



## SAR EVALUATION REPORT

**Applicant Name:**  
 Samsung Electronics, Co. Ltd.  
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 Gyeonggi-do 443-742, Korea

**Date of Testing:**  
 11/22/13 - 12/19/13  
**Test Site/Location:**  
 PCTEST Lab, Columbia, MD, USA  
**Document Serial No.:**  
 0Y1311202208-R1.A3L

**FCC ID:** A3LSMG7109

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

**DUT Type:** Portable Handset  
**Application Type:** Certification  
**FCC Rule Part(s):** CFR §2.1093  
**Model(s):** SM-G7109

Equipment Class	Band & Mode	Tx Frequency	Measured Conducted Power [dBm]	SAR		
				1 gm Head (W/kg)	1 gm Body-Worn (W/kg)	1 gm Hotspot (W/kg)
PCE	GSM/GPRS/EDGE 850	824.20 - 848.80 MHz	32.95	0.19	0.32	0.32
PCE	UMTS 850	826.40 - 846.60 MHz	23.02	0.13	0.24	0.38
PCE	GSM/GPRS/EDGE 1900	1850.20 - 1909.80 MHz	30.50	0.29	0.49	0.67
PCE	UMTS 1900	1852.4 - 1907.6 MHz	23.23	0.33	0.54	0.79
PCE	Cell. CDMA/EVDO	824.70 - 848.31 MHz	24.59	0.20	0.30	0.30
PCE	PCS CDMA/EVDO	1851.25 - 1908.75 MHz	24.81	0.48	1.04	1.09
DTS	2.4 GHz WLAN	2412 - 2462 MHz	17.00	< 0.1	< 0.1	< 0.1
DTS	5.8 GHz WLAN	5745 - 5825 MHz	11.14	< 0.1	0.51	0.51
NII	5.2 GHz WLAN	5180 - 5240 MHz	11.57	< 0.1	0.66	
NII	5.3 GHz WLAN	5260 - 5320 MHz	11.06	< 0.1	0.68	
NII	5.5 GHz WLAN	5500 - 5700 MHz	11.61	< 0.1	0.26	
DSS/DTS	Bluetooth	2402 - 2480 MHz	9.73	N/A		
<b>Simultaneous SAR per KDB 690783 D01v01r02:</b>				0.74	1.49	1.55

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: 0Y1311202208-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 tests 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 1.8 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



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# 1 DEVICE UNDER TEST



## 1.1 Device Overview

Band & Mode	Operating Modes	Tx Frequency
GSM/GPRS/EDGE 850	Voice/Data	824.20 - 848.80 MHz
UMTS 850	Voice/Data	826.40 - 846.60 MHz
GSM/GPRS/EDGE 1900	Voice/Data	1850.20 - 1909.80 MHz
UMTS 1900	Voice/Data	1852.4 - 1907.6 MHz
Cell. CDMA/EVDO	Voice/Data	824.70 - 848.31 MHz
PCS CDMA/EVDO	Voice/Data	1851.25 - 1908.75 MHz
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
NFC	Data	13.56 MHz

## 1.2 Nominal and Maximum Output Power Specifications

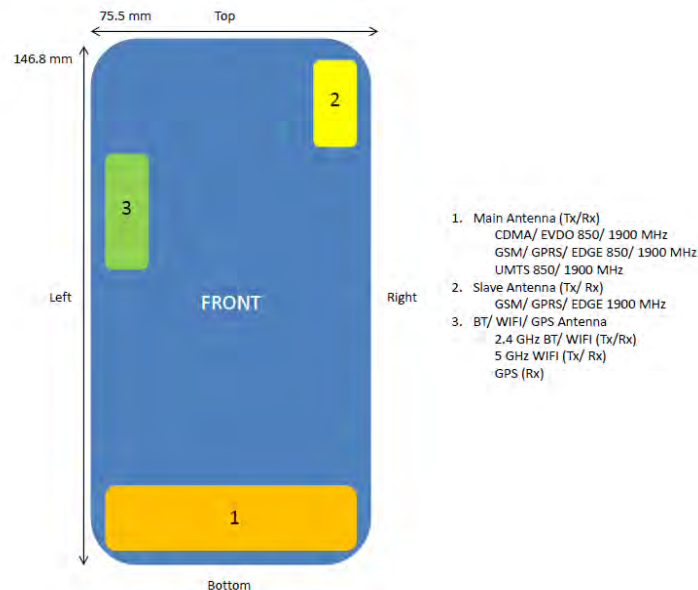
This device operates using the following maximum and nominal output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498 D01v05.

Mode / Band		Voice (dBm)	Burst Average GSMK (dBm)		Burst Average 8-PSK (dBm)	
		1 TX Slot	1 TX Slots	2 TX Slots	1 TX Slots	2 TX Slots
GSM/GPRS/EDGE 850	Maximum	33.5	33.5	31.5	28.0	27.5
	Nominal	33.0	33.0	31.0	27.5	27.0
GSM/GPRS/EDGE 1900 (Main Antenna)	Maximum	30.5	30.5	28.5	26.5	26.5
	Nominal	30.0	30.0	28.0	26.0	26.0
GSM/GPRS/EDGE 1900 (Slave Antenna)	Maximum	30.5	30.5	28.5	26.5	26.5
	Nominal	30.0	30.0	28.0	26.0	26.0
Mode / Band		Modulated Average (dBm)				
		3GPP WCDMA Rel 99	3GPP HSDPA Rel 5	3GPP HSUPA Rel 6		
UMTS Band 5 (850 MHz)	Maximum	23.5	22.5	22.5		
	Nominal	23.0	22.0	22.0		
UMTS Band 2 (1900 MHz)	Maximum	23.5	22.5	22.5		
	Nominal	23.0	22.0	22.0		
Mode / Band		Modulated Average (dBm)				
		Maximum	25.0			
Cell. CDMA/EVDO	Nominal	24.5				
	Maximum	25.0				
PCS CDMA/EVDO	Nominal	24.5				

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Mode / Band		Modulated Average (dBm)
IEEE 802.11b (2.4 GHz)	Maximum	17.5
	Nominal	17.0
IEEE 802.11g (2.4 GHz)	Maximum	12.5
	Nominal	12.0
IEEE 802.11n (2.4 GHz)	Maximum	11.5
	Nominal	11.0
IEEE 802.11a (5 GHz)	Maximum	12.0
	Nominal	11.5
IEEE 802.11n (5 GHz - 20 MHz)	Maximum	12.0
	Nominal	11.5
IEEE 802.11n (5 GHz - 40 MHz)	Maximum	9.0
	Nominal	8.5
Bluetooth	Maximum	10.0
	Nominal	9.5
Bluetooth LE	Maximum	2.0
	Nominal	1.5

### 1.3 DUT Antenna Locations



Note: Exact antenna dimensions and separation distances are shown in the Technical Descriptions.

**Figure 1-1**  
**DUT Antenna Locations**

**Table 1-1**  
**Mobile Hotspot Sides for SAR Testing**

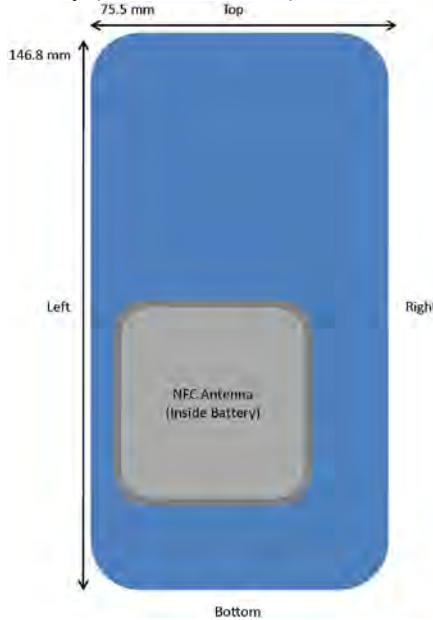
Mobile Hotspot Sides for SAR Testing						
Mode	Back	Front	Top	Bottom	Right	Left
GPRS 850	Yes	Yes	No	Yes	Yes	Yes
UMTS 850	Yes	Yes	No	Yes	Yes	Yes
GPRS 1900 - Main Antenna	Yes	Yes	No	Yes	Yes	Yes
GPRS 1900 - Slave Antenna	Yes	Yes	Yes	No	Yes	No
UMTS 1900	Yes	Yes	No	Yes	Yes	Yes
Cell. EVDO	Yes	Yes	No	Yes	Yes	Yes
PCS EVDO	Yes	Yes	No	Yes	Yes	Yes
2.4 GHz WLAN	Yes	Yes	No	No	No	Yes
5.8 GHz WLAN	Yes	Yes	No	No	No	Yes

Note: Particular DUT edges were not required to be evaluated for Wireless Router SAR if the edges were greater than 2.5 cm from the transmitting antenna according to FCC KDB Publication 941225 D06v01 guidance, page 2.

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### 1.4 Near Field Communications (NFC) Antenna

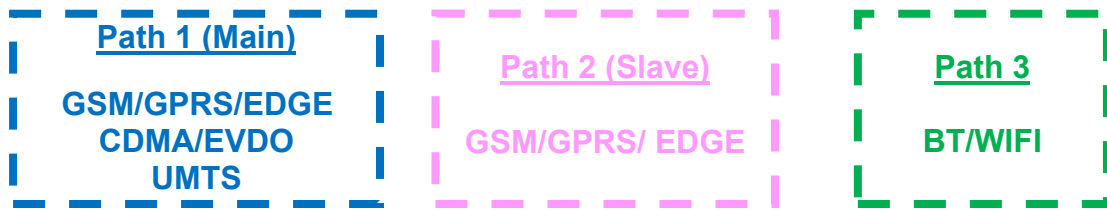
This DUT has NFC operations. The NFC antenna is integrated into the specialized battery. The SAR tests were performed with the standard battery (model: B600BC).



**Figure 1-2**  
NFC Antenna Locations



### 1.5 Simultaneous Transmission Capabilities

According to FCC KDB Publication 447498 D05v01, transmitters are considered to be transmitting simultaneously when there is overlapping transmission, with the exception of transmissions during network hand-offs with maximum hand-off duration less than 30 seconds. Possible transmission paths for the DUT are shown in Figure 1-3 and are color-coded to indicate communication modes which share the same path. Modes which share the same transmission path cannot transmit simultaneously with one another.



**Figure 1-3**  
Simultaneous Transmission Paths

This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis according to FCC KDB Publication 447498 D01v05 3) procedures.

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**Table 1-2  
Simultaneous Transmission Scenarios**

No.	Capable Transmit Configuration	Head	Body-Worn Accessory	Wireless Router
1	GSM 850/1900 MHz Voice + 2.4GHz WIFI	Yes	Yes	N/A
2	GSM 850/1900 MHz Voice + 2.4GHz Bluetooth	N/A	Yes	N/A
3	GSM 850/1900 MHz Voice + 5 GHz WIFI	Yes	Yes	N/A
4	GPRS 850/1900 MHz Data + 2.4GHz WIFI	N/A	N/A	Yes
5	GPRS 850/1900 MHz Data + 5.8 GHz WIFI	N/A	N/A	Yes
6	UMTS 850/1900 MHz Voice + 2.4GHz WIFI	Yes	Yes	N/A
7	UMTS 850/1900 MHz Voice + 2.4GHz Bluetooth	N/A	Yes	N/A
8	UMTS 850/1900 MHz Voice + 5 GHz WIFI	Yes	Yes	N/A
9	UMTS 850/1900 MHz Data + 2.4GHz WIFI	Yes	Yes	Yes
10	UMTS 850/1900 MHz Data + 5.8 GHz WIFI	Yes	Yes	Yes
11	1x CDMA 850/1900 MHz Voice + 2.4GHz WIFI	Yes	Yes	N/A
12	1x CDMA 850/1900 MHz Voice + 2.4GHz Bluetooth	N/A	Yes	N/A
13	1x CDMA 850/1900 MHz Voice + 5 GHz WIFI	Yes	Yes	N/A
14	EVDO 850/1900 MHz Data + 2.4GHz WIFI	Yes	Yes	Yes
15	EVDO 850/1900 MHz Data + 2.4GHz Bluetooth	N/A	Yes	N/A
16	EVDO 850/1900 MHz Data + 5.8 GHz WIFI	Yes	Yes	Yes
17	1x CDMA 850/1900 MHz Voice + GPRS 1900 MHz Data	Yes	Yes	N/A
18	1x CDMA 850/1900 MHz Voice + GPRS 1900 MHz Data + 2.4GHz WIFI	Yes	Yes	Yes
19	1x CDMA 850/1900 MHz Voice + GPRS 1900 MHz Data + 2.4GHz Bluetooth	N/A	Yes	N/A
20	1x CDMA 850/1900 MHz Voice + GPRS 1900 MHz Data + 5.8 GHz WIFI	Yes	Yes	Yes
21	GSM 1900 MHz Voice + EVDO 850/1900 MHz Data	Yes	Yes	N/A
22	GSM 1900 MHz Voice + EVDO 850/1900 MHz Data + 2.4GHz WIFI	Yes	Yes	Yes
23	GSM 1900 MHz Voice + EVDO 850/1900 MHz Data + 2.4GHz Bluetooth	N/A	Yes	N/A
24	GSM 1900 MHz Voice + EVDO 850/1900 MHz Data + 5.8 GHz WIFI	Yes	Yes	Yes
25	UMTS 850/1900 MHz Voice + GPRS 1900 MHz Data	Yes	Yes	N/A
26	UMTS 850/1900 MHz Voice + GPRS 1900 MHz Data + 2.4GHz WIFI	Yes	Yes	Yes
27	UMTS 850/1900 MHz Voice + GPRS 1900 MHz Data + 2.4GHz Bluetooth	N/A	Yes	N/A
28	UMTS 850/1900 MHz Voice + GPRS 1900 MHz Data + 5.8 GHz WIFI	Yes	Yes	Yes
29	GSM 1900 MHz Voice + UMTS 850/1900 MHz Data	Yes	Yes	N/A
30	GSM 1900 MHz Voice + UMTS 850/1900 MHz Data + 2.4GHz WIFI	Yes	Yes	Yes
31	GSM 1900 MHz Voice + UMTS 850/1900 MHz Data + 2.4GHz Bluetooth	N/A	Yes	N/A
32	GSM 1900 MHz Voice + UMTS 850/1900 MHz Data + 5.8 GHz WIFI	Yes	Yes	Yes
33	GSM 850/1900 MHz Voice + GPRS 1900 MHz Data	Yes	Yes	N/A
34	GSM 850/1900 MHz Voice + GPRS 1900 MHz Data + 2.4GHz WIFI	Yes	Yes	Yes
35	GSM 850/1900 MHz Voice + GPRS 1900 MHz Data + 2.4GHz Bluetooth	N/A	Yes	N/A
36	GSM 850/1900 MHz Voice + GPRS 1900 MHz Data + 5.8 GHz WIFI	Yes	Yes	Yes
37	GSM 1900 MHz Voice + GPRS 850/1900 MHz Data	Yes	Yes	N/A
38	GSM 1900 MHz Voice + GPRS 850/1900 MHz Data + 2.4GHz WIFI	Yes	Yes	Yes
39	GSM 1900 MHz Voice + GPRS 850/1900 MHz Data + 2.4GHz Bluetooth	N/A	Yes	N/A
40	GSM 1900 MHz Voice + GPRS 850/1900 MHz Data + 5.8 GHz WIFI	Yes	Yes	Yes

Notes:

- All modes that share the same antenna path cannot transmit simultaneously.
- Bluetooth and WLAN share the same antenna path and cannot transmit simultaneously.
- 5 GHz hotspot is only supported for the 5.8 GHz Band; therefore, all other 5 GHz bands were not evaluated for hotspot conditions.
- Per the manufacturer, WIFI Direct is not expected to be used in conjunction with a held-to-ear or body-worn accessory voice call. Therefore, there are no new simultaneous transmission scenarios involving WIFI direct.

## 1.6 SAR Test Exclusions Applied

### (A) WIFI/BT



2.4 GHz WIFI Hotspot SAR tests and combinations are considered for SAR with respect to Wireless Router configurations according to FCC KDB 941225 D06v01r01. 5 GHz hotspot is only supported for the 5.8 GHz Band; therefore, all other 5 GHz bands were not evaluated for hotspot conditions.

Per FCC KDB 447498 D01v05, the SAR exclusion threshold for distances <50mm is defined by the following equation:

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

Based on the maximum conducted power of Bluetooth (rounded to the nearest mW) and the antenna to user separation distance, Bluetooth SAR was not required;  $[(10/10) * \sqrt{2.441}] = 1.6 < 3.0$ . Per KDB Publication 447498 D01v05, the maximum power of the channel was rounded to the nearest mW before calculation.

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.

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## (B) Licensed Transmitter(s)

GSM/GPRS/EDGE DTM is not supported for US bands. Therefore, the GSM Voice modes in this report do not transmit simultaneously with GPRS/EDGE Data of the same antenna path.

This device is only capable of QPSK HSUPA in the uplink. Therefore, no additional SAR tests are required beyond that described for devices with HSUPA in KDB 941225 D01v02.

When the user utilizes multiple services in UMTS 3G mode it uses multi-Radio Access Bearer or multi-RAB. The power control is based on a physical control channel (Dedicated Physical Control Channel [DPCCH]) and power control will be adjusted to meet the needs of both services. Therefore, the UMTS+WLAN scenario also represents the UMTS Voice/DATA + WLAN Hotspot scenario.

CDMA 1X Advanced technology was not required for SAR since the maximum output powers for 1x Advanced was not more than 0.25 dB higher than the maximum measured powers for 1x and the measured SAR in any 1x mode exposure conditions was not greater than 1.2 W/kg.

## 1.7 Power Reduction for SAR

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



## 1.8 Guidance Applied

- FCC OET Bulletin 65 Supplement C [June 2001]
- IEEE 1528-2003
- FCC KDB Publication 941225 D01-D06 (2G/3G and Hotspot)
- 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)
- April 2013 TCB Workshop Notes (1x Advanced)
- October 2013 TCB Workshop Notes (GSM/GPRS/EDGE SAR Testing Criteria)

## 1.9 Device Serial Numbers

Several samples were used with identical hardware to support SAR testing. 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.

	Head Serial Number	Body-Worn Serial Number	Hotspot Serial Number
GSM/GPRS/EDGE 850	FK-345-A	FK-345-A	FK-345-A
UMTS 850	FK-345-B	FK-345-A	FK-345-A
GSM/GPRS/EDGE 1900 (Main Antenna)	FK-345-B	FK-345-B	FK-345-B
GSM/GPRS/EDGE 1900 (Slave Antenna)	FK-345-1	FK-345-1	FK-345-1
UMTS 1900	FK-345-B	FK-345-B	FK-345-B
Cell. CDMA/EVDO	FK-345-B	FK-345-A	FK-345-A
PCS CDMA/EVDO	FK-345-B	FK-345-B	FK-345-B
2.4 GHz WLAN	FK-345-A	FK-345-B	FK-345-B
5 GHz WLAN	FK-345-B	FK-345-A	FK-345-A

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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 ( $\rho$ ). 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:

- $\sigma$  = conductivity of the tissue-simulating material (S/m)
- $\rho$  = mass density of the tissue-simulating material ( $\text{kg/m}^3$ )
- 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]

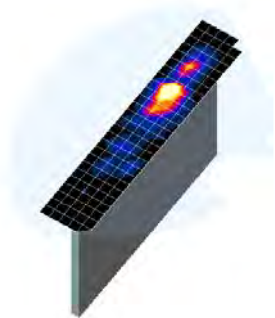
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### 3 DOSIMETRIC ASSESSMENT

#### 3.1 Measurement Procedure

The evaluation was performed using the following procedure:



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.



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

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

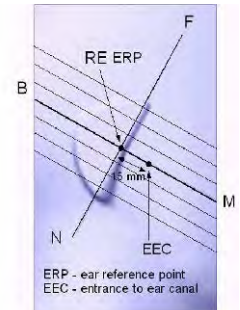
Frequency	Maximum Area Scan Resolution (mm) ( $\Delta x_{area}, \Delta y_{area}$ )	Maximum Zoom Scan Resolution (mm) ( $\Delta x_{zoom}, \Delta y_{zoom}$ )	Maximum Zoom Scan Spatial Resolution (mm)			Minimum Zoom Scan Volume (mm) (x, y, z)
			Uniform Grid	Graded Grid		
			$\Delta z_{zoom}(n)$	$\Delta z_{zoom}(1)^*$	$\Delta z_{zoom}(n>1)^*$	
≤ 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 DEFINITION OF REFERENCE POINTS

## 4.1 EAR REFERENCE POINT

Figure 4-2 shows the front, back and side views of the SAM Twin Phantom. The point “M” is the reference point for the center of the mouth, “LE” is the left ear reference point (ERP), and “RE” is the right ERP. The ERP is 15mm posterior to the entrance to the ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 4-1. The plane passing through the two ear canals and M is defined as the Reference Plane. The line N-F (Neck-Front) is perpendicular to the reference plane and passing through the RE (or LE) is called the Reference Pivoting Line (see Figure 4-1). Line B-M is perpendicular to the N-F line. Both N-F and B-M lines are marked on the external phantom shell to facilitate handset positioning [5].



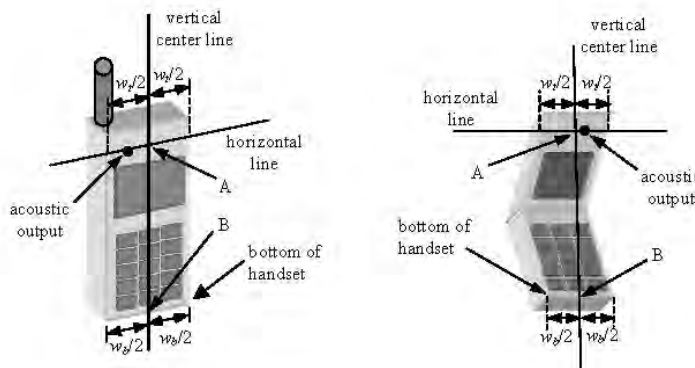
**Figure 4-1**  
Close-Up Side view of ERP

## 4.2 HANDSET REFERENCE POINTS



Two imaginary lines on the handset were established: the vertical centerline and the horizontal line. The test device was placed in a normal operating position with the “test device reference point” located along the “vertical centerline” on the front of the device aligned to the “ear reference point” (See Figure 4-3). The “test device reference point” was then located at the same level as the center of the ear reference point. The test device was positioned so that the “vertical centerline” was bisecting the front surface of the handset at its top and bottom edges, positioning the “ear reference point” on the outer surface of the both the left and right head phantoms on the ear reference point.



**Figure 4-2**  
Front, back and side view of SAM Twin Phantom



**Figure 4-3**  
Handset Vertical Center & Horizontal Line Reference Points

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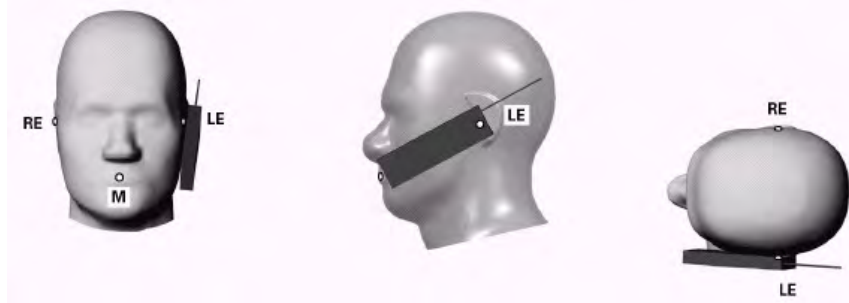
## 5 TEST CONFIGURATION POSITIONS FOR HANDSETS

### 5.1 Device Holder

The device holder is made out of low-loss POM material having the following dielectric parameters: relative permittivity  $\epsilon = 3$  and loss tangent  $\delta = 0.02$ .

### 5.2 Positioning for Cheek

1. The test device was positioned with the device close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 5-1), such that the plane defined by the vertical center line and the horizontal line of the phone is approximately parallel to the sagittal plane of the phantom.





**Figure 5-1 Front, Side and Top View of Cheek Position**

2. The handset was translated towards the phantom along the line passing through RE & LE until the handset touches the ear.
3. While maintaining the handset in this plane, the handset was rotated around the LE-RE line until the vertical centerline was in the plane normal to MB-NF including the line MB (reference plane).
4. The phone was then rotated around the vertical centerline until the phone (horizontal line) was symmetrical with respect to the line NF.
5. While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the device contact with the ear, the device was rotated about the NF line until any point on the handset made contact with a phantom point below the ear (cheek) (See Figure 5-2).

### 5.3 Positioning for Ear / 15° Tilt

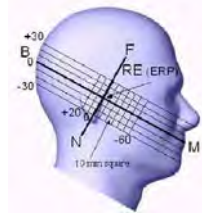
With the test device aligned in the “Cheek Position”:

1. While maintaining the orientation of the phone, the phone was retracted parallel to the reference plane far enough to enable a rotation of the phone by 15 degrees.
2. The phone was then rotated around the horizontal line by 15 degrees.
3. While maintaining the orientation of the phone, the phone was moved parallel to the reference plane until any part of the handset touched the head. (In this position, point A was located on the line RE-LE). The tilted position is obtained when the contact is on the pinna. If the contact was at any location other than the pinna, the angle of the phone would then be reduced. The tilted position was obtained when any part of the phone was in contact of the ear as well as a second part of the phone was in contact with the head (see Figure 5-2).

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**Figure 5-2 Front, Side and Top View of Ear/15° Tilt Position**



**Figure 5-3 Side view w/ relevant markings**

#### 5.4 SAR Evaluations near the Mouth/Jaw Regions of the SAM Phantom

Antennas located near the bottom of a phone may require SAR measurements around the mouth and jaw regions of the SAM head phantom. This typically applies to clam-shell style phones that are generally longer in the unfolded normal use positions or to certain older style long rectangular phones.

Under these circumstances, the following procedures apply, adopted from the FCC guidance on SAR handsets document FCC KDB Publication 648474 D04\_v01. The SAR required in these regions of SAM should be measured using a flat phantom. The phone should be positioned with a separation distance of 4 mm between the ear reference point (ERP) and the outer surface of the flat phantom shell. While maintaining this distance at the ERP location, the low (bottom) edge of the phone should be lowered from the phantom to establish the same separation distance between the peak SAR location identified by the truncated partial SAR distribution measured with the SAM phantom. The distance from the peak SAR location to the phone is determined by the straight line passing perpendicularly through the phantom surface. When it is not feasible to maintain 4 mm separation at the ERP while also establishing the required separation at the peak SAR location, the top edge of the phone will be allowed to touch the phantom with a separation < 4 mm at the ERP. The phone should not be tilted to the left or right while placed in this inclined position to the flat phantom.

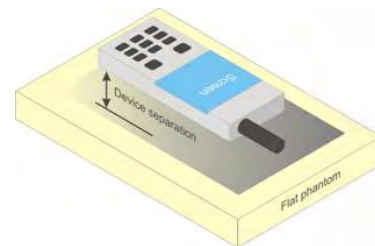
The latest IEEE 1528 committee developments propose the usage of a tilted phantom when the antenna of the phone is mounted at the bottom or in all cases the peak absorption is in the chin region. Both SAM heads of the TwinSAM-Chin20 are rotated 20 degrees around the NF line. Each head can be removed individually from the table for emptying and cleaning.





**Figure 5-4 Twin SAM Chin20**

#### 5.5 Body-Worn Accessory Configurations

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration (see Figure 5-5). Per FCC KDB Publication 648474 D04v01, Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in FCC KDB Publication 447498 D01v05 should be used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode, when applicable. When the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.



**Figure 5-5 Sample Body-Worn Diagram**

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Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are tested with the device with each accessory. If multiple accessories share an identical metallic component (i.e. the same metallic belt-clip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.

Body-worn accessories may not always be supplied or available as options for some devices intended to be authorized for body-worn use. In this case, a test configuration with a separation distance between the back of the device and the flat phantom is used. Test position spacing was documented. Transmitters that are designed to operate in front of a person's face, as in push-to-talk configurations, are tested for SAR compliance with the front of the device positioned to face the flat phantom in head fluid. For devices that are carried next to the body such as a shoulder, waist or chest-worn transmitters, SAR compliance is tested with the accessories, including headsets and microphones, attached to the device and positioned against a flat phantom in a normal use configuration.

## 5.6 Extremity Exposure Configurations



Devices that are designed or intended for use on extremities or mainly operated in extremity only exposure conditions; i.e., hands, wrists, feet and ankles, may require extremity SAR evaluation. When the device also operates in close proximity to the user's body, SAR compliance for the body is also required. The 1-g body and 10-g extremity SAR Exclusion Thresholds found in KDB Publication 44798 D01v05 should be applied to determine SAR test requirements.

Per KDB Publication 44798 D01v05, Cell phones (handsets) are not normally designed to be used on extremities or operated in extremity only exposure conditions. The maximum output power levels of handsets generally do not require extremity SAR testing to show compliance. Therefore, extremity SAR was not evaluated for this device.

## 5.7 Wireless Router Configurations

Some battery-operated handsets have the capability to transmit and receive user data through simultaneous transmission of WIFI simultaneously with a separate licensed transmitter. The FCC has provided guidance in FCC KDB Publication 941225 D06 v01 where SAR test considerations for handsets ( $L \times W \geq 9 \text{ cm} \times 5 \text{ cm}$ ) are based on a composite test separation distance of 10 mm from the front, back and edges of the device containing transmitting antennas within 2.5 cm of their edges, determined from general mixed use conditions for this type of devices. Since the hotspot SAR results may overlap with the body-worn accessory SAR requirements, the more conservative configurations can be considered, thus excluding some body-worn accessory SAR tests.

When the user enables the personal wireless router functions for the handset, actual operations include simultaneous transmission of both the WIFI transmitter and another licensed transmitter. Both transmitters often do not transmit at the same transmitting frequency and thus cannot be evaluated for SAR under actual use conditions due to the limitations of the SAR assessment probes. Therefore, SAR must be evaluated for each frequency transmission and mode separately and spatially summed with the WIFI transmitter according to FCC KDB Publication 447498 D01v05 publication procedures. The "Portable Hotspot" feature on the handset was NOT activated during SAR assessments, to ensure the SAR measurements were evaluated for a single transmission frequency RF signal at a time.

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## 6 RF EXPOSURE LIMITS

### 6.1 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.



### 6.2 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 6-1**  
**SAR Human Exposure Specified in ANSI/IEEE C95.1-1992 and Health Canada Safety Code 6**

HUMAN EXPOSURE LIMITS		
	UNCONTROLLED ENVIRONMENT <i>General Population</i> (W/kg) or (mW/g)	CONTROLLED ENVIRONMENT <i>Occupational</i> (W/kg) or (mW/g)
<b>Peak Spatial Average SAR</b> Head	1.6	8.0
<b>Whole Body SAR</b>	0.08	0.4
<b>Peak Spatial Average SAR</b> Hands, Feet, Ankle, Wrists, etc.	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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# 7 FCC MEASUREMENT PROCEDURES

## 7.1 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.

## 7.2 Procedures Used to Establish RF Signal for SAR

The following procedures are according to FCC KDB Publication 941225 D01 "SAR Measurement Procedures for 3G Devices" v02, October 2007.

The device was placed into a simulated call using a base station simulator in a RF shielded chamber. Establishing connections in this manner ensure a consistent means for testing SAR and are recommended for evaluating SAR [4]. 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.



## 7.3 SAR Measurement Conditions for CDMA2000

The following procedures were performed according to FCC KDB Publication 941225 D01 "SAR Measurement Procedures for 3G Devices" v02, October 2007.

### 7.3.1 Output Power Verification

See 3GPP2 C.S0011/TIA-98-E as recommended by "SAR Measurement Procedures for 3G Devices" v02, October 2007. Maximum output power is verified on the High, Middle and Low channels according to procedures in section 4.4.5.2 of 3GPP2 C.S0011/TIA-98-E. SO55 tests were measured with power control bits in the "All Up" condition.

1. If the mobile station (MS) supports Reverse TCH RC 1 and Forward TCH RC 1, set up a call using Fundamental Channel Test Mode 1 (RC=1/1) with 9600 bps data rate only.
2. Under RC1, C.S0011 Table 4.4.5.2-1, Table 7-1 parameters were applied.
3. If the MS supports the RC 3 Reverse FCH, RC3 Reverse SCH<sub>0</sub> and demodulation of RC 3,4, or 5, set up a call using Supplemental Channel Test Mode 3 (RC 3/3) with 9600 bps Fundamental Channel and 9600 bps SCH<sub>0</sub> data rate.
4. Under RC3, C.S0011 Table 4.4.5.2-2, Table 7-2 was applied.

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**Table 7-1  
Parameters for Max. Power for RC1**

Parameter	Units	Value
$I_{or}$	dBm/1.23 MHz	-104
$\frac{Pilot E_c}{I_{or}}$	dB	-7
$\frac{Traffic E_c}{I_{or}}$	dB	-7.4

**Table 7-2  
Parameters for Max. Power for RC3**

Parameter	Units	Value
$I_{or}$	dBm/1.23 MHz	-86
$\frac{Pilot E_c}{I_{or}}$	dB	-7
$\frac{Traffic E_c}{I_{or}}$	dB	-7.4

5. FCHs were configured at full rate for maximum SAR with “All Up” power control bits.

### 7.3.2 CDMA2000 1x Advanced

This device additionally supports 1x Advanced. Conducted powers were measured using SO75 with RC8 on the uplink and RC11 on the downlink per April 2013 TCB Workshop notes. Smart blanking was disabled for all measurements. The EUT was configured with forward power control Mode 000 and reverse power control at 400 bps. Conducted powers were measured on an Agilent 8960 Series 10 Wireless Communications Test Set, Model E5515C using the CDMA2000 1x Advanced application, Option E1962B-410.

Based on the maximum output power measured for 1x Advanced, SAR is required for 1x advanced when if the maximum output for 1x Advanced is more than 0.25 dB higher than the maximum measured for 1x. Also, if the measured SAR in any 1x mode exposure conditions (head, body etc.) is larger than 1.2 W/kg, the highest of those configurations above 1.2 W/kg for each exposure condition in 1x Advanced has to be repeated. All measured SAR in 1x mode higher than 1.5 W/kg must be repeated for 1x Advanced.

### 7.3.3 Head SAR Measurements

SAR for head exposure configurations is measured in RC3 with the DUT configured to transmit at full rate using Loopback Service Option SO55. SAR for RC1 is not required when the maximum average output of each channel is less than ¼ dB higher than that measured in RC3. Otherwise, SAR is measured on the maximum output channel in RC1 using the exposure configuration that results in the highest SAR for that channel in RC3.

Head SAR was additionally evaluated using EVDO Rev. A to support compliance for VoIP operations. See Section 7.3.5 for EVDO Rev. A configuration parameters.



### 7.3.4 Body SAR Measurements

SAR for body exposure configurations is measured in RC3 with the DUT configured to transmit at full rate on FCH with all other code channels disabled using TDSO / SO32. SAR for multiple code channels (FCH + SCH<sub>n</sub>) is not required when the maximum average output of each RF channel is less than ¼ dB higher than that measured with FCH only. Otherwise, SAR is measured on the maximum output channel (FCH + SCH<sub>n</sub>) with FCH at full rate and SCH<sub>0</sub> enabled at 9600 bps using the exposure configuration that results in the highest SAR for that channel with FCH only. When multiple code channels are enabled, the DUT output may shift by more than 0.5 dB and lead to higher SAR drifts and SCH dropouts. Body SAR was measured using TDSO / SO32 with power control bits in the “All Up”

Body SAR in RC1 is not required when the maximum average output of each channel is less than ¼ dB higher than that measured in RC3. Otherwise, SAR is measured on the maximum output channel in RC1; with Loopback Service Option SO55, at full rate, using the body exposure configuration that results in the highest SAR for that channel in RC3.

### 7.3.5 Handsets with EVDO

For handsets with Ev-Do capabilities, when the maximum average output of each channel in Rev. 0 is less than ¼ dB higher than that measured in RC3 (1x RTT), body SAR for EV-DO is not

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required. Otherwise, SAR for Rev. 0 is measured on the maximum output channel at 153.6 kbps using the body exposure configuration that results in the highest SAR for that channel in RC3. SAR for Rev. A is not required when the maximum average output of each channel is less than that measured in Rev. 0 or less than ¼ dB higher than that measured in RC3. Otherwise, SAR is measured on the maximum output channel for Rev. A using a Reverse Data Channel payload size of 4096 bits and a Termination Target of 16 slots defined for Subtype 2 Physical Layer configurations. A Forward Traffic Channel data rate corresponding to the 2-slot version of 307.2 kbps with the ACK Channel transmitting in all slots would be configured in the downlink for both Rev. 0 and Rev. A.

### 7.3.6 Body SAR Measurements for EVDO Hotspot

Hotspot Body SAR is measured using Subtype 0/1 Physical Layer configurations for Rev. 0 per KDB Publication 941225 D01 procedures for “1x Ev-Do data Devices”. SAR for Subtype 2 Physical layer configurations is not required for Rev. A when the maximum average output of each RF channels is less than that measured in Subtype 0/1 Physical layer configurations. Otherwise, SAR is measured on the maximum output channel for Rev. A using the exposure configuration that results in the highest SAR for the RF channels in Rev. 0. The AT is tested with a Reverse Data Channel rate of 153.6 kbps in Subtype 0/1 Physical Layer configurations; and a Reverse Data Channel payload size of 4096 bits and Termination Target of 16 slots in Subtype 2 Physical Layer configurations.

SAR is not required for 1x RTT for Ev-Do devices that also support 1x RTT voice and/or data operations, when the maximum average output of each channel is less than ¼ dB higher than that measured in Subtype 0/1 Physical Layer configurations for Rev. 0. Otherwise, CDMA “Body-SAR Measurement” procedures for “CDMA 2000 1x Handsets” were applied.

## 7.4 SAR Measurement Conditions for UMTS

### 7.4.1 Output Power Verification

Maximum output power is measured on the High, Middle and Low channels for each applicable transmission band according to the general descriptions in section 5.2 of 3GPP TS 34.121, using the appropriate RMC or AMR with TPC (transmit power control) set to all “1s”.



Maximum output power is verified on the High, Middle and Low channels according to the general descriptions in section 5.2 of 3GPP TS 34.121 (release 5), using the appropriate RMC with TPC (transmit power control) set to all “1s” or applying the required inner loop power control procedures to maintain maximum output power while HSUPA is active. Results for all applicable physical channel configurations (DPCCH, DPDCHn and spreading codes, HS-DPCCH etc) are tabulated in this test report. All configurations that are not supported by the DUT or cannot be measured due to technical or equipment limitations are identified.

### 7.4.2 Head SAR Measurements for Handsets

SAR for head exposure configurations is measured using the 12.2 kbps RMC with TPC bits configured to all “1s”. SAR in AMR configurations is not required when the maximum average output of each RF channel for 12.2 kbps AMR is less than 0.25 dB higher than that measured in 12.2 kbps RMC. Otherwise, SAR is measured on the maximum output channel in 12.2 AMR with a 3.4 kbps SRB (signaling radio bearer) using the exposure configuration that resulted in the highest SAR for that RF channel in the 12.2 kbps RMC mode.

### 7.4.3 Body SAR Measurements

SAR for body exposure configurations is measured using the 12.2 kbps RMC with the TPC bits all “1s”.

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## 7.4.4 SAR Measurements for Handsets with Rel 5 HSDPA

Body SAR for HSDPA is not required for handsets with HSDPA capabilities when the maximum average output power of each RF channel with HSDPA active is less than 0.25 dB higher than that measured without HSDPA using 12.2 kbps RMC and the maximum SAR for 12.2 kbps RMC is  $\leq 75\%$  of the SAR limit. Otherwise, SAR is measured for HSDPA, using an FRC with H-Set 1 in Sub-test 1 and a 12.2 kbps RMC configured in Test Loop Mode 1, using the highest body SAR configuration measured in 12.2 kbps RMC without HSDPA, on the maximum output channel with the body exposure configuration that resulted in the highest SAR in 12.2 kbps RMC mode for that RF channel.

The H-set used in FRC for HSDPA should be configured according to the UE category of a test device. The number of HS-DSCH/HSPDSCHs, HARQ processes, minimum inter-TTI interval, transport block sizes and RV coding sequence are defined by the applicable H-set. To maintain a consistent test configuration and stable transmission conditions, QPSK is used in the FRC for SAR testing. HS-DPCCH should be configured with a CQI feedback cycle of 2 ms to maintain a constant rate of active CQI slots. DPCCH and DPDCH gain factors of  $\beta_c=9$  and  $\beta_d=15$ , and power offset parameters of  $\Delta_{ACK} = \Delta_{NACK} = 5$  and  $\Delta_{CQI}=2$  is used. The CQI value is determined by the UE category, transport block size, number of HS-PDSCHs and modulation used in the FRC.

Sub-Test	$\beta_c$	$\beta_d$	$\beta_d$ (SF)	$\beta_c/\beta_d$	$\beta_{HS}$ (Note 1, Note 2)	CM (dB) (Note 3)	MPR (dB) (Note 3)
1	2/15	15/15	64	2/15	4/15	0.0	0.0
2	12/15 (Note 4)	15/15 (Note 4)	64	12/15 (Note 4)	24/15	1.0	0.0
3	15/15	8/15	64	15/8	30/15	1.5	0.5
4	15/15	4/15	64	15/4	30/15	1.5	0.5



Note 1:  $\Delta_{ACK}$ ,  $\Delta_{NACK}$  and  $\Delta_{CQI} = 8 \Leftrightarrow A_{HS} = \beta_{HS}/\beta_c = 30/15 \Leftrightarrow \beta_{HS} = 30/15 * \beta_c$ .  
 Note 2: For the HS-DPCCH power mask requirement test in clause 5.2C, 5.7A, and the Error Vector Magnitude (EVM) with HS-DPCCH test in clause 5.13.1A, and HSDPA EVM with phase discontinuity in clause 5.13.1AA,  $\Delta_{ACK}$  and  $\Delta_{NACK} = 8$  ( $A_{HS} = 30/15$ ) with  $\beta_{HS} = 30/15 * \beta_c$ , and  $\Delta_{CQI} = 7$  ( $A_{HS} = 24/15$ ) with  $\beta_{HS} = 24/15 * \beta_c$ .  
 Note 3: CM = 1 for  $\beta_c/\beta_d = 12/15$ ,  $\beta_{HS}/\beta_c = 24/15$ . For all other combinations of DPDCH, DPCCH and HS-DPCCH the MPR is based on the relative CM difference. This is applicable for only UEs that support HSDPA in release 6 and later releases.

Figure 7-1  
Table C.10.1.4 of TS 234.121-1

## 7.4.5 SAR Measurements for Handsets with Rel 6 HSUPA

Body SAR for HSUPA is not required when the maximum average output of each RF channel with HSUPA/HSDPA active is less than 0.25 dB higher than as measured without HSUPA/HSDPA using 12.2 kbps RMC and maximum SAR for 12.2 kbps RMC is  $\leq 75\%$  of the SAR limit. Otherwise SAR is measured on the maximum output channel for the body exposure configuration produced highest SAR in 12.2 kbps RMC for that RF channel, using the additional procedures under "Release 6 HSPA data devices"

Head SAR for VOIP operations under HSPA is not required when maximum average output of each RF channel with HSPA is less than 0.25 dB higher than as measured using 12.2 kbps RMC. Otherwise SAR is measured using same HSPA configuration as used for body SAR.

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Sub-test	$\beta_c$	$\beta_d$	$\beta_d$ (SF)	$\beta_c/\beta_d$	$\beta_{hs}^{(1)}$	$\beta_{ec}$	$\beta_{ed}$	$\beta_{ed}$ (SF)	$\beta_{ed}$ (codes)	CM <sup>(2)</sup> (dB)	MPR (dB)	AG <sup>(4)</sup> Index	E-TFCI
1	11/15 <sup>(3)</sup>	15/15 <sup>(3)</sup>	64	11/15 <sup>(3)</sup>	22/15	209/225	1039/225	4	1	1.0	0.0	20	75
2	6/15	15/15	64	6/15	12/15	12/15	94/75	4	1	3.0	2.0	12	67
3	15/15	9/15	64	15/9	30/15	30/15	$\beta_{ed}: 47/15$ $\beta_{ec}: 47/15$	4	2	2.0	1.0	15	92
4	2/15	15/15	64	2/15	4/15	2/15	56/75	4	1	3.0	2.0	17	71
5	15/15 <sup>(4)</sup>	15/15 <sup>(4)</sup>	64	15/15 <sup>(4)</sup>	30/15	24/15	134/15	4	1	1.0	0.0	21	81

Note 1:  $\Delta_{ACK} \Delta_{NACK}$  and  $\Delta_{CQI} = 8 \Leftrightarrow A_{hs} = \beta_{hs}/\beta_c = 30/15 \Leftrightarrow \beta_{hs} = 30/15 * \beta_c$ .

Note 2: CM = 1 for  $\beta_c/\beta_d = 12/15$ ,  $\beta_{hs}/\beta_c = 24/15$ . For all other combinations of DPDCH, DPCCH, HS-DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference.

Note 3: For subtest 1 the  $\beta_c/\beta_d$  ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 10/15$  and  $\beta_d = 15/15$ .

Note 4: For subtest 5 the  $\beta_c/\beta_d$  ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 14/15$  and  $\beta_d = 15/15$ .

Note 5: Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Table 5.1g.

Note 6:  $\beta_{ed}$  can not be set directly; it is set by Absolute Grant Value.

## 7.5 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.

### 7.5.1 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.

### 7.5.2 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 than 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 and 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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# 8 RF CONDUCTED POWERS

## 8.1 CDMA Conducted Powers

Band	Channel	Frequency	SO55 [dBm]	SO55 [dBm]	TDSO SO32 [dBm]	TDSO SO32 [dBm]	1x EvDO Rev. 0 [dBm]	1x EvDO Rev. A [dBm]
	F-RC	MHz	RC1	RC3	FCH+SCH	FCH	(RTAP)	(RETAP)
Cellular	1013	824.7	24.69	24.68	24.71	24.70	23.70	23.65
	384	836.52	24.54	24.59	24.60	24.57	23.66	23.62
	777	848.31	24.20	24.21	24.19	24.22	23.33	23.26
PCS	25	1851.25	25.00	25.00	24.99	24.97	23.70	23.56
	600	1880	24.76	24.81	24.74	24.77	23.33	23.22
	1175	1908.75	24.54	24.54	24.53	24.48	23.11	23.00

Note: RC1 is only applicable for IS-95 compatibility.

Per KDB Publication 941225 D01v02:

1. Head SAR was tested with SO55 RC3. SO55 RC1 was not required since the average output power was not more than 0.25 dB higher than the SO55 RC3 powers.
2. Body-Worn SAR was tested with 1x RTT with TDSO / SO32 FCH Only. Ev-Do and TDSO / SO32 FCH+SCH SAR tests were not required since the average output power was not more than 0.25 dB higher than the TDSO / SO32 FCH only powers.
3. Hotspot SAR is measured using Subtype 0/1 Physical Layer configurations for Rev. 0. If the average output power of Subtype 2 for Rev. A is less than the Rev. 0 power levels, then Rev. A SAR is not required. Otherwise, SAR is measured on the maximum output channel for Rev. A using the exposure configuration that results in the highest SAR for that RF channel in Rev. 0. SAR is not required for 1x RTT for Ev-Do hotspot devices when the maximum average output of each channel is less than 1/4 dB higher than that measured in Subtype 0/1 Physical Layer configurations for Rev. 0
4. CDMA 1x-RTT SAR was additionally required to be evaluated for Hotspot exposure conditions to support simultaneous transmission capabilities.
5. Ev-Do Rev. 0 SAR was additionally required to be evaluated for Head exposure conditions to support simultaneous transmission capabilities.
6. Head SAR was additionally evaluated with EVDO Rev. A to determine compliance for held-to-ear VoIP operations.

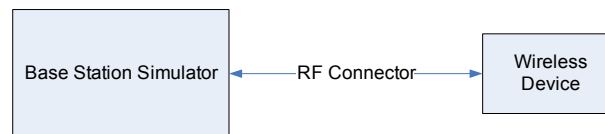




Figure 8-1  
Power Measurement Setup

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## 8.2 GSM Conducted Powers

### 8.2.1 Main Antenna

		Maximum Burst-Averaged Output Power				
		Voice	GPRS/EDGE Data (GMSK)		EDGE Data (8-PSK)	
Band	Channel	GSM [dBm] CS (1 Slot)	GPRS [dBm] 1 Tx Slot	GPRS [dBm] 2 Tx Slot	EDGE [dBm] 1 Tx Slot	EDGE [dBm] 2 Tx Slot
GSM 850	128	33.09	33.15	31.03	27.61	27.48
	190	32.95	32.98	30.86	27.45	27.32
	251	32.79	32.84	30.73	27.36	27.29
GSM 1900	512	30.42	30.27	28.03	26.50	26.44
	661	30.06	29.95	27.73	26.19	26.02
	810	29.94	29.67	27.47	25.92	25.76
		Calculated Maximum Frame-Averaged Output Power				
		Voice	GPRS/EDGE Data (GMSK)		EDGE Data (8-PSK)	
Band	Channel	GSM [dBm] CS (1 Slot)	GPRS [dBm] 1 Tx Slot	GPRS [dBm] 2 Tx Slot	EDGE [dBm] 1 Tx Slot	EDGE [dBm] 2 Tx Slot
GSM 850	128	24.06	24.12	25.01	18.58	21.46
	190	23.92	23.95	24.84	18.42	21.30
	251	23.76	23.81	24.71	18.33	21.27
GSM 1900	512	21.39	21.24	22.01	17.47	20.42
	661	21.03	20.92	21.71	17.16	20.00
	810	20.91	20.64	21.45	16.89	19.74
GSM 850	Frame	23.97	23.97	24.98	18.47	20.98
GSM 1900	Avg.Targets:	20.97	20.97	21.98	16.97	19.98

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## 8.2.2 Slave Antenna

		Maximum Burst-Averaged Output Power				
		Voice	GPRS/EDGE Data (GMSK)		EDGE Data (8-PSK)	
Band	Channel	GSM [dBm] CS (1 Slot)	GPRS [dBm] 1 Tx Slot	GPRS [dBm] 2 Tx Slot	EDGE [dBm] 1 Tx Slot	EDGE [dBm] 2 Tx Slot
GSM 1900	512	30.49	30.46	<b>28.31</b>	26.40	26.30
	661	30.50	30.50	<b>28.36</b>	26.47	26.24
	810	30.50	30.48	<b>28.24</b>	26.36	26.23
		Calculated Maximum Frame-Averaged Output Power				
		Voice	GPRS/EDGE Data (GMSK)		EDGE Data (8-PSK)	
Band	Channel	GSM [dBm] CS (1 Slot)	GPRS [dBm] 1 Tx Slot	GPRS [dBm] 2 Tx Slot	EDGE [dBm] 1 Tx Slot	EDGE [dBm] 2 Tx Slot
GSM 1900	512	21.46	21.43	<b>22.29</b>	17.37	20.28
	661	21.47	21.47	<b>22.34</b>	17.44	20.22
	810	21.47	21.45	<b>22.22</b>	17.33	20.21
GSM 1900	Frame Avg.Targets:	20.97	20.97	<b>21.98</b>	16.97	19.98



Note:

- Both burst-averaged and calculated frame-averaged powers are included. Frame-averaged power was calculated from the measured burst-averaged power by converting the slot powers into linear units and calculating the energy over 8 timeslots.
- The source-based frame-averaged output power was evaluated for all GPRS slot configurations. Per October 2013 TCB Workshop Notes, the configuration with the highest target frame averaged output power was evaluated for hotspot SAR. When the maximum frame-averaged powers are equivalent across two or more slots (within 0.25 dB), the configuration with the most number of time slots was tested
- GPRS/EDGE (GMSK) output powers were measured with coding scheme setting of 1 (CS1) on the base station simulator. CS1 was configured to measure GPRS output power measurements and SAR to ensure GMSK modulation in the signal. Our Investigation has shown that CS1 - CS4 settings do not have any impact on the output levels or modulation in the GPRS modes.
- EDGE (8-PSK) output powers were measured with MCS7 on the base station simulator. MCS7 coding scheme was used to measure the output powers for EDGE since investigation has shown that choosing MCS7 coding scheme will ensure 8-PSK modulation. It has been shown that MCS levels that produce 8PSK modulation do not have an impact on output power.

**GSM Class: B**  
**GPRS Multislot class: 10** (Max 2 Tx uplink slots)  
**EDGE Multislot class: 10** (Max 2 Tx uplink slots)  
**DTM Multislot Class: N/A**



**Figure 8-2**  
**Power Measurement Setup**

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### 8.3 UMTS Conducted Powers

3GPP Release Version	Mode	3GPP 34.121 Subtest	Cellular Band [dBm]			PCS Band [dBm]			3GPP MPR [dB]
			4132	4183	4233	9262	9400	9538	
99	WCDMA	12.2 kbps RMC	23.04	23.02	22.82	23.23	22.96	22.62	-
99		12.2 kbps AMR	23.03	22.91	22.84	23.22	22.94	22.66	-
6	HSDPA	Subtest 1	22.13	22.16	21.80	22.38	22.00	21.71	0
6		Subtest 2	22.25	22.22	21.91	22.29	21.99	21.77	0
6		Subtest 3	21.66	21.68	21.42	21.77	21.45	21.32	0.5
6		Subtest 4	21.65	21.66	21.39	21.79	21.48	21.27	0.5
6	HSUPA	Subtest 1	22.07	22.12	21.58	22.21	22.04	21.64	0
6		Subtest 2	21.12	20.96	20.78	21.08	20.61	20.32	2
6		Subtest 3	21.13	21.17	20.75	21.28	20.29	20.02	1
6		Subtest 4	21.12	21.32	20.74	21.20	20.82	20.88	2
6		Subtest 5	22.16	21.35	21.34	22.16	21.82	21.50	0



UMTS SAR was tested under RMC 12.2 kbps with HSPA Inactive per KDB Publication 941225 D01v02. HSPA SAR was not required since the average output power of the HSPA subtests was not more than 0.25 dB higher than the RMC level and SAR was less than 1.2 W/kg.

This device does not support DC-HSDPA.

It is expected by the manufacturer that MPR for some HSPA subtests may be up to 1 dB more than specified by 3GPP, but also as low as 0 dB according to the chipset implementation in this model.



**Figure 8-3**  
**Power Measurement Setup**

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## 8.4 WLAN Conducted Powers

**Table 8-1  
IEEE 802.11b Average RF Power**

Mode	Freq [MHz]	Channel	802.11b (2.4 GHz) Conducted Power [dBm]			
			Data Rate [Mbps]			
			1	2	5.5	11
802.11b	2412	1*	16.88	16.90	17.18	17.05
802.11b	2437	6*	16.71	16.75	17.21	17.00
802.11b	2462	11*	17.00	17.00	17.21	17.20

**Table 8-2  
IEEE 802.11g Average RF Power**

Mode	Freq [MHz]	Channel	802.11g (2.4 GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			6	9	12	18	24	36	48	54
802.11g	2412	1	12.10	12.11	12.12	12.11	12.27	12.35	12.30	12.30
802.11g	2437	6	11.66	11.64	11.65	11.86	11.68	11.80	11.80	11.73
802.11g	2462	11	12.05	12.20	12.22	12.15	12.20	12.15	12.08	12.15

**Table 8-3  
IEEE 802.11n Average RF Power**



Mode	Freq [MHz]	Channel	802.11n (2.4 GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			6.5	13	20	26	39	52	58	65
802.11n	2412	1	11.40	11.37	11.28	11.28	11.24	11.12	11.22	11.17
802.11n	2437	6	10.71	10.80	10.78	10.76	10.76	10.70	10.65	10.78
802.11n	2462	11	11.37	11.40	11.34	11.26	11.25	11.28	11.24	11.30

**Table 8-4  
IEEE 802.11a Average RF Power**

Mode	Freq [MHz]	Channel	802.11a (5GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			6	9	12	18	24	36	48	54
802.11a	5180	36*	11.50	11.55	11.53	11.55	11.55	11.64	11.57	11.59
802.11a	5200	40	10.50	10.56	10.54	10.58	10.53	10.69	10.49	10.57
802.11a	5220	44	11.02	11.09	11.01	11.09	11.09	11.19	11.07	11.10
802.11a	5240	48*	11.57	11.57	11.57	11.58	11.64	11.73	11.71	11.63
802.11a	5260	52*	10.65	10.62	10.64	10.65	10.70	10.65	10.46	10.40
802.11a	5280	56	11.02	11.03	10.93	11.02	11.10	11.01	10.88	10.75
802.11a	5300	60	11.00	10.99	11.03	10.99	11.03	11.03	10.75	10.71
802.11a	5320	64*	11.06	11.02	11.11	11.05	11.29	11.00	10.88	10.84
802.11a	5500	100	11.45	11.42	11.47	11.46	11.67	11.42	11.47	11.42
802.11a	5520	104*	11.61	11.57	11.65	11.62	11.82	11.55	11.61	11.55
802.11a	5540	108	11.26	11.20	11.34	11.30	11.46	11.21	11.23	11.19
802.11a	5560	112	11.04	11.04	11.05	11.06	11.20	10.98	10.97	10.97
802.11a	5580	116*	11.07	11.07	11.05	11.03	11.21	11.12	11.07	10.99
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	11.14	11.19	11.10	11.14	11.35	11.16	11.17	11.06
802.11a	5680	136*	11.42	11.39	11.49	11.48	11.71	11.39	11.43	11.39
802.11a	5700	140	10.42	10.35	10.45	10.39	10.62	10.47	10.50	10.42
802.11a	5745	149*	11.14	11.09	11.22	11.28	11.17	11.11	11.22	11.19
802.11a	5765	153	10.50	10.44	10.62	10.61	10.55	10.50	10.60	10.47
802.11a	5785	157*	10.23	10.20	10.34	10.32	10.27	10.23	10.27	10.36
802.11a	5805	161*	10.90	10.78	10.98	11.00	10.96	10.88	10.99	10.87
802.11a	5825	165	10.57	10.57	10.63	10.71	10.56	10.55	10.67	10.61

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 than the default channels, these “required channels” are considered for SAR testing instead of the default channels.

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**Table 8-5  
IEEE 802.11n Average RF Power – 20 MHz Bandwidth**

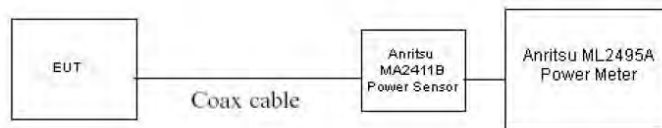
Mode	Freq [MHz]	Channel	20MHz BW 802.11n (5GHz) Conducted Power [dBm]								
			Data Rate [Mbps]								
			6.5	13	19.5	26	39	52	58.5	65	
802.11n	5180	36	10.70	10.50	10.78	10.70	10.65	10.67	10.58	10.58	
802.11n	5200	40	9.63	9.46	9.77	9.64	9.60	9.68	9.57	9.58	
802.11n	5220	44	10.14	9.98	10.21	10.17	10.06	10.17	10.04	10.02	
802.11n	5240	48	10.56	10.38	10.69	10.62	10.48	10.52	10.44	10.48	
802.11n	5260	52	10.51	10.75	10.70	10.59	10.56	10.52	10.52	10.51	
802.11n	5280	56	11.03	11.28	11.23	11.09	11.14	11.01	11.05	11.01	
802.11n	5300	60	11.00	11.24	11.20	11.16	10.99	11.04	11.03	11.04	
802.11n	5320	64	11.05	11.27	11.28	11.12	11.07	11.08	11.00	11.11	
802.11n	5500	100	10.77	10.75	10.75	10.79	10.66	10.50	10.51	10.44	
802.11n	5520	104	10.68	10.69	10.68	10.65	10.55	10.43	10.34	10.35	
802.11n	5540	108	10.41	10.42	10.34	10.39	10.36	10.06	10.11	10.10	
802.11n	5560	112	10.96	10.90	10.92	10.94	10.92	10.61	10.67	10.62	
802.11n	5580	116	11.20	11.24	11.22	11.17	11.13	10.89	11.00	10.88	
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	11.09	11.01	11.09	11.13	11.06	10.78	10.81	10.82	
802.11n	5680	136	11.59	11.50	11.59	11.53	11.51	11.26	11.26	11.21	
802.11n	5700	140	10.60	10.57	10.55	10.61	10.52	10.40	10.36	10.36	
802.11n	5745	149	10.37	10.26	10.40	10.38	10.37	10.33	10.20	10.36	
802.11n	5765	153	10.54	10.49	10.55	10.59	10.53	10.52	10.38	10.53	
802.11n	5785	157	10.32	10.19	10.38	10.35	10.31	10.27	10.11	10.32	
802.11n	5805	161	10.90	10.78	10.91	10.91	10.87	10.87	10.71	10.93	
802.11n	5825	165	10.66	10.51	10.67	10.73	10.69	10.61	10.48	10.62	

**Table 8-6  
IEEE 802.11n Average RF Power – 40 MHz Bandwidth**

Mode	Freq [MHz]	Channel	40MHz BW 802.11n (5GHz) Conducted Power [dBm]								
			Data Rate [Mbps]								
			13.5	27	40.5	54	81	108	121.5	135	
802.11n	5190	38	6.24	6.30	6.22	6.25	6.08	6.19	6.10	6.19	
802.11n	5230	46	6.22	6.30	6.13	6.23	6.08	6.21	6.05	6.10	
802.11n	5270	54	5.58	5.55	5.98	5.50	5.56	5.54	5.49	5.59	
802.11n	5310	62	6.12	6.16	6.49	6.07	6.14	6.06	6.00	6.12	
802.11n	5510	102	7.40	7.43	7.45	7.53	7.40	7.48	7.43	7.53	
802.11n	5550	110	7.32	7.38	7.42	7.42	7.36	7.20	7.25	7.22	
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	8.35	8.39	8.32	8.31	8.33	8.35	8.57	8.25	
802.11n	5755	151	5.61	5.70	5.66	5.67	5.53	5.61	5.56	5.58	
802.11n	5795	159	5.94	6.06	6.04	5.96	5.83	5.88	5.90	5.88	

Justification for reduced test configurations for WIFI channels per KDB Publication 248227 D01v01r02 and October 2012/April 2013 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 and 40 MHz) 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.



**Figure 8-4  
Power Measurement Setup**

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# 9 SYSTEM VERIFICATION

## 9.1 Tissue Verification

**Table 9-1  
Measured Tissue Properties**

Calibrated for Tests Performed on:	Tissue Type	Tissue Temp During Calibration (C°)	Measured Frequency (MHz)	Measured Conductivity, $\sigma$ (S/m)	Measured Dielectric Constant, $\epsilon$	TARGET Conductivity, $\sigma$ (S/m)	TARGET Dielectric Constant, $\epsilon$	% dev $\sigma$	% dev $\epsilon$
12/16/2013	835H	21.5	820	0.892	41.333	0.899	41.578	-0.78%	-0.59%
			835	0.907	41.128	0.900	41.500	0.78%	-0.90%
			850	0.922	40.956	0.916	41.500	0.66%	-1.31%
12/05/2013	1900H	21.8	1850	1.367	39.368	1.400	40.000	-2.36%	-1.58%
			1880	1.396	39.210	1.400	40.000	-0.29%	-1.98%
			1910	1.428	39.082	1.400	40.000	2.00%	-2.30%
12/16/2013	1900H	22.7	1850	1.385	38.983	1.400	40.000	-1.07%	-2.54%
			1880	1.415	38.832	1.400	40.000	1.07%	-2.92%
			1910	1.448	38.709	1.400	40.000	3.43%	-3.23%
11/25/2013	2450H	21.0	2401	1.804	39.350	1.756	39.287	2.73%	0.16%
			2450	1.863	39.159	1.800	39.200	3.50%	-0.10%
			2499	1.918	38.958	1.853	39.138	3.51%	-0.46%
11/26/2013	5200H - 5800H	22.1	5200	4.500	35.078	4.655	35.986	-3.33%	-2.52%
			5240	4.566	35.023	4.696	35.940	-2.98%	-2.55%
			5300	4.587	34.954	4.758	35.871	-3.59%	-2.56%
			5320	4.608	34.919	4.778	35.849	-3.56%	-2.59%
			5500	4.809	34.681	4.963	35.643	-3.10%	-2.70%
			5520	4.825	34.702	4.983	35.620	-3.17%	-2.58%
			5745	5.071	34.382	5.214	35.363	-2.74%	-2.77%
			5800	5.088	34.302	5.270	35.300	-3.45%	-2.83%
12/09/2013	835B	20.1	820	0.995	54.007	0.969	55.258	2.68%	-2.26%
			835	1.012	53.814	0.970	55.200	4.33%	-2.51%
			850	1.026	53.646	0.988	55.154	3.85%	-2.73%
12/09/2013	1900B	20.7	1850	1.521	53.031	1.520	53.300	0.07%	-0.50%
			1880	1.555	52.890	1.520	53.300	2.30%	-0.77%
			1910	1.593	52.793	1.520	53.300	4.80%	-0.95%
12/09/2013	1900B	22.2	1850	1.526	52.060	1.520	53.300	0.39%	-2.33%
			1880	1.559	51.962	1.520	53.300	2.57%	-2.51%
			1910	1.590	51.849	1.520	53.300	4.61%	-2.72%
12/19/2013	1900B	21.8	1850	1.509	51.368	1.520	53.300	-0.72%	-3.62%
			1880	1.543	51.252	1.520	53.300	1.51%	-3.84%
			1910	1.578	51.162	1.520	53.300	3.82%	-4.01%
11/22/2013	2450B	23.0	2401	1.935	51.492	1.903	52.765	1.68%	-2.41%
			2450	1.997	51.345	1.950	52.700	2.41%	-2.57%
			2499	2.074	51.148	2.019	52.638	2.72%	-2.83%
11/25/2013	5200B-5800B	21.5	5180	5.455	46.926	5.276	49.041	3.39%	-4.31%
			5200	5.470	46.900	5.299	49.014	3.23%	-4.31%
			5240	5.521	46.827	5.346	48.960	3.27%	-4.36%
			5280	5.581	46.722	5.393	48.906	3.49%	-4.47%
			5300	5.602	46.718	5.416	48.879	3.43%	-4.42%
			5320	5.623	46.702	5.439	48.851	3.38%	-4.40%
			5500	5.848	46.349	5.650	48.607	3.50%	-4.65%
			5520	5.871	46.327	5.673	48.580	3.49%	-4.64%
			5745	6.187	45.924	5.936	48.275	4.23%	-4.87%
			5765	6.221	45.860	5.959	48.248	4.40%	-4.95%
			5800	6.261	45.808	6.000	48.200	4.35%	-4.96%
			5805	6.273	45.818	6.006	48.193	4.45%	-4.93%

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.

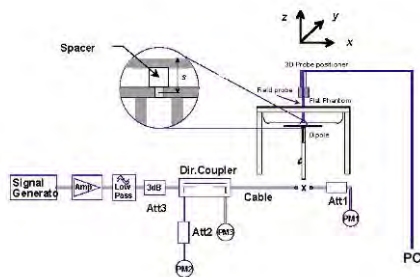
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## 9.2 Test System Verification

Prior to SAR assessment, the system is verified to  $\pm 10\%$  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 9-2  
System Verification Results**



System Verification TARGET & MEASURED												
SAR System #	Tissue Frequency (MHz)	Tissue Type	Date:	Amb. Temp (°C)	Liquid Temp (°C)	Input Power (W)	Dipole SN	Probe SN	Measured SAR1g (W/kg)	1 W Target SAR1g (W/kg)	1 W Normalized SAR1g (W/kg)	Deviation <sub>1g</sub> (%)
D	835	HEAD	12/16/2013	21.3	21.4	0.100	4d119	3022	0.901	9.680	9.010	-6.92%
F	1900	HEAD	12/05/2013	24.0	23.0	0.100	5d148	3213	4.180	39.700	41.800	5.29%
G	1900	HEAD	12/16/2013	24.5	23.1	0.100	5d148	3209	4.220	39.700	42.200	6.30%
C	2450	HEAD	11/25/2013	19.1	19.8	0.100	882	3263	5.190	51.700	51.900	0.39%
E	5200	HEAD	11/26/2013	22.1	21.7	0.040	1120	3914	3.020	76.000	75.500	-0.66%
E	5300	HEAD	11/26/2013	22.1	21.7	0.040	1120	3914	3.040	78.700	76.000	-3.43%
E	5500	HEAD	11/26/2013	22.1	21.7	0.040	1120	3914	3.180	80.100	79.500	-0.75%
E	5800	HEAD	11/26/2013	22.1	21.7	0.040	1120	3914	3.050	74.900	76.250	1.80%
G	835	BODY	12/09/2013	23.6	20.1	0.100	4d119	3209	0.986	9.540	9.860	3.35%
F	1900	BODY	12/09/2013	23.8	22.5	0.100	5d148	3213	4.030	40.800	40.300	-1.23%
H	1900	BODY	12/09/2013	22.7	22.4	0.100	5d148	3318	4.110	40.800	41.100	0.74%
I	1900	BODY	12/19/2013	21.9	22.7	0.100	5d148	3319	4.020	40.800	40.200	-1.47%
D	2450	BODY	11/22/2013	22.9	23.0	0.100	797	3022	5.080	49.600	50.800	2.42%
A	5200	BODY	11/25/2013	23.0	21.5	0.100	1057	3589	7.580	75.500	75.800	0.40%
A	5300	BODY	11/25/2013	23.0	21.5	0.100	1057	3589	7.890	75.300	78.900	4.78%
A	5500	BODY	11/25/2013	23.0	21.5	0.100	1057	3589	8.140	80.800	81.400	0.74%
A	5800	BODY	11/25/2013	23.0	21.5	0.100	1057	3589	7.400	75.100	74.000	-1.46%



**Figure 9-1  
System Verification Setup Diagram**



**Figure 9-2  
System Verification Setup Photo**

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# 10 SAR DATA SUMMARY

## 10.1 Standalone Head SAR Data

**Table 10-1  
GSM 850 Head SAR**



MEASUREMENT RESULTS															
FREQUENCY		Mode/Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Side	Test Position	Device Serial Number	# of Time Slots	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
836.60	190	GSM 850	GSM	33.5	32.95	-0.04	Right	Cheek	FK-345-A	1	1:8.3	0.144	1.135	0.163	
836.60	190	GSM 850	GSM	33.5	32.95	0.00	Right	Tilt	FK-345-A	1	1:8.3	0.086	1.135	0.098	
836.60	190	GSM 850	GSM	33.5	32.95	-0.01	Left	Cheek	FK-345-A	1	1:8.3	0.145	1.135	0.165	
836.60	190	GSM 850	GSM	33.5	32.95	0.15	Left	Tilt	FK-345-A	1	1:8.3	0.088	1.135	0.100	
836.60	190	GSM 850	GPRS	31.5	30.86	-0.02	Right	Cheek	FK-345-A	2	1:4.15	0.160	1.159	0.185	A1
836.60	190	GSM 850	GPRS	31.5	30.86	0.14	Right	Tilt	FK-345-A	2	1:4.15	0.096	1.159	0.111	
836.60	190	GSM 850	GPRS	31.5	30.86	-0.12	Left	Cheek	FK-345-A	2	1:4.15	0.157	1.159	0.182	
836.60	190	GSM 850	GPRS	31.5	30.86	0.08	Left	Tilt	FK-345-A	2	1:4.15	0.103	1.159	0.119	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Head 1.6 W/kg (mW/g) averaged over 1 gram								

**Table 10-2  
UMTS 850 Head SAR**

MEASUREMENT RESULTS														
FREQUENCY		Mode/Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Side	Test Position	Device Serial Number	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.										(W/kg)		(W/kg)	
836.60	4183	UMTS 850	RMC	23.5	23.02	-0.02	Right	Cheek	FK-345-B	1:1	0.120	1.117	0.134	A2
836.60	4183	UMTS 850	RMC	23.5	23.02	0.04	Right	Tilt	FK-345-B	1:1	0.066	1.117	0.074	
836.60	4183	UMTS 850	RMC	23.5	23.02	0.16	Left	Cheek	FK-345-B	1:1	0.108	1.117	0.121	
836.60	4183	UMTS 850	RMC	23.5	23.02	0.02	Left	Tilt	FK-345-B	1:1	0.060	1.117	0.067	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Head 1.6 W/kg (mW/g) averaged over 1 gram							

**Table 10-3  
GSM 1900 (Main Antenna) Head SAR**

MEASUREMENT RESULTS															
FREQUENCY		Mode/Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Side	Test Position	Device Serial Number	# of Time Slots	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
1880.00	661	GSM 1900	GSM	30.5	30.06	0.05	Right	Cheek	FK-345-B	1	1:8.3	0.209	1.107	0.231	
1880.00	661	GSM 1900	GSM	30.5	30.06	0.16	Right	Tilt	FK-345-B	1	1:8.3	0.060	1.107	0.066	
1880.00	661	GSM 1900	GSM	30.5	30.06	-0.02	Left	Cheek	FK-345-B	1	1:8.3	0.123	1.107	0.136	
1880.00	661	GSM 1900	GSM	30.5	30.06	-0.03	Left	Tilt	FK-345-B	1	1:8.3	0.071	1.107	0.079	
1850.20	512	GSM 1900	GPRS	28.5	28.03	0.02	Right	Cheek	FK-345-B	2	1:4.15	0.232	1.114	0.258	
1850.20	512	GSM 1900	GPRS	28.5	28.03	-0.05	Right	Tilt	FK-345-B	2	1:4.15	0.057	1.114	0.063	
1850.20	512	GSM 1900	GPRS	28.5	28.03	0.05	Left	Cheek	FK-345-B	2	1:4.15	0.128	1.114	0.143	
1850.20	512	GSM 1900	GPRS	28.5	28.03	-0.03	Left	Tilt	FK-345-B	2	1:4.15	0.078	1.114	0.087	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Head 1.6 W/kg (mW/g) averaged over 1 gram								

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**Table 10-4  
GSM 1900 (Slave Antenna) Head SAR**



MEASUREMENT RESULTS															
FREQUENCY		Mode/Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Side	Test Position	Device Serial Number	# of Time Slots	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
1880.00	661	GSM 1900	GSM	30.5	30.50	0.03	Right	Cheek	FK-345-1	1	1:8.3	0.175	1.000	0.175	
1880.00	661	GSM 1900	GSM	30.5	30.50	-0.09	Right	Tilt	FK-345-1	1	1:8.3	0.239	1.000	0.239	
1880.00	661	GSM 1900	GSM	30.5	30.50	0.04	Left	Cheek	FK-345-1	1	1:8.3	0.274	1.000	0.274	
1880.00	661	GSM 1900	GSM	30.5	30.50	0.06	Left	Tilt	FK-345-1	1	1:8.3	0.257	1.000	0.257	
1880.00	661	GSM 1900	GPRS	28.5	28.36	-0.01	Right	Cheek	FK-345-1	2	1:4.15	0.180	1.033	0.186	
1880.00	661	GSM 1900	GPRS	28.5	28.36	0.02	Right	Tilt	FK-345-1	2	1:4.15	0.259	1.033	0.268	
1880.00	661	GSM 1900	GPRS	28.5	28.36	0.20	Left	Cheek	FK-345-1	2	1:4.15	0.277	1.033	0.286	
1880.00	661	GSM 1900	GPRS	28.5	28.36	0.09	Left	Tilt	FK-345-1	2	1:4.15	0.279	1.033	0.288	A3
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population								Head 1.6 W/kg (mW/g) averaged over 1 gram							

**Table 10-5  
UMTS 1900 Head SAR**

MEASUREMENT RESULTS														
FREQUENCY		Mode/Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Side	Test Position	Device Serial Number	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.										(W/kg)		(W/kg)	
1852.40	9262	UMTS 1900	RMC	23.5	23.23	0.08	Right	Cheek	FK-345-B	1:1	0.308	1.064	0.328	A4
1852.40	9262	UMTS 1900	RMC	23.5	23.23	0.08	Right	Tilt	FK-345-B	1:1	0.096	1.064	0.102	
1852.40	9262	UMTS 1900	RMC	23.5	23.23	-0.01	Left	Cheek	FK-345-B	1:1	0.162	1.064	0.172	
1852.40	9262	UMTS 1900	RMC	23.5	23.23	-0.04	Left	Tilt	FK-345-B	1:1	0.087	1.064	0.093	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population								Head 1.6 W/kg (mW/g) averaged over 1 gram						

**Table 10-6  
Cell. CDMA Head SAR**

MEASUREMENT RESULTS														
FREQUENCY		Mode/Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Side	Test Position	Device Serial Number	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.										(W/kg)		(W/kg)	
836.52	384	Cell. CDMA	RC3 / SO55	25.0	24.59	-0.03	Right	Cheek	FK-345-B	1:1	0.176	1.099	0.193	A5
836.52	384	Cell. CDMA	RC3 / SO55	25.0	24.59	0.12	Right	Tilt	FK-345-B	1:1	0.096	1.099	0.106	
836.52	384	Cell. CDMA	RC3 / SO55	25.0	24.59	0.02	Left	Cheek	FK-345-B	1:1	0.157	1.099	0.173	
836.52	384	Cell. CDMA	RC3 / SO55	25.0	24.59	0.04	Left	Tilt	FK-345-B	1:1	0.089	1.099	0.098	
836.52	384	Cell. CDMA	EVDO Rev. 0	25.0	23.66	-0.07	Right	Cheek	FK-345-B	1:1	0.145	1.361	0.197	
836.52	384	Cell. CDMA	EVDO Rev. 0	25.0	23.66	-0.01	Right	Tilt	FK-345-B	1:1	0.076	1.361	0.103	
836.52	384	Cell. CDMA	EVDO Rev. 0	25.0	23.66	0.15	Left	Cheek	FK-345-B	1:1	0.139	1.361	0.189	
836.52	384	Cell. CDMA	EVDO Rev. 0	25.0	23.66	0.08	Left	Tilt	FK-345-B	1:1	0.076	1.361	0.103	
836.52	384	Cell. CDMA	EVDO Rev. A	25.0	23.62	0.07	Right	Cheek	FK-345-B	1:1	0.142	1.374	0.195	
836.52	384	Cell. CDMA	EVDO Rev. A	25.0	23.62	-0.02	Right	Tilt	FK-345-B	1:1	0.075	1.374	0.103	
836.52	384	Cell. CDMA	EVDO Rev. A	25.0	23.62	-0.17	Left	Cheek	FK-345-B	1:1	0.135	1.374	0.185	
836.52	384	Cell. CDMA	EVDO Rev. A	25.0	23.62	0.07	Left	Tilt	FK-345-B	1:1	0.078	1.374	0.107	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population								Head 1.6 W/kg (mW/g) averaged over 1 gram						

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**Table 10-7  
PCS CDMA Head SAR**



MEASUREMENT RESULTS														
FREQUENCY		Mode/Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Side	Test Position	Device Serial Number	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.										(W/kg)		(W/kg)	
1880.00	600	PCS CDMA	RC3 / SO55	25.0	24.81	0.00	Right	Cheek	FK-345-B	1:1	0.462	1.045	0.483	A6
1880.00	600	PCS CDMA	RC3 / SO55	25.0	24.81	0.16	Right	Tilt	FK-345-B	1:1	0.133	1.045	0.139	
1880.00	600	PCS CDMA	RC3 / SO55	25.0	24.81	-0.05	Left	Cheek	FK-345-B	1:1	0.252	1.045	0.263	
1880.00	600	PCS CDMA	RC3 / SO55	25.0	24.81	0.06	Left	Tilt	FK-345-B	1:1	0.150	1.045	0.157	
1851.25	25	PCS CDMA	EVDO Rev. 0	25.0	23.70	0.06	Right	Cheek	FK-345-B	1:1	0.327	1.349	0.441	
1851.25	25	PCS CDMA	EVDO Rev. 0	25.0	23.70	0.00	Right	Tilt	FK-345-B	1:1	0.111	1.349	0.150	
1851.25	25	PCS CDMA	EVDO Rev. 0	25.0	23.70	-0.02	Left	Cheek	FK-345-B	1:1	0.171	1.349	0.231	
1851.25	25	PCS CDMA	EVDO Rev. 0	25.0	23.70	-0.17	Left	Tilt	FK-345-B	1:1	0.098	1.349	0.132	
1851.25	25	PCS CDMA	EVDO Rev. A	25.0	23.56	0.06	Right	Cheek	FK-345-B	1:1	0.300	1.393	0.418	
1851.25	25	PCS CDMA	EVDO Rev. A	25.0	23.56	-0.03	Right	Tilt	FK-345-B	1:1	0.088	1.393	0.123	
1851.25	25	PCS CDMA	EVDO Rev. A	25.0	23.56	0.02	Left	Cheek	FK-345-B	1:1	0.330	1.393	0.460	
1851.25	25	PCS CDMA	EVDO Rev. A	25.0	23.56	-0.02	Left	Tilt	FK-345-B	1:1	0.188	1.393	0.262	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Head 1.6 W/kg (mW/g) averaged over 1 gram							

**Table 10-8  
DTS Head SAR**

MEASUREMENT RESULTS															
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Side	Test Position	Device Serial Number	Data Rate (Mbps)	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
2462	11	IEEE 802.11b	DSSS	17.5	17.00	0.10	Right	Cheek	FK-345-A	1	1:1	0.067	1.122	0.075	A7
2462	11	IEEE 802.11b	DSSS	17.5	17.00	0.02	Right	Tilt	FK-345-A	1	1:1	0.026	1.122	0.029	
2462	11	IEEE 802.11b	DSSS	17.5	17.00	0.12	Left	Cheek	FK-345-A	1	1:1	0.026	1.122	0.029	
2462	11	IEEE 802.11b	DSSS	17.5	17.00	0.15	Left	Tilt	FK-345-A	1	1:1	0.012	1.122	0.013	
5745	149	IEEE 802.11a	OFDM	12.0	11.14	0.00	Right	Cheek	FK-345-B	6	1:1	0.000	1.219	0.000	
5745	149	IEEE 802.11a	OFDM	12.0	11.14	0.01	Right	Tilt	FK-345-B	6	1:1	0.001	1.219	0.001	A8
5745	149	IEEE 802.11a	OFDM	12.0	11.14	0.00	Left	Cheek	FK-345-B	6	1:1	0.000	1.219	0.000	
5745	149	IEEE 802.11a	OFDM	12.0	11.14	0.00	Left	Tilt	FK-345-B	6	1:1	0.001	1.219	0.001	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Head 1.6 W/kg (mW/g) averaged over 1 gram								

**Table 10-9  
NII Head SAR**

MEASUREMENT RESULTS															
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Side	Test Position	Device Serial Number	Data Rate (Mbps)	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
5240	48	IEEE 802.11a	OFDM	12.0	11.57	0.00	Right	Cheek	FK-345-B	6	1:1	0.000	1.104	0.000	
5240	48	IEEE 802.11a	OFDM	12.0	11.57	0.02	Right	Tilt	FK-345-B	6	1:1	0.001	1.104	0.001	
5240	48	IEEE 802.11a	OFDM	12.0	11.57	-0.05	Left	Cheek	FK-345-B	6	1:1	0.024	1.104	0.026	A9
5240	48	IEEE 802.11a	OFDM	12.0	11.57	0.00	Left	Tilt	FK-345-B	6	1:1	0.000	1.104	0.000	
5320	64	IEEE 802.11a	OFDM	12.0	11.06	0.04	Right	Cheek	FK-345-B	6	1:1	0.001	1.242	0.001	
5320	64	IEEE 802.11a	OFDM	12.0	11.06	0.02	Right	Tilt	FK-345-B	6	1:1	0.002	1.242	0.002	
5320	64	IEEE 802.11a	OFDM	12.0	11.06	0.05	Left	Cheek	FK-345-B	6	1:1	0.023	1.242	0.029	
5320	64	IEEE 802.11a	OFDM	12.0	11.06	0.09	Left	Tilt	FK-345-B	6	1:1	0.001	1.242	0.001	
5520	104	IEEE 802.11a	OFDM	12.0	11.61	0.00	Right	Cheek	FK-345-B	6	1:1	0.000	1.094	0.000	
5520	104	IEEE 802.11a	OFDM	12.0	11.61	-0.03	Right	Tilt	FK-345-B	6	1:1	0.002	1.094	0.002	
5520	104	IEEE 802.11a	OFDM	12.0	11.61	0.00	Left	Cheek	FK-345-B	6	1:1	0.000	1.094	0.000	
5520	104	IEEE 802.11a	OFDM	12.0	11.61	0.00	Left	Tilt	FK-345-B	6	1:1	0.000	1.094	0.000	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Head 1.6 W/kg (mW/g) averaged over 1 gram								

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## 10.2 Standalone Body-Worn SAR Data

**Table 10-10  
GSM/UMTS/CDMA Body-Worn SAR Data**



MEASUREMENT RESULTS																
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Type	Device Serial Number	# of Time Slots	Duty Cycle	Side	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.												(W/kg)		(W/kg)	
836.60	190	GSM 850	GSM	33.5	32.95	0.06	10 mm	Main	FK-345-A	1	1:8.3	back	0.285	1.135	0.323	A10
836.60	190	GSM 850	GPRS	31.5	30.86	-0.05	10 mm	Main	FK-345-A	2	1:4.15	back	0.277	1.159	0.321	
836.60	4183	UMTS 850	RMC	23.5	23.02	-0.05	10 mm	Main	FK-345-A	N/A	1:1	back	0.211	1.117	0.236	A11
1880.00	661	GSM 1900	GSM	30.5	30.06	0.00	10 mm	Main	FK-345-B	1	1:8.3	back	0.387	1.107	0.428	
1850.20	512	GSM 1900	GPRS	28.5	28.03	-0.02	10 mm	Main	FK-345-B	2	1:4.15	back	0.435	1.114	0.485	A13
1880.00	661	GSM 1900	GSM	30.5	30.50	0.15	10 mm	Slave	FK-345-1	1	1:8.3	back	0.146	1.000	0.146	
1880.00	661	GSM 1900	GPRS	28.5	28.36	0.09	10 mm	Slave	FK-345-1	2	1:4.15	back	0.123	1.033	0.127	
1852.40	9262	UMTS 1900	RMC	23.5	23.23	-0.07	10 mm	Main	FK-345-B	N/A	1:1	back	0.510	1.064	0.543	A15
836.52	384	Cell. CDMA	TDSO / SO32	25.0	24.57	0.01	10 mm	Main	FK-345-A	N/A	1:1	back	0.269	1.104	0.297	A17
836.52	384	Cell. CDMA	EVDO Rev. 0	25.0	23.66	0.00	10 mm	Main	FK-345-A	N/A	1:1	back	0.199	1.361	0.271	
1880.00	600	PCS CDMA	TDSO / SO32	25.0	24.77	-0.02	10 mm	Main	FK-345-B	N/A	1:1	back	0.642	1.054	0.677	
1851.25	25	PCS CDMA	EVDO Rev. 0	25.0	23.70	-0.07	10 mm	Main	FK-345-B	N/A	1:1	back	0.771	1.349	1.040	A18
1880.00	600	PCS CDMA	EVDO Rev. 0	25.0	23.33	-0.03	10 mm	Main	FK-345-B	N/A	1:1	back	0.649	1.469	0.953	
1908.75	1175	PCS CDMA	EVDO Rev. 0	25.0	23.11	-0.03	10 mm	Main	FK-345-B	N/A	1:1	back	0.643	1.545	0.993	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Body 1.6 W/kg (mW/g) averaged over 1 gram									

**Table 10-11  
DTS Body-Worn SAR**

MEASUREMENT RESULTS															
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
2462	11	IEEE 802.11b	DSSS	17.5	17.00	0.02	10 mm	FK-345-B	1	back	1:1	0.070	1.122	0.079	A20
5745	149	IEEE 802.11a	OFDM	12.0	11.14	-0.06	10 mm	FK-345-A	6	back	1:1	0.415	1.219	0.506	A21
5765	153	IEEE 802.11a	OFDM	12.0	10.50	-0.01	10 mm	FK-345-A	6	back	1:1	0.310	1.413	0.438	
5805	161	IEEE 802.11a	OFDM	12.0	10.90	-0.01	10 mm	FK-345-A	6	back	1:1	0.340	1.288	0.438	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Body 1.6 W/kg (mW/g) averaged over 1 gram								

**Table 10-12  
NII Body-Worn SAR**

MEASUREMENT RESULTS															
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
5180	36	IEEE 802.11a	OFDM	12.0	11.50	-0.09	10 mm	FK-345-A	6	back	1:1	0.584	1.122	0.655	
5240	48	IEEE 802.11a	OFDM	12.0	11.57	-0.03	10 mm	FK-345-A	6	back	1:1	0.598	1.104	0.660	A22
5280	56	IEEE 802.11a	OFDM	12.0	11.02	-0.16	10 mm	FK-345-A	6	back	1:1	0.545	1.253	0.683	
5320	64	IEEE 802.11a	OFDM	12.0	11.06	-0.01	10 mm	FK-345-A	6	back	1:1	0.462	1.242	0.574	
5520	104	IEEE 802.11a	OFDM	12.0	11.61	-0.08	10 mm	FK-345-A	6	back	1:1	0.236	1.094	0.258	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Body 1.6 W/kg (mW/g) averaged over 1 gram								

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### 10.3 Standalone Wireless Router SAR Data

**Table 10-13  
GSM/UMTS Hotspot SAR Data**

MEASUREMENT RESULTS																
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Type	Device Serial Number	# of GPRS Slots	Duty Cycle	Side	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.												(W/kg)		(W/kg)	
836.60	190	GSM 850	GSM	33.5	32.95	0.06	10 mm	Main	FK-345-A	1	1:8.3	back	0.285	1.135	0.323	A10
836.60	190	GSM 850	GSM	33.5	32.95	0.02	10 mm	Main	FK-345-A	1	1:8.3	front	0.211	1.135	0.239	
836.60	190	GSM 850	GSM	33.5	32.95	0.09	10 mm	Main	FK-345-A	1	1:8.3	bottom	0.017	1.135	0.019	
836.60	190	GSM 850	GSM	33.5	32.95	0.01	10 mm	Main	FK-345-A	1	1:8.3	right	0.169	1.135	0.192	
836.60	190	GSM 850	GSM	33.5	32.95	-0.01	10 mm	Main	FK-345-A	1	1:8.3	left	0.149	1.135	0.169	
836.60	190	GSM 850	GPRS	31.5	30.86	-0.05	10 mm	Main	FK-345-A	2	1:4.15	back	0.277	1.159	0.321	
836.60	190	GSM 850	GPRS	31.5	30.86	-0.02	10 mm	Main	FK-345-A	2	1:4.15	front	0.227	1.159	0.263	
836.60	190	GSM 850	GPRS	31.5	30.86	0.02	10 mm	Main	FK-345-A	2	1:4.15	bottom	0.016	1.159	0.019	
836.60	190	GSM 850	GPRS	31.5	30.86	-0.08	10 mm	Main	FK-345-A	2	1:4.15	right	0.135	1.159	0.156	
836.60	190	GSM 850	GPRS	31.5	30.86	0.09	10 mm	Main	FK-345-A	2	1:4.15	left	0.118	1.159	0.137	
836.60	4183	UMTS 850	RMC	23.5	23.02	-0.05	10 mm	Main	FK-345-A	N/A	1:1	back	0.211	1.117	0.236	
836.60	4183	UMTS 850	RMC	23.5	23.02	0.00	10 mm	Main	FK-345-A	N/A	1:1	front	0.339	1.117	0.379	A12
836.60	4183	UMTS 850	RMC	23.5	23.02	-0.12	10 mm	Main	FK-345-A	N/A	1:1	bottom	0.181	1.117	0.202	
836.60	4183	UMTS 850	RMC	23.5	23.02	-0.12	10 mm	Main	FK-345-A	N/A	1:1	right	0.097	1.117	0.108	
836.60	4183	UMTS 850	RMC	23.5	23.02	0.05	10 mm	Main	FK-345-A	N/A	1:1	left	0.013	1.117	0.015	
1880.00	661	GSM 1900	GSM	30.5	30.06	0.00	10 mm	Main	FK-345-B	1	1:8.3	back	0.387	1.107	0.428	
1880.00	661	GSM 1900	GSM	30.5	30.06	0.03	10 mm	Main	FK-345-B	1	1:8.3	front	0.609	1.107	0.674	A14
1880.00	661	GSM 1900	GSM	30.5	30.06	-0.04	10 mm	Main	FK-345-B	1	1:8.3	bottom	0.301	1.107	0.333	
1880.00	661	GSM 1900	GSM	30.5	30.06	-0.06	10 mm	Main	FK-345-B	1	1:8.3	right	0.184	1.107	0.204	
1880.00	661	GSM 1900	GSM	30.5	30.06	-0.07	10 mm	Main	FK-345-B	1	1:8.3	left	0.029	1.107	0.032	
1850.20	512	GSM 1900	GPRS	28.5	28.03	-0.02	10 mm	Main	FK-345-B	2	1:4.15	back	0.435	1.114	0.485	
1850.20	512	GSM 1900	GPRS	28.5	28.03	-0.05	10 mm	Main	FK-345-B	2	1:4.15	front	0.531	1.114	0.592	
1850.20	512	GSM 1900	GPRS	28.5	28.03	-0.03	10 mm	Main	FK-345-B	2	1:4.15	bottom	0.347	1.114	0.387	
1850.20	512	GSM 1900	GPRS	28.5	28.03	-0.07	10 mm	Main	FK-345-B	2	1:4.15	right	0.216	1.114	0.241	
1850.20	512	GSM 1900	GPRS	28.5	28.03	-0.09	10 mm	Main	FK-345-B	2	1:4.15	left	0.030	1.114	0.033	
1880.00	661	GSM 1900	GSM	30.5	30.50	0.15	10 mm	Slave	FK-345-1	1	1:8.3	back	0.146	1.000	0.146	
1880.00	661	GSM 1900	GSM	30.5	30.50	0.09	10 mm	Slave	FK-345-1	1	1:8.3	front	0.045	1.000	0.045	
1880.00	661	GSM 1900	GSM	30.5	30.50	0.01	10 mm	Slave	FK-345-1	1	1:8.3	top	0.137	1.000	0.137	
1880.00	661	GSM 1900	GSM	30.5	30.50	0.07	10 mm	Slave	FK-345-1	1	1:8.3	right	0.093	1.000	0.093	
1880.00	661	GSM 1900	GPRS	28.5	28.36	0.09	10 mm	Slave	FK-345-1	2	1:4.15	back	0.123	1.033	0.127	
1880.00	661	GSM 1900	GPRS	28.5	28.36	0.18	10 mm	Slave	FK-345-1	2	1:4.15	front	0.042	1.033	0.043	
1880.00	661	GSM 1900	GPRS	28.5	28.36	0.06	10 mm	Slave	FK-345-1	2	1:4.15	top	0.140	1.033	0.145	
1880.00	661	GSM 1900	GPRS	28.5	28.36	0.06	10 mm	Slave	FK-345-1	2	1:4.15	right	0.107	1.033	0.111	
1852.40	9262	UMTS 1900	RMC	23.5	23.23	-0.07	10 mm	Main	FK-345-B	N/A	1:1	back	0.510	1.064	0.543	
1852.40	9262	UMTS 1900	RMC	23.5	23.23	-0.04	10 mm	Main	FK-345-B	N/A	1:1	front	0.742	1.064	0.789	A16
1852.40	9262	UMTS 1900	RMC	23.5	23.23	-0.08	10 mm	Main	FK-345-B	N/A	1:1	bottom	0.419	1.064	0.446	
1852.40	9262	UMTS 1900	RMC	23.5	23.23	0.03	10 mm	Main	FK-345-B	N/A	1:1	right	0.218	1.064	0.232	
1852.40	9262	UMTS 1900	RMC	23.5	23.23	0.11	10 mm	Main	FK-345-B	N/A	1:1	left	0.035	1.064	0.037	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT							Body									
Spatial Peak							1.6 W/kg (mW/g)									
Uncontrolled Exposure/General Population							averaged over 1 gram									



**Table 10-14  
CDMA Hotspot SAR Data**

MEASUREMENT RESULTS														
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Device Serial Number	Duty Cycle	Side	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.										(W/kg)		(W/kg)	
836.52	384	Cell. CDMA	TDSO / SO32	25.0	24.57	0.01	10 mm	FK-345-A	1:1	back	0.269	1.104	0.297	A17
836.52	384	Cell. CDMA	TDSO / SO32	25.0	24.57	0.01	10 mm	FK-345-A	1:1	front	0.193	1.104	0.213	
836.52	384	Cell. CDMA	TDSO / SO32	25.0	24.57	0.17	10 mm	FK-345-A	1:1	bottom	0.018	1.104	0.020	
836.52	384	Cell. CDMA	TDSO / SO32	25.0	24.57	0.03	10 mm	FK-345-A	1:1	right	0.154	1.104	0.170	
836.52	384	Cell. CDMA	TDSO / SO32	25.0	24.57	0.07	10 mm	FK-345-A	1:1	left	0.132	1.104	0.146	
836.52	384	Cell. CDMA	EVDO Rev. 0	25.0	23.66	0.00	10 mm	FK-345-A	1:1	back	0.199	1.361	0.271	
836.52	384	Cell. CDMA	EVDO Rev. 0	25.0	23.66	0.17	10 mm	FK-345-A	1:1	front	0.173	1.361	0.235	
836.52	384	Cell. CDMA	EVDO Rev. 0	25.0	23.66	0.12	10 mm	FK-345-A	1:1	bottom	0.014	1.361	0.019	
836.52	384	Cell. CDMA	EVDO Rev. 0	25.0	23.66	0.00	10 mm	FK-345-A	1:1	right	0.134	1.361	0.182	
836.52	384	Cell. CDMA	EVDO Rev. 0	25.0	23.66	-0.06	10 mm	FK-345-A	1:1	left	0.123	1.361	0.167	
1880.00	600	PCS CDMA	TDSO / SO32	25.0	24.77	-0.02	10 mm	FK-345-B	1:1	back	0.642	1.054	0.677	
1880.00	600	PCS CDMA	TDSO / SO32	25.0	24.77	0.02	10 mm	FK-345-B	1:1	front	0.696	1.054	0.734	
1880.00	600	PCS CDMA	TDSO / SO32	25.0	24.77	-0.04	10 mm	FK-345-B	1:1	bottom	0.584	1.054	0.616	
1880.00	600	PCS CDMA	TDSO / SO32	25.0	24.77	-0.05	10 mm	FK-345-B	1:1	right	0.296	1.054	0.312	
1880.00	600	PCS CDMA	TDSO / SO32	25.0	24.77	-0.14	10 mm	FK-345-B	1:1	left	0.039	1.054	0.041	
1851.25	25	PCS CDMA	EVDO Rev. 0	25.0	23.70	-0.07	10 mm	FK-345-B	1:1	back	0.771	1.349	1.040	
1880.00	600	PCS CDMA	EVDO Rev. 0	25.0	23.33	-0.03	10 mm	FK-345-B	1:1	back	0.649	1.469	0.953	
1908.75	1175	PCS CDMA	EVDO Rev. 0	25.0	23.11	-0.03	10 mm	FK-345-B	1:1	back	0.643	1.545	0.993	
1851.25	25	PCS CDMA	EVDO Rev. 0	25.0	23.70	-0.02	10 mm	FK-345-B	1:1	front	0.808	1.349	1.090	A19
1880.00	600	PCS CDMA	EVDO Rev. 0	25.0	23.33	0.01	10 mm	FK-345-B	1:1	front	0.713	1.469	1.047	
1908.75	1175	PCS CDMA	EVDO Rev. 0	25.0	23.11	0.07	10 mm	FK-345-B	1:1	front	0.701	1.545	1.083	
1851.25	25	PCS CDMA	EVDO Rev. 0	25.0	23.70	-0.14	10 mm	FK-345-B	1:1	bottom	0.493	1.349	0.665	
1851.25	25	PCS CDMA	EVDO Rev. 0	25.0	23.70	-0.14	10 mm	FK-345-B	1:1	right	0.273	1.349	0.368	
1851.25	25	PCS CDMA	EVDO Rev. 0	25.0	23.70	0.01	10 mm	FK-345-B	1:1	left	0.047	1.349	0.063	
1851.25	25	PCS CDMA	EVDO Rev. 0	25.0	23.70	0.00	10 mm	FK-345-B	1:1	front	0.755	1.349	1.018	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT							Body							
Spatial Peak							1.6 W/kg (mW/g)							
Uncontrolled Exposure/General Population							averaged over 1 gram							

Note: Tests highlighted in blue represent variability.

**Table 10-15  
WLAN Hotspot SAR**

MEASUREMENT RESULTS															
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
2462	11	IEEE 802.11b	DSSS	17.5	17.00	0.02	10 mm	FK-345-B	1	back	1:1	0.070	1.122	0.079	A20
2462	11	IEEE 802.11b	DSSS	17.5	17.00	0.18	10 mm	FK-345-B	1	front	1:1	0.016	1.122	0.018	
2462	11	IEEE 802.11b	DSSS	17.5	17.00	0.16	10 mm	FK-345-B	1	left	1:1	0.050	1.122	0.056	
5745	149	IEEE 802.11a	OFDM	12.0	11.14	-0.06	10 mm	FK-345-A	6	back	1:1	0.415	1.219	0.506	A21
5765	153	IEEE 802.11a	OFDM	12.0	10.50	-0.01	10 mm	FK-345-A	6	back	1:1	0.310	1.413	0.438	
5805	161	IEEE 802.11a	OFDM	12.0	10.90	-0.01	10 mm	FK-345-A	6	back	1:1	0.340	1.288	0.438	
5745	149	IEEE 802.11a	OFDM	12.0	11.14	-0.09	10 mm	FK-345-A	6	front	1:1	0.031	1.219	0.038	
5745	149	IEEE 802.11a	OFDM	12.0	11.14	-0.09	10 mm	FK-345-A	6	left	1:1	0.329	1.219	0.401	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT							Body								
Spatial Peak							1.6 W/kg (mW/g)								
Uncontrolled Exposure/General Population							averaged over 1 gram								

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## 10.4 SAR Test Notes

### General Notes:



1. The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2003, FCC/OET Bulletin 65, Supplement C [June 2001] and FCC KDB Publication 447498 D01v05.
2. Batteries are fully charged at the beginning of the SAR measurements. A specialized battery was used for all 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. Device was tested using a fixed spacing for body-worn accessory testing. A separation distance of 10 mm was considered because the manufacturer has determined that there will be body-worn accessories available in the marketplace for users to support this separation distance.
7. Per FCC KDB Publication 648474 D04v01, SAR was evaluated without a headset connected to the device. Since the standalone reported SAR was  $\leq 1.2$  W/kg, no additional SAR evaluations using a headset cable were required.
8. 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 12 for variability analysis.
9. During SAR Testing for the Wireless Router conditions per FCC KDB Publication 941225 D06v01, the actual Portable Hotspot operation (with actual simultaneous transmission of a transmitter with WIFI) was not activated (See Section 5.7 for more details).

### GSM Test Notes:

1. Body-Worn accessory testing is typically associated with voice operations. Therefore, GSM voice was evaluated for body-worn SAR. Additionally, GPRS data was evaluated for body-worn SAR to support simultaneous capabilities
2. GSM Voice Hotspot SAR and GPRS Data Head SAR were additionally evaluated to support simultaneous capabilities.
3. The source-based frame-averaged output power was evaluated for all GPRS slot configurations. Per October 2013 TCB Workshop Notes, the configuration with the highest target frame averaged output power was evaluated for hotspot SAR. When the maximum frame-averaged powers are equivalent across two or more slots (within 0.25 dB), the configuration with the most number of time slots was tested.
4. Per FCC KDB Publication 447498 D01v05, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is  $\leq 0.8$  W/kg then testing at the other channels is not required for such test configuration(s). When the maximum output power variation across the required test channels is  $> \frac{1}{2}$  dB, instead of the middle channel, the highest output power channel was used.

### CDMA Notes:

1. Head SAR for CDMA2000 mode was tested under RC3/SO55 per FCC KDB Publication 941225 D01v02.
2. Body-Worn SAR was tested with 1x RTT with TDSO / SO32 FCH Only. EVDO and TDSO / SO32 FCH+SCH SAR tests were not required since the average output power was not more than 0.25 dB higher than the TDSO / SO32 FCH only powers, per FCC KDB Publication 941225 D01v02. EVDO Rev 0 was evaluated for Body-Worn exposure to support simultaneous capabilities.
3. CDMA Wireless Router SAR is measured using Subtype 0/1 Physical Layer configurations for Rev. 0 according to KDB 941225 D01 procedures for data devices. Since the average output power of Subtype 2 for Rev. A is less than the Rev. 0 power levels, then EVDO Rev. A SAR is not required. SAR is not required for 1x RTT for Ev-Do hotspot devices when the maximum average output of each channel is less than 1/4 dB higher than that measured in Subtype 0/1 Physical Layer configurations for Rev. 0.
4. Head SAR was additionally evaluated using EVDO Rev. A to determine compliance for VoIP operations.
5. CDMA 1xRTT Hotspot SAR and EVDO Rev. 0 Head SAR were additionally evaluated to support simultaneous capabilities.
6. Per FCC KDB Publication 447498 D01v05, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is  $\leq 0.8$  W/kg then testing at the other channels is not required for such test configuration(s). When the maximum output power variation across the required test channels is  $> \frac{1}{2}$  dB, instead of the middle channel, the highest output power channel was used.



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UMTS Notes:

1. UMTS mode in Body SAR was tested under RMC 12.2 kbps with HSPA Inactive per KDB Publication 941225 D01v02. HSPA SAR was not required since the average output power of the HSPA subtests was not more than 0.25 dB higher than the RMC level and SAR was less than 1.2 W/kg.
2. Per FCC KDB Publication 447498 D01v05, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is  $\leq 0.8$  W/kg then testing at the other channels is not required for such test configuration(s). When the maximum output power variation across the required test channels is  $> \frac{1}{2}$  dB, instead of the middle channel, the highest output power channel was used.

WLAN Notes:

1. Justification for reduced test configurations for WIFI channels per KDB Publication 248227 D01v01r02 and October 2012 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 October 2012 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. 5 GHz hotspot is only supported for the 5.8 GHz Band; therefore, all other 5 GHz bands were not evaluated for hotspot conditions.
4. WIFI transmission was verified using an uncalibrated spectrum analyzer.
5. When the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is  $< 1.6$  W/kg, SAR testing on other default channels was required.

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# 11 FCC MULTI-TX AND ANTENNA SAR CONSIDERATIONS

## 11.1 Introduction

The following procedures adopted from FCC KDB Publication 447498 D01v05 are applicable to handsets with built-in unlicensed transmitters such as 802.11a/b/g/n and Bluetooth devices which may simultaneously transmit with the licensed transmitter.

Possible transmission paths for the DUT are shown in Figure 11-1 and are color-coded to match the Simultaneous Transmission Tables in Sections 11.3-11.5. The colors are used to indicate communication modes which share the same path. Modes which share the same transmission path cannot transmit simultaneously with one another.

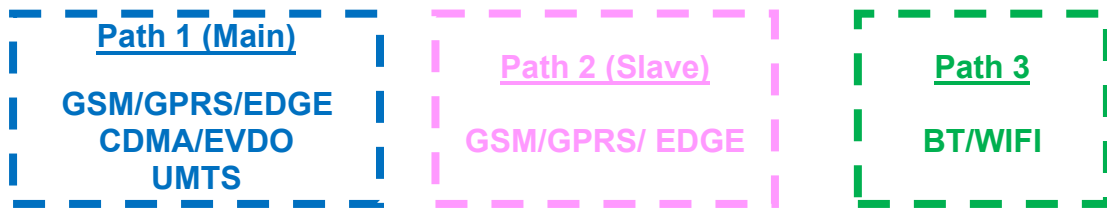


Figure 11-1  
Simultaneous Transmission Paths

## 11.2 Simultaneous Transmission Procedures



This device contains transmitters that may operate simultaneously. Therefore simultaneous transmission analysis is required. Per FCC KDB 447498 D01v05 IV.C.1.iii, simultaneous transmission SAR test exclusion may be applied when the sum of the 1-g SAR for all the simultaneous transmitting antennas in a specific a physical test configuration is  $\leq 1.6$  W/kg. When standalone SAR is not required to be measured, per FCC KDB 447498 D01v05 4.3.2 2), the following equation must be used to estimate the standalone 1g SAR for simultaneous transmission assessment involving that transmitter.

$$\text{Estimated SAR} = \frac{\sqrt{f(\text{GHz})}}{7.5} * \frac{(\text{Max Power of channel, mW})}{\text{Min. Separation Distance, mm}}$$

Table 11-1  
Estimated SAR

Mode	Frequency	Maximum Allowed Power	Separation Distance (Body)	Estimated SAR (Body)
	[MHz]	[dBm]	[mm]	[W/kg]
Bluetooth	2441	10.00	10	<b>0.208</b>



Note: Held-to ear configurations are not applicable to Bluetooth operations and therefore were not considered for simultaneous transmission. Per KDB Publication 447498 D01v05, the maximum power of the channel was rounded to the nearest mW before calculation.

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### 11.3 Head SAR Simultaneous Transmission Analysis

**Table 11-2**  
**Simultaneous Transmission Scenario with 2.4 GHz WLAN (Held to Ear)**

Simult Tx	Configuration	GSM 850 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	UMTS 850 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.163	0.075	0.238	Head SAR	Right Cheek	0.134	0.075	0.209
	Right Tilt	0.098	0.029	0.127		Right Tilt	0.074	0.029	0.103
	Left Cheek	0.165	0.029	0.194		Left Cheek	0.121	0.029	0.150
	Left Tilt	0.100	0.013	0.113		Left Tilt	0.067	0.013	0.080
Simult Tx	Configuration	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.231	0.075	0.306	Head SAR	Right Cheek	0.328	0.075	0.403
	Right Tilt	0.066	0.029	0.095		Right Tilt	0.102	0.029	0.131
	Left Cheek	0.136	0.029	0.165		Left Cheek	0.172	0.029	0.201
	Left Tilt	0.079	0.013	0.092		Left Tilt	0.093	0.013	0.106
Simult Tx	Configuration	Cell. CDMA SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	PCS CDMA SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.193	0.075	0.268	Head SAR	Right Cheek	0.483	0.075	0.558
	Right Tilt	0.106	0.029	0.135		Right Tilt	0.139	0.029	0.168
	Left Cheek	0.173	0.029	0.202		Left Cheek	0.263	0.029	0.292
	Left Tilt	0.098	0.013	0.111		Left Tilt	0.157	0.013	0.170
Simult Tx	Configuration	Cell. EVDO SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	PCS EVDO SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.195	0.075	0.270	Head SAR	Right Cheek	0.418	0.075	0.493
	Right Tilt	0.103	0.029	0.132		Right Tilt	0.123	0.029	0.152
	Left Cheek	0.185	0.029	0.214		Left Cheek	0.460	0.029	0.489
	Left Tilt	0.107	0.013	0.120		Left Tilt	0.262	0.013	0.275

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**Table 11-3**  
**Simultaneous Transmission Scenario with 2.4 GHz WLAN (Held to Ear)**

Simult Tx	Configuration	Cell. CDMA SAR (W/kg)	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3
Head SAR	Right Cheek	0.193	0.186	0.075	0.379	0.454
	Right Tilt	0.106	0.268	0.029	0.374	0.403
	Left Cheek	0.173	0.286	0.029	0.459	0.488
	Left Tilt	0.098	0.288	0.013	0.386	0.399
Simult Tx	Configuration	Cell. EVDO SAR (W/kg)	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3
Head SAR	Right Cheek	0.197	0.175	0.075	0.372	0.447
	Right Tilt	0.103	0.239	0.029	0.342	0.371
	Left Cheek	0.189	0.274	0.029	0.463	0.492
	Left Tilt	0.103	0.257	0.013	0.360	0.373
Simult Tx	Configuration	UMTS 850 SAR (W/kg)	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3
Head SAR	Right Cheek	0.134	0.186	0.075	0.320	0.395
	Right Tilt	0.074	0.268	0.029	0.342	0.371
	Left Cheek	0.121	0.286	0.029	0.407	0.436
	Left Tilt	0.067	0.288	0.013	0.355	0.368
Simult Tx	Configuration	UMTS 850 SAR (W/kg)	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3
Head SAR	Right Cheek	0.134	0.175	0.075	0.309	0.384
	Right Tilt	0.074	0.239	0.029	0.313	0.342
	Left Cheek	0.121	0.274	0.029	0.395	0.424
	Left Tilt	0.067	0.257	0.013	0.324	0.337
Simult Tx	Configuration	GSM 850 SAR (W/kg)	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3
Head SAR	Right Cheek	0.163	0.186	0.075	0.349	0.424
	Right Tilt	0.098	0.268	0.029	0.366	0.395
	Left Cheek	0.165	0.286	0.029	0.451	0.480
	Left Tilt	0.100	0.288	0.013	0.388	0.401
Simult Tx	Configuration	GPRS 850 SAR (W/kg)	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3
Head SAR	Right Cheek	0.185	0.175	0.075	0.360	0.435
	Right Tilt	0.111	0.239	0.029	0.350	0.379
	Left Cheek	0.182	0.274	0.029	0.456	0.485
	Left Tilt	0.119	0.257	0.013	0.376	0.389
Simult Tx	Configuration	PCS CDMA SAR (W/kg)	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3
Head SAR	Right Cheek	0.483	0.186	0.075	0.669	0.744
	Right Tilt	0.139	0.268	0.029	0.407	0.436
	Left Cheek	0.263	0.286	0.029	0.549	0.578
	Left Tilt	0.157	0.288	0.013	0.445	0.458
Simult Tx	Configuration	PCS EVDO SAR (W/kg)	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3
Head SAR	Right Cheek	0.441	0.175	0.075	0.616	0.691
	Right Tilt	0.150	0.239	0.029	0.389	0.418
	Left Cheek	0.231	0.274	0.029	0.505	0.534
	Left Tilt	0.132	0.257	0.013	0.389	0.402
Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3
Head SAR	Right Cheek	0.328	0.186	0.075	0.514	0.589
	Right Tilt	0.102	0.268	0.029	0.370	0.399
	Left Cheek	0.172	0.286	0.029	0.468	0.487
	Left Tilt	0.093	0.288	0.013	0.381	0.394
Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3
Head SAR	Right Cheek	0.328	0.175	0.075	0.503	0.578
	Right Tilt	0.102	0.239	0.029	0.341	0.370
	Left Cheek	0.172	0.274	0.029	0.446	0.475
	Left Tilt	0.093	0.257	0.013	0.350	0.363
Simult Tx	Configuration	GSM 1900 SAR (W/kg)	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3
Head SAR	Right Cheek	0.231	0.186	0.075	0.417	0.492
	Right Tilt	0.066	0.268	0.029	0.334	0.363
	Left Cheek	0.136	0.286	0.029	0.422	0.451
	Left Tilt	0.079	0.288	0.013	0.367	0.380
Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3
Head SAR	Right Cheek	0.258	0.175	0.075	0.433	0.508
	Right Tilt	0.063	0.239	0.029	0.302	0.331
	Left Cheek	0.143	0.274	0.029	0.417	0.446
	Left Tilt	0.087	0.257	0.013	0.344	0.357

**Table 11-4  
Simultaneous Transmission Scenario with 5 GHz WLAN (Held to Ear)**

Simult Tx	Configuration	GSM 850 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	UMTS 850 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.163	0.001	0.164	Head SAR	Right Cheek	0.134	0.001	0.135
	Right Tilt	0.098	0.002	0.100		Right Tilt	0.074	0.002	0.076
	Left Cheek	0.165	0.029	0.194		Left Cheek	0.121	0.029	0.150
	Left Tilt	0.100	0.001	0.101		Left Tilt	0.067	0.001	0.068
Simult Tx	Configuration	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.231	0.001	0.232	Head SAR	Right Cheek	0.328	0.001	0.329
	Right Tilt	0.066	0.002	0.068		Right Tilt	0.102	0.002	0.104
	Left Cheek	0.136	0.029	0.165		Left Cheek	0.172	0.029	0.201
	Left Tilt	0.079	0.001	0.080		Left Tilt	0.093	0.001	0.094
Simult Tx	Configuration	Cell. CDMA SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	PCS CDMA SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.193	0.001	0.194	Head SAR	Right Cheek	0.483	0.001	0.484
	Right Tilt	0.106	0.002	0.108		Right Tilt	0.139	0.002	0.141
	Left Cheek	0.173	0.029	0.202		Left Cheek	0.263	0.029	0.292
	Left Tilt	0.098	0.001	0.099		Left Tilt	0.157	0.001	0.158
Simult Tx	Configuration	Cell. EVDO SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	PCS EVDO SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.195	0.001	0.196	Head SAR	Right Cheek	0.418	0.001	0.419
	Right Tilt	0.103	0.002	0.105		Right Tilt	0.123	0.002	0.125
	Left Cheek	0.185	0.029	0.214		Left Cheek	0.460	0.029	0.489
	Left Tilt	0.107	0.001	0.108		Left Tilt	0.262	0.001	0.263



The worst case 5 GHz WLAN reported SAR for each head configuration was used for SAR summation, regardless of whether the WLAN channel has WIFI Hotspot capability. Therefore, the summations above represent the absolute worst cases for simultaneous transmission with 5 GHz WLAN.

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**Table 11-5  
Simultaneous Transmission Scenario with 5 GHz WLAN (Held to Ear)**

Simult Tx	Configuration	Cell. CDMA SAR (W/kg)	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)		Simult Tx	Configuration	PCS CDMA SAR (W/kg)	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3			1	2	3	1+2	1+2+3
Head SAR	Right Cheek	0.193	0.186	0.001	0.379	0.380	Head SAR	Right Cheek	0.483	0.186	0.001	0.669	0.670
	Right Tilt	0.106	0.268	0.002	0.374	0.376		Right Tilt	0.139	0.268	0.002	0.407	0.409
	Left Cheek	0.173	0.286	0.029	0.459	0.488		Left Cheek	0.263	0.286	0.029	0.549	0.578
	Left Tilt	0.098	0.288	0.001	0.386	0.387		Left Tilt	0.157	0.288	0.001	0.445	0.446
Simult Tx	Configuration	Cell. EVDO SAR (W/kg)	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)		Simult Tx	Configuration	PCS EVDO SAR (W/kg)	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
	1	2	3	1+2	1+2+3	1		2	3	1+2	1+2+3		
Head SAR	Right Cheek	0.197	0.175	0.001	0.372	0.373	Head SAR	Right Cheek	0.441	0.175	0.001	0.616	0.617
	Right Tilt	0.103	0.239	0.002	0.342	0.344		Right Tilt	0.150	0.239	0.002	0.389	0.391
	Left Cheek	0.189	0.274	0.029	0.463	0.492		Left Cheek	0.231	0.274	0.029	0.505	0.534
	Left Tilt	0.103	0.257	0.001	0.360	0.361		Left Tilt	0.132	0.257	0.001	0.389	0.390
Simult Tx	Configuration	UMTS 850 SAR (W/kg)	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)		Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
	1	2	3	1+2	1+2+3	1		2	3	1+2	1+2+3		
Head SAR	Right Cheek	0.134	0.186	0.001	0.320	0.321	Head SAR	Right Cheek	0.328	0.186	0.001	0.514	0.515
	Right Tilt	0.074	0.268	0.002	0.342	0.344		Right Tilt	0.102	0.268	0.002	0.370	0.372
	Left Cheek	0.121	0.286	0.029	0.407	0.436		Left Cheek	0.172	0.286	0.029	0.468	0.487
	Left Tilt	0.067	0.288	0.001	0.355	0.356		Left Tilt	0.093	0.288	0.001	0.381	0.382
Simult Tx	Configuration	UMTS 850 SAR (W/kg)	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)		Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
	1	2	3	1+2	1+2+3	1		2	3	1+2	1+2+3		
Head SAR	Right Cheek	0.134	0.175	0.001	0.309	0.310	Head SAR	Right Cheek	0.328	0.175	0.001	0.503	0.504
	Right Tilt	0.074	0.239	0.002	0.313	0.315		Right Tilt	0.102	0.239	0.002	0.341	0.343
	Left Cheek	0.121	0.274	0.029	0.395	0.424		Left Cheek	0.172	0.274	0.029	0.446	0.475
	Left Tilt	0.067	0.257	0.001	0.324	0.325		Left Tilt	0.093	0.257	0.001	0.350	0.351
Simult Tx	Configuration	GSM 850 SAR (W/kg)	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)		Simult Tx	Configuration	GSM 1900 SAR (W/kg)	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
	1	2	3	1+2	1+2+3	1		2	3	1+2	1+2+3		
Head SAR	Right Cheek	0.163	0.186	0.001	0.349	0.350	Head SAR	Right Cheek	0.231	0.186	0.001	0.417	0.418
	Right Tilt	0.098	0.268	0.002	0.366	0.368		Right Tilt	0.066	0.268	0.002	0.334	0.336
	Left Cheek	0.165	0.286	0.029	0.451	0.480		Left Cheek	0.136	0.286	0.029	0.422	0.451
	Left Tilt	0.100	0.288	0.001	0.388	0.389		Left Tilt	0.079	0.288	0.001	0.367	0.368
Simult Tx	Configuration	GPRS 850 SAR (W/kg)	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)		Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
	1	2	3	1+2	1+2+3	1		2	3	1+2	1+2+3		
Head SAR	Right Cheek	0.185	0.175	0.001	0.360	0.361	Head SAR	Right Cheek	0.258	0.175	0.001	0.433	0.434
	Right Tilt	0.111	0.239	0.002	0.350	0.352		Right Tilt	0.063	0.239	0.002	0.302	0.304
	Left Cheek	0.182	0.274	0.029	0.456	0.485		Left Cheek	0.143	0.274	0.029	0.417	0.446
	Left Tilt	0.119	0.257	0.001	0.376	0.377		Left Tilt	0.087	0.257	0.001	0.344	0.345

The worst case 5 GHz WLAN reported SAR for each head configuration was used for SAR summation, regardless of whether the WLAN channel has WIFI Hotspot capability. Therefore, the summations above represent the absolute worst cases for simultaneous transmission with 5 GHz WLAN.

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## 11.4 Body-Worn Simultaneous Transmission Analysis

**Table 11-6**  
Simultaneous Transmission Scenario with 2.4 GHz WLAN (Body-Worn at 10 mm)

Configuration	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Back Side	GSM 850	0.323	0.079	0.402
Back Side	UMTS 850	0.236	0.079	0.315
Back Side	GSM 1900	0.428	0.079	0.507
Back Side	UMTS 1900	0.543	0.079	0.622
Back Side	Cell. CDMA	0.297	0.079	0.376
Back Side	PCS CDMA	0.677	0.079	0.756

**Table 11-7**  
Simultaneous Transmission Scenario with 2.4 GHz WLAN (Body-Worn at 10 mm)

Configuration	Cell. EVDO SAR (W/kg)	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	Configuration	PCS EVDO SAR (W/kg)	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)
	1	2	3	1+2	1+2+3		1	2	3	1+2	1+2+3
Back Side	0.271	0.146	0.079	0.417	0.496	Back Side	1.040	0.146	0.079	1.186	1.265
Configuration	Cell. CDMA SAR (W/kg)	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	Configuration	PCS CDMA SAR (W/kg)	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)
	1	2	3	1+2	1+2+3		1	2	3	1+2	1+2+3
Back Side	0.297	0.127	0.079	0.424	0.503	Back Side	0.677	0.127	0.079	0.804	0.883
Configuration	UMTS 850 SAR (W/kg)	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	Configuration	UMTS 1900 SAR (W/kg)	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)
	1	2	3	1+2	1+2+3		1	2	3	1+2	1+2+3
Back Side	0.236	0.146	0.079	0.382	0.461	Back Side	0.543	0.146	0.079	0.689	0.768
Configuration	UMTS 850 SAR (W/kg)	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	Configuration	UMTS 1900 SAR (W/kg)	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)
	1	2	3	1+2	1+2+3		1	2	3	1+2	1+2+3
Back Side	0.236	0.127	0.079	0.363	0.442	Back Side	0.543	0.127	0.079	0.670	0.749
Configuration	GPRS 850 SAR (W/kg)	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	Configuration	GPRS 1900 SAR (W/kg)	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)
	1	2	3	1+2	1+2+3		1	2	3	1+2	1+2+3
Back Side	0.321	0.146	0.079	0.467	0.546	Back Side	0.485	0.146	0.079	0.631	0.710
Configuration	GSM 850 SAR (W/kg)	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	Configuration	GSM 1900 SAR (W/kg)	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)
	1	2	3	1+2	1+2+3		1	2	3	1+2	1+2+3
Back Side	0.323	0.127	0.079	0.450	0.529	Back Side	0.428	0.127	0.079	0.555	0.634

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**Table 11-8**  
**Simultaneous Transmission Scenario with 5 GHz WLAN (Body-Worn at 10 mm)**

Configuration	Mode	2G/3G SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Back Side	GSM 850	0.323	0.683	1.006
Back Side	UMTS 850	0.236	0.683	0.919
Back Side	GSM 1900	0.428	0.683	1.111
Back Side	UMTS 1900	0.543	0.683	1.226
Back Side	Cell. CDMA	0.297	0.683	0.980
Back Side	PCS CDMA	0.677	0.683	1.360

The worst case 5 GHz WLAN reported SAR for each body-worn configuration was used for SAR summation, regardless of whether the WLAN channel has WIFI Hotspot capability. Therefore, the summations above represent the absolute worst cases for simultaneous transmission with 5 GHz WLAN.

**Table 11-9**  
**Simultaneous Transmission Scenario with 5 GHz WLAN (Body-Worn at 10 mm)**

Configuration	Cell. EVDO SAR (W/kg)	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	SPLS		
	1	2	3	1+2	1+2+3	1+2	1+3	2+3
Back Side	0.271	0.146	0.683	0.417	1.100	N/A	N/A	N/A
Configuration	PCS EVDO SAR (W/kg)	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	SPLS		
	1	2	3	1+2	1+2+3	1+2	1+3	2+3
Back Side	1.040	0.146	0.683	1.186	See Note 1	0.010	0.020	0.010
Configuration	Cell. CDMA SAR (W/kg)	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	SPLS		
	1	2	3	1+2	1+2+3	1+2	1+3	2+3
Back Side	0.297	0.127	0.683	0.424	1.107	N/A	N/A	N/A
Configuration	PCS CDMA SAR (W/kg)	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	SPLS		
	1	2	3	1+2	1+2+3	1+2	1+3	2+3
Back Side	0.677	0.127	0.683	0.804	1.487	N/A	N/A	N/A
Configuration	UMTS 850 SAR (W/kg)	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	SPLS		
	1	2	3	1+2	1+2+3	1+2	1+3	2+3
Back Side	0.236	0.146	0.683	0.382	1.065	N/A	N/A	N/A
Configuration	UMTS 1900 SAR (W/kg)	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	SPLS		
	1	2	3	1+2	1+2+3	1+2	1+3	2+3
Back Side	0.543	0.146	0.683	0.689	1.372	N/A	N/A	N/A
Configuration	UMTS 850 SAR (W/kg)	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	SPLS		
	1	2	3	1+2	1+2+3	1+2	1+3	2+3
Back Side	0.236	0.127	0.683	0.363	1.046	N/A	N/A	N/A

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Configuration	UMTS 1900 SAR (W/kg)	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	$\Sigma$ SAR (W/kg)	$\Sigma$ SAR (W/kg)	SPLS		
	1	2	3	1+2	1+2+3	1+2	1+3	2+3
Back Side	0.543	0.127	0.683	0.670	1.353	N/A	N/A	N/A
Configuration	GPRS 850 SAR (W/kg)	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	$\Sigma$ SAR (W/kg)	$\Sigma$ SAR (W/kg)	SPLS		
	1	2	3	1+2	1+2+3	1+2	1+3	2+3
Back Side	0.321	0.146	0.683	0.467	1.150	N/A	N/A	N/A
Configuration	GPRS 1900 SAR (W/kg)	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	$\Sigma$ SAR (W/kg)	$\Sigma$ SAR (W/kg)	SPLS		
	1	2	3	1+2	1+2+3	1+2	1+3	2+3
Back Side	0.485	0.146	0.683	0.631	1.314	N/A	N/A	N/A
Configuration	GSM 850 SAR (W/kg)	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	$\Sigma$ SAR (W/kg)	$\Sigma$ SAR (W/kg)	SPLS		
	1	2	3	1+2	1+2+3	1+2	1+3	2+3
Back Side	0.323	0.127	0.683	0.450	1.133	N/A	N/A	N/A
Configuration	GSM 1900 SAR (W/kg)	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	$\Sigma$ SAR (W/kg)	$\Sigma$ SAR (W/kg)	SPLS		
	1	2	3	1+2	1+2+3	1+2	1+3	2+3
Back Side	0.428	0.127	0.683	0.555	1.238	N/A	N/A	N/A



Notes:

1. No evaluation was performed to determine the aggregate 1g SAR for these configurations as the SPLS ratio between the antenna pairs was below 0.04 per FCC KDB 447498 D01v05. See Section 12.7 for detailed SPLS ratio analysis.
2. The worst case 5 GHz WLAN reported SAR for each body-worn configuration was used for SAR summation, regardless of whether the WLAN channel has WIFI Hotspot capability. Therefore, the summations above represent the absolute worst cases for simultaneous transmission with 5 GHz WLAN.

**Table 11-10**  
**Simultaneous Transmission Scenario with Bluetooth (Body-Worn at 10 mm)**

Configuration	Mode	2G/3G SAR (W/kg)	Bluetooth SAR (W/kg)	$\Sigma$ SAR (W/kg)
Back Side	GSM 850	0.323	0.208	0.531
Back Side	UMTS 850	0.236	0.208	0.444
Back Side	GSM 1900	0.428	0.208	0.636
Back Side	UMTS 1900	0.543	0.208	0.751
Back Side	Cell. CDMA	0.297	0.208	0.505
Back Side	PCS CDMA	0.677	0.208	0.885



Note: Bluetooth SAR was not required to be measured per FCC KDB 447498. Estimated SAR results were used in the above table to determine simultaneous transmission SAR test exclusion.

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**Table 11-11  
Simultaneous Transmission Scenario with Bluetooth (Body-Worn at 10 mm)**

Configuration	Cell. EVDO SAR (W/kg)	GSM 1900 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	Configuration	PCS EVDO SAR (W/kg)	GSM 1900 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)
	1	2	3	1+2	1+2+3		1	2	3	1+2	1+2+3
Back Side	0.271	0.146	0.208	0.417	0.625	Back Side	1.040	0.146	0.208	1.186	1.394
Configuration	Cell. CDMA SAR (W/kg)	GPRS 1900 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	Configuration	PCS CDMA SAR (W/kg)	GPRS 1900 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)
	1	2	3	1+2	1+2+3		1	2	3	1+2	1+2+3
Back Side	0.297	0.127	0.208	0.424	0.632	Back Side	0.677	0.127	0.208	0.804	1.012
Configuration	UMTS 850 SAR (W/kg)	GSM 1900 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	Configuration	UMTS 1900 SAR (W/kg)	GSM 1900 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)
	1	2	3	1+2	1+2+3		1	2	3	1+2	1+2+3
Back Side	0.236	0.146	0.208	0.382	0.590	Back Side	0.543	0.146	0.208	0.689	0.897
Configuration	UMTS 850 SAR (W/kg)	GPRS 1900 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	Configuration	UMTS 1900 SAR (W/kg)	GPRS 1900 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)
	1	2	3	1+2	1+2+3		1	2	3	1+2	1+2+3
Back Side	0.236	0.127	0.208	0.363	0.571	Back Side	0.543	0.127	0.208	0.670	0.878
Configuration	GPRS 850 SAR (W/kg)	GSM 1900 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	Configuration	GPRS 1900 SAR (W/kg)	GSM 1900 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)
	1	2	3	1+2	1+2+3		1	2	3	1+2	1+2+3
Back Side	0.321	0.146	0.208	0.467	0.675	Back Side	0.485	0.146	0.208	0.631	0.839
Configuration	GSM 850 SAR (W/kg)	GPRS 1900 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	Configuration	GSM 1900 SAR (W/kg)	GPRS 1900 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)
	1	2	3	1+2	1+2+3		1	2	3	1+2	1+2+3
Back Side	0.323	0.127	0.208	0.450	0.658	Back Side	0.428	0.127	0.208	0.555	0.763

Note: Bluetooth SAR was not required to be measured per FCC KDB 447498. Estimated SAR results were used in the above table to determine simultaneous transmission SAR test exclusion.



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## 11.5 Hotspot SAR Simultaneous Transmission Analysis

Per FCC KDB Publication 941225 D06v01, the devices edges with antennas more than 2.5 cm from edge are not required to be evaluated for SAR (“-”).

**Table 11-12**  
**Simultaneous Transmission Scenario (2.4 GHz Hotspot at 1.0 cm)**

Simult Tx	Configuration	GPRS 850 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	UMTS 850 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.321	0.079	0.400	Body SAR	Back	0.236	0.079	0.315
	Front	0.263	0.018	0.281		Front	0.379	0.018	0.397
	Top	-	-	0.000		Top	-	-	0.000
	Bottom	0.019	-	0.019		Bottom	0.202	-	0.202
	Right	0.156	-	0.156		Right	0.108	-	0.108
	Left	0.137	0.056	0.193		Left	0.015	0.056	0.071
Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.485	0.079	0.564	Body SAR	Back	0.543	0.079	0.622
	Front	0.592	0.018	0.610		Front	0.789	0.018	0.807
	Top	-	-	0.000		Top	-	-	0.000
	Bottom	0.387	-	0.387		Bottom	0.446	-	0.446
	Right	0.241	-	0.241		Right	0.232	-	0.232
	Left	0.033	0.056	0.089		Left	0.037	0.056	0.093
Simult Tx	Configuration	Cell. EVDO SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	PCS EVDO SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.271	0.079	0.350	Body SAR	Back	1.040	0.079	1.119
	Front	0.235	0.018	0.253		Front	1.090	0.018	1.108
	Top	-	-	0.000		Top	-	-	0.000
	Bottom	0.019	-	0.019		Bottom	0.665	-	0.665
	Right	0.182	-	0.182		Right	0.368	-	0.368
	Left	0.167	0.056	0.223		Left	0.063	0.056	0.119



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**Table 11-13**  
**Simultaneous Transmission Scenario (2.4 GHz Hotspot at 1.0 cm)**

Simult Tx	Configuration	Cell. EVDO SAR (W/kg)	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3
Body SAR	Back	0.271	0.146	0.079	0.496
	Front	0.235	0.045	0.018	0.298
	Top	-	0.137	-	0.137
	Bottom	0.019	-	-	0.019
	Right	0.182	0.093	-	0.275
	Left	0.167	-	0.056	0.223
Simult Tx	Configuration	PCS EVDO SAR (W/kg)	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3
Body SAR	Back	1.040	0.146	0.079	1.265
	Front	1.090	0.045	0.018	1.153
	Top	-	0.137	-	0.137
	Bottom	0.665	-	-	0.665
	Right	0.368	0.093	-	0.461
	Left	0.063	-	0.056	0.119
Simult Tx	Configuration	Cell. CDMA SAR (W/kg)	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3
Body SAR	Back	0.297	0.127	0.079	0.503
	Front	0.213	0.043	0.018	0.274
	Top	-	0.145	-	0.145
	Bottom	0.020	-	-	0.020
	Right	0.170	0.111	-	0.281
	Left	0.146	-	0.056	0.202
Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3
Body SAR	Back	0.543	0.146	0.079	0.768
	Front	0.789	0.045	0.018	0.852
	Top	-	0.137	-	0.137
	Bottom	0.446	-	-	0.446
	Right	0.232	0.093	-	0.325
	Left	0.037	-	0.056	0.093
Simult Tx	Configuration	UMTS 850 SAR (W/kg)	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3
Body SAR	Back	0.236	0.146	0.079	0.461
	Front	0.379	0.045	0.018	0.442
	Top	-	0.137	-	0.137
	Bottom	0.202	-	-	0.202
	Right	0.108	0.093	-	0.201
	Left	0.015	-	0.056	0.071
Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3
Body SAR	Back	0.543	0.127	0.079	0.749
	Front	0.789	0.043	0.018	0.850
	Top	-	0.145	-	0.145
	Bottom	0.446	-	-	0.446
	Right	0.232	0.111	-	0.343
	Left	0.037	-	0.056	0.093
Simult Tx	Configuration	UMTS 850 SAR (W/kg)	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3
Body SAR	Back	0.236	0.127	0.079	0.442
	Front	0.379	0.043	0.018	0.440
	Top	-	0.145	-	0.145
	Bottom	0.202	-	-	0.202
	Right	0.108	0.111	-	0.219
	Left	0.015	-	0.056	0.071
Simult Tx	Configuration	GPRS 850 SAR (W/kg)	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3
Body SAR	Back	0.321	0.146	0.079	0.546
	Front	0.263	0.045	0.018	0.326
	Top	-	0.137	-	0.137
	Bottom	0.019	-	-	0.019
	Right	0.156	0.093	-	0.249
	Left	0.137	-	0.056	0.193
Simult Tx	Configuration	GSM 1900 SAR (W/kg)	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3
Body SAR	Back	0.428	0.127	0.079	0.634
	Front	0.674	0.043	0.018	0.735
	Top	-	0.145	-	0.145
	Bottom	0.333	-	-	0.333
	Right	0.204	0.111	-	0.315
	Left	0.032	-	0.056	0.088

**Table 11-14**  
**Simultaneous Transmission Scenario (5.8 GHz Hotspot at 1.0 cm)**

Simult Tx	Configuration	GPRS 850 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	UMTS 850 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.321	0.506	0.827	Body SAR	Back	0.236	0.506	0.742
	Front	0.263	0.038	0.301		Front	0.379	0.038	0.417
	Top	-	-	0.000		Top	-	-	0.000
	Bottom	0.019	-	0.019		Bottom	0.202	-	0.202
	Right	0.156	-	0.156		Right	0.108	-	0.108
	Left	0.137	0.401	0.538		Left	0.015	0.401	0.416
Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.485	0.506	0.991	Body SAR	Back	0.543	0.506	1.049
	Front	0.592	0.038	0.630		Front	0.789	0.038	0.827
	Top	-	-	0.000		Top	-	-	0.000
	Bottom	0.387	-	0.387		Bottom	0.446	-	0.446
	Right	0.241	-	0.241		Right	0.232	-	0.232
	Left	0.033	0.401	0.434		Left	0.037	0.401	0.438
Simult Tx	Configuration	Cell. EVDO SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	PCS EVDO SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.271	0.506	0.777	Body SAR	Back	1.040	0.506	1.546
	Front	0.235	0.038	0.273		Front	1.090	0.038	1.128
	Top	-	-	0.000		Top	-	-	0.000
	Bottom	0.019	-	0.019		Bottom	0.665	-	0.665
	Right	0.182	-	0.182		Right	0.368	-	0.368
	Left	0.167	0.401	0.568		Left	0.063	0.401	0.464

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**Table 11-15**  
**Simultaneous Transmission Scenario (5.8 GHz Hotspot at 1.0 cm)**

Simult Tx	Configuration	Cell. EVDO SAR (W/kg)	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLS		
		1	2	3	1+2+3	1+2	1+3	2+3
Body SAR	Back	0.271	0.146	0.506	0.923	N/A	N/A	N/A
	Front	0.235	0.045	0.038	0.318	N/A	N/A	N/A
	Top	-	0.137	-	0.137	N/A	N/A	N/A
	Bottom	0.019	-	-	0.019	N/A	N/A	N/A
	Right	0.182	0.093	-	0.275	N/A	N/A	N/A
	Left	0.167	-	0.401	0.568	N/A	N/A	N/A
Simult Tx	Configuration	PCS EVDO SAR (W/kg)	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLS		
		1	2	3	1+2+3	1+2	1+3	2+3
Body SAR	Back	1.040	0.146	0.506	See Note	0.010	0.020	0.010
	Front	1.090	0.045	0.038	1.173	N/A	N/A	N/A
	Top	-	0.137	-	0.137	N/A	N/A	N/A
	Bottom	0.665	-	-	0.665	N/A	N/A	N/A
	Right	0.368	0.093	-	0.461	N/A	N/A	N/A
	Left	0.063	-	0.401	0.464	N/A	N/A	N/A
Simult Tx	Configuration	Cell. CDMA SAR (W/kg)	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLS		
		1	2	3	1+2+3	1+2	1+3	2+3
Body SAR	Back	0.297	0.127	0.506	0.930	N/A	N/A	N/A
	Front	0.213	0.043	0.038	0.294	N/A	N/A	N/A
	Top	-	0.145	-	0.145	N/A	N/A	N/A
	Bottom	0.020	-	-	0.020	N/A	N/A	N/A
	Right	0.170	0.111	-	0.281	N/A	N/A	N/A
	Left	0.146	-	0.401	0.547	N/A	N/A	N/A
Simult Tx	Configuration	PCS CDMA SAR (W/kg)	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLS		
		1	2	3	1+2+3	1+2	1+3	2+3
Body SAR	Back	0.677	0.127	0.506	1.310	N/A	N/A	N/A
	Front	0.734	0.043	0.038	0.815	N/A	N/A	N/A
	Top	-	0.145	-	0.145	N/A	N/A	N/A
	Bottom	0.616	-	-	0.616	N/A	N/A	N/A
	Right	0.312	0.111	-	0.423	N/A	N/A	N/A
	Left	0.041	-	0.401	0.442	N/A	N/A	N/A
Simult Tx	Configuration	UMTS 850 SAR (W/kg)	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLS		
		1	2	3	1+2+3	1+2	1+3	2+3
Body SAR	Back	0.236	0.146	0.506	0.888	N/A	N/A	N/A
	Front	0.379	0.045	0.038	0.462	N/A	N/A	N/A
	Top	-	0.137	-	0.137	N/A	N/A	N/A
	Bottom	0.202	-	-	0.202	N/A	N/A	N/A
	Right	0.108	0.093	-	0.201	N/A	N/A	N/A
	Left	0.015	-	0.401	0.416	N/A	N/A	N/A
Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLS		
		1	2	3	1+2+3	1+2	1+3	2+3
Body SAR	Back	0.543	0.146	0.506	1.195	N/A	N/A	N/A
	Front	0.789	0.045	0.038	0.872	N/A	N/A	N/A
	Top	-	0.137	-	0.137	N/A	N/A	N/A
	Bottom	0.446	-	-	0.446	N/A	N/A	N/A
	Right	0.232	0.093	-	0.325	N/A	N/A	N/A
	Left	0.037	-	0.401	0.438	N/A	N/A	N/A
Simult Tx	Configuration	UMTS 850 SAR (W/kg)	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLS		
		1	2	3	1+2+3	1+2	1+3	2+3
Body SAR	Back	0.236	0.127	0.506	0.869	N/A	N/A	N/A
	Front	0.379	0.043	0.038	0.460	N/A	N/A	N/A
	Top	-	0.145	-	0.145	N/A	N/A	N/A
	Bottom	0.202	-	-	0.202	N/A	N/A	N/A
	Right	0.108	0.111	-	0.219	N/A	N/A	N/A
	Left	0.015	-	0.401	0.416	N/A	N/A	N/A

Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLS		
		1	2	3	1+2+3	1+2	1+3	2+3
Body SAR	Back	0.543	0.127	0.506	1.176	N/A	N/A	N/A
	Front	0.789	0.043	0.038	0.870	N/A	N/A	N/A
	Top	-	0.145	-	0.145	N/A	N/A	N/A
	Bottom	0.446	-	-	0.446	N/A	N/A	N/A
	Right	0.232	0.111	-	0.343	N/A	N/A	N/A
	Left	0.037	-	0.401	0.438	N/A	N/A	N/A
Simult Tx	Configuration	GPRS 850 SAR (W/kg)	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLS		
		1	2	3	1+2+3	1+2	1+3	2+3
Body SAR	Back	0.321	0.146	0.506	0.973	N/A	N/A	N/A
	Front	0.263	0.045	0.038	0.346	N/A	N/A	N/A
	Top	-	0.137	-	0.137	N/A	N/A	N/A
	Bottom	0.019	-	-	0.019	N/A	N/A	N/A
	Right	0.156	0.093	-	0.249	N/A	N/A	N/A
	Left	0.137	-	0.401	0.538	N/A	N/A	N/A
Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLS		
		1	2	3	1+2+3	1+2	1+3	2+3
Body SAR	Back	0.485	0.146	0.506	1.137	N/A	N/A	N/A
	Front	0.592	0.045	0.038	0.675	N/A	N/A	N/A
	Top	-	0.137	-	0.137	N/A	N/A	N/A
	Bottom	0.387	-	-	0.387	N/A	N/A	N/A
	Right	0.241	0.093	-	0.334	N/A	N/A	N/A
	Left	0.033	-	0.401	0.434	N/A	N/A	N/A
Simult Tx	Configuration	GSM 850 SAR (W/kg)	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLS		
		1	2	3	1+2+3	1+2	1+3	2+3
Body SAR	Back	0.323	0.127	0.506	0.956	N/A	N/A	N/A
	Front	0.239	0.043	0.038	0.320	N/A	N/A	N/A
	Top	-	0.145	-	0.145	N/A	N/A	N/A
	Bottom	0.019	-	-	0.019	N/A	N/A	N/A
	Right	0.192	0.111	-	0.303	N/A	N/A	N/A
	Left	0.169	-	0.401	0.570	N/A	N/A	N/A
Simult Tx	Configuration	GSM 1900 SAR (W/kg)	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLS		
		1	2	3	1+2+3	1+2	1+3	2+3
Body SAR	Back	0.428	0.127	0.506	1.061	N/A	N/A	N/A
	Front	0.674	0.043	0.038	0.755	N/A	N/A	N/A
	Top	-	0.145	-	0.145	N/A	N/A	N/A
	Bottom	0.333	-	-	0.333	N/A	N/A	N/A
	Right	0.204	0.111	-	0.315	N/A	N/A	N/A
	Left	0.032	-	0.401	0.433	N/A	N/A	N/A



Note: No evaluation was performed to determine the aggregate 1g SAR for these configurations as the SPLS ratio between the antenna pairs was below 0.04 per FCC KDB 447498 D01v05. See Section 12.7 for detailed SPLS ratio analysis.

## 11.6 SPLSR Evaluation and Analysis

Per FCC KDB Publication 447498 D01v05, when the sum of the standalone transmitters is more than 1.6 W/kg, the SAR sum to peak locations can be analyzed to determine SAR distribution overlaps. When the SAR peak to location ratio (shown below) for each pair of antennas is  $\leq 0.04$ , simultaneous SAR evaluation is not required. The distance between the transmitters was calculated using the following formula.

$$\text{Distance}_{\text{Tx1} - \text{Tx2}} = R_i = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2}$$

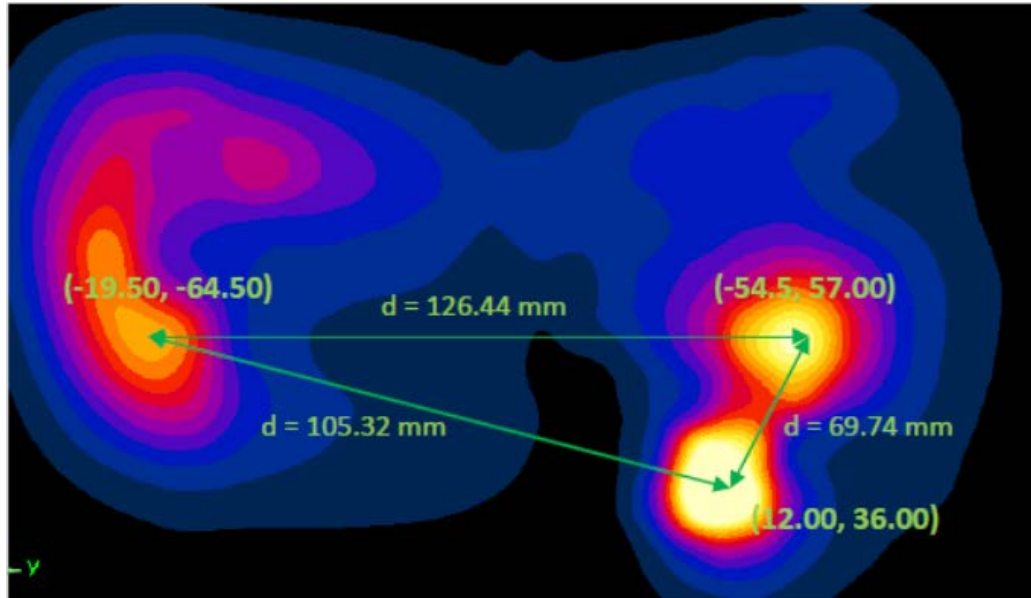
$$\text{SPLS Ratio} = \frac{(SAR_1 + SAR_2)^{1.5}}{R_i}$$

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The sum of the standalone SAR values was above 1.6 W/kg for the Body Back side configuration at a separation distance of 10 mm with EVDO 1900 MHz antenna, GSM 1900 MHz slave antenna, and 5 GHz WIFI Body-Worn.

**Table 11-16**  
**Peak SAR Locations for Body Back Side at 10 mm**

Mode/Band	x (mm)	y (mm)
PCS EVDO	-19.50	-64.50
GSM 1900	-54.50	57.00
802.11a	12.00	36.00



**Figure 11-2**  
**Peak SAR Locations of EVDO 1900 MHz, GSM 1900 MHz, and 802.11a**

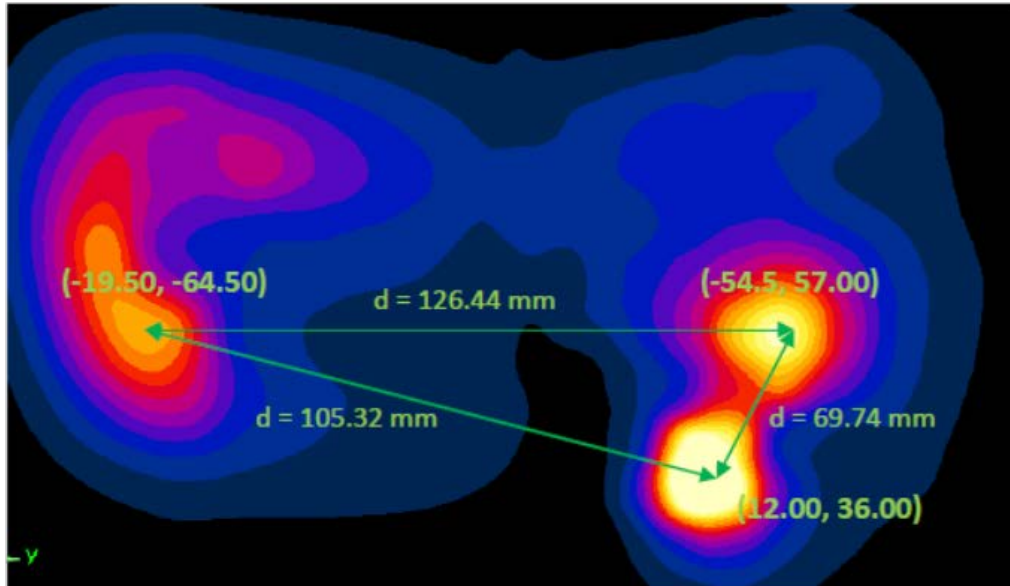
**Table 11-17**  
**SAR Sum to Peak Location Separation Ratio Calculation**

Antenna Pair		Standalone 1g SAR (W/kg)		Standalone SAR Sum (W/kg)	Peak SAR Separation Distance (mm)	SPLS Ratio
Ant "a"	Ant "b"	a	b	a+b	$D_{a-b}$	$(a+b)^{1.5}/D_{a-b}$
PCS EVDO	GSM 1900	1.04	0.146	1.186	126.44	0.01
PCS EVDO	802.11a	1.04	0.683	1.723	105.32	0.02
GSM 1900	802.11a	0.146	0.683	0.829	69.74	0.01

The sum of the standalone SAR values was above 1.6 W/kg for the Body Back side configuration at a separation distance of 10 mm with EVDO 1900 MHz antenna, GSM 1900 MHz slave antenna, and 5.8 GHz WIFI Hotspot.

**Table 11-18**  
**Peak SAR Locations for Body Back Side at 10 mm**

Mode/Band	x (mm)	y (mm)
PCS EVDO	-19.50	-64.50
GSM 1900	-54.50	57.00
802.11a	12.00	36.00





**Figure 11-3**  
**Peak SAR Locations of EVDO 1900 MHz, GSM 1900 MHz, and 802.11a**

**Table 11-19**  
**SAR Sum to Peak Location Separation Ratio Calculation**

Antenna Pair		Standalone 1g SAR (W/kg)		Standalone SAR Sum (W/kg)	Peak SAR Separation Distance (mm)	SPLS Ratio
Ant "a"	Ant "b"	a	b	a+b	$D_{a-b}$	$(a+b)^{1.5}/D_{a-b}$
PCS EVDO	GSM 1900	1.04	0.146	1.186	126.44	0.01
PCS EVDO	802.11a	1.04	0.506	1.546	105.32	0.02
GSM 1900	802.11a	0.146	0.506	0.652	69.74	0.01

## 11.7 Simultaneous Transmission Conclusion

The above numerical summed SAR and SPLSR analysis results for all the worst-case simultaneous transmission conditions were below the SAR limit. Therefore, the above analysis is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit and therefore no measured volumetric simultaneous SAR summation is required per FCC KDB Publication 447498 D01v05.

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## 12 SAR MEASUREMENT VARIABILITY

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

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



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

**Table 12-1**  
**Body SAR Measurement Variability Results**

BODY VARIABILITY RESULTS													
Band	FREQUENCY		Mode	Service	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)	
1900	1851.25	25	PCS CDMA	EVDO Rev. 0	front	10 mm	0.808	0.755	1.07	N/A	N/A	N/A	N/A
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Body 1.6 W/kg (mW/g) averaged over 1 gram						

### 12.2 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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# 13 EQUIPMENT LIST

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	E8257D	(250kHz-20GHz) Signal Generator	4/16/2013	Annual	4/16/2014	MY45470194
Agilent	8753E	(30kHz-6GHz) Network Analyzer	4/16/2013	Annual	4/16/2014	JP38020182
Agilent	8753E	(30kHz-6GHz) Network Analyzer	7/23/2013	Annual	7/23/2014	US37390350
Agilent	8594A	(9kHz-2.9GHz) Spectrum Analyzer	N/A	N/A	N/A	3051A00187
Agilent	8648D	(9kHz-4GHz) Signal Generator	4/17/2013	Annual	4/17/2014	3629U00687
Agilent	85070C	Dielectric Probe Kit	2/14/2013	Annual	2/14/2014	MY44300633
Agilent	N9020A	NXA Signal Analyzer	10/29/2013	Annual	10/29/2014	US46470561
Agilent	N5182A	MXG Vector Signal Generator	10/28/2013	Annual	10/28/2014	US46240505
Agilent	8753ES	S-Parameter Network Analyzer	10/29/2013	Annual	10/29/2014	US39170122
Agilent	85047A	S-Parameter Test Set	N/A	N/A	N/A	2904A00579
Agilent	E5515C	Wireless Communications Test Set	10/18/2012	Biennial	10/18/2014	GB43193563
Amplifier Research	551G4	5W, 800MHz-4.2GHz	CBT	N/A	CBT	21910
Anritsu	ML2495A	Power Meter	10/31/2013	Annual	10/31/2014	1039008
Anritsu	ML2438A	Power Meter	2/14/2013	Annual	2/14/2014	98150041
Anritsu	MA2481A	Power Sensor	2/14/2013	Annual	2/14/2014	5318
Anritsu	MA2481A	Power Sensor	2/14/2013	Annual	2/14/2014	5821
Anritsu	MA2411B	Pulse Power Sensor	11/14/2013	Annual	11/14/2014	1126066
Anritsu	MT8820C	Radio Communication Analyzer	6/28/2013	Annual	6/28/2014	6201240328
COMTECH	AR85729-5/5759B	Solid State Amplifier	CBT	N/A	CBT	M3W1A00-1002
COMTECH	AR85729-5	Solid State Amplifier	CBT	N/A	CBT	M155A00-009
Control Company	36934-158	Wall-Mounted Thermometer	1/4/2012	Biennial	1/4/2014	122014497
Fisher Scientific	15-077-960	Thermometer	11/6/2012	Biennial	11/6/2014	122640025
Gigatronics	80701A	(0.05-18GHz) Power Sensor	10/30/2013	Annual	10/30/2014	1833460
Gigatronics	8651A	Universal Power Meter	10/30/2013	Annual	10/30/2014	8650319
MCL	BW-N6W5+	6dB Attenuator	CBT	N/A	CBT	1139
MiniCircuits	VLF-6000+	Low Pass Filter	CBT	N/A	CBT	N/A
MiniCircuits	SLP-2400+	Low Pass Filter	CBT	N/A	CBT	R8979500903
Mini-Circuits	BW-N20W5+	DC to 18 GHz Precision Fixed 20 dB Attenuator	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
Mini-Circuits	BW-N20W5	Power Attenuator	CBT	N/A	CBT	1226
Narda	4014C-6	4 - 8 GHz SMA 6 dB Directional Coupler	CBT	N/A	CBT	N/A
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Narda	BW-S3W2	Attenuator (3dB)	CBT	N/A	CBT	120
Pasternack	PE2208-6	Bidirectional Coupler	CBT	N/A	CBT	N/A
Pasternack	PE2209-10	Bidirectional Coupler	CBT	N/A	CBT	N/A
Rohde & Schwarz	CMU200	Base Station Simulator	5/3/2013	Annual	5/3/2014	836371/0079
Rohde & Schwarz	NRVD	Dual Channel Power Meter	10/12/2012	Biennial	10/12/2014	101695
Rohde & Schwarz	NRV-Z32	Peak Power Sensor	10/12/2012	Biennial	10/12/2014	836019/013
Rohde & Schwarz	SMI003B	Signal Generator	4/17/2013	Annual	4/17/2014	DE27259
Rohde & Schwarz	SME06	Signal Generator	10/30/2013	Annual	10/30/2014	832026
Rohde & Schwarz	NRV5	Single Channel Power Meter	10/31/2013	Annual	10/31/2014	835360/0079
Seekonk	NC-100	Torque Wrench (8" lb)	11/29/2011	Triennial	11/29/2014	21053
SPEAG	D1900V2	1900 MHz SAR Dipole	2/6/2013	Annual	2/6/2014	5d148
SPEAG	D2450V2	2450 MHz SAR Dipole	1/8/2013	Annual	1/8/2014	797
SPEAG	D2450V2	2450 MHz SAR Dipole	2/11/2013	Annual	2/11/2014	882
SPEAG	D5GH2V2	5 GHz SAR Dipole	1/11/2013	Annual	1/11/2014	1057
SPEAG	D5GH2V2	5 GHz SAR Dipole	2/14/2013	Annual	2/14/2014	1120
SPEAG	D835V2	835 MHz SAR Dipole	4/25/2013	Annual	4/25/2014	4d119
SPEAG	DAE4	Dasy Data Acquisition Electronics	1/17/2013	Annual	1/17/2014	1272
SPEAG	DAE4	Dasy Data Acquisition Electronics	2/6/2013	Annual	2/6/2014	649
SPEAG	DAE4	Dasy Data Acquisition Electronics	3/8/2013	Annual	3/8/2014	1334
SPEAG	DAE4	Dasy Data Acquisition Electronics	4/22/2013	Annual	4/22/2014	665
SPEAG	DAE4	Dasy Data Acquisition Electronics	4/22/2013	Annual	4/22/2014	1364
SPEAG	DAE4	Dasy Data Acquisition Electronics	4/22/2013	Annual	4/22/2014	1368
SPEAG	DAE4	Dasy Data Acquisition Electronics	5/13/2013	Annual	5/13/2014	859
SPEAG	DAE4	Dasy Data Acquisition Electronics	8/21/2013	Annual	8/21/2014	1322
SPEAG	DAK-3.5	Dielectric Assessment Kit	5/14/2013	Annual	5/14/2014	1070
SPEAG	DAK-3.5	Dielectric Assessment Kit	11/13/2013	Annual	11/13/2014	1091
SPEAG	DAKS-3.5	Portable Dielectric Assessment Kit	8/18/2013	Annual	8/18/2014	1008
SPEAG	DAKS-3.5	Portable Dielectric Assessment Kit	8/18/2013	Annual	8/18/2014	1009
SPEAG	ES3DV4	SAR Probe	1/17/2013	Annual	1/17/2014	3589
SPEAG	ES3DV3	SAR Probe	3/15/2013	Annual	3/15/2014	3209
SPEAG	ES3DV3	SAR Probe	4/29/2013	Annual	4/29/2014	3213
SPEAG	ES3DV3	SAR Probe	4/29/2013	Annual	4/29/2014	3318
SPEAG	ES3DV3	SAR Probe	4/29/2013	Annual	4/29/2014	3319
SPEAG	ES3DV3	SAR Probe	5/16/2013	Annual	5/16/2014	3263
SPEAG	ES3DV2	SAR Probe	8/22/2013	Annual	8/22/2014	3022
SPEAG	ES3DV4	SAR Probe	10/23/2013	Annual	10/23/2014	3914
Tektronix	RSA6114A	Real Time Spectrum Analyzer	4/17/2013	Annual	4/17/2014	8010177
VWR	23226-658	Long Stem Thermometer	3/30/2012	Biennial	3/30/2014	122179874

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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# 14 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 <sub>i</sub> 1gm	c <sub>i</sub> 10 gms	1gm u <sub>i</sub> (± %)	10gms u <sub>i</sub> (± %)	v <sub>i</sub>
<b>Measurement System</b>									
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	∞
<b>Test Sample Related</b>									
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	∞
<b>Phantom &amp; Tissue Parameters</b>									
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
<b>Combined Standard Uncertainty (k=1)</b>				RSS			12.1	11.7	299
<b>Expanded Uncertainty (95% CONFIDENCE LEVEL)</b>				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 <sub>i</sub> 1gm	c <sub>i</sub> 10 gms	1gm u <sub>i</sub> (± %)	10gms u <sub>i</sub> (± %)	v <sub>i</sub>	
<b>Measurement System</b>										
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	∞	
<b>Test Sample Related</b>										
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	∞	
<b>Phantom &amp; Tissue Parameters</b>										
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	
<b>Combined Standard Uncertainty (k=1)</b>							RSS	12.4	12.0	299
<b>Expanded Uncertainty</b> (95% CONFIDENCE LEVEL)							k=2	24.7	24.0	

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



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## 15 CONCLUSION

### 15.1 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

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-A**

Communication System: UID 0, GSM GPRS; 2 Tx slots; Frequency: 836.6 MHz; Duty Cycle: 1:4.15

Medium: 835 Head, Medium parameters used (interpolated):

$f = 836.6 \text{ MHz}$ ;  $\sigma = 0.909 \text{ S/m}$ ;  $\epsilon_r = 41.11$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Test Date: 12-16-2013; Ambient Temp: 21.3°C; Tissue Temp: 21.4°C

Probe: ES3DV2 - SN3022; ConvF(6.09, 6.09, 6.09); Calibrated: 8/22/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1322; Calibrated: 8/21/2013

Phantom: SAM v5.0 Left; Type: QD000P40CD; Serial: TP: 1687

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: GPRS 850, Right Head, Cheek, Mid.ch, 2 Tx slots**

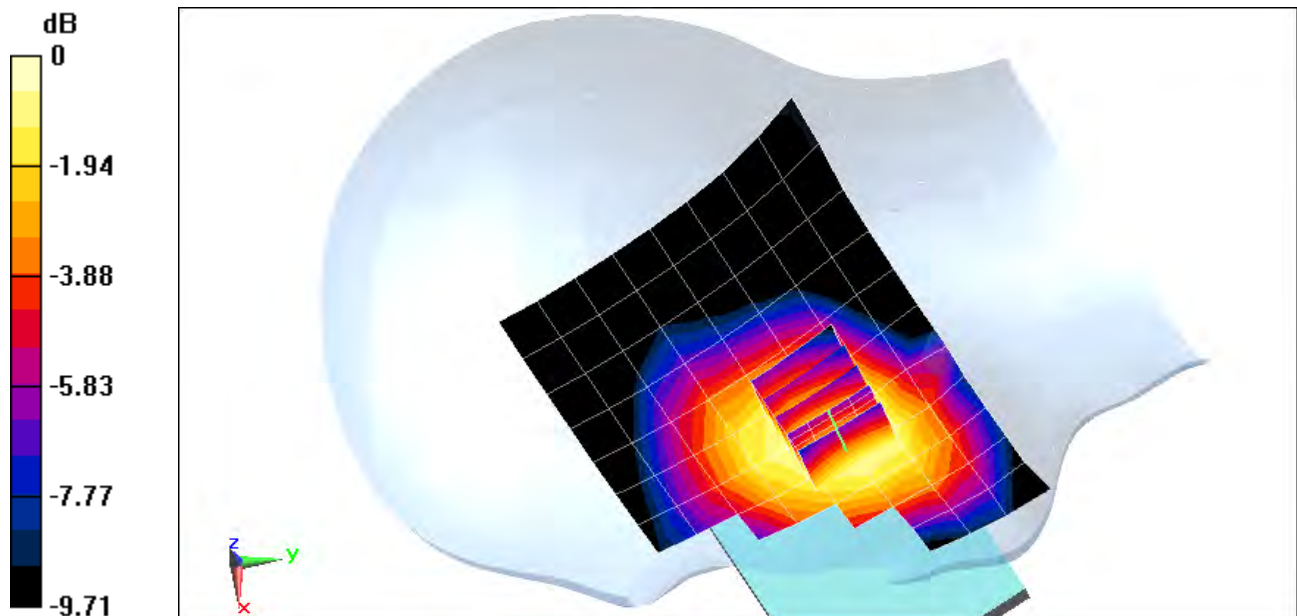
**Area Scan (9x15x1):** Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 14.027 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 0.199 W/kg

**SAR(1 g) = 0.160 W/kg**



0 dB = 0.165 W/kg = -7.83 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-B**

Communication System: UID 0, UMTS; Frequency: 836.6 MHz; Duty Cycle: 1:1

Medium: 835 Head, Medium parameters used (interpolated):

$f = 836.6 \text{ MHz}$ ;  $\sigma = 0.909 \text{ S/m}$ ;  $\epsilon_r = 41.11$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Test Date: 12-16-2013; Ambient Temp: 21.3°C; Tissue Temp: 21.4°C

Probe: ES3DV2 - SN3022; ConvF(6.09, 6.09, 6.09); Calibrated: 8/22/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1322; Calibrated: 8/21/2013

Phantom: SAM v5.0 Left; Type: QD000P40CD; Serial: TP: 1687

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: UMTS 850, Right Head, Cheek, Mid.ch**

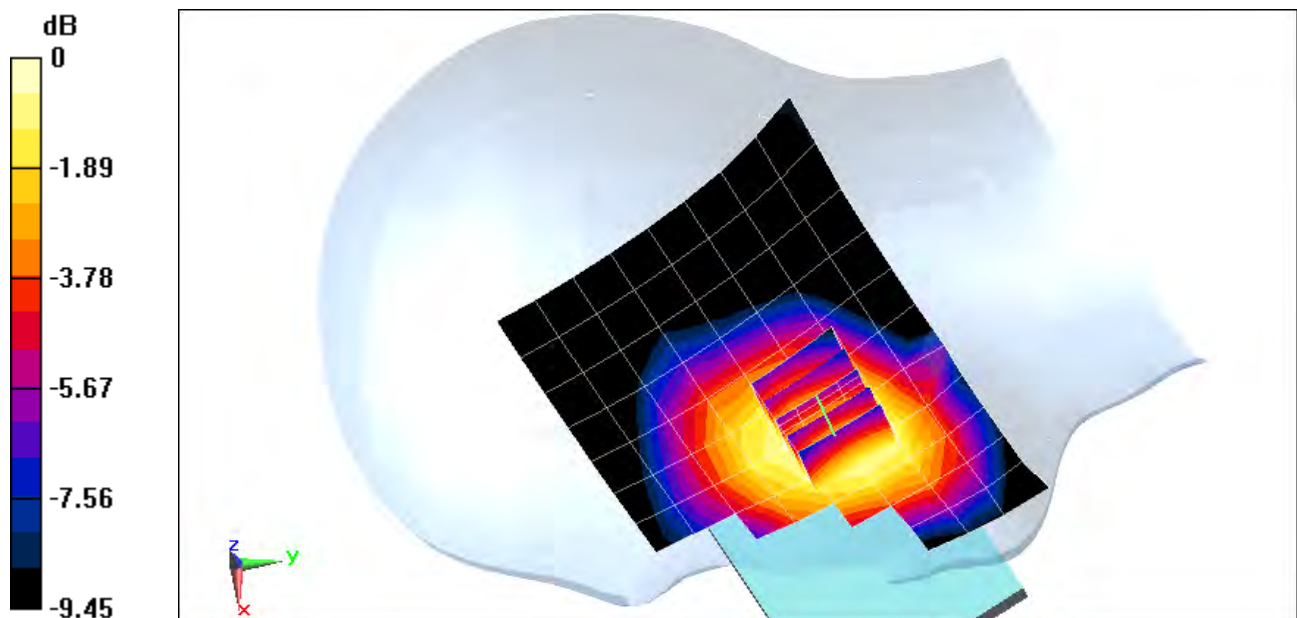
**Area Scan (9x15x1):** Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 11.937 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 0.150 W/kg

**SAR(1 g) = 0.120 W/kg**



0 dB = 0.125 W/kg = -9.03 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-1**

Communication System: UID 0, GSM GPRS; 2 Tx slots; Frequency: 1880 MHz; Duty Cycle: 1:4.15

Medium: 1900 Head, Medium parameters used:

$f = 1880 \text{ MHz}$ ;  $\sigma = 1.415 \text{ S/m}$ ;  $\epsilon_r = 38.832$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Left Section

Test Date: 12-16-2013; Ambient Temp: 24.5°C; Tissue Temp: 23.1°C

Probe: ES3DV3 - SN3209; ConvF(5.21, 5.21, 5.21); Calibrated: 3/15/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1334; Calibrated: 3/8/2013

Phantom: SAM Front; Type: SAM; Serial: 1686

Measurement SW: DASYS2, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: GPRS 1900, Left Head, Tilt, Mid.ch, 2 Tx slots, Slave Antenna**

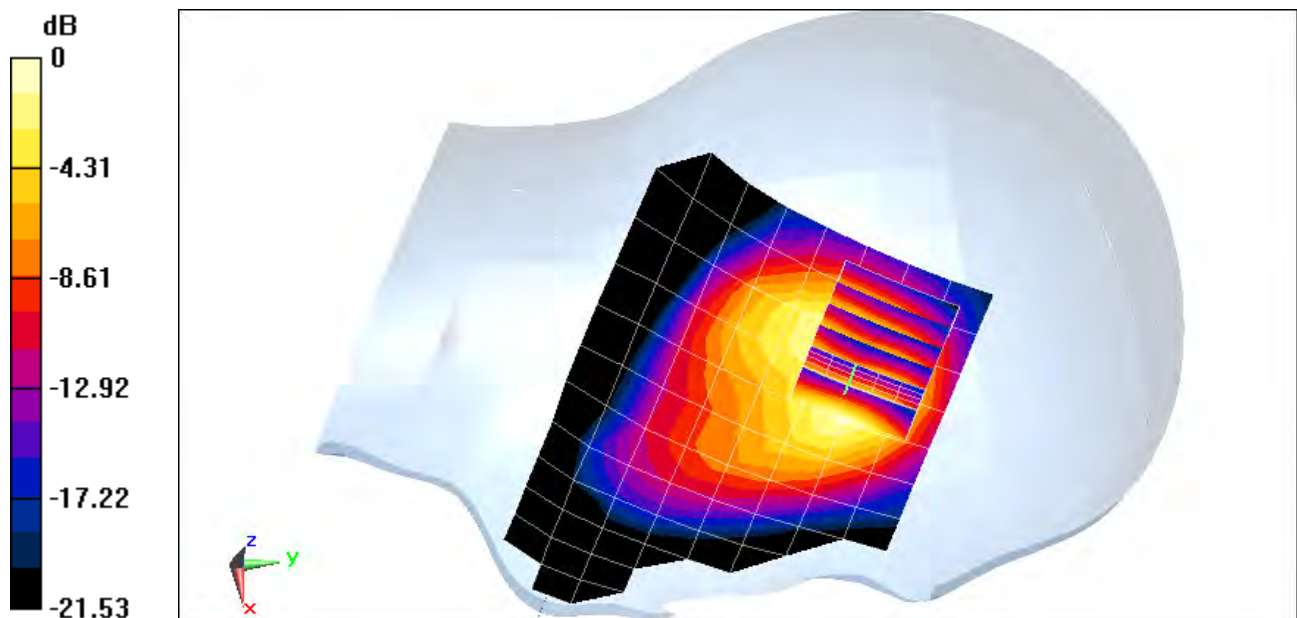
**Area Scan (9x15x1):** Measurement grid: dx=15mm, dy=15mm

**Zoom Scan (6x6x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 13.149 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 0.531 W/kg

**SAR(1 g) = 0.279 W/kg**



0 dB = 0.299 W/kg = -5.24 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-B**

Communication System: UID 0, UMTS; Frequency: 1852.4 MHz; Duty Cycle: 1:1

Medium: 1900 Head, Medium parameters used (interpolated):

$f = 1852.4 \text{ MHz}$ ;  $\sigma = 1.369 \text{ S/m}$ ;  $\epsilon_r = 39.355$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Test Date: 12-05-2013; Ambient Temp: 24.0°C; Tissue Temp: 23.0°C

Probe: ES3DV3 - SN3213; ConvF(5.08, 5.08, 5.08); Calibrated: 4/29/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn665; Calibrated: 4/22/2013

Phantom: SAM Front; Type: QD000P40CD; Serial: 1717

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: UMTS 1900, Right Head, Cheek, Low.ch**

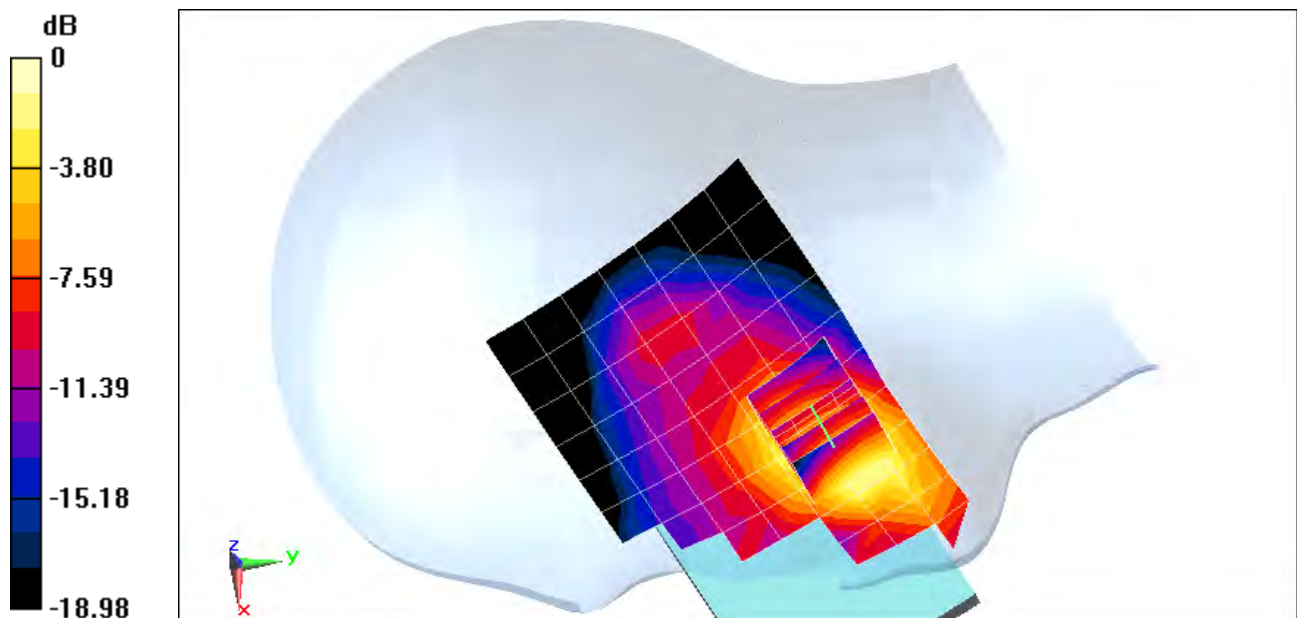
**Area Scan (8x13x1):** Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 15.069 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 0.474 W/kg

**SAR(1 g) = 0.308 W/kg**



0 dB = 0.339 W/kg = -4.70 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-B**

Communication System: UID 0, CDMA; Frequency: 836.52 MHz; Duty Cycle: 1:1

Medium: 835 Head, Medium parameters used (interpolated):

$f = 836.52 \text{ MHz}$ ;  $\sigma = 0.909 \text{ S/m}$ ;  $\epsilon_r = 41.111$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Test Date: 12-16-2013; Ambient Temp: 21.3°C; Tissue Temp: 21.4°C

Probe: ES3DV2 - SN3022; ConvF(6.09, 6.09, 6.09); Calibrated: 8/22/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1322; Calibrated: 8/21/2013

Phantom: SAM v5.0 Left; Type: QD000P40CD; Serial: TP: 1687

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: Cell. CDMA, Right Head, Cheek, Mid.ch**

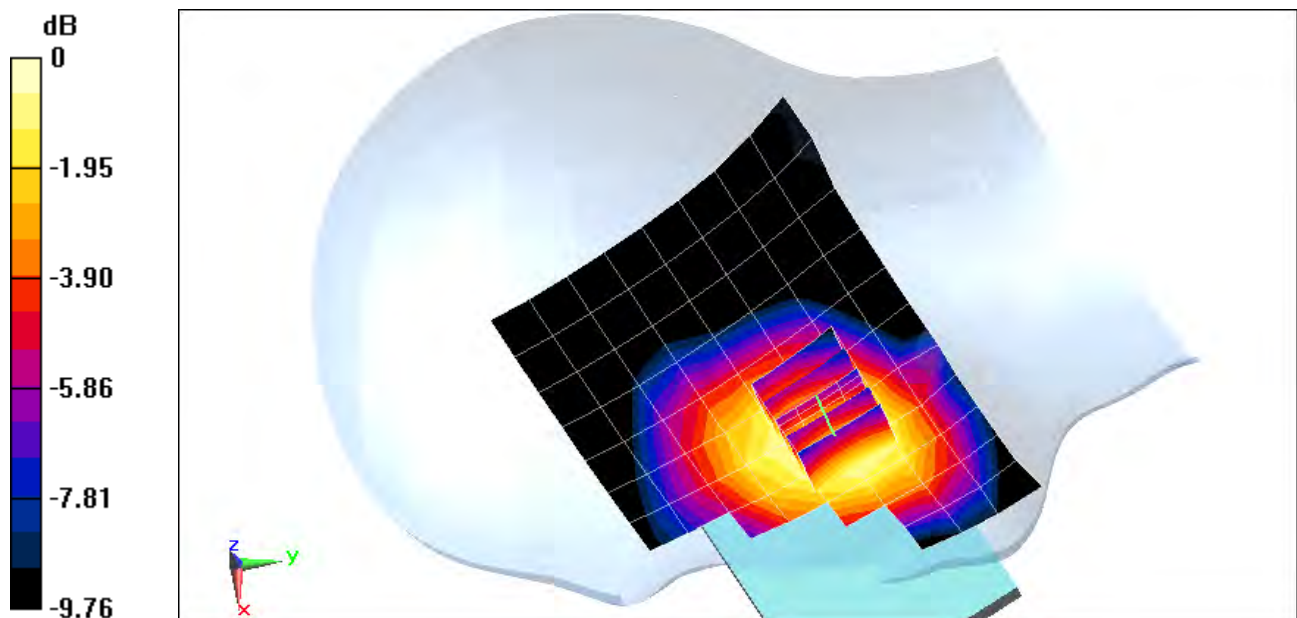
**Area Scan (9x15x1):** Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 14.063 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 0.226 W/kg

**SAR(1 g) = 0.176 W/kg**



0 dB = 0.183 W/kg = -7.38 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-B**

Communication System: UID 0, CDMA; Frequency: 1880 MHz; Duty Cycle: 1:1

Medium: 1900 Head, Medium parameters used:

$f = 1880 \text{ MHz}$ ;  $\sigma = 1.396 \text{ S/m}$ ;  $\epsilon_r = 39.21$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Test Date: 12-05-2013; Ambient Temp: 24.0°C; Tissue Temp: 23.0°C

Probe: ES3DV3 - SN3213; ConvF(5.08, 5.08, 5.08); Calibrated: 4/29/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn665; Calibrated: 4/22/2013

Phantom: SAM Front; Type: QD000P40CD; Serial: 1717

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: PCS CDMA, Right Head, Cheek, Mid.ch**

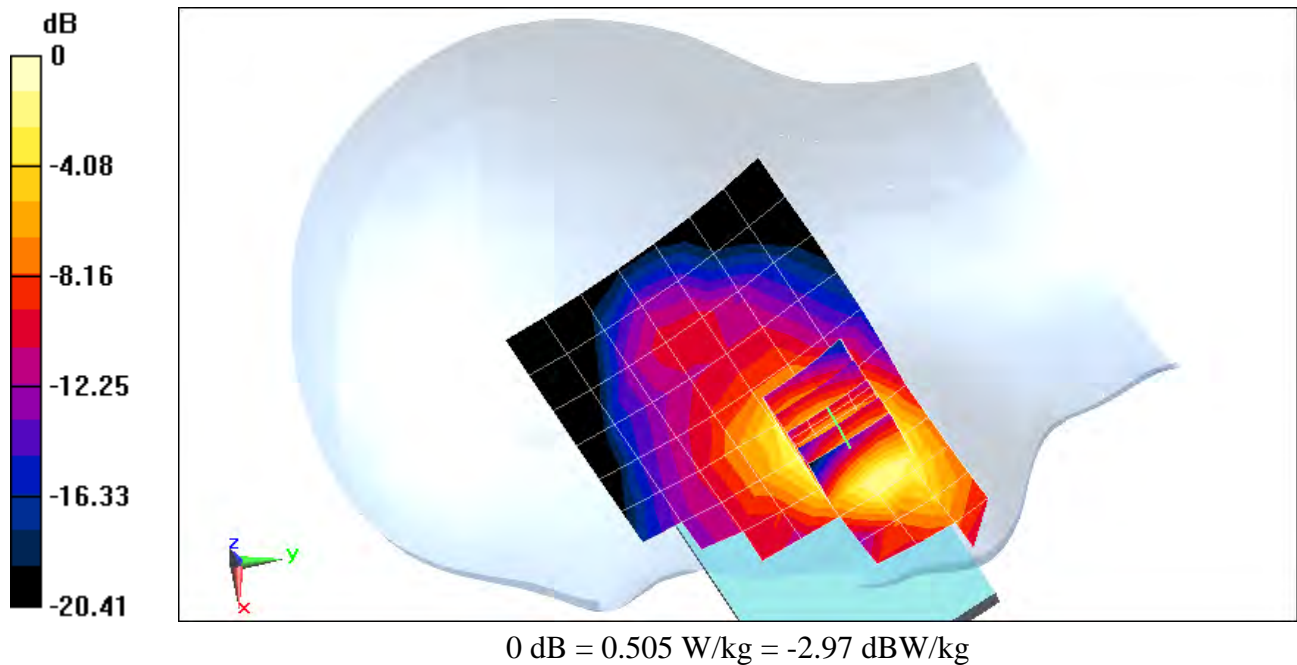
**Area Scan (8x13x1):** Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 18.545 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 0.720 W/kg

**SAR(1 g) = 0.462 W/kg**



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-A**

Communication System: UID 0, IEEE 802.11b; Frequency: 2462 MHz; Duty Cycle: 1:1

Medium: 2450 Head, Medium parameters used (interpolated):

$f = 2462 \text{ MHz}$ ;  $\sigma = 1.876 \text{ S/m}$ ;  $\epsilon_r = 39.11$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Test Date: 11-25-2013; Ambient Temp: 19.1°C; Tissue Temp: 19.8°C

Probe: ES3DV3 - SN3263; ConvF(4.47, 4.47, 4.47); Calibrated: 5/16/2013;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn859; Calibrated: 5/13/2013

Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1403

Measurement SW: DASYS2, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: IEEE 802.11b, Right Head, Cheek, Ch 11, 1 Mbps**

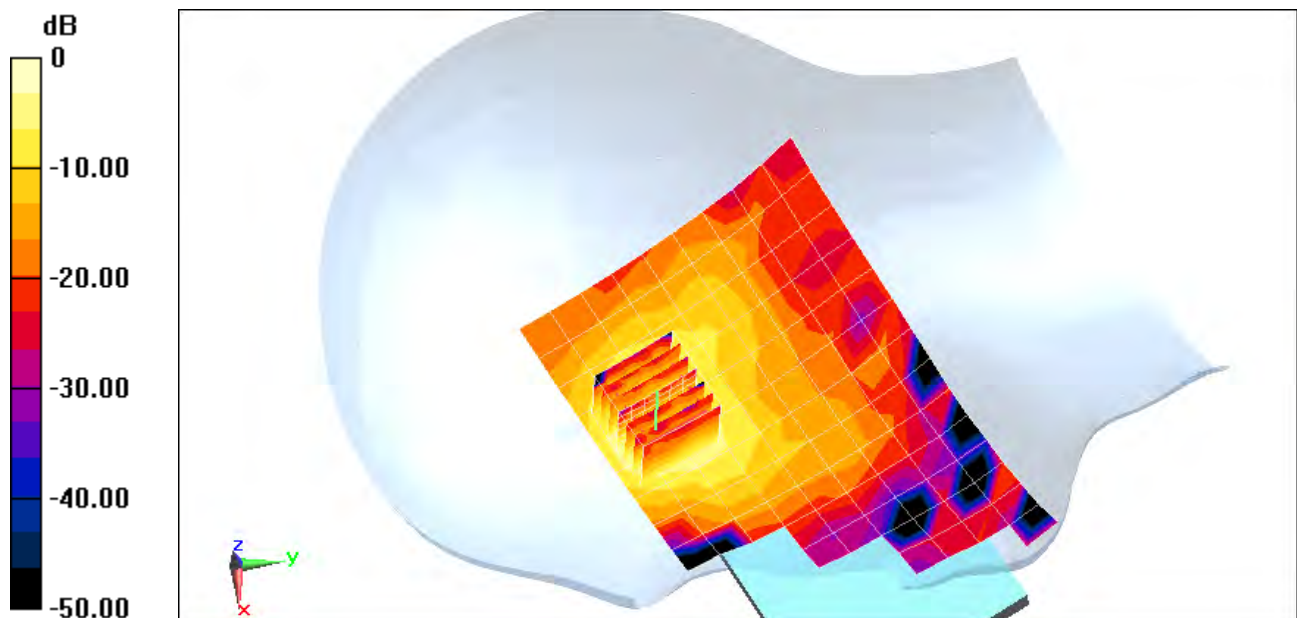
**Area Scan (10x16x1):** Measurement grid: dx=12mm, dy=12mm

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

Reference Value = 6.077 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 0.158 W/kg

**SAR(1 g) = 0.0665 W/kg**



0 dB = 0.0906 W/kg = -10.43 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-B**

Communication System: UID 0, IEEE 802.11a; Frequency: 5745 MHz; Duty Cycle: 1:1

Medium: 5 GHz Head, Medium parameters used:

$f = 5745 \text{ MHz}$ ;  $\sigma = 5.071 \text{ S/m}$ ;  $\epsilon_r = 34.382$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Test Date: 11-26-2013; Ambient Temp: 22.1°C; Tissue Temp: 21.7°C

Probe: EX3DV4 - SN3914; ConvF(4.52, 4.52, 4.52); Calibrated: 10/23/2013;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn649; Calibrated: 2/6/2013

Phantom: SAM V5.0 Right; Type: QD000P40CD; Serial: 1647

Measurement SW: DASYS2, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: IEEE 802.11a, 5.8 GHz, Right Head, Tilt, Ch 149, 6 Mbps**

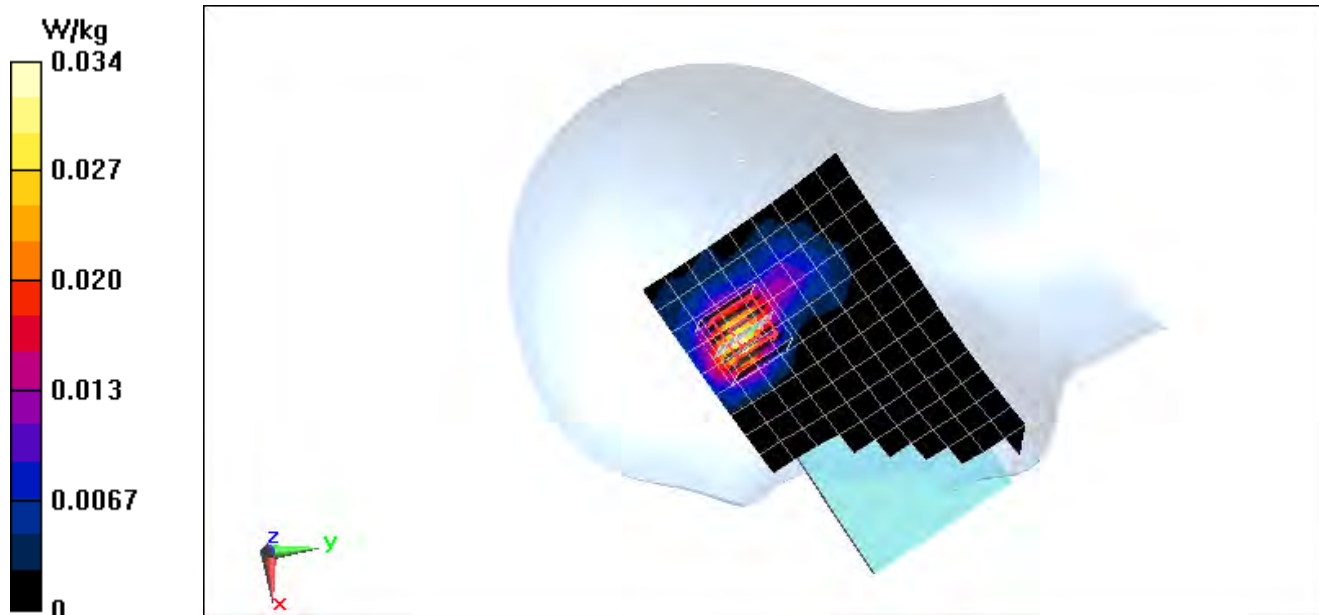
**Area Scan (11x21x1):** Measurement grid: dx=10mm, dy=10mm

**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4

Reference Value = 0 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 0.0590 W/kg

**SAR(1 g) = 0.000733 W/kg**



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-B**

Communication System: UID 0, IEEE 802.11a; Frequency: 5240 MHz; Duty Cycle: 1:1  
Medium: 5 GHz Head, Medium parameters used:

$f = 5240 \text{ MHz}$ ;  $\sigma = 4.556 \text{ S/m}$ ;  $\epsilon_r = 35.023$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Left Section

Test Date: 11-26-2013; Ambient Temp: 22.1°C; Tissue Temp: 21.7°C

Probe: EX3DV4 - SN3914; ConvF(4.99, 4.99, 4.99); Calibrated: 10/23/2013;  
Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn649; Calibrated: 2/6/2013

Phantom: SAM V5.0 Right; Type: QD000P40CD; Serial: 1647

Measurement SW: DASYS2, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: IEEE 802.11a, 5.2 GHz, Left Head, Cheek, Ch 48, 6 Mbps**

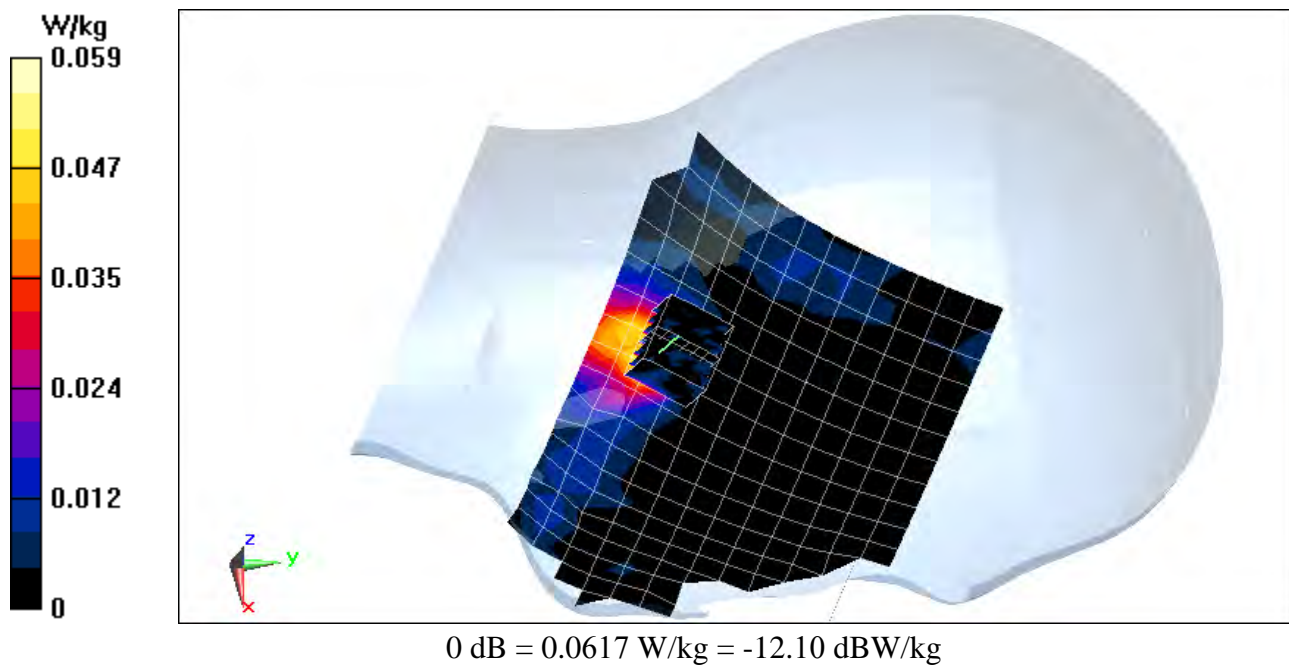
**Area Scan (13x21x1):** Measurement grid: dx=10mm, dy=10mm

**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4

Reference Value = 2.592 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 0.129 W/kg

**SAR(1 g) = 0.024 W/kg**



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-A**

Communication System: UID 0, GSM; Frequency: 836.6 MHz; Duty Cycle: 1:8.3

Medium: 835 Body, Medium parameters used (interpolated):

$f = 836.6 \text{ MHz}$ ;  $\sigma = 1.013 \text{ S/m}$ ;  $\epsilon_r = 53.796$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-09-2013; Ambient Temp: 23.6°C; Tissue Temp: 20.1°C

Probe: ES3DV3 - SN3209; ConvF(6.28, 6.28, 6.28); Calibrated: 3/15/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1334; Calibrated: 3/8/2013

Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP-1158

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: GSM 850, Body SAR, Back side, Mid.ch**

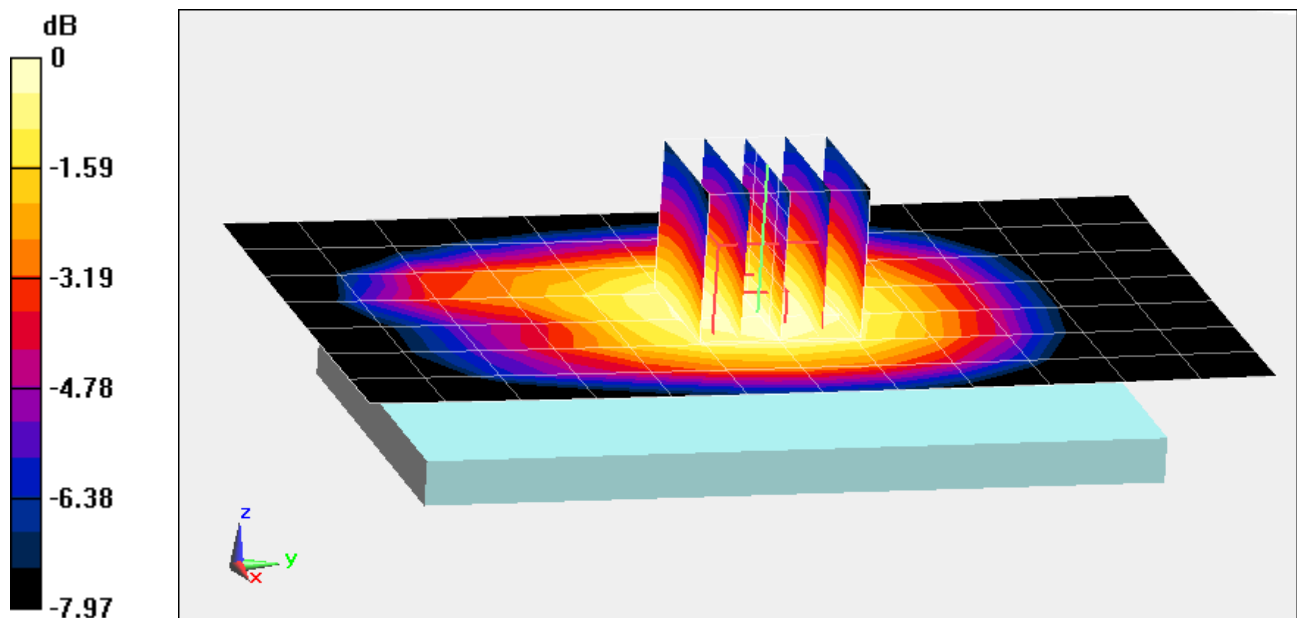
**Area Scan (8x13x1):** Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 17.382 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 0.348 W/kg

**SAR(1 g) = 0.285 W/kg**



0 dB = 0.300 W/kg = -5.23 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-A**

Communication System: UID 0, UMTS; Frequency: 836.6 MHz; Duty Cycle: 1:1

Medium: 835 Body, Medium parameters used (interpolated):

$f = 836.6 \text{ MHz}$ ;  $\sigma = 1.013 \text{ S/m}$ ;  $\epsilon_r = 53.796$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-09-2013; Ambient Temp: 23.6°C; Tissue Temp: 20.1°C

Probe: ES3DV3 - SN3209; ConvF(6.28, 6.28, 6.28); Calibrated: 3/15/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1334; Calibrated: 3/8/2013

Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP-1158

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: UMTS 850, Body SAR, Back side, Mid.ch**

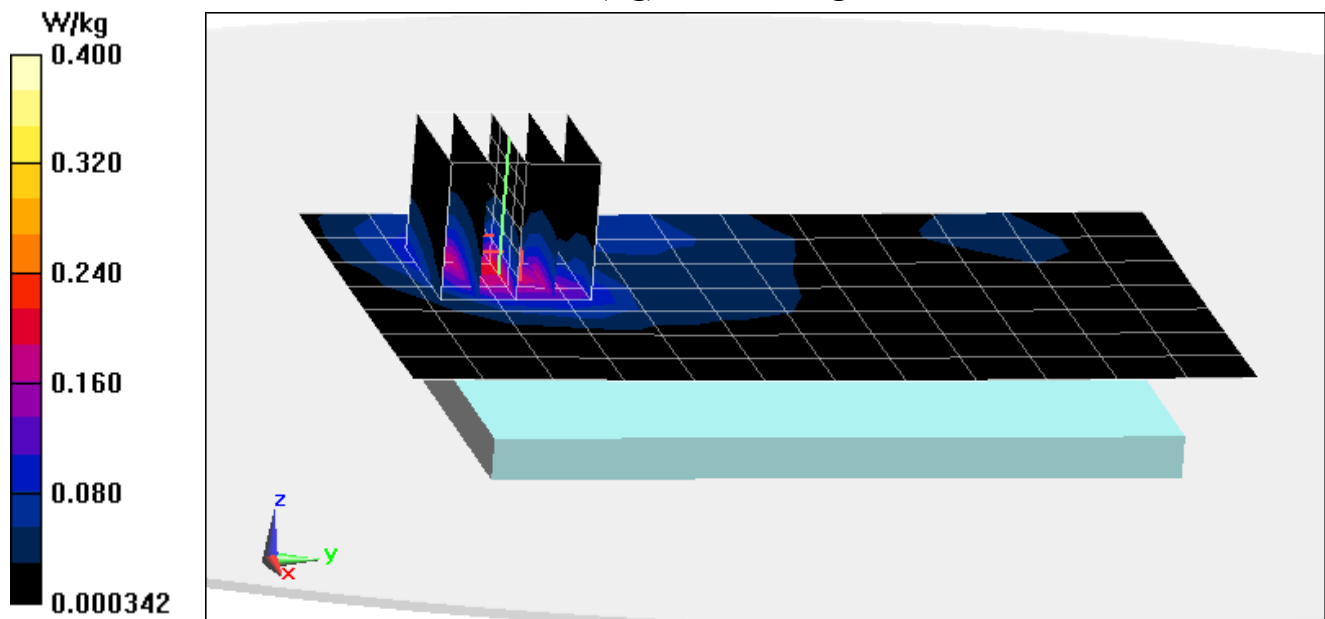
**Area Scan (8x13x1):** Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 7.151 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 0.437 W/kg

**SAR(1 g) = 0.211 W/kg**



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-A**

Communication System: UID 0, UMTS; Frequency: 836.6 MHz; Duty Cycle: 1:1

Medium: 835 Body, Medium parameters used (interpolated):

$f = 836.6 \text{ MHz}$ ;  $\sigma = 1.013 \text{ S/m}$ ;  $\epsilon_r = 53.796$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-09-2013; Ambient Temp: 23.6°C; Tissue Temp: 20.1°C

Probe: ES3DV3 - SN3209; ConvF(6.28, 6.28, 6.28); Calibrated: 3/15/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1334; Calibrated: 3/8/2013

Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP-1158

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: UMTS 850, Body SAR, Front side, Mid.ch**

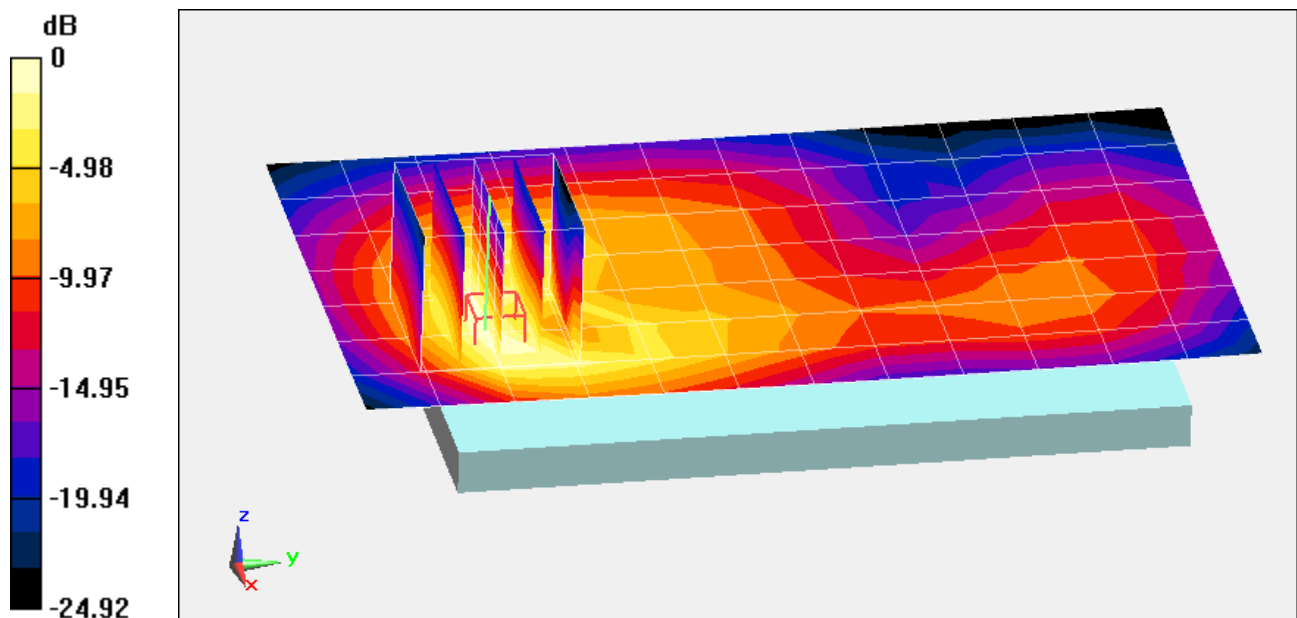
**Area Scan (8x13x1):** Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 19.651 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 0.738 W/kg

**SAR(1 g) = 0.339 W/kg**



0 dB = 0.380 W/kg = -4.20 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-B**

Communication System: UID 0, GSM GPRS; 2 Tx slots; Frequency: 1850.2 MHz; Duty Cycle: 1:4.15

Medium: 1900 Body, Medium parameters used (interpolated):

$f = 1850.2 \text{ MHz}$ ;  $\sigma = 1.526 \text{ S/m}$ ;  $\epsilon_r = 52.059$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-09-2013; Ambient Temp: 22.7°C; Tissue Temp: 22.4°C

Probe: ES3DV3 - SN3318; ConvF(4.79, 4.79, 4.79); Calibrated: 4/29/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1364; Calibrated: 4/22/2013

Phantom: ELI left; Type: QDOVA002AA; Serial: TP:1202

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: GPRS 1900, Body SAR, Back side, Low.ch, 2 Tx Slots, Main Antenna**

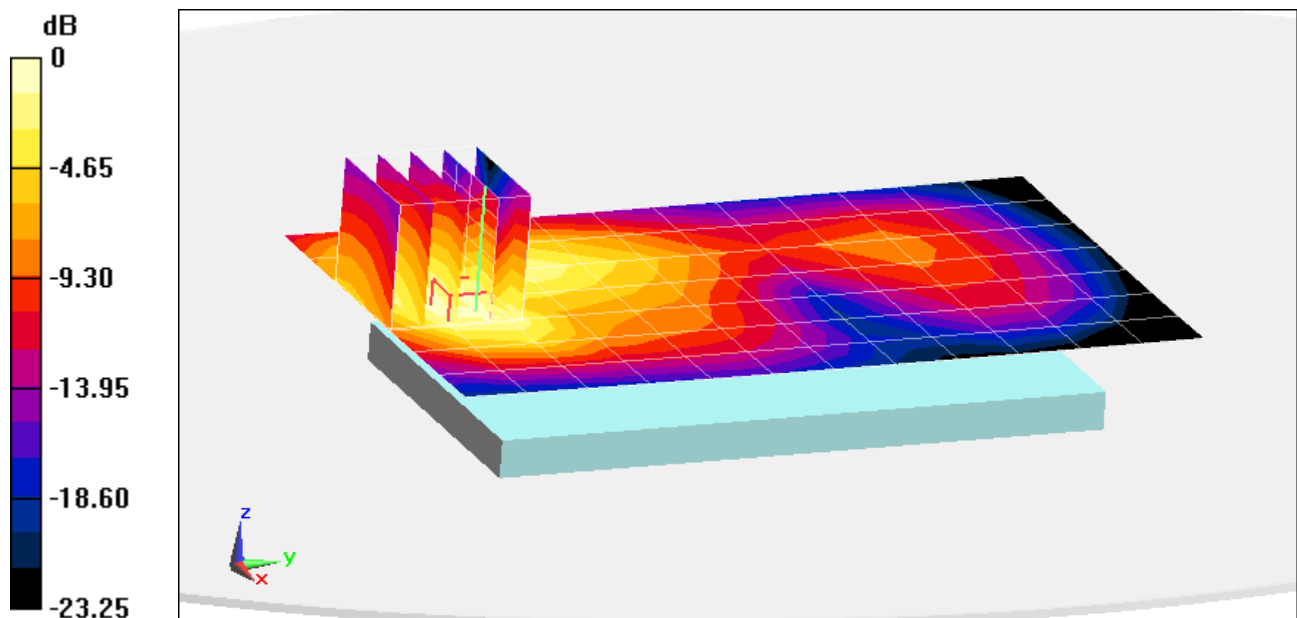
**Area Scan (8x13x1):** Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 16.984 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 0.749 W/kg

**SAR(1 g) = 0.435 W/kg**



0 dB = 0.471 W/kg = -3.27 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-B**

Communication System: UID 0, GSM; Frequency: 1880 MHz; Duty Cycle: 1:8.3

Medium: 1900 Body, Medium parameters used:

$f = 1880 \text{ MHz}$ ;  $\sigma = 1.559 \text{ S/m}$ ;  $\epsilon_r = 51.962$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-09-2013; Ambient Temp: 22.7°C; Tissue Temp: 22.4°C

Probe: ES3DV3 - SN3318; ConvF(4.79, 4.79, 4.79); Calibrated: 4/29/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1364; Calibrated: 4/22/2013

Phantom: ELI left; Type: QDOVA002AA; Serial: TP:1202

Measurement SW: DASYS2, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: GSM 1900, Body SAR, Front side, Mid.ch, Main Antenna**

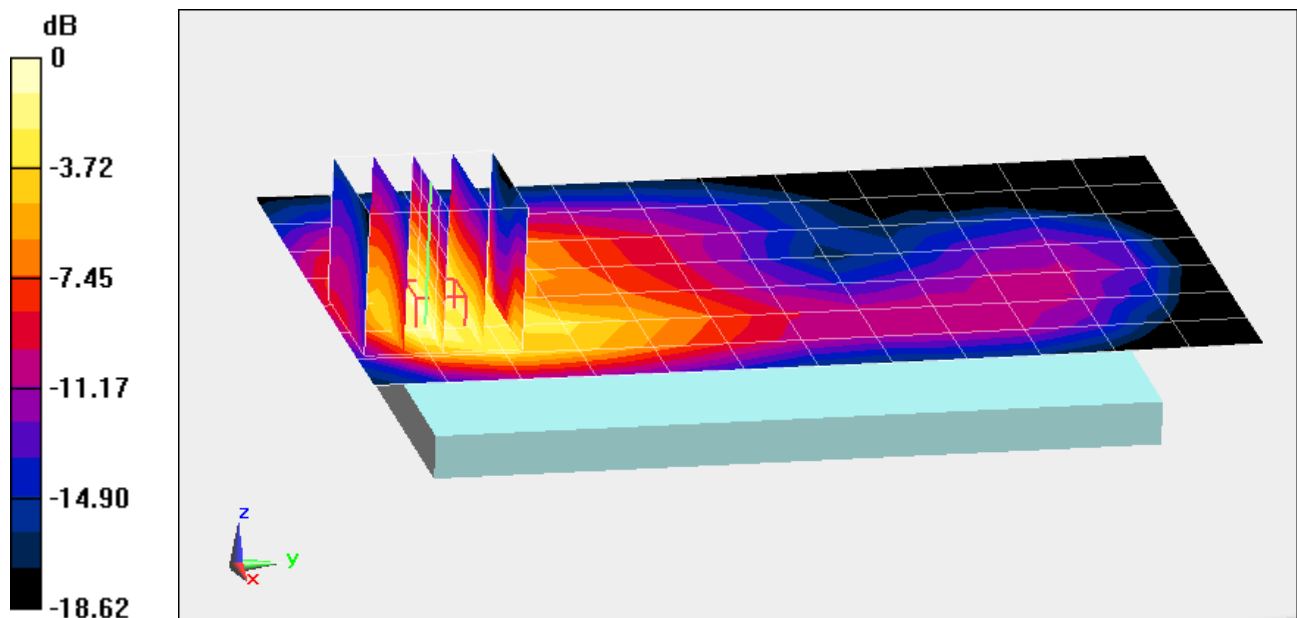
**Area Scan (8x13x1):** Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 18.134 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 1.11 W/kg

**SAR(1 g) = 0.609 W/kg**



0 dB = 0.654 W/kg = -1.84 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-B**

Communication System: UID 0, UMTS; Frequency: 1852.4 MHz; Duty Cycle: 1:1

Medium: 1900 Body, Medium parameters used (interpolated):

$f = 1852.4 \text{ MHz}$ ;  $\sigma = 1.524 \text{ S/m}$ ;  $\epsilon_r = 53.02$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-09-2013; Ambient Temp: 23.8°C; Tissue Temp: 22.5°C

Probe: ES3DV3 - SN3213; ConvF(4.73, 4.73, 4.73); Calibrated: 4/29/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn665; Calibrated: 4/22/2013

Phantom: SAM Front; Type: QD000P40CD; Serial: 1717

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: UMTS 1900, Body SAR, Back side, Low.ch**

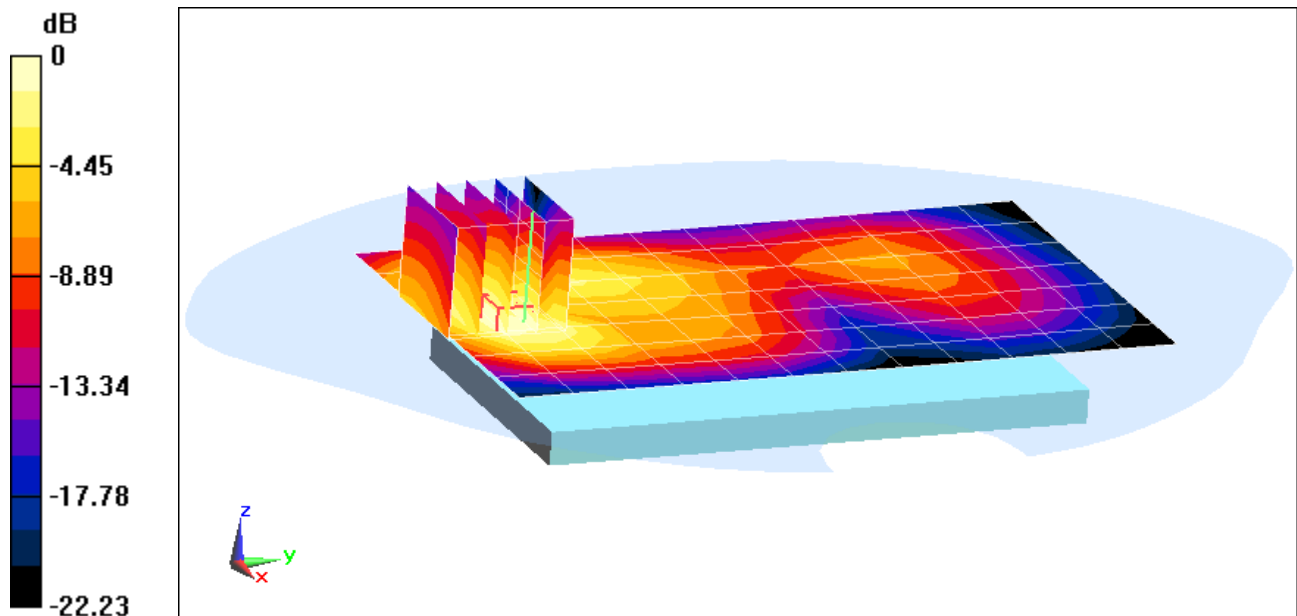
**Area Scan (8x13x1):** Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 18.431 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 0.880 W/kg

**SAR(1 g) = 0.510 W/kg**



0 dB = 0.530 W/kg = -2.76 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-B**

Communication System: UID 0, UMTS; Frequency: 1852.4 MHz; Duty Cycle: 1:1

Medium: 1900 Body, Medium parameters used (interpolated):

$f = 1852.4 \text{ MHz}$ ;  $\sigma = 1.524 \text{ S/m}$ ;  $\epsilon_r = 53.02$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-09-2013; Ambient Temp: 23.8°C; Tissue Temp: 22.5°C

Probe: ES3DV3 - SN3213; ConvF(4.73, 4.73, 4.73); Calibrated: 4/29/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn665; Calibrated: 4/22/2013

Phantom: SAM Front; Type: QD000P40CD; Serial: 1717

Measurement SW: DASYS2, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: UMTS 1900, Body SAR, Front side, Low.ch**

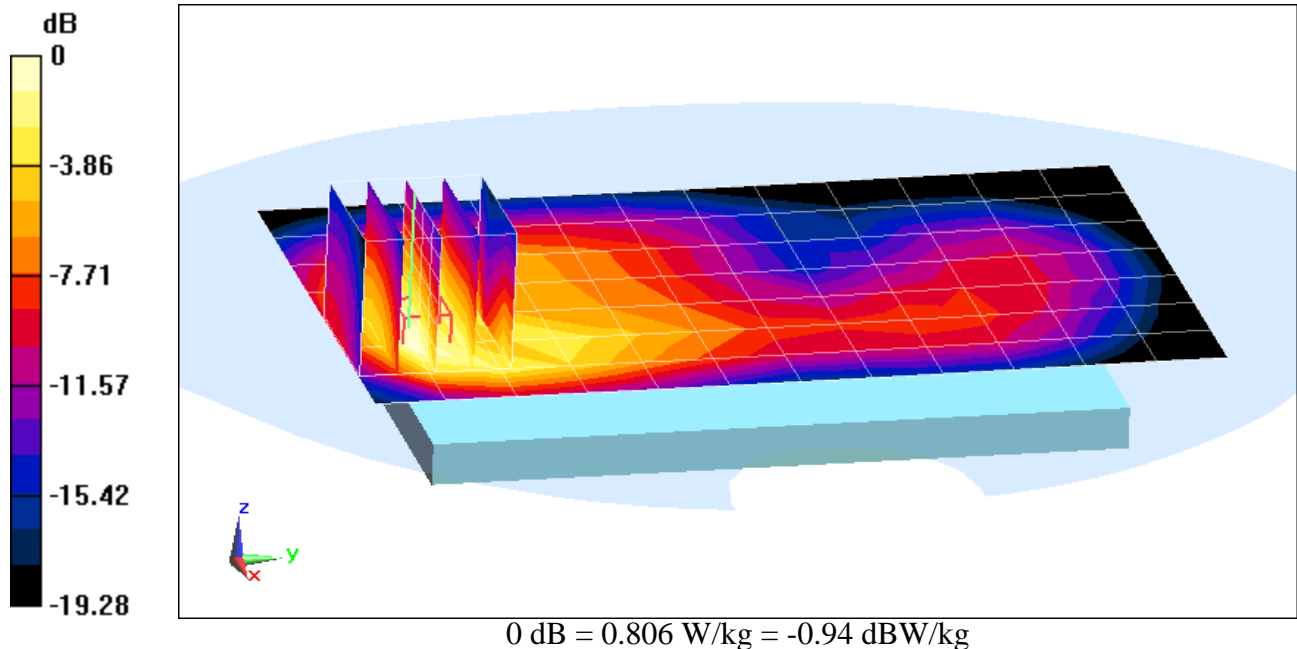
**Area Scan (8x13x1):** Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 23.482 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 1.33 W/kg

**SAR(1 g) = 0.742 W/kg**



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-A**

Communication System: UID 0, CDMA; Frequency: 836.52 MHz; Duty Cycle: 1:1  
Medium: 835 Body, Medium parameters used (interpolated):  
 $f = 836.52 \text{ MHz}$ ;  $\sigma = 1.013 \text{ S/m}$ ;  $\epsilon_r = 53.797$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-09-2013; Ambient Temp: 23.6°C; Tissue Temp: 20.1°C

Probe: ES3DV3 - SN3209; ConvF(6.28, 6.28, 6.28); Calibrated: 3/15/2013;  
Sensor-Surface: 4mm (Mechanical Surface Detection)  
Electronics: DAE4 Sn1334; Calibrated: 3/8/2013  
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP-1158  
Measurement SW: DASYS2, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: Cell. CDMA, Body SAR, Back side, Mid.ch**

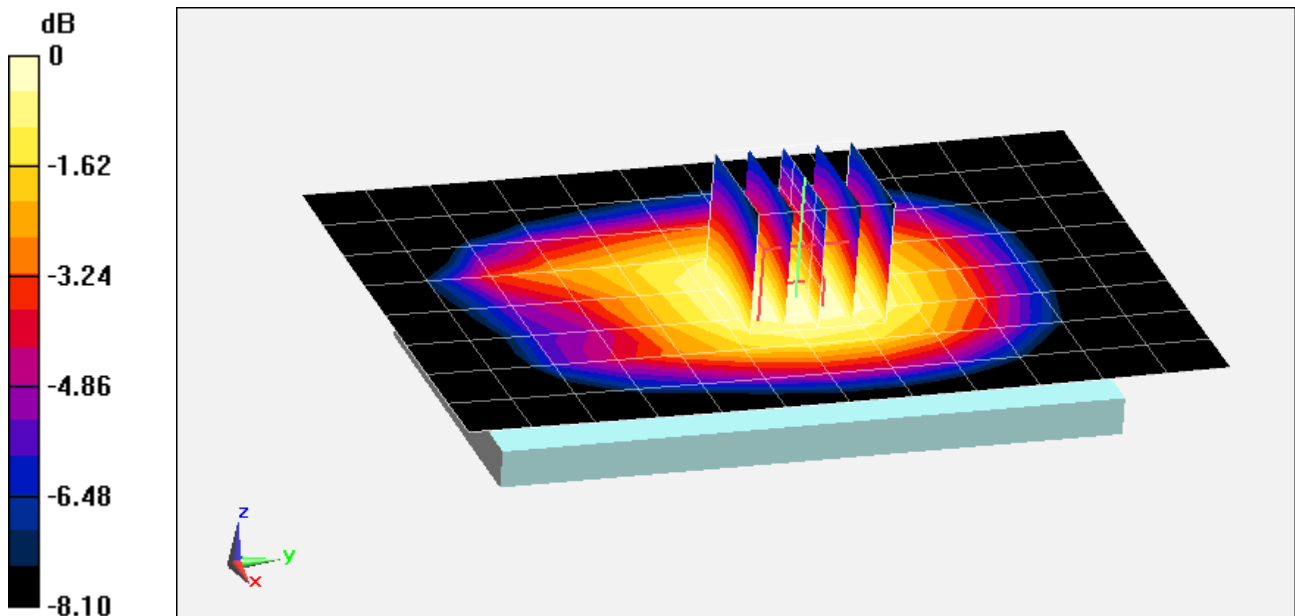
**Area Scan (9x13x1):** Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 16.729 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 0.329 W/kg

**SAR(1 g) = 0.269 W/kg**



0 dB = 0.282 W/kg = -5.50 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-B**

Communication System: UID 0, CDMA; Frequency: 1851.25 MHz; Duty Cycle: 1:1

Medium: 1900 Body, Medium parameters used (interpolated):

$f = 1851.25 \text{ MHz}$ ;  $\sigma = 1.522 \text{ S/m}$ ;  $\epsilon_r = 53.025$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-09-2013; Ambient Temp: 23.8°C; Tissue Temp: 22.5°C

Probe: ES3DV3 - SN3213; ConvF(4.73, 4.73, 4.73); Calibrated: 4/29/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn665; Calibrated: 4/22/2013

Phantom: SAM Front; Type: QD000P40CD; Serial: 1717

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: PCS EVDO, Body SAR, Back side, Low.ch**

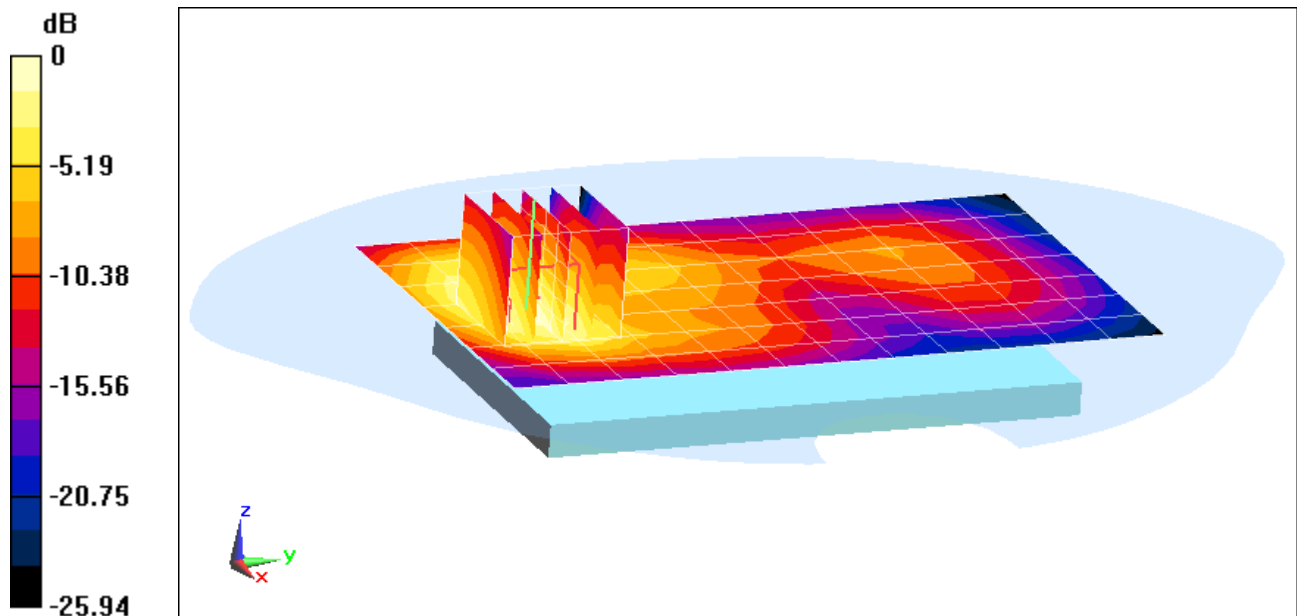
**Area Scan (8x13x1):** Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 21.570 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 1.36 W/kg

**SAR(1 g) = 0.771 W/kg**



0 dB = 0.804 W/kg = -0.95 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-B**

Communication System: UID 0, CDMA; Frequency: 1851.25 MHz; Duty Cycle: 1:1

Medium: 1900 Body, Medium parameters used (interpolated):

$f = 1851.25 \text{ MHz}$ ;  $\sigma = 1.522 \text{ S/m}$ ;  $\epsilon_r = 53.025$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-09-2013; Ambient Temp: 23.8°C; Tissue Temp: 22.5°C

Probe: ES3DV3 - SN3213; ConvF(4.73, 4.73, 4.73); Calibrated: 4/29/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn665; Calibrated: 4/22/2013

Phantom: SAM Front; Type: QD000P40CD; Serial: 1717

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: PCS EVDO, Body SAR, Front side, Low.ch**

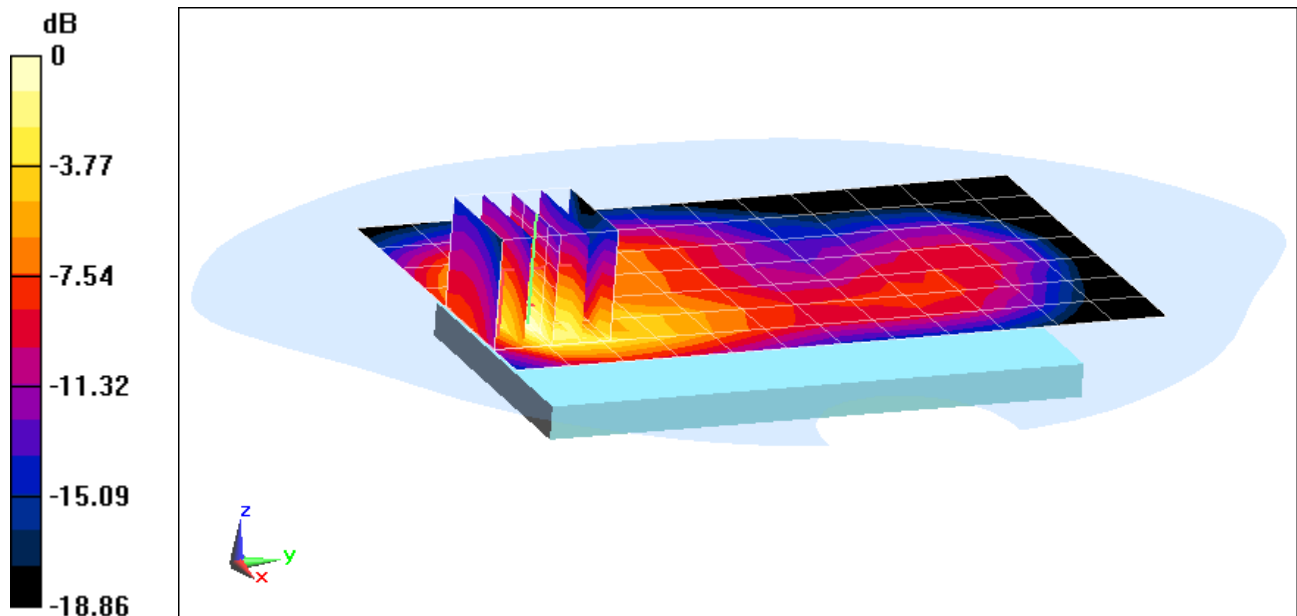
**Area Scan (8x13x1):** Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 24.489 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 1.41 W/kg

**SAR(1 g) = 0.808 W/kg**



0 dB = 0.928 W/kg = -0.32 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-B**

Communication System: UID 0, IEEE 802.11b; Frequency: 2462 MHz; Duty Cycle: 1:1

Medium: 2450 Body, Medium parameters used (interpolated):

$f = 2462 \text{ MHz}$ ;  $\sigma = 2.016 \text{ S/m}$ ;  $\epsilon_r = 51.297$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 11-22-2013; Ambient Temp: 22.9°C; Tissue Temp: 23.0°C

Probe: ES3DV2 - SN3022; ConvF(4.01, 4.01, 4.01); Calibrated: 8/22/2013;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1322; Calibrated: 8/21/2013

Phantom: SAM v5.0 front; Type: QD000P40CD; Serial: TP-1646

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**Mode: IEEE 802.11b, Body SAR, Ch 11, 1 Mbps, Back Side**

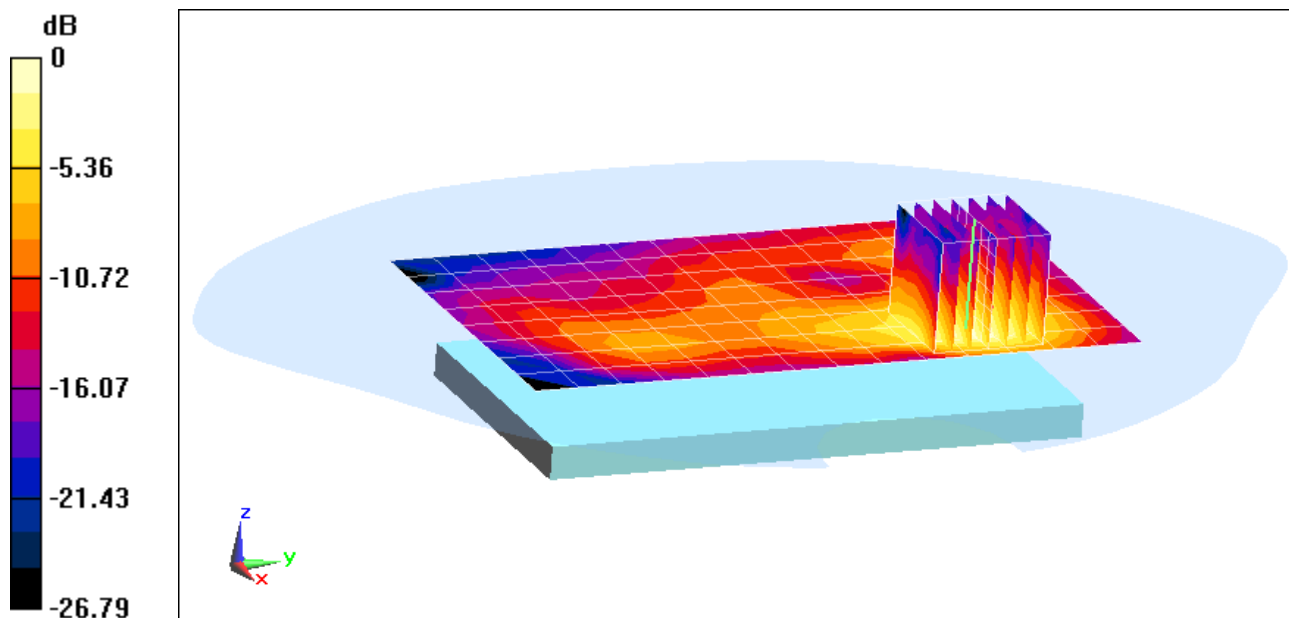
**Area Scan (9x15x1):** Measurement grid: dx=12mm, dy=12mm

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

Reference Value = 5.958 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 0.140 W/kg

**SAR(1 g) = 0.070 W/kg**



0 dB = 0.0899 W/kg = -10.46 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-A**

Communication System: UID 0, IEEE 802.11a 5.2-5.8 GHz Band; Frequency: 5745 MHz; Duty Cycle: 1:1

Medium: 5 GHz Body, Medium parameters used:

$f = 5745 \text{ MHz}$ ;  $\sigma = 6.187 \text{ S/m}$ ;  $\epsilon_r = 45.924$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 11-25-2013; Ambient Temp: 23.0°C; Tissue Temp: 21.5°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 14.6.10 (7164)

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

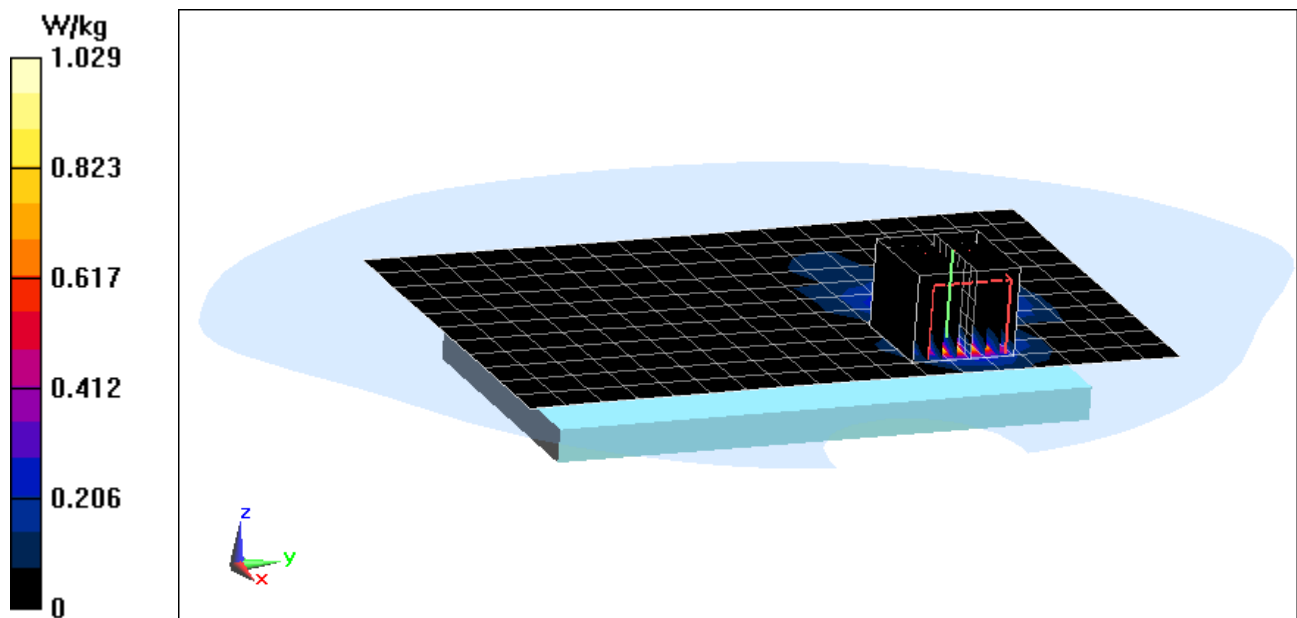
**Area Scan (12x19x1):** Measurement grid: dx=10mm, dy=10mm

**Zoom Scan (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm, Graded Ratio: 1.4

Reference Value = 8.929 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 1.81 W/kg

**SAR(1 g) = 0.415 W/kg**



0 dB = 1.03 W/kg = 0.13 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMG7109; Type: Portable Handset; Serial: FK-345-A**

Communication System: UID 0, IEEE 802.11a 5.2-5.8 GHz Band; Frequency: 5240 MHz; Duty Cycle: 1:1

Medium: 5 GHz Body, Medium parameters used:

$f = 5240 \text{ MHz}$ ;  $\sigma = 5.521 \text{ S/m}$ ;  $\epsilon_r = 46.827$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 11-25-2013; Ambient Temp: 23.0°C; Tissue Temp: 21.5°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 14.6.10 (7164)

**Mode: IEEE 802.11a, 5.2 GHz, Body SAR, Ch 48, 6 Mbps, Back Side**

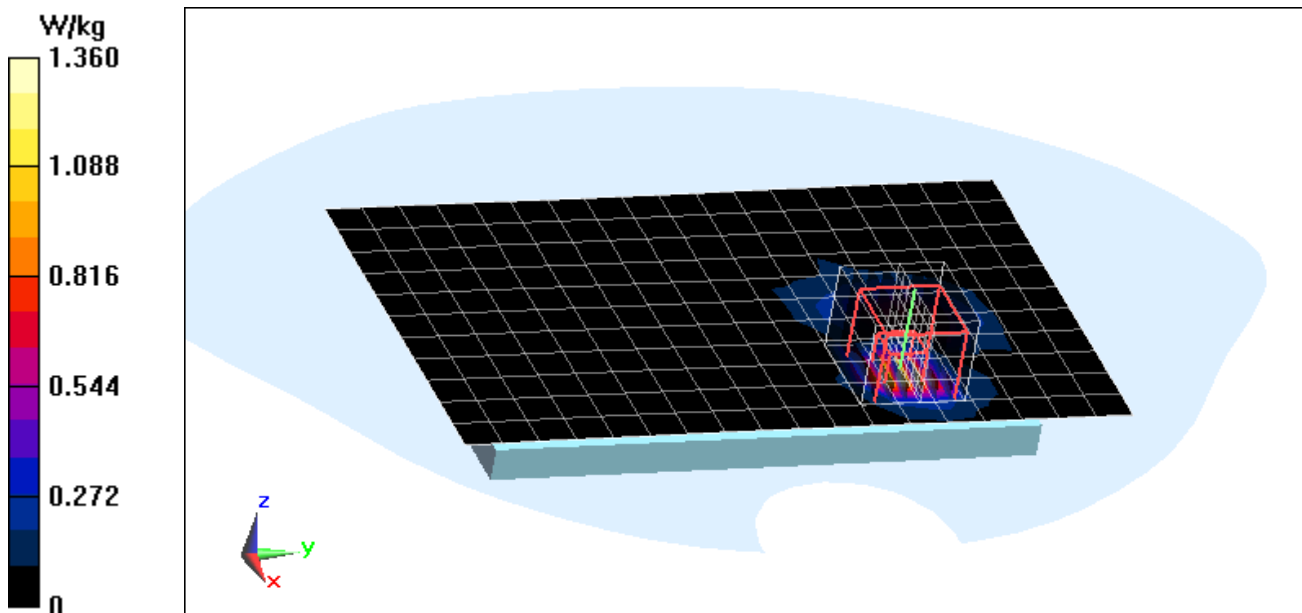
**Area Scan (12x19x1):** Measurement grid: dx=10mm, dy=10mm

**Zoom Scan (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4

Reference Value = 11.413 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 2.48 W/kg

**SAR(1 g) = 0.598 W/kg**



## APPENDIX B: SYSTEM VERIFICATION

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: SAR Dipole 835 MHz; Type: D835V2; Serial: 4d119**

Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium: 835 Head, Medium parameters used:

$f = 835 \text{ MHz}$ ;  $\sigma = 0.907 \text{ S/m}$ ;  $\epsilon_r = 41.128$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section ; Space: 1.5 cm

Test Date: 12-16-2013; Ambient Temp: 21.3°C; Tissue Temp: 21.4°C

Probe: ES3DV2 - SN3022; ConvF(6.09, 6.09, 6.09); Calibrated: 8/22/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1322; Calibrated: 8/21/2013

Phantom: SAM v5.0 Left; Type: QD000P40CD; Serial: TP: 1687

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

## 835 MHz System Verification

**Area Scan (7x14x1):** Measurement grid: dx=15mm, dy=15mm

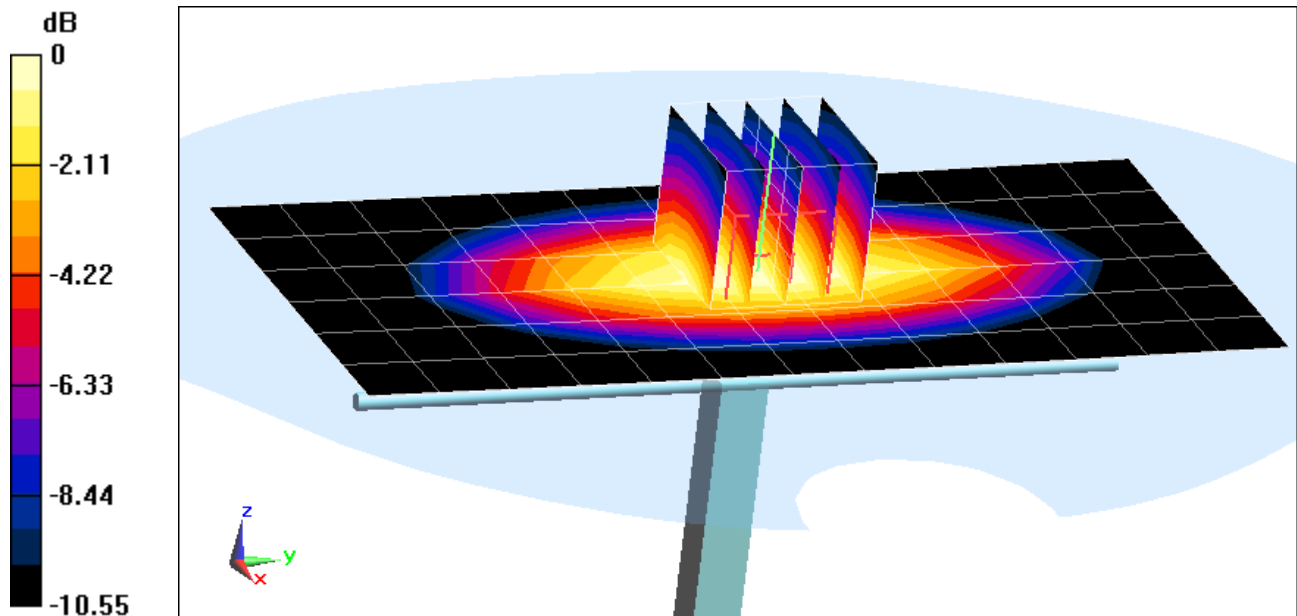
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 1.32 W/kg

**SAR(1 g) = 0.901 W/kg**

Deviation = -6.92%



0 dB = 0.975 W/kg = -0.11 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: SAR Dipole 1900 MHz; Type: D1900V2; Serial: 5d148**

Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: 1900 Head, Medium parameters used (interpolated):

$f = 1900 \text{ MHz}$ ;  $\sigma = 1.417 \text{ S/m}$ ;  $\epsilon_r = 39.125$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-05-2013; Ambient Temp: 24.0°C; Tissue Temp: 23.0°C

Probe: ES3DV3 - SN3213; ConvF(5.08, 5.08, 5.08); Calibrated: 4/29/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn665; Calibrated: 4/22/2013

Phantom: SAM Front; Type: QD000P40CD; Serial: 1717

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

## 1900 MHz System Verification

**Area Scan (7x10x1):** Measurement grid: dx=15mm, dy=15mm

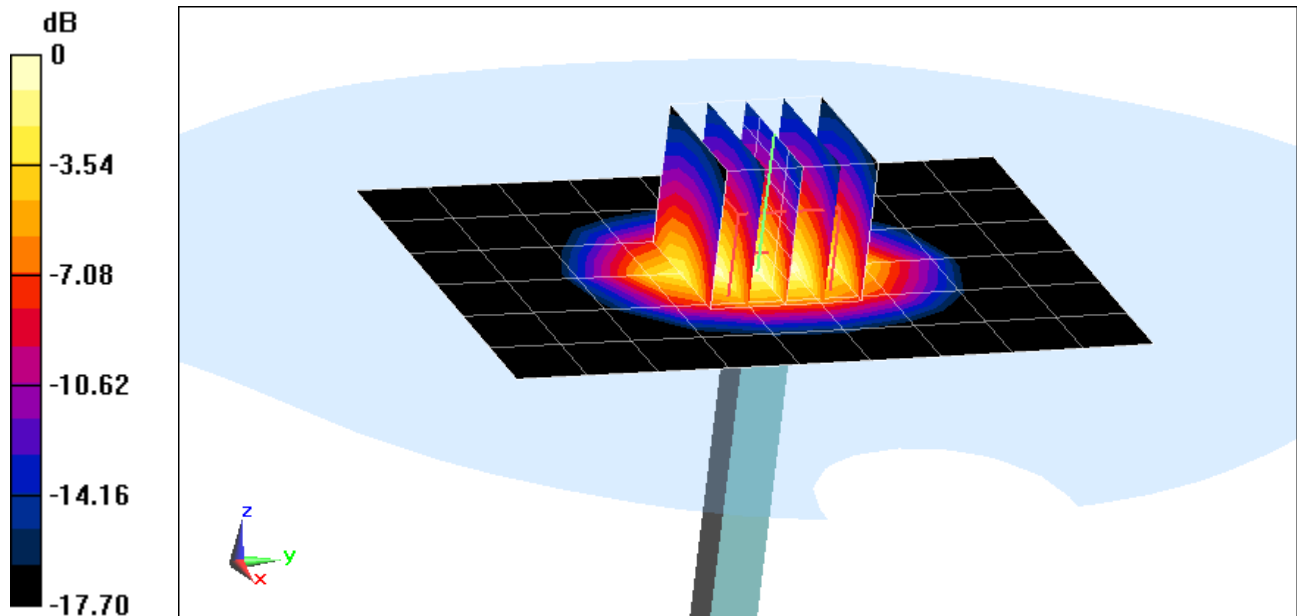
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 7.74 W/kg

**SAR(1 g) = 4.18 W/kg**

Deviation = 5.29%



0 dB = 4.70 W/kg = 6.72 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: SAR Dipole 1900 MHz; Type: D1900V2; Serial: 5d148**

Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: 1900 Head, Medium parameters used (interpolated):

$f = 1900 \text{ MHz}$ ;  $\sigma = 1.437 \text{ S/m}$ ;  $\epsilon_r = 38.75$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-16-2013; Ambient Temp: 24.5°C; Tissue Temp: 23.1°C

Probe: ES3DV3 - SN3209; ConvF(5.21, 5.21, 5.21); Calibrated: 3/15/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1334; Calibrated: 3/8/2013

Phantom: SAM Front; Type: SAM; Serial: 1686

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

## 1900 MHz System Verification

**Area Scan (7x10x1):** Measurement grid: dx=15mm, dy=15mm

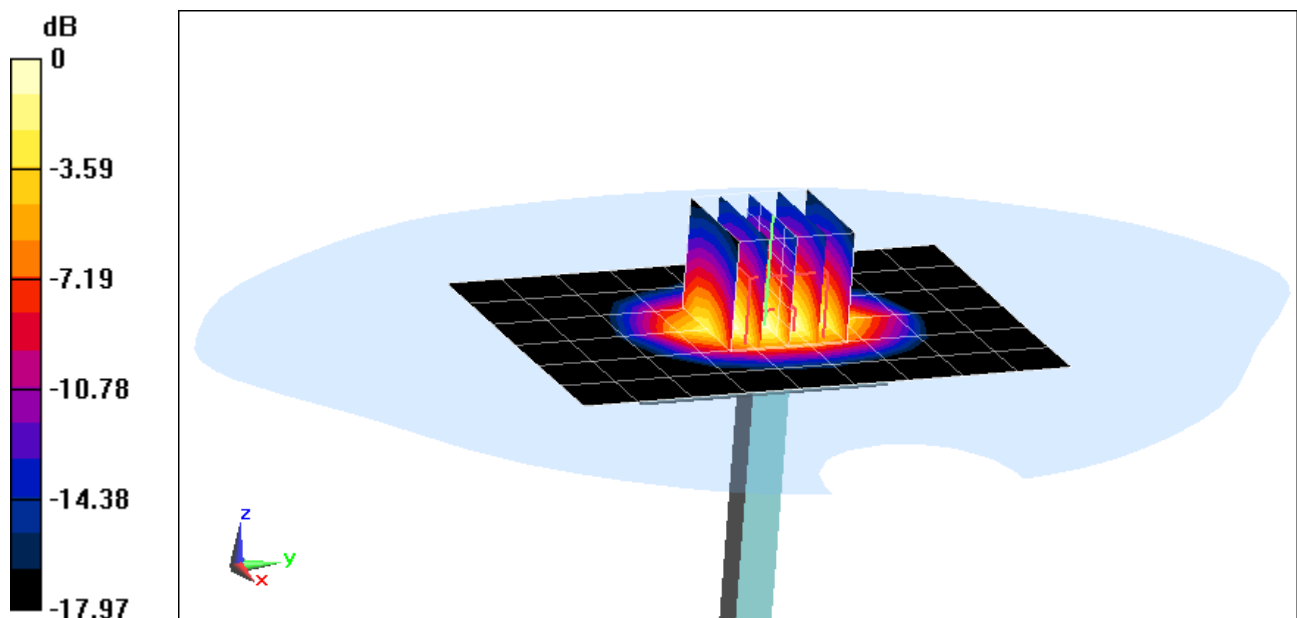
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 7.82 W/kg

**SAR(1 g) = 4.22 W/kg**

Deviation = 6.30%



0 dB = 4.74 W/kg = 6.76 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: SAR Dipole 2450 MHz; Type: D2450V2; Serial: 882**

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: 2450 Head, Medium parameters used:

$f = 2450 \text{ MHz}$ ;  $\sigma = 1.863 \text{ S/m}$ ;  $\epsilon_r = 39.159$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 11-25-2013; Ambient Temp: 19.1°C; Tissue Temp: 19.8°C

Probe: ES3DV3 - SN3263; ConvF(4.47, 4.47, 4.47); Calibrated: 5/16/2013;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn859; Calibrated: 5/13/2013

Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1403

Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.10 (7164)

## 2450 MHz System Verification

**Area Scan (6x9x1):** Measurement grid: dx=12mm, dy=12mm

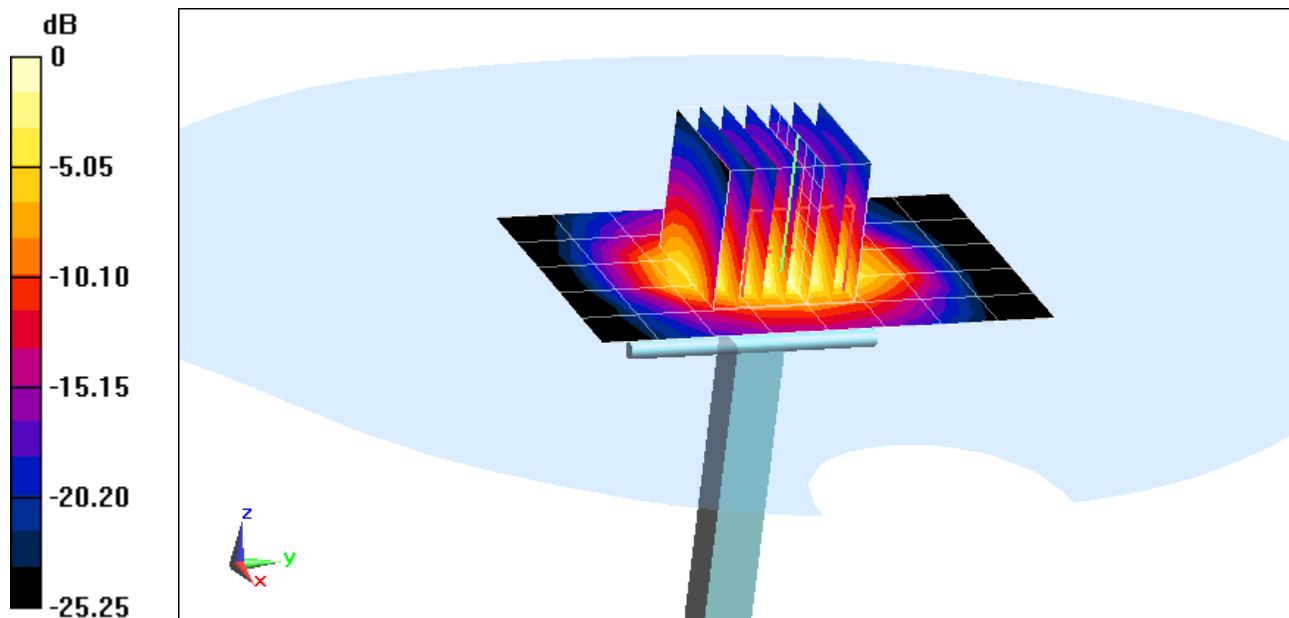
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 11.4 W/kg

**SAR(1 g) = 5.19 W/kg**

Deviation = 0.39%



0 dB = 6.86 W/kg = 8.36 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5200 MHz; Type: D5GHzV2; Serial: 1120**

Communication System: UID 0, CW; Frequency: 5200 MHz; Duty Cycle: 1:1

Medium: 5 GHz Head, Medium parameters used:

$f = 5200 \text{ MHz}$ ;  $\sigma = 4.5 \text{ S/m}$ ;  $\epsilon_r = 35.078$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 11-26-2013; Ambient Temp: 22.1°C; Tissue Temp: 21.7°C

Probe: EX3DV4 - SN3914; ConvF(4.99, 4.99, 4.99); Calibrated: 10/23/2013;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn649; Calibrated: 2/6/2013

Phantom: SAM V5.0 Right; Type: QD000P40CD; Serial: 1647

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

## 5200 MHz System Verification

**Area Scan (7x7x1):** Measurement grid: dx=10mm, dy=10mm

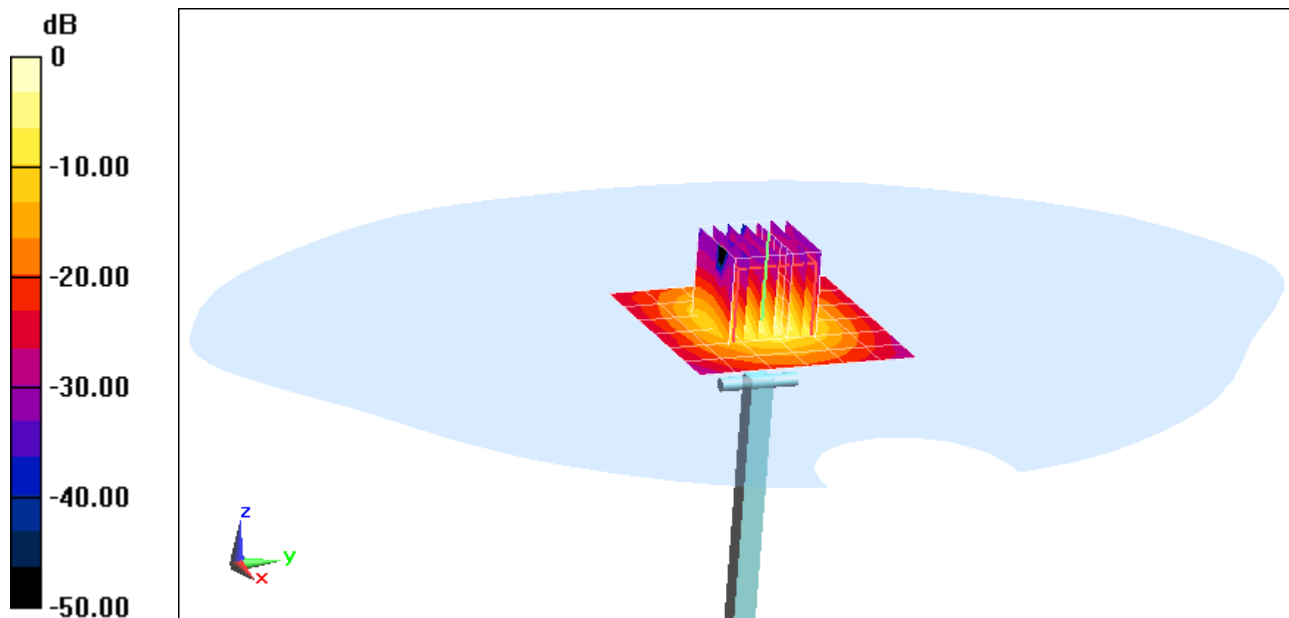
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4

Input Power = 16.0 dBm (40 mW)

Peak SAR (extrapolated) = 12.7 W/kg

**SAR(1 g) = 3.02 W/kg**

Deviation = -0.66%



0 dB = 7.20 W/kg = 8.57 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5300 MHz; Type: D5GHzV2; Serial: 1120**

Communication System: UID 0, CW; Frequency: 5300 MHz; Duty Cycle: 1:1

Medium: 5 GHz Head, Medium parameters used:

$f = 5300 \text{ MHz}$ ;  $\sigma = 4.587 \text{ S/m}$ ;  $\epsilon_r = 34.954$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 11-26-2013; Ambient Temp: 22.1°C; Tissue Temp: 21.7°C

Probe: EX3DV4 - SN3914; ConvF(4.82, 4.82, 4.82); Calibrated: 10/23/2013;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn649; Calibrated: 2/6/2013

Phantom: SAM V5.0 Right; Type: QD000P40CD; Serial: 1647

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

## 5300 MHz System Verification

**Area Scan (7x8x1):** Measurement grid: dx=10mm, dy=10mm

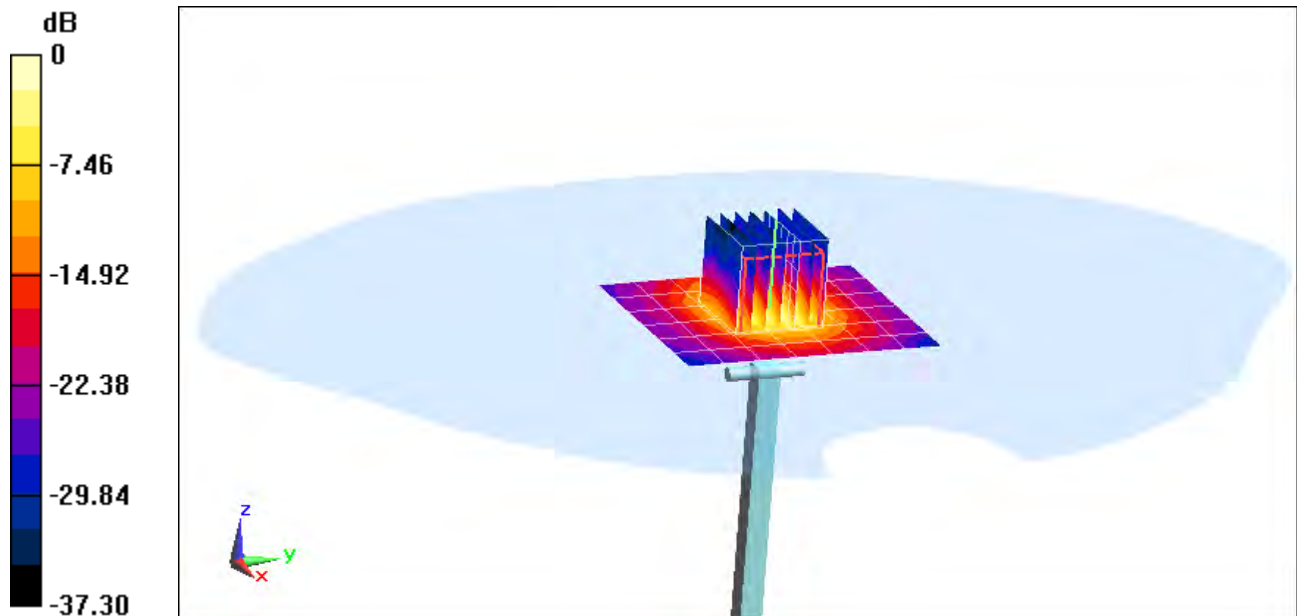
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4

Input Power = 16.0 dBm (40 mW)

Peak SAR (extrapolated) = 12.9 W/kg

**SAR(1 g) = 3.04 W/kg**

Deviation = -3.43%



0 dB = 6.03 W/kg = 7.80 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5500 MHz; Type: D5GHzV2; Serial: 1120**

Communication System: UID 0, CW; Frequency: 5500 MHz; Duty Cycle: 1:1

Medium: 5 GHz Head, Medium parameters used:

$f = 5500 \text{ MHz}$ ;  $\sigma = 4.809 \text{ S/m}$ ;  $\epsilon_r = 34.681$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 11-26-2013; Ambient Temp: 22.1°C; Tissue Temp: 21.7°C

Probe: EX3DV4 - SN3914; ConvF(4.55, 4.55, 4.55); Calibrated: 10/23/2013;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn649; Calibrated: 2/6/2013

Phantom: SAM V5.0 Right; Type: QD000P40CD; Serial: 1647

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

## 5500 MHz System Verification

**Area Scan (7x7x1):** Measurement grid: dx=10mm, dy=10mm

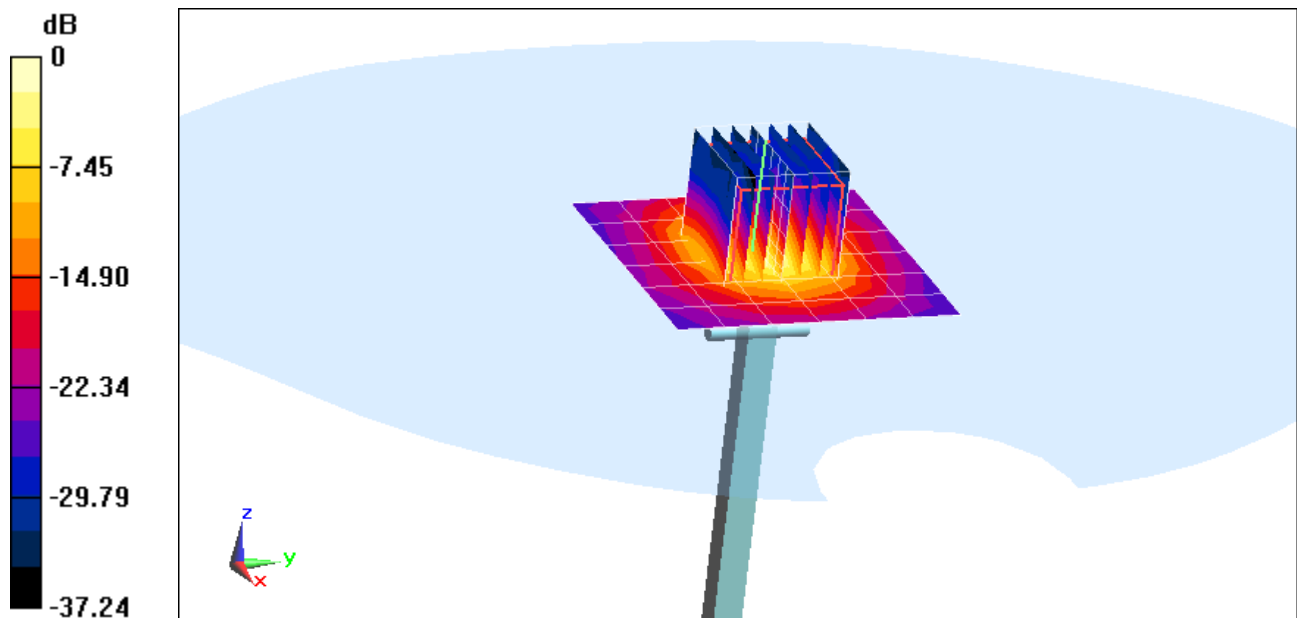
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4

Input Power = 16.0 dBm (40 mW)

Peak SAR (extrapolated) = 14.0 W/kg

**SAR(1 g) = 3.18 W/kg**

Deviation = -0.75%



0 dB = 7.67 W/kg = 8.85 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5800 MHz; Type: D5GHzV2; Serial: 1120**

Communication System: UID 0, CW; Frequency: 5800 MHz; Duty Cycle: 1:1

Medium: 5 GHz Head, Medium parameters used:

$f = 5800 \text{ MHz}$ ;  $\sigma = 5.088 \text{ S/m}$ ;  $\epsilon_r = 34.302$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 11-26-2013; Ambient Temp: 22.1°C; Tissue Temp: 21.7°C

Probe: EX3DV4 - SN3914; ConvF(4.52, 4.52, 4.52); Calibrated: 10/23/2013;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn649; Calibrated: 2/6/2013

Phantom: SAM V5.0 Right; Type: QD000P40CD; Serial: 1647

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

## 5800 MHz System Verification

**Area Scan (7x7x1):** Measurement grid: dx=10mm, dy=10mm

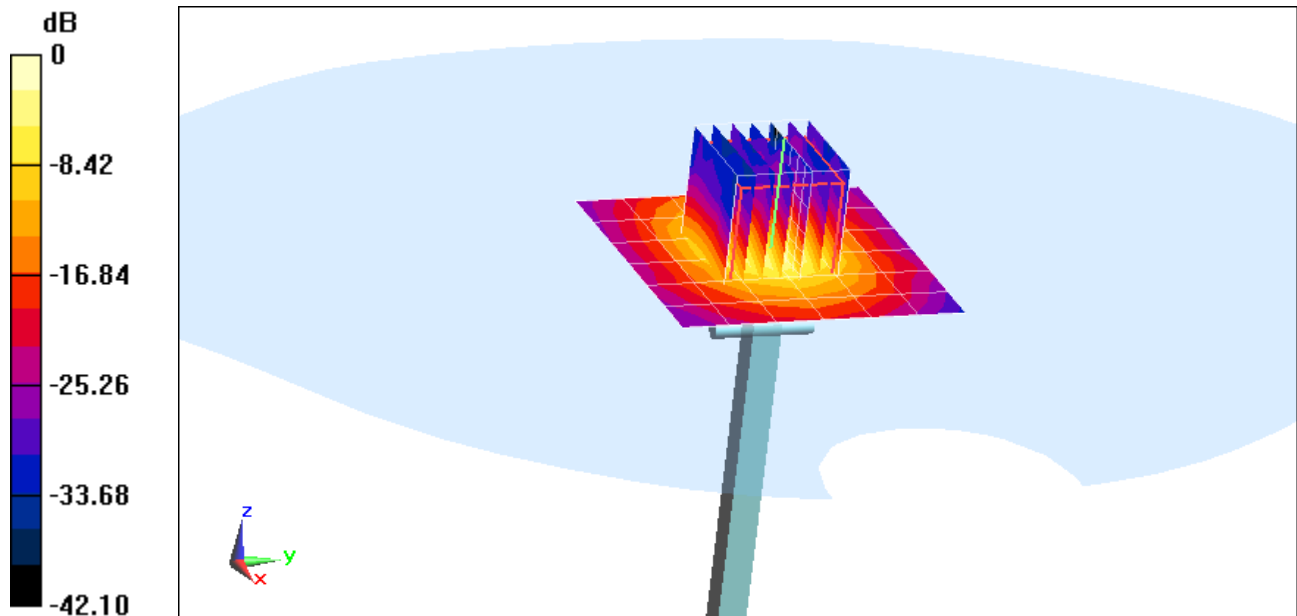
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4

Input Power = 16.0 dBm (40 mW)

Peak SAR (extrapolated) = 14.3 W/kg

**SAR(1 g) = 3.05 W/kg**

Deviation = 1.80%



0 dB = 7.37 W/kg = 8.67 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: SAR Dipole 835 MHz; Type: D835V2; Serial: 4d119**

Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium: 835 Body, Medium parameters used:

$f = 835 \text{ MHz}$ ;  $\sigma = 1.012 \text{ S/m}$ ;  $\epsilon_r = 53.814$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.5 cm

Test Date: 12-09-2013; Ambient Temp: 23.6°C; Tissue Temp: 20.1°C

Probe: ES3DV3 - SN3209; ConvF(6.28, 6.28, 6.28); Calibrated: 3/15/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1334; Calibrated: 3/8/2013

Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP-1158

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

## 835 MHz System Verification

**Area Scan (7x14x1):** Measurement grid: dx=15mm, dy=15mm

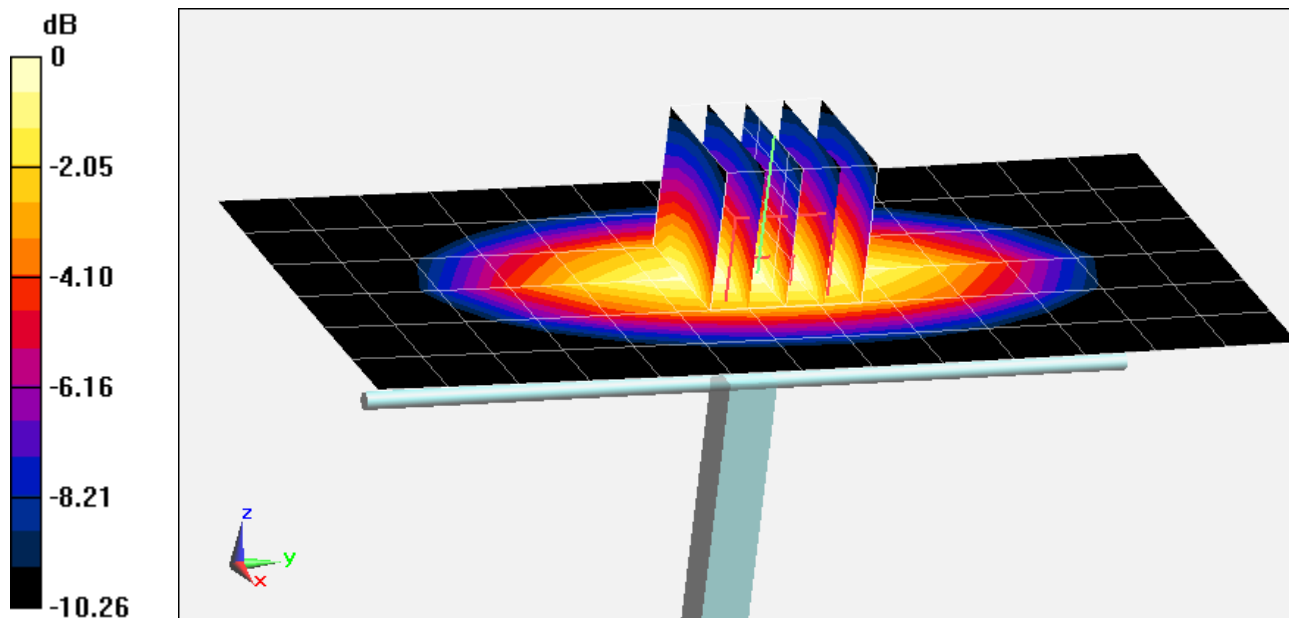
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 1.44 W/kg

**SAR(1 g) = 0.986 W/kg**

Deviation = 3.35%



0 dB = 1.07 W/kg = 0.29 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: SAR Dipole 1900 MHz; Type: D1900V2; Serial: 5d148**

Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: 1900 Body, Medium parameters used (interpolated):

$f = 1900 \text{ MHz}$ ;  $\sigma = 1.58 \text{ S/m}$ ;  $\epsilon_r = 52.825$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-09-2013; Ambient Temp: 23.8°C; Tissue Temp: 22.5°C

Probe: ES3DV3 - SN3213; ConvF(4.73, 4.73, 4.73); Calibrated: 4/29/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn665; Calibrated: 4/22/2013

Phantom: SAM Front; Type: QD000P40CD; Serial: 1717

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

## 1900 MHz System Verification

**Area Scan (7x10x1):** Measurement grid: dx=15mm, dy=15mm

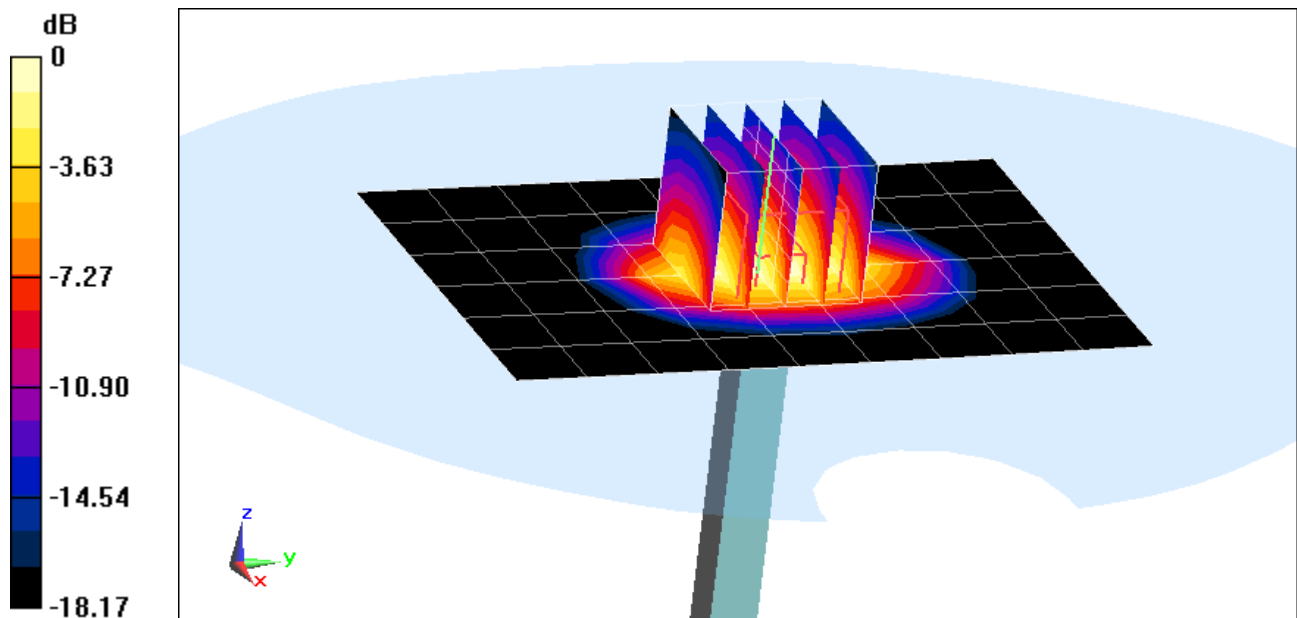
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 7.31 W/kg

**SAR(1 g) = 4.03 W/kg**

Deviation = -1.23%



0 dB = 4.49 W/kg = 6.52 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: SAR Dipole 1900 MHz; Type: D1900V2; Serial: 5d148**

Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: 1900 Body, Medium parameters used (interpolated):

$f = 1900 \text{ MHz}$ ;  $\sigma = 1.58 \text{ S/m}$ ;  $\epsilon_r = 51.887$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-09-2013; Ambient Temp: 22.7°C; Tissue Temp: 22.4°C

Probe: ES3DV3 - SN3318; ConvF(4.79, 4.79, 4.79); Calibrated: 4/29/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1364; Calibrated: 4/22/2013

Phantom: ELI left; Type: QDOVA002AA; Serial: TP:1202

Measurement SW: DASYS2, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

## 1900 MHz System Verification

**Area Scan (7x10x1):** Measurement grid: dx=15mm, dy=15mm

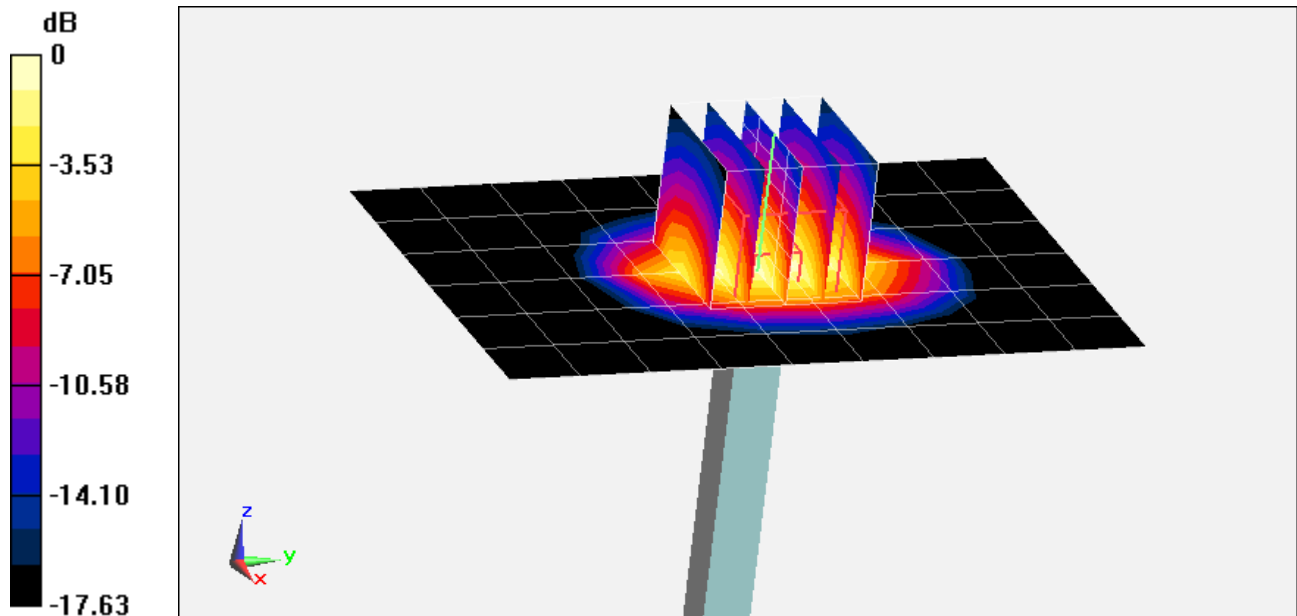
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 7.32 W/kg

**SAR(1 g) = 4.11 W/kg**

Deviation = 0.74%



0 dB = 4.61 W/kg = 6.64 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: SAR Dipole 1900 MHz; Type: D1900V2; Serial: 5d148**

Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: 1900 Body, Medium parameters used (interpolated):

$f = 1900 \text{ MHz}$ ;  $\sigma = 1.566 \text{ S/m}$ ;  $\epsilon_r = 51.192$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-19-2013; Ambient Temp: 21.9°C; Tissue Temp: 22.7°C

Probe: ES3DV3 - SN3319; ConvF(4.85, 4.85, 4.85); Calibrated: 4/29/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1368; Calibrated: 4/22/2013

Phantom: SAM front; Type: QD000P40CD; Serial: TP:1759

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

## 1900 MHz System Verification

**Area Scan (7x10x1):** Measurement grid: dx=15mm, dy=15mm

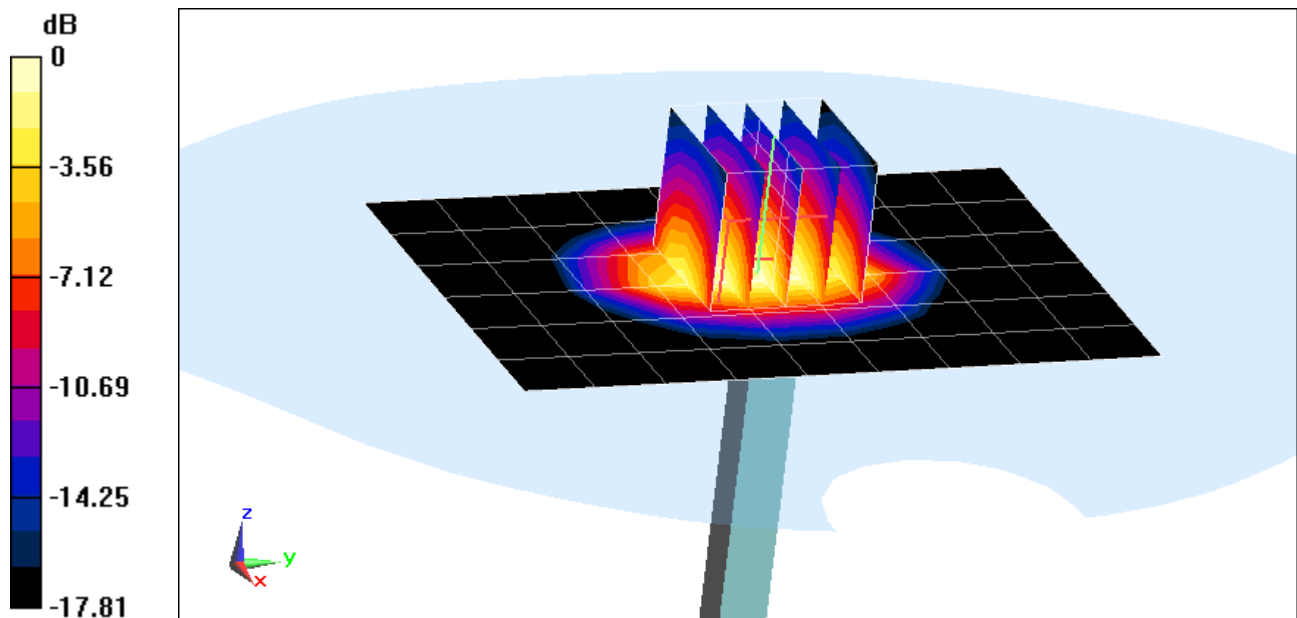
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 7.24 W/kg

**SAR(1 g) = 4.02 W/kg**

Deviation = -1.47%



0 dB = 4.50 W/kg = 6.53 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

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

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: 2450 Body, Medium parameters used:

$f = 2450 \text{ MHz}$ ;  $\sigma = 1.997 \text{ S/m}$ ;  $\epsilon_r = 51.345$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 11-22-2013; Ambient Temp: 22.9°C; Tissue Temp: 23.0°C

Probe: ES3DV2 - SN3022; ConvF(4.01, 4.01, 4.01); Calibrated: 8/22/2013;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1322; Calibrated: 8/21/2013

Phantom: SAM v5.0 front; Type: QD000P40CD; Serial: TP-1646

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

## 2450 MHz System Verification

**Area Scan (8x9x1):** Measurement grid: dx=12mm, dy=12mm

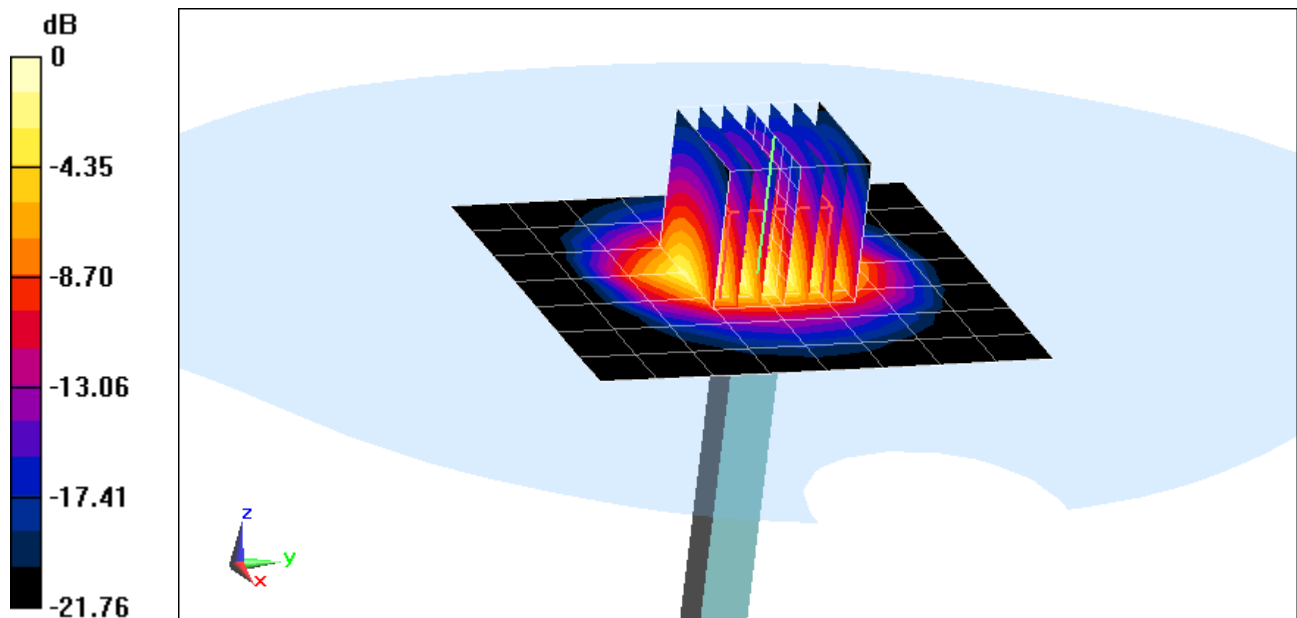
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 10.8 W/kg

**SAR(1 g) = 5.08 W/kg**

Deviation = 2.42%



0 dB = 6.67 W/kg = 8.24 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

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

Communication System: UID 0, CW; Frequency: 5200 MHz; Duty Cycle: 1:1

Medium: 5 GHz Body, Medium parameters used:

$f = 5200 \text{ MHz}$ ;  $\sigma = 5.47 \text{ S/m}$ ;  $\epsilon_r = 46.9$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 11-25-2013; Ambient Temp: 23.0°C; Tissue Temp: 21.5°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 14.6.10 (7164)

## 5200 MHz System Verification

**Area Scan (7x9x1):** Measurement grid: dx=10mm, dy=10mm

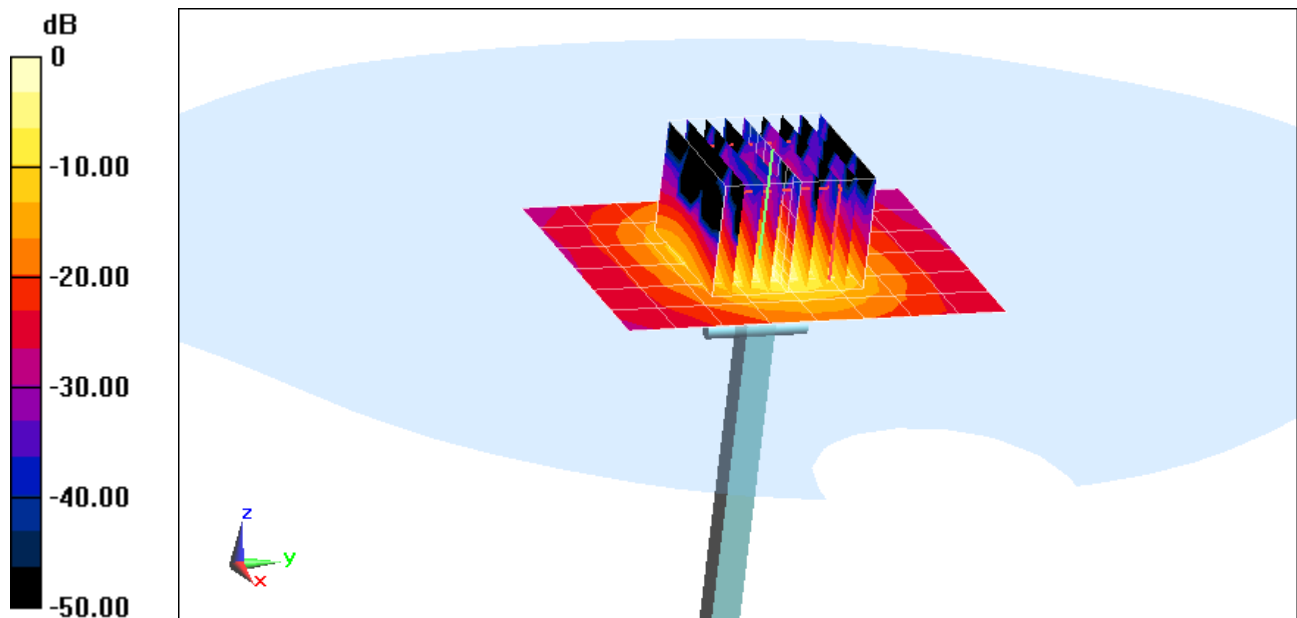
**Zoom Scan (9x9x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 31.6 W/kg

**SAR(1 g) = 7.58 W/kg**

Deviation = 0.40%



0 dB = 18.5 W/kg = 12.67 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

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

Communication System: UID 0, CW; Frequency: 5300 MHz; Duty Cycle: 1:1

Medium: 5 GHz Body, Medium parameters used:

$f = 5300 \text{ MHz}$ ;  $\sigma = 5.602 \text{ S/m}$ ;  $\epsilon_r = 46.718$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 11-25-2013; Ambient Temp: 23.0°C; Tissue Temp: 21.5°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 14.6.10 (7164)

## 5300 MHz System Verification

**Area Scan (7x9x1):** Measurement grid: dx=10mm, dy=10mm

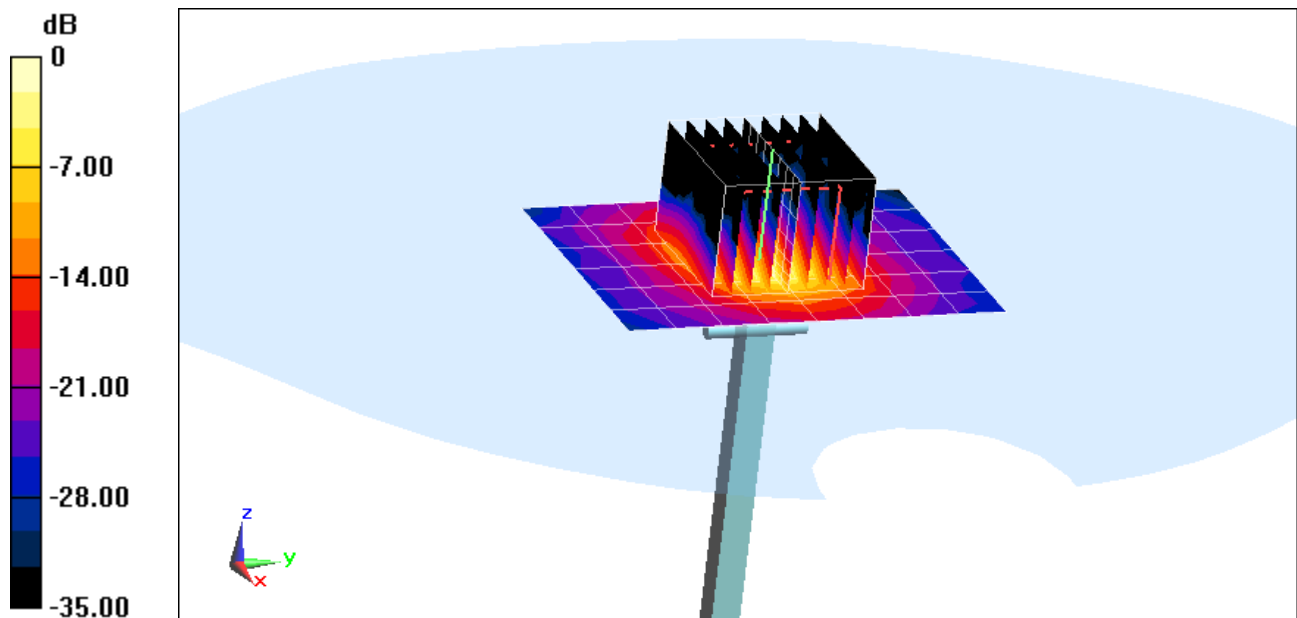
**Zoom Scan (9x9x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 34.2 W/kg

**SAR(1 g) = 7.89 W/kg**

Deviation = 4.78%



0 dB = 19.1 W/kg = 12.81 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

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

Communication System: UID 0, CW; Frequency: 5500 MHz; Duty Cycle: 1:1

Medium: 5 GHz Body, Medium parameters used:

$f = 5500 \text{ MHz}$ ;  $\sigma = 5.848 \text{ S/m}$ ;  $\epsilon_r = 46.349$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 11-25-2013; Ambient Temp: 23.0°C; Tissue Temp: 21.5°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 14.6.10 (7164)

## 5500 MHz System Verification

**Area Scan (7x9x1):** Measurement grid: dx=10mm, dy=10mm

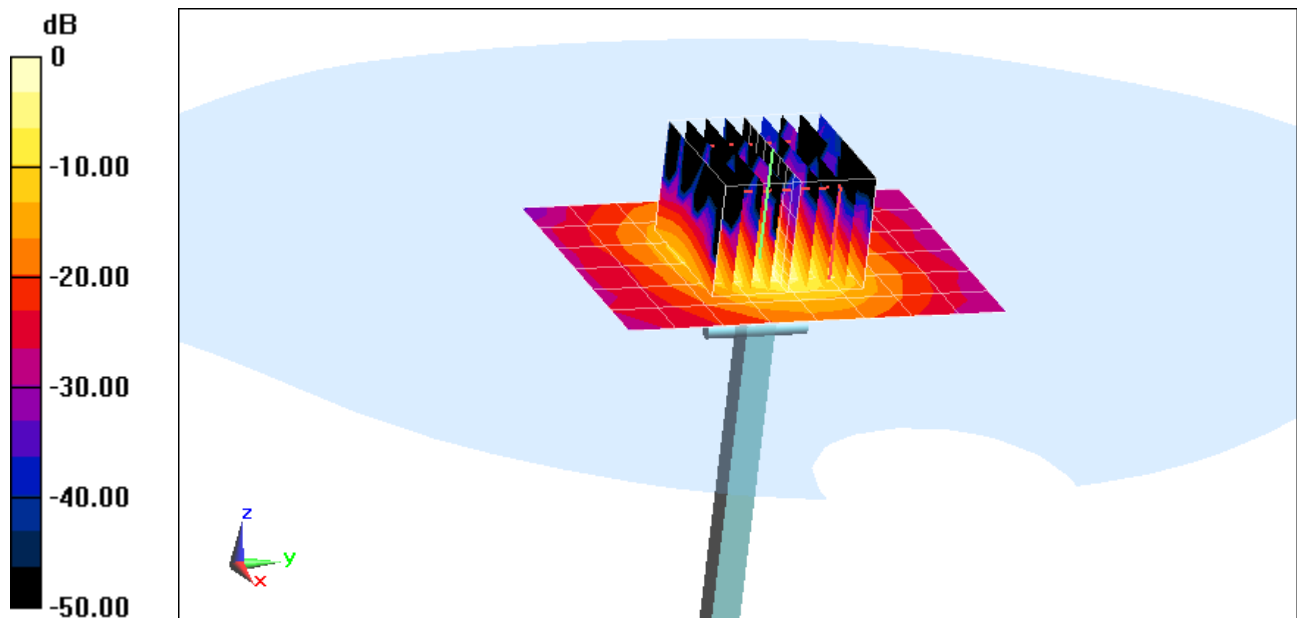
**Zoom Scan (9x9x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 36.4 W/kg

**SAR(1 g) = 8.14 W/kg**

Deviation = 0.74%



0 dB = 20.2 W/kg = 13.05 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

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

Communication System: UID 0, CW; Frequency: 5800 MHz; Duty Cycle: 1:1

Medium: 5 GHz Body, Medium parameters used:

$f = 5800 \text{ MHz}$ ;  $\sigma = 6.261 \text{ S/m}$ ;  $\epsilon_r = 45.808$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 11-25-2013; Ambient Temp: 23.0°C; Tissue Temp: 21.5°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 14.6.10 (7164)

## 5800 MHz System Verification

**Area Scan (7x9x1):** Measurement grid: dx=10mm, dy=10mm

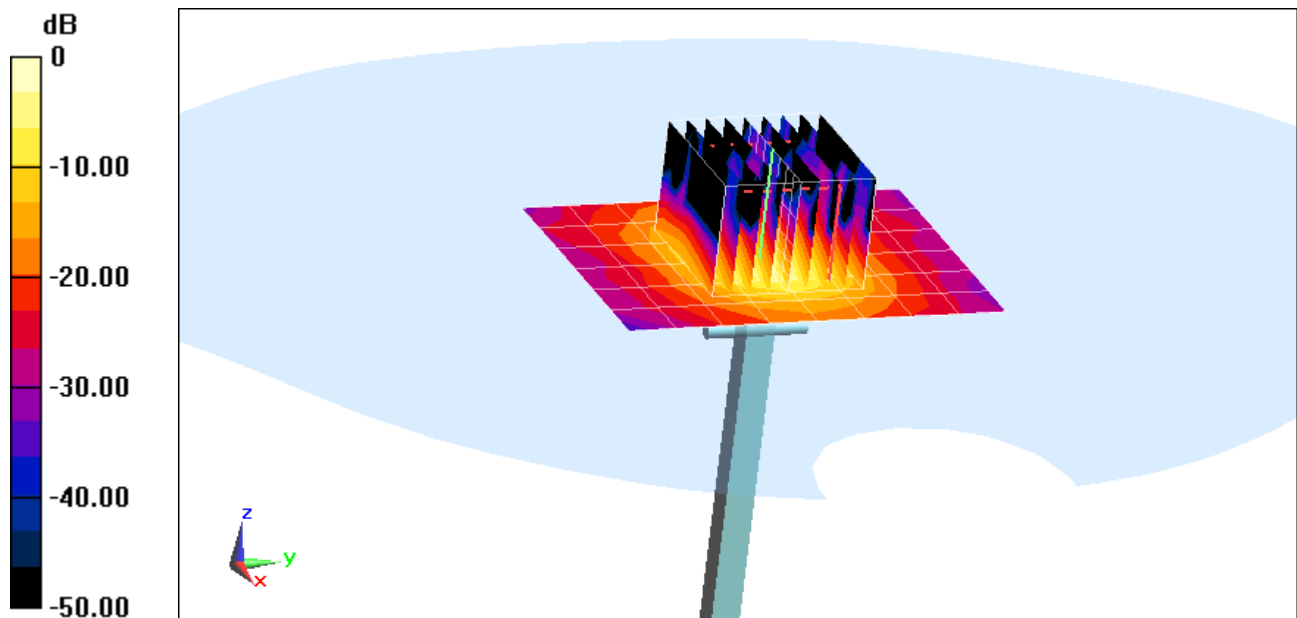
**Zoom Scan (9x9x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 35.7 W/kg

**SAR(1 g) = 7.4 W/kg**

Deviation = -1.46%



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

## APPENDIX C: PROBE CALIBRATION



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: **D835V2-4d119\_Apr13**

## CALIBRATION CERTIFICATE

Object **D835V2 - SN: 4d119**

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

Calibration date: **April 25, 2013**

✓  
KOK  
5/8/13

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)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 909	11-Sep-12 (No. DAE4-909_Sep12)	Sep-13
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

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

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

Signature

Issued: April 26, 2013

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



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

Accreditation No.: **SCS 108**

### Glossary:

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

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

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

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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

## Measurement Conditions

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

DASY Version	DASY5	V52.8.6
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz $\pm$ 1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	40.8 $\pm$ 6 %	0.94 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

## SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.51 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>9.68 W/kg <math>\pm</math> 17.0 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.62 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>6.30 W/kg <math>\pm</math> 16.5 % (k=2)</b>

## Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	54.0 $\pm$ 6 %	1.01 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

## SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.47 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>9.54 W/kg <math>\pm</math> 17.0 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.62 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>6.31 W/kg <math>\pm</math> 16.5 % (k=2)</b>

## Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.1 $\Omega$ - 4.7 j $\Omega$
Return Loss	- 26.6 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.8 $\Omega$ - 6.3 j $\Omega$
Return Loss	- 22.1 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.385 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	June 29, 2010

## DASY5 Validation Report for Head TSL

Date: 25.04.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d119**

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.94$  S/m;  $\epsilon_r = 40.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.05, 6.05, 6.05); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn909; Calibrated: 11.09.2012
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

**Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:**

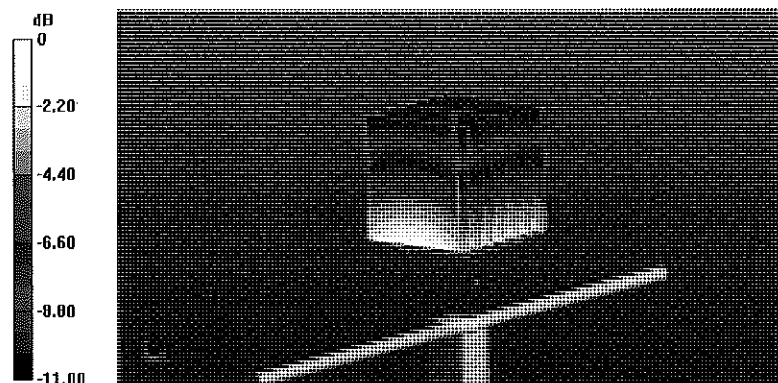
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 57.387 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 3.86 W/kg

**SAR(1 g) = 2.51 W/kg; SAR(10 g) = 1.62 W/kg**

Maximum value of SAR (measured) = 2.93 W/kg



0 dB = 2.93 W/kg = 4.67 dBW/kg

# Impedance Measurement Plot for Head TSL

25 Apr 2013 09:11:06

CH1 S11 1 U FS

1: 50.061  $\Omega$  -4.6621  $\Omega$  40.884 pF

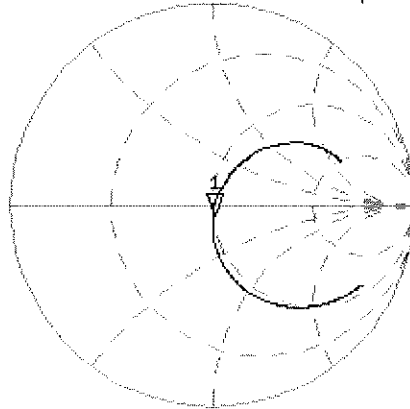
835.000 000 MHz

\*  
Del

CA

Avg  
16

H1 d

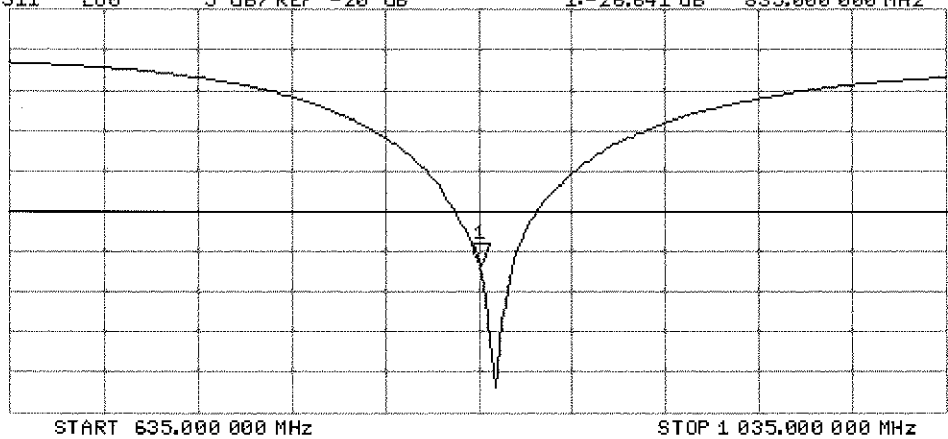


CH2 S11 LOG 5 dB/REF -20 dB 1:-26.641 dB 835.000 000 MHz

CA

Avg  
16

H1 d



## DASY5 Validation Report for Body TSL

Date: 24.04.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d119**

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used:  $f = 835$  MHz;  $\sigma = 1.01$  S/m;  $\epsilon_r = 54$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.04, 6.04, 6.04); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn909; Calibrated: 11.09.2012
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

### **Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:**

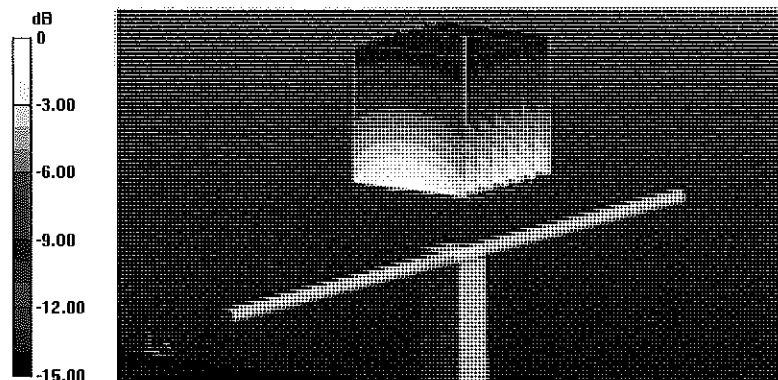
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 55.178 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 3.68 W/kg

**SAR(1 g) = 2.47 W/kg; SAR(10 g) = 1.62 W/kg**

Maximum value of SAR (measured) = 2.89 W/kg



0 dB = 2.89 W/kg = 4.61 dBW/kg

# Impedance Measurement Plot for Body TSL

24 Apr 2013 11:33:44

CH1 S11 1 U FS

2: 45.773  $\Omega$  -6.2773  $\Delta$  30.364 pF

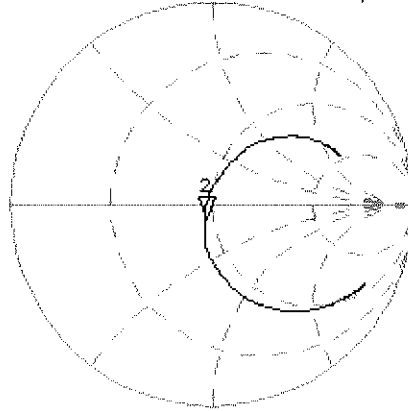
835.000 000 MHz

\*  
DeI

CΔ

Avg  
16

H1d



CH2 S11 LOG

5 dB/REF -20 dB

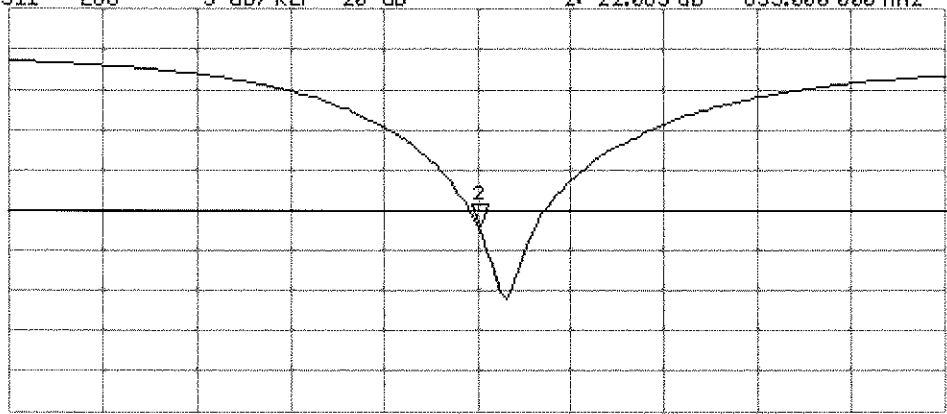
2: -22.065 dB

835.000 000 MHz

CΔ

Avg  
16

H1d



START 835.000 000 MHz

STOP 1 835.000 000 MHz



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D1900V2-5d148\_Feb13**

## CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d148**

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

Calibration date: **February 06, 2013**

*KOK  
2/21/13*

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 ( $22 \pm 3$ )°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

Calibrated by: **Leif Klysner**      Name: **Leif Klysner**      Function: **Laboratory Technician**

Signature: *Leif Klysner*

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

Signature: *Katja Pokovic*

Issued: February 6, 2013

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



Accredited by the Swiss Accreditation Service (SAS)

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

Accreditation No.: **SCS 108**

### Glossary:

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

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

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

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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

## Measurement Conditions

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

<b>DASY Version</b>	DASY5	V52.8.5
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Modular Flat Phantom	
<b>Distance Dipole Center - TSL</b>	10 mm	with Spacer
<b>Zoom Scan Resolution</b>	dx, dy, dz = 5 mm	
<b>Frequency</b>	1900 MHz $\pm$ 1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	40.0	1.40 mho/m
<b>Measured Head TSL parameters</b>	(22.0 $\pm$ 0.2) °C	39.4 $\pm$ 6 %	1.38 mho/m $\pm$ 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Head TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	250 mW input power	9.87 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>39.7 W/kg <math>\pm</math> 17.0 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	250 mW input power	5.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>20.8 W/kg <math>\pm</math> 16.5 % (k=2)</b>

## Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	53.3	1.52 mho/m
<b>Measured Body TSL parameters</b>	(22.0 $\pm$ 0.2) °C	51.9 $\pm$ 6 %	1.53 mho/m $\pm$ 6 %
<b>Body TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Body TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>	Condition	
SAR measured	250 mW input power	10.3 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>40.8 W/kg <math>\pm</math> 17.0 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b>	condition	
SAR measured	250 mW input power	5.45 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>21.7 W/kg <math>\pm</math> 16.5 % (k=2)</b>

## Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.1 $\Omega$ + 5.9 j $\Omega$
Return Loss	- 24.3 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.3 $\Omega$ + 6.3 j $\Omega$
Return Loss	- 23.6 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.199 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	March 11, 2011

## DASY5 Validation Report for Head TSL

Date: 06.02.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d148**

Communication System: CW; Frequency: 1900 MHz

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.38$  S/m;  $\epsilon_r = 39.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.98, 4.98, 4.98); 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 52.8.5(1059); SEMCAD X 14.6.8(7028)

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

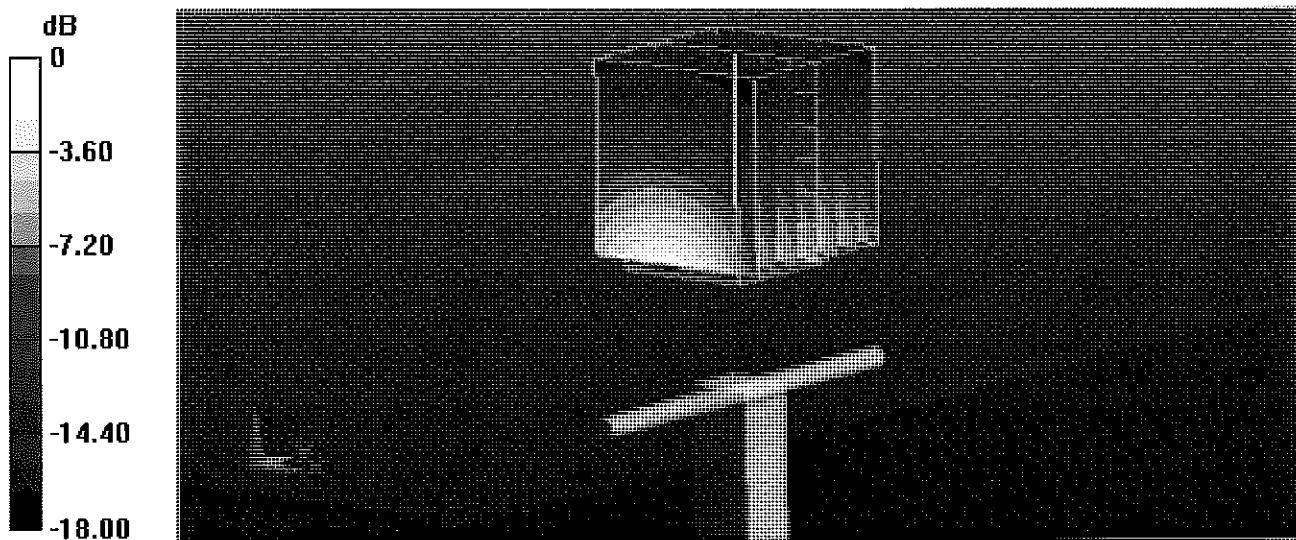
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.534 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 17.8 W/kg

**SAR(1 g) = 9.87 W/kg; SAR(10 g) = 5.18 W/kg**

Maximum value of SAR (measured) = 12.1 W/kg



0 dB = 12.1 W/kg = 10.83 dBW/kg

# Impedance Measurement Plot for Head TSL

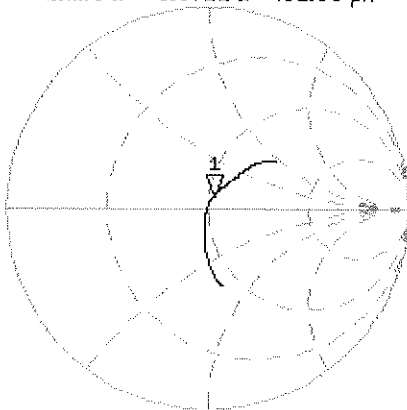
6 Feb 2013 09:25:10

CH1 S11 1 U FS

1: 52.125  $\Omega$  5.8711  $\Omega$  491.80  $\mu$ H

1 900.000 000 MHz

\*  
Del  
CA  
Avg  
16  
H1d

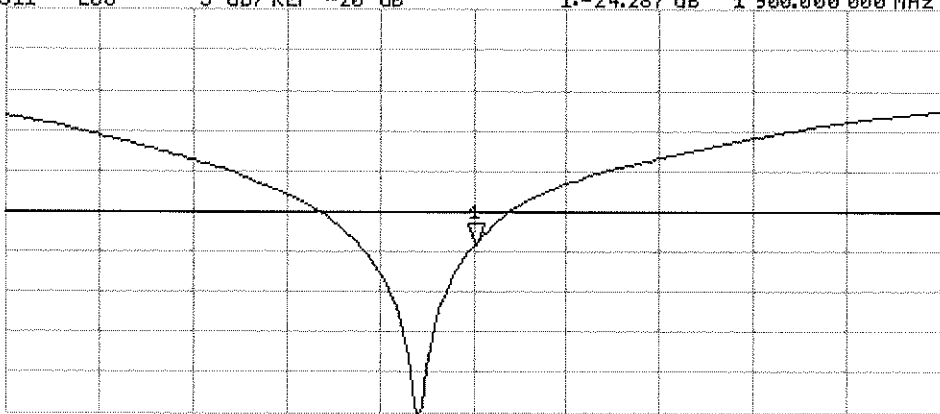


CH2 S11 LOG

5 dB/REF -20 dB

1: -24.287 dB 1 900.000 000 MHz

CA  
Avg  
16  
H1d



START 1 700.000 000 MHz

STOP 2 100.000 000 MHz

## DASY5 Validation Report for Body TSL

Date: 06.02.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d148**

Communication System: CW; Frequency: 1900 MHz

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.53$  S/m;  $\epsilon_r = 51.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.6, 4.6, 4.6); 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 52.8.5(1059); SEMCAD X 14.6.8(7028)

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

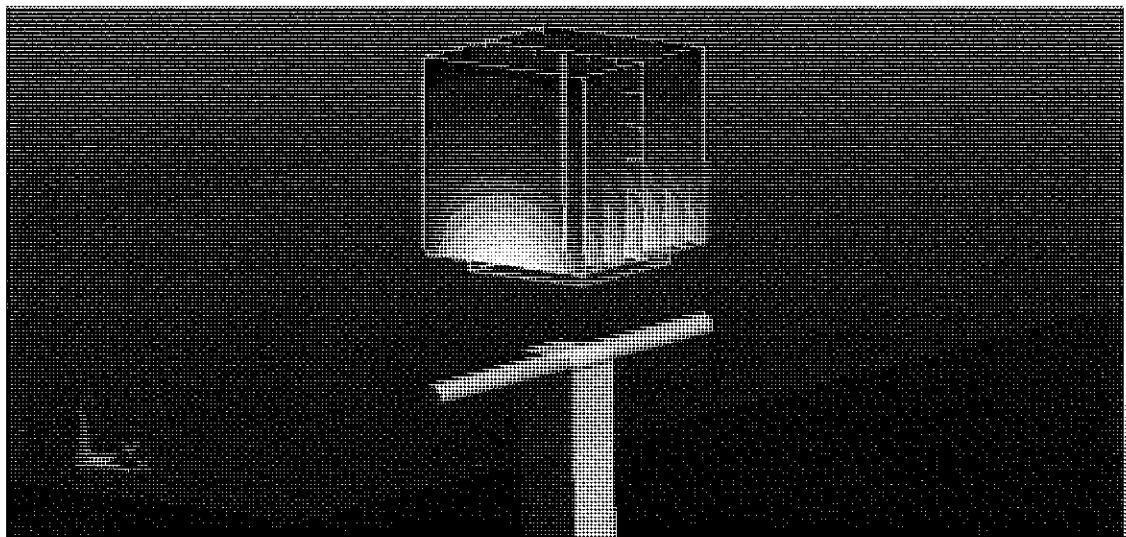
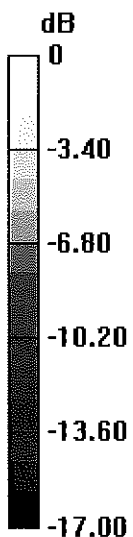
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.534 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 17.9 W/kg

**SAR(1 g) = 10.3 W/kg; SAR(10 g) = 5.45 W/kg**

Maximum value of SAR (measured) = 13.1 W/kg



0 dB = 13.1 W/kg = 11.17 dBW/kg

# Impedance Measurement Plot for Body TSL

6 Feb 2013 09:24:17

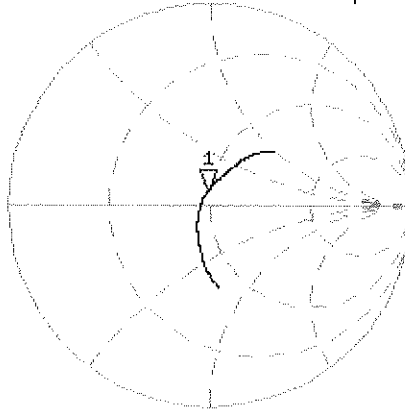
CH1 S11 1 U FS 1: 48.344  $\Omega$  6.2715  $\Omega$  525.34  $\mu$ H 1 900.000 000 MHz

\*  
De1

CA

Avg  
16

H1d

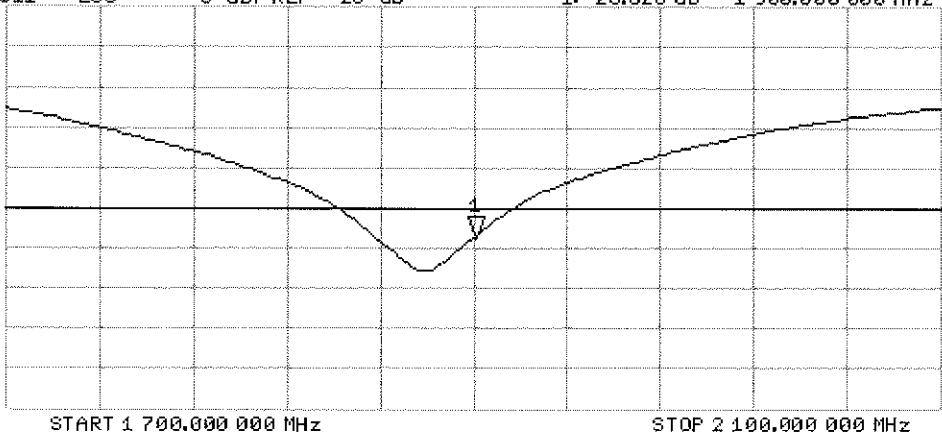


CH2 S11 LOG 5 dB/REF -20 dB 1:-23.628 dB 1 900.000 000 MHz

CA

Avg  
16

H1d





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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D2450V2-882\_Feb13**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 882**

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

Calibration date: **February 11, 2013**

*KOK  
2/21/13*

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 ( $22 \pm 3$ )°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

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

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

Signature  
*Israe El-Naouq*  
*Katja Pokovic*

Issued: February 11, 2013

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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**

**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.

<b>DASY Version</b>	DASY5	V52.8.5
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Modular Flat Phantom	
<b>Distance Dipole Center - TSL</b>	10 mm	with Spacer
<b>Zoom Scan Resolution</b>	dx, dy, dz = 5 mm	
<b>Frequency</b>	2450 MHz $\pm$ 1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	39.2	1.80 mho/m
<b>Measured Head TSL parameters</b>	(22.0 $\pm$ 0.2) °C	37.9 $\pm$ 6 %	1.85 mho/m $\pm$ 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Head TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>51.7 W/kg <math>\pm</math> 17.0 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	250 mW input power	6.07 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>24.0 W/kg <math>\pm</math> 16.5 % (k=2)</b>

## Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	52.7	1.95 mho/m
<b>Measured Body TSL parameters</b>	(22.0 $\pm$ 0.2) °C	50.9 $\pm$ 6 %	2.02 mho/m $\pm$ 6 %
<b>Body TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Body TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>	Condition	
SAR measured	250 mW input power	12.8 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>49.9 W/kg <math>\pm</math> 17.0 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b>	condition	
SAR measured	250 mW input power	5.91 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>23.3 W/kg <math>\pm</math> 16.5 % (k=2)</b>

## Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.6 $\Omega$ - 0.4 j $\Omega$
Return Loss	- 29.0 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.5 $\Omega$ + 1.2 j $\Omega$
Return Loss	- 37.4 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.157 ns
----------------------------------	----------

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

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

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

### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	October 06, 2011

## DASY5 Validation Report for Head TSL

Date: 11.02.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 882**

Communication System: CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.85$  S/m;  $\epsilon_r = 37.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

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 52.8.5(1059); SEMCAD X 14.6.8(7028)

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

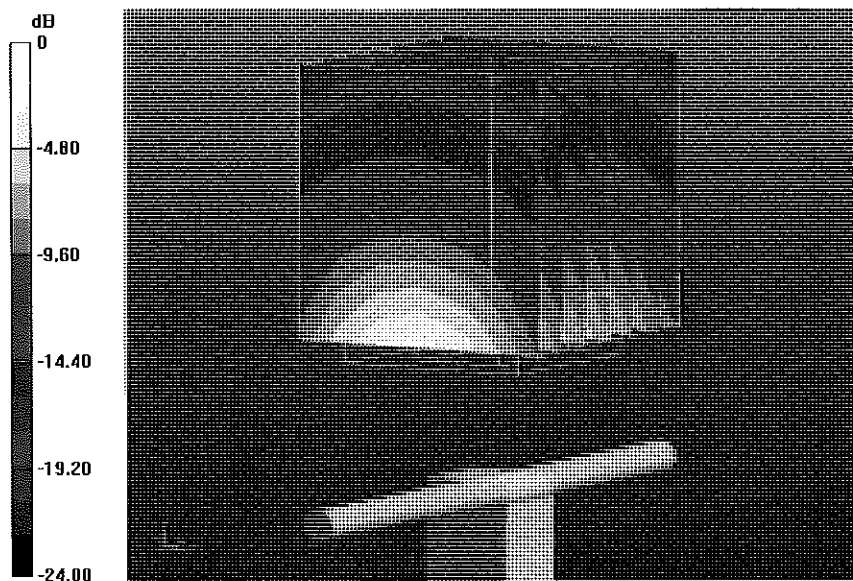
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 97.806 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 27.6 W/kg

**SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.07 W/kg**

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



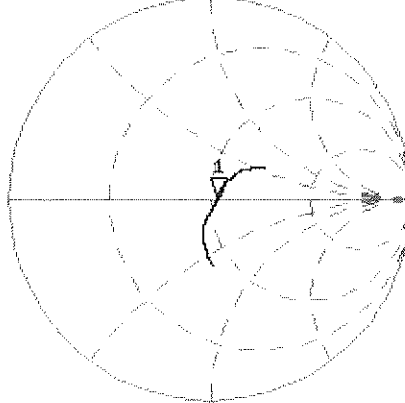
0 dB = 16.7 W/kg = 12.23 dBW/kg

# Impedance Measurement Plot for Head TSL

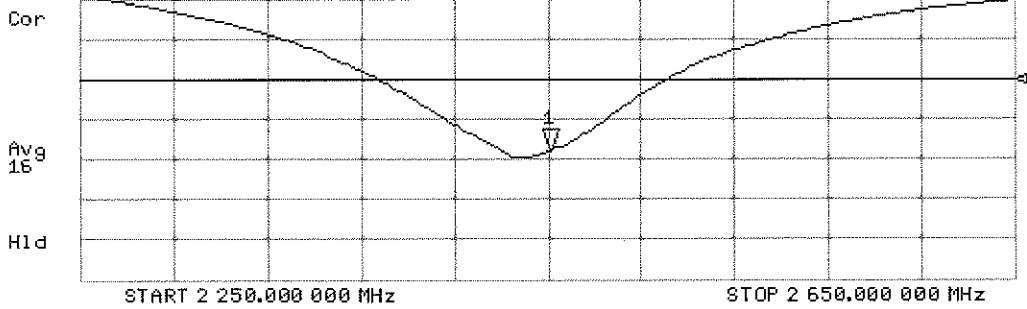
11 Feb 2013 11:51:51

CH1 S11 1 U FS 1: 53.639  $\Omega$  -363.28  $m\Omega$  178.82  $\mu F$  2 450.000 000 MHz

\*  
Del  
Cor  
Avg  
16  
H1d



CH2 S11 LOG 5 dB/REF -20 dB 1:-29.047 dB 2 450.000 000 MHz



# DASY5 Validation Report for Body TSL

Date: 11.02.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 882**

Communication System: CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.02$  S/m;  $\epsilon_r = 50.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

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 52.8.5(1059); SEMCAD X 14.6.8(7028)

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

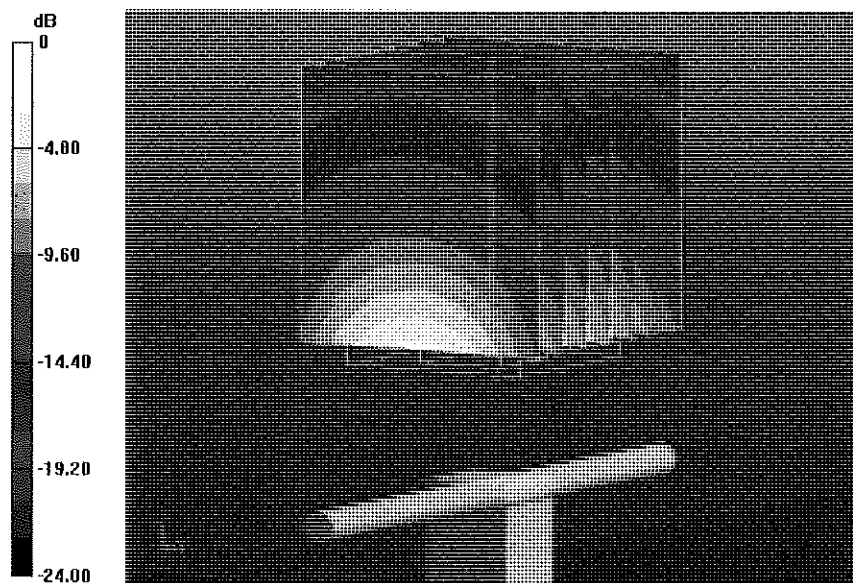
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.474 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 27.1 W/kg

**SAR(1 g) = 12.8 W/kg; SAR(10 g) = 5.91 W/kg**

Maximum value of SAR (measured) = 16.9 W/kg



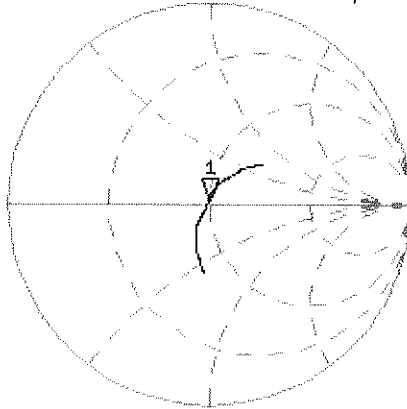
0 dB = 16.9 W/kg = 12.28 dBW/kg

# Impedance Measurement Plot for Body TSL

11 Feb 2013 11:51:25

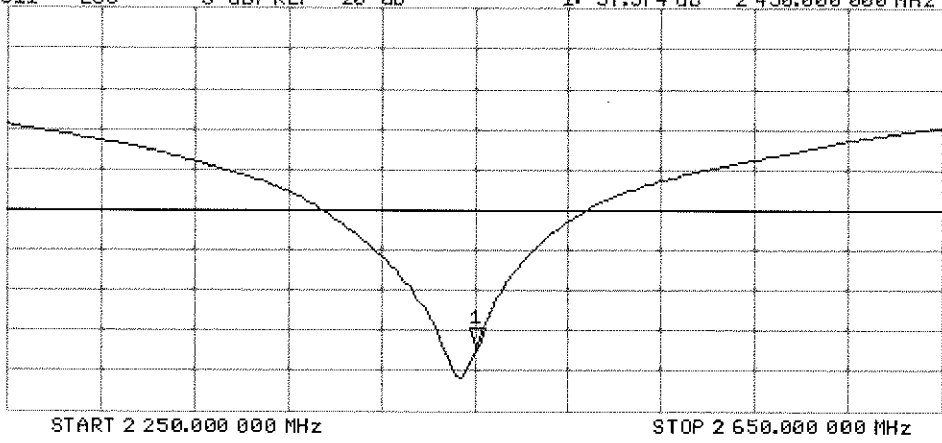
CH1 S11 1 U FS 1: 49.500  $\Omega$  1.2461  $\Omega$  80.948 pF 2 450.000 000 MHz

\*  
De1  
Cor  
Avg  
16  
H1d



CH2 S11 LOG 5 dB/REF -20 dB 1: -37.374 dB 2 450.000 000 MHz

Cor  
Avg  
16  
H1d





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: **D5GHzV2-1120\_Feb13**

## CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN: 1120**

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

Calibration date: **February 14, 2013**

*✓  
Kok  
2/2/13*

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 ( $22 \pm 3$ )°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

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

Approved by: **Katja Pokovic**      Technical Manager

Signature

*Israe El-Naouq*  
*Katja Pokovic*

Issued: February 14, 2013

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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

### Glossary:

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

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

- 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.

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

## Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	36.0	4.66 mho/m
<b>Measured Head TSL parameters</b>	(22.0 ± 0.2) °C	34.7 ± 6 %	4.47 mho/m ± 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Head TSL at 5200 MHz

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	100 mW input power	7.67 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>76.0 W/kg ± 19.9 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	100 mW input power	2.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>21.5 W/kg ± 19.5 % (k=2)</b>

### 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 %	4.57 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 <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.94 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>78.7 W / kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>22.4 W/kg ± 19.5 % (k=2)</b>

### 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 %	4.74 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 <sup>3</sup> (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	<b>80.1 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>22.6 W/kg ± 19.5 % (k=2)</b>

### 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 %	4.83 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 <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.08 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>79.9 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (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	<b>22.5 W/kg ± 19.5 % (k=2)</b>

### 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	33.9 ± 6 %	5.05 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 <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.57 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>74.9 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.13 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>21.0 W/kg ± 19.5 % (k=2)</b>

### Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.9 ± 6 %	5.36 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

### SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.73 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>76.6 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.17 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>21.5 W/kg ± 19.5 % (k=2)</b>

### Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.42 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.7 ± 6 %	5.48 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 <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.75 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>76.8 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.18 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>21.5 W/kg ± 19.5 % (k=2)</b>

### 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	46.3 ± 6 %	5.71 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 <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.06 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>79.8 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>22.1 W/kg ± 19.5 % (k=2)</b>

### Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.2 ± 6 %	5.83 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 <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.15 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>80.7 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (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	<b>22.3 W/kg ± 19.5 % (k=2)</b>

### Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	45.9 ± 6 %	6.12 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 <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.62 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>75.5 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.12 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>20.9 W/kg ± 19.5 % (k=2)</b>

## Appendix

### Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	53.8 $\Omega$ - 6.3 j $\Omega$
Return Loss	- 23.0 dB

### Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	50.1 $\Omega$ + 0.5 j $\Omega$
Return Loss	- 45.3 dB

### Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	51.0 $\Omega$ - 0.9 j $\Omega$
Return Loss	- 37.9 dB

### Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	55.3 $\Omega$ - 0.9 j $\Omega$
Return Loss	- 25.8 dB

### Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	53.5 $\Omega$ + 3.3 j $\Omega$
Return Loss	- 26.7 dB

### Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	53.7 $\Omega$ - 4.8 j $\Omega$
Return Loss	- 24.8 dB

### Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	50.2 $\Omega$ + 2.4 j $\Omega$
Return Loss	- 32.5 dB

### Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	51.6 $\Omega$ - 1.5 j $\Omega$
Return Loss	- 33.3 dB

### Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	57.4 $\Omega$ + 0.9 j $\Omega$
Return Loss	- 23.2 dB

## Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	53.5 $\Omega$ + 3.2 j $\Omega$
Return Loss	- 26.7 dB

## General Antenna Parameters and Design

Electrical Delay (one direction)	1.206 ns
----------------------------------	----------

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

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

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

## Additional EUT Data

Manufactured by	SPEAG
Manufactured on	September 08, 2011

## DASY5 Validation Report for Head TSL

Date: 08.02.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1120**

Communication System: CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz

Medium parameters used:  $f = 5200$  MHz;  $\sigma = 4.47$  S/m;  $\epsilon_r = 34.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5300$  MHz;  $\sigma = 4.57$  S/m;  $\epsilon_r = 34.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5500$  MHz;  $\sigma = 4.74$  S/m;  $\epsilon_r = 34.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5600$  MHz;  $\sigma = 4.83$  S/m;  $\epsilon_r = 34.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5800$  MHz;  $\sigma = 5.05$  S/m;  $\epsilon_r = 33.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

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 = 61.561 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 28.8 W/kg

**SAR(1 g) = 7.67 W/kg; SAR(10 g) = 2.18 W/kg**

Maximum value of SAR (measured) = 17.7 W/kg

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

Reference Value = 62.429 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 30.3 W/kg

**SAR(1 g) = 7.94 W/kg; SAR(10 g) = 2.27 W/kg**

Maximum value of SAR (measured) = 18.5 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 61.998 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 32.7 W/kg

**SAR(1 g) = 8.09 W/kg; SAR(10 g) = 2.29 W/kg**

Maximum value of SAR (measured) = 19.3 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 = 62.540 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 33.3 W/kg

**SAR(1 g) = 8.08 W/kg; SAR(10 g) = 2.28 W/kg**

Maximum value of SAR (measured) = 19.5 W/kg

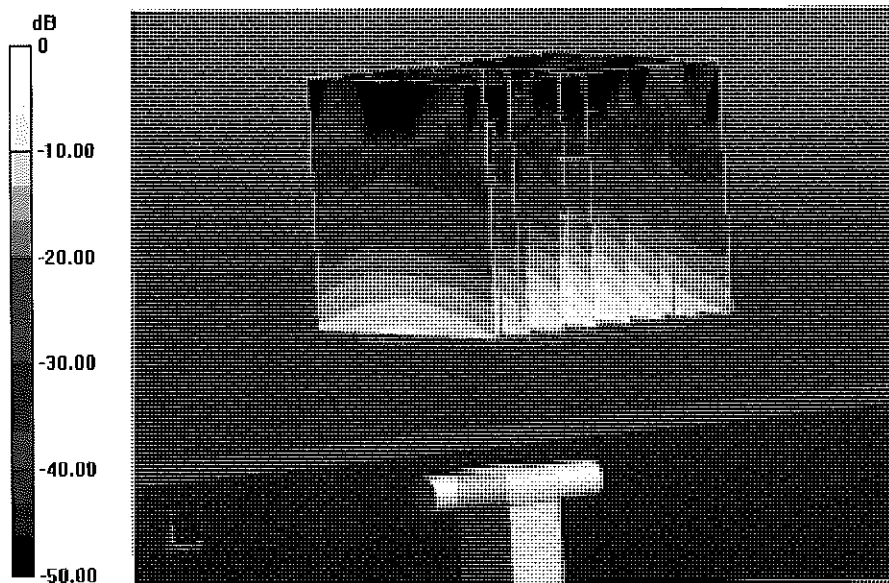
**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 58.600 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 32.9 W/kg

**SAR(1 g) = 7.57 W/kg; SAR(10 g) = 2.13 W/kg**

Maximum value of SAR (measured) = 18.8 W/kg



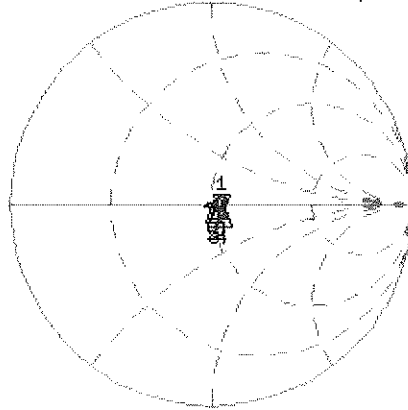
0 dB = 18.8 W/kg = 12.74 dBW/kg

# Impedance Measurement Plot for Head TSL

8 Feb 2013 10:10:29

CH1 S11 1 U FS 1: 53.764  $\Omega$  -6.3086  $\Omega$  4.8516 pF 5 200.000 000 MHz

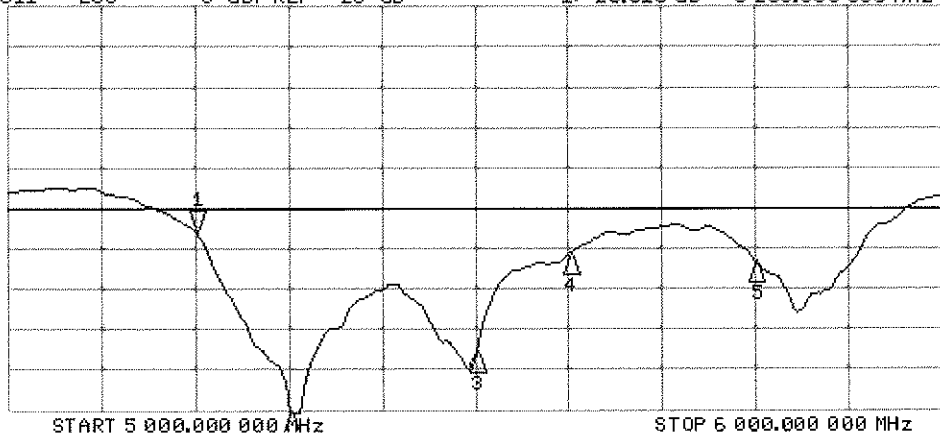
\*  
De1  
Cor  
Avg  
0  
H1d



CH1 Markers  
2: 50.104  $\Omega$   
0.5313  $\Omega$   
5.30000 GHz  
3: 50.959  $\Omega$   
-853.52 m $\Omega$   
5.50000 GHz  
4: 55.305  $\Omega$   
-902.34 m $\Omega$   
5.60000 GHz  
5: 53.500  $\Omega$   
3.3027  $\Omega$   
5.80000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 1: -23.013 dB 5 200.000 000 MHz

Cor  
Avg  
0  
H1d



CH2 Markers  
2: -45.321 dB  
5.30000 GHz  
3: -37.887 dB  
5.50000 GHz  
4: -25.835 dB  
5.60000 GHz  
5: -26.651 dB  
5.80000 GHz

## DASY5 Validation Report for Body TSL

Date: 14.02.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1120**

Communication System: CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz

Medium parameters used:  $f = 5200$  MHz;  $\sigma = 5.36$  S/m;  $\epsilon_r = 46.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5300$  MHz;  $\sigma = 5.48$  S/m;  $\epsilon_r = 46.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5500$  MHz;  $\sigma = 5.71$  S/m;  $\epsilon_r = 46.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.83$  S/m;  $\epsilon_r = 46.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5800$  MHz;  $\sigma = 6.12$  S/m;  $\epsilon_r = 45.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

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 = 61.053 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 31.1 W/kg

**SAR(1 g) = 7.73 W/kg; SAR(10 g) = 2.17 W/kg**

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

**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan,**

**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 60.021 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 32.1 W/kg

**SAR(1 g) = 7.75 W/kg; SAR(10 g) = 2.18 W/kg**

Maximum value of SAR (measured) = 18.5 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 = 59.894 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 35.3 W/kg

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

Maximum value of SAR (measured) = 19.4 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 = 59.730 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 36.8 W/kg

**SAR(1 g) = 8.15 W/kg; SAR(10 g) = 2.26 W/kg**

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

**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan,**

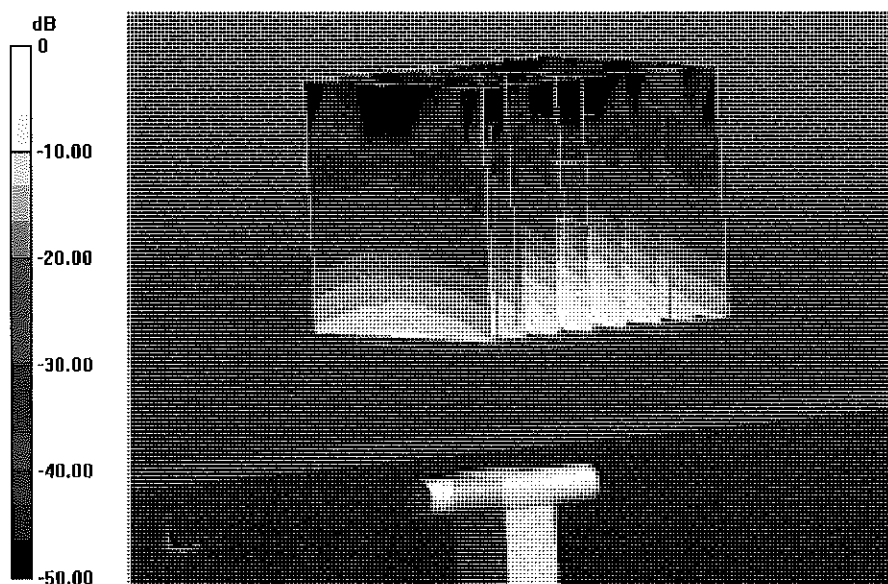
**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 56.663 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 36.4 W/kg

**SAR(1 g) = 7.62 W/kg; SAR(10 g) = 2.12 W/kg**

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



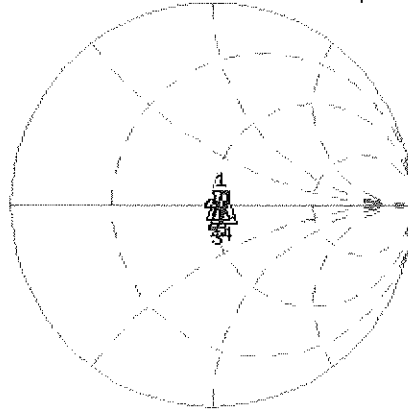
0 dB = 19.0 W/kg = 12.79 dBW/kg

# Impedance Measurement Plot for Body TSL

14 Feb 2013 15:47:05

CH1 S11 1 U FS 1: 53.672  $\Omega$  -4.7539  $\Omega$  6.4382 pF 5 200.000 000 MHz

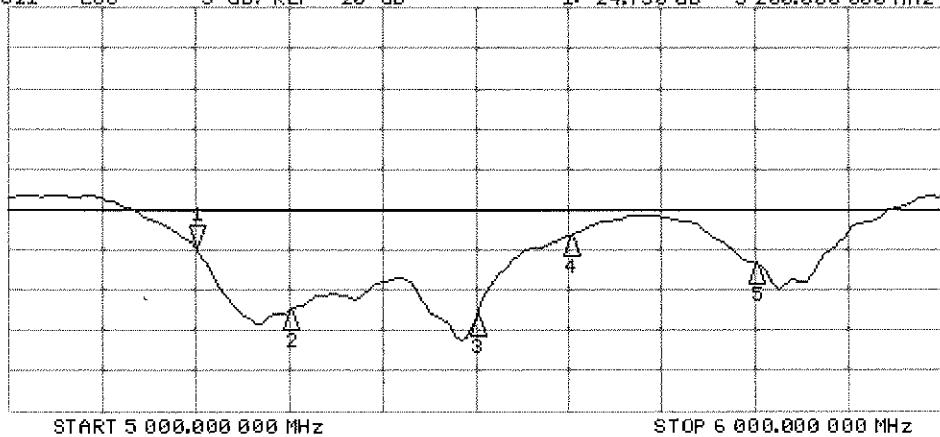
\*  
De1  
Cor  
Avg  
16  
H1d



CH1 Markers  
2: 50.250  $\Omega$   
2.3555  $\Omega$   
5.30000 GHz  
3: 51.629  $\Omega$   
-1.4824  $\Omega$   
5.50000 GHz  
4: 57.389  $\Omega$   
0.9180  $\Omega$   
5.60000 GHz  
5: 53.543  $\Omega$   
3.2441  $\Omega$   
5.80000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 1: -24.750 dB 5 200.000 000 MHz

Cor  
Avg  
16  
H1d



CH2 Markers  
2: -32.508 dB  
5.30000 GHz  
3: -33.267 dB  
5.50000 GHz  
4: -23.183 dB  
5.60000 GHz  
5: -26.672 dB  
5.80000 GHz



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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  
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

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

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

Issued: January 8, 2013

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

### Glossary:

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

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

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

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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

## Measurement Conditions

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

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

## Head TSL parameters

The following parameters and calculations were applied.

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

## SAR result with Head TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	250 mW input power	13.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>52.5 W/kg ± 17.0 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	250 mW input power	6.20 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>24.5 W/kg ± 16.5 % (k=2)</b>

## Body TSL parameters

The following parameters and calculations were applied.

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

## SAR result with Body TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>	Condition	
SAR measured	250 mW input power	12.7 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>49.6 W/kg ± 17.0 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b>	condition	
SAR measured	250 mW input power	5.88 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>23.2 W/kg ± 16.5 % (k=2)</b>

## Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.3 $\Omega$ + 3.1 j $\Omega$
Return Loss	- 27.1 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.1 $\Omega$ + 4.9 j $\Omega$
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;  $\epsilon_r = 37.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

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/ $P_{in}=250$ mW, $d=10$ mm/Zoom Scan (7x7x7)/Cube 0:

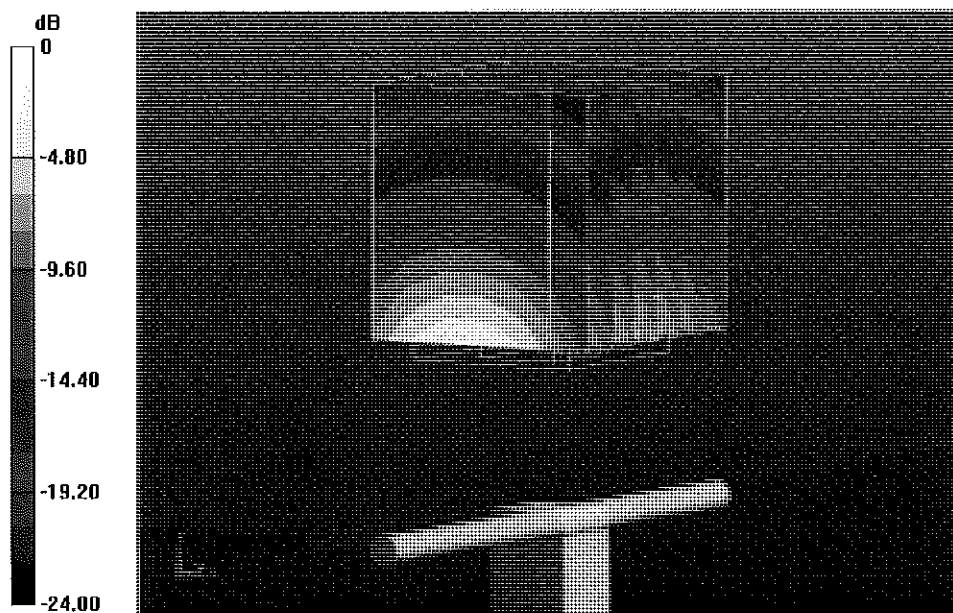
Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

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

8 Jan 2013 12:37:14

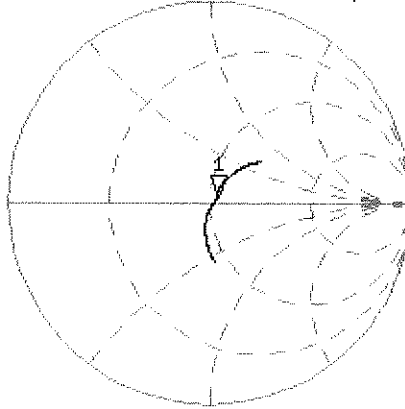
CH1 S11 1 U FS 1: 53.346  $\Delta$  3.0762  $\Delta$  199.83 pH 2 450.000 000 MHz

#  
De1

Cor

Avg  
16

H1d

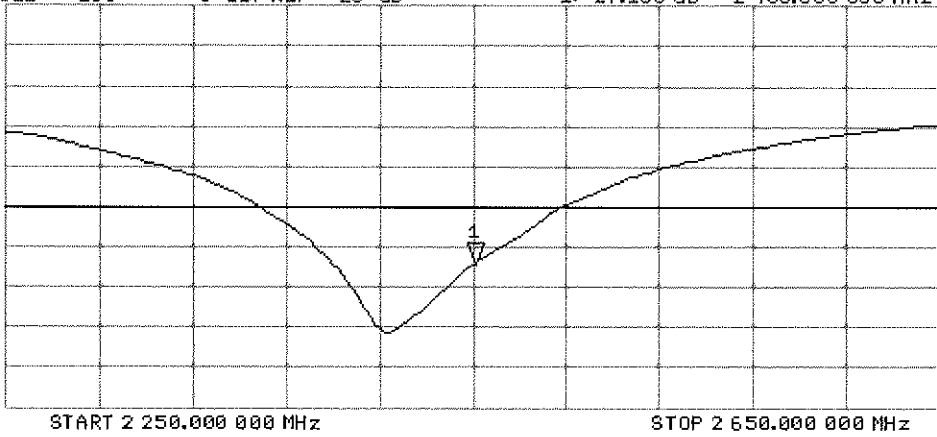


CH2 S11 LOG 5 dB/REF -20 dB 1: -27.136 dB 2 450.000 000 MHz

Cor

Avg  
16

H1d



## 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;  $\epsilon_r = 50.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>

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:

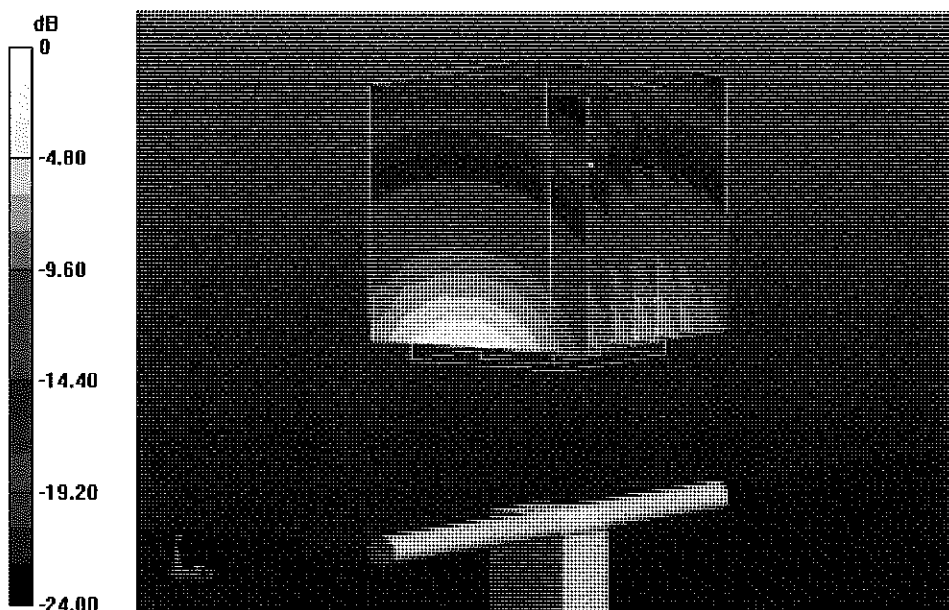
Measurement grid: dx=5mm, dy=5mm, dz=5mm

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

8 Jan 2013 12:36:45

CH1 S11 1 U FS

1: 49.090  $\angle$  4.9102  $\angle$  318.97  $\mu$ H

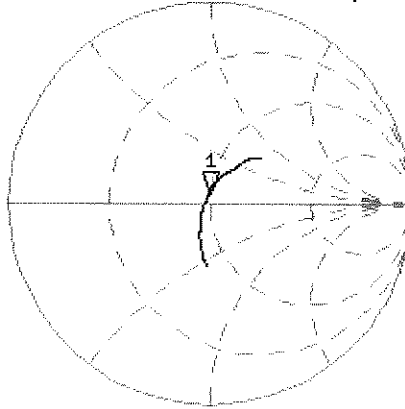
2 450.000 000 MHz

\*  
De1

Cor

Avg  
16

H1d



CH2 S11 LOG

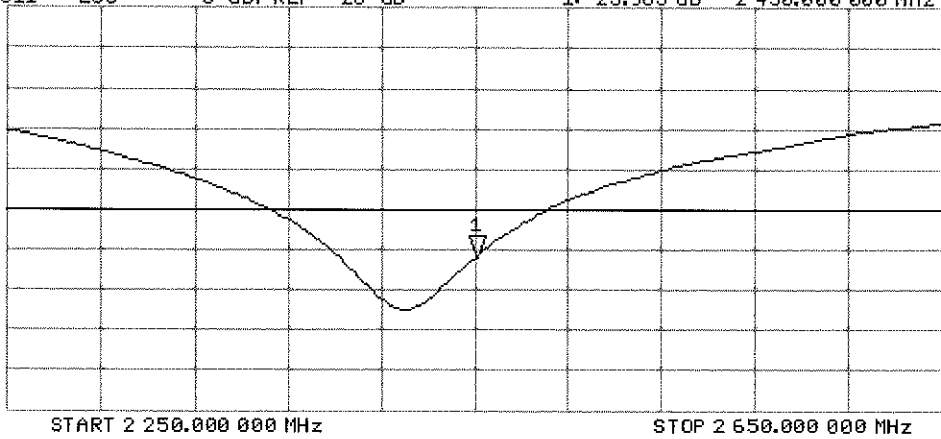
5 dB/REF -20 dB

1: -25.963 dB 2 450.000 000 MHz

Cor

Avg  
16

H1d





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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  
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 ( $22 \pm 3$ )°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

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

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

Issued: January 11, 2013

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Accreditation No.: **SCS 108**

### Glossary:

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

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

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

### Additional Documentation:

- c) DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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

## Measurement Conditions

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

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

## Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

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

## SAR result with Head TSL at 5200 MHz

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	100 mW input power	7.66 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>75.9 W/kg ± 19.9 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	100 mW input power	2.17 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>21.4 W/kg ± 19.5 % (k=2)</b>

### 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 <sup>3</sup> (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	<b>76.9 W / kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (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	<b>21.9 W/kg ± 19.5 % (k=2)</b>

### 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 <sup>3</sup> (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	<b>80.1 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (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	<b>22.5 W/kg ± 19.5 % (k=2)</b>

### 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 <sup>3</sup> (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	<b>80.4 W/kg ± 19.9 % (k=2)</b>

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

### 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 <sup>3</sup> (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	<b>76.1 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (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	<b>21.4 W/kg ± 19.5 % (k=2)</b>

### 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 <sup>3</sup> (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	<b>75.5 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (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	<b>21.1 W/kg ± 19.5 % (k=2)</b>

### 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 <sup>3</sup> (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	<b>75.3 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (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	<b>21.1 W/kg ± 19.5 % (k=2)</b>

### 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 <sup>3</sup> (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	<b>80.8 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (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	<b>22.4 W/kg ± 19.5 % (k=2)</b>

### 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 <sup>3</sup> (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	<b>80.3 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (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	<b>22.3 W/kg ± 19.5 % (k=2)</b>

### 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 <sup>3</sup> (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	<b>75.1 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (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	<b>20.7 W/kg ± 19.5 % (k=2)</b>

## Appendix

### Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	50.5 $\Omega$ - 9.8 j $\Omega$
Return Loss	- 20.3 dB

### Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	48.5 $\Omega$ - 4.5 j $\Omega$
Return Loss	- 26.4 dB

### Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	50.6 $\Omega$ - 5.8 j $\Omega$
Return Loss	- 24.8 dB

### Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	53.9 $\Omega$ - 3.8 j $\Omega$
Return Loss	- 25.6 dB

### Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	52.5 $\Omega$ - 4.4 j $\Omega$
Return Loss	- 26.1 dB

### Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	49.3 $\Omega$ - 7.9 j $\Omega$
Return Loss	- 22.0 dB

### Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	48.7 $\Omega$ - 3.2 j $\Omega$
Return Loss	- 29.2 dB

### Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	51.2 $\Omega$ - 4.8 j $\Omega$
Return Loss	- 26.2 dB

### Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	53.6 $\Omega$ - 2.1 j $\Omega$
Return Loss	- 27.9 dB

## Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	53.3 $\Omega$ - 2.9 j $\Omega$
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;  $\epsilon_r = 34.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5300$  MHz;  $\sigma = 4.6$  S/m;  $\epsilon_r = 34.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5500$  MHz;  $\sigma = 4.79$  S/m;  $\epsilon_r = 34.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5600$  MHz;  $\sigma = 4.88$  S/m;  $\epsilon_r = 34.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5800$  MHz;  $\sigma = 5.09$  S/m;  $\epsilon_r = 33.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

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

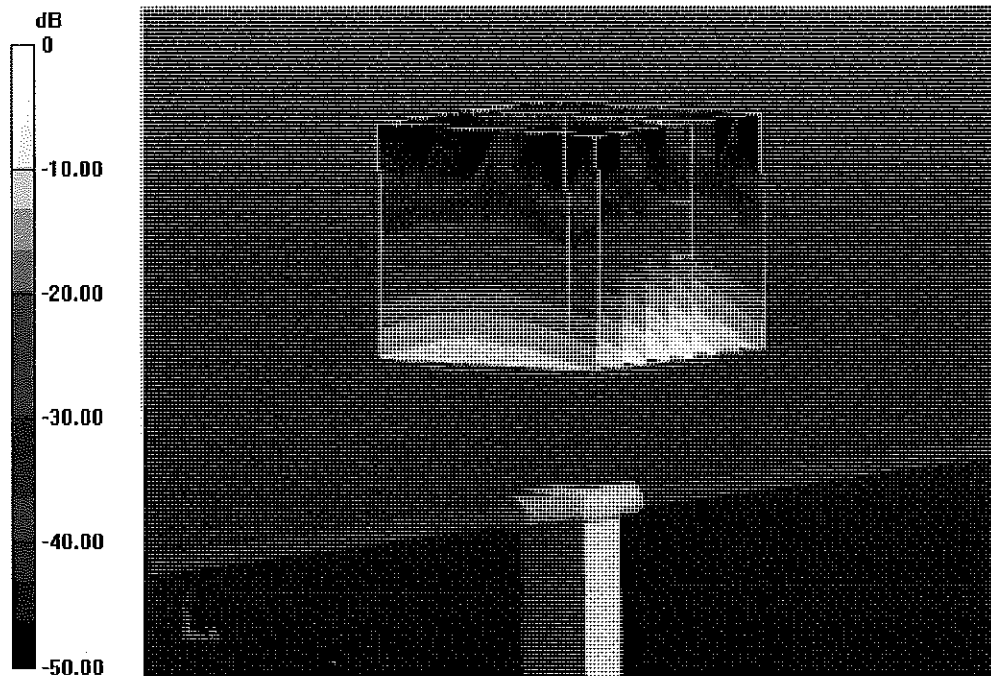
Peak SAR (extrapolated) = 33.2 W/kg

**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



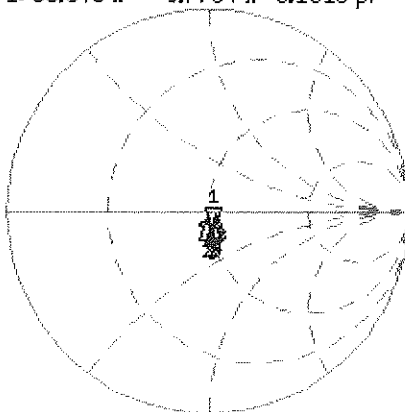
0 dB = 19.4 W/kg = 12.88 dBW/kg

# Impedance Measurement Plot for Head TSL

11 Jan 2013 09:26:56

CH1 S11 1 U FS 1: 50.543  $\Omega$  -9.7754  $\Omega$  3.1310 pF 5 200.000 000 MHz

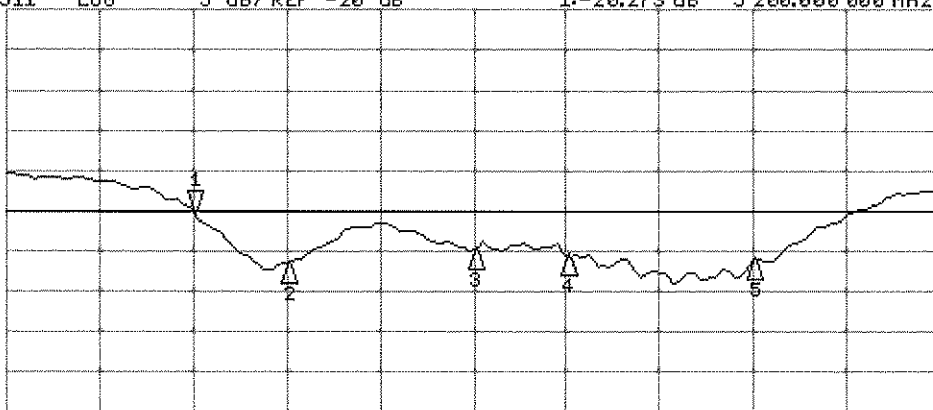
\*  
De1  
CA  
Avg  
16  
H1d



CH1 Markers  
2: 48.508  $\Omega$   
-4.4805  $\Omega$   
5.30000 GHz  
3: 50.617  $\Omega$   
-5.7559  $\Omega$   
5.50000 GHz  
4: 53.891  $\Omega$   
-3.8418  $\Omega$   
5.60000 GHz  
5: 52.500  $\Omega$   
-4.4160  $\Omega$   
5.80000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 1: -20.273 dB 5 200.000 000 MHz

CA  
Avg  
16  
H1d



CH2 Markers  
2: -25.396 dB  
5.30000 GHz  
3: -24.818 dB  
5.50000 GHz  
4: -25.573 dB  
5.60000 GHz  
5: -26.115 dB  
5.80000 GHz

## 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;  $\epsilon_r = 47$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5300$  MHz;  $\sigma = 5.55$  S/m;  $\epsilon_r = 46.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5500$  MHz;  $\sigma = 5.81$  S/m;  $\epsilon_r = 46.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.94$  S/m;  $\epsilon_r = 46.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5800$  MHz;  $\sigma = 6.21$  S/m;  $\epsilon_r = 46$ ;  $\rho = 1000$  kg/m<sup>3</sup>

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,**

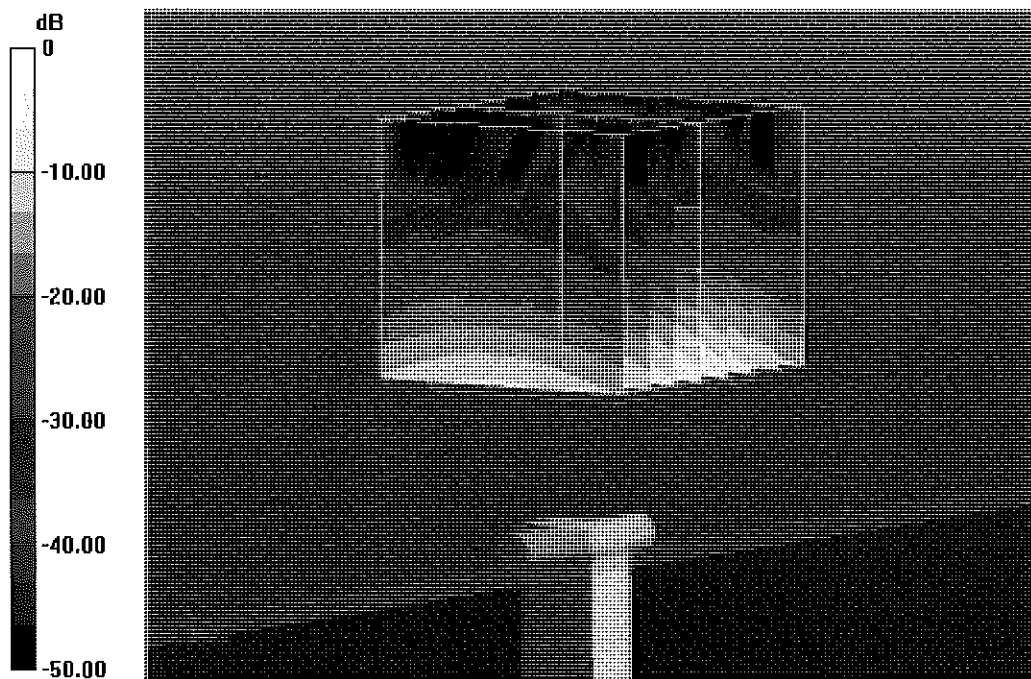
**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

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



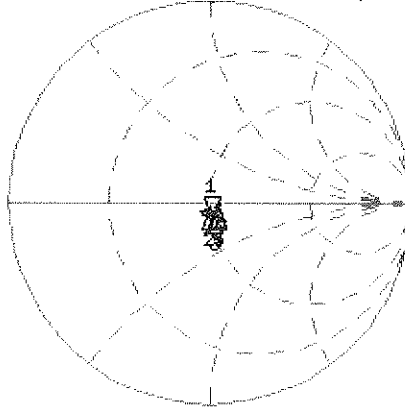
0 dB = 18.9 W/kg = 12.76 dBW/kg

# Impedance Measurement Plot for Body TSL

10 Jan 2013 13:20:10

CH1 S11 1 U FS 1: 49.311  $\Omega$  -7.8789  $\Omega$  3.8846 pF 5 200.000 000 MHz

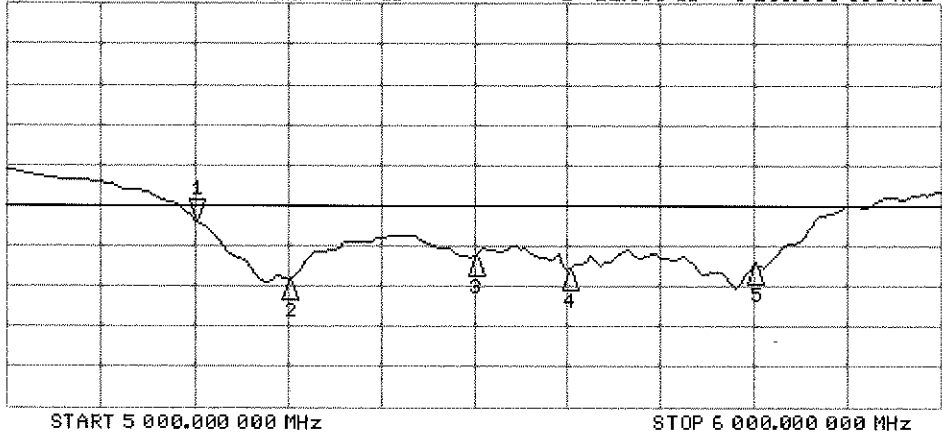
\*  
Del  
CA  
Avg  
16  
H1d



CH1 Markers  
2: 48.729  $\Omega$   
-3.1895  $\Omega$   
5.30000 GHz  
3: 51.209  $\Omega$   
-4.8184  $\Omega$   
5.50000 GHz  
4: 53.596  $\Omega$   
-2.1113  $\Omega$   
5.60000 GHz  
5: 53.314  $\Omega$   
-2.9355  $\Omega$   
5.90000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 1: -22.005 dB 5 200.000 000 MHz

CA  
Avg  
16  
H1d



CH2 Markers  
2: -29.181 dB  
5.30000 GHz  
3: -26.190 dB  
5.50000 GHz  
4: -27.903 dB  
5.60000 GHz  
5: -27.367 dB  
5.80000 GHz



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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.: **ES3-3022\_Aug13**

## CALIBRATION CERTIFICATE

Object **ES3DV2 - SN:3022**

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

Calibration date: **August 22, 2013**

*UTC*  
*9/13/13*

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 E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
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: August 23, 2013

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Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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### Glossary:

TSL	tissue simulating liquid
NORM <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization $\varphi$	$\varphi$ rotation around probe axis
Polarization $\vartheta$	$\vartheta$ 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:

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

### Methods Applied and Interpretation of Parameters:

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

# Probe ES3DV2

## SN:3022

Manufactured: April 15, 2003  
Calibrated: August 22, 2013

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

## DASY/EASY - Parameters of Probe: ES3DV2 - SN:3022

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	1.00	1.04	0.99	± 10.1 %
DCP (mV) <sup>B</sup>	100.7	97.4	99.7	

### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB/ $\mu\text{V}$	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	178.6	±3.0 %
		Y	0.0	0.0	1.0		141.9	
		Z	0.0	0.0	1.0		134.7	

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

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

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

<sup>E</sup> 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: ES3DV2 - SN:3022

### Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	6.21	6.21	6.21	0.19	2.37	± 12.0 %
835	41.5	0.90	6.09	6.09	6.09	0.30	1.70	± 12.0 %
1750	40.1	1.37	5.19	5.19	5.19	0.65	1.23	± 12.0 %
1900	40.0	1.40	5.03	5.03	5.03	0.51	1.43	± 12.0 %
2450	39.2	1.80	4.36	4.36	4.36	0.51	1.51	± 12.0 %
2600	39.0	1.96	4.16	4.16	4.16	0.74	1.29	± 12.0 %

<sup>C</sup> 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.

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

## DASY/EASY - Parameters of Probe: ES3DV2 - SN:3022

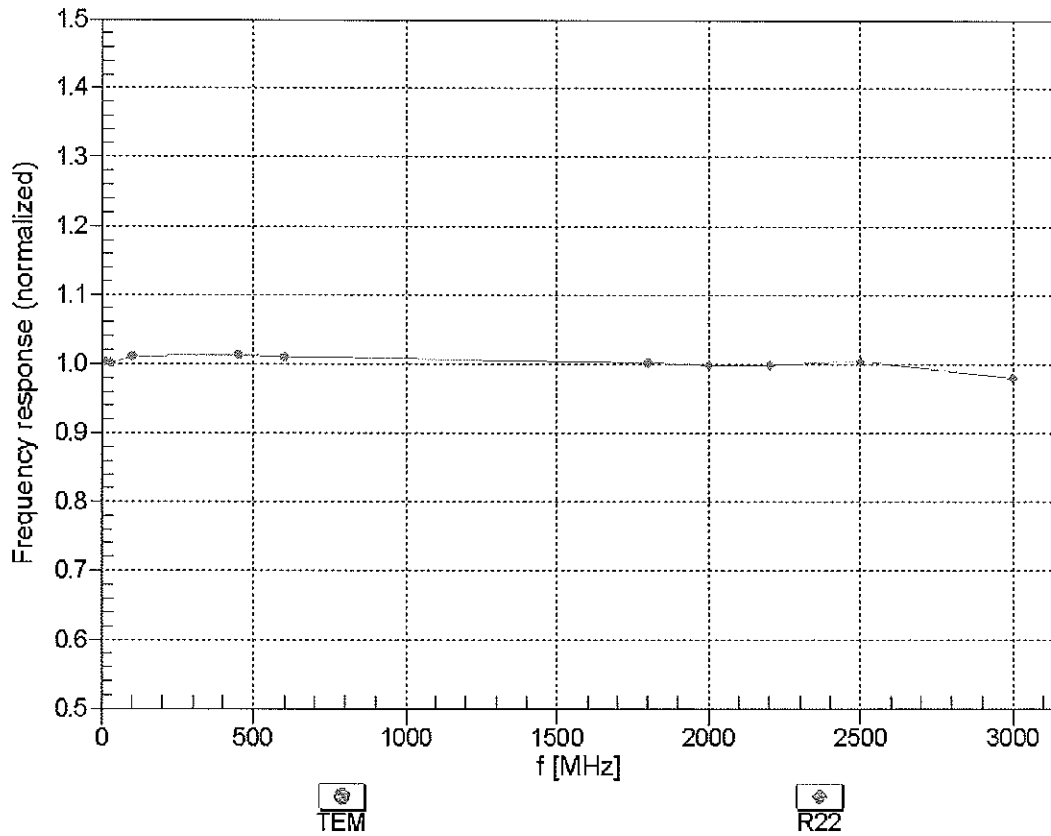
### Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	5.92	5.92	5.92	0.24	1.99	± 12.0 %
835	55.2	0.97	5.91	5.91	5.91	0.29	1.85	± 12.0 %
1750	53.4	1.49	4.75	4.75	4.75	0.52	1.52	± 12.0 %
1900	53.3	1.52	4.49	4.49	4.49	0.49	1.56	± 12.0 %
2450	52.7	1.95	4.01	4.01	4.01	0.70	1.02	± 12.0 %
2600	52.5	2.16	3.85	3.85	3.85	0.58	0.90	± 12.0 %

<sup>C</sup> 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.

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

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

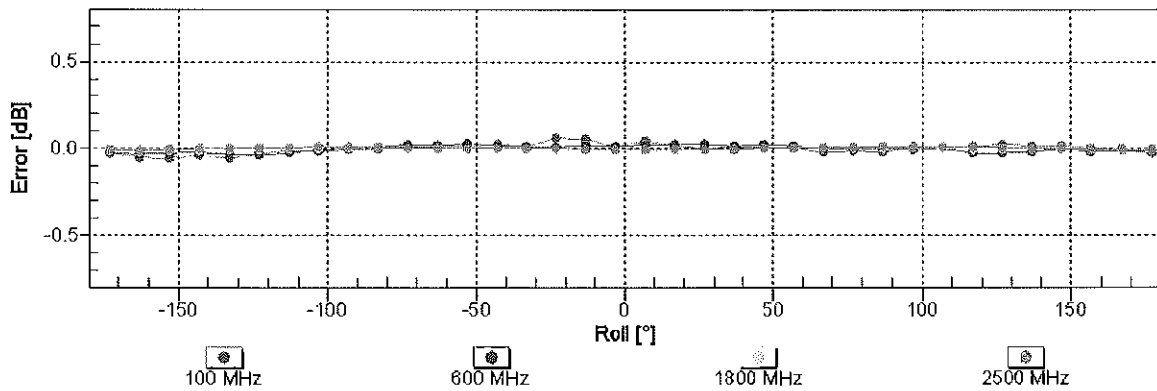
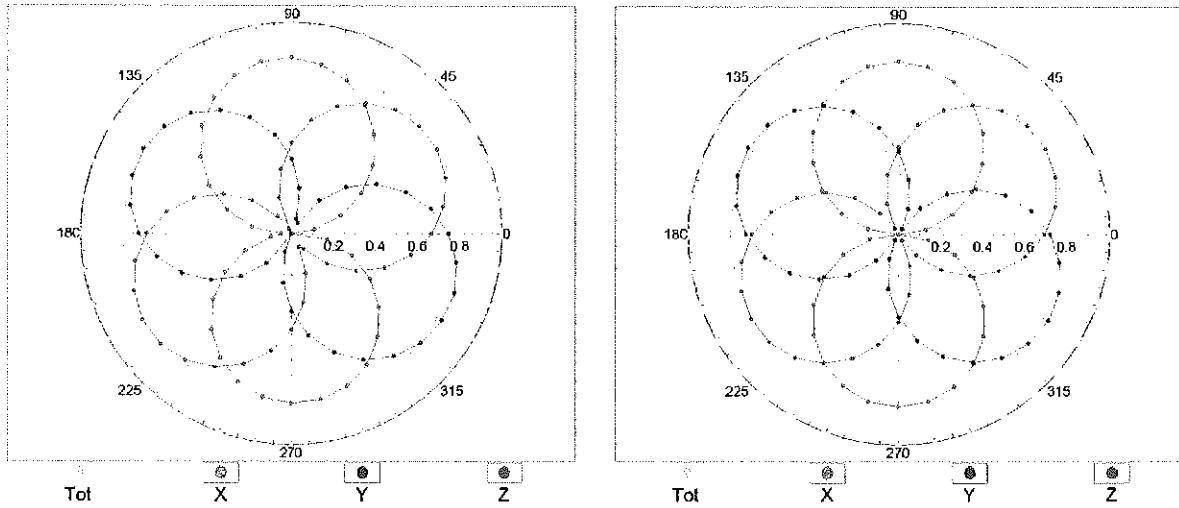


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

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

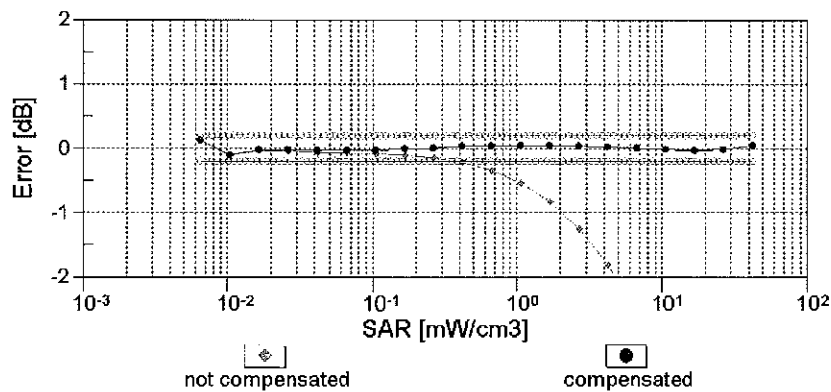
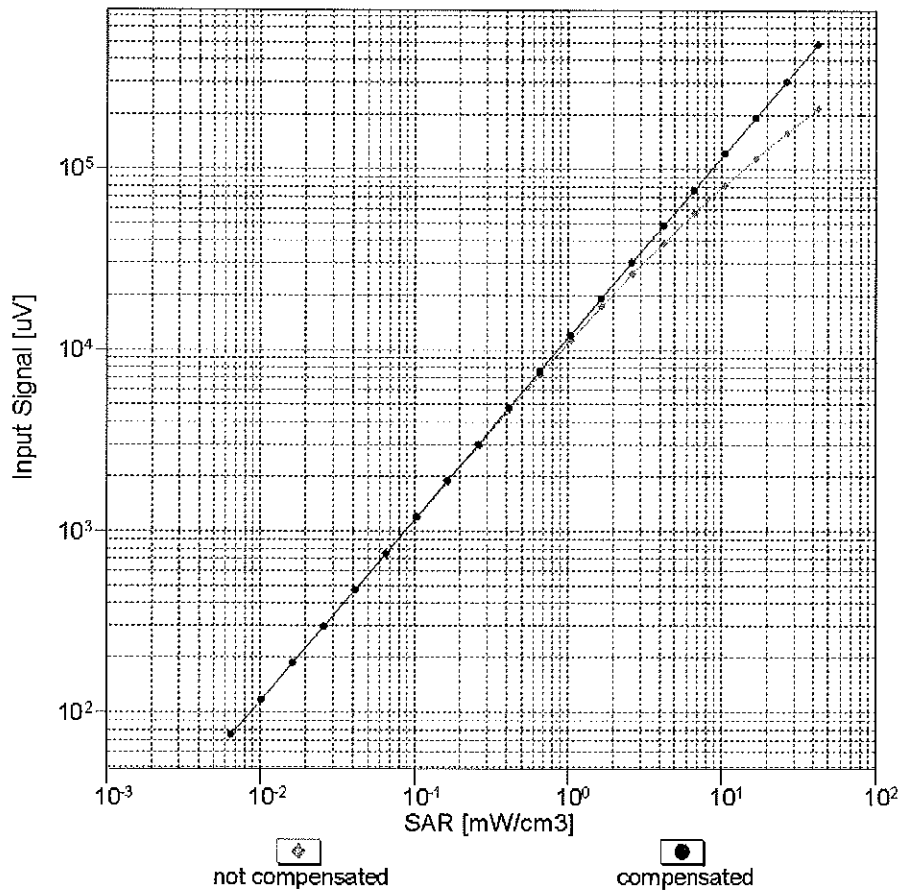
f=600 MHz,TEM

f=1800 MHz,R22



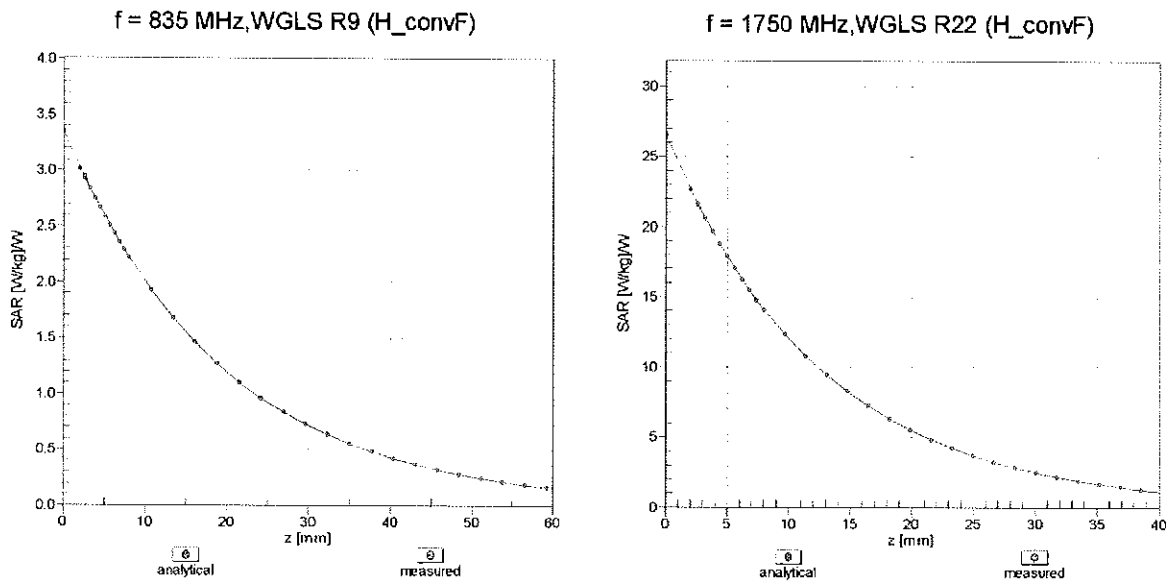
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

### Dynamic Range f(SAR<sub>head</sub>) (TEM cell , f = 900 MHz)

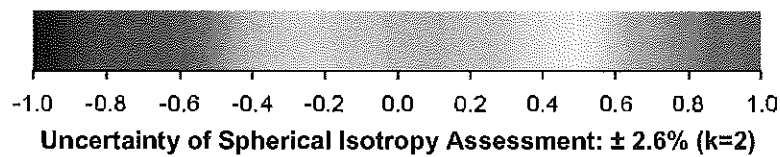
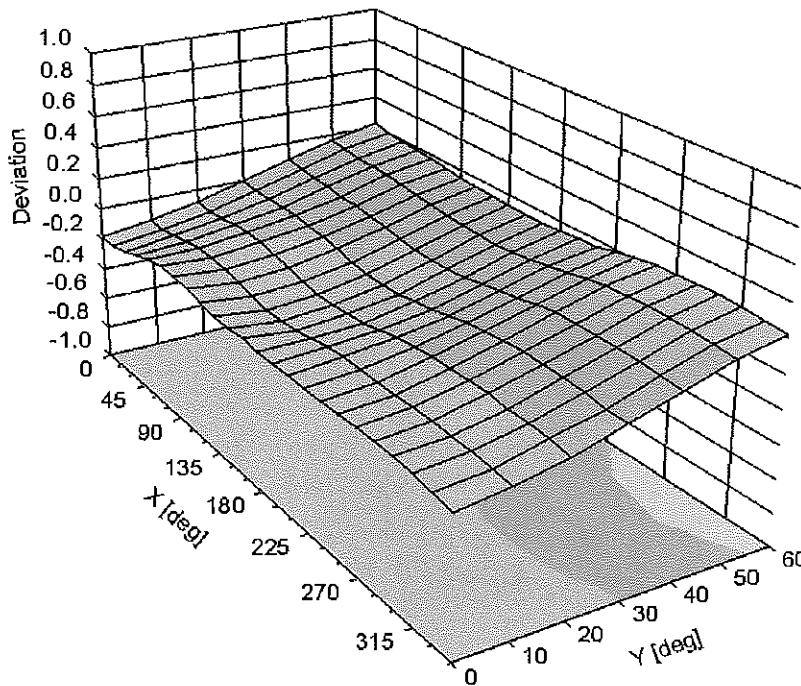


**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

# Conversion Factor Assessment



## Deviation from Isotropy in Liquid Error ( $\phi, \theta$ ), $f = 900$ MHz



## DASY/EASY - Parameters of Probe: ES3DV2 - SN:3022

### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-83.1
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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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **ES3-3213\_Apr13**

**CALIBRATION CERTIFICATE**

Object **ES3DV3 - SN:3213**

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

Calibration date: **April 29, 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)

✓  
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Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Dirce Iliev	Laboratory Technician	<i>D. Iliev</i>
Approved by:	Katja Pokovic	Technical Manager	<i>K. Pokovic</i>

Issued: April 29, 2013

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



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**Glossary:**

TSL	tissue simulating liquid
NORM <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization $\phi$	$\phi$ 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:**

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

# Probe ES3DV3

## SN:3213

Manufactured: October 14, 2008  
Calibrated: April 29, 2013

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

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3213

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	1.47	1.36	1.33	$\pm 10.1 \%$
DCP (mV) <sup>B</sup>	103.0	100.8	100.7	

### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB/ $\mu\text{V}$	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	171.2	$\pm 2.7 \%$
		Y	0.0	0.0	1.0		172.4	
		Z	0.0	0.0	1.0		169.5	

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%.

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

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

<sup>E</sup> 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:3213

### Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	6.54	6.54	6.54	0.45	1.49	± 12.0 %
835	41.5	0.90	6.30	6.30	6.30	0.31	1.77	± 12.0 %
1450	40.5	1.20	5.41	5.41	5.41	0.26	2.35	± 12.0 %
1750	40.1	1.37	5.22	5.22	5.22	0.79	1.18	± 12.0 %
1900	40.0	1.40	5.08	5.08	5.08	0.80	1.20	± 12.0 %
2450	39.2	1.80	4.49	4.49	4.49	0.79	1.28	± 12.0 %
2600	39.0	1.96	4.36	4.36	4.36	0.79	1.24	± 12.0 %

<sup>C</sup> 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.

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

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3213

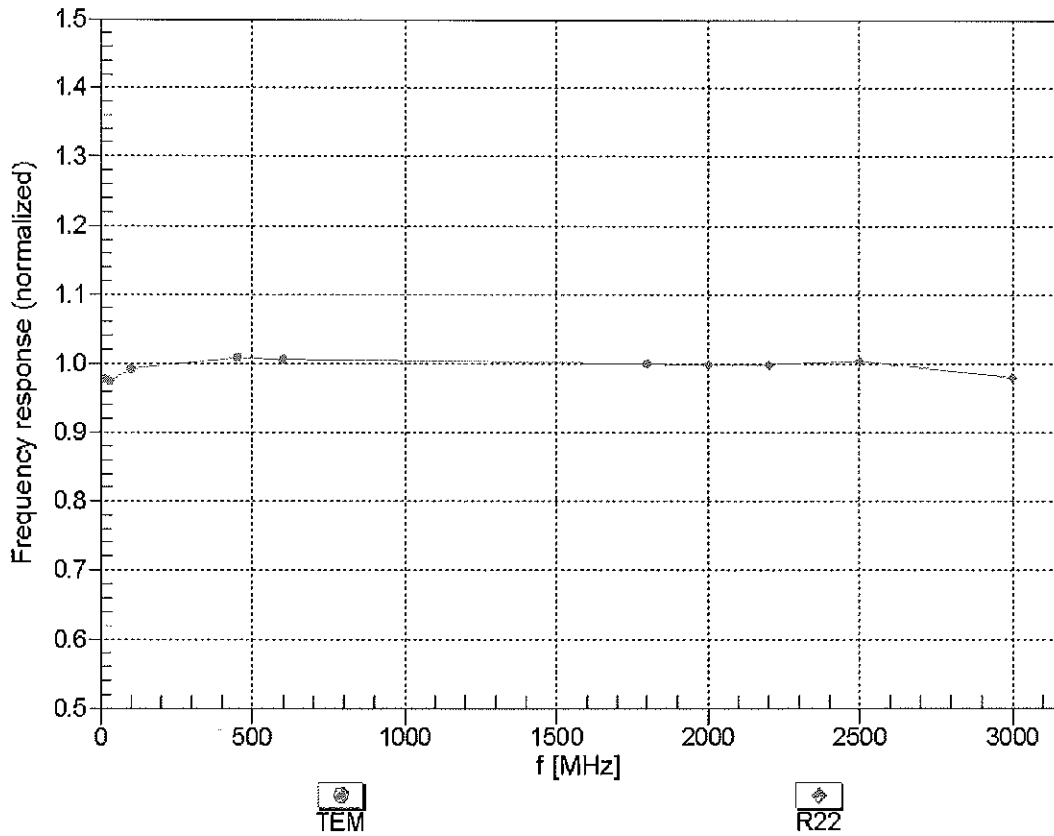
### Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	6.32	6.32	6.32	0.44	1.54	± 12.0 %
835	55.2	0.97	6.25	6.25	6.25	0.37	1.77	± 12.0 %
1450	54.0	1.30	5.28	5.28	5.28	0.57	1.42	± 12.0 %
1750	53.4	1.49	4.95	4.95	4.95	0.66	1.34	± 12.0 %
1900	53.3	1.52	4.73	4.73	4.73	0.55	1.51	± 12.0 %
2450	52.7	1.95	4.29	4.29	4.29	0.65	1.18	± 12.0 %
2600	52.5	2.16	4.11	4.11	4.11	0.60	0.87	± 12.0 %

<sup>C</sup> 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.

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

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

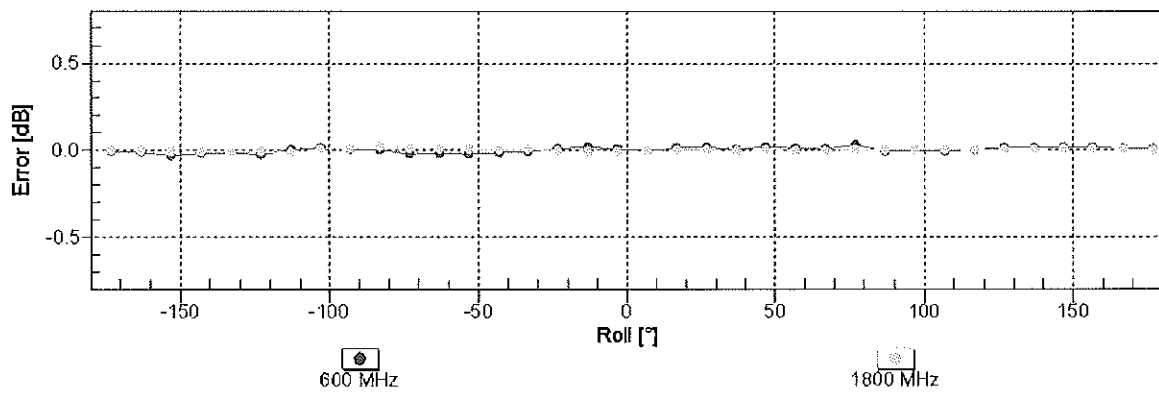
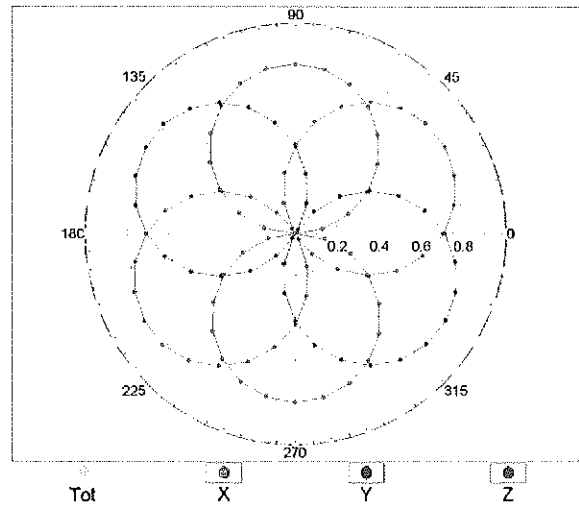
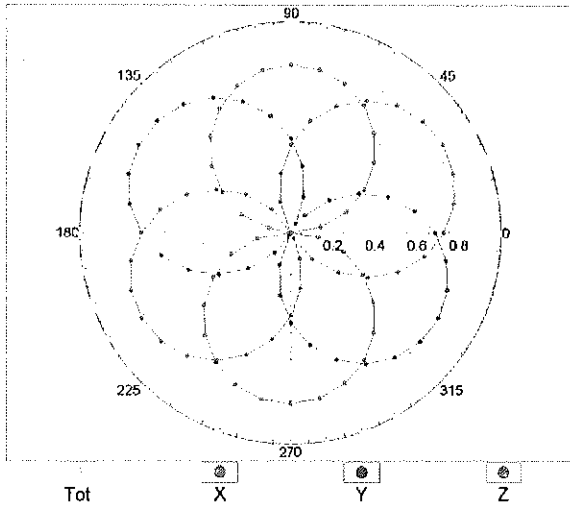


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

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

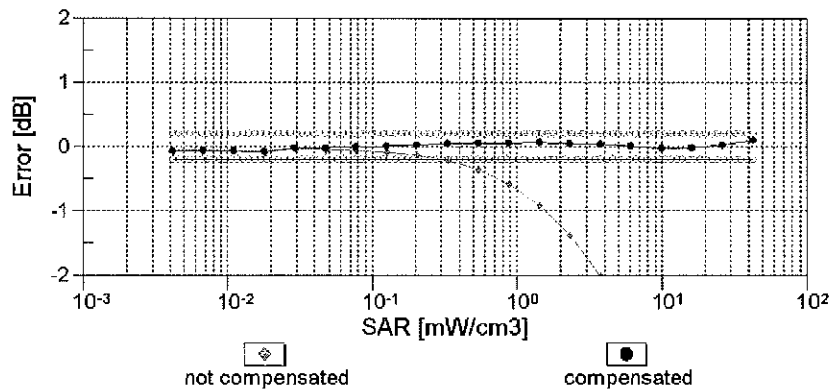
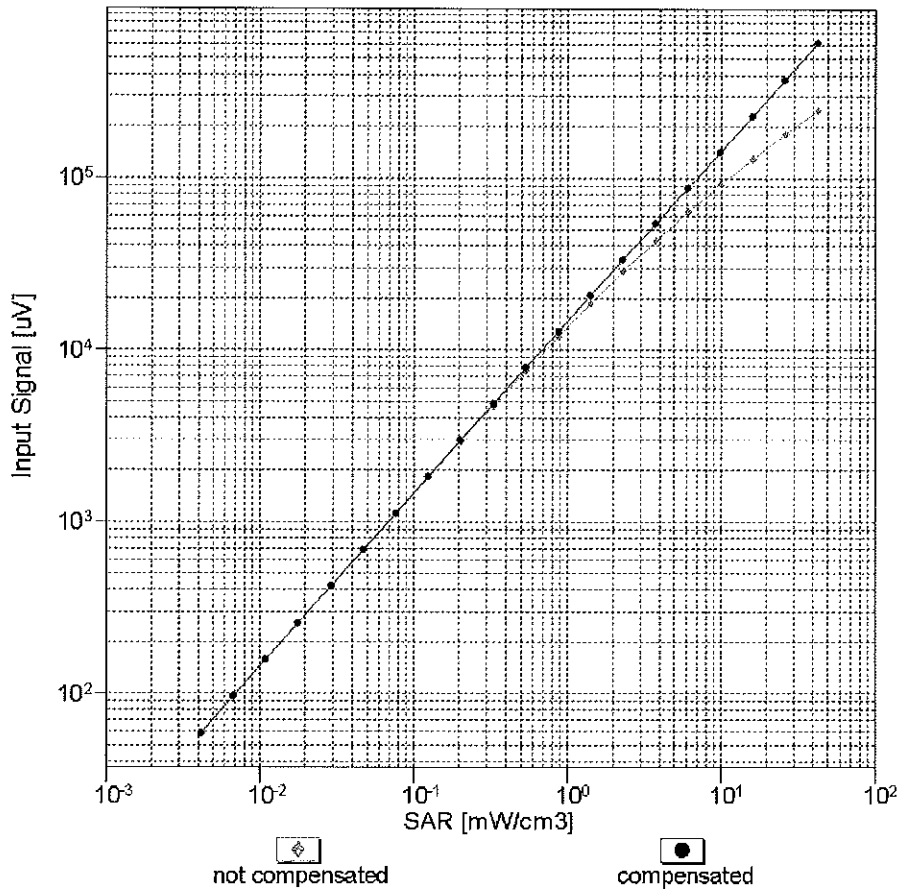
f=600 MHz,TEM

f=1800 MHz,R22



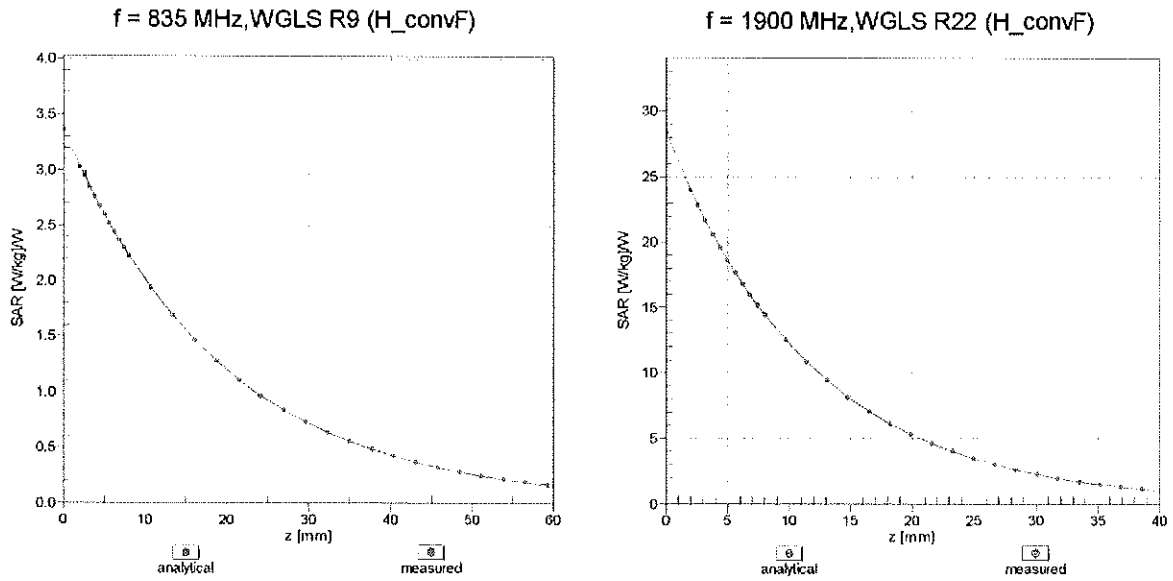
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

### Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell , $f = 900 \text{ MHz}$ )

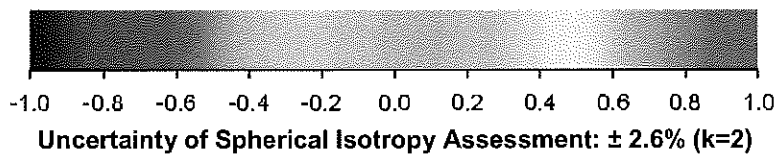
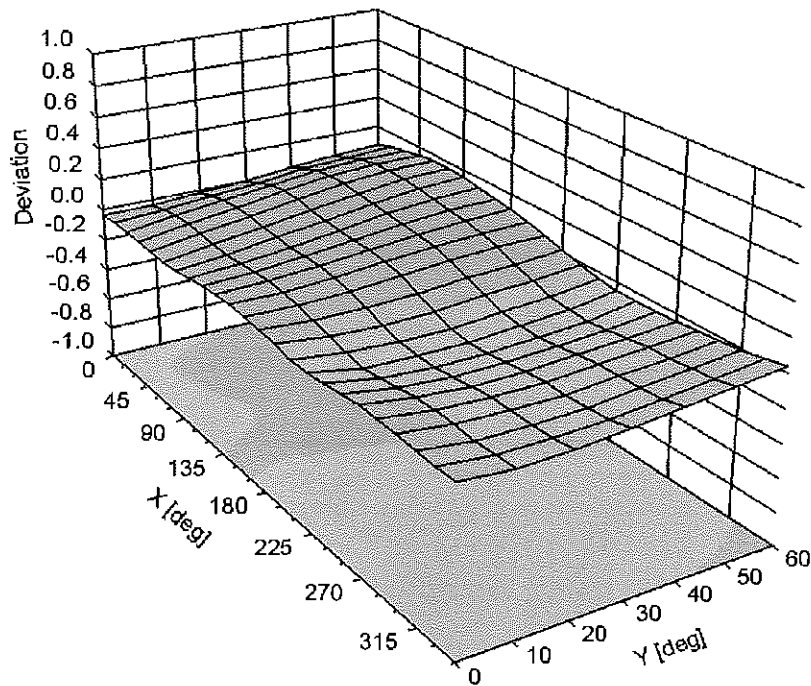


**Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )**

# Conversion Factor Assessment



## Deviation from Isotropy in Liquid Error ( $\phi, \theta$ ), f = 900 MHz



**DASY/EASY - Parameters of Probe: ES3DV3 - SN:3213****Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-33.1
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

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



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

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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: **ES3-3209\_Mar13**

**CALIBRATION CERTIFICATE**

Object **ES3DV3 - SN:3209**

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

Calibration date: **March 15, 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%.

*✓ KOK 3/22/13*

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	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
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:	Israe El-Naouq	Laboratory Technician	<i>Israe El-Naouq</i>
Approved by:	Katja Pokovic	Technical Manager	<i>Katja Pokovic</i>

Issued: March 15, 2013

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80242



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Accreditation No.: **SCS 108**

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**Glossary:**

TSL	tissue simulating liquid
NORM <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization $\varphi$	$\varphi$ rotation around probe axis
Polarization $\vartheta$	$\vartheta$ 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:**

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

# Probe ES3DV3

## SN:3209

Manufactured: October 14, 2008  
Calibrated: March 15, 2013

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

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	1.35	1.33	1.14	$\pm 10.1 \%$
DCP (mV) <sup>B</sup>	99.2	97.8	98.3	

### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	163.6	$\pm 3.5 \%$
		Y	0.0	0.0	1.0		170.3	
		Z	0.0	0.0	1.0		158.7	

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

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

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

<sup>E</sup> 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:3209

### Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	6.74	6.74	6.74	0.76	1.18	± 12.0 %
835	41.5	0.90	6.46	6.46	6.46	0.31	1.81	± 12.0 %
1750	40.1	1.37	5.39	5.39	5.39	0.80	1.21	± 12.0 %
1900	40.0	1.40	5.21	5.21	5.21	0.78	1.26	± 12.0 %
2450	39.2	1.80	4.57	4.57	4.57	0.65	1.43	± 12.0 %
2600	39.0	1.96	4.43	4.43	4.43	0.75	1.36	± 12.0 %

<sup>C</sup> 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.

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

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209

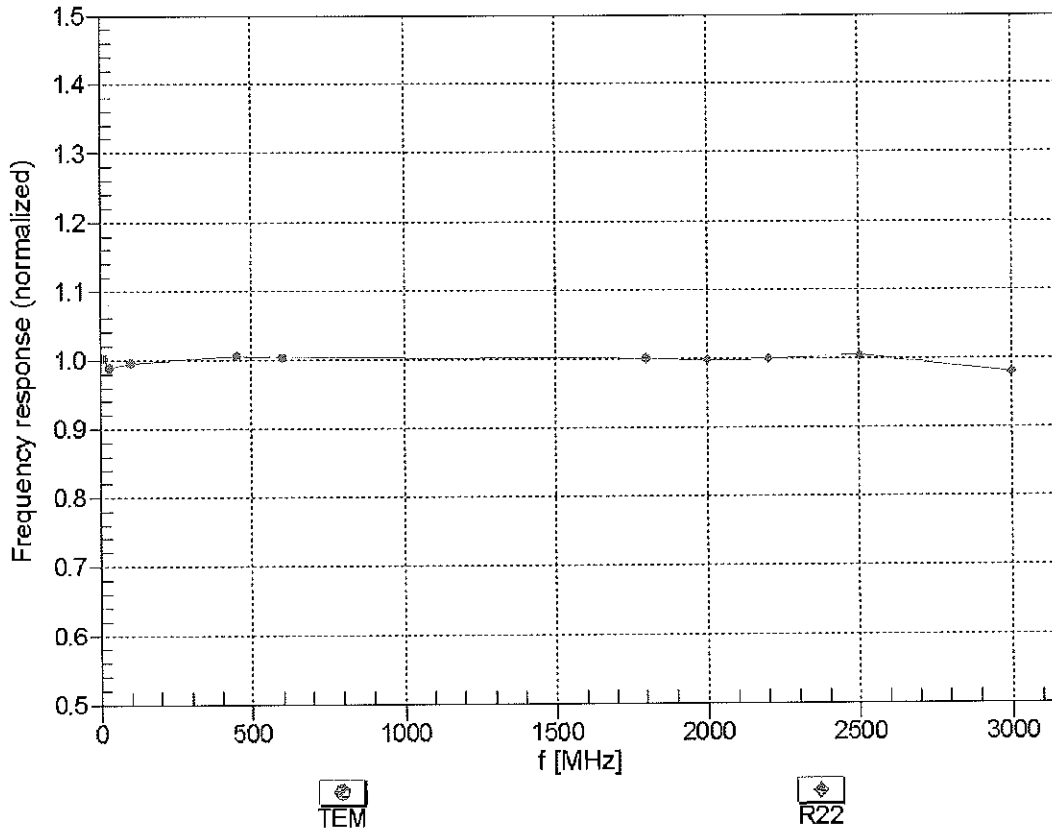
### Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	6.38	6.38	6.38	0.80	1.16	± 12.0 %
835	55.2	0.97	6.28	6.28	6.28	0.52	1.45	± 12.0 %
1750	53.4	1.49	5.03	5.03	5.03	0.58	1.45	± 12.0 %
1900	53.3	1.52	4.77	4.77	4.77	0.70	1.36	± 12.0 %
2450	52.7	1.95	4.34	4.34	4.34	0.80	1.15	± 12.0 %
2600	52.5	2.16	4.11	4.11	4.11	0.80	1.00	± 12.0 %

<sup>C</sup> 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.

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

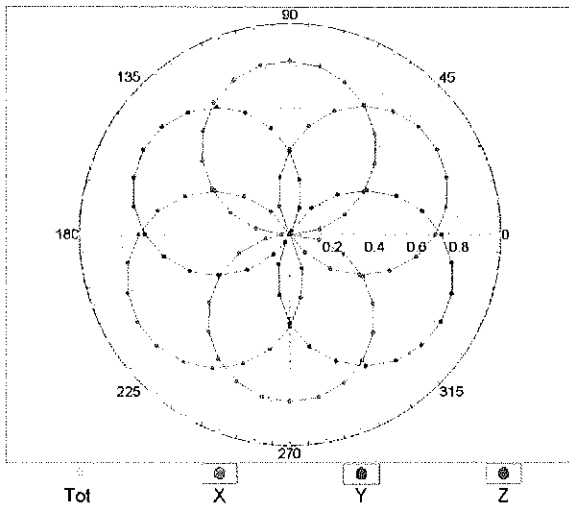
# Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



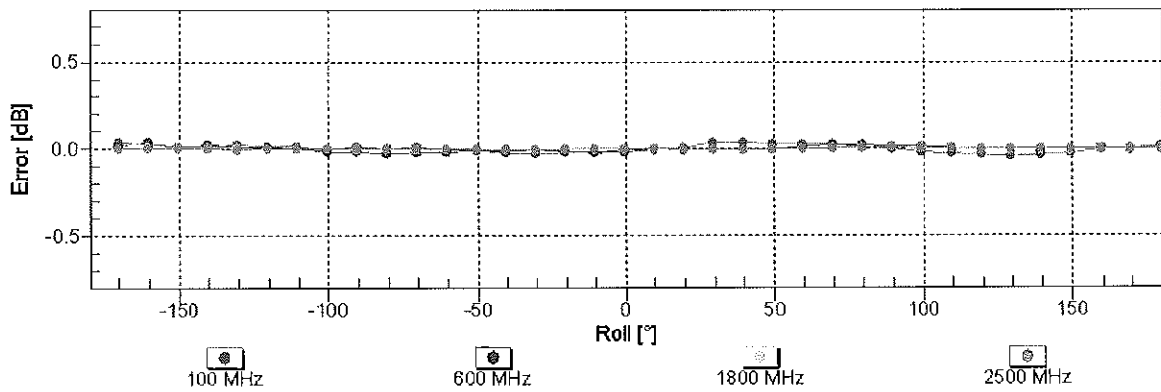
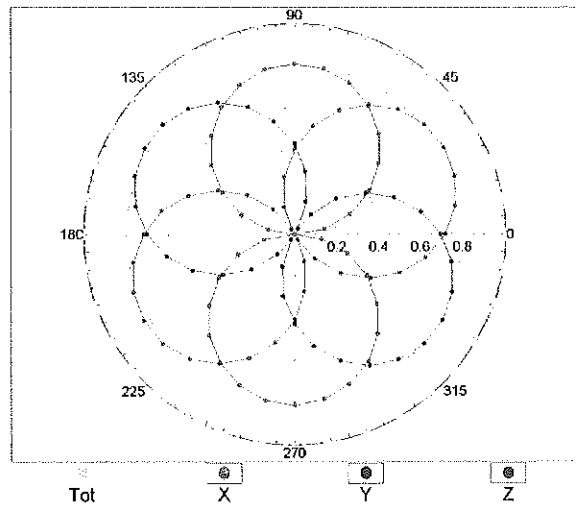
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

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

f=600 MHz,TEM

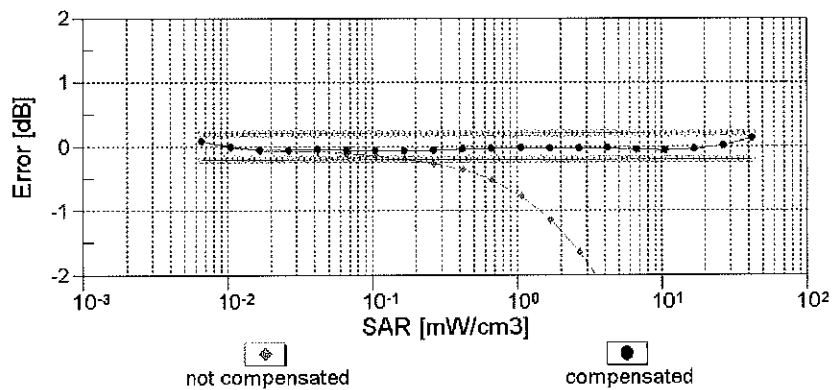
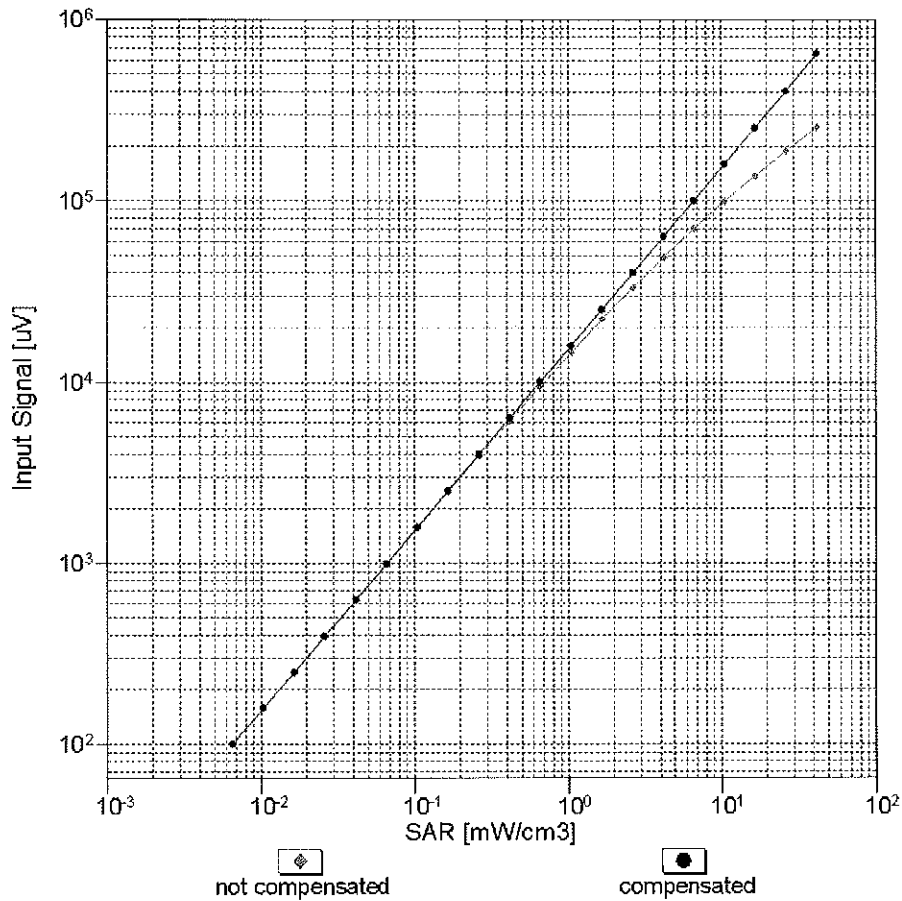


f=1800 MHz,R22



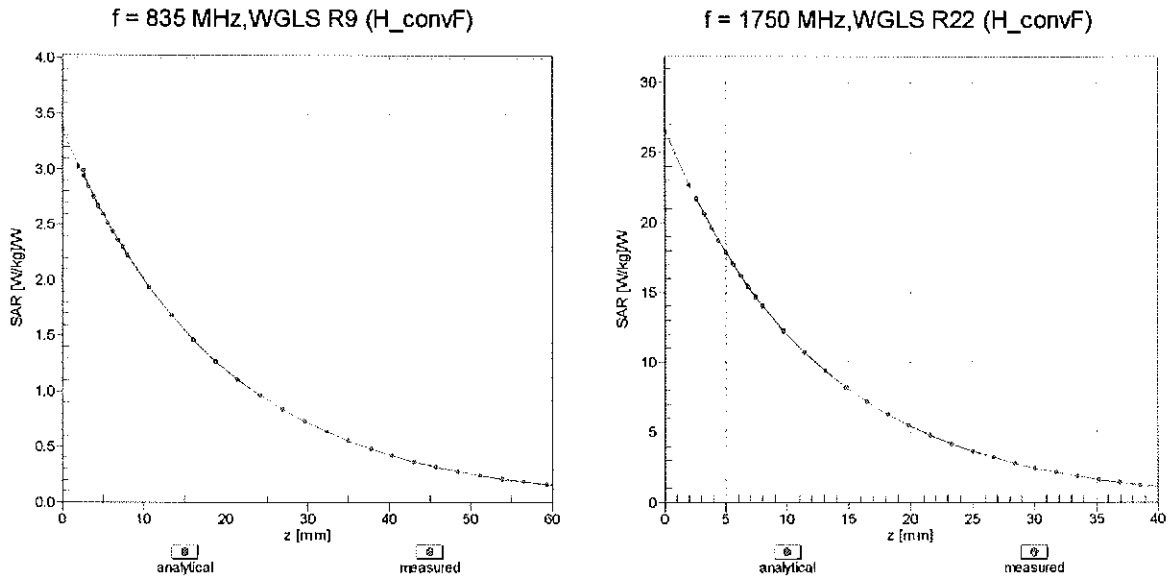
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)

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

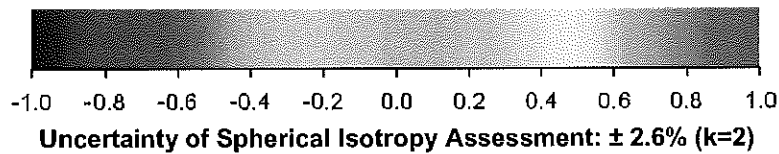
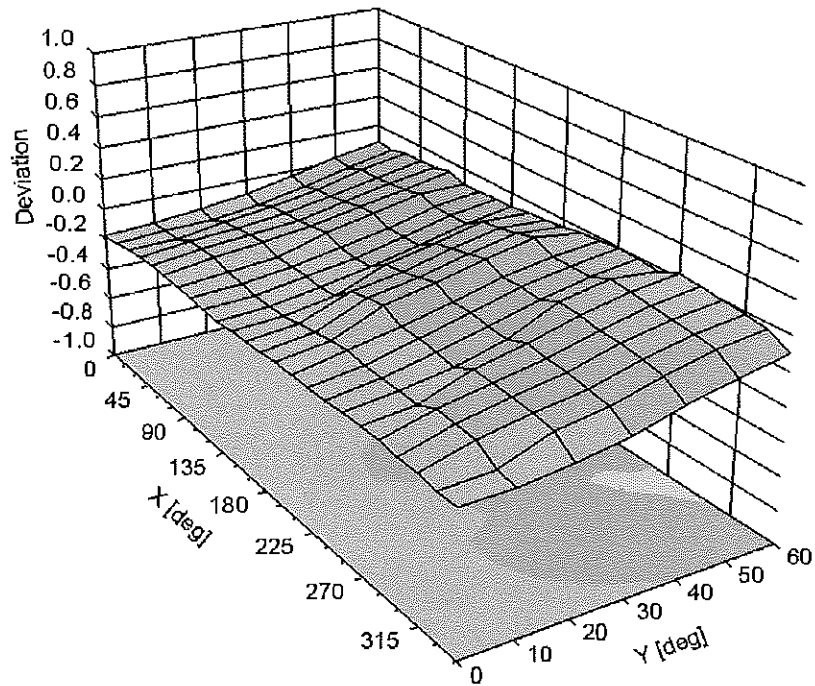


Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

# Conversion Factor Assessment



## Deviation from Isotropy in Liquid Error ( $\phi, \theta$ ), f = 900 MHz



**DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209****Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-40.6
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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Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **ES3-3263\_May13**

## CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3263**

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

Calibration date: **May 16, 2013**

*✓ KOK  
5/23/13*

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 E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	<i>Leif Klysner</i>
Approved by:	Katja Pokovic	Technical Manager	<i>Katja Pokovic</i>
			Issued: May 17, 2013

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**Glossary:**

TSL	tissue simulating liquid
NORM <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization 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:**

- NORM<sub>x,y,z</sub>: Assessed for E-field polarization θ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- NORM(f)<sub>x,y,z</sub> = NORM<sub>x,y,z</sub> \* frequency\_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP<sub>x,y,z</sub>: 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 NORM<sub>x,y,z</sub> \* 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 16, 2013

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 ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	1.21	1.25	1.12	$\pm 10.1 \%$
DCP (mV) <sup>B</sup>	101.2	100.2	103.7	

### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	156.5	$\pm 2.5 \%$
		Y	0.0	0.0	1.0		153.2	
		Z	0.0	0.0	1.0		147.2	

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

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

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

<sup>E</sup> 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) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	6.51	6.51	6.51	0.21	2.29	± 12.0 %
835	41.5	0.90	6.29	6.29	6.29	0.50	1.38	± 12.0 %
1750	40.1	1.37	5.30	5.30	5.30	0.45	1.54	± 12.0 %
1900	40.0	1.40	5.11	5.11	5.11	0.57	1.38	± 12.0 %
2450	39.2	1.80	4.47	4.47	4.47	0.59	1.49	± 12.0 %
2600	39.0	1.96	4.31	4.31	4.31	0.80	1.28	± 12.0 %

<sup>C</sup> 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.

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

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

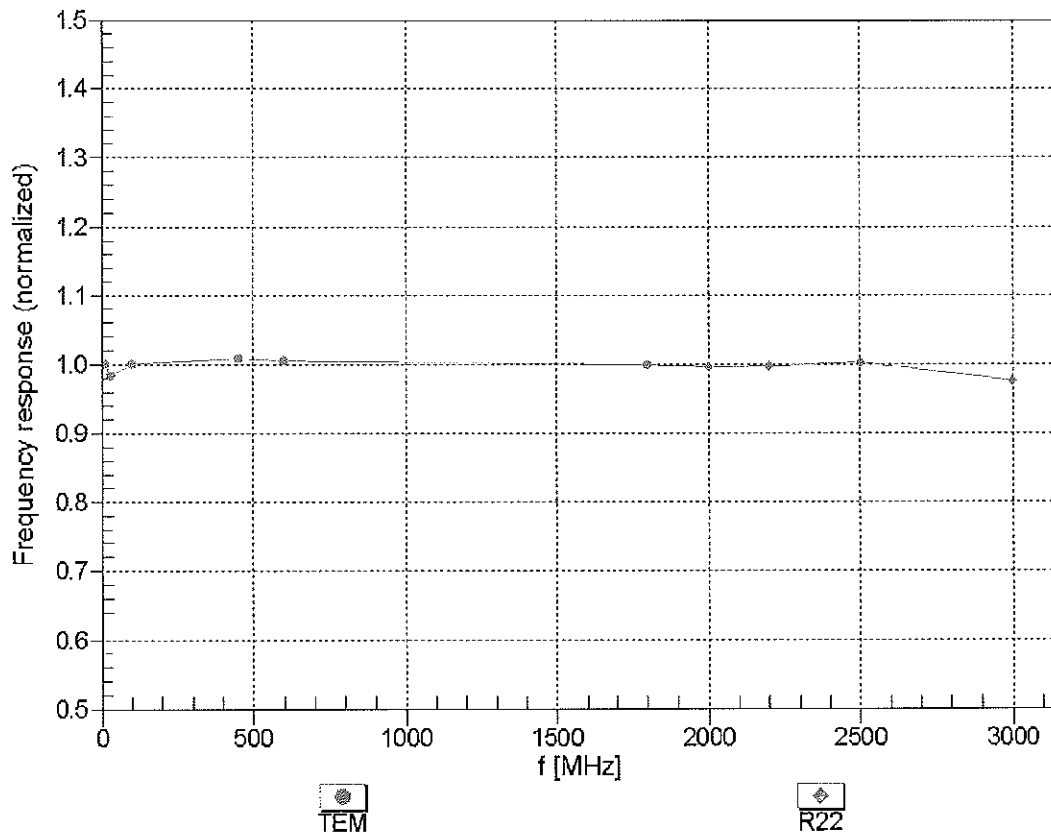
### Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	6.37	6.37	6.37	0.34	1.82	± 12.0 %
835	55.2	0.97	6.29	6.29	6.29	0.54	1.39	± 12.0 %
1750	53.4	1.49	5.01	5.01	5.01	0.72	1.27	± 12.0 %
1900	53.3	1.52	4.78	4.78	4.78	0.53	1.56	± 12.0 %
2450	52.7	1.95	4.33	4.33	4.33	0.80	1.14	± 12.0 %
2600	52.5	2.16	4.14	4.14	4.14	0.80	1.02	± 12.0 %

<sup>C</sup> 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.

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

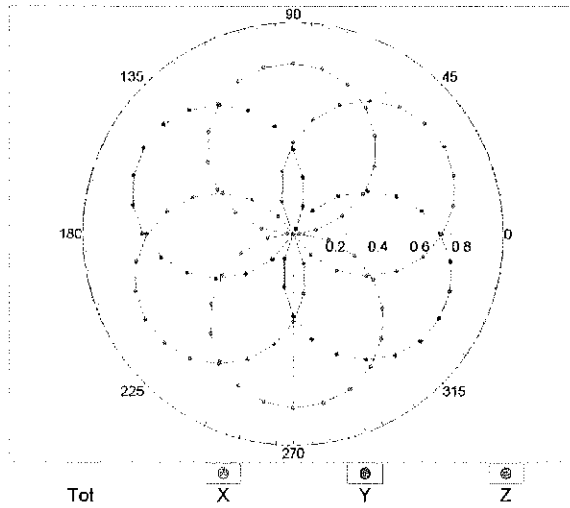
### Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



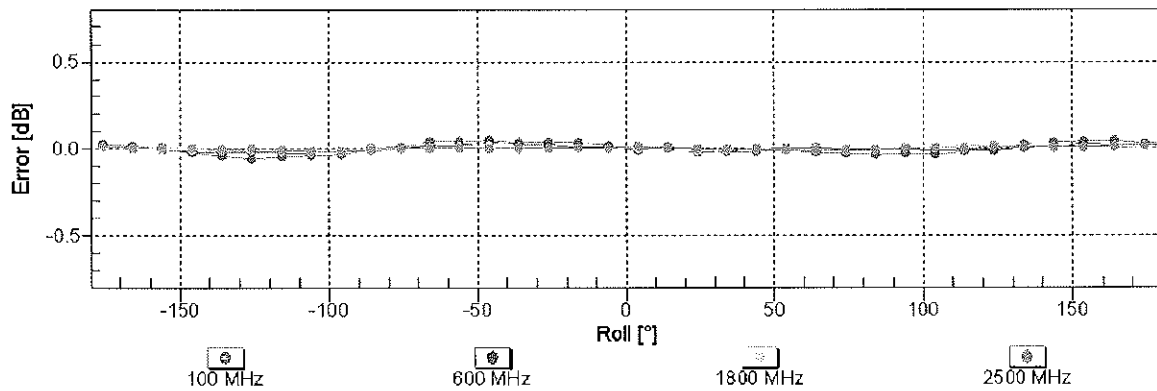
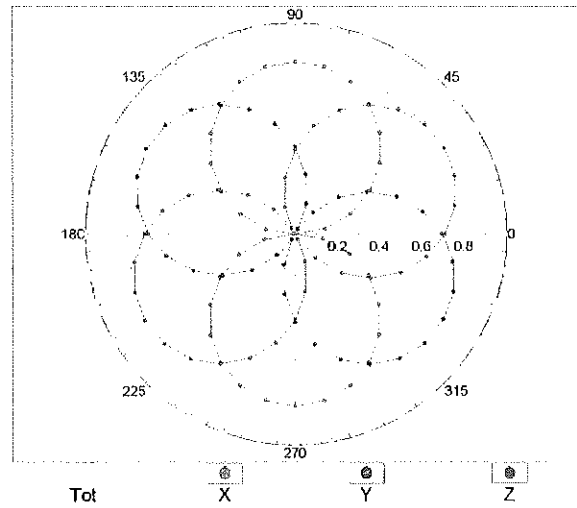
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

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

f=600 MHz,TEM

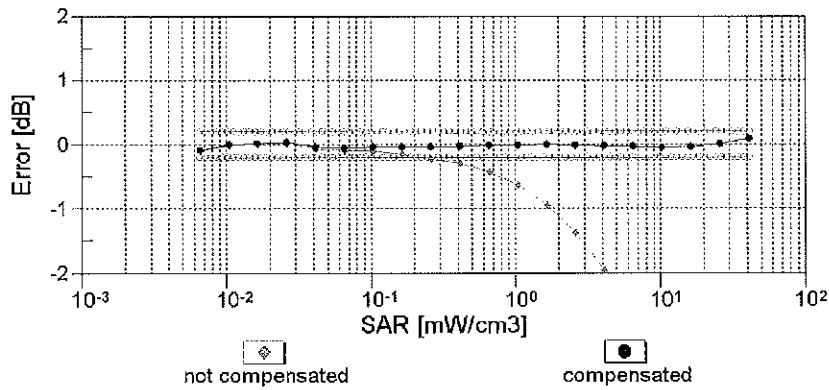
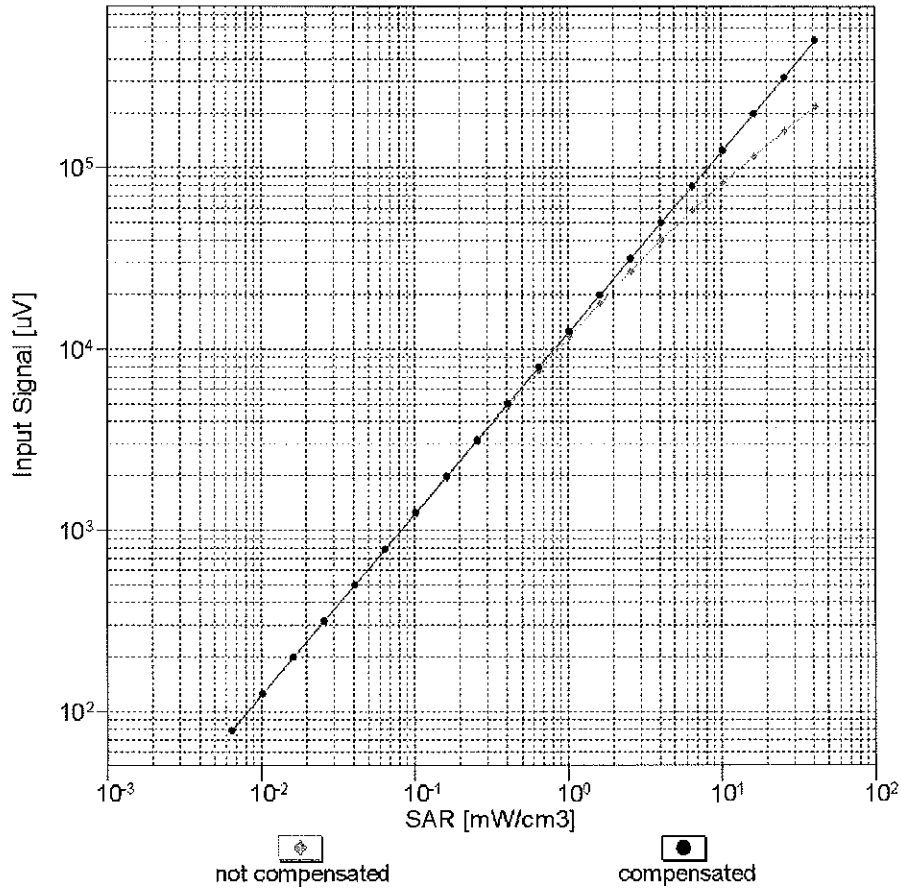


f=1800 MHz,R22



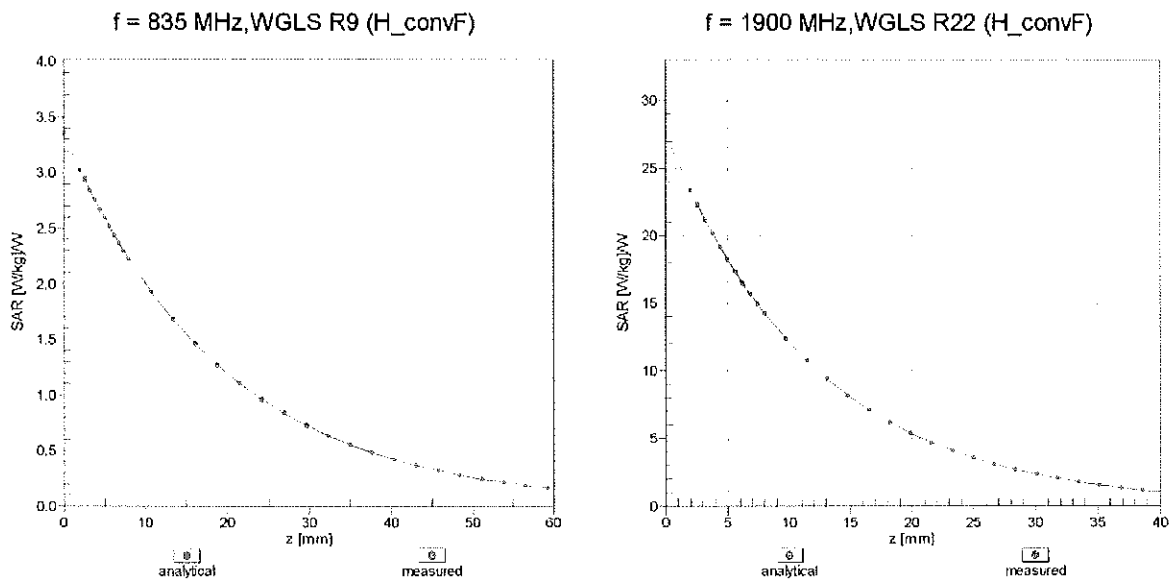
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)

### Dynamic Range f(SAR<sub>head</sub>) (TEM cell , f = 900 MHz)

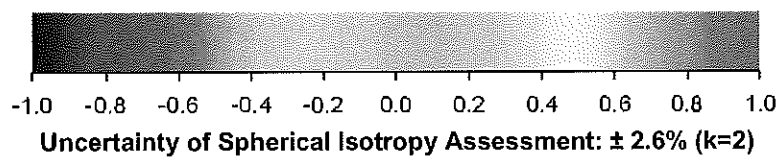
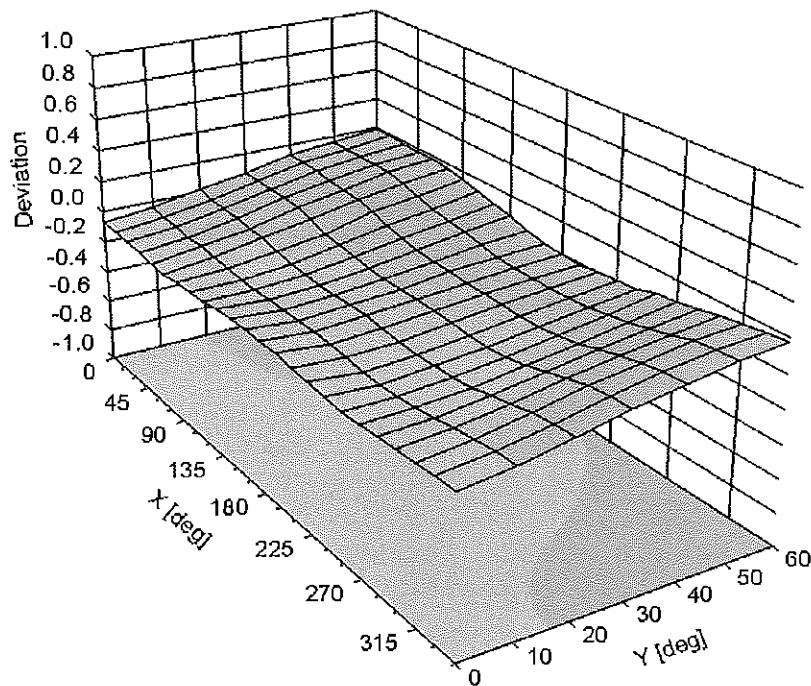


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

## Conversion Factor Assessment



## Deviation from Isotropy in Liquid Error ( $\phi, \theta$ ), f = 900 MHz



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

### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-116
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

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: **EX3-3914\_Oct13**

## CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3914**

Calibration procedure(s) **DIA CAL-01 v3, GA CAL-14 v4, GA CAL-23 v5, DIA CAL-25 v6  
Calibration procedure for dielectric E-field probes**

Calibration date: **October 23, 2013** VCC  
11/20/2013

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	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	4-Sep-13 (No. DAE4-660_Sep13)	Sep-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

	<b>Name</b>	<b>Function</b>	<b>Signature</b>
Calibrated by:	<b>Leif Klysner</b>	<b>Laboratory Technician</b>	
Approved by:	<b>Katja Pokovic</b>	<b>Technical Manager</b>	
			Issued: October 25, 2013

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

PCT # 81072



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**Glossary:**

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

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

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

**Methods Applied and Interpretation of Parameters:**

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

# Probe EX3DV4

## SN:3914

Manufactured: December 18, 2012  
Calibrated: October 23, 2013

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

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3914

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	0.47	0.49	0.51	$\pm 10.1 \%$
DCP (mV) <sup>B</sup>	99.2	98.9	98.2	

### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	158.3	$\pm 3.0 \%$
		Y	0.0	0.0	1.0		154.6	
		Z	0.0	0.0	1.0		170.8	
10010- CAA	SAR Validation (Square, 100ms, 10ms)	X	0.71	53.3	6.1	10.00	48.4	$\pm 2.5 \%$
		Y	2.43	67.0	13.8		39.9	
		Z	4.18	68.7	13.8		45.7	
10011- CAA	UMTS-FDD (WCDMA)	X	3.05	64.4	16.5	2.91	122.4	$\pm 0.5 \%$
		Y	3.31	66.5	18.2		123.5	
		Z	3.34	66.3	17.8		136.6	
10012- CAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	X	2.49	64.8	16.1	1.87	120.6	$\pm 0.5 \%$
		Y	2.94	68.6	18.7		123.6	
		Z	2.63	65.9	17.0		135.4	
10021- DAA	GSM-FDD (TDMA, GMSK)	X	1.52	61.5	10.9	9.39	83.6	$\pm 1.2 \%$
		Y	2.22	67.4	15.0		116.0	
		Z	2.47	66.8	14.7		95.9	
10023- DAA	GPRS-FDD (TDMA, GMSK, TN 0)	X	1.73	63.3	11.9	9.57	81.5	$\pm 1.7 \%$
		Y	2.11	66.2	14.2		111.8	
		Z	2.76	69.0	16.0		93.6	
10024- DAA	GPRS-FDD (TDMA, GMSK, TN 0-1)	X	1.34	62.1	9.4	6.56	121.0	$\pm 1.2 \%$
		Y	4.24	78.6	17.9		130.0	
		Z	2.91	70.7	14.9		141.4	
10027- DAA	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	X	1.25	63.5	9.7	4.80	143.5	$\pm 1.4 \%$
		Y	1.59	66.9	12.2		149.7	
		Z	2.98	71.5	14.0		123.3	
10028- DAA	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	X	0.51	58.3	7.4	3.55	113.4	$\pm 1.2 \%$
		Y	25.43	100.0	22.6		121.3	
		Z	38.67	97.5	20.6		133.3	
10032- CAA	IEEE 802.15.1 Bluetooth (GFSK, DH5)	X	0.28	58.6	5.3	1.16	134.7	$\pm 0.9 \%$
		Y	65.75	99.6	18.6		141.3	
		Z	0.20	55.6	4.1		112.1	
10039- CAA	CDMA2000 (1xRTT, RC1)	X	4.33	64.6	17.4	4.57	113.8	$\pm 0.7 \%$
		Y	4.55	66.0	18.6		120.8	
		Z	4.85	66.2	18.4		135.9	
10062- CAA	IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps)	X	9.83	67.6	20.7	8.68	109.0	$\pm 2.5 \%$
		Y	10.06	68.4	21.5		118.2	
		Z	10.66	69.2	21.7		134.0	

10081-CAA	CDMA2000 (1xRTT, RC3)	X	3.59	63.9	16.9	3.97	113.6	±0.7 %
		Y	3.84	65.6	18.2		119.6	
		Z	3.95	65.4	17.8		134.5	
10098-CAA	UMTS-FDD (HSUPA, Subtest 2)	X	4.41	65.2	17.3	3.98	126.0	±0.7 %
		Y	4.73	66.9	18.6		132.5	
		Z	4.51	65.5	17.7		105.6	
10100-CAB	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	6.26	66.2	18.6	5.67	130.5	±1.2 %
		Y	6.61	67.7	19.8		139.3	
		Z	6.21	66.0	18.7		107.7	
10108-CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	6.13	65.8	18.6	5.80	126.3	±1.2 %
		Y	6.40	67.1	19.6		135.6	
		Z	6.10	65.5	18.5		107.4	
10110-CAB	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK)	X	5.78	65.3	18.3	5.75	123.1	±1.2 %
		Y	5.97	66.3	19.2		131.5	
		Z	5.86	65.3	18.4		104.9	
10114-CAA	IEEE 802.11n (HT Greenfield, 13.5 Mbps, BPSK)	X	9.92	67.7	20.3	8.10	115.7	±2.5 %
		Y	10.25	68.7	21.2		126.8	
		Z	10.71	69.4	21.3		146.0	
10117-CAA	IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK)	X	9.95	67.8	20.3	8.07	116.6	±2.5 %
		Y	10.26	68.7	21.1		128.3	
		Z	10.70	69.4	21.3		146.9	
10151-CAB	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	7.19	67.3	21.5	9.28	145.0	±2.2 %
		Y	7.40	68.3	22.4		110.8	
		Z	7.79	68.4	22.0		128.0	
10154-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	5.79	65.3	18.3	5.75	124.2	±1.2 %
		Y	6.03	66.5	19.4		131.9	
		Z	6.29	66.9	19.3		149.7	
10160-CAB	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK)	X	6.23	65.9	18.6	5.82	128.3	±1.2 %
		Y	6.51	67.2	19.7		136.9	
		Z	6.24	65.7	18.6		107.3	
10169-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	4.83	66.0	18.9	5.73	147.5	±1.2 %
		Y	4.72	65.8	19.2		113.8	
		Z	5.03	66.1	19.1		129.7	
10172-CAB	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	5.83	69.2	22.8	9.21	149.9	±1.9 %
		Y	5.81	69.4	23.4		120.3	
		Z	6.38	70.0	23.2		137.2	
10175-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	4.86	66.1	18.9	5.72	149.8	±1.2 %
		Y	4.72	65.8	19.2		113.3	
		Z	5.09	66.4	19.1		126.0	
10181-CAB	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	X	4.83	66.0	18.9	5.72	146.3	±1.2 %
		Y	4.69	65.6	19.1		112.2	
		Z	5.02	66.1	19.0		125.1	
10193-CAA	IEEE 802.11n (HT Greenfield, 6.5 Mbps, BPSK)	X	9.51	67.4	20.2	8.09	108.6	±2.5 %
		Y	9.72	68.1	20.9		118.2	
		Z	10.30	68.9	21.1		135.0	

10196-CAA	IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK)	X	9.52	67.4	20.2	8.10	111.6	±2.5 %
		Y	9.79	68.3	21.1		121.3	
		Z	10.30	68.9	21.2		139.2	
10219-CAA	IEEE 802.11n (HT Mixed, 7.2 Mbps, BPSK)	X	9.47	67.4	20.2	8.03	111.8	±2.2 %
		Y	9.67	68.3	21.0		120.0	
		Z	10.20	68.9	21.1		138.0	
10222-CAA	IEEE 802.11n (HT Mixed, 15 Mbps, BPSK)	X	9.96	67.9	20.4	8.06	118.4	±2.5 %
		Y	10.25	68.8	21.2		128.2	
		Z	10.65	69.3	21.3		144.5	
10225-CAA	UMTS-FDD (HSPA+)	X	6.96	66.7	18.9	5.97	140.0	±1.4 %
		Y	7.23	67.9	20.0		148.9	
		Z	7.03	66.4	18.9		115.6	
10237-CAB	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	5.51	67.5	21.8	9.21	114.2	±1.9 %
		Y	5.82	69.4	23.4		123.0	
		Z	6.49	70.6	23.6		140.2	
10252-CAB	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	6.83	67.1	21.4	9.24	136.6	±1.9 %
		Y	7.30	69.4	23.2		147.3	
		Z	7.36	68.1	22.0		117.5	
10267-CAB	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	7.26	67.5	21.6	9.30	142.7	±1.9 %
		Y	7.44	68.4	22.4		110.5	
		Z	7.84	68.7	22.2		122.6	
10274-CAA	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.10)	X	5.86	66.2	18.2	4.87	135.4	±0.9 %
		Y	6.12	67.5	19.2		142.3	
		Z	5.91	65.9	18.2		107.6	
10275-CAA	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.4)	X	4.17	64.8	17.3	3.96	115.6	±0.7 %
		Y	4.42	66.4	18.5		124.6	
		Z	4.47	66.0	18.0		132.6	
10291-AAA	CDMA2000, RC3, SO55, Full Rate	X	3.36	64.7	17.1	3.46	109.4	±0.5 %
		Y	3.55	66.2	18.3		118.2	
		Z	3.60	65.6	17.7		120.9	
10292-AAA	CDMA2000, RC3, SO32, Full Rate	X	3.34	64.9	17.2	3.39	110.1	±0.5 %
		Y	3.57	66.7	18.5		121.0	
		Z	3.54	65.6	17.7		123.9	
10297-AAA	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	6.14	65.8	18.6	5.81	125.1	±1.2 %
		Y	6.44	67.2	19.7		135.7	
		Z	6.52	67.0	19.3		142.2	
10311-AAA	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK)	X	6.76	66.6	19.1	6.06	131.8	±1.4 %
		Y	7.03	67.8	20.0		142.5	
		Z	7.15	67.7	19.7		148.6	
10315-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 96pc duty cycle)	X	2.42	64.6	16.1	1.71	116.8	±0.5 %
		Y	3.00	69.3	19.0		126.9	
		Z	2.61	66.3	17.2		128.2	
10317-AAA	IEEE 802.11a WiFi 5 GHz (OFDM, 6 Mbps, 96pc duty cycle)	X	9.71	67.6	20.5	8.36	111.7	±2.5 %
		Y	9.99	68.6	21.4		122.2	
		Z	10.38	68.9	21.3		129.5	

10400-AAA	IEEE 802.11ac WiFi (20MHz, 64-QAM, 99pc duty cycle)	X	9.83	67.8	20.6	8.37	112.9	±2.5 %
		Y	10.09	68.7	21.4		123.9	
		Z	10.48	68.9	21.3		130.5	
10402-AAA	IEEE 802.11ac WiFi (80MHz, 64-QAM, 99pc duty cycle)	X	10.61	68.3	20.7	8.53	121.1	±2.5 %
		Y	11.25	70.0	21.9		135.4	
		Z	11.15	69.4	21.4		137.4	
10403-AAA	CDMA2000 (1xEV-DO, Rev. 0)	X	4.51	67.4	17.8	3.76	119.2	±0.5 %
		Y	4.91	69.5	19.3		128.3	
		Z	4.84	67.5	18.1		135.4	
10404-AAA	CDMA2000 (1xEV-DO, Rev. A)	X	4.51	67.7	18.0	3.77	117.4	±0.5 %
		Y	4.92	69.8	19.5		125.4	
		Z	4.71	67.3	18.0		131.9	

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

<sup>A</sup> The uncertainties of NormX,Y,Z do not affect the  $E^2$ -field uncertainty inside TSL (see Pages 8 and 9).

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

<sup>E</sup> 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:3914

### Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct. (k=2)
750	41.9	0.89	9.70	9.70	9.70	0.34	1.01	± 12.0 %
835	41.5	0.90	9.34	9.34	9.34	0.67	0.67	± 12.0 %
1750	40.1	1.37	7.99	7.99	7.99	0.79	0.56	± 12.0 %
1900	40.0	1.40	7.69	7.69	7.69	0.80	0.58	± 12.0 %
2450	39.2	1.80	6.95	6.95	6.95	0.41	0.77	± 12.0 %
2600	39.0	1.96	6.79	6.79	6.79	0.40	0.82	± 12.0 %
5200	36.0	4.66	4.99	4.99	4.99	0.30	1.80	± 13.1 %
5300	35.9	4.76	4.82	4.82	4.82	0.30	1.80	± 13.1 %
5500	35.6	4.96	4.55	4.55	4.55	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.37	4.37	4.37	0.35	1.80	± 13.1 %
5800	35.3	5.27	4.52	4.52	4.52	0.35	1.80	± 13.1 %

<sup>C</sup> 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.

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

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

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3914

### Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct. (k=2)
750	55.5	0.96	9.39	9.39	9.39	0.63	0.74	± 12.0 %
835	55.2	0.97	9.31	9.31	9.31	0.56	0.76	± 12.0 %
1750	53.4	1.49	7.89	7.89	7.89	0.32	1.03	± 12.0 %
1900	53.3	1.52	7.51	7.51	7.51	0.51	0.76	± 12.0 %
2450	52.7	1.95	7.02	7.02	7.02	0.80	0.50	± 12.0 %
2600	52.5	2.16	6.81	6.81	6.81	0.80	0.50	± 12.0 %
5200	49.0	5.30	4.52	4.52	4.52	0.35	1.90	± 13.1 %
5300	48.9	5.42	4.32	4.32	4.32	0.35	1.90	± 13.1 %
5500	48.6	5.65	4.07	4.07	4.07	0.35	1.90	± 13.1 %
5600	48.5	5.77	3.97	3.97	3.97	0.35	1.90	± 13.1 %
5800	48.2	6.00	4.14	4.14	4.14	0.40	1.90	± 13.1 %

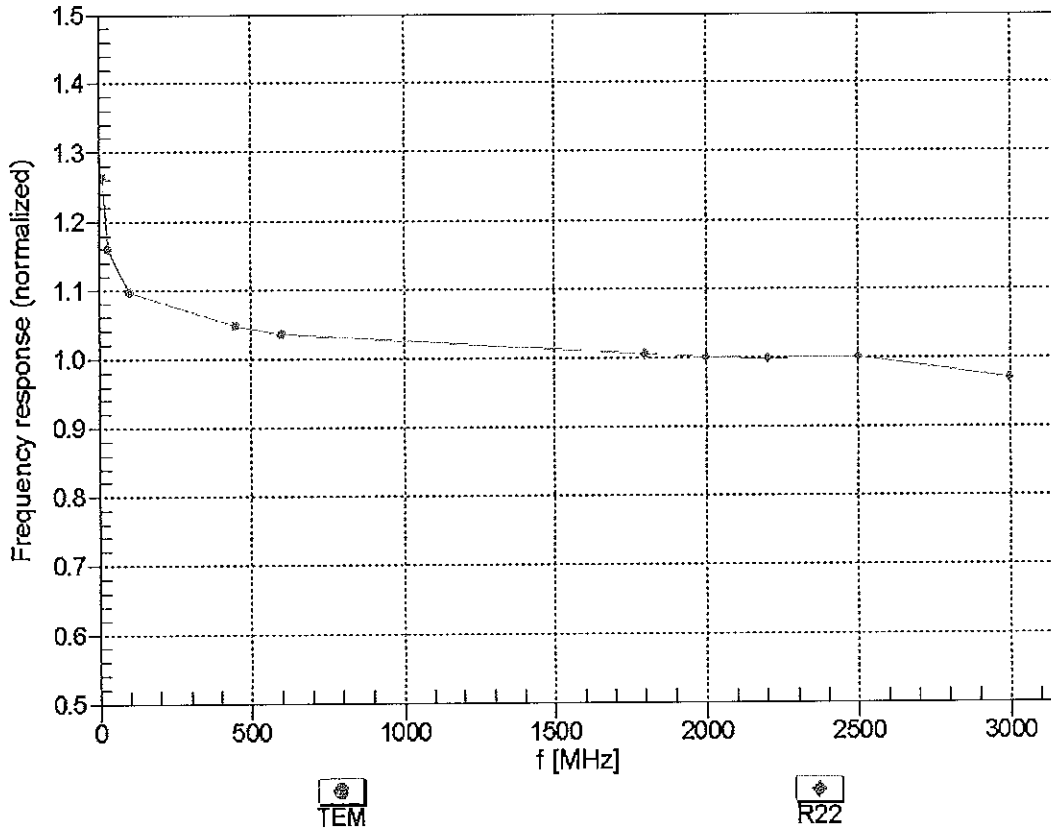
<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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

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

# Frequency Response of E-Field

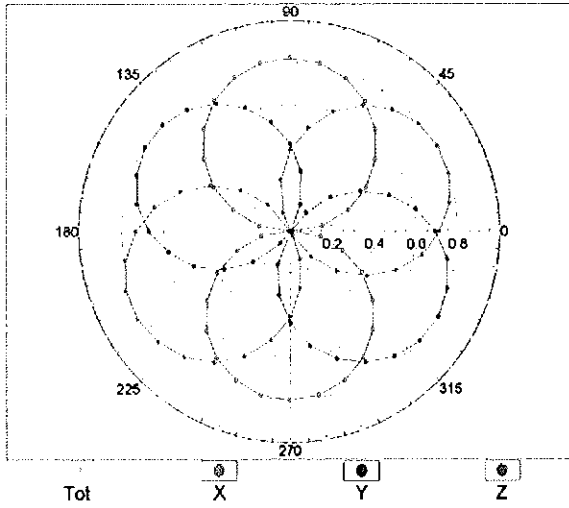
(TEM-Cell:ifi110 EXX, Waveguide: R22)



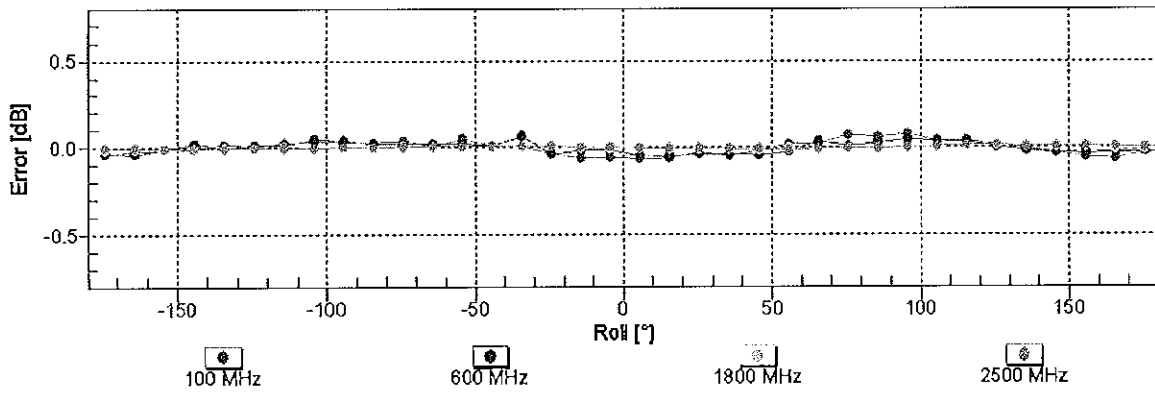
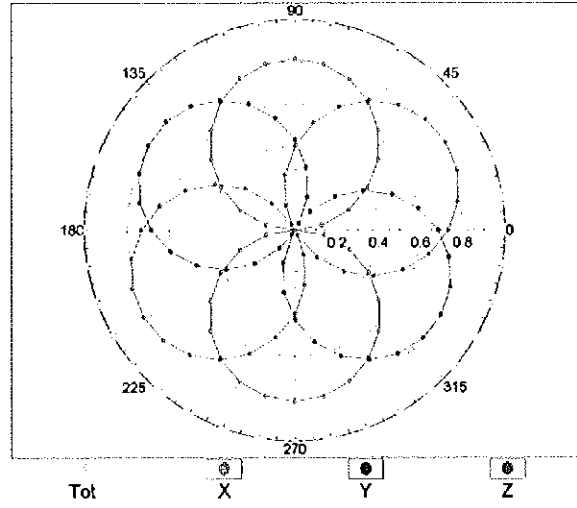
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

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

f=600 MHz,TEM

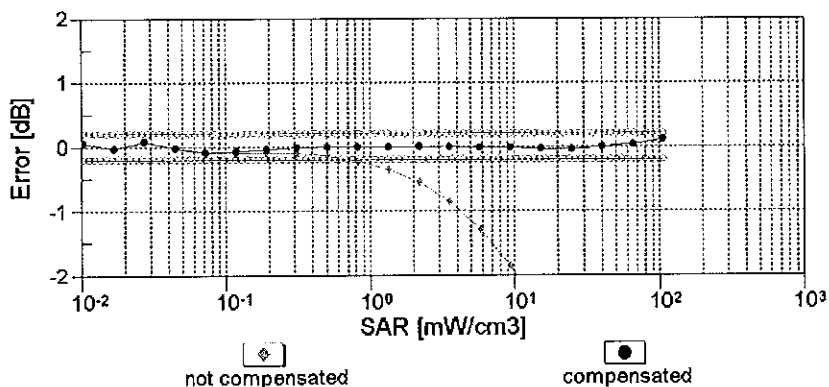
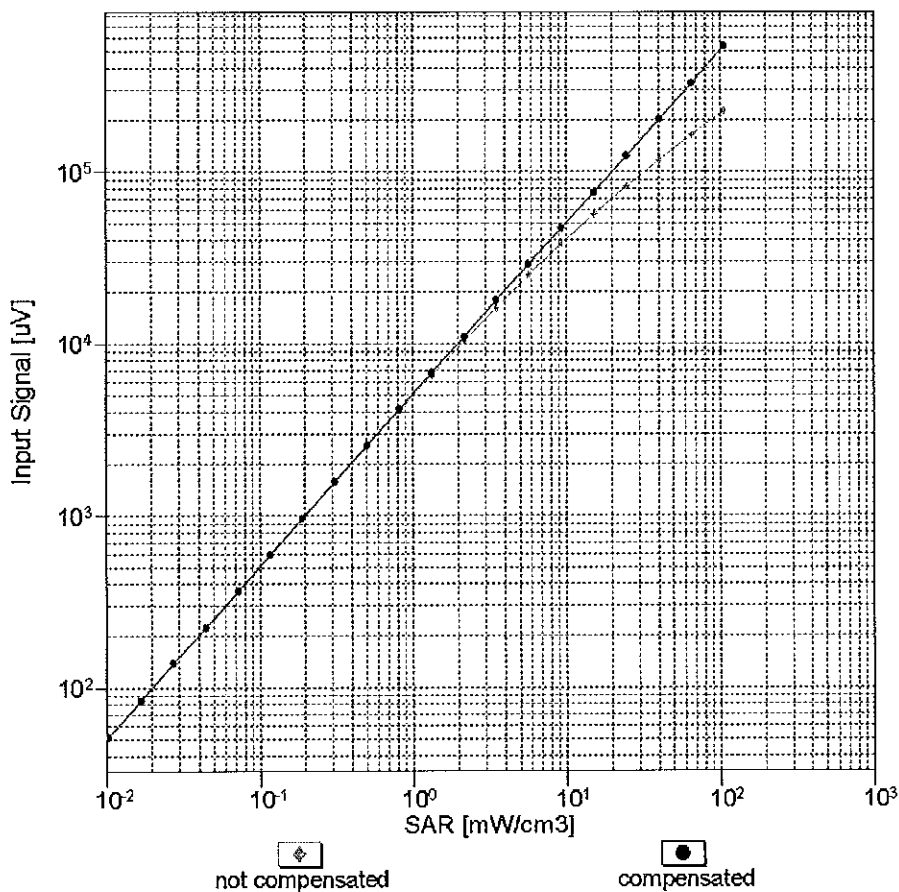


f=1800 MHz,R22



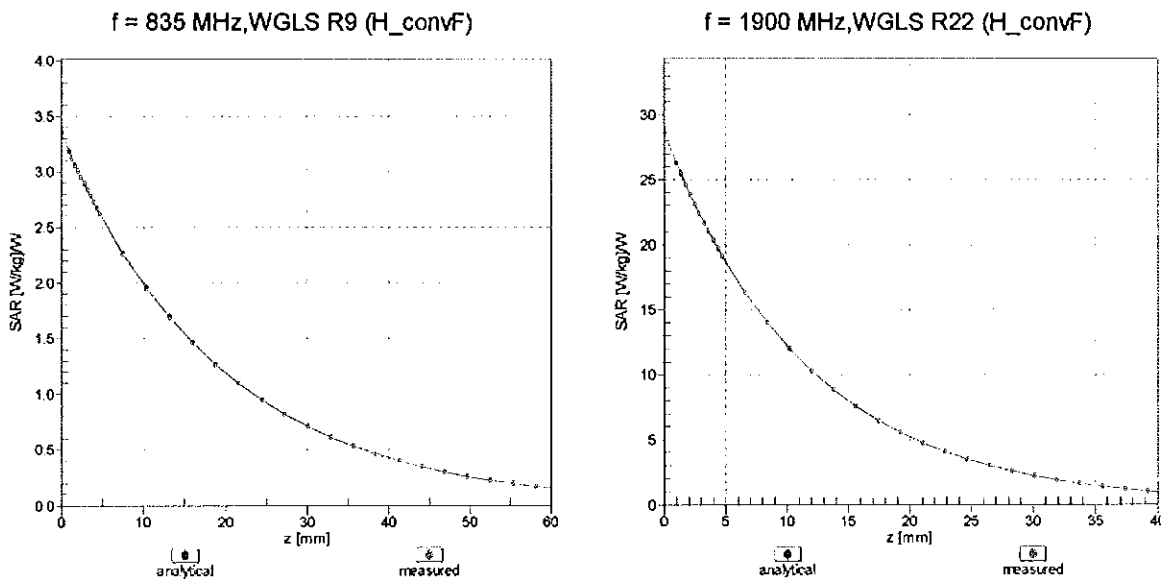
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)

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



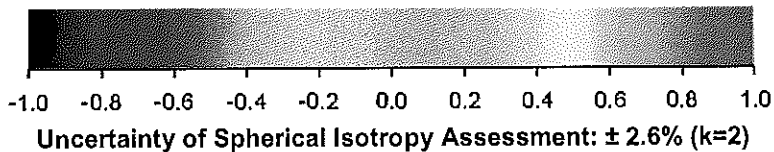
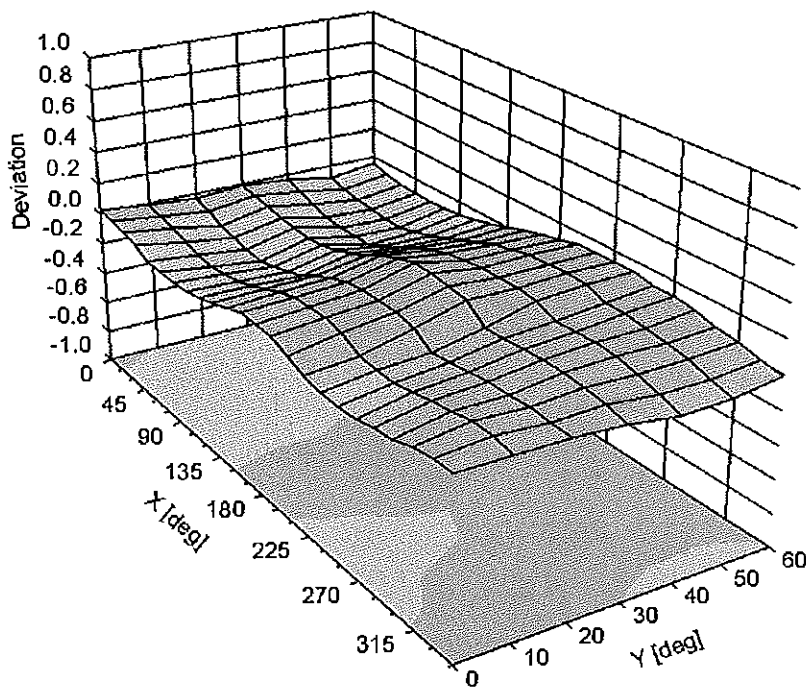
Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

# Conversion Factor Assessment



## Deviation from Isotropy in Liquid

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



**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3914****Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-24.3
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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Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **ES3-3318\_Apr13**

**CALIBRATION CERTIFICATE**

Object: **ES3DV3 - SN:3318**

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

Calibration date: **April 29, 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)

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6/14/13

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Dimce Iliev	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: April 29, 2013

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### Glossary:

TSL	tissue simulating liquid
NORM <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization $\varphi$	$\varphi$ rotation around probe axis
Polarization $\vartheta$	$\vartheta$ 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:

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

### Methods Applied and Interpretation of Parameters:

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

# Probe ES3DV3

## SN:3318

Manufactured: January 10, 2012  
Calibrated: April 29, 2013

**Calibrated for DASV/EASY Systems**  
(Note: non-compatible with DASV2 system!)

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3318

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	1.15	0.92	1.29	± 10.1 %
DCP (mV) <sup>B</sup>	102.6	105.4	100.8	

### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB/ $\mu\text{V}$	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	153.6	±3.5 %
		Y	0.0	0.0	1.0		133.8	
		Z	0.0	0.0	1.0		154.8	

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

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

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

<sup>E</sup> 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:3318

### Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	6.59	6.59	6.59	0.25	2.12	± 12.0 %
850	41.5	0.92	6.33	6.33	6.33	0.57	1.25	± 12.0 %
1900	40.0	1.40	5.22	5.22	5.22	0.79	1.25	± 12.0 %
2450	39.2	1.80	4.59	4.59	4.59	0.80	1.30	± 12.0 %

<sup>C</sup> 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.

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

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3318

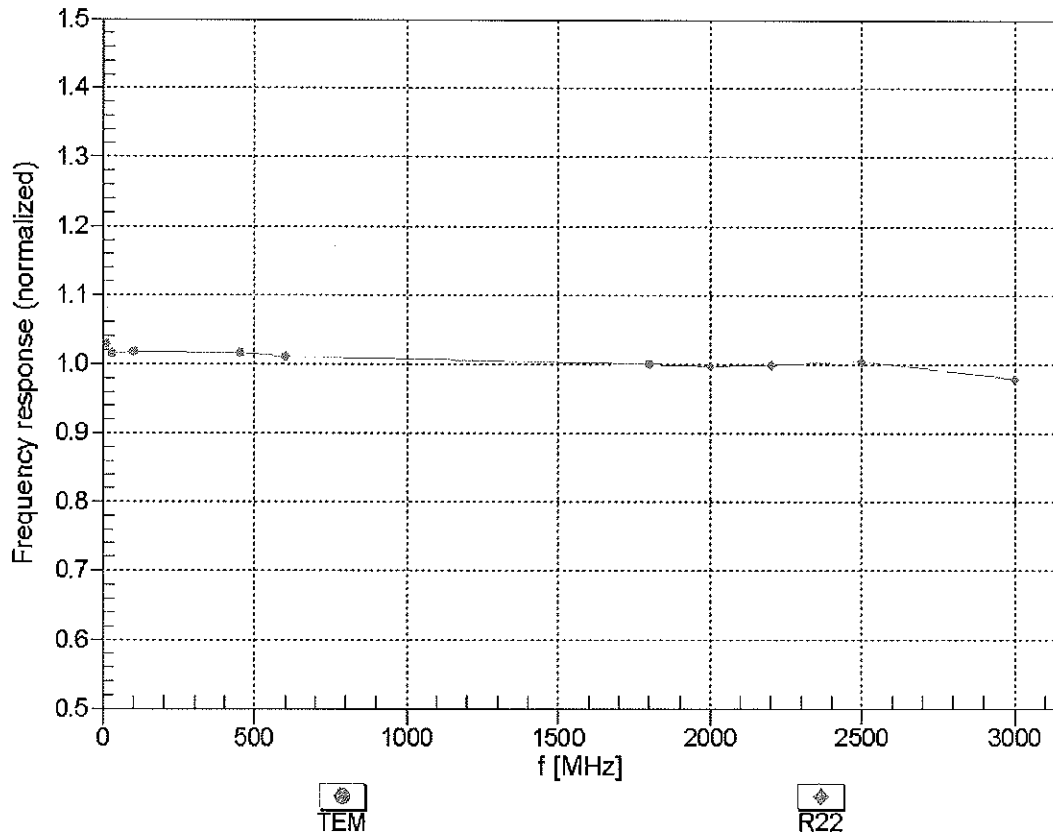
### Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	6.35	6.35	6.35	0.53	1.42	± 12.0 %
850	55.2	0.99	6.21	6.21	6.21	0.57	1.38	± 12.0 %
1900	53.3	1.52	4.79	4.79	4.79	0.46	1.77	± 12.0 %
2450	52.7	1.95	4.31	4.31	4.31	0.80	1.09	± 12.0 %

<sup>C</sup> 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.

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

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

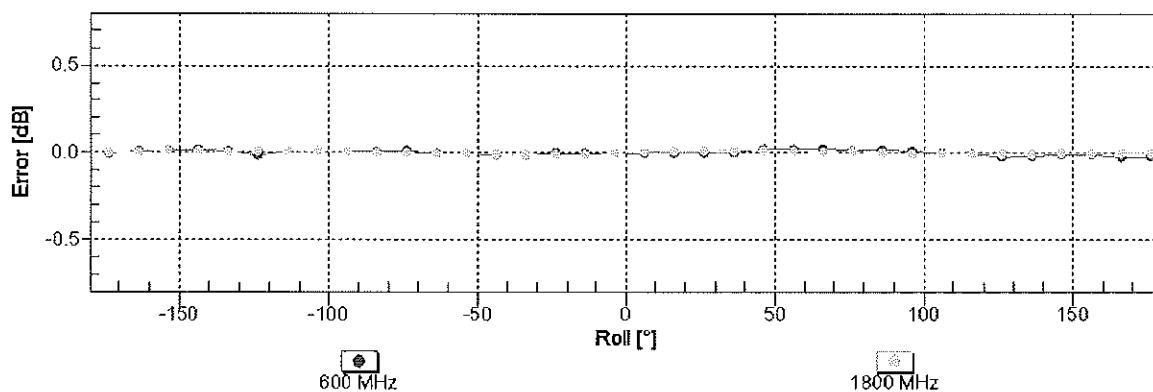
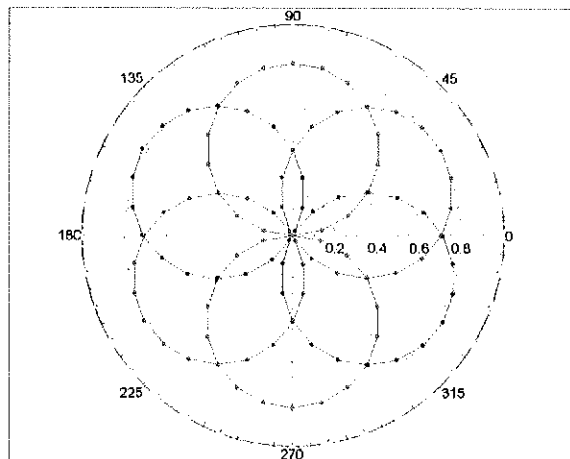
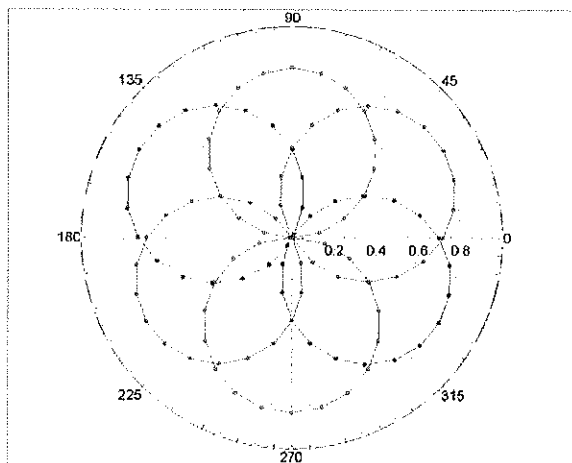


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

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

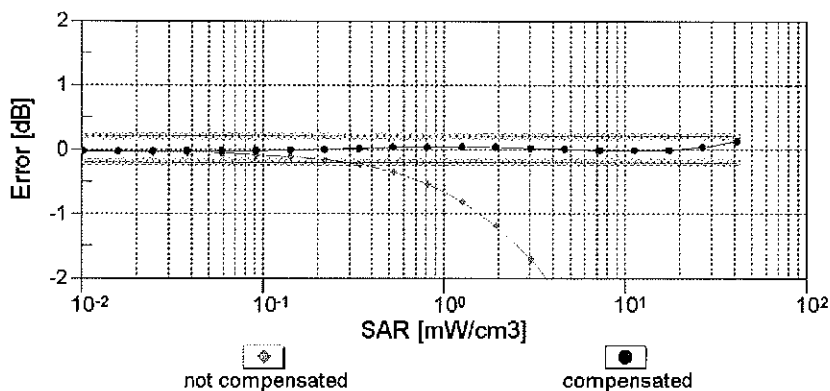
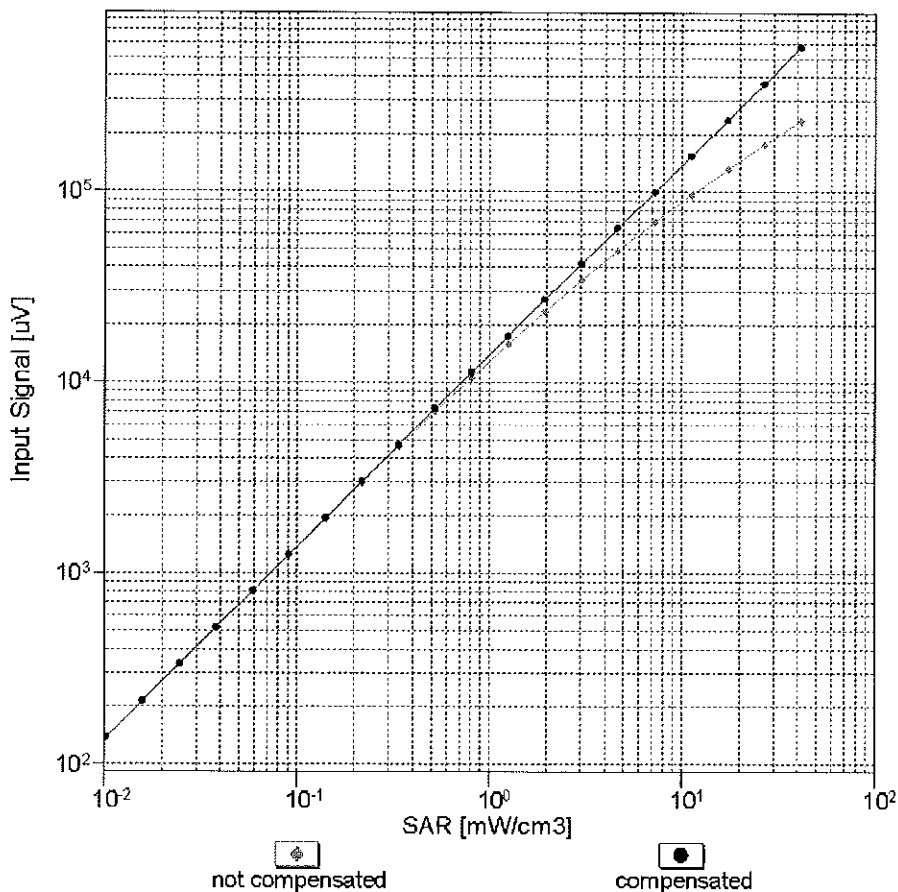
f=600 MHz,TEM

f=1800 MHz,R22



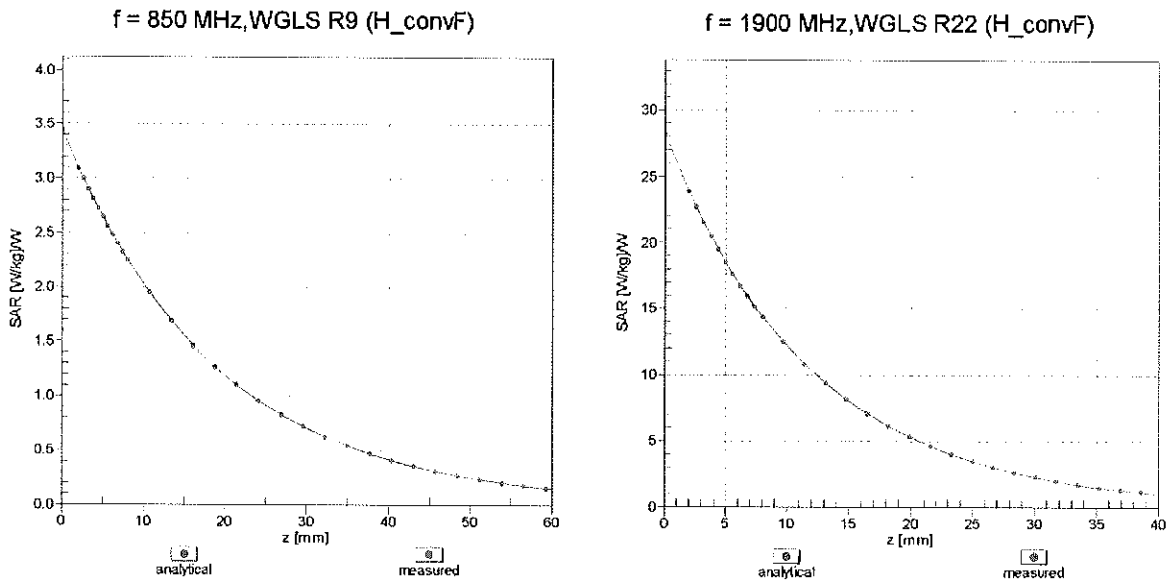
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)

## Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell , $f = 900 \text{ MHz}$ )

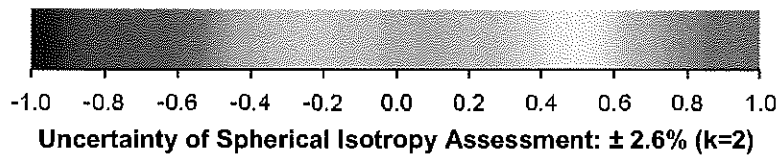
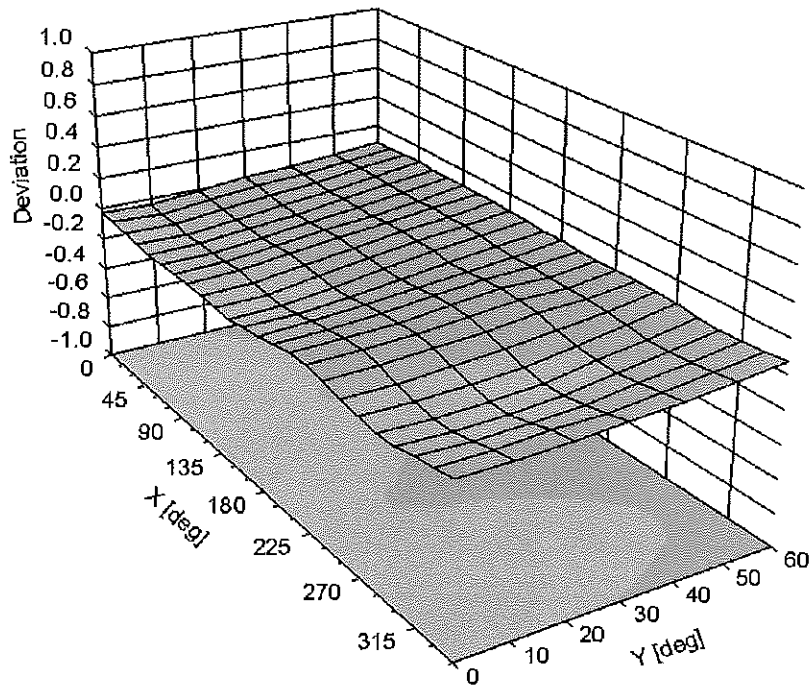


**Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )**

# Conversion Factor Assessment



## Deviation from Isotropy in Liquid Error ( $\phi, \theta$ ), f = 900 MHz



**DASY/EASY - Parameters of Probe: ES3DV3 - SN:3318****Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-103.8
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

## Additional Conversion Factors for Dosimetric E-Field Probe

Type:	<b>ES3DV3</b>
Serial Number:	<b>3318</b>
Place of Assessment:	<b>Zurich</b>
Date of Assessment:	<b>June 19, 2013</b>
Probe Calibration Date:	<b>April 29, 2013</b>

✓  
Kox  
6/25/13

Schmid & Partner Engineering AG hereby certifies that conversion factor(s) of this probe have been evaluated on the date indicated above. The assessment was performed using the FDTD numerical code SEMCAD of Schmid & Partner Engineering AG. The evaluation is coupled with measured conversion factors (probe calibration date indicated above). The uncertainty of the numerical assessment is based on the extrapolation from measured value at 835 MHz or at 1900 MHz.

Assessed by: 

## Dosimetric E-Field Probe ES3DV3 SN:3318

Conversion factor ( $\pm$  standard deviation)

1750  $\pm$  50 MHz      *ConvF*      5.59  $\pm$  7%

$\epsilon_r = 40.1 \pm 5\%$   
 $\sigma = 1.37 \pm 5\%$  mho/m  
(head tissue)

1750  $\pm$  50 MHz      *ConvF*      5.22  $\pm$  7%

$\epsilon_r = 53.4 \pm 5\%$   
 $\sigma = 1.49 \pm 5\%$  mho/m  
(body tissue)

### Important Note:

For numerically assessed probe conversion factors, parameters Alpha and Delta in the DASY software must have the following entries: Alpha = 0 and Delta = 1.

**Please see also DASY Manual.**



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Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **ES3-3319\_Apr13**

**CALIBRATION CERTIFICATE**

Object: **ES3DV3 - SN:3319**

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

Calibration date: **April 29, 2013**

*VCC  
6/14/13*

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 E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

Calibrated by:	Name <b>Dimce Iliev</b>	Function <b>Laboratory Technician</b>	Signature <i>[Signature]</i>
Approved by:	Name <b>Katja Pokovic</b>	Function <b>Technical Manager</b>	Signature <i>[Signature]</i>

Issued: April 29, 2013

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### Glossary:

TSL	tissue simulating liquid
NORM <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization $\varphi$	$\varphi$ rotation around probe axis
Polarization $\vartheta$	$\vartheta$ 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:

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

### Methods Applied and Interpretation of Parameters:

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

# Probe ES3DV3

## SN:3319

Manufactured: January 10, 2012  
Calibrated: April 29, 2013

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

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3319

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	1.12	1.20	1.22	$\pm 10.1 \%$
DCP (mV) <sup>B</sup>	100.7	102.6	102.4	

### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	152.0	$\pm 3.8 \%$
		Y	0.0	0.0	1.0		159.0	
		Z	0.0	0.0	1.0		149.8	

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

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

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

<sup>E</sup> 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:3319

### Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	6.49	6.49	6.49	0.28	1.97	± 12.0 %
850	41.5	0.92	6.23	6.23	6.23	0.42	1.57	± 12.0 %
1900	40.0	1.40	5.22	5.22	5.22	0.80	1.24	± 12.0 %
2450	39.2	1.80	4.57	4.57	4.57	0.80	1.32	± 12.0 %

<sup>C</sup> 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.

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

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3319

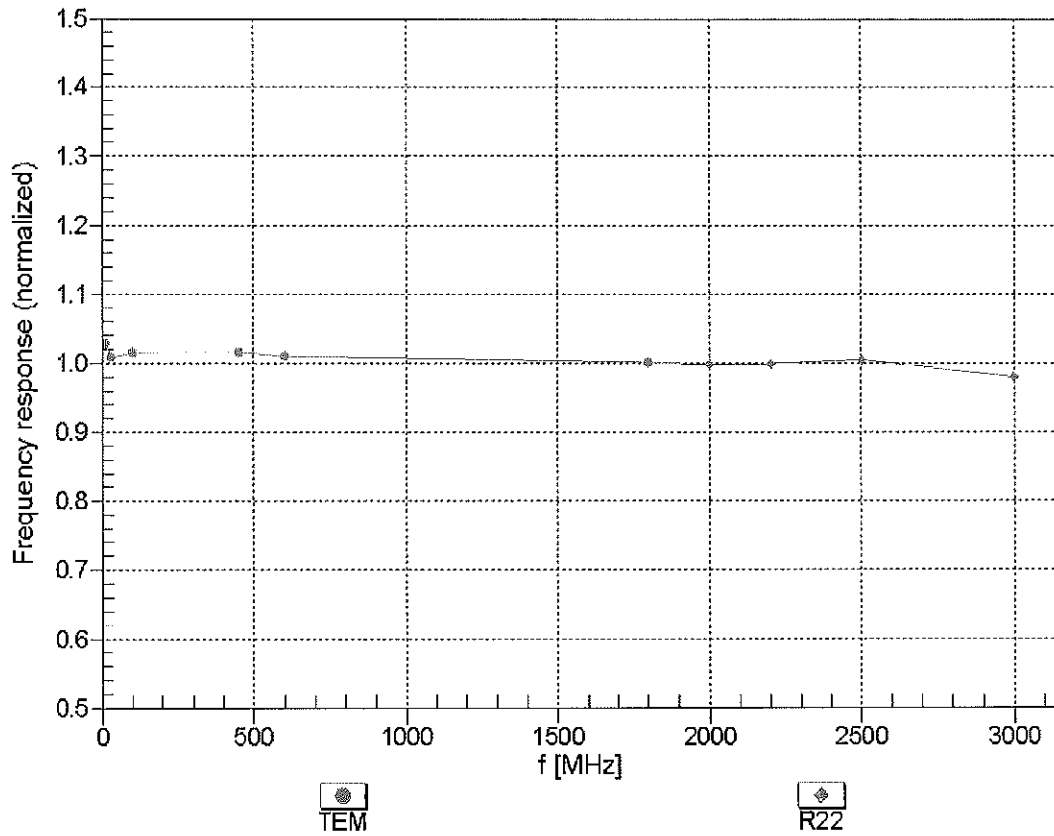
### Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	6.30	6.30	6.30	0.45	1.53	± 12.0 %
850	55.2	0.99	6.15	6.15	6.15	0.42	1.65	± 12.0 %
1900	53.3	1.52	4.85	4.85	4.85	0.63	1.49	± 12.0 %
2450	52.7	1.95	4.32	4.32	4.32	0.69	1.20	± 12.0 %

<sup>C</sup> 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.

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

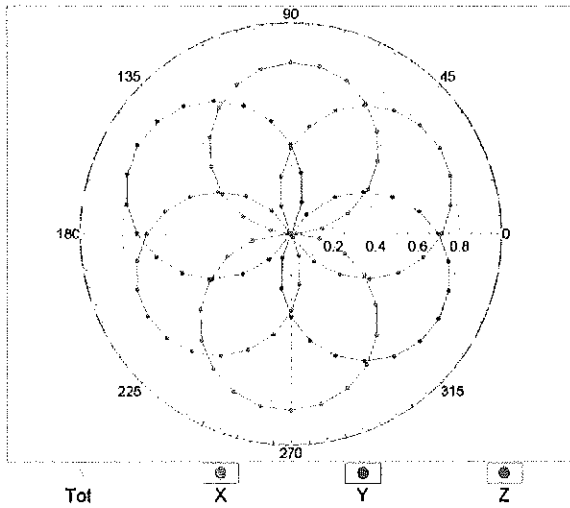
### Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



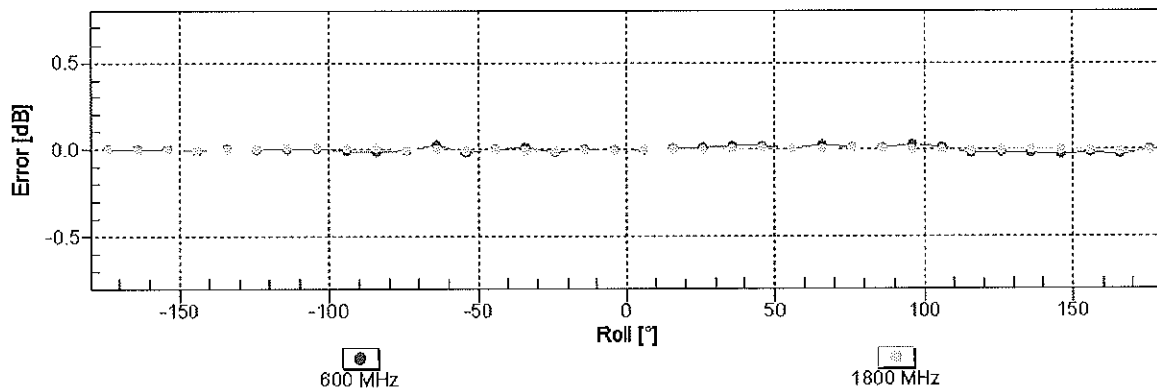
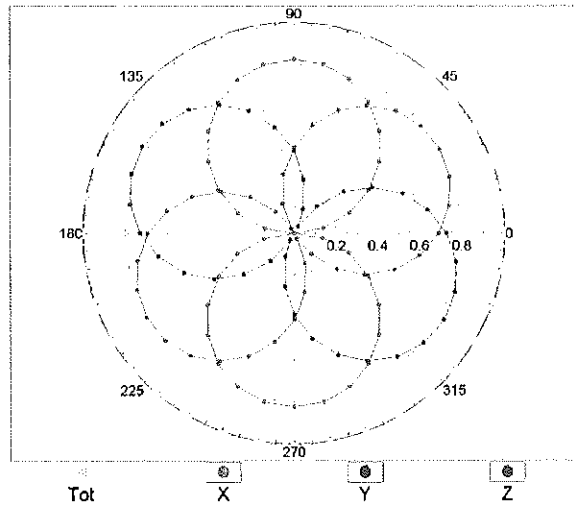
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

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

f=600 MHz,TEM

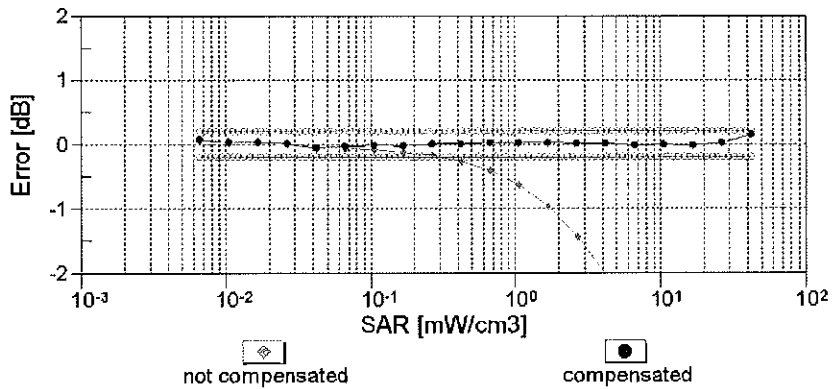
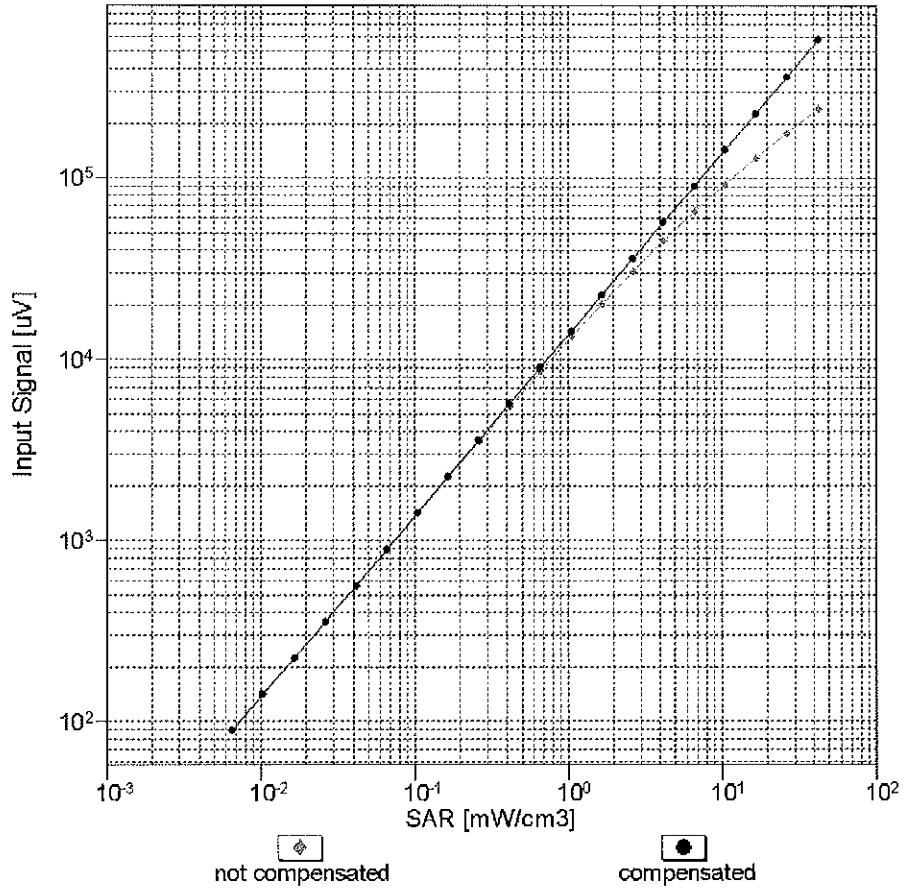


f=1800 MHz,R22



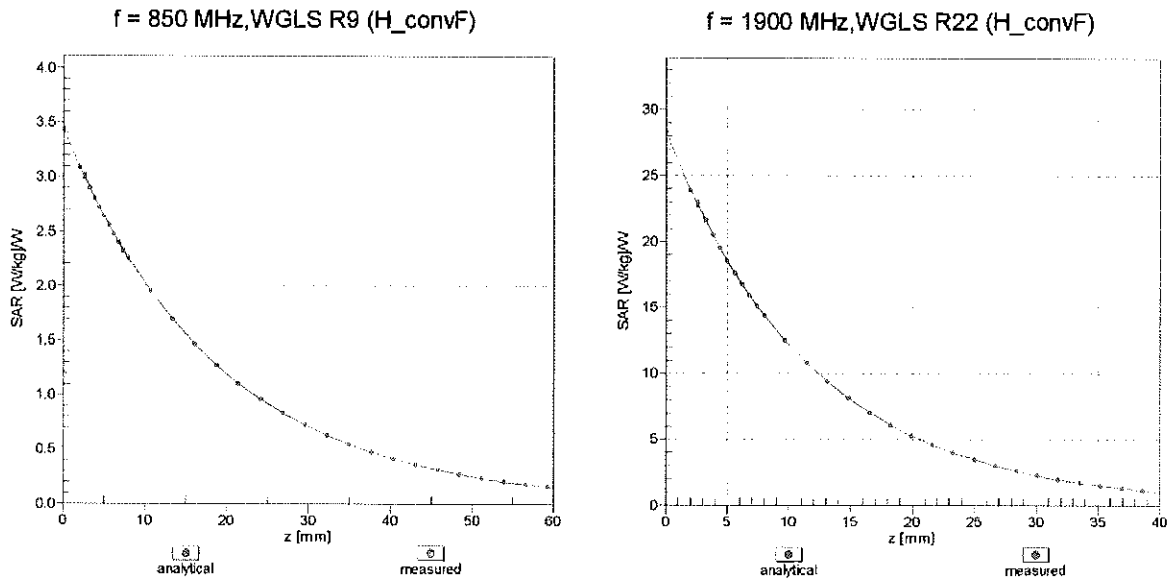
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)

### Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell , $f = 900 \text{ MHz}$ )

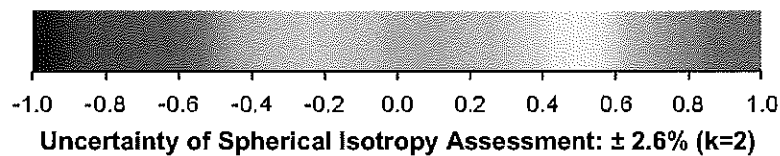
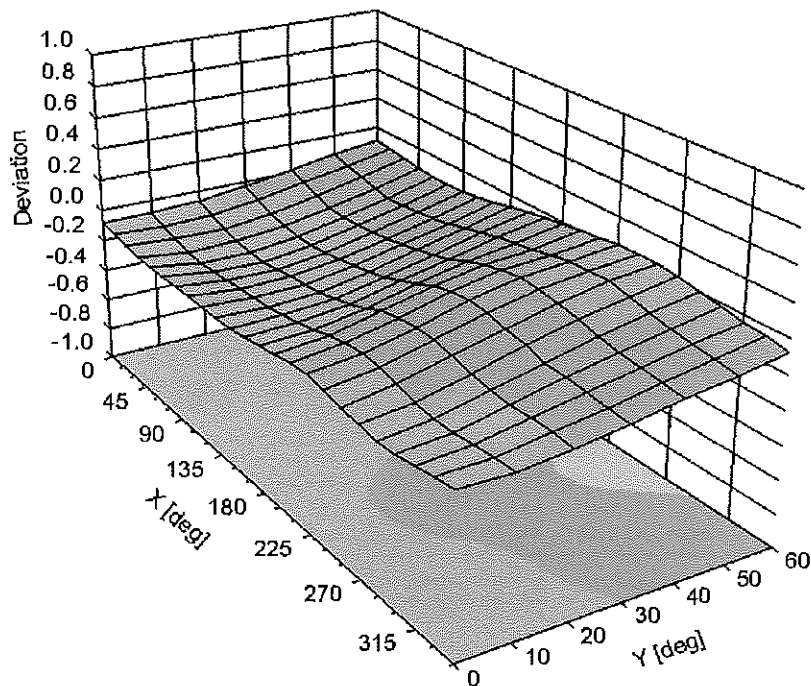


Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

# Conversion Factor Assessment



## Deviation from Isotropy in Liquid Error ( $\phi, \theta$ ), f = 900 MHz



## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3319

### Other Probe Parameters

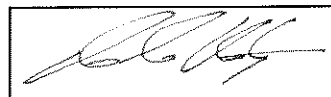
Sensor Arrangement	Triangular
Connector Angle (°)	-104.1
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

## Additional Conversion Factors for Dosimetric E-Field Probe

Type:	<b>ES3DV3</b>
Serial Number:	<b>3319</b>
Place of Assessment:	<b>Zurich</b>
Date of Assessment:	<b>June 19, 2013</b>
Probe Calibration Date:	<b>April 29, 2013</b>

Schmid & Partner Engineering AG hereby certifies that conversion factor(s) of this probe have been evaluated on the date indicated above. The assessment was performed using the FDTD numerical code SEMCAD of Schmid & Partner Engineering AG. The evaluation is coupled with measured conversion factors (probe calibration date indicated above). The uncertainty of the numerical assessment is based on the extrapolation from measured value at 835 MHz or at 1900 MHz.

Assessed by:



✓  
KOK  
6/25/13

**Dosimetric E-Field Probe ES3DV3 SN:3319**Conversion factor ( $\pm$  standard deviation)1750  $\pm$  50 MHz      *ConvF*      5.59  $\pm$  7% $\epsilon_r = 40.1 \pm 5\%$   
 $\sigma = 1.37 \pm 5\%$  mho/m  
(head tissue)1750  $\pm$  50 MHz      *ConvF*      5.22  $\pm$  7% $\epsilon_r = 53.4 \pm 5\%$   
 $\sigma = 1.49 \pm 5\%$  mho/m  
(body tissue)**Important Note:**

For numerically assessed probe conversion factors, parameters Alpha and Delta in the DASY software must have the following entries: Alpha = 0 and Delta = 1.

Please see also DASY Manual.



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 v3, QA CAL-14 v3, QA CAL-23 v4, QA CAL-25 v4  
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.



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

### Glossary:

TSL	tissue simulating liquid
NORM <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization $\varphi$	$\varphi$ rotation around probe axis
Polarization $\vartheta$	$\vartheta$ 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:

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

### Methods Applied and Interpretation of Parameters:

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

# 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 ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	0.46	0.40	0.40	$\pm 10.1 \%$
DCP (mV) <sup>B</sup>	100.5	103.8	99.6	

### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	165.8	$\pm 3.3 \%$
		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%.

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

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

<sup>E</sup> 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) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	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 %

<sup>C</sup> 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.

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

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

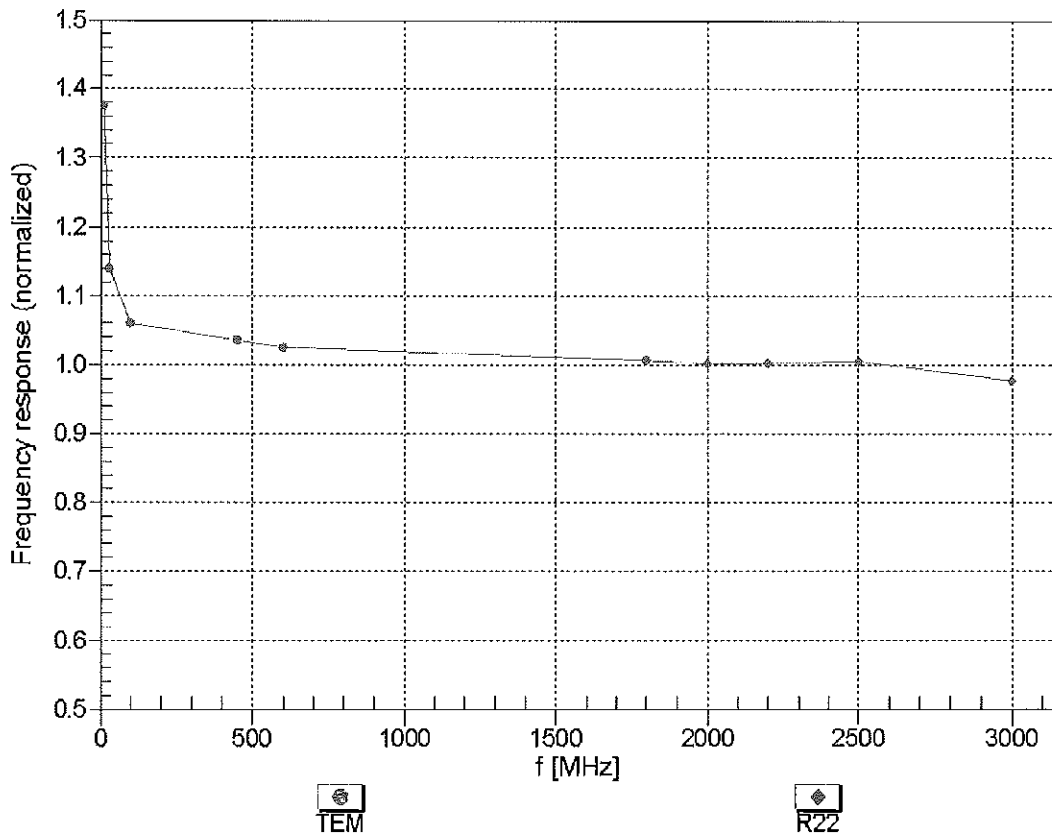
### Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	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 %

<sup>C</sup> 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.

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

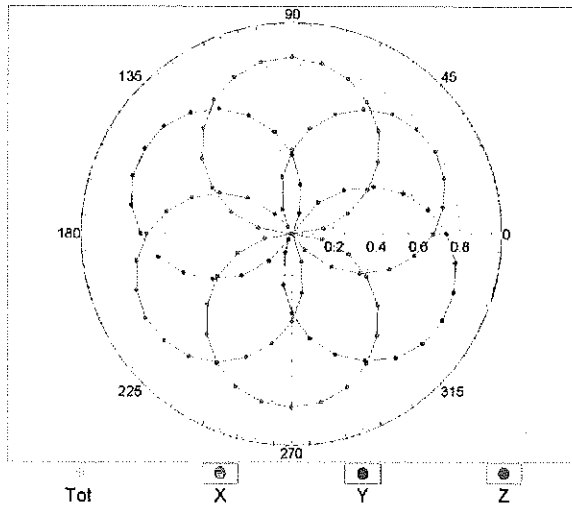
### Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



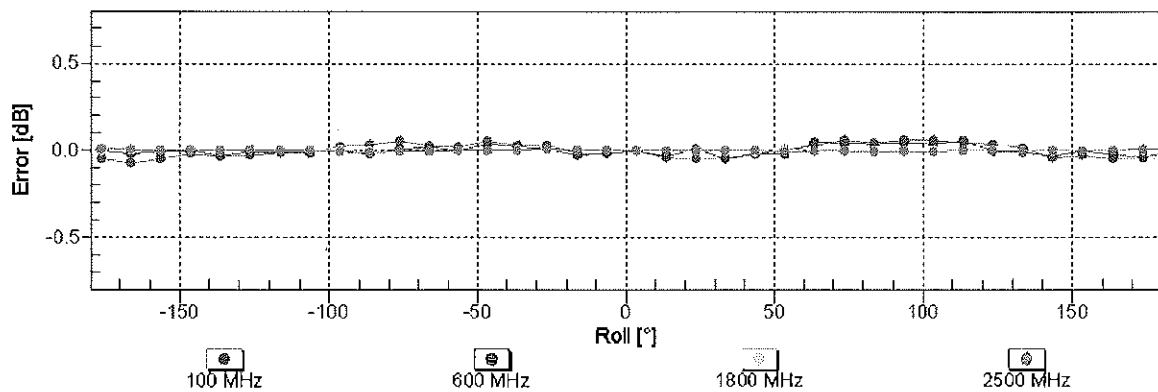
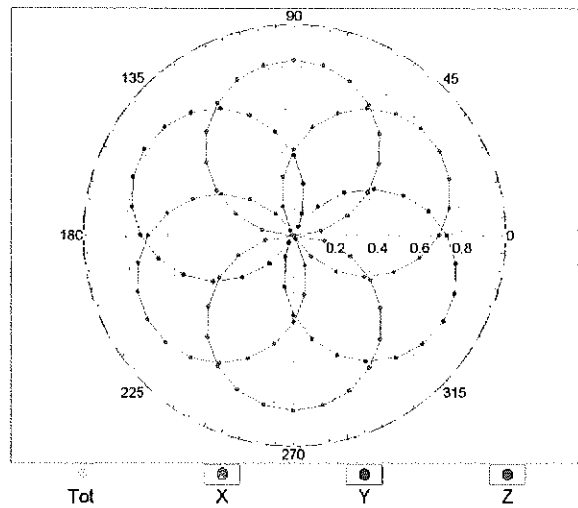
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

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

f=600 MHz, TEM

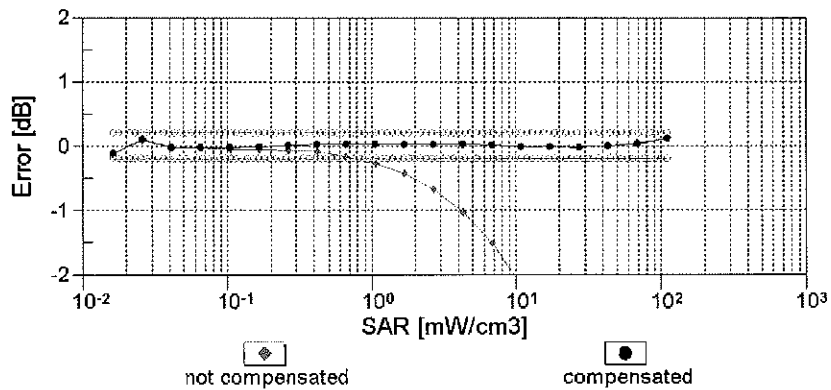
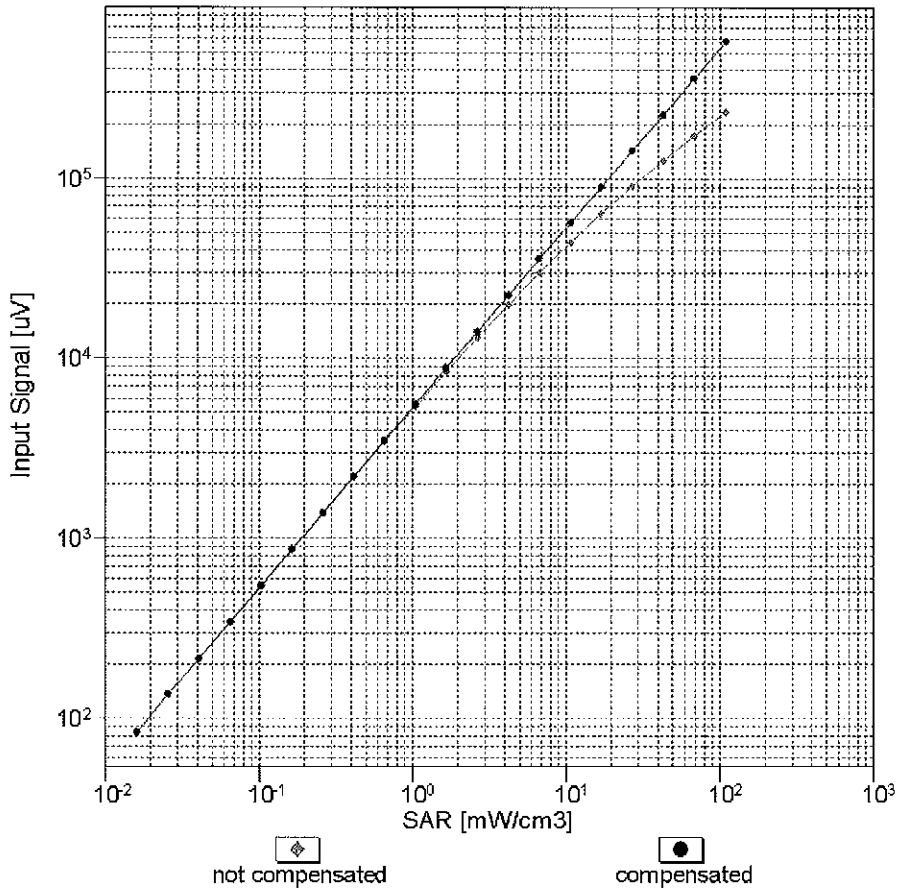


f=1800 MHz, R22



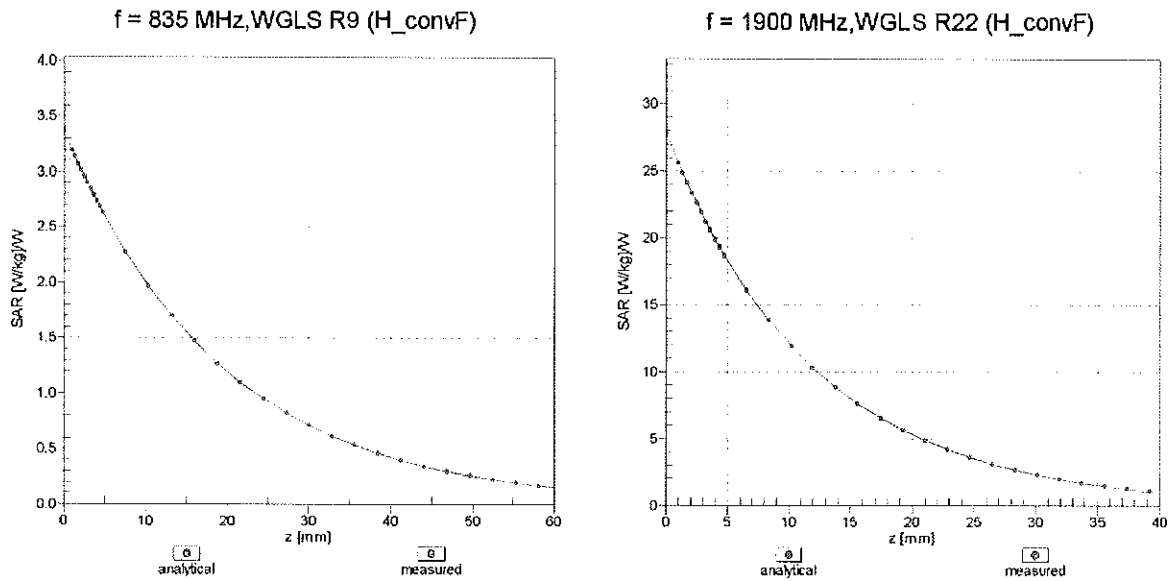
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)

### Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell , $f = 900 \text{ MHz}$ )

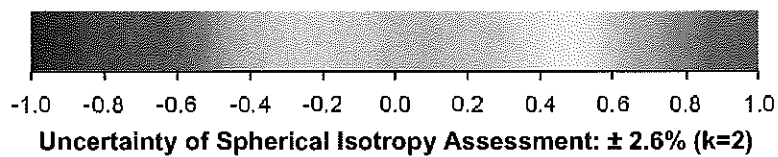
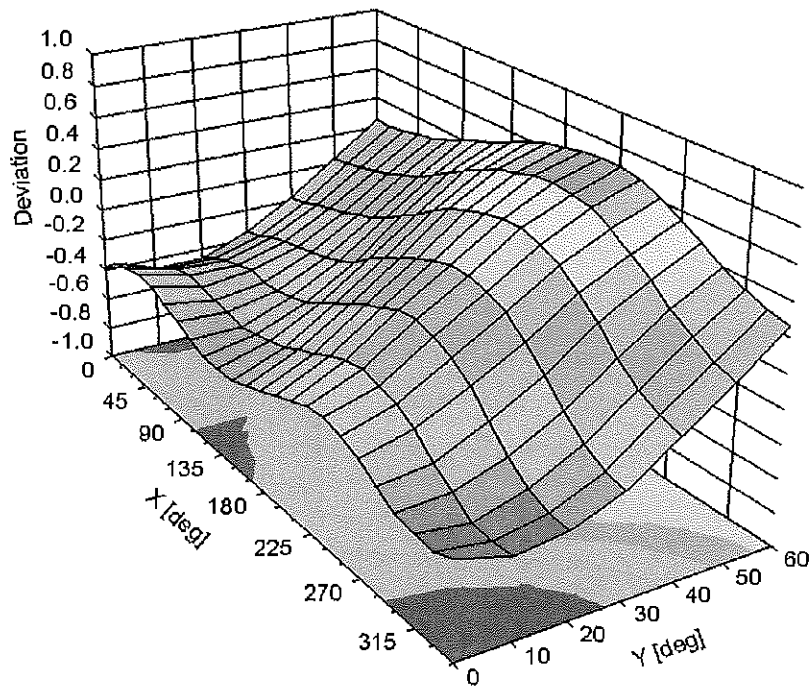


**Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )**

# Conversion Factor Assessment



## Deviation from Isotropy in Liquid Error ( $\phi, \vartheta$ ), $f = 900$ MHz



## 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

## 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  $\epsilon$  can be calculated from the below equation (Pournaropoulos and Misra):

$$Y = \frac{j2\omega\epsilon_r\epsilon_0}{[\ln(b/a)]^2} \int_a^b \int_a^b \int_0^\pi \cos\phi' \frac{\exp[-j\omega r(\mu_0\epsilon_r\epsilon_0)^{1/2}]}{r} d\phi' d\rho' d\rho$$

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)	835	835	1900	1900	2450	2450	5200-5800	5200-5800
Tissue	Head	Body	Head	Body	Head	Body	Head	Body
Ingredients (% by weight)								
Bactericide	0.1	0.1			See Page 2		See Page 3	
DGBE			44.92	29.44		26.7		
HEC	1	1						
NaCl	1.45	0.94	0.18	0.39		0.1		
Sucrose	57	44.9						
Polysorbate (Tween) 80								20
Water	40.45	53.06	54.9	70.17		73.2		80

FCC ID: A3LSMG7109	 <b>PCTEST</b> <small>ENGINEERING LABORATORY, INC.</small>	<b>SAR EVALUATION REPORT</b>		Reviewed by: Quality Manager
Test Dates: 11/22/13 - 12/19/13	DUT Type: Portable Handset			APPENDIX D: Page 1 of 3

## 2 Composition / Information on ingredients

The Item is composed of the following ingredients:

H2O	Water, 52 – 75%
C8H18O3	Diethylene glycol monobutyl ether (DGBE), 25 – 48% (CAS-No. 112-34-5, EC-No. 203-961-6, EC-index-No. 603-096-00-8) Relevant for safety; Refer to the respective Safety Data Sheet*.
NaCl	Sodium Chloride, <1.0%

**Figure D-1**  
**Composition of 2.4 GHz Head Tissue Equivalent Matter**

**Note:** 2.4 GHz head liquid recipes are proprietary SPEAG. Since the composition is approximate to the actual liquids utilized, the manufacturer tissue-equivalent liquid data sheets are provided below.

### Measurement Certificate / Material Test

Item Name	Head Tissue Simulating Liquid (HSL 2450)
Product No.	SL AAH 245 BA (Charge: 120112-4)
Manufacturer	SPEAG

### Measurement Method

TSL dielectric parameters measured using calibrated OCP probe (type DAK).

### Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

### Test Condition

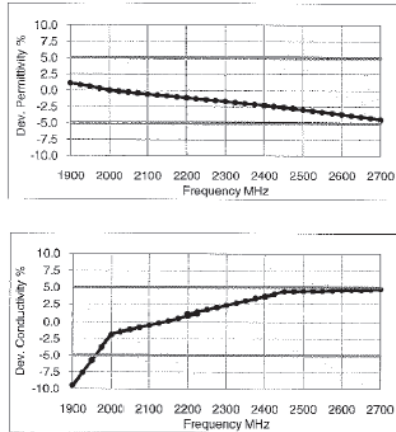
Ambient Condition 22°C; 30% humidity  
TSL Temperature 23°C  
Test Date 18-Jan-12

### Additional Information

TSL Density 0.988 g/cm<sup>3</sup>  
TSL Heat-capacity 3.680 kJ/(kg\*K)

### Results

f [MHz]	Measured			Target		Diff.to Target [%]	
	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
1900	40.5	11.99	1.27	40.0	1.40	1.1	-9.5
1925	40.3	12.08	1.29	40.0	1.40	0.9	-7.6
1950	40.2	12.17	1.32	40.0	1.40	0.6	-5.7
1975	40.1	12.26	1.35	40.0	1.40	0.3	-3.8
2000	40.0	12.35	1.37	40.0	1.40	0.0	-1.9
2025	39.9	12.44	1.40	40.0	1.42	-0.1	-1.5
2050	39.8	12.53	1.43	39.9	1.44	-0.3	-1.1
2075	39.7	12.60	1.46	39.9	1.47	-0.4	-0.8
2100	39.6	12.68	1.48	39.8	1.49	-0.6	-0.5
2125	39.5	12.76	1.51	39.8	1.51	-0.7	-0.2
2150	39.4	12.84	1.54	39.7	1.53	-0.8	0.2
2175	39.3	12.93	1.56	39.7	1.56	-1.0	0.6
2200	39.2	13.02	1.59	39.6	1.58	-1.1	1.0
2225	39.1	13.09	1.62	39.6	1.60	-1.3	1.3
2250	39.0	13.17	1.65	39.6	1.62	-1.4	1.6
2275	38.9	13.25	1.68	39.5	1.64	-1.5	2.0
2300	38.8	13.33	1.71	39.5	1.67	-1.7	2.3
2325	38.7	13.40	1.73	39.4	1.69	-1.8	2.7
2350	38.6	13.48	1.76	39.4	1.71	-2.0	3.0
2375	38.5	13.56	1.79	39.3	1.73	-2.1	3.3
2400	38.4	13.63	1.82	39.3	1.76	-2.3	3.7
2425	38.3	13.71	1.85	39.2	1.78	-2.4	4.0
2450	38.2	13.78	1.88	39.2	1.80	-2.6	4.4
2475	38.1	13.85	1.91	39.2	1.83	-2.7	4.4
2500	38.0	13.93	1.94	39.1	1.85	-2.9	4.4
2525	37.9	13.99	1.97	39.1	1.88	-3.1	4.4
2550	37.8	14.06	1.99	39.1	1.91	-3.3	4.4
2575	37.7	14.13	2.02	39.0	1.94	-3.5	4.5
2600	37.6	14.20	2.05	39.0	1.96	-3.7	4.6
2625	37.5	14.28	2.08	39.0	1.99	-3.8	4.6
2650	37.4	14.32	2.11	38.9	2.02	-4.0	4.6
2675	37.3	14.39	2.14	38.9	2.05	-4.3	4.7
2700	37.1	14.46	2.17	38.9	2.07	-4.5	4.8



**Figure D-2**  
**2.4 GHz Head Tissue Equivalent Matter**

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## 2 Composition / Information on ingredients

The Item is composed of the following ingredients:

Water	50 – 65%
Mineral oil	10 – 30%
Emulsifiers	8 – 25%
Sodium salt	0 – 1.5%

**Figure D-3**

### Composition of 5 GHz Head Tissue Equivalent Matter

**Note:** 5GHz head liquid recipes are proprietary SPEAG. Since the composition is approximate to the actual liquids utilized, the manufacturer tissue-equivalent liquid data sheets are provided below.

#### Measurement Certificate / Material Test

Item Name	Head Tissue Simulating Liquid (HBBL3500-5800V5)
Product No.	SL AAH 502 AB (Charge: 120402-2)
Manufacturer	SPEAG

#### Measurement Method

TSL dielectric parameters measured using calibrated OCP probe (type DAK).

#### Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

#### Test Condition

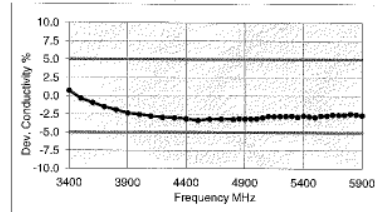
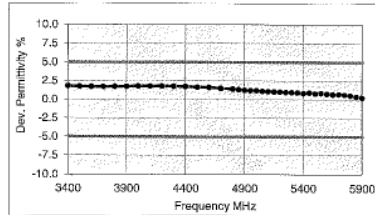
Ambient Condition 22°C ; 30% humidity  
TSL Temperature 22°C  
Test Date 4-Apr-12

#### Additional Information

TSL Density 0.985 g/cm<sup>3</sup>  
TSL Heat-capacity 3.383 kJ/(kg\*K)



#### Results

f [MHz]	Measured			Target		Diff. to Target [%]	
	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
3400	38.7	14.96	2.83	38.0	2.81	1.8	0.7
3500	38.6	14.91	2.90	37.9	2.91	1.7	-0.3
3600	38.5	14.92	2.99	37.8	3.02	1.7	-0.9
3700	38.3	14.92	3.07	37.7	3.12	1.7	-1.5
3800	38.2	14.94	3.16	37.6	3.22	1.7	-1.9
3900	38.1	14.95	3.24	37.5	3.32	1.7	-2.4
4000	38.0	15.00	3.34	37.4	3.43	1.8	-2.5
4100	37.9	15.04	3.43	37.2	3.53	1.8	-2.6
4200	37.8	15.08	3.52	37.1	3.63	1.8	-2.9
4300	37.7	15.14	3.62	37.0	3.73	1.8	-3.0
4400	37.5	15.18	3.71	36.9	3.84	1.7	-3.1
4500	37.4	15.20	3.81	36.8	3.94	1.6	-3.3
4600	37.3	15.29	3.91	36.7	4.04	1.6	-3.2
4700	37.1	15.34	4.01	36.6	4.14	1.5	-3.2
4800	37.0	15.39	4.11	36.4	4.25	1.4	-3.2
4850	36.9	15.43	4.16	36.4	4.30	1.3	-3.1
4900	36.8	15.45	4.21	36.3	4.35	1.3	-3.1
4950	36.7	15.47	4.26	36.3	4.40	1.2	-3.1
5000	36.7	15.50	4.31	36.2	4.45	1.2	-3.1
5050	36.6	15.55	4.37	36.2	4.50	1.1	-3.0
5100	36.5	15.60	4.43	36.1	4.55	1.1	-2.8
5150	36.4	15.62	4.48	36.0	4.60	1.0	-2.8
5200	36.4	15.65	4.53	36.0	4.66	1.0	-2.8
5250	36.3	15.67	4.58	35.9	4.71	1.0	-2.8
5300	36.2	15.70	4.63	35.9	4.76	1.0	-2.7
5350	36.1	15.70	4.67	35.8	4.81	0.9	-2.9
5400	36.1	15.74	4.73	35.8	4.86	0.8	-2.7
5450	36.0	15.75	4.77	35.7	4.91	0.9	-2.8
5500	35.9	15.78	4.82	35.6	4.96	0.8	-2.9
5550	35.9	15.80	4.88	35.6	5.01	0.8	-2.7
5600	35.8	15.82	4.93	35.5	5.07	0.7	-2.7
5650	35.7	15.86	4.98	35.5	5.12	0.7	-2.6
5700	35.7	15.88	5.03	35.4	5.17	0.7	-2.6
5750	35.6	15.90	5.08	35.4	5.22	0.6	-2.6
5800	35.5	15.94	5.14	35.3	5.27	0.6	-2.4
5850	35.4	15.98	5.20	35.3	5.34	0.4	-2.5
5900	35.4	16.02	5.26	35.3	5.40	0.2	-2.6



**Figure D-4**

### 5GHz Head Tissue Equivalent Matter

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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		
							( $\sigma$ )	( $\epsilon_r$ )	SENSI-TIVITY	PROBE LINEARITY	PROBE ISOTROPY	MOD. TYPE	DUTY FACTOR	PAR
D	835	10/7/2013	3022	ES3DV2	835	Head	0.910	39.82	PASS	PASS	PASS	GMSK	PASS	N/A
F	1900	5/9/2013	3213	ES3DV3	1900	Head	1.464	39.97	PASS	PASS	PASS	GMSK	PASS	N/A
G	1900	12/16/2013	3209	ES3DV3	1900	Head	1.437	38.75	PASS	PASS	PASS	GMSK	PASS	N/A
C	2450	8/12/2013	3263	ES3DV3	2450	Head	1.863	38.51	PASS	PASS	PASS	OFDM	N/A	PASS
E	5200	12/3/2013	3914	EX3DV4	5200	Head	4.482	34.70	PASS	PASS	PASS	OFDM	N/A	PASS
E	5300	12/3/2013	3914	EX3DV4	5300	Head	4.604	34.60	PASS	PASS	PASS	OFDM	N/A	PASS
E	5500	12/3/2013	3914	EX3DV4	5500	Head	4.821	34.28	PASS	PASS	PASS	OFDM	N/A	PASS
E	5800	12/3/2013	3914	EX3DV4	5800	Head	5.133	33.89	PASS	PASS	PASS	OFDM	N/A	PASS
G	835	3/26/2013	3209	ES3DV3	835	Body	1.006	54.42	PASS	PASS	PASS	GMSK	PASS	N/A
F	1900	5/10/2013	3213	ES3DV3	1900	Body	1.591	52.24	PASS	PASS	PASS	GMSK	PASS	N/A
H	1900	6/18/2013	3318	ES3DV3	1900	Body	1.572	52.46	PASS	PASS	PASS	GMSK	PASS	N/A
I	1900	7/1/2013	3319	ES3DV3	1900	Body	1.502	52.10	PASS	PASS	PASS	GMSK	PASS	N/A
D	2450	10/11/2013	3022	ES3DV2	2450	Body	2.008	52.50	PASS	PASS	PASS	OFDM	N/A	PASS
A	5200	1/23/2013	3589	EX3DV4	5200	Body	5.292	47.85	PASS	PASS	PASS	OFDM	N/A	PASS
A	5300	1/23/2013	3589	EX3DV4	5300	Body	5.477	47.47	PASS	PASS	PASS	OFDM	N/A	PASS
A	5500	1/23/2013	3589	EX3DV4	5500	Body	5.729	47.03	PASS	PASS	PASS	OFDM	N/A	PASS
A	5800	1/23/2013	3589	EX3DV4	5800	Body	6.233	46.20	PASS	PASS	PASS	OFDM	N/A	PASS

NOTE: While the probes have been calibrated for both a CW and modulated signals, all measurements were performed using communication systems calibrated for CW signals only. Modulations in the table above represent test configurations for which the measurement system has been validated per FCC KDB Publication 865664 D01v01 for scenarios when CW probe calibrations are used with other signal types. SAR systems were validated for modulated signals with a periodic duty cycle, such as GMSK, or with a high peak to average ratio (>5 dB), such as OFDM according to KDB 865664.

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