antenna path and cannot transmit simultaneously.

This device supports 20 MHz and 40 MHz Bandwidths for IEEE 802.11n for 5 GHz WIFI only. IEEE 802.11n was not evaluated for SAR since the average output power of 20 MHz and 40 MHz bandwidths was not more than 0.25 dB higher than the average output power of IEEE 802.11a.

Per FCC KDB 447498 D01 v05, the SAR exclusion threshold for distances <50mm is defined by the following equation:

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

Based on the maximum average conducted power of Bluetooth LE and the antenna to use separation distance, Bluetooth LE SAR was not required; [(6/5)* √2.441] = 1.9 < 3.0.

## 1.7 Guidance Applied

- FCC KDB Publication 616217 D04v01 (Tablet SAR Considerations)
- FCC KDB Publication 248227 D01v01r02 (SAR Considerations for 802.11 Devices)
- FCC KDB Publication 447498 D01v05 (General SAR Guidance)
- FCC KDB Publication 865664 D01-D02 (SAR Measurements up to 6 GHz)


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# 2 INTRODUCTION

The FCC and Industry Canada have adopted the guidelines for evaluating the environmental effects of radio frequency (RF) radiation in ET Docket 93-62 on Aug. 6, 1996 and Health Canada Safety Code 6 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices. [1]

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [3] and Health Canada RF Exposure Guidelines Safety Code 6 [24]. The measurement procedure described in IEEE/ANSI C95.3-2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave [4] is used for guidance in measuring the Specific Absorption Rate (SAR) due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the International Committee for Non-Ionizing Radiation Protection (ICNIRP) in Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," Report No. Vol 74. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

## 2.1 SAR Definition

Specific Absorption Rate is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Equation 2-1).

**Equation 2-1**
**SAR Mathematical Equation**

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

**SAR is expressed in units of Watts per Kilogram (W/kg).**

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

where:

σ = conductivity of the tissue-simulating material (S/m)
ρ = mass density of the tissue-simulating material (kg/m$^3$)
E = Total RMS electric field strength (V/m)

NOTE: The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relation to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.[6]


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# 3 DOSIMETRIC ASSESSMENT

## 3.1 Measurement Procedure

The evaluation was performed using the following procedure:

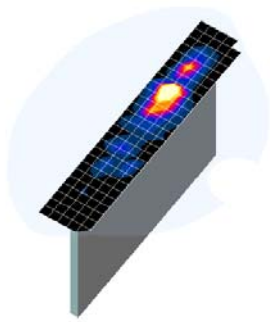

**Figure 3-1**
**Sample SAR Area Scan**

1. The SAR distribution at the exposed side of the head or body was measured at a distance no greater than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the device-head and body interface and the horizontal grid resolution was determined per FCC KDB Publication 865664 D01v01 (See Table 3-1).
2. The point SAR measurement was taken at the maximum SAR region determined from Step 1 to enable the monitoring of SAR fluctuations/drifts during the 1g/10g cube evaluation. SAR at this fixed point was measured and used as a reference value.
3. Based on the area scan data, the peak of the region with maximum SAR was determined by spline interpolation. Around this point, a volume was assessed according to the measurement resolution and volume size requirements of FCC KDB Publication 865664 D01v01 (See Table 3-1). On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the DASY manual online for more details):

   a. The data was extrapolated to the surface of the outer-shell of the phantom. The combined distance extrapolated was the combined distance from the center of the dipoles 2.7mm away from the tip of the probe housing plus the 1.2 mm distance between the surface and the lowest measuring point. The extrapolation was based on a least-squares algorithm. A polynomial of the fourth order was calculated through the points in the z-axis (normal to the phantom shell).

   b. After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1g or 10g) using a 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the "Not a knot" condition (in x, y, and z directions). The volume was then integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were obtained through interpolation, in order to calculate the averaged SAR.

   c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as step 2, was re-measured after the zoom scan was complete to calculate the SAR drift. If the drift deviated by more than 5%, the SAR test and drift measurements were repeated.

**Table 3-1**
**Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01**

| Frequency | Maximum Area Scan Resolution (mm) ($\Delta x_{area}$, $\Delta y_{area}$) | Maximum Zoom Scan Resolution (mm) ($\Delta x_{zoom}$, $\Delta y_{zoom}$) | Maximum Zoom Scan Spatial Resolution (mm) | | | Minimum Zoom Scan Volume (mm) (x,y,z) |
|---|---|---|---|---|---|---|
| | | | Uniform Grid | Graded Grid | | |
| | | | $\Delta z_{zoom}(n)$ | $\Delta z_{zoom}(1)$* | $\Delta z_{zoom}(n>1)$* | |
| ≤ 2 GHz | ≤ 15 | ≤ 8 | ≤ 5 | ≤ 4 | ≤ 1.5*$\Delta z_{zoom}(n-1)$ | ≥ 30 |
| 2-3 GHz | ≤ 12 | ≤ 5 | ≤ 5 | ≤ 4 | ≤ 1.5*$\Delta z_{zoom}(n-1)$ | ≥ 30 |
| 3-4 GHz | ≤ 12 | ≤ 5 | ≤ 4 | ≤ 3 | ≤ 1.5*$\Delta z_{zoom}(n-1)$ | ≥ 28 |
| 4-5 GHz | ≤ 10 | ≤ 4 | ≤ 3 | ≤ 2.5 | ≤ 1.5*$\Delta z_{zoom}(n-1)$ | ≥ 25 |
| 5-6 GHz | ≤ 10 | ≤ 4 | ≤ 2 | ≤ 2 | ≤ 1.5*$\Delta z_{zoom}(n-1)$ | ≥ 22 |


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# 4 RF EXPOSURE LIMITS

## 4.1 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.

## 4.2 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. This 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.

**Table 4-1**
**SAR Human Exposure Specified in ANSI/IEEE C95.1-1992 and Health Canada Safety Code 6**

| HUMAN EXPOSURE LIMITS | | |
|---|---|---|
| | UNCONTROLLED ENVIRONMENT<br>*General Population*<br>(W/kg) or (mW/g) | CONTROLLED ENVIRONMENT<br>*Occupational*<br>(W/kg) or (mW/g) |
| SPATIAL PEAK SAR<br>Brain | 1.6 | 8.0 |
| SPATIAL AVERAGE SAR<br>Whole Body | 0.08 | 0.4 |
| SPATIAL PEAK SAR<br>Hands, Feet, Ankles, Wrists | 4.0 | 20 |

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


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# 5 FCC MEASUREMENT PROCEDURES

## 5.1 Measured and Reported SAR

Per FCC KDB Publication 447498 D01v05, When SAR is not measured at the maximum power level allowed for production units, the results must be scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested to determine compliance. For simultaneous transmission, the measured aggregate SAR must be scaled according to the sum of the differences between the maximum tune-up tolerance and actual power used to test each transmitter. When SAR is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as *reported* SAR. The highest *reported* SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r02.

## 5.2 Procedures Used to Establish RF Signal for SAR

Devices under test were evaluated prior to testing, with a fully charged battery and were configured to operate at maximum output power. In order to verify that the device was tested throughout the SAR test at maximum output power, the SAR measurement system measures a “point SAR” at an arbitrary reference point at the start and end of the 1 gram SAR evaluation, to assess for any power drifts during the evaluation. If the power drift deviated by more than 5%, the SAR test and drift measurements were repeated.

## 5.3 SAR Testing with 802.11 Transmitters

Normal network operating configurations are not suitable for measuring the SAR of 802.11 a/b/g/n transmitters. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure the results are consistent and reliable. See KDB Publication 248227 D01v01r02 for more details.

### 5.3.1 General Device Setup

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.

### 5.3.2 Frequency Channel Configurations [27]

For 2.4 GHz, the highest average RF output power channel between the low, mid and high channel at the lowest data rate was selected for SAR evaluation in 802.11b mode. 802.11g/n modes and higher data rates for 802.11b were additionally evaluated for SAR if the output power of the respective mode was 0.25 dB or higher than the powers of the SAR configurations tested in the 802.11b mode.

For 5 GHz, the highest average RF output power channel across the default test channels at the lowest data rate was selected for SAR evaluation in 802.11a. When the adjacent channels are higher in power then the default channels, these “required channels” were considered instead of the default channels for SAR testing. 802.11n modes and higher data rates for 802.11a/n were evaluated only if the respective mode was 0.25 dB or higher than the 802.11a mode.

If the maximum extrapolated peak SAR of the zoom scan for the highest output channel was less than 1.6 W/kg or if the 1g averaged SAR was less than 0.8 W/kg, SAR testing was not required for the other test channels in the band.


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# 6 TABLET SAR TESTING PROCEDURES

## 6.1 SAR Testing for Tablet per KDB Publication 616217 D04v01

Per FCC KDB 616217, the back surface and edges of the tablet should be tested for SAR compliance with the tablet touching the phantom. The SAR Exclusion Threshold in KDB 447498 D01v05 can be applied to determine SAR test exclusion for adjacent edge configurations. The closest distance from the antenna to an adjacent tablet edge is used to determine if SAR testing is required for the adjacent edges, with the adjacent edge positioned against the phantom and the edge containing the antenna positioned perpendicular to the phantom.

Based on the location and output power of the Bluetooth/WIFI antenna, back side and top and right edges were required to be evaluated for SAR. Front side was not required to be evaluated.


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# 7 RF CONDUCTED POWERS

## 7.1 WLAN/ BT Conducted Powers

**Table 7-1**
**IEEE 802.11b Average RF Power**

| Mode | Freq | Channel | 802.11b (2.4 GHz) Conducted Power [dBm] | | | |
|---|---|---|---|---|---|---|
| | | | Data Rate [Mbps] | | | |
| | [MHz] | | 1 | 2 | 5.5 | 11 |
| 802.11b | 2412 | 1* | 16.08 | 16.07 | 16.11 | 16.17 |
| 802.11b | 2437 | 6* | 16.17 | 16.19 | 16.27 | 16.10 |
| 802.11b | 2462 | 11* | **16.21** | 16.17 | 16.21 | 16.17 |

**Table 7-2**
**IEEE 802.11g Average RF Power**

| Mode | Freq | Channel | 802.11g (2.4 GHz) Conducted Power [dBm] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Data Rate [Mbps] | | | | | | | |
| | [MHz] | | 6 | 9 | 12 | 18 | 24 | 36 | 48 | 54 |
| 802.11g | 2412 | 1 | 11.63 | 11.60 | 11.53 | 11.58 | 11.65 | 11.57 | 11.57 | 11.54 |
| 802.11g | 2437 | 6 | 11.67 | 11.68 | 11.66 | 11.63 | 11.74 | 11.71 | 11.69 | 11.65 |
| 802.11g | 2462 | 11 | 11.75 | 11.66 | 11.73 | 11.75 | 11.74 | 11.66 | 11.71 | 11.67 |

**Table 7-3**
**IEEE 802.11n Average RF Power**

| Mode | Freq | Channel | 802.11n (2.4 GHz) Conducted Power [dBm] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Data Rate [Mbps] | | | | | | | |
| | [MHz] | | 6.5 | 13 | 20 | 26 | 39 | 52 | 58 | 65 |
| 802.11n | 2412 | 1 | 10.42 | 10.34 | 10.45 | 10.37 | 10.37 | 10.38 | 10.42 | 10.36 |
| 802.11n | 2437 | 6 | 10.44 | 10.52 | 10.52 | 10.45 | 10.46 | 10.60 | 10.41 | 10.55 |
| 802.11n | 2462 | 11 | 10.57 | 10.54 | 10.51 | 10.51 | 10.47 | 10.50 | 10.52 | 10.52 |

**Table 7-4**
**IEEE 802.11a Average RF Power**

| Mode | Freq | Channel | 802.11a (5GHz) Conducted Power [dBm] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Data Rate [Mbps] | | | | | | | |
| | [MHz] | | 6 | 9 | 12 | 18 | 24 | 36 | 48 | 54 |
| 802.11a | 5180 | 36* | 8.10 | 8.03 | 7.98 | 8.09 | 7.98 | 8.01 | 7.94 | 7.94 |
| 802.11a | 5200 | 40 | 8.06 | 7.98 | 7.92 | 8.05 | 7.88 | 7.95 | 7.88 | 7.95 |
| 802.11a | 5220 | 44 | 8.15 | 7.99 | 7.96 | 8.09 | 7.92 | 8.00 | 7.95 | 8.02 |
| 802.11a | 5240 | 48* | **8.23** | 8.11 | 8.07 | 8.11 | 8.02 | 8.07 | 8.04 | 8.05 |
| 802.11a | 5260 | 52* | 8.16 | 8.15 | 8.14 | 8.13 | 8.14 | 8.04 | 7.96 | 7.93 |
| 802.11a | 5280 | 56 | 8.22 | 8.21 | 8.20 | 8.11 | 8.13 | 8.08 | 8.01 | 7.98 |
| 802.11a | 5300 | 60 | 8.19 | 8.18 | 8.17 | 8.10 | 8.15 | 8.09 | 7.96 | 8.03 |
| 802.11a | 5320 | 64* | **8.31** | 8.28 | 8.29 | 8.21 | 8.17 | 8.17 | 8.11 | 8.15 |
| 802.11a | 5500 | 100 | 8.23 | 8.24 | 8.17 | 8.10 | 8.04 | 8.14 | 8.04 | 8.02 |
| 802.11a | 5520 | 104* | 8.31 | 8.30 | 8.28 | 8.30 | 8.13 | 8.24 | 8.15 | 8.11 |
| 802.11a | 5540 | 108 | 8.35 | 8.33 | 8.32 | 8.32 | 8.22 | 8.30 | 8.23 | 8.15 |
| 802.11a | 5560 | 112 | 8.42 | 8.36 | 8.35 | 8.40 | 8.32 | 8.38 | 8.33 | 8.26 |
| 802.11a | 5580 | 116* | 8.54 | 8.46 | 8.43 | 8.41 | 8.33 | 8.32 | 8.36 | 8.31 |
| 802.11a | 5600 | 120 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11a | 5620 | 124* | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11a | 5640 | 128 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11a | 5660 | 132 | 8.65 | 8.61 | 8.57 | 8.48 | 8.45 | 8.47 | 8.51 | 8.44 |
| 802.11a | 5680 | 136* | **8.76** | 8.71 | 8.70 | 8.67 | 8.65 | 8.71 | 8.68 | 8.66 |
| 802.11a | 5700 | 140 | 8.75 | 8.71 | 8.68 | 8.71 | 8.61 | 8.66 | 8.65 | 8.64 |
| 802.11a | 5745 | 149* | 8.59 | 8.55 | 8.58 | 8.56 | 8.44 | 8.49 | 8.42 | 8.41 |
| 802.11a | 5765 | 153 | 8.57 | 8.55 | 8.40 | 8.45 | 8.48 | 8.36 | 8.42 | 8.32 |
| 802.11a | 5785 | 157* | 8.62 | 8.51 | 8.50 | 8.44 | 8.50 | 8.51 | 8.53 | 8.50 |
| 802.11a | 5805 | 161* | 8.62 | 8.61 | 8.56 | 8.54 | 8.58 | 8.48 | 8.45 | 8.43 |
| 802.11a | 5825 | 165 | **8.67** | 8.65 | 8.66 | 8.64 | 8.60 | 8.58 | 8.56 | 8.58 |

Per FCC KDB Publication 443999 and RSS-210 A9.2(3), transmission on channels which overlap the 5600-5650 MHz is prohibited as a client. This device does not transmit any beacons or initiate any transmissions in 5.3 and 5.5 GHz Band.

(*) – indicates default channels per KDB Publication 248227 D01v01r02. When the adjacent channels are higher in power then the default channels, these “required channels” are considered for SAR testing instead of the default channels.


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**Table 7-5**
**IEEE 802.11n Average RF Power – 20 MHz Bandwidth**

| Mode | Freq | Channel | 20MHz BW 802.11n (5GHz) Conducted Power [dBm] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Data Rate [Mbps] | | | | | | | |
| | [MHz] | | 6.5 | 13 | 20 | 26 | 39 | 52 | 58 | 65 |
| 802.11n | 5180 | 36 | 8.05 | 8.02 | 8.04 | 7.98 | 8.00 | 8.04 | 7.92 | 7.86 |
| 802.11n | 5200 | 40 | 8.04 | 8.01 | 7.98 | 8.03 | 7.98 | 7.95 | 8.00 | 7.94 |
| 802.11n | 5220 | 44 | 7.92 | 7.87 | 7.89 | 7.78 | 7.91 | 7.81 | 7.79 | 7.78 |
| 802.11n | 5240 | 48 | 7.97 | 7.95 | 7.93 | 7.91 | 7.90 | 7.88 | 7.82 | 7.81 |
| 802.11n | 5260 | 52 | 7.99 | 7.97 | 7.98 | 7.96 | 7.95 | 7.91 | 7.93 | 7.90 |
| 802.11n | 5280 | 56 | 8.02 | 8.01 | 8.00 | 7.96 | 7.98 | 7.92 | 7.91 | 8.01 |
| 802.11n | 5300 | 60 | 8.04 | 8.00 | 7.96 | 7.93 | 8.02 | 7.99 | 7.97 | 7.96 |
| 802.11n | 5320 | 64 | 8.05 | 8.03 | 8.01 | 7.98 | 7.94 | 8.00 | 8.01 | 8.02 |
| 802.11n | 5500 | 100 | 7.55 | 7.54 | 7.51 | 7.49 | 7.50 | 7.48 | 7.45 | 7.49 |
| 802.11n | 5520 | 104 | 7.50 | 7.49 | 7.45 | 7.40 | 7.39 | 7.35 | 7.33 | 7.30 |
| 802.11n | 5540 | 108 | 7.57 | 7.55 | 7.52 | 7.56 | 7.52 | 7.50 | 7.52 | 7.49 |
| 802.11n | 5560 | 112 | 7.61 | 7.59 | 7.48 | 7.54 | 7.50 | 7.55 | 7.53 | 7.52 |
| 802.11n | 5580 | 116 | 7.63 | 7.58 | 7.62 | 7.61 | 7.58 | 7.61 | 7.58 | 7.59 |
| 802.11n | 5600 | 120 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11n | 5620 | 124 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11n | 5640 | 128 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11n | 5660 | 132 | 7.83 | 7.81 | 7.78 | 7.73 | 7.69 | 7.67 | 7.67 | 7.66 |
| 802.11n | 5680 | 136 | 7.90 | 7.89 | 7.86 | 7.85 | 7.81 | 7.80 | 7.74 | 7.72 |
| 802.11n | 5700 | 140 | 7.92 | 7.91 | 7.89 | 7.86 | 7.82 | 7.80 | 7.71 | 7.70 |
| 802.11n | 5745 | 149 | 7.78 | 7.75 | 7.68 | 7.77 | 7.68 | 7.69 | 7.76 | 7.64 |
| 802.11n | 5765 | 153 | 7.76 | 7.71 | 7.74 | 7.74 | 7.69 | 7.70 | 7.68 | 7.65 |
| 802.11n | 5785 | 157 | 7.86 | 7.83 | 7.84 | 7.85 | 7.84 | 7.82 | 7.82 | 7.81 |
| 802.11n | 5805 | 161 | 7.84 | 7.83 | 7.81 | 7.80 | 7.79 | 7.82 | 7.78 | 7.83 |
| 802.11n | 5825 | 165 | 7.93 | 7.91 | 7.89 | 7.87 | 7.87 | 7.86 | 7.81 | 7.73 |

Per FCC KDB Publication 443999 and RSS-210 A9.2(3), transmission on channels which overlap the 5600-5650 MHz is prohibited as a client. This device does not transmit any beacons or initiate any transmissions in 5.3 and 5.5 GHz Band.

**Table 7-6**
**IEEE 802.11n Average RF Power – 40 MHz Bandwidth**

| Mode | Freq | Channel | 40MHz BW 802.11n (5GHz) Conducted Power [dBm] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Data Rate [Mbps] | | | | | | | |
| | [MHz] | | 13.5/15 | 27/30 | 40.5/45 | 54/60 | 81/90 | 108/120 | 121.5/135 | 135/150 |
| 802.11n | 5190 | 38 | 8.17 | 8.15 | 8.13 | 8.11 | 8.05 | 8.09 | 8.08 | 7.96 |
| 802.11n | 5230 | 46 | 8.02 | 8.00 | 8.01 | 7.96 | 7.98 | 8.00 | 7.99 | 8.00 |
| 802.11n | 5270 | 54 | 8.02 | 8.00 | 7.97 | 7.86 | 7.91 | 7.88 | 7.84 | 7.82 |
| 802.11n | 5310 | 62 | 8.04 | 7.97 | 7.98 | 7.90 | 7.92 | 7.89 | 7.88 | 7.87 |
| 802.11n | 5510 | 102 | 7.51 | 7.50 | 7.49 | 7.42 | 7.43 | 7.42 | 7.36 | 7.30 |
| 802.11n | 5550 | 110 | 7.61 | 7.58 | 7.57 | 7.54 | 7.52 | 7.48 | 7.40 | 7.38 |
| 802.11n | 5590 | 118 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11n | 5630 | 126 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11n | 5670 | 134 | 7.92 | 7.87 | 7.86 | 7.81 | 7.73 | 7.74 | 7.74 | 7.73 |
| 802.11n | 5755 | 151 | 7.86 | 7.84 | 7.81 | 7.80 | 7.74 | 7.68 | 7.57 | 7.54 |
| 802.11n | 5795 | 159 | 7.97 | 7.95 | 7.94 | 7.89 | 7.82 | 7.81 | 7.74 | 7.72 |

Per FCC KDB Publication 443999 and RSS-210 A9.2(3), transmission on channels which overlap the 5600-5650 MHz is prohibited as a client. This device does not transmit any beacons or initiate any transmissions in 5.3 and 5.5 GHz Band.

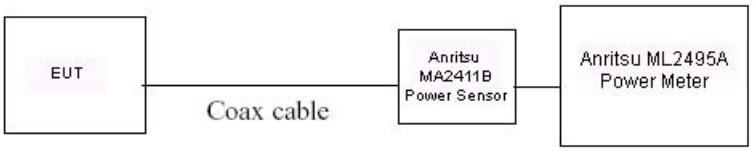


**Figure 7-1**
**Power Measurement Setup**


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**Table 7-7**
**Bluetooth RF Conducted Powers**

| Frequency [MHz] | Data Rate [Mbps] | Channel No. | Peak Conducted Power | | Avg Conducted Power | |
|---|---|---|---|---|---|---|
| | | | [dBm] | [mW] | [dBm] | [mW] |
| 2402 | 1.0 | 0 | 11.34 | 13.614 | **11.25** | **13.323** |
| 2441 | 1.0 | 39 | 11.08 | 12.832 | 10.97 | 12.515 |
| 2480 | 1.0 | 78 | 10.80 | 12.020 | 10.66 | 11.644 |
| 2402 | 2.0 | 0 | 11.05 | 12.732 | 9.10 | 8.124 |
| 2441 | 2.0 | 39 | 11.08 | 12.826 | 8.96 | 7.876 |
| 2480 | 2.0 | 78 | 10.67 | 11.663 | 8.28 | 6.730 |
| 2402 | 3.0 | 0 | 11.45 | 13.967 | 9.17 | 8.264 |
| 2441 | 3.0 | 39 | 11.32 | 13.558 | 9.04 | 8.017 |
| 2480 | 3.0 | 78 | 10.99 | 12.572 | 8.42 | 6.945 |

**Table 7-8**
**Bluetooth LE RF Conducted Powers**

| Frequency [MHz] | Channel No. | Bluetooth Mode | Peak Conducted Power | | Average Conducted Power | |
|---|---|---|---|---|---|---|
| | | | [dBm] | [mW] | [dBm] | [mW] |
| 2402 | 0 | LE | 8.59 | 7.224 | 6.58 | 4.548 |
| 2440 | 19 | LE | 9.04 | 8.019 | 7.03 | 5.048 |
| 2480 | 39 | LE | 8.76 | 7.523 | 6.75 | 4.736 |

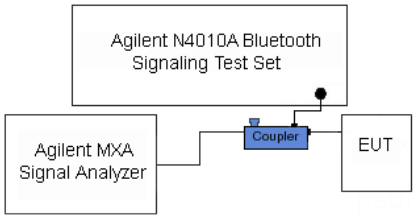


**Figure 7-2**
**Power Measurement Setup**

Justification for reduced test configurations for WIFI channels per KDB Publication 248227 D01v01r02 and April 2010 FCC/TCB Meeting Notes:

- For 2.4 GHz, highest average RF output power channel for the lowest data rate for IEEE 802.11b were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11g/n) 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 IEEE 802.11b mode.
- For 5 GHz, highest average RF output power channel for the lowest data rate for IEEE 802.11a were selected for SAR evaluation. Other IEEE 802.11 modes ((including 802.11n 20 MHz Bandwidth and 802.11n 40 MHz Bandwidth) 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 IEEE 802.11a mode.
- When the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is <1.6 W/kg and the reported 1g averaged SAR is <0.8 W/kg, SAR testing on other channels is not required. Otherwise, the other default (or corresponding required) test channels were additionally tested using the lowest data rate.
- The bolded data rate and channel above were tested for SAR.

Note: Previous Conducted Powers data was found equivalent to the device of FCC ID: A3LGTN5110 (S/N: 0Y1301070043-R2.A3L) with respect to 2.4 GHz WLAN, 5 GHz WLAN and Bluetooth modes.


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# 8 SYSTEM VERIFICATION

## 8.1 Tissue Verification

**Table 8-1**
**Measured Tissue Properties**

| Calibrated for Tests Performed on: | Tissue Type | Tissue Temp During Calibration (C˚) | Measured Frequency (MHz) | Measured Conductivity, σ (S/m) | Measured Dielectric Constant, ε | TARGET Conductivity, σ (S/m) | TARGET Dielectric Constant, ε | % dev σ | % dev ε |
|---|---|---|---|---|---|---|---|---|---|
| 02/20/2013 | 2450B | 24.5 | 2401 | 1.923 | 51.233 | 1.903 | 52.765 | *1.05%* | *-2.90%* |
| | | | 2450 | 1.982 | 51.037 | 1.950 | 52.700 | *1.64%* | *-3.16%* |
| | | | 2499 | 2.055 | 50.823 | 2.019 | 52.638 | *1.78%* | *-3.45%* |
| 03/04/2013 | 2450B | 23.0 | 2401 | 1.915 | 51.521 | 1.903 | 52.765 | *0.63%* | *-2.36%* |
| | | | 2450 | 1.977 | 51.362 | 1.950 | 52.700 | *1.38%* | *-2.54%* |
| | | | 2499 | 2.042 | 51.164 | 2.019 | 52.638 | *1.14%* | *-2.80%* |
| 02/27/2013 | 5200B-5800B | 22.5 | 5200 | 5.346 | 47.63 | 5.299 | 49.014 | *0.89%* | *-2.82%* |
| | | | 5240 | 5.396 | 47.57 | 5.346 | 48.933 | *0.94%* | *-2.79%* |
| | | | 5300 | 5.472 | 47.46 | 5.416 | 48.851 | *1.03%* | *-2.84%* |
| | | | 5320 | 5.494 | 47.43 | 5.439 | 48.607 | *1.01%* | *-2.43%* |
| | | | 5500 | 5.732 | 47.14 | 5.650 | 48.580 | *1.45%* | *-2.97%* |
| | | | 5540 | 5.784 | 47.13 | 5.696 | 48.526 | *1.54%* | *-2.88%* |
| | | | 5580 | 5.854 | 47.03 | 5.743 | 48.471 | *1.93%* | *-2.97%* |
| | | | 5600 | 5.848 | 46.97 | 5.766 | 48.444 | *1.42%* | *-3.03%* |
| | | | 5680 | 5.977 | 46.90 | 5.860 | 48.336 | *2.00%* | *-2.98%* |
| | | | 5745 | 6.069 | 46.78 | 5.936 | 48.248 | *2.24%* | *-3.05%* |
| | | | 5785 | 6.111 | 46.59 | 5.982 | 48.242 | *2.16%* | *-3.43%* |
| | | | 5800 | 6.147 | 46.56 | 6.000 | 48.200 | *2.45%* | *-3.41%* |
| | | | 5825 | 6.192 | 46.61 | 6.029 | 48.132 | *2.70%* | *-3.16%* |

The above measured tissue parameters were used in the DASY software. The DASY software was used to perform interpolation to determine the dielectric parameters at the SAR test device frequencies (per IEEE 1528 6.6.1.2). The tissue parameters listed in the SAR test plots may slightly differ from the table above due to significant digit rounding in the software.


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## 8.2 Test System Verification

Prior to SAR assessment, the system is verified to ±10% of the SAR measurement on the reference dipole at the time of calibration by the calibration facility. Full system validation status and result summary can be found in Appendix E.

**Table 8-2**
**System Verification Results**

| System Verification TARGET & MEASURED | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Tissue Frequency (MHz) | Tissue Type | Date: | Amb. Temp (°C) | Liquid Temp (°C) | Input Power (W) | Dipole SN | Probe SN | Measured $SAR_{1g}$ (W/kg) | 1 W Target $SAR_{1g}$ (W/kg) | 1 W Normalized $SAR_{1g}$ | Deviation (%) |
| 2450 | BODY | 02/20/2013 | 24.2 | 22.9 | 0.040 | 797 | 3263 | 1.980 | 49.600 | 49.500 | -0.20% |
| 2450 | BODY | 03/04/2013 | 23.8 | 22.1 | 0.100 | 719 | 3287 | 4.910 | 51.600 | 49.100 | -4.84% |
| 5200 | BODY | 02/27/2013 | 23.9 | 22.7 | 0.100 | 1057 | 3589 | 7.140 | 75.500 | 71.400 | -5.43% |
| 5300 | BODY | 02/27/2013 | 23.7 | 22.6 | 0.100 | 1057 | 3589 | 7.340 | 75.300 | 73.400 | -2.52% |
| 5500 | BODY | 02/27/2013 | 23.8 | 22.6 | 0.100 | 1057 | 3589 | 7.770 | 80.800 | 77.700 | -3.84% |
| 5600 | BODY | 02/27/2013 | 24.1 | 22.8 | 0.100 | 1057 | 3589 | 8.370 | 80.300 | 83.700 | 4.23% |
| 5800 | BODY | 02/27/2013 | 24.2 | 22.8 | 0.100 | 1057 | 3589 | 7.300 | 75.100 | 73.000 | -2.80% |

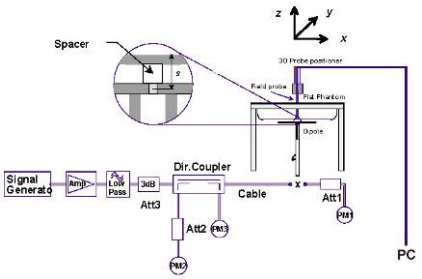


**Figure 8-1**
**System Verification Setup Diagram**

**Figure 8-2**
**System Verification Setup Photo**


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# 9 SAR DATA SUMMARY

## 9.1 Standalone Body SAR Data

**Table 9-1**
**DTS Body SAR**

| MEASUREMENT RESULTS | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FREQUENCY | | Mode | Service | Maximum Allowed Power [dBm] | Conducted Power [dBm] | Power Drift [dB] | Spacing | Data Rate (Mbps) | Side | Duty Cycle | SAR (1g) | Scaling Factor | Scaled SAR (1g) | Plot # |
| MHz | Ch. | | | | | | | | | | (W/kg) | | (W/kg) | |
| 2412 | 1 | IEEE 802.11b | DSSS | 16.5 | 16.08 | 0.06 | 0 mm | 1 | back | 1:1 | 0.982 | 1.102 | **1.082** | A1 |
| 2437 | 6 | IEEE 802.11b | DSSS | 16.5 | 16.17 | -0.01 | 0 mm | 1 | back | 1:1 | 0.928 | 1.079 | 1.001 | |
| 2462 | 11 | IEEE 802.11b | DSSS | 16.5 | 16.21 | 0.02 | 0 mm | 1 | back | 1:1 | 0.961 | 1.069 | 1.027 | |
| 2412 | 1 | IEEE 802.11b | DSSS | 16.5 | 16.08 | -0.02 | 0 mm | 1 | top | 1:1 | 0.978 | 1.102 | 1.077 | |
| 2437 | 6 | IEEE 802.11b | DSSS | 16.5 | 16.17 | -0.02 | 0 mm | 1 | top | 1:1 | 0.888 | 1.079 | 0.958 | |
| 2462 | 11 | IEEE 802.11b | DSSS | 16.5 | 16.21 | 0.04 | 0 mm | 1 | top | 1:1 | 0.768 | 1.069 | 0.821 | |
| 2462 | 11 | IEEE 802.11b | DSSS | 16.5 | 16.21 | -0.04 | 0 mm | 1 | right | 1:1 | 0.389 | 1.069 | 0.416 | |
| 2412 | 1 | IEEE 802.11b | DSSS | 16.5 | 16.08 | -0.03 | 0 mm | 1 | back | 1:1 | 0.902 | 1.102 | 0.994 | |
| 5745 | 149 | IEEE 802.11a | OFDM | 9.0 | 8.59 | 0.02 | 0 mm | 6 | back | 1:1 | 0.432 | 1.099 | 0.475 | A3 |
| 5785 | 157 | IEEE 802.11a | OFDM | 9.0 | 8.62 | 0.01 | 0 mm | 6 | back | 1:1 | 0.393 | 1.091 | 0.429 | |
| 5825 | 165 | IEEE 802.11a | OFDM | 9.0 | 8.67 | 0.19 | 0 mm | 6 | back | 1:1 | 0.409 | 1.079 | 0.441 | |
| 5825 | 165 | IEEE 802.11a | OFDM | 9.0 | 8.67 | -0.04 | 0 mm | 6 | top | 1:1 | 0.136 | 1.079 | 0.147 | |
| 5825 | 165 | IEEE 802.11a | OFDM | 9.0 | 8.67 | 0.00 | 0 mm | 6 | right | 1:1 | 0.000 | 1.079 | 0.000 | |
| **ANSI / IEEE C95.1 1992 - SAFETY LIMIT<br>Spatial Peak<br>Uncontrolled Exposure/General Population** | | | | | | | **Body<br>1.6 W/kg (mW/g)<br>averaged over 1 gram** | | | | | | | |

Note: Blue entries represent repeatability measurements.

**Table 9-2**
**NII Body SAR**

| MEASUREMENT RESULTS | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FREQUENCY | | Mode | Service | Maximum Allowed Power [dBm] | Conducted Power [dBm] | Power Drift [dB] | Spacing | Data Rate (Mbps) | Side | Duty Cycle | SAR (1g) | Scaling Factor | Scaled SAR (1g) | Plot # |
| MHz | Ch. | | | | | | | | | | (W/kg) | | (W/kg) | |
| 5240 | 48 | IEEE 802.11a | OFDM | 9.0 | 8.23 | 0.12 | 0 mm | 6 | back | 1:1 | 0.128 | 1.194 | 0.153 | |
| 5240 | 48 | IEEE 802.11a | OFDM | 9.0 | 8.23 | -0.01 | 0 mm | 6 | top | 1:1 | 0.085 | 1.194 | 0.101 | |
| 5240 | 48 | IEEE 802.11a | OFDM | 9.0 | 8.23 | 0.09 | 0 mm | 6 | right | 1:1 | 0.034 | 1.194 | 0.041 | |
| 5320 | 64 | IEEE 802.11a | OFDM | 9.0 | 8.31 | 0.04 | 0 mm | 6 | back | 1:1 | 0.214 | 1.172 | 0.251 | |
| 5320 | 64 | IEEE 802.11a | OFDM | 9.0 | 8.31 | -0.12 | 0 mm | 6 | top | 1:1 | 0.099 | 1.172 | 0.115 | |
| 5320 | 64 | IEEE 802.11a | OFDM | 9.0 | 8.31 | -0.04 | 0 mm | 6 | right | 1:1 | 0.052 | 1.172 | 0.061 | |
| 5540 | 108 | IEEE 802.11a | OFDM | 9.0 | 8.35 | 0.05 | 0 mm | 6 | back | 1:1 | **0.915** | 1.161 | **1.063** | A4 |
| 5580 | 116 | IEEE 802.11a | OFDM | 9.0 | 8.54 | -0.06 | 0 mm | 6 | back | 1:1 | 0.808 | 1.112 | 0.898 | |
| 5680 | 136 | IEEE 802.11a | OFDM | 9.0 | 8.76 | 0.14 | 0 mm | 6 | back | 1:1 | 0.608 | 1.057 | 0.643 | |
| 5680 | 136 | IEEE 802.11a | OFDM | 9.0 | 8.76 | -0.01 | 0 mm | 6 | top | 1:1 | 0.309 | 1.057 | 0.327 | |
| 5680 | 136 | IEEE 802.11a | OFDM | 9.0 | 8.76 | 0.04 | 0 mm | 6 | right | 1:1 | 0.003 | 1.057 | 0.003 | |
| 5540 | 108 | IEEE 802.11a | OFDM | 9.0 | 8.35 | 0.06 | 0 mm | 6 | back | 1:1 | 0.777 | 1.161 | 0.902 | |
| 5580 | 116 | IEEE 802.11a | OFDM | 9.0 | 8.54 | 0.00 | 0 mm | 6 | back | 1:1 | 0.703 | 1.112 | 0.782 | |
| **ANSI / IEEE C95.1 1992 - SAFETY LIMIT<br>Spatial Peak<br>Uncontrolled Exposure/General Population** | | | | | | | **Body<br>1.6 W/kg (mW/g)<br>averaged over 1 gram** | | | | | | | |

Note: Blue entries represent repeatability measurements.


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**Table 9-3**
**DSS Body SAR**

| MEASUREMENT RESULTS | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FREQUENCY | | Mode | Service | Maximum Allowed Power [dBm] | Conducted Power [dBm] | Power Drift [dB] | Spacing | Data Rate (Mbps) | Side | Duty Cycle | SAR (1g) | Scaling Factor | Scaled SAR (1g) | Plot # |
| MHz | Ch. | | | | | | | | | | (W/kg) | | (W/kg) | |
| 2402 | 0 | Bluetooth | FHSS | 11.5 | 11.25 | -0.05 | 0 mm | 1 | back | 1:1 | **0.143** | 1.059 | **0.151** | A2 |
| 2402 | 0 | Bluetooth | FHSS | 11.5 | 11.25 | -0.01 | 0 mm | 1 | top | 1:1 | 0.130 | 1.059 | 0.138 | |
| 2402 | 0 | Bluetooth | FHSS | 11.5 | 11.25 | 0.16 | 0 mm | 1 | right | 1:1 | 0.059 | 1.059 | 0.063 | |
| **ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population** | | | | | | | **Body 1.6 W/kg (mW/g)** averaged over 1 gram | | | | | | | |

## 9.2 SAR Test Notes

General Notes:

1. The test data reported are the worst-case SAR values according to test procedures specified in FCC KDB Publication 616217 D04.
2. Batteries are fully charged at the beginning of the SAR measurements.
3. Liquid tissue depth was at least 15.0 cm for all frequencies.
4. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
5. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01v05.
6. Per FCC KDB 865664 D01 v01, variability SAR tests were performed when the measured SAR results for a frequency band were greater than 0.8 W/kg. Repeated SAR measurements are highlighted in the tables above for clarity. Please see Section 10 for variability analysis.

BT/ WLAN Notes:

1. Justification for reduced test configurations for WIFI channels per KDB Publication 248227 D01v01r02 and April 2010 FCC/TCB Meeting Notes for 2.4 GHz WIFI: Highest average RF output power channel for the lowest data rate was selected for SAR evaluation in 802.11b. Other IEEE 802.11 modes (including 802.11g/n) 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 IEEE 802.11b mode.
2. Justification for reduced test configurations for WIFI channels per KDB Publication 248227 D01v01r02 and April 2010 FCC/TCB Meeting Notes for 5 GHz WIFI: Highest average RF output power channel for the lowest data rate was selected for SAR evaluation in 802.11a. Other IEEE 802.11 modes (including 802.11n 20 MHz and 40 MHz bandwidths) 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 IEEE 802.11a mode.
3. WIFI transmission was verified using an uncalibrated spectrum analyzer.
4. When the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is >1.6 W/kg or the reported 1g averaged SAR is >0.8 W/kg, SAR testing on other default channels or adjacent required test channels was performed.


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# 10 SAR MEASUREMENT VARIABILITY

## 10.1 Measurement Variability

Per FCC KDB Publication 865664 D01v01, SAR measurement variability was assessed for each frequency band, which was determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. These additional measurements were repeated after the completion of all measurements requiring the same tissue-equivalent medium in a frequency band. The test device was returned to ambient conditions (normal room temperature) with the battery fully charged before it was re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

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

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

**Table 10-1**
**Body SAR Measurement Variability Results**

| BODY VARIABILITY RESULTS | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Band | FREQUENCY | | Mode | Service | Data Rate (Mbps) | Side | Spacing | Measured SAR (1g) | 1st Repeated SAR (1g) | Ratio | 2nd Repeated SAR (1g) | Ratio | 3rd Repeated SAR (1g) | Ratio |
| | MHz | Ch. | | | | | | (W/kg) | (W/kg) | | (W/kg) | | (W/kg) | |
| 2450 | 2412.00 | 1 | IEEE 802.11b | DSSS | 1 | back | 0 mm | 0.982 | 0.902 | 1.09 | N/A | N/A | N/A | N/A |
| 5500 | 5540.00 | 108 | IEEE 802.11a | OFDM | 6 | back | 0 mm | 0.915 | 0.777 | 1.18 | N/A | N/A | N/A | N/A |
| 5600 | 5580.00 | 116 | IEEE 802.11a | OFDM | 6 | back | 0 mm | 0.808 | 0.703 | 1.15 | N/A | N/A | N/A | N/A |
| ANSI / IEEE C95.1 1992 - SAFETY LIMIT<br>Spatial Peak<br>Uncontrolled Exposure/General Population | | | | | | | Body<br>1.6 W/kg (mW/g)<br>averaged over 1 gram | | | | | | | |

## 10.2 Measurement Uncertainty

The measured SAR was <1.5 W/kg for all frequency bands. Therefore, per KDB Publication 865664 D01v01, the extended measurement uncertainty analysis per IEEE 1528-2003 was not required.


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# 11 EQUIPMENT LIST

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|---|---|---|---|---|---|---|
| Gigatronics | 80701A | (0.05-18GHz) Power Sensor | 10/10/2012 | Annual | 10/10/2013 | 1833460 |
| Agilent | E8257D | (250kHz-20GHz) Signal Generator | 4/5/2012 | Annual | 4/5/2013 | MY45470194 |
| Agilent | 8753E | (30kHz-6GHz) Network Analyzer | 4/3/2012 | Annual | 4/3/2013 | US37390350 |
| Agilent | 8753E | (30kHz-6GHz) Network Analyzer | 4/4/2012 | Annual | 4/4/2013 | JP38020182 |
| Agilent | 8594A | (9kHz-2.9GHz) Spectrum Analyzer | N/A | N/A | N/A | 3051A00187 |
| Agilent | 8648D | (9kHz-4GHz) Signal Generator | 10/10/2012 | Annual | 10/10/2013 | 3613A00315 |
| SPEAG | D2450V2 | 2450 MHz SAR Dipole | 8/23/2012 | Annual | 8/23/2013 | 719 |
| SPEAG | D2450V2 | 2450 MHz SAR Dipole | 1/8/2013 | Annual | 1/8/2014 | 797 |
| Narda | 4014C-6 | 4 - 8 GHz SMA 6 dB Directional Coupler | CBT | N/A | CBT | N/A |
| SPEAG | D5GHzV2 | 5 GHz SAR Dipole | 1/11/2013 | Annual | 1/11/2014 | 1057 |
| Amplifier Research | 5S1G4 | 5W, 800MHz-4.2GHz | CBT | N/A | CBT | 21910 |
| MCL | BW-N6W5+ | 6dB Attenuator | CBT | N/A | CBT | 1139 |
| Narda | 4772-3 | Attenuator (3dB) | CBT | N/A | CBT | 9406 |
| Pasternack | PE2208-6 | Bidirectional Coupler | CBT | N/A | CBT | N/A |
| Pasternack | PE2209-10 | Bidirectional Coupler | CBT | N/A | CBT | N/A |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 5/7/2012 | Annual | 5/7/2013 | 1334 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 11/13/2012 | Annual | 11/13/2013 | 1333 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 1/17/2013 | Annual | 1/17/2014 | 1272 |
| Mini-Circuits | BW-N20W5+ | DC to 18 GHz Precision Fixed 20 dB Attenuator | CBT | N/A | CBT | N/A |
| SPEAG | DAK-3.5 | Dielectic Assessment Kit | 6/19/2012 | Annual | 6/19/2013 | 1070 |
| SPEAG | DAK-3.5 | Dielectric Assessment Kit | 12/11/2012 | Annual | 12/11/2013 | 1091 |
| Agilent | 85070E | Dielectric Probe Kit | 2/14/2013 | Annual | 2/14/2014 | MY44300633 |
| Rohde & Schwarz | NRVD | Dual Channel Power Meter | 10/12/2012 | Biennial | 10/12/2014 | 101695 |
| Intelligent Weigh | PD-3000 | Electronic Balance | 3/27/2012 | Annual | 3/27/2013 | 11081534 |
| VWR | 23226-658 | Long Stem Thermometer | 3/30/2012 | Biennial | 3/30/2014 | 122179874 |
| MiniCircuits | SLP-2400+ | Low Pass Filter | CBT | N/A | CBT | R8979500903 |
| MiniCircuits | VLF-6000+ | Low Pass Filter | CBT | N/A | CBT | N/A |
| Mini-Circuits | NLP-1200+ | Low Pass Filter DC to 1000 MHz | CBT | N/A | CBT | N/A |
| Mini-Circuits | NLP-2950+ | Low Pass Filter DC to 2700 MHz | CBT | N/A | CBT | N/A |
| VWR | 62344-925 | Mini-Thermometer | 10/24/2011 | Biennial | 10/24/2013 | 111886430 |
| VWR | 62344-925 | Mini-Thermometer | 10/24/2011 | Biennial | 10/24/2013 | 111886441 |
| Rohde & Schwarz | NRV-Z32 | Peak Power Sensor | 10/12/2012 | Biennial | 10/12/2014 | 836019/013 |
| Mini-Circuits | BW-N20W5 | Power Attenuator | CBT | N/A | CBT | 1226 |
| Anritsu | ML2495A | Power Meter | 10/11/2012 | Annual | 10/11/2013 | 1039008 |
| Anritsu | MA2411B | Power Sensor | 3/5/2012 | Annual | 3/5/2013 | 846215 |
| Anritsu | MA2481A | Power Sensor | 4/5/2012 | Annual | 4/5/2013 | 5605 |
| Anritsu | MA2411B | Pulse Power Sensor | 12/4/2012 | Annual | 12/4/2013 | 1207364 |
| Anritsu | MA2411B | Pulse Power Sensor | 12/5/2012 | Annual | 12/5/2013 | 1126066 |
| Anritsu | MA2411B | Pulse Sensor | 9/19/2012 | Annual | 9/19/2013 | 1027293 |
| Tektronix | RSA-6114A | Real Time Spectrum Analyzer | 4/5/2012 | Annual | 4/5/2013 | B010177 |
| SPEAG | ES3DV3 | SAR Probe | 5/18/2012 | Annual | 5/18/2013 | 3263 |
| SPEAG | ES3DV3 | SAR Probe | 11/15/2012 | Annual | 11/15/2013 | 3287 |
| SPEAG | EX3DV4 | SAR Probe | 1/17/2013 | Annual | 1/17/2014 | 3589 |
| Agilent | 8648D | Signal Generator | 4/3/2012 | Annual | 4/3/2013 | 3629U00687 |
| COMTECH | AR85729-5/5759B | Solid State Amplifier | CBT | N/A | CBT | M3W1A00-1002 |
| Agilent | 85047A | S-Parameter Test Set | N/A | N/A | N/A | 2904A00579 |
| Seekonk | NC-100 | Torque Wrench (8" lb) | 11/29/2011 | Triennial | 11/29/2014 | 21053 |
| Gigatronics | 8651A | Universal Power Meter | 10/10/2012 | Annual | 10/10/2013 | 8650319 |
| Anritsu | MA2481D | Universal Sensor | 12/17/2012 | Annual | 12/17/2013 | 1204419 |
| Anritsu | MA2481D | Universal Sensor | 12/17/2012 | Annual | 12/17/2013 | 1204343 |
| Anritsu | MA24106A | USB Power Sensor | 8/22/2012 | Annual | 8/22/2013 | 1231538 |
| Anritsu | MA24106A | USB Power Sensor | 8/22/2012 | Annual | 8/22/2013 | 1231535 |
| VWR | 36934-158 | Wall-Mounted Thermometer | 9/30/2011 | Biennial | 9/30/2013 | 111859323 |

Note: CBT (Calibrated Before Testing). Prior to testing, the measurement paths containing a cable, amplifier, attenuator, coupler or filter were connected to a calibrated source (i.e. a signal generator) to determine the losses of the measurement path. The power meter offset was then adjusted to compensate for the measurement system losses. This level offset is stored within the power meter before measurements are made. This calibration verification procedure applies to the system verification and output power measurements. The calibrated reading is then taken directly from the power meter after compensation of the losses for all final power measurements.


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# 12 MEASUREMENT UNCERTAINTIES

Applicable for frequencies less than 3000 MHz:

| a | b | c | d | e= f(d,k) | f | g | h = c x f/e | i = c x g/e | k |
|---|---|---|---|---|---|---|---|---|---|
| **Uncertainty Component** | **IEEE 1528 Sec.** | **Tol. (± %)** | **Prob. Dist.** | **Div.** | **$c_i$ 1gm** | **$c_i$ 10 gms** | **1gm $u_i$ (± %)** | **10gms $u_i$ (± %)** | **$v_i$** |
| **Measurement System** | | | | | | | | | |
| Probe Calibration | E.2.1 | 6.0 | N | 1 | 1.0 | 1.0 | 6.0 | 6.0 | ∞ |
| Axial Isotropy | E.2.2 | 0.25 | N | 1 | 0.7 | 0.7 | 0.2 | 0.2 | ∞ |
| Hemishperical Isotropy | E.2.2 | 1.3 | N | 1 | 1.0 | 1.0 | 1.3 | 1.3 | ∞ |
| Boundary Effect | E.2.3 | 0.4 | N | 1 | 1.0 | 1.0 | 0.4 | 0.4 | ∞ |
| Linearity | E.2.4 | 0.3 | N | 1 | 1.0 | 1.0 | 0.3 | 0.3 | ∞ |
| System Detection Limits | E.2.5 | 5.1 | N | 1 | 1.0 | 1.0 | 5.1 | 5.1 | ∞ |
| Readout Electronics | E.2.6 | 1.0 | N | 1 | 1.0 | 1.0 | 1.0 | 1.0 | ∞ |
| Response Time | E.2.7 | 0.8 | R | 1.73 | 1.0 | 1.0 | 0.5 | 0.5 | ∞ |
| Integration Time | E.2.8 | 2.6 | R | 1.73 | 1.0 | 1.0 | 1.5 | 1.5 | ∞ |
| RF Ambient Conditions | E.6.1 | 3.0 | R | 1.73 | 1.0 | 1.0 | 1.7 | 1.7 | ∞ |
| Probe Positioner Mechanical Tolerance | E.6.2 | 0.4 | R | 1.73 | 1.0 | 1.0 | 0.2 | 0.2 | ∞ |
| Probe Positioning w/ respect to Phantom | E.6.3 | 2.9 | R | 1.73 | 1.0 | 1.0 | 1.7 | 1.7 | ∞ |
| Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation | E.5 | 1.0 | R | 1.73 | 1.0 | 1.0 | 0.6 | 0.6 | ∞ |
| **Test Sample Related** | | | | | | | | | |
| Test Sample Positioning | E.4.2 | 6.0 | N | 1 | 1.0 | 1.0 | 6.0 | 6.0 | 287 |
| Device Holder Uncertainty | E.4.1 | 3.32 | R | 1.73 | 1.0 | 1.0 | 1.9 | 1.9 | ∞ |
| Output Power Variation - SAR drift measurement | 6.6.2 | 5.0 | R | 1.73 | 1.0 | 1.0 | 2.9 | 2.9 | ∞ |
| **Phantom & Tissue Parameters** | | | | | | | | | |
| Phantom Uncertainty (Shape & Thickness tolerances) | E.3.1 | 4.0 | R | 1.73 | 1.0 | 1.0 | 2.3 | 2.3 | ∞ |
| Liquid Conductivity - deviation from target values | E.3.2 | 5.0 | R | 1.73 | 0.64 | 0.43 | 1.8 | 1.2 | ∞ |
| Liquid Conductivity - measurement uncertainty | E.3.3 | 3.8 | N | 1 | 0.64 | 0.43 | 2.4 | 1.6 | 6 |
| Liquid Permittivity - deviation from target values | E.3.2 | 5.0 | R | 1.73 | 0.60 | 0.49 | 1.7 | 1.4 | ∞ |
| Liquid Permittivity - measurement uncertainty | E.3.3 | 4.5 | N | 1 | 0.60 | 0.49 | 2.7 | 2.2 | 6 |
| **Combined Standard Uncertainty (k=1)** | | | RSS | | | | 12.1 | 11.7 | 299 |
| **Expanded Uncertainty** (95% CONFIDENCE LEVEL) | | | k=2 | | | | 24.2 | 23.5 | |

The above measurement uncertainties are according to IEEE Std. 1528-2003


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Applicable for frequencies up to 6 GHz:

| a | b | c | d | e= f(d,k) | f | g | h = c x f/e | i = c x g/e | k |
|---|---|---|---|---|---|---|---|---|---|
| **Uncertainty Component** | **IEEE 1528 Sec.** | **Tol. (± %)** | **Prob. Dist.** | **Div.** | **$c_i$ 1gm** | **$c_i$ 10 gms** | **1gm $u_i$ (± %)** | **10gms $u_i$ (± %)** | **$v_i$** |
| **Measurement System** | | | | | | | | | |
| Probe Calibration | E.2.1 | 6.55 | N | 1 | 1.0 | 1.0 | 6.6 | 6.6 | ∞ |
| Axial Isotropy | E.2.2 | 0.25 | N | 1 | 0.7 | 0.7 | 0.2 | 0.2 | ∞ |
| Hemishperical Isotropy | E.2.2 | 1.3 | N | 1 | 1.0 | 1.0 | 1.3 | 1.3 | ∞ |
| Boundary Effect | E.2.3 | 0.4 | N | 1 | 1.0 | 1.0 | 0.4 | 0.4 | ∞ |
| Linearity | E.2.4 | 0.3 | N | 1 | 1.0 | 1.0 | 0.3 | 0.3 | ∞ |
| System Detection Limits | E.2.5 | 5.1 | N | 1 | 1.0 | 1.0 | 5.1 | 5.1 | ∞ |
| Readout Electronics | E.2.6 | 1.0 | N | 1 | 1.0 | 1.0 | 1.0 | 1.0 | ∞ |
| Response Time | E.2.7 | 0.8 | R | 1.73 | 1.0 | 1.0 | 0.5 | 0.5 | ∞ |
| Integration Time | E.2.8 | 2.6 | R | 1.73 | 1.0 | 1.0 | 1.5 | 1.5 | ∞ |
| RF Ambient Conditions | E.6.1 | 3.0 | R | 1.73 | 1.0 | 1.0 | 1.7 | 1.7 | ∞ |
| Probe Positioner Mechanical Tolerance | E.6.2 | 0.4 | R | 1.73 | 1.0 | 1.0 | 0.2 | 0.2 | ∞ |
| Probe Positioning w/ respect to Phantom | E.6.3 | 2.9 | R | 1.73 | 1.0 | 1.0 | 1.7 | 1.7 | ∞ |
| Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation | E.5 | 1.0 | R | 1.73 | 1.0 | 1.0 | 0.6 | 0.6 | ∞ |
| **Test Sample Related** | | | | | | | | | |
| Test Sample Positioning | E.4.2 | 6.0 | N | 1 | 1.0 | 1.0 | 6.0 | 6.0 | 287 |
| Device Holder Uncertainty | E.4.1 | 3.32 | R | 1.73 | 1.0 | 1.0 | 1.9 | 1.9 | ∞ |
| Output Power Variation - SAR drift measurement | 6.6.2 | 5.0 | R | 1.73 | 1.0 | 1.0 | 2.9 | 2.9 | ∞ |
| **Phantom & Tissue Parameters** | | | | | | | | | |
| Phantom Uncertainty (Shape & Thickness tolerances) | E.3.1 | 4.0 | R | 1.73 | 1.0 | 1.0 | 2.3 | 2.3 | ∞ |
| Liquid Conductivity - deviation from target values | E.3.2 | 5.0 | R | 1.73 | 0.64 | 0.43 | 1.8 | 1.2 | ∞ |
| Liquid Conductivity - measurement uncertainty | E.3.3 | 3.8 | N | 1 | 0.64 | 0.43 | 2.4 | 1.6 | 6 |
| Liquid Permittivity - deviation from target values | E.3.2 | 5.0 | R | 1.73 | 0.60 | 0.49 | 1.7 | 1.4 | ∞ |
| Liquid Permittivity - measurement uncertainty | E.3.3 | 4.5 | N | 1 | 0.60 | 0.49 | 2.7 | 2.2 | 6 |
| **Combined Standard Uncertainty (k=1)** | | | RSS | | | | 12.4 | 12.0 | 299 |
| **Expanded Uncertainty** (95% CONFIDENCE LEVEL) | | | k=2 | | | | 24.7 | 24.0 | |

The above measurement uncertainties are according to IEEE Std. 1528-2003


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# 13 CONCLUSION

## 13.1 Measurement Conclusion

The SAR evaluation indicates that the EUT complies with the RF radiation exposure limits of the FCC and Industry Canada, with respect to all parameters subject to this test. These measurements were taken to simulate the RF effects of RF exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The results and statements relate only to the item(s) tested.

Please note that the absorption and distribution of electromagnetic energy in the body are very complex phenomena that depend on the mass, shape, and size of the body, the orientation of the body with respect to the field vectors, and the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because various factors may interact with one another to vary the specific biological outcome of an exposure to electromagnetic fields, any protection guide should consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables. [3]


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# APPENDIX A: SAR TEST DATA

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# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LGTN5110; Type: Portable Tablet; Serial: R31D20MH56R**

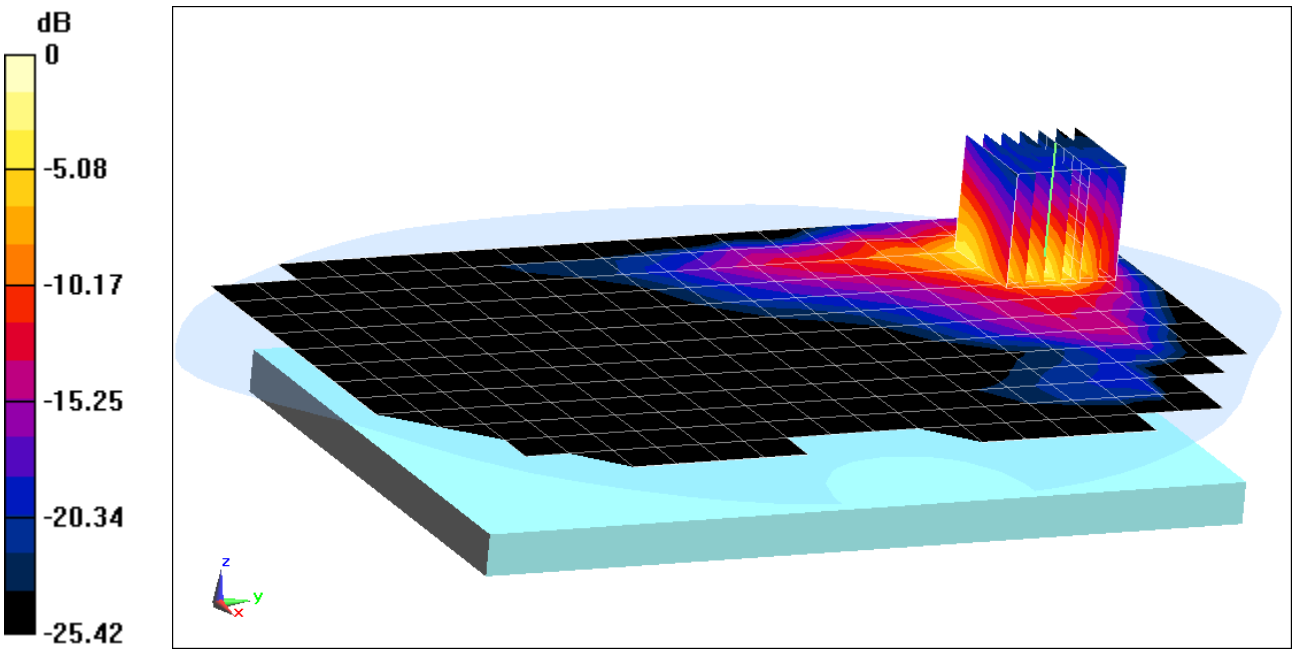
Communication System: IEEE 802.11b; Frequency: 2412 MHz; Duty Cycle: 1:1
Medium: 2450 Body, Medium parameters used (interpolated):
f = 2412 MHz; $\sigma$ = 1.936 S/m; $\varepsilon_r$ = 51.189; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 02-20-2013; Ambient Temp: 24.2°C; Tissue Temp: 22.9°C

Probe: ES3DV3 - SN3263; ConvF(4.35, 4.35, 4.35); Calibrated: 5/18/2012;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1334; Calibrated: 5/7/2012
Phantom: SAM 5.0 front; Type: QD000P40CD; Serial: TP:-1648
Measurement SW: DASY52, Version 52.8 (5); SEMCAD X Version 14.6.8 (7028)

## Mode: IEEE 802.11b, Body SAR, Ch 1, 1 Mbps, Back Side

**Area Scan (14x21x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 24.196 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 3.03 W/kg
**SAR(1 g) = 0.982 W/kg**




0 dB = 1.33 W/kg = 1.24 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LGTN5110; Type: Portable Tablet; Serial: R31D20MH56R**

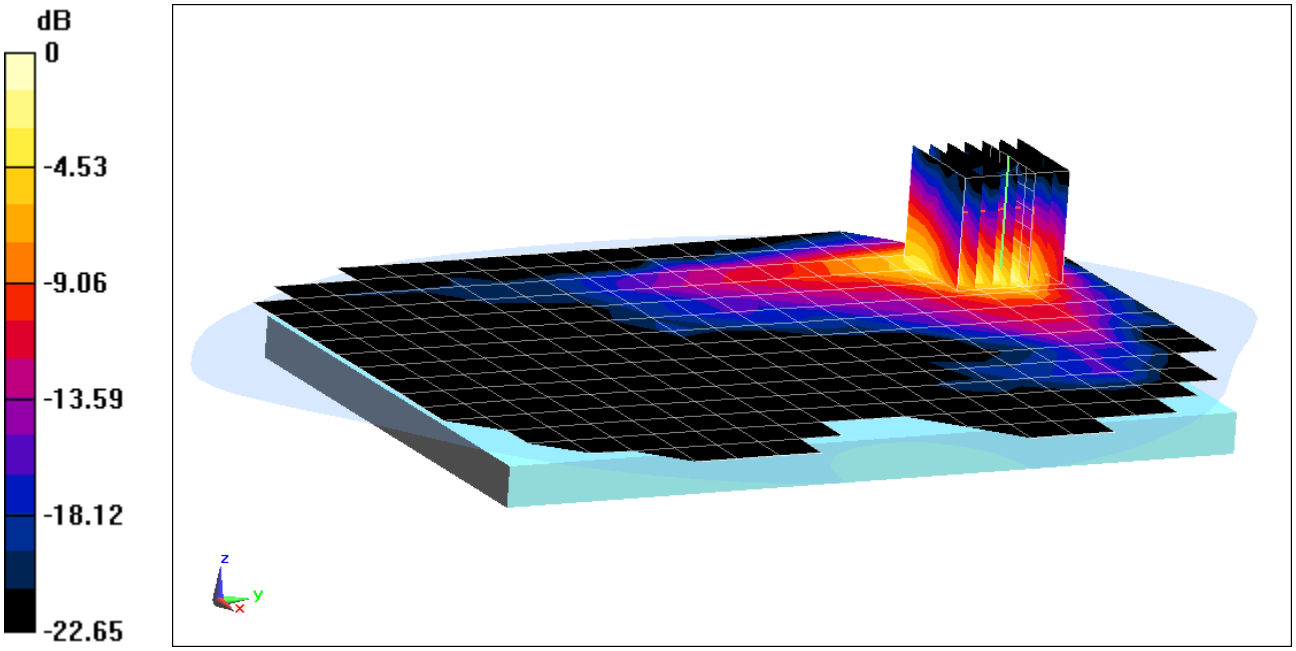
Communication System: Bluetooth; Frequency: 2402 MHz; Duty Cycle: 1:1
Medium: 2450 Body, Medium parameters used (interpolated):
f = 2402 MHz; $\sigma$ = 1.916 S/m; $\varepsilon_r$ = 51.518; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 03-04-2013; Ambient Temp: 23.8°C; Tissue Temp: 22.1°C

Probe: ES3DV3 - SN3287; ConvF(4.29, 4.29, 4.29); Calibrated: 11/15/2012;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1333; Calibrated: 11/13/2012
Phantom: SAM Sub Dasy B; Type: SAM 5.0; Serial: TP-1626
Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.8 (7028)

## Mode: Bluetooth, Body SAR, Ch 0, 1 Mbps, Back Side

**Area Scan (16x20x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 8.110 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 0.467 W/kg
**SAR(1 g) = 0.143 W/kg; SAR(10 g) = 0.061 W/kg**




0 dB = 0.193 W/kg = -7.14 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LGTN5110; Type: Portable Tablet; Serial: R31D20MH56R**

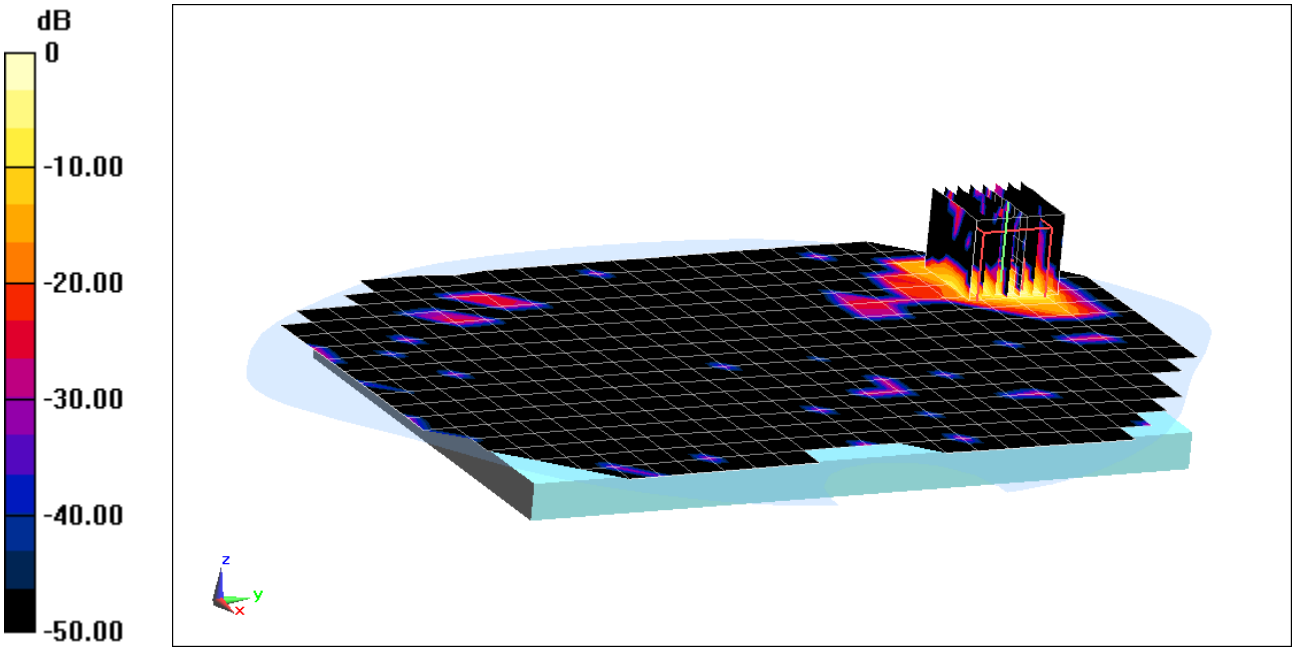
Communication System: IEEE 802.11a 5.2-5.8 GHz Band; Frequency: 5745 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body, Medium parameters used:
f = 5745 MHz; $\sigma$ = 6..069 S/m; $\varepsilon_r$ = 46.775; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 02-27-2013; Ambient Temp: 24.2°C; Tissue Temp: 22.8°C

Probe: EX3DV4 - SN3589; ConvF(3.66, 3.66, 3.66); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357
Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.8 (7028)

## Mode: IEEE 802.11a, 5.8 GHz, Body SAR, Ch 149, 6 Mbps, Back Side

**Area Scan (18x26x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm, Graded Ratio: 1.4
Reference Value = 8.662 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 4.68 W/kg
**SAR(1 g) = 0.432 W/kg**




0 dB = 1.19 W/kg = 0.76 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LGTN5110; Type: Portable Tablet; Serial: R31D20MH56R**

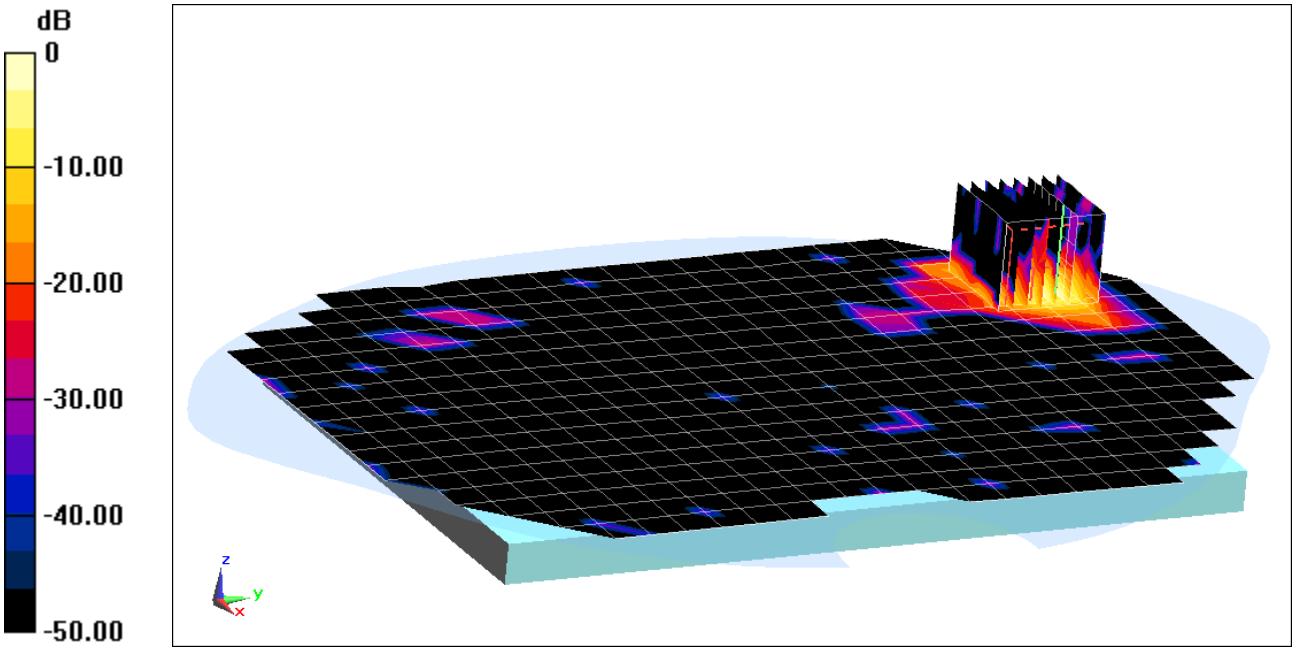
Communication System: IEEE 802.11a 5.2-5.8 GHz Band; Frequency: 5540 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body, Medium parameters used:
f = 5540 MHz; $\sigma$ = 5.784 S/m; $\varepsilon_r$ = 47.129; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 02-27-2013; Ambient Temp: 23.8°C; Tissue Temp: 22.6°C

Probe: EX3DV4 - SN3589; ConvF(3.52, 3.52, 3.52); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357
Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.8 (7028)

## Mode: IEEE 802.11a, 5.5 GHz, Body SAR, Ch 108, 6 Mbps, Back Side

**Area Scan (18x26x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm, Graded Ratio: 1.4
Reference Value = 11.096 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 6.15 W/kg
**SAR(1 g) = 0.915 W/kg; SAR(10 g) = 0.189 W/kg**




0 dB = 2.49 W/kg = 3.96 dBW/kg

# APPENDIX B: SYSTEM VERIFICATION

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# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 797**

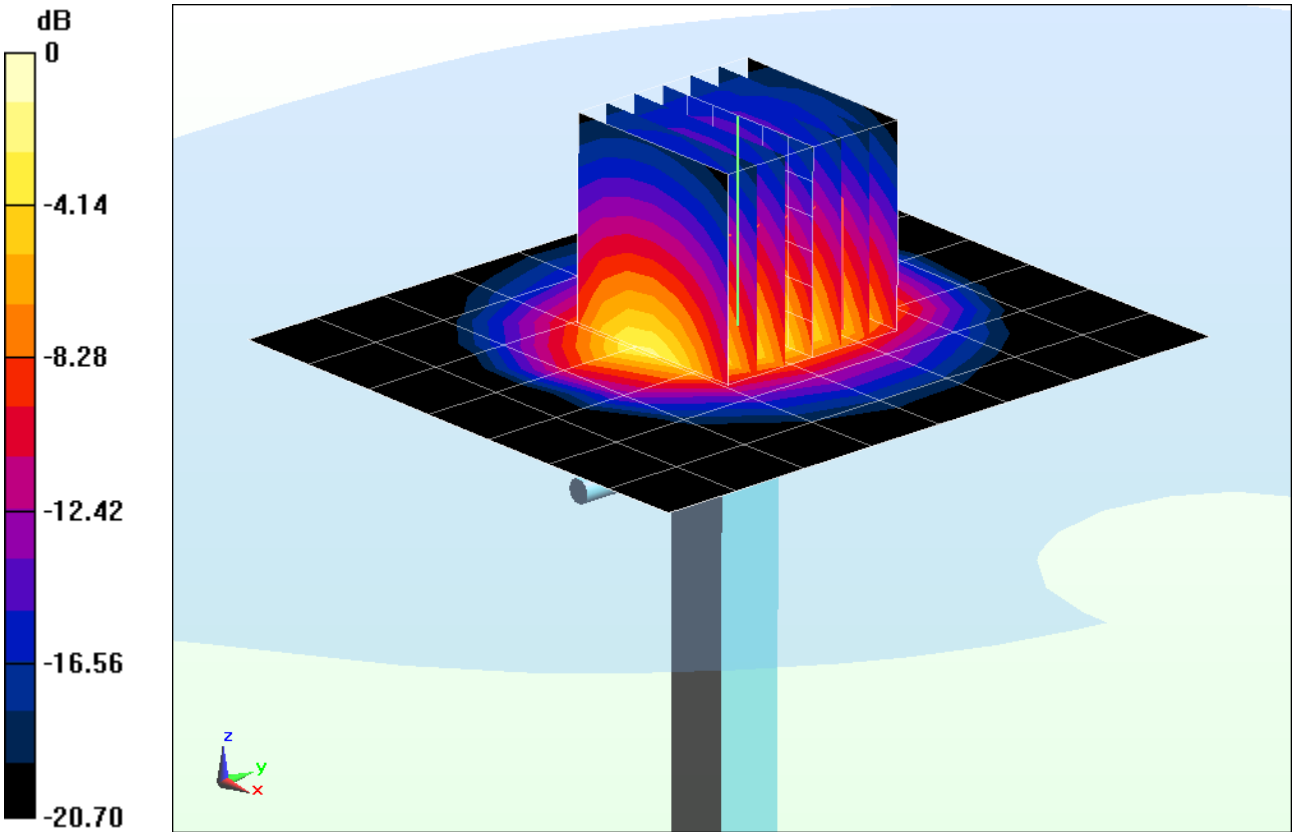
Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: 2450 Body; Medium parameters used:
f = 2450 MHz; $\sigma$ = 1.982 S/m; $\varepsilon_r$ = 51.037; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-20-2013; Ambient Temp: 24.2°C; Tissue Temp: 22.9°C

Probe: ES3DV3 - SN3263; ConvF(4.35, 4.35, 4.35); Calibrated: 5/18/2012;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1334; Calibrated: 5/7/2012
Phantom: SAM 5.0 front; Type: QD000P40CD; Serial: TP:-1648
Measurement SW: DASY52, Version 52.8 (5);SEMCAD X Version 14.6.8 (7028)

## 2450 MHz System Verification

**Area Scan (8x9x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Input Power = 16.0 dBm (40 mW)
Peak SAR (extrapolated) = 4.06 W/kg
**SAR(1 g) = 1.98 W/kg; SAR(10 g) = 0.929 W/kg**
Deviation = -0.20%




0 dB = 2.58 W/kg = 4.12 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: SAR Dipole 2450 MHz; Type: D2450V2; Serial: 719**

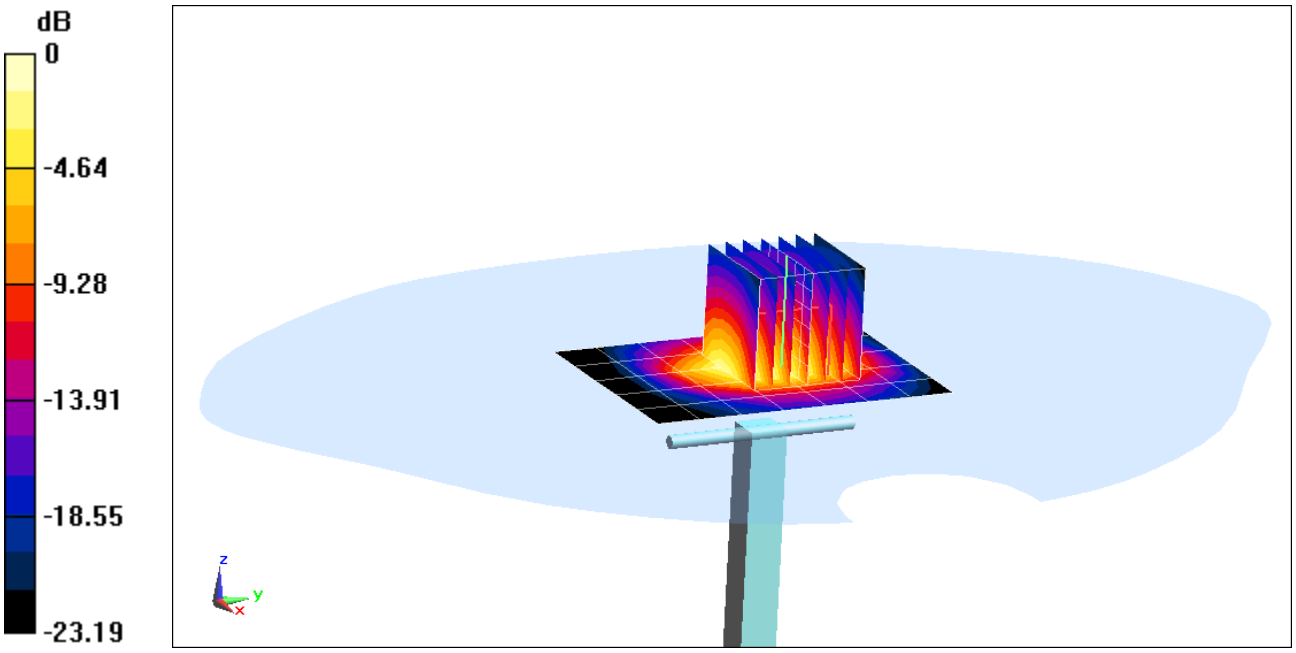
Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: 2450 Body, Medium parameters used:
f = 2450 MHz; $\sigma$ = 1.977 S/m; $\varepsilon_r$ = 51.362; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 03-04-2013; Ambient Temp: 23.8°C; Tissue Temp: 22.1°C

Probe: ES3DV3 - SN3287; ConvF(4.29, 4.29, 4.29); Calibrated: 11/15/2012;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1333; Calibrated: 11/13/2012
Phantom: SAM Sub Dasy B; Type: SAM 5.0; Serial: TP-1626
Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.8 (7028)

## 2450 MHz System Verification

**Area Scan (6x8x1):** Measurement grid: dx=12mm, dy=12mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 10.7 W/kg
**SAR(1 g) = 4.91 W/kg; SAR(10 g) = 2.25 W/kg**
Deviation = -4.84%




0 dB = 6.17 W/kg = 7.90 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5200 MHz; Type: D5GHzV2; Serial: 1057**

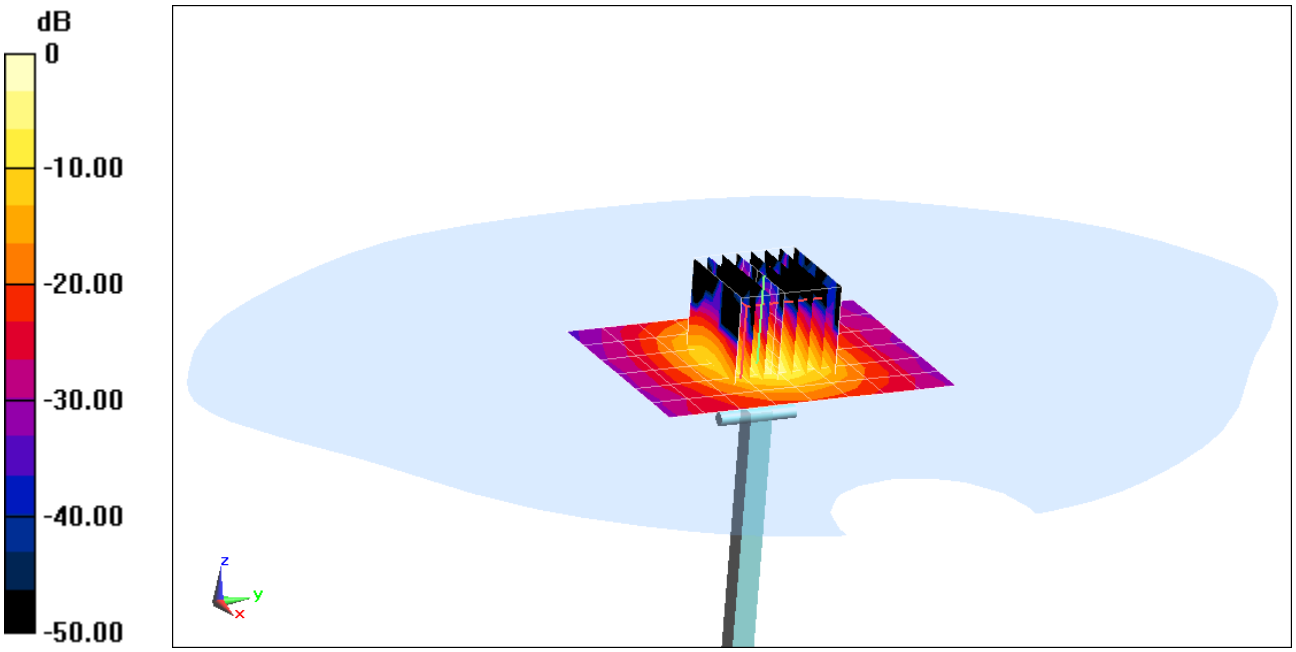
Communication System: CW; Frequency: 5200 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body, Medium parameters used:
f = 5200 MHz; $\sigma$ = 5.346 S/m; $\varepsilon_r$ = 47.63; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-27-2013; Ambient Temp: 23.9°C; Tissue Temp: 22.7°C

Probe: EX3DV4 - SN3589; ConvF(3.99, 3.99, 3.99); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357
Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.8 (7028)

## 5200 MHz System Verification

**Area Scan (7x9x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm, Graded Ratio: 1.4
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 32.1 W/kg
**SAR(1 g) = 7.14 W/kg; SAR(10 g) = 1.99 W/kg**
Deviation = -5.43%




0 dB = 16.1 W/kg = 12.07 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5300 MHz; Type: D5GHzV2; Serial: 1057**

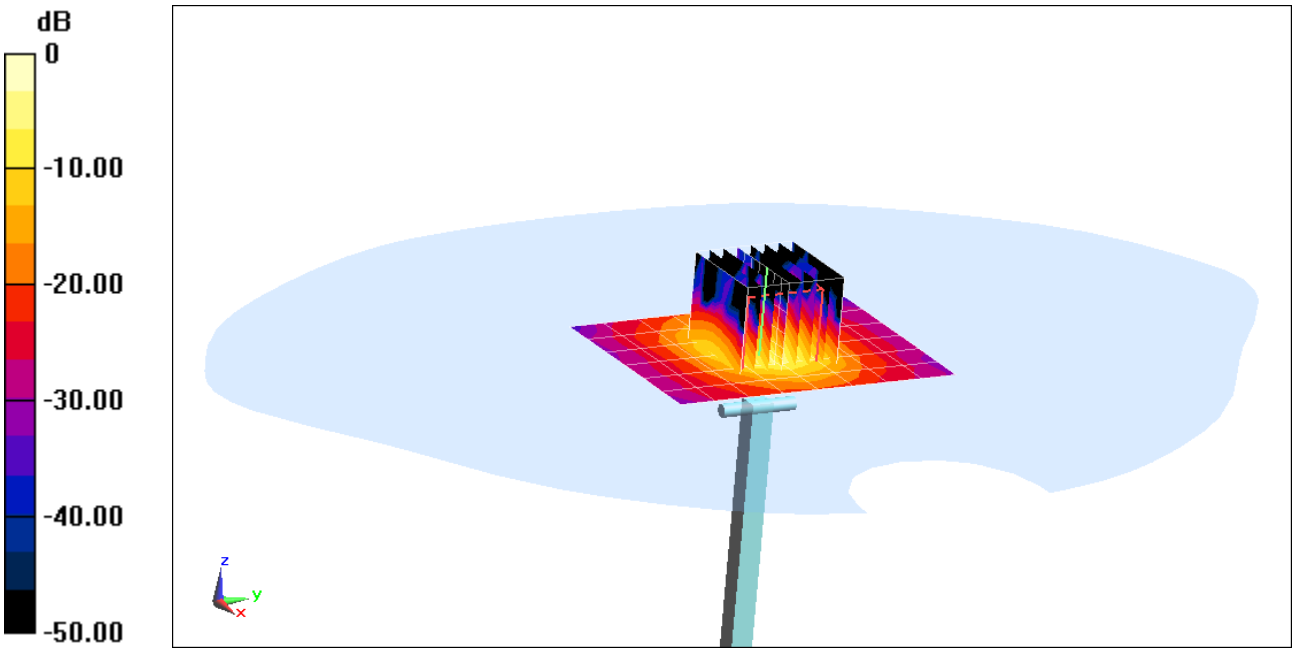
Communication System: CW; Frequency: 5300 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body, Medium parameters used:
f = 5300 MHz; $\sigma$ = 5.472 S/m; $\varepsilon_r$ = 47.464; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-27-2013; Ambient Temp: 23.7°C; Tissue Temp: 22.6°C

Probe: EX3DV4 - SN3589; ConvF(3.81, 3.81, 3.81); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357
Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.8 (7028)

## 5300 MHz System Verification

**Area Scan (7x9x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm, Graded Ratio: 1.4
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 34.0 W/kg
**SAR(1 g) = 7.34 W/kg; SAR(10 g) = 2.02 W/kg**
Deviation = -2.52%




0 dB = 16.9 W/kg = 12.28 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5500 MHz; Type: D5GHzV2; Serial: 1057**

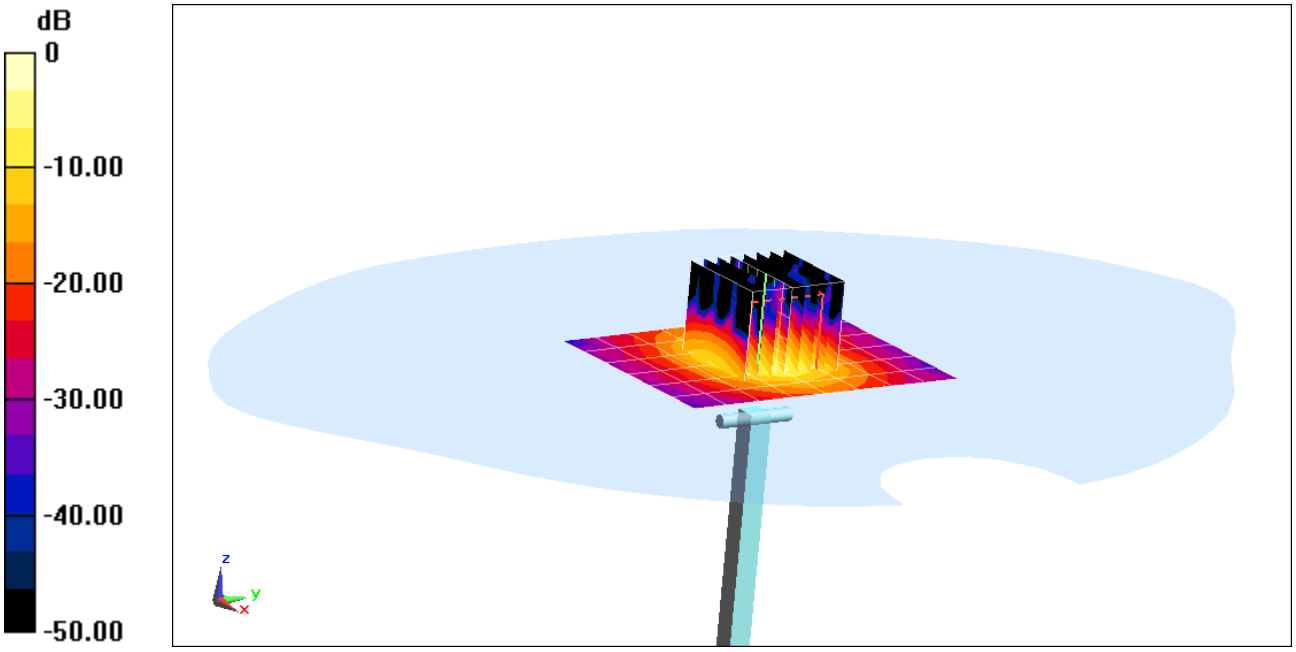
Communication System: CW; Frequency: 5500 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body, Medium parameters used:
f = 5500 MHz; $\sigma$ = 5.732 S/m; $\varepsilon_r$ = 47.135; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-27-2013; Ambient Temp: 23.8°C; Tissue Temp: 22.6°C

Probe: EX3DV4 - SN3589; ConvF(3.52, 3.52, 3.52); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357
Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.8 (7028)

## 5500 MHz System Verification

**Area Scan (7x9x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm,Graded Ratio: 1.4
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 35.3 W/kg
**SAR(1 g) = 7.77 W/kg; SAR(10 g) = 2.14 W/kg**
Deviation = -3.84%




0 dB = 18.0 W/kg = 12.55 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5600 MHz; Type: D5GHzV2; Serial: 1057**

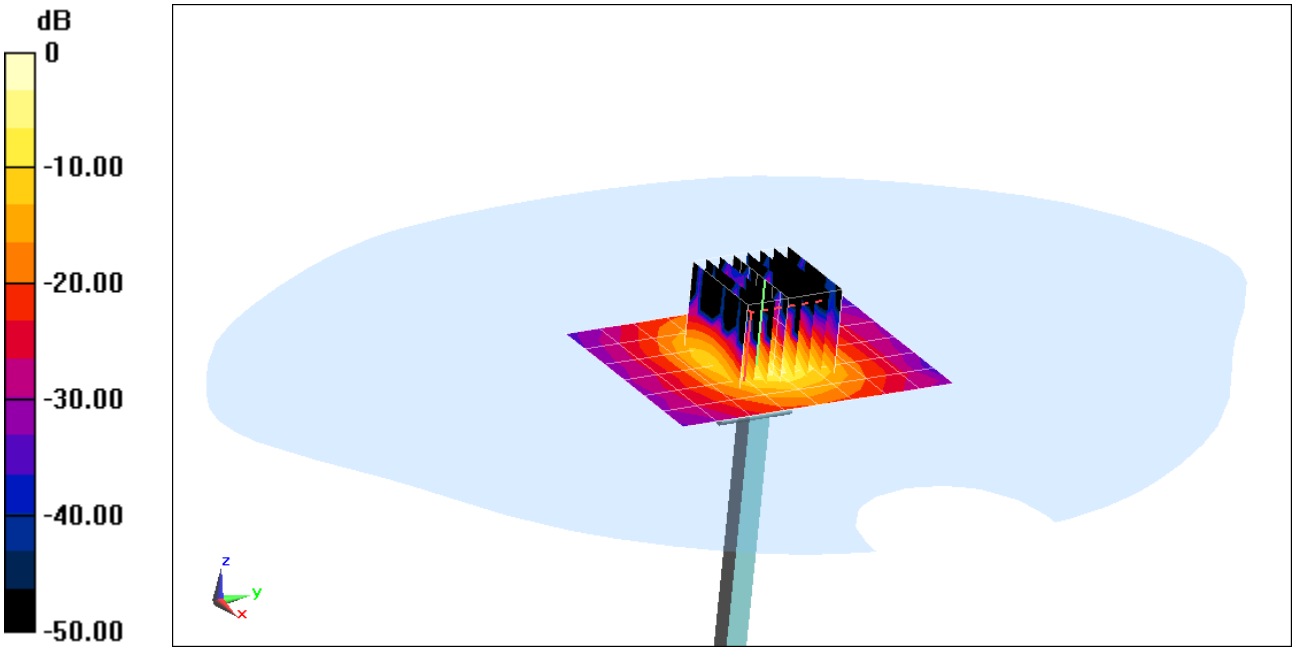
Communication System: CW; Frequency: 5600 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body, Medium parameters used:
f = 5600 MHz; $\sigma$ = 5.848 S/m; $\varepsilon_r$ = 46.974; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-27-2013; Ambient Temp: 24.1°C; Tissue Temp: 22.8°C

Probe: EX3DV4 - SN3589; ConvF(3.32, 3.32, 3.32); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357
Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.8 (7028)

## 5600 MHz System Verification

**Area Scan (7x9x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm,Graded Ratio: 1.4
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 38.4 W/kg
**SAR(1 g) = 8.37 W/kg; SAR(10 g) = 2.29 W/kg**
Deviation = 4.23%




0 dB = 20.4 W/kg = 13.10 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5800 MHz; Type: D5GHzV2; Serial: 1057**

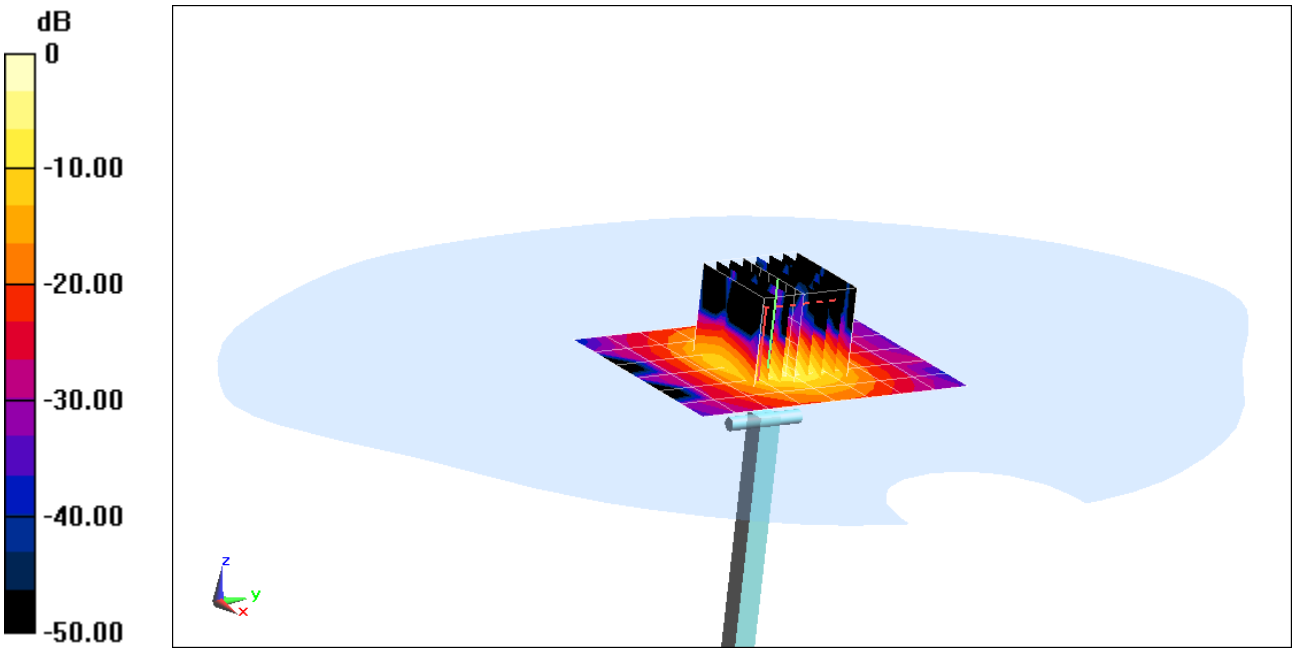
Communication System: CW; Frequency: 5800 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body, Medium parameters used:
f = 5800 MHz; $\sigma$ = 6.147 S/m; $\varepsilon_r$ = 46.555; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-27-2013; Ambient Temp: 24.2°C; Tissue Temp: 22.8°C

Probe: EX3DV4 - SN3589; ConvF(3.66, 3.66, 3.66); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357
Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.8 (7028)

## 5800 MHz System Verification

**Area Scan (7x9x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm,Graded Ratio: 1.4
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 36.9 W/kg
**SAR(1 g) = 7.3 W/kg; SAR(10 g) = 1.99 W/kg**
Deviation = -2.80%




0 dB = 18.0 W/kg = 12.55 dBW/kg

# APPENDIX C: PROBE CALIBRATION

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

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

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

**Accreditation No.: SCS 108**

**Client** PC Test

**Certificate No: ES3-3263_May12**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | ES3DV3 - SN:3263 |
| Calibration procedure(s) | QA CAL-01.v8, QA CAL-12.v7, QA CAL-23.v4, QA CAL-25.v4<br>Calibration procedure for dosimetric E-field probes |
| Calibration date: | May 18, 2012 |

✓ KOK 6/5/12

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter E4419B | GB41293874 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Power sensor E4412A | MY41498087 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 27-Mar-12 (No. 217-01531) | Apr-13 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 27-Mar-12 (No. 217-01529) | Apr-13 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 27-Mar-12 (No. 217-01532) | Apr-13 |
| Reference Probe ES3DV2 | SN: 3013 | 29-Dec-11 (No. ES3-3013_Dec11) | Dec-12 |
| DAE4 | SN: 660 | 10-Jan-12 (No. DAE4-660_Jan12) | Jan-13 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-11) | In house check: Apr-13 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-11) | In house check: Oct-12 |

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

Issued: May 21, 2012

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

## Glossary:

| | |
|---|---|
| TSL | tissue simulating liquid |
| NORMx,y,z | sensitivity in free space |
| ConvF | sensitivity in TSL / NORMx,y,z |
| DCP | diode compression point |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A, B, C | 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 |

## Calibration is Performed According to the Following Standards:

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

## Methods Applied and Interpretation of Parameters:

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

# Probe ES3DV3

## SN:3263

Manufactured: January 25, 2010
Calibrated: May 18, 2012

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

# DASY/EASY - Parameters of Probe: ES3DV3 - SN:3263

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm ($\mu V/(V/m)^2$)[A] | 1.21 | 1.23 | 1.12 | ± 10.1 % |
| DCP (mV)[B] | 100.1 | 99.6 | 104.5 | |

## Modulation Calibration Parameters

| UID | Communication System Name | PAR | | A dB | B dB | C dB | VR mV | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|
| 0 | CW | 0.00 | X | 0.00 | 0.00 | 1.00 | 153.9 | ±4.4 % |
| | | | Y | 0.00 | 0.00 | 1.00 | 159.2 | |
| | | | Z | 0.00 | 0.00 | 1.00 | 150.3 | |

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

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

# DASY/EASY - Parameters of Probe: ES3DV3 - SN:3263

## Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 41.9 | 0.89 | 6.40 | 6.40 | 6.40 | 0.32 | 1.73 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 6.16 | 6.16 | 6.16 | 0.40 | 1.54 | ± 12.0 % |
| 1640 | 40.3 | 1.29 | 5.46 | 5.46 | 5.46 | 0.53 | 1.37 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 5.30 | 5.30 | 5.30 | 0.47 | 1.50 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 5.09 | 5.09 | 5.09 | 0.55 | 1.35 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 4.45 | 4.45 | 4.45 | 0.77 | 1.27 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 4.34 | 4.34 | 4.34 | 0.76 | 1.34 | ± 12.0 % |

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

# DASY/EASY - Parameters of Probe: ES3DV3 - SN:3263

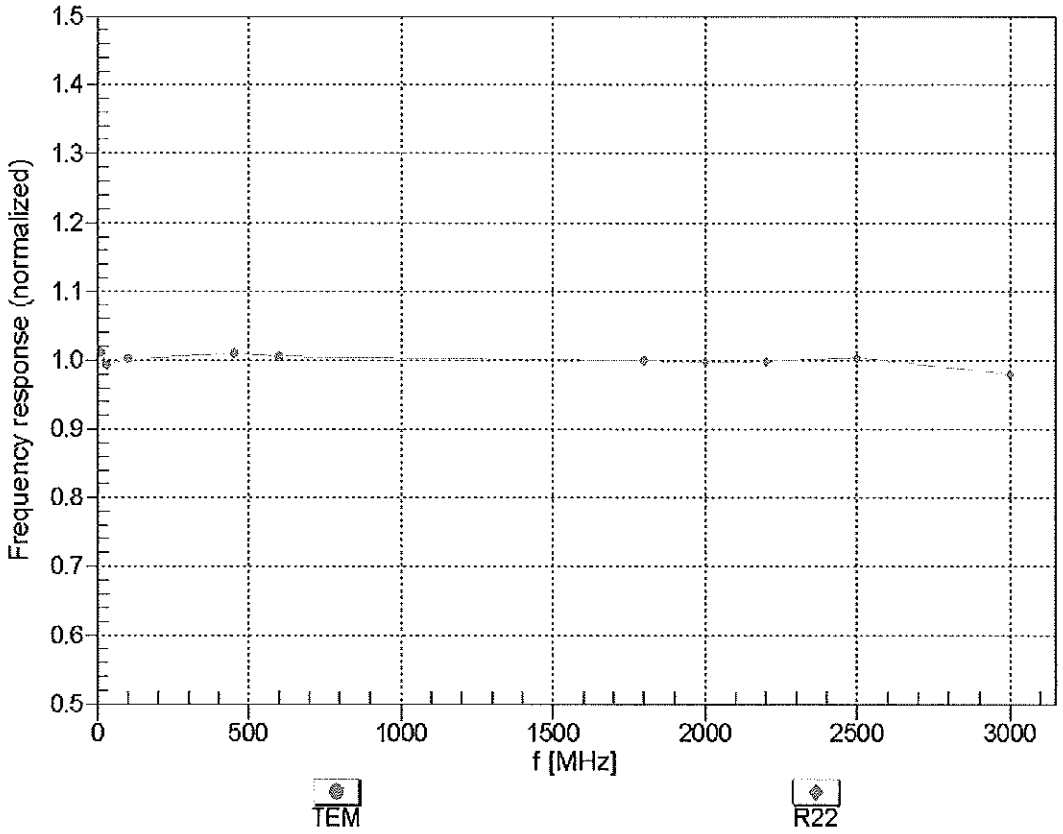
## Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 450 | 56.7 | 0.94 | 7.05 | 7.05 | 7.05 | 0.08 | 1.15 | ± 13.4 % |
| 750 | 55.5 | 0.96 | 6.26 | 6.26 | 6.26 | 0.68 | 1.24 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 6.15 | 6.15 | 6.15 | 0.40 | 1.65 | ± 12.0 % |
| 1640 | 53.8 | 1.40 | 5.33 | 5.33 | 5.33 | 0.74 | 1.27 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 4.96 | 4.96 | 4.96 | 0.62 | 1.41 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 4.76 | 4.76 | 4.76 | 0.54 | 1.48 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 4.35 | 4.35 | 4.35 | 0.80 | 1.15 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 4.16 | 4.16 | 4.16 | 0.80 | 1.00 | ± 12.0 % |

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

# Frequency Response of E-Field

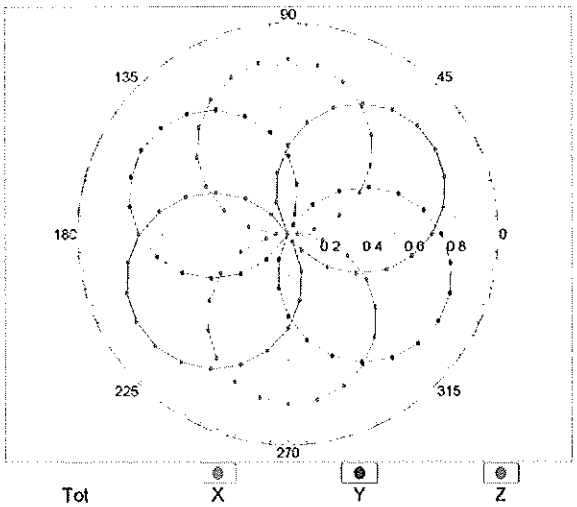
**(TEM-Cell:ifi110 EXX, Waveguide: R22)**



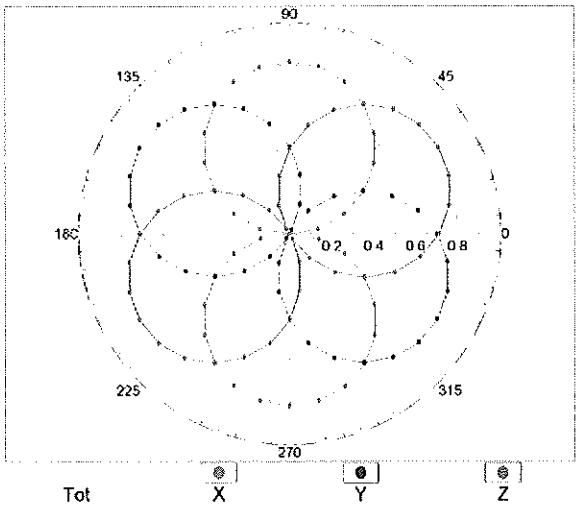

**Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)**

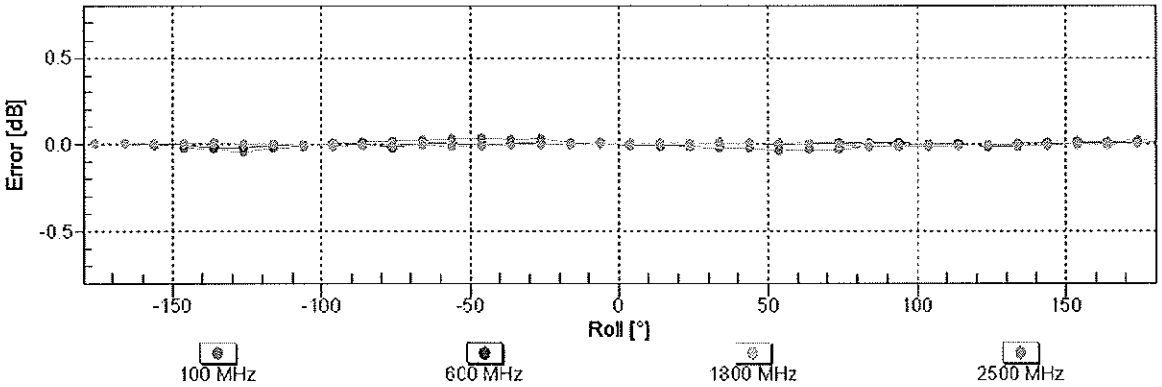
# Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



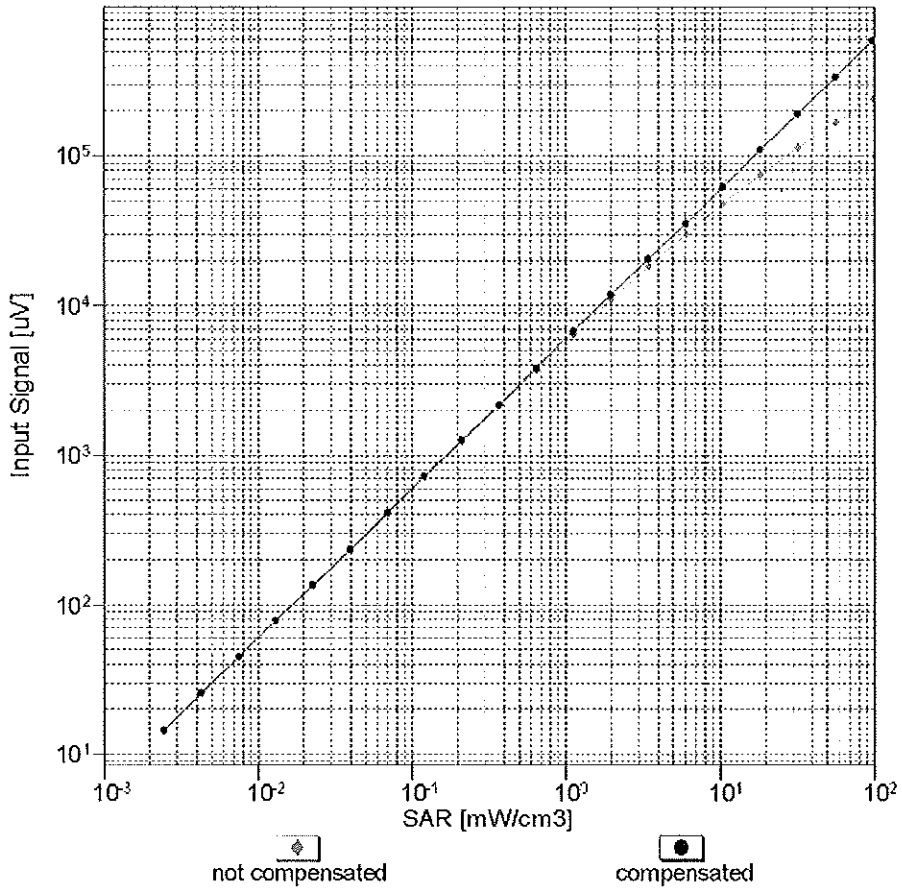

f=1800 MHz,R22

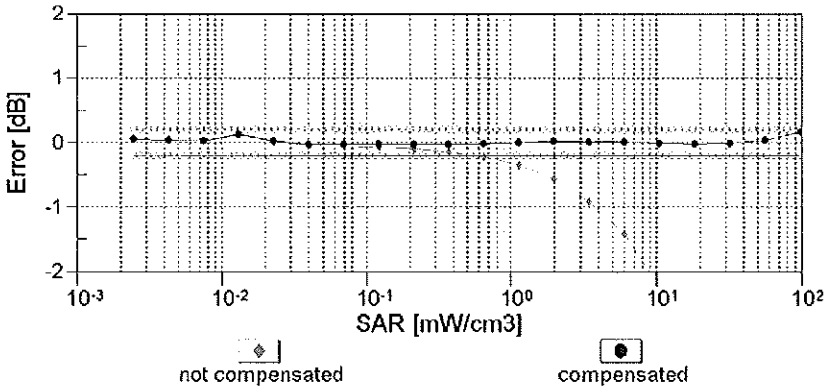



**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

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

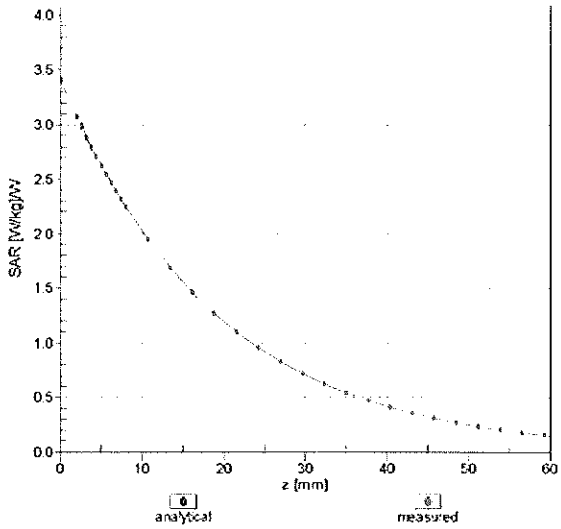


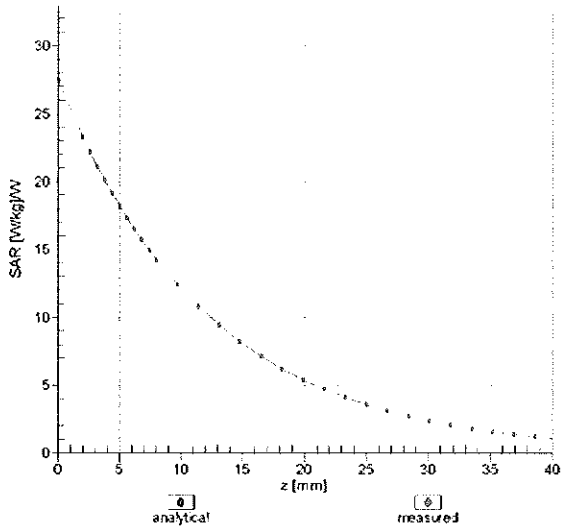

**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

# Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

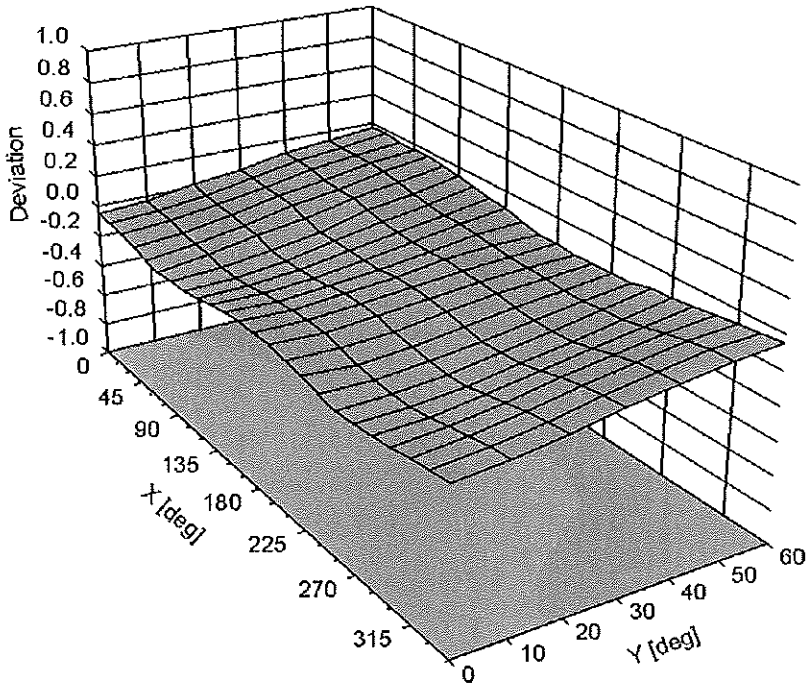


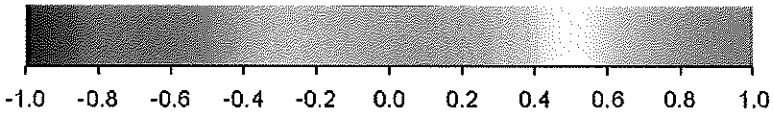

f = 1900 MHz,WGLS R22 (H_convF)




# Deviation from Isotropy in Liquid

**Error (ϕ, ϑ), f = 900 MHz**




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

# DASY/EASY - Parameters of Probe: ES3DV3 - SN:3263

## Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 63.9 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 10 mm |
| Tip Diameter | 4 mm |
| Probe Tip to Sensor X Calibration Point | 2 mm |
| Probe Tip to Sensor Y Calibration Point | 2 mm |
| Probe Tip to Sensor Z Calibration Point | 2 mm |
| Recommended Measurement Distance from Surface | 3 mm |

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Schmid & Partner
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**Zeughausstrasse 43, 8004 Zurich, Switzerland**

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

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

**Accreditation No.: SCS 108**

**Client** PC Test

**Certificate No: EX3-3589_Jan13**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | EX3DV4 - SN:3589 |
| Calibration procedure(s) | QA CAL-01.v8, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4<br>Calibration procedure for dosimetric E-field probes |
| Calibration date: | January 17, 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 E4419B | GB41293874 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Power sensor E4412A | MY41498087 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 27-Mar-12 (No. 217-01531) | Apr-13 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 27-Mar-12 (No. 217-01529) | Apr-13 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 27-Mar-12 (No. 217-01532) | Apr-13 |
| Reference Probe ES3DV2 | SN: 3013 | 28-Dec-12 (No. ES3-3013_Dec12) | Dec-13 |
| DAE4 | SN: 660 | 20-Jun-12 (No. DAE4-660_Jun12) | Jun-13 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-11) | In house check: Apr-13 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

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

Issued: January 17, 2013

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

## Glossary:

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

## Calibration is Performed According to the Following Standards:

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

## Methods Applied and Interpretation of Parameters:

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

# Probe EX3DV4

# SN:3589

Manufactured: March 30, 2006
Calibrated: January 17, 2013

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

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3589

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm ($\mu V/(V/m)^2$)[A] | 0.46 | 0.40 | 0.40 | ± 10.1 % |
| DCP (mV)[B] | 100.5 | 103.8 | 99.6 | |

## Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB$\sqrt{\mu V}$ | C | D dB | VR mV | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 165.8 | ±3.3 % |
| | | Y | 0.0 | 0.0 | 1.0 | | 134.3 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 140.5 | |

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

[A] The uncertainties of NormX,Y,Z do not affect the $E^2$-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:3589

## Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 41.9 | 0.89 | 8.70 | 8.70 | 8.70 | 0.39 | 0.96 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 8.40 | 8.40 | 8.40 | 0.52 | 0.74 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 7.34 | 7.34 | 7.34 | 0.45 | 0.93 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 7.09 | 7.09 | 7.09 | 0.80 | 0.65 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 6.37 | 6.37 | 6.37 | 0.39 | 0.97 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 6.19 | 6.19 | 6.19 | 0.30 | 1.12 | ± 12.0 % |
| 5200 | 36.0 | 4.66 | 4.48 | 4.48 | 4.48 | 0.45 | 1.80 | ± 13.1 % |
| 5300 | 35.9 | 4.76 | 4.27 | 4.27 | 4.27 | 0.45 | 1.80 | ± 13.1 % |
| 5500 | 35.6 | 4.96 | 4.14 | 4.14 | 4.14 | 0.50 | 1.80 | ± 13.1 % |
| 5600 | 35.5 | 5.07 | 3.81 | 3.81 | 3.81 | 0.55 | 1.80 | ± 13.1 % |
| 5800 | 35.3 | 5.27 | 3.85 | 3.85 | 3.85 | 0.55 | 1.80 | ± 13.1 % |

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3589

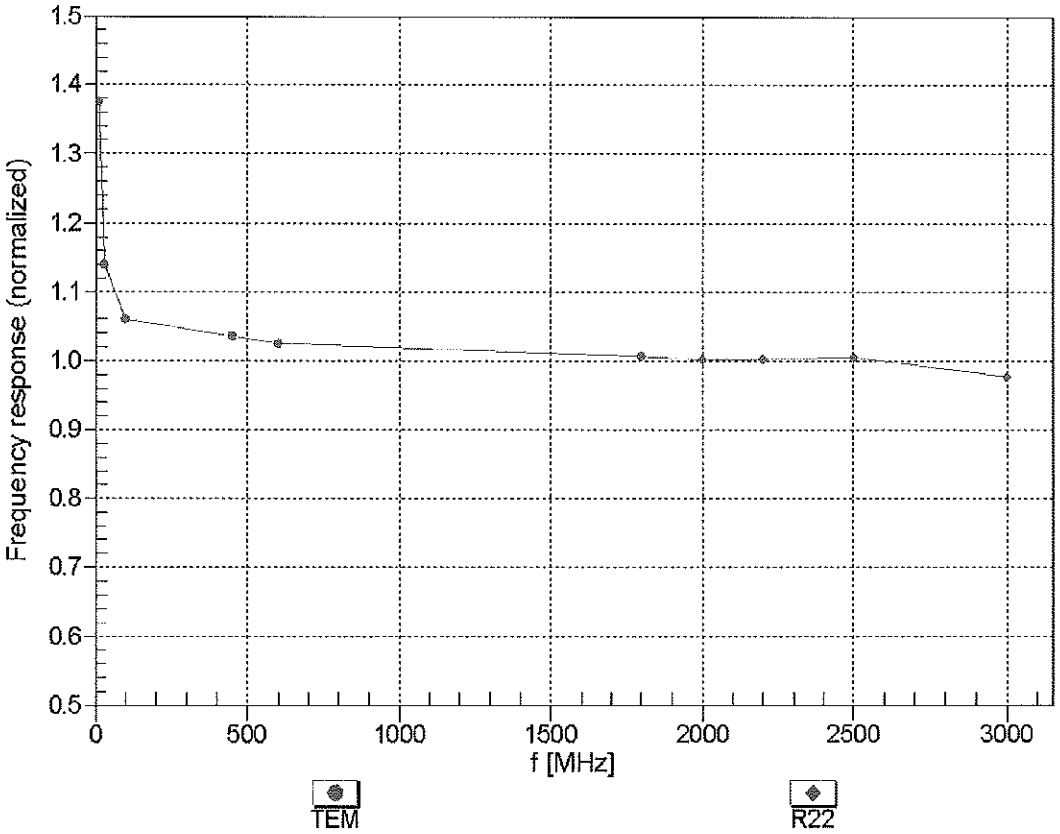
## Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 55.5 | 0.96 | 8.59 | 8.59 | 8.59 | 0.49 | 0.86 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 8.43 | 8.43 | 8.43 | 0.38 | 1.05 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 7.87 | 7.87 | 7.87 | 0.44 | 0.89 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 7.46 | 7.46 | 7.46 | 0.58 | 0.75 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 7.07 | 7.07 | 7.07 | 0.80 | 0.50 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 6.68 | 6.68 | 6.68 | 0.80 | 0.50 | ± 12.0 % |
| 5200 | 49.0 | 5.30 | 3.99 | 3.99 | 3.99 | 0.50 | 1.90 | ± 13.1 % |
| 5300 | 48.9 | 5.42 | 3.81 | 3.81 | 3.81 | 0.50 | 1.90 | ± 13.1 % |
| 5500 | 48.6 | 5.65 | 3.52 | 3.52 | 3.52 | 0.55 | 1.90 | ± 13.1 % |
| 5600 | 48.5 | 5.77 | 3.32 | 3.32 | 3.32 | 0.60 | 1.90 | ± 13.1 % |
| 5800 | 48.2 | 6.00 | 3.66 | 3.66 | 3.66 | 0.60 | 1.90 | ± 13.1 % |

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

# Frequency Response of E-Field

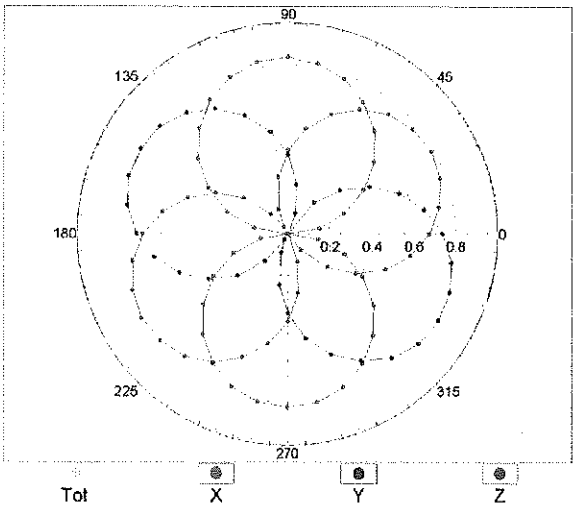
**(TEM-Cell:ifi110 EXX, Waveguide: R22)**



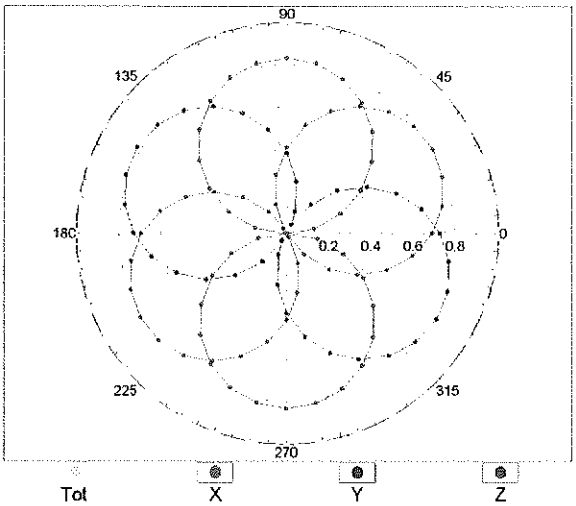

**Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)**

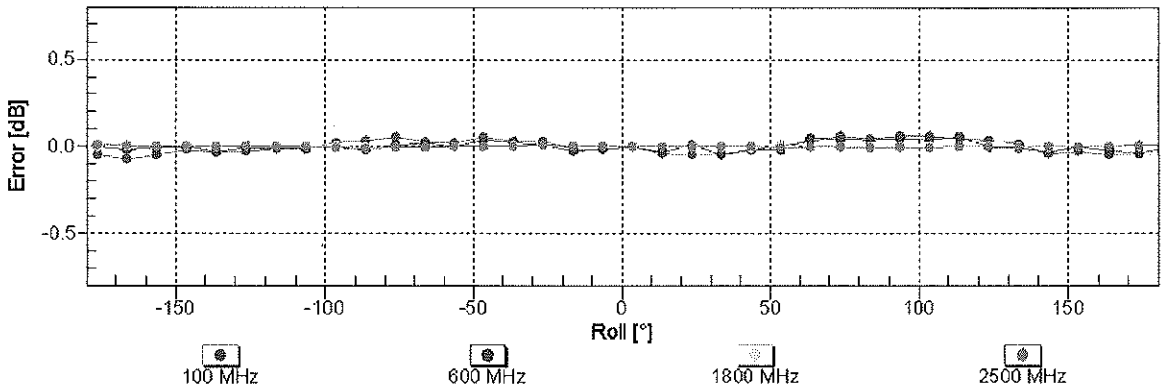
# Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



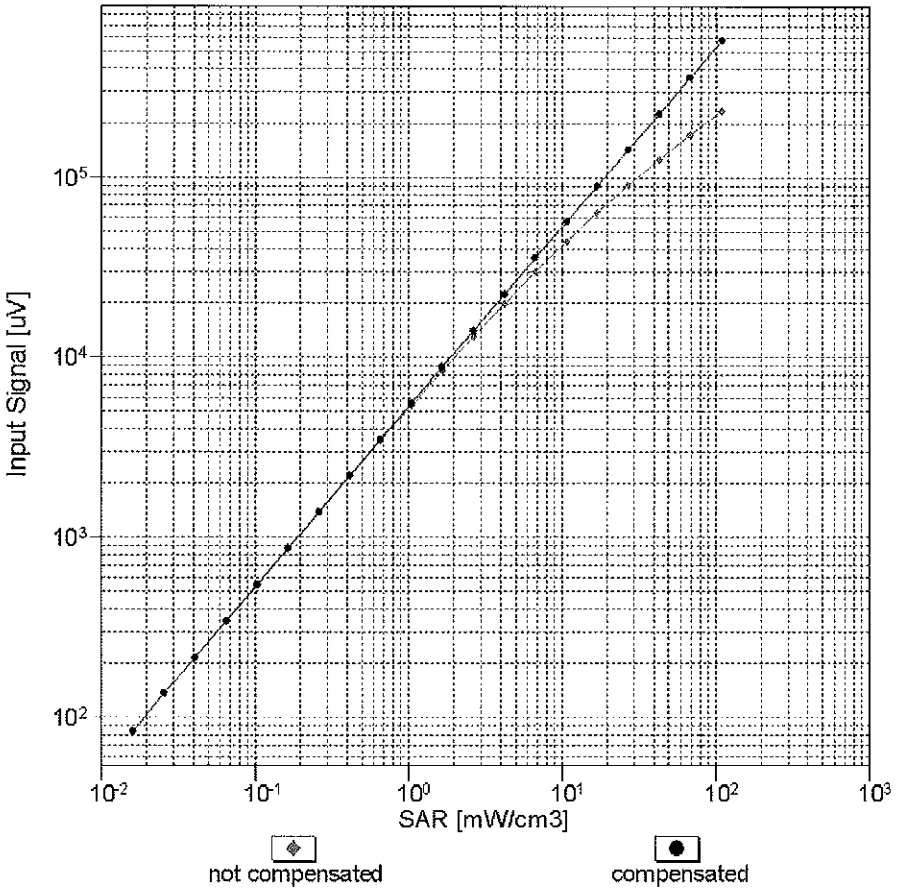

f=1800 MHz,R22

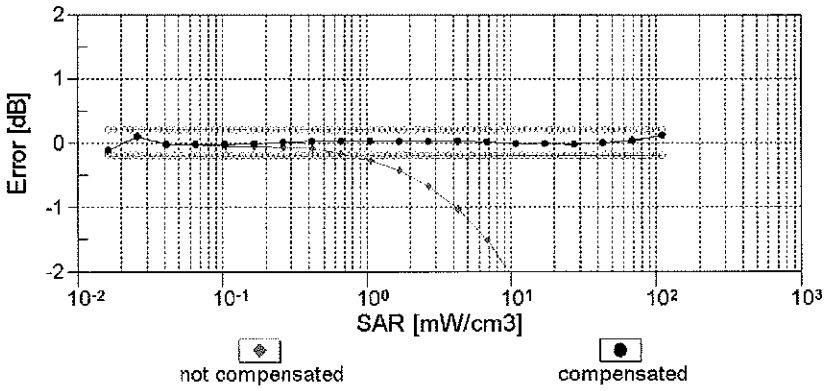



**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

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

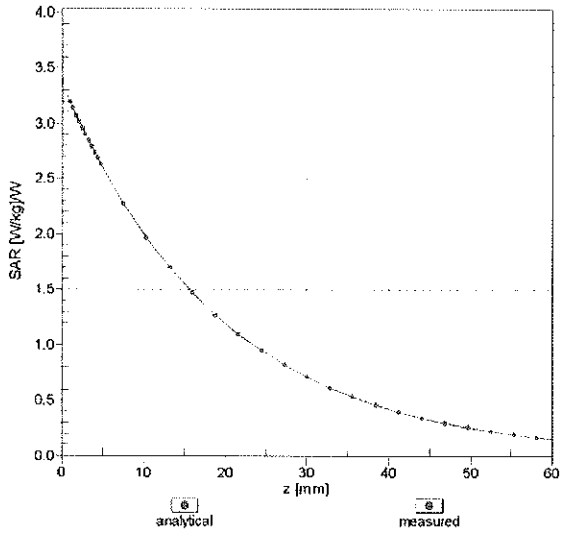


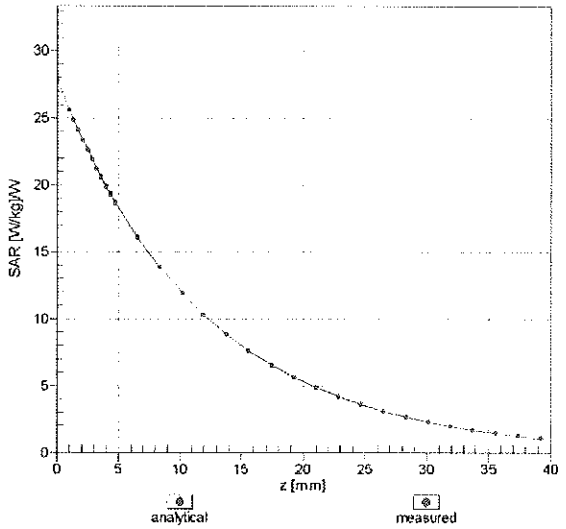

**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

# Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

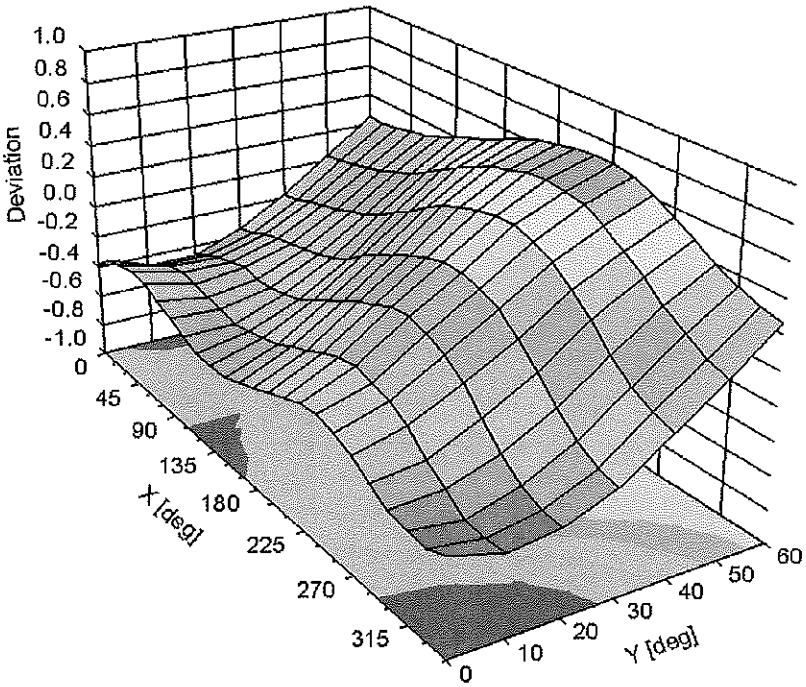


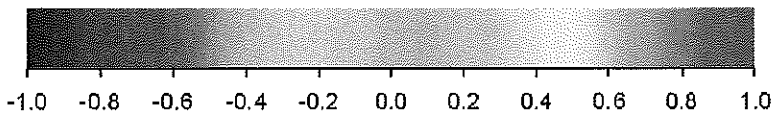

f = 1900 MHz,WGLS R22 (H_convF)




# Deviation from Isotropy in Liquid

**Error (ϕ, ϑ), f = 900 MHz**




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

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3589

## Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | -26.4 |
| 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 |

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**Zeughausstrasse 43, 8004 Zurich, Switzerland**

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

**Accreditation No.: SCS 108**

**Client** PC Test

**Certificate No: ES3-3287_Nov12**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | ES3DV3 - SN:3287 |
| Calibration procedure(s) | QA CAL-01.v8, QA CAL-23.v4, QA CAL-25.v4<br>Calibration procedure for dosimetric E-field probes |
| Calibration date: | November 15, 2012 |

✓ KOK 11/20/12

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

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

Calibration Equipment used (M&TE critical for calibration)

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

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

Issued: November 16, 2012

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## Glossary:

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

## Calibration is Performed According to the Following Standards:

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

## Methods Applied and Interpretation of Parameters:

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

# Probe ES3DV3

# SN:3287

Manufactured: June 7, 2010
Calibrated: November 15, 2012

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

# DASY/EASY - Parameters of Probe: ES3DV3 - SN:3287

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm ($\mu V/(V/m)^2$)[A] | 1.31 | 1.25 | 1.25 | ± 10.1 % |
| DCP (mV)[B] | 102.9 | 103.6 | 101.6 | |

## Modulation Calibration Parameters

| UID | Communication System Name | PAR | | A dB | B dB | C dB | VR mV | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|
| 0 | CW | 0.00 | X | 0.0 | 0.0 | 1.0 | 116.8 | ±3.5 % |
| | | | Y | 0.0 | 0.0 | 1.0 | 118.5 | |
| | | | Z | 0.0 | 0.0 | 1.0 | 154.1 | |

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: ES3DV3 - SN:3287

## Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 41.9 | 0.89 | 6.40 | 6.40 | 6.40 | 0.20 | 2.54 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 6.17 | 6.17 | 6.17 | 0.34 | 1.68 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 5.16 | 5.16 | 5.16 | 0.63 | 1.30 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 4.96 | 4.96 | 4.96 | 0.48 | 1.55 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 4.30 | 4.30 | 4.30 | 0.79 | 1.31 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 4.19 | 4.19 | 4.19 | 0.80 | 1.31 | ± 12.0 % |

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

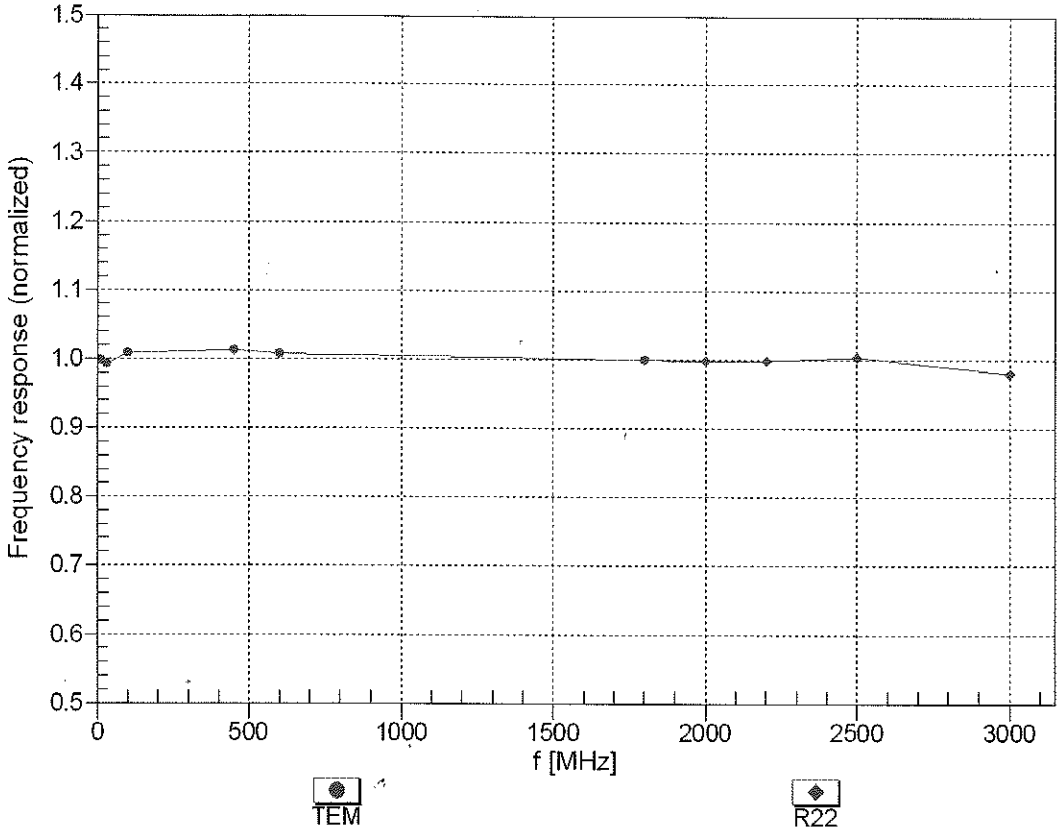
# DASY/EASY - Parameters of Probe: ES3DV3 - SN:3287

## Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 55.5 | 0.96 | 6.14 | 6.14 | 6.14 | 0.28 | 2.06 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 6.06 | 6.06 | 6.06 | 0.42 | 1.63 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 4.86 | 4.86 | 4.86 | 0.43 | 1.64 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 4.69 | 4.69 | 4.69 | 0.56 | 1.54 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 4.29 | 4.29 | 4.29 | 0.80 | 1.02 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 4.12 | 4.12 | 4.12 | 0.64 | 0.92 | ± 12.0 % |

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

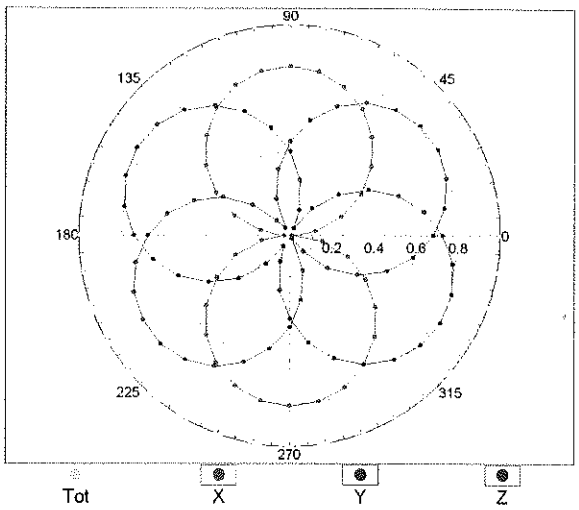
# Frequency Response of E-Field
## (TEM-Cell:ifi110 EXX, Waveguide: R22)



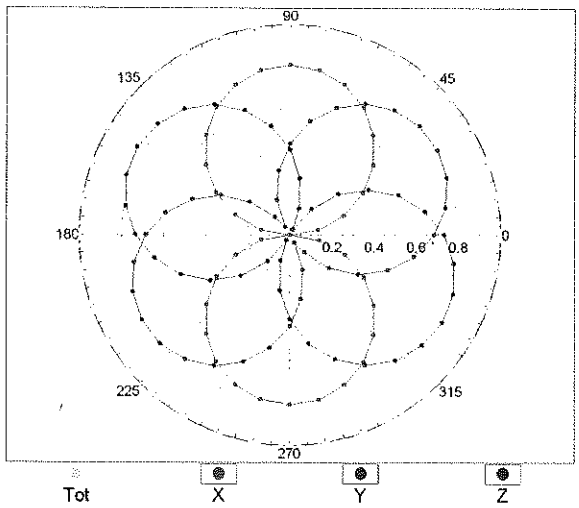

**Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)**

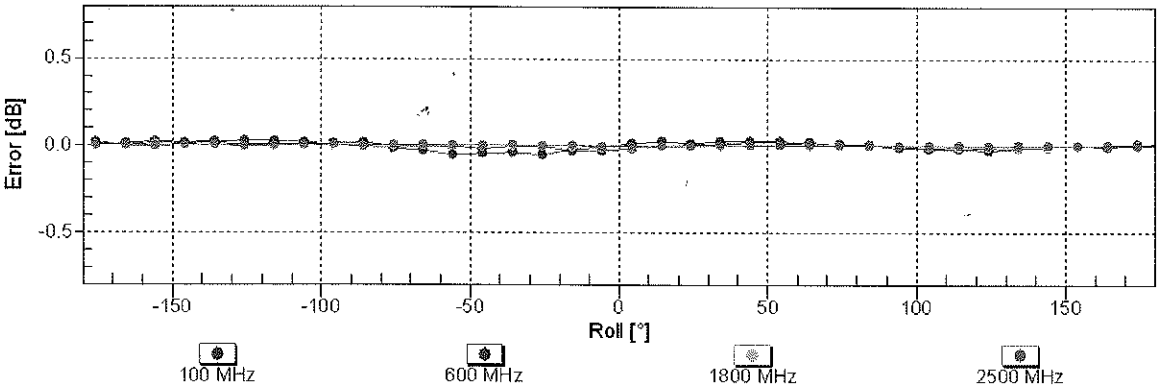
# Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



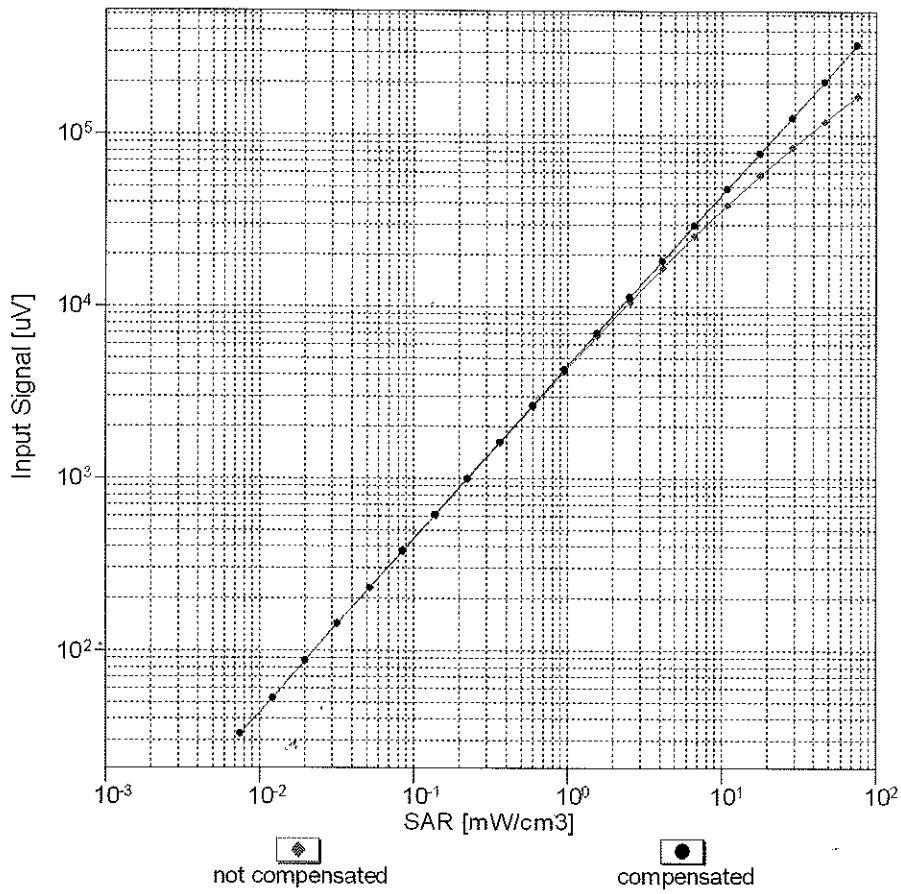

f=1800 MHz,R22

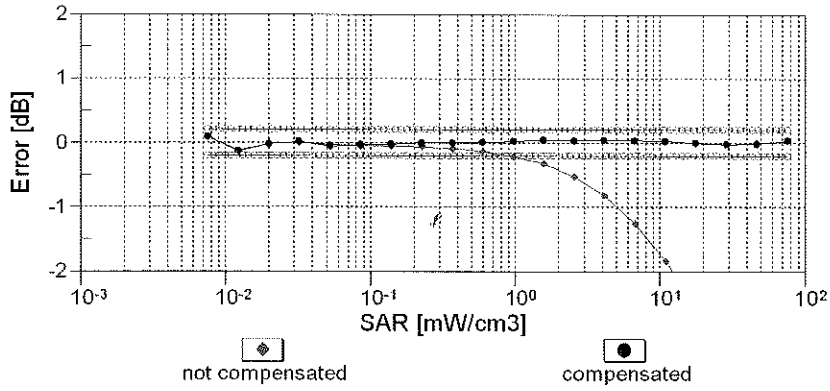



**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

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

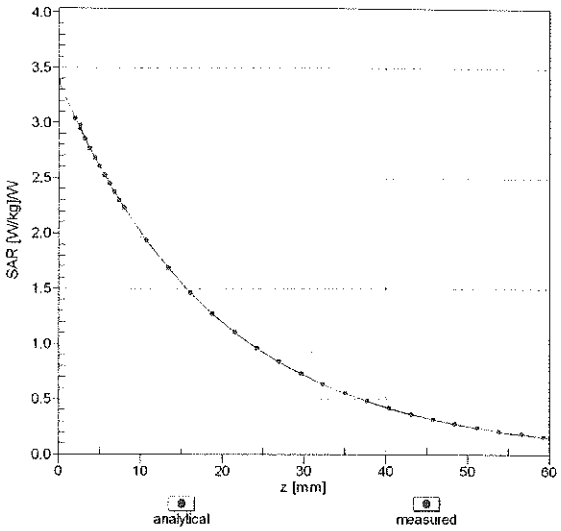


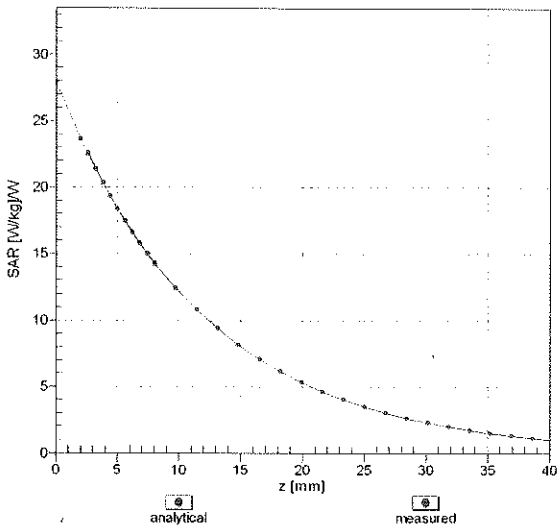

**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

# Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

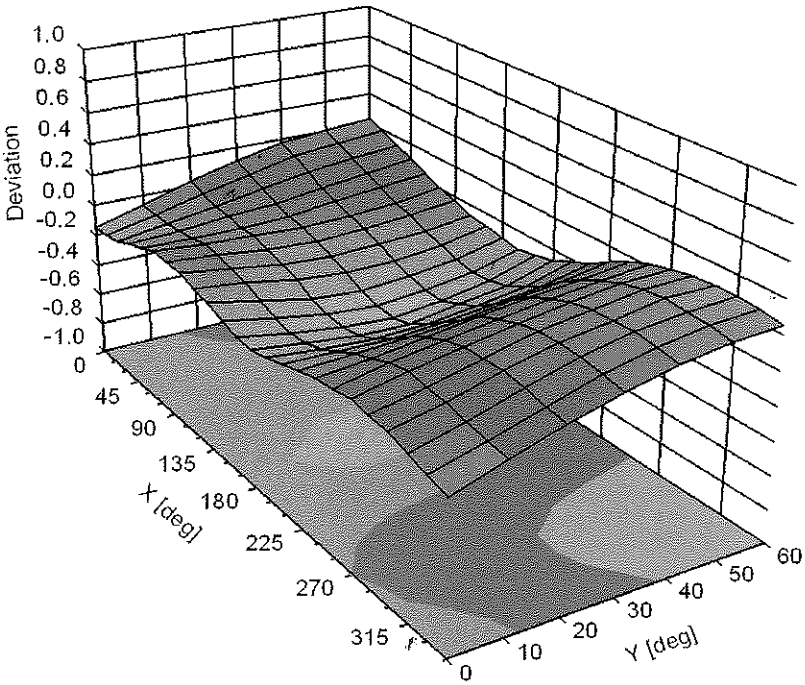


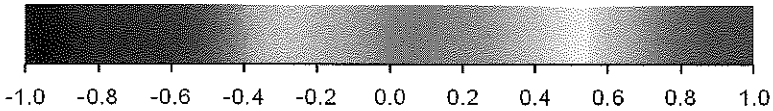

f = 1900 MHz,WGLS R22 (H_convF)




# Deviation from Isotropy in Liquid

**Error (ϕ, ϑ), f = 900 MHz**




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

# DASY/EASY - Parameters of Probe: ES3DV3 - SN:3287

## Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | -15.9 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 10 mm |
| Tip Diameter | 4 mm |
| Probe Tip to Sensor X Calibration Point | 2 mm |
| Probe Tip to Sensor Y Calibration Point | 2 mm |
| Probe Tip to Sensor Z Calibration Point | 2 mm |
| Recommended Measurement Distance from Surface | 3 mm |

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**S** Swiss Calibration Service

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**Accreditation No.: SCS 108**

**Client** **PC Test**

**Certificate No: D2450V2-797_Jan13**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D2450V2 - SN: 797 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | January 08, 2013 |

✓ KOK 1/28/13

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter EPM-442A | GB37480704 | 01-Nov-12 (No. 217-01640) | Oct-13 |
| Power sensor HP 8481A | US37292783 | 01-Nov-12 (No. 217-01640) | Oct-13 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 27-Mar-12 (No. 217-01530) | Apr-13 |
| Type-N mismatch combination | SN: 5047.3 / 06327 | 27-Mar-12 (No. 217-01533) | Apr-13 |
| Reference Probe ES3DV3 | SN: 3205 | 28-Dec-12 (No. ES3-3205_Dec12) | Dec-13 |
| DAE4 | SN: 601 | 27-Jun-12 (No. DAE4-601_Jun12) | Jun-13 |

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

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

Issued: January 8, 2013

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## Glossary:

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

## Calibration is Performed According to the Following Standards:

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

## Additional Documentation:

d) DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

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

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

## Measurement Conditions

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

| | | |
|---|---|---|
| **DASY Version** | DASY5 | V52.8.4 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 2450 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 39.2 | 1.80 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 37.9 ± 6 % | 1.85 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 13.4 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **52.5 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.20 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **24.5 W/kg ± 16.5 % (k=2)** |

## Body TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 52.7 | 1.95 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 50.5 ± 6 % | 2.01 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 12.7 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **49.6 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.88 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **23.2 W/kg ± 16.5 % (k=2)** |

## Appendix

## Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 53.3 Ω + 3.1 jΩ |
| Return Loss | - 27.1 dB |

## Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 49.1 Ω + 4.9 jΩ |
| Return Loss | - 26.0 dB |

## General Antenna Parameters and Design

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

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

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

## Additional EUT Data

| | |
|---|---|
| Manufactured by | SPEAG |
| Manufactured on | January 24, 2006 |

## DASY5 Validation Report for Head TSL

Date: 08.01.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 797**

Communication System: CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.85 S/m; $\varepsilon_r$ = 37.9; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

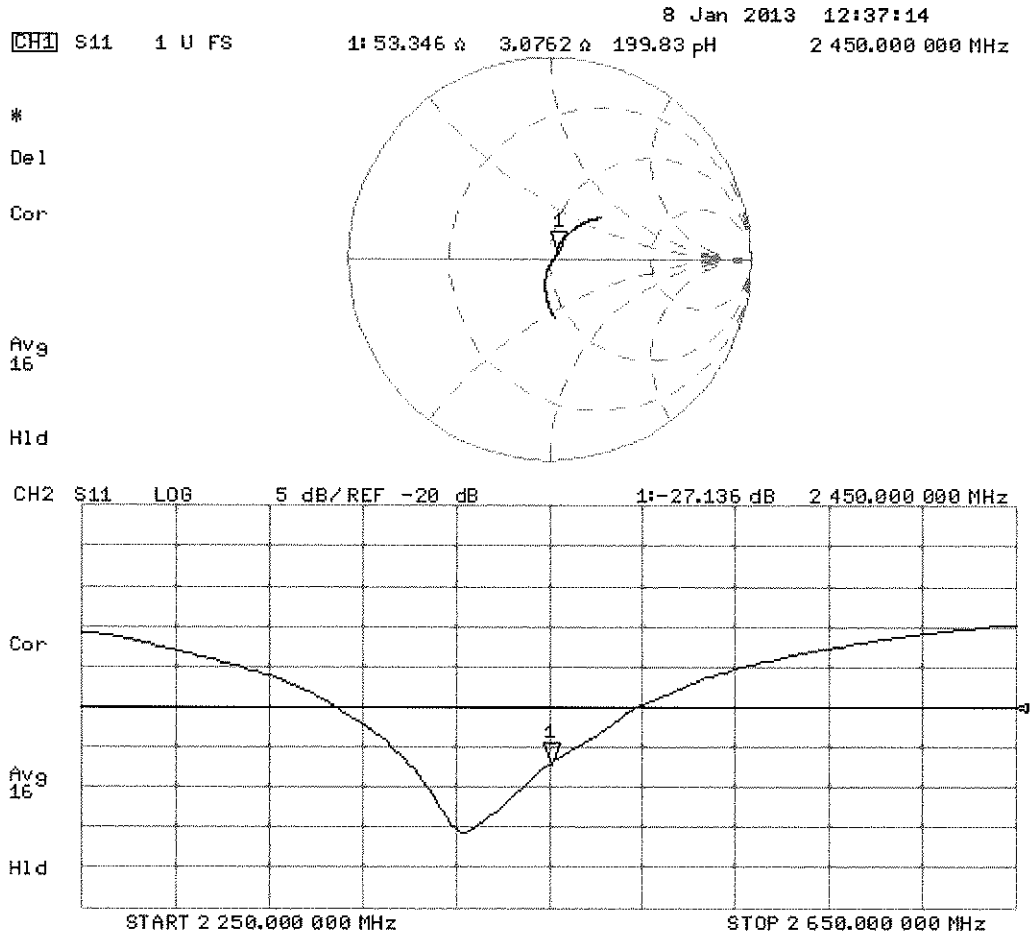
- Probe: ES3DV3 - SN3205; ConvF(4.52, 4.52, 4.52); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.4(1052); SEMCAD X 14.6.8(7028)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 99.154 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 27.8 W/kg
**SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.2 W/kg**
Maximum value of SAR (measured) = 17.0 W/kg

0 dB = 17.0 W/kg = 12.30 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 08.01.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 797**

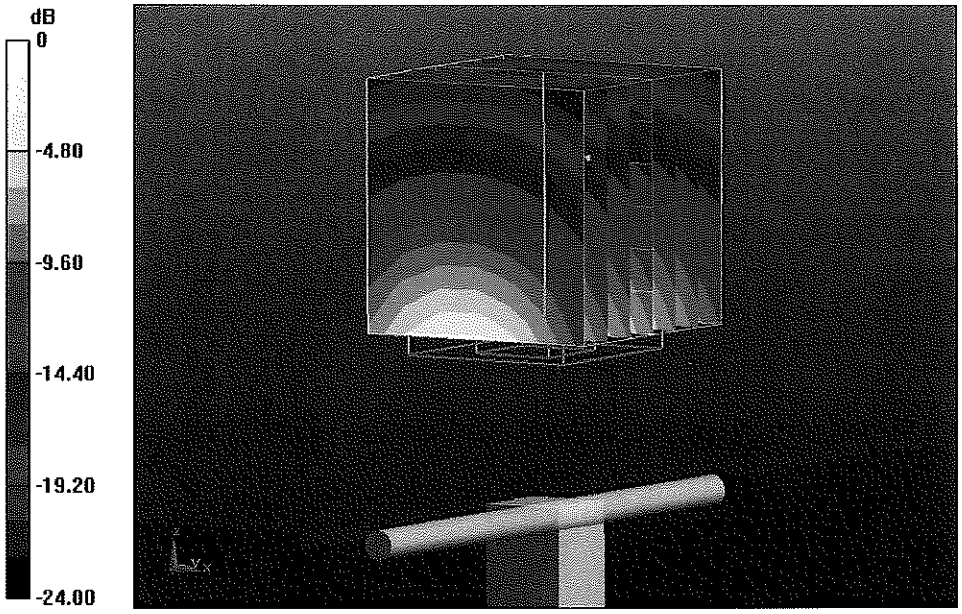
Communication System: CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 2.01 S/m; $\varepsilon_r$ = 50.5; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

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: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.4(1052); SEMCAD X 14.6.8(7028)

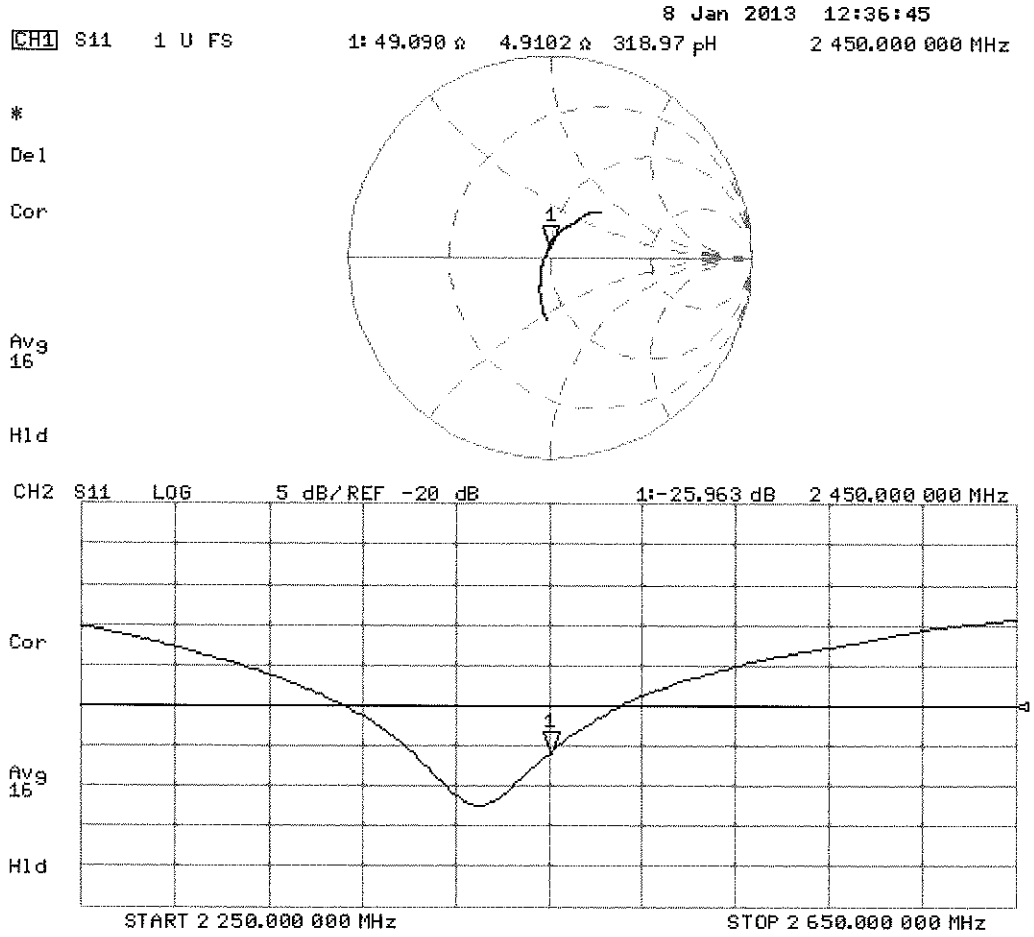
### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 93.935 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 26.7 W/kg
**SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.88 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 Body TSL



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

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**S** Swiss Calibration Service

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

**Accreditation No.: SCS 108**

**Client** **PC Test**

**Certificate No: D2450V2-719_Aug12**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D2450V2 - SN: 719 |
| Calibration procedure(s) | QA CAL-05.v8<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | August 23, 2012 |

KOK 9/17/12

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter EPM-442A | GB37480704 | 05-Oct-11 (No. 217-01451) | Oct-12 |
| Power sensor HP 8481A | US37292783 | 05-Oct-11 (No. 217-01451) | Oct-12 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 27-Mar-12 (No. 217-01530) | Apr-13 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 27-Mar-12 (No. 217-01533) | Apr-13 |
| Reference Probe ES3DV3 | SN: 3205 | 30-Dec-11 (No. ES3-3205_Dec11) | Dec-12 |
| DAE4 | SN: 601 | 27-Jun-12 (No. DAE4-601_Jun12) | Jun-13 |

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

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

Issued: August 23, 2012

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

## Glossary:

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

## Calibration is Performed According to the Following Standards:

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

## Additional Documentation:

d) DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

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

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

## Measurement Conditions

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

| | | |
|---|---|---|
| **DASY Version** | DASY5 | V52.8.2 |
| **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 | 39.2 ± 6 % | 1.81 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 13.2 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **52.7 mW /g ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.19 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **24.7 mW /g ± 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 | 51.3 ± 6 % | 1.99 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 13.1 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **51.6 mW / g ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.16 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **24.4 mW / g ± 16.5 % (k=2)** |

# Appendix

## Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 54.4 Ω + 3.8 jΩ |
| Return Loss | - 25.1 dB |

## Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 50.7 Ω + 5.9 jΩ |
| Return Loss | - 24.6 dB |

## General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.150 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 10, 2002 |

## DASY5 Validation Report for Head TSL

Date: 23.08.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 719**

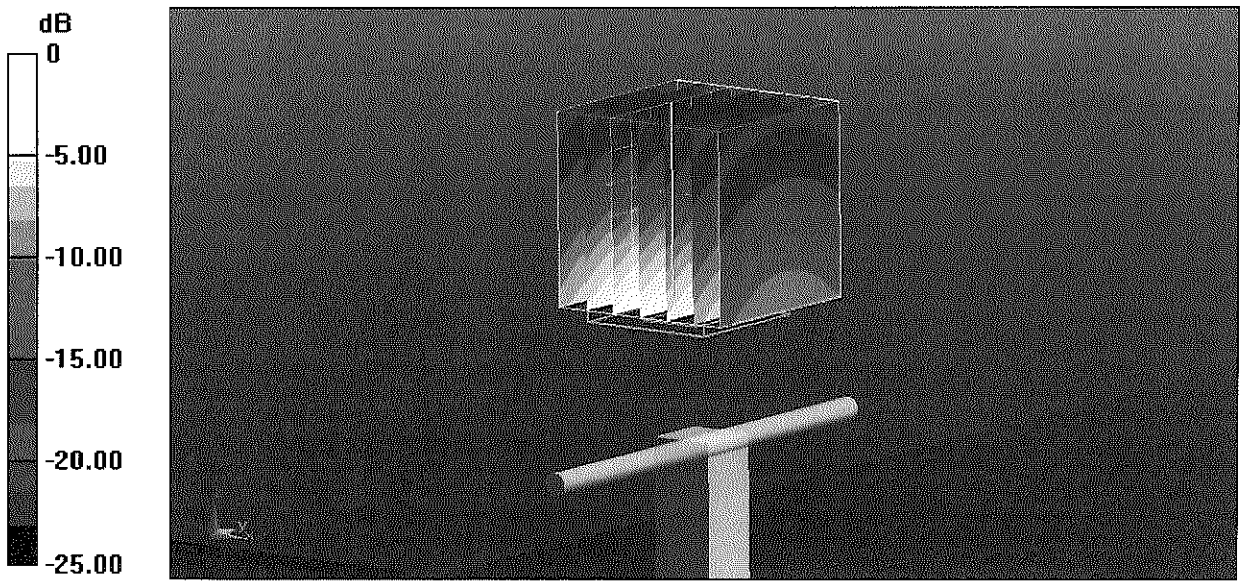
Communication System: CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.81 mho/m; $\varepsilon_r$ = 39.2; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.45, 4.45, 4.45); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.2(969); SEMCAD X 14.6.6(6824)

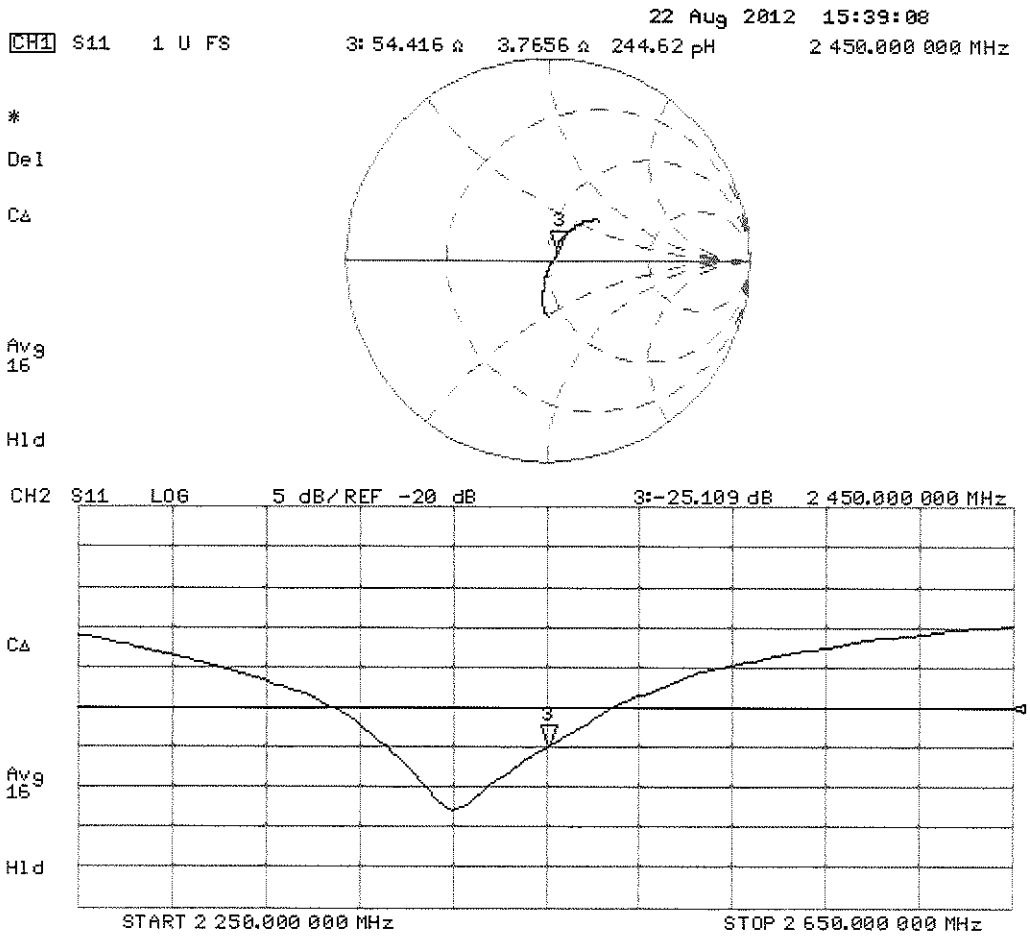
### Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 99.219 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 26.633 mW/g
**SAR(1 g) = 13.2 mW/g; SAR(10 g) = 6.19 mW/g**
Maximum value of SAR (measured) = 16.5 W/kg




0 dB = 16.5 W/kg = 24.35 dB W/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 22.08.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 719**

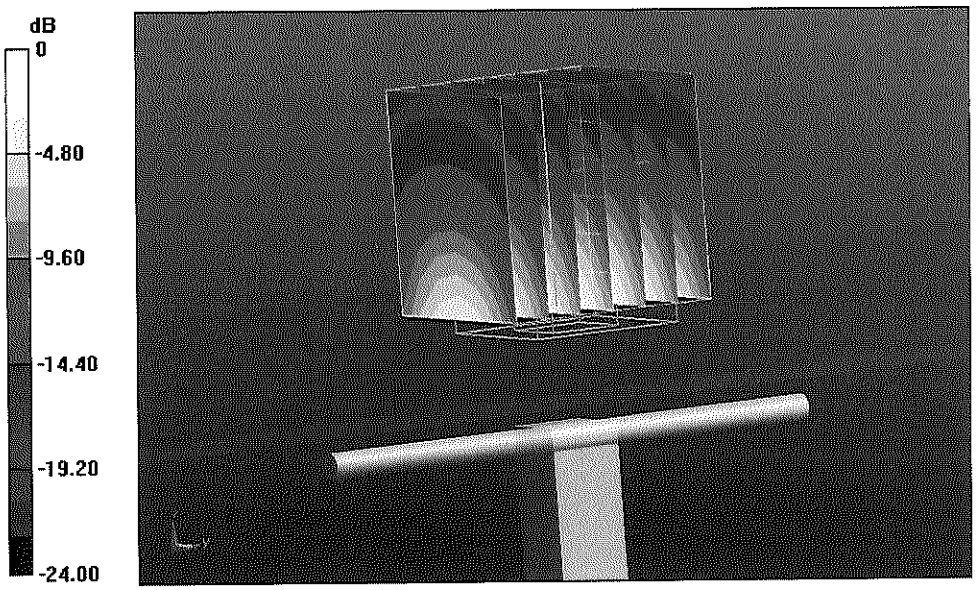
Communication System: CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.99 mho/m; $\varepsilon_r$ = 51.3; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.26, 4.26, 4.26); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.2(969); SEMCAD X 14.6.6(6824)

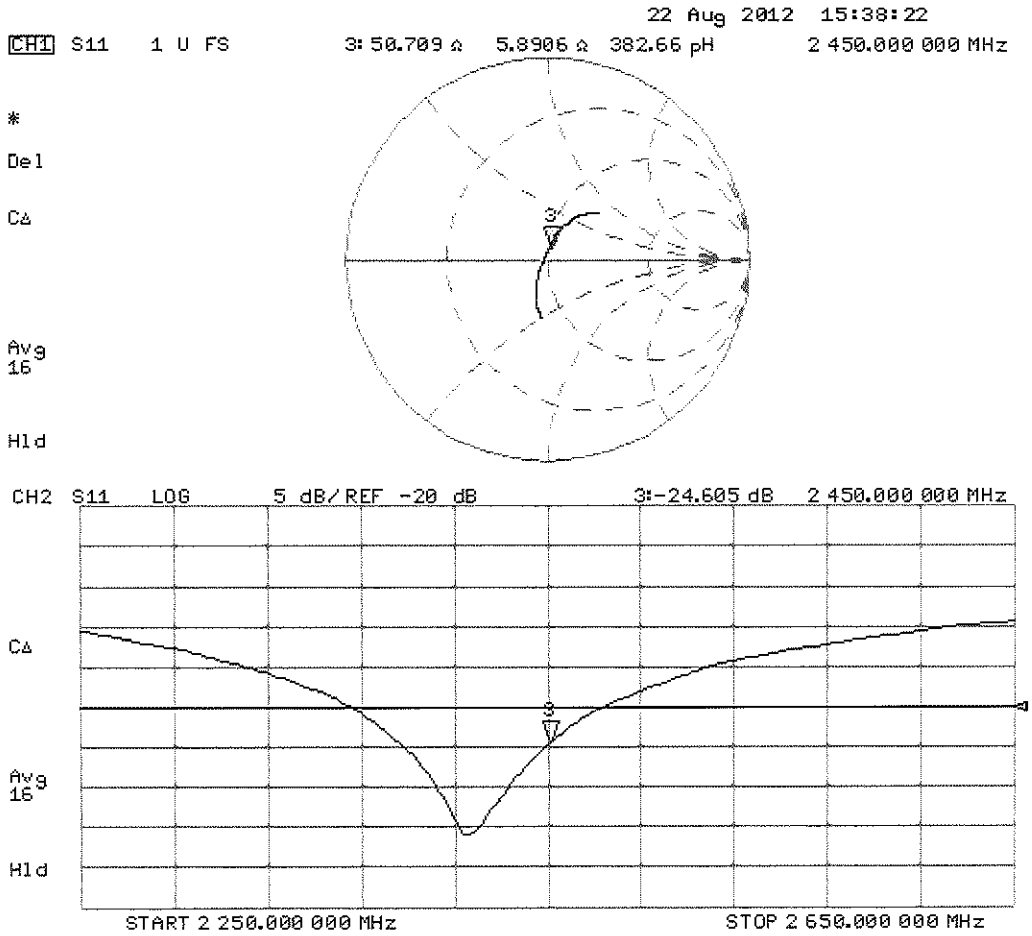
### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 95.970 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 26.692 mW/g
**SAR(1 g) = 13.1 mW/g; SAR(10 g) = 6.16 mW/g**
Maximum value of SAR (measured) = 17.1 W/kg




0 dB = 17.1 W/kg = 24.66 dB W/kg

## Impedance Measurement Plot for Body TSL



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

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**Accreditation No.: SCS 108**

**Client** **PC Test**

**Certificate No: D5GHzV2-1057_Jan13**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D5GHzV2 - SN: 1057 |
| Calibration procedure(s) | QA CAL-22.v2<br>Calibration procedure for dipole validation kits between 3-6 GHz |
| Calibration date: | January 11, 2013 |

✓ KOK 1/29/13

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter EPM-442A | GB37480704 | 01-Nov-12 (No. 217-01640) | Oct-13 |
| Power sensor HP 8481A | US37292783 | 01-Nov-12 (No. 217-01640) | Oct-13 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 27-Mar-12 (No. 217-01530) | Apr-13 |
| Type-N mismatch combination | SN: 5047.3 / 06327 | 27-Mar-12 (No. 217-01533) | Apr-13 |
| Reference Probe EX3DV4 | SN: 3503 | 28-Dec-12 (No. EX3-3503_Dec12) | Dec-13 |
| DAE4 | SN: 601 | 27-Jun-12 (No. DAE4-601_Jun12) | Jun-13 |

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

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

Issued: January 11, 2013

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

## Glossary:

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

## Calibration is Performed According to the Following Standards:

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

b) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

## Additional Documentation:

c) DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

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

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

## Measurement Conditions

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

| | | |
|---|---|---|
| **DASY Version** | DASY5 | V52.8.5 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom V5.0 | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy = 4.0 mm, dz = 1.4 mm | Graded Ratio = 1.4 (Z direction) |
| **Frequency** | 5200 MHz ± 1 MHz<br>5300 MHz ± 1 MHz<br>5500 MHz ± 1 MHz<br>5600 MHz ± 1 MHz<br>5800 MHz ± 1 MHz | |

## Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 36.0 | 4.66 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 34.6 ± 6 % | 4.50 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL at 5200 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.66 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **75.9 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.17 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **21.4 W/kg ± 19.5 % (k=2)** |

## Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 35.9 | 4.76 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 34.5 ± 6 % | 4.60 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 | 7.76 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **76.9 W / kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.22 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **21.9 W/kg ± 19.5 % (k=2)** |

## Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 35.6 | 4.96 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 34.2 ± 6 % | 4.79 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL at 5500 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 8.09 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **80.1 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 | **22.5 W/kg ± 19.5 % (k=2)** |

## Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 35.5 | 5.07 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 34.1 ± 6 % | 4.88 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 | 8.12 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 | 2.30 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 | 33.8 ± 6 % | 5.09 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 | 7.69 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **76.1 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 | **21.4 W/kg ± 19.5 % (k=2)** |

## Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 49.0 | 5.30 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 47.0 ± 6 % | 5.42 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 | 7.61 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **75.5 W/kg ± 19.9 % (k=2)** |

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

## Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 48.9 | 5.42 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 46.8 ± 6 % | 5.55 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 | 7.59 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **75.3 W/kg ± 19.9 % (k=2)** |

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

## Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 48.6 | 5.65 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 46.5 ± 6 % | 5.81 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL at 5500 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 8.14 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **80.8 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.26 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **22.4 W/kg ± 19.5 % (k=2)** |

## Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 48.5 | 5.77 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 46.3 ± 6 % | 5.94 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL at 5600 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 8.10 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **80.3 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.25 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **22.3 W/kg ± 19.5 % (k=2)** |

## Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 48.2 | 6.00 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 46.0 ± 6 % | 6.21 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 | 7.57 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **75.1 W/kg ± 19.9 % (k=2)** |

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

## Appendix

### Antenna Parameters with Head TSL at 5200 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 50.5 Ω - 9.8 jΩ |
| Return Loss | - 20.3 dB |

### Antenna Parameters with Head TSL at 5300 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 48.5 Ω - 4.5 jΩ |
| Return Loss | - 26.4 dB |

### Antenna Parameters with Head TSL at 5500 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 50.6 Ω - 5.8 jΩ |
| Return Loss | - 24.8 dB |

### Antenna Parameters with Head TSL at 5600 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 53.9 Ω - 3.8 jΩ |
| Return Loss | - 25.6 dB |

### Antenna Parameters with Head TSL at 5800 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 52.5 Ω - 4.4 jΩ |
| Return Loss | - 26.1 dB |

### Antenna Parameters with Body TSL at 5200 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 49.3 Ω - 7.9 jΩ |
| Return Loss | - 22.0 dB |

### Antenna Parameters with Body TSL at 5300 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 48.7 Ω - 3.2 jΩ |
| Return Loss | - 29.2 dB |

### Antenna Parameters with Body TSL at 5500 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 51.2 Ω - 4.8 jΩ |
| Return Loss | - 26.2 dB |

### Antenna Parameters with Body TSL at 5600 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 53.6 Ω - 2.1 jΩ |
| Return Loss | - 27.9 dB |

## Antenna Parameters with Body TSL at 5800 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 53.3 Ω - 2.9 jΩ |
| Return Loss | - 27.4 dB |

## General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.202 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 | November 27, 2006 |

## DASY5 Validation Report for Head TSL

Date: 11.01.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1057**

Communication System: CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; $\sigma$ = 4.5 S/m; $\varepsilon_r$ = 34.6; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5300 MHz; $\sigma$ = 4.6 S/m; $\varepsilon_r$ = 34.5; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5500 MHz; $\sigma$ = 4.79 S/m; $\varepsilon_r$ = 34.2; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5600 MHz; $\sigma$ = 4.88 S/m; $\varepsilon_r$ = 34.1; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5800 MHz; $\sigma$ = 5.09 S/m; $\varepsilon_r$ = 33.8; $\rho$ = 1000 kg/m$^3$
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(4.91, 4.91, 4.91); 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: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

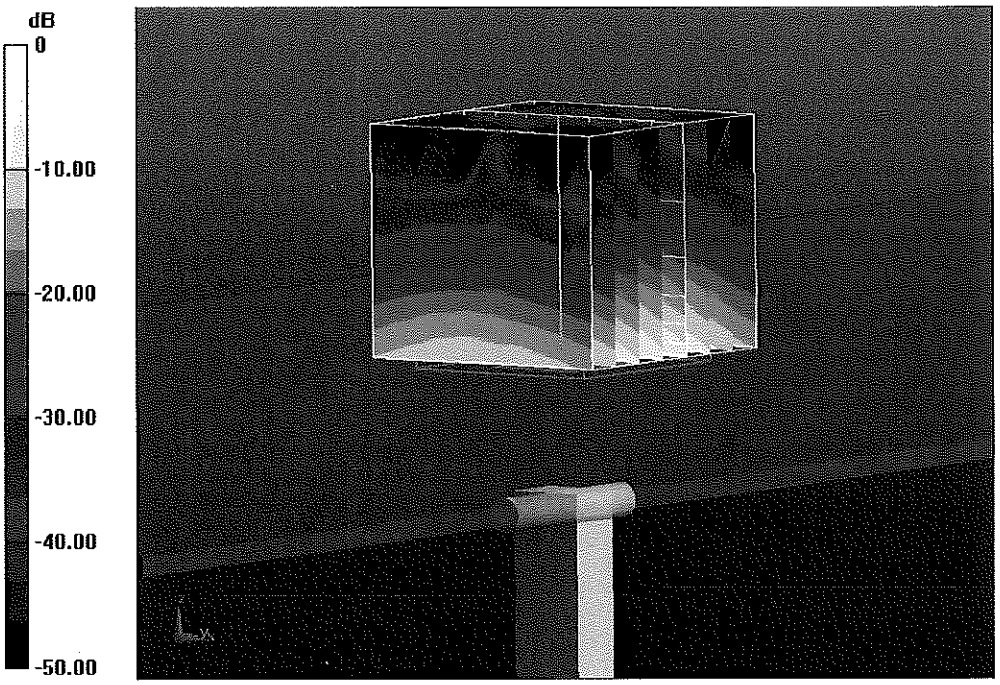
**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.671 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 29.4 W/kg
**SAR(1 g) = 7.66 W/kg; SAR(10 g) = 2.17 W/kg**
Maximum value of SAR (measured) = 18.5 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.473 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 30.3 W/kg
**SAR(1 g) = 7.76 W/kg; SAR(10 g) = 2.22 W/kg**
Maximum value of SAR (measured) = 18.8 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.735 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 33.2 W/kg
**SAR(1 g) = 8.09 W/kg; SAR(10 g) = 2.28 W/kg**
Maximum value of SAR (measured) = 20.1 W/kg

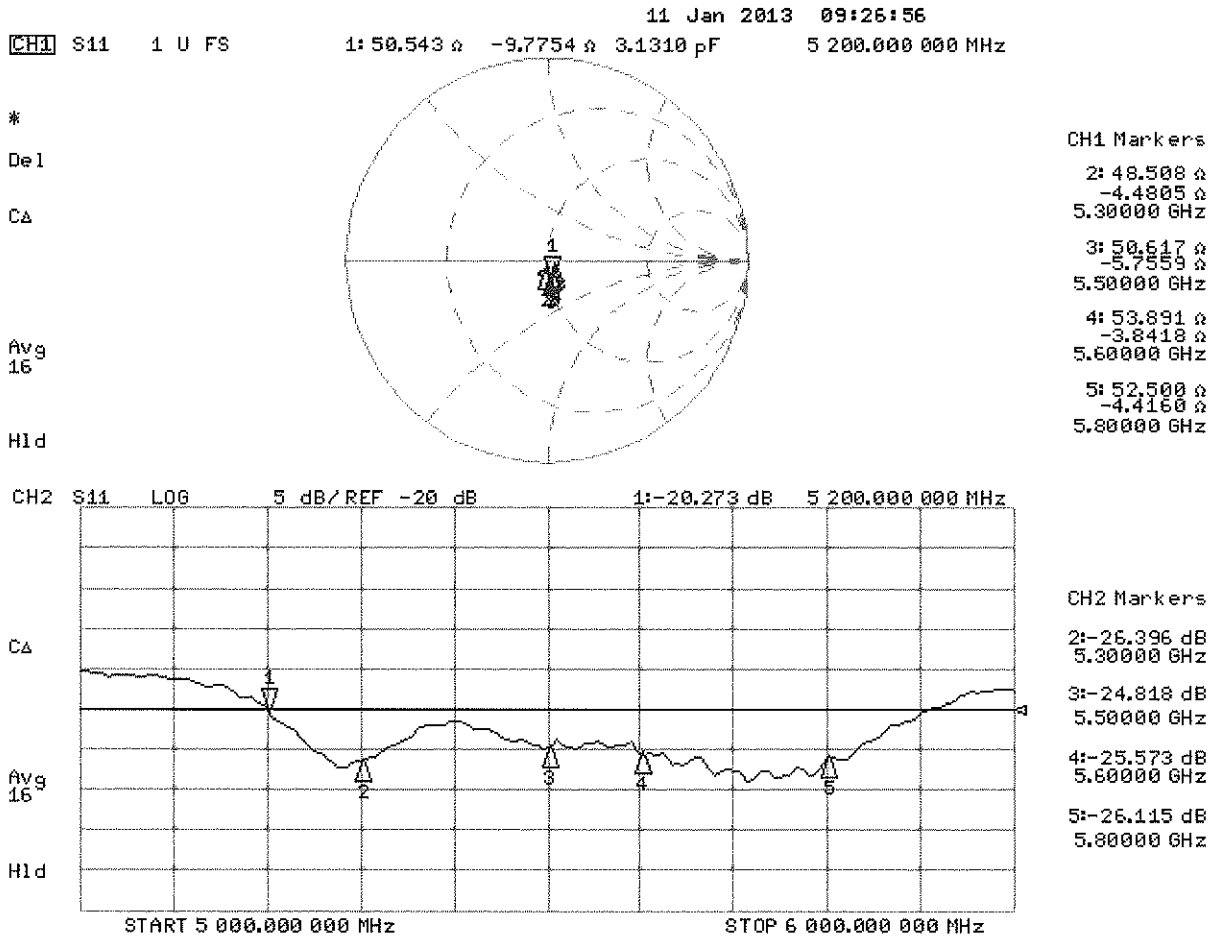
**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.848 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 33.5 W/kg
**SAR(1 g) = 8.12 W/kg; SAR(10 g) = 2.3 W/kg**
Maximum value of SAR (measured) = 20.2 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 60.467 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 33.3 W/kg
**SAR(1 g) = 7.69 W/kg; SAR(10 g) = 2.17 W/kg**
Maximum value of SAR (measured) = 19.4 W/kg



0 dB = 19.4 W/kg = 12.88 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 10.01.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1057**

Communication System: CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; $\sigma$ = 5.42 S/m; $\varepsilon_r$ = 47; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5300 MHz; $\sigma$ = 5.55 S/m; $\varepsilon_r$ = 46.8; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5500 MHz; $\sigma$ = 5.81 S/m; $\varepsilon_r$ = 46.5; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5600 MHz; $\sigma$ = 5.94 S/m; $\varepsilon_r$ = 46.3; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5800 MHz; $\sigma$ = 6.21 S/m; $\varepsilon_r$ = 46; $\rho$ = 1000 kg/m$^3$
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(4.43, 4.43, 4.43); 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: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

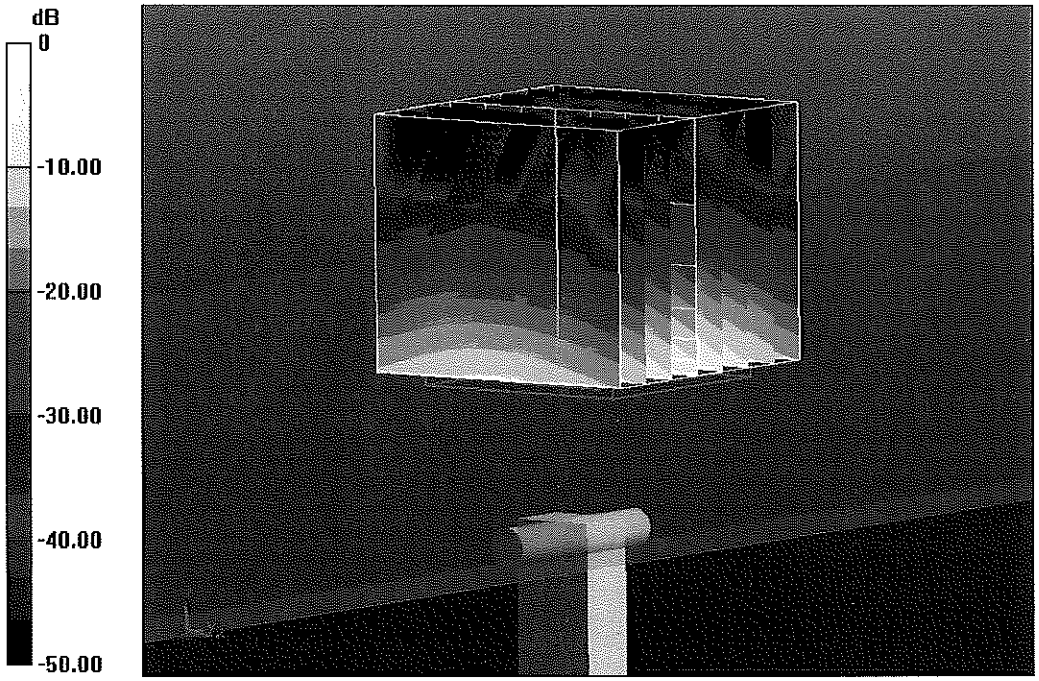
**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.074 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 30.4 W/kg
**SAR(1 g) = 7.61 W/kg; SAR(10 g) = 2.13 W/kg**
Maximum value of SAR (measured) = 18.0 W/kg

**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 58.924 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 30.9 W/kg
**SAR(1 g) = 7.59 W/kg; SAR(10 g) = 2.13 W/kg**
Maximum value of SAR (measured) = 17.9 W/kg

**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.561 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 35.3 W/kg
**SAR(1 g) = 8.14 W/kg; SAR(10 g) = 2.26 W/kg**
Maximum value of SAR (measured) = 19.7 W/kg

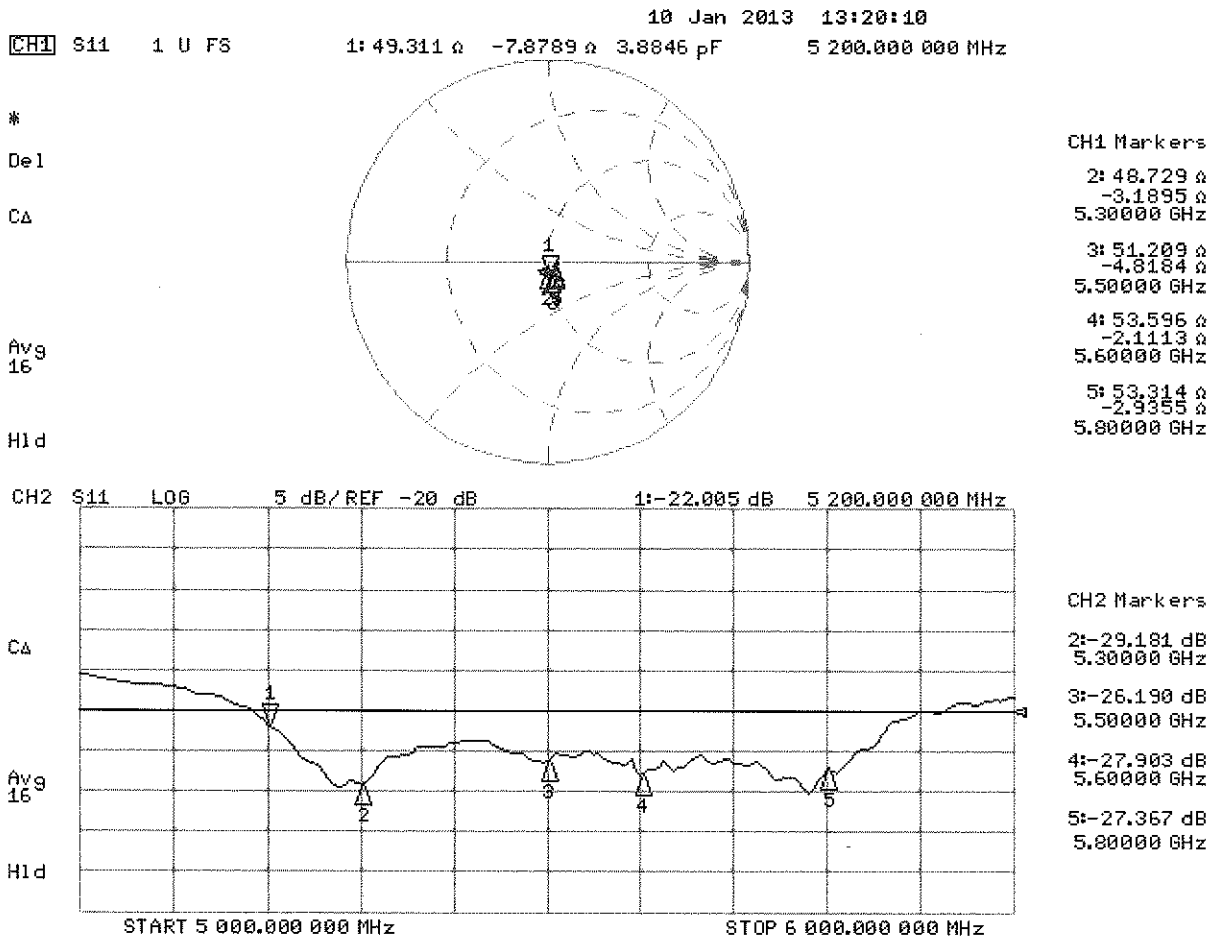
**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 58.884 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 36.3 W/kg
**SAR(1 g) = 8.1 W/kg; SAR(10 g) = 2.25 W/kg**
Maximum value of SAR (measured) = 20.0 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 = 55.753 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 35.6 W/kg
**SAR(1 g) = 7.57 W/kg; SAR(10 g) = 2.09 W/kg**
Maximum value of SAR (measured) = 18.9 W/kg



0 dB = 18.9 W/kg = 12.76 dBW/kg

## Impedance Measurement Plot for Body TSL



# APPENDIX D: SAR TISSUE SPECIFICATIONS

Measurement Procedure for Tissue Verification:

1) The network analyzer and probe system was configured and calibrated.
2) The probe was immersed in the tissue. The tissue was placed in a nonmetallic container. Trapped air bubbles beneath the flange were minimized by placing the probe at a slight angle.
3) The complex admittance with respect to the probe aperture was measured
4) The complex relative permittivity $\varepsilon_r^{'}$ can be calculated from the below equation (Pournaropoulos and Misra):

$$Y = \frac{j2\omega\varepsilon_r\varepsilon_0}{[\ln(b/a)]^2}\int_a^b\int_a^b\int_0^\pi \cos\phi' \frac{\exp\left[-j\omega r(\mu_0\varepsilon_r^{'}\varepsilon_0)^{1/2}\right]}{r} d\phi' d\rho' d\rho$$

where *Y* is the admittance of the probe in contact with the sample, the primed and unprimed coordinates refer to source and observation points, respectively, $r^2 = \rho^2 + \rho'^2 - 2\rho\rho'\cos\phi'$ , $\omega$ is the angular frequency, and $j = \sqrt{-1}$ .

**Table D-I**
**Composition of the Tissue Equivalent Matter**

| Frequency (MHz) | 2450 | 5200-5800 |
|---|---|---|
| Tissue | Body | Body |
| Ingredients (% by weight) | | |
| DGBE | 26.7 | |
| NaCl | 0.1 | |
| Polysorbate (Tween) 80 | | 20 |
| Water | 73.2 | 80 |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# APPENDIX E: SAR SYSTEM VALIDATION

Per FCC KDB 865664 D02v01, SAR system validation status should be documented to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the required tissue- equivalent media for system validation, according to the procedures outlined in IEEE 1528-2003 and FCC KDB 865664 D01 v01. Since SAR probe calibrations are frequency dependent, each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media.

A tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probes and tissue dielectric parameters has been included.

**Table E-I**
**SAR System Validation Summary**

| SAR SYSTEM # | FREQ. [MHz] | DATE | PROBE SN | PROBE TYPE | PROBE CAL. POINT | | COND. | PERM. | CW VALIDATION | | | MOD. VALIDATION | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | (σ) | ($\varepsilon_r$) | SENSI-TIVITY | PROBE LINEARITY | PROBE ISOTROPY | MOD. TYPE | DUTY FACTOR | PAR |
| E | 2450 | 11/1/2012 | 3263 | ES3DV3 | 2450 | Body | 2.032 | 50.78 | PASS | PASS | PASS | OFDM | N/A | PASS |
| B | 2450 | 1/30/2013 | 3287 | ES3DV3 | 2450 | Body | 1.985 | 51.49 | PASS | PASS | PASS | OFDM | N/A | PASS |
| A | 5200 | 1/23/2013 | 3589 | EX3DV4 | 5200 | Body | 5.292 | 47.850 | PASS | PASS | PASS | OFDM | N/A | PASS |
| A | 5300 | 1/23/2013 | 3589 | EX3DV4 | 5300 | Body | 5.477 | 47.470 | PASS | PASS | PASS | OFDM | N/A | PASS |
| A | 5500 | 1/23/2013 | 3589 | EX3DV4 | 5500 | Body | 5.729 | 47.030 | PASS | PASS | PASS | OFDM | N/A | PASS |
| A | 5600 | 1/23/2013 | 3589 | EX3DV4 | 5600 | Body | 5.916 | 46.700 | PASS | PASS | PASS | OFDM | N/A | PASS |
| A | 5800 | 1/23/2013 | 3589 | EX3DV4 | 5800 | Body | 6.233 | 46.200 | PASS | PASS | PASS | OFDM | N/A | PASS |


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