



SAR EVALUATION REPORT

Applicant Name:
 LG Electronics MobileComm U.S.A., Inc.
 1000 Sylvan Avenue
 Englewood Cliffs, NJ 07632
 United States

Date of Testing:
 10/15/13 – 10/29/13
Test Site/Location:
 PCTEST Lab, Columbia, MD, USA
Document Serial No.:
 OY1310162030.ZNF

FCC ID: ZNFD520
APPLICANT: LG ELECTRONICS MOBILECOMM U.S.A., INC.

DUT Type: Portable Handset
Application Type: Class II Permissive Change
FCC Rule Part(s): CFR §2.1093
Model(s): LG-D520, D520, LGD520, LG-D520BK
Permissive Change(s): See FCC Change Document
Date of Original Certification: 09/16/2013

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	32.93	0.33	0.66	0.66
PCE	UMTS 850	826.40 - 846.60 MHz	23.67	0.21	0.46	0.46
PCE	UMTS 1750	1712.4 - 1752.5 MHz	24.37	0.45	0.67	0.67
PCE	GSM/GPRS/EDGE 1900	1850.20 - 1909.80 MHz	31.03	0.23	0.54	0.54
PCE	UMTS 1900	1852.4 - 1907.6 MHz	23.60	0.29	0.71	0.71
PCE	LTE Band 17	706.5 - 713.5 MHz	23.69	0.28	0.61	0.61
PCE	LTE Band 4 (AWS)	1712.5 - 1752.5 MHz	24.07	0.43	0.91	0.91
PCE	LTE Band 2 (PCS)	1852.5 - 1907.5 MHz	23.65	0.30	0.55	0.55
DTS	2.4 GHz WLAN	2412 - 2462 MHz	16.46	0.21	0.17	0.20
DTS	5.8 GHz WLAN	5745 - 5825 MHz	12.08	0.63	0.29	
NII	5.2 GHz WLAN	5180 - 5240 MHz	12.53	0.16	< 0.1	
NII	5.3 GHz WLAN	5260 - 5320 MHz	12.64	0.15	< 0.1	
NII	5.5 GHz WLAN	5500 - 5700 MHz	12.69	0.21	< 0.1	
DSS/DTS	Bluetooth	2402 - 2480 MHz	8.94	N/A		
Simultaneous SAR per KDB 690783 D01v01r02:				0.95	1.2	1.09

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.

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
UMTS 1750	Voice/Data	1712.4 - 1752.5 MHz
GSM/GPRS/EDGE 1900	Voice/Data	1850.20 - 1909.80 MHz
UMTS 1900	Voice/Data	1852.4 - 1907.6 MHz
LTE Band 17	Data	706.5 - 713.5 MHz
LTE Band 4 (AWS)	Data	1712.5 - 1752.5 MHz
LTE Band 2 (PCS)	Data	1852.5 - 1907.5 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 GMSK (dBm)				Burst Average 8-PSK (dBm)			
			1 TX Slot	1 TX Slots	2 TX Slots	3 TX Slots	4 TX Slots	1 TX Slots	2 TX Slots	3 TX Slots
GSM/GPRS/EDGE 850	Maximum	33.2	33.2	31.2	30.2	29.2	27.7	25.7	24.7	23.7
	Nominal	32.7	32.7	30.7	29.7	28.7	27.2	25.2	24.2	23.2
GSM/GPRS/EDGE 1900	Maximum	31.7	31.7	28.7	27.7	26.7	26.7	24.7	23.7	22.7
	Nominal	31.2	31.2	28.2	27.2	26.2	26.2	24.2	23.2	22.2

Mode / Band		Modulated Average (dBm)			
		3GPP Rel 99	3GPP Rel 5	3GPP Rel 6	3GPP Rel 8
		WCDMA	HSDPA	HSUPA	DC-HSDPA
UMTS Band 5 (850 MHz)	Maximum	23.7	23.7	23.7	23.7
	Nominal	23.2	23.2	23.2	23.2
UMTS Band 4 (1750 MHz)	Maximum	24.5	24.5	24.5	24.5
	Nominal	24.0	24.0	24.0	24.0
UMTS Band 2 (1900 MHz)	Maximum	23.7	23.7	23.7	23.7
	Nominal	23.2	23.2	23.2	23.2

Mode / Band	Modulated Average (dBm)	
LTE Band 17	Maximum	23.7
	Nominal	23.2
LTE Band 4 (AWS)	Maximum	24.5
	Nominal	24.0
LTE Band 2 (PCS)	Maximum	23.7
	Nominal	23.2

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Mode / Band		Modulated Average (dBm)
IEEE 802.11b (2.4 GHz)	Maximum	16.7
	Nominal	16.0
IEEE 802.11g (2.4 GHz)	Maximum	14.7
	Nominal	14.0
IEEE 802.11n (2.4 GHz)	Maximum	12.7
	Nominal	12.0
IEEE 802.11a (5 GHz)	Maximum	12.7
	Nominal	12.0
IEEE 802.11n (5 GHz)	Maximum	10.7
	Nominal	10.0
Bluetooth	Maximum	9.2
	Nominal	8.5
Bluetooth LE	Maximum	7.2
	Nominal	6.5

1.3 DUT Antenna Locations

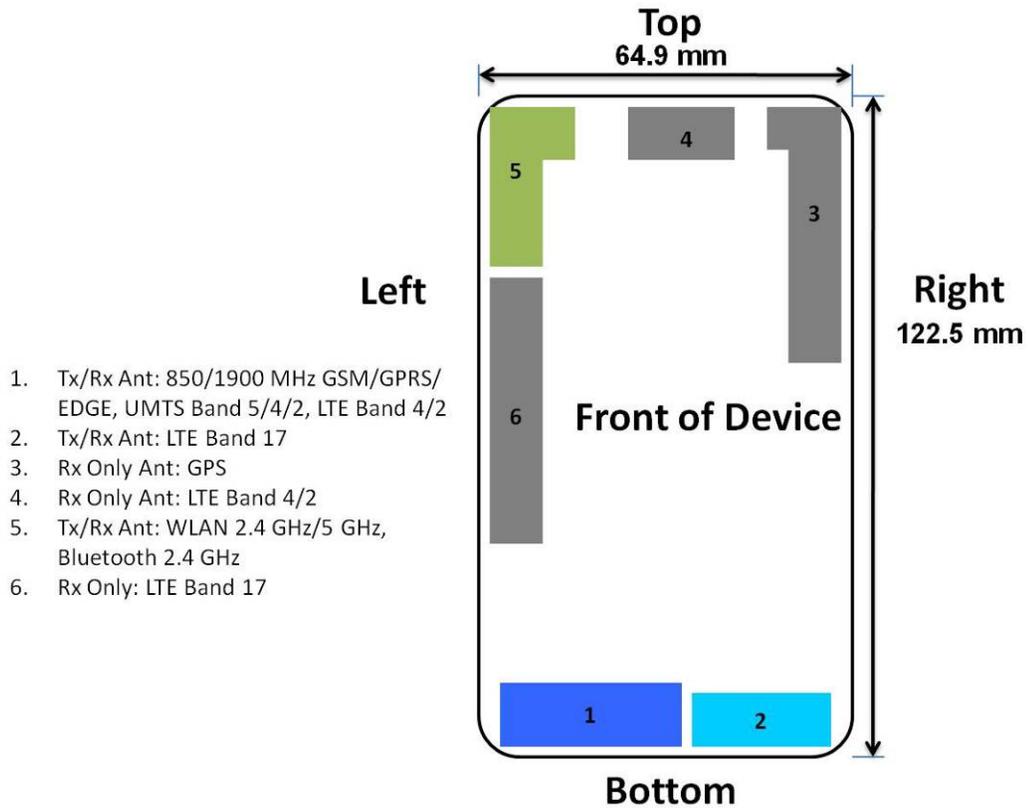


Figure 1-1
DUT Antenna Locations

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

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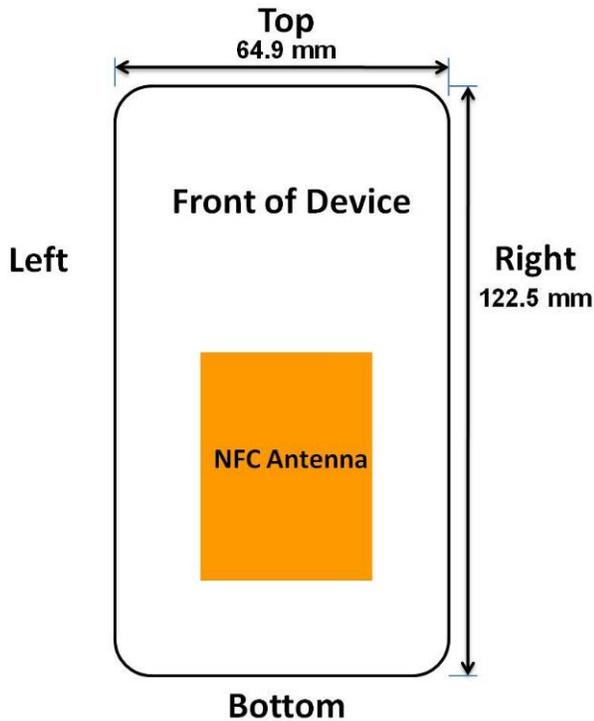
**Table 1-1
Hotspot Sides for SAR Testing**

Mode	Back	Front	Top	Bottom	Right	Left
GPRS 850	Yes	Yes	No	Yes	No	Yes
UMTS 850	Yes	Yes	No	Yes	No	Yes
UMTS 1750	Yes	Yes	No	Yes	No	Yes
GPRS 1900	Yes	Yes	No	Yes	No	Yes
UMTS 1900	Yes	Yes	No	Yes	No	Yes
LTE Band 17	Yes	Yes	No	Yes	Yes	No
LTE Band 4 (AWS)	Yes	Yes	No	Yes	No	Yes
LTE Band 2 (PCS)	Yes	Yes	No	Yes	No	Yes
2.4 GHz WLAN	Yes	Yes	Yes	No	No	Yes

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 D06v01r01 guidance, page 2. When Hotspot is enabled, all 5 GHz bands are disabled. Therefore no 5 GHz WIFI Hotspot SAR Data was required.

1.4 Near Field Communications (NFC) Antenna

This DUT has NFC operations. The NFC antenna is integrated into the specialized battery cover. The SAR tests were performed with the specialized battery cover.



**Figure 1-2
NFC Antenna Locations**

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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.

Table 1-2
Simultaneous Transmission Scenarios

No.	Capable TX Configuration	Head SAR	Body Worn SAR	Wireless Router SAR
1	GSM 850/1900 MHz Voice + WiFi 2.4Ghz	Yes	Yes	No
2	GSM 850/1900 MHz Voice + WiFi 5Ghz	Yes	Yes	No
3	GSM 850/1900 MHz Voice + Bluetooth 2.4Ghz	No	Yes	No
4	GSM/GPRS/EDGE 850/1900 MHz Data + WiFi 2.4Ghz	Yes	Yes	Yes
5	GSM/GPRS/EDGE 850/1900 MHz Data + WiFi 5Ghz	Yes	Yes	No
6	UMTS Band 2/4/5 + WiFi 2.4Ghz	Yes	Yes	Yes
7	UMTS Band 2/4/5 + WiFi 5Ghz	Yes	Yes	No
8	UMTS Band 2/4/5 + Bluetooth 2.4Ghz	No	Yes	No
9	LTE B17/4/2 + WiFi 2.4Ghz	Yes	Yes	Yes
10	LTE B17/4/2 + WiFi 5Ghz	Yes	Yes	No
11	LTE B17/4/2 + Bluetooth 2.4Ghz	No	Yes	No

1. Hotspot and WiFi-Direct (GO/GC) for WiFi 2.4GHz are supported.
 2. For WiFi 5GHz, Hotspot is not supported but WiFi-Direct is supported (WiFi-Direct: GC only in UNII I and III)
 3. VoIP for GSM, WCDMA, LTE is supported. (EX. 3rd party VoIP and VoLTE)
 4. Bluetooth and WiFi cannot transmit simultaneously since they share the same RF path.
 5. GSM, WCDMA and LTE cannot transmit simultaneously since they share the same RF path. (CSFB supported)

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.

There are no new simultaneous transmission scenarios involving WIFI direct beyond that listed in the above table.

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1.6 SAR Test Exclusions Applied

(A) WIFI/BT

Since Hotspot operations are not allowed by the chipset firmware using 5 GHz WIFI, only 2.4 GHz WIFI Hotspot SAR tests and combinations are additionally considered for SAR with respect to Wireless Router configurations according to FCC KDB 941225 D06v01r01.

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; $[(8/10) * \sqrt{2.441}] = 1.2 < 3.0$. Per KDB Publication 447498 D01v05, the maximum power of the channel was rounded to the nearest mW before calculation.

Based on the maximum conducted power of Bluetooth LE (rounded to the nearest mW) and the antenna to user separation distance, Bluetooth LE SAR was not required; $[(5/10) * \sqrt{2.440}] = 0.8 < 3.0$. 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.

(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.

Per KDB Publication 941225 D03v01 EDGE testing was excluded for SAR testing because the frame-averaged output powers were lower than the frame-averaged output powers for GPRS.

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.

LTE SAR for the higher modulations and lower bandwidths were not tested since the maximum average output power of all required channels and configurations was not more than 0.5 dB higher than the highest bandwidth; and the reported LTE SAR for the highest bandwidth was less than 1.45 W/kg for all configurations according to FCC KDB 941225 D05v02.

1.7 Power Reduction for SAR

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

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1.8 Guidance Applied

- FCC OET Bulletin 65 Supplement C [June 2001]
- IEEE 1528-2013
- FCC KDB Publication 941225 D01-D06 (2G/3G/4G and Hotspot)
- FCC KDB Publication 248227 D01v01r02 (SAR Considerations for 802.11 Devices)
- FCC KDB Publication 447498 D01v05r01 (General SAR Guidance)
- FCC KDB Publication 865664 D01-D02 (SAR Measurements up to 6 GHz)

1.9 Device Serial Numbers

Several samples with identical hardware were used 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	1610-5	1610-5	1610-5
UMTS 850	1610-5	1610-5	1610-5
UMTS 1750	1610-4	1610-4	1610-4
GSM/GPRS/EDGE 1900	1610-5	1610-5	1610-5
UMTS 1900	1610-5	1610-5	1610-5
LTE Band 17	1610-9	1610-9	1610-9
LTE Band 4 (AWS)	1610-9	1610-9	1610-9
LTE Band 2 (PCS)	1610-8	1610-8	1610-8
2.4 GHz WLAN	1610-1	1610-11	1610-11
5 GHz WLAN	2510-1	2510-1	-

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LTE INFORMATION

LTE Information			
FCC ID	ZNFD520		
Form Factor	Portable Handset		
Frequency Range of each LTE transmission band	LTE Band 17 (706.5 - 713.5 MHz)		
	LTE Band 4 (AWS) (1712.5 - 1752.5 MHz)		
	LTE Band 2 (PCS) (1852.5 - 1907.5 MHz)		
Channel Bandwidths	LTE Band 17: 5 MHz, 10 MHz		
	LTE Band 4 (AWS): 5 MHz, 10 MHz, 15 MHz, 20 MHz		
	LTE Band 2 (PCS): 5 MHz, 10 MHz		
Channel Numbers and Frequencies (MHz)	Low	Mid	High
LTE Band 17: 5 MHz	706.5 (23755)	710 (23790)	713.5 (23825)
LTE Band 17: 10 MHz	709 (23780)	710 (23790)	711 (23800)
LTE Band 4 (AWS): 5 MHz	1712.5 (19975)	1732.5 (20175)	1752.5 (20375)
LTE Band 4 (AWS): 10 MHz	1715 (20000)	1732.5 (20175)	1750 (20350)
LTE Band 4 (AWS): 15 MHz	1717.5 (20025)	1732.5 (20175)	1747.5 (20325)
LTE Band 4 (AWS): 20 MHz	1720 (20050)	1732.5 (20175)	1745 (20300)
LTE Band 2 (PCS): 5 MHz	1852.5 (18625)	1880 (18900)	1907.5 (19175)
LTE Band 2 (PCS): 10 MHz	1855 (18650)	1880 (18900)	1905 (19150)
UE Category	3		
Modulations Supported in UL	QPSK, 16QAM		
LTE MPR Permanently implemented per 3GPP TS 36.101 section 6.2.3~6.2.5? (manufacturer attestation to be provided)	YES		
A-MPR (Additional MPR) disabled for SAR Testing?	YES		

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3 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.

3.1 SAR Definition

Specific Absorption Rate is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Equation 3-1).

Equation 3-1
SAR Mathematical Equation

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

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

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

where:

- σ = conductivity of the tissue-simulating material (S/m)
- ρ = mass density of the tissue-simulating material (kg/m³)
- 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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4 DOSIMETRIC ASSESSMENT

4.1 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 4-1).
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 4-1). On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the DASYS 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.

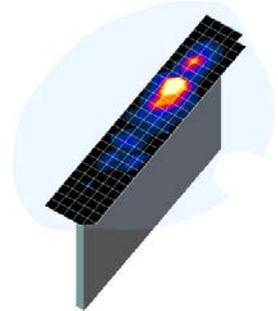


Figure 4-1
Sample SAR Area Scan

Table 4-1
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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5 DEFINITION OF REFERENCE POINTS

5.1 EAR REFERENCE POINT

Figure 5-2 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 5-1. 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 5-1). 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].

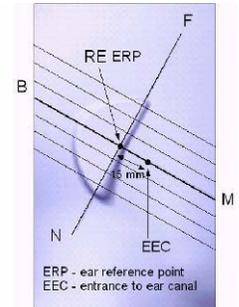


Figure 5-1
Close-Up Side view of ERP

5.2 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 5-3). 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 5-2
Front, back and side view of SAM Twin Phantom

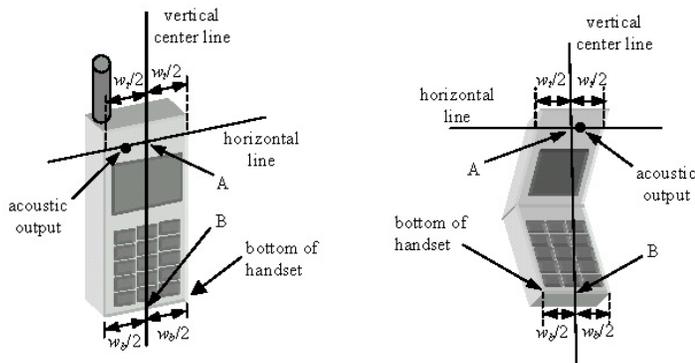


Figure 5-3
Handset Vertical Center & Horizontal Line Reference Points

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6 TEST CONFIGURATION POSITIONS FOR HANDSETS

6.1 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 $\delta = 0.02$.

6.2 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 6-1), 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.

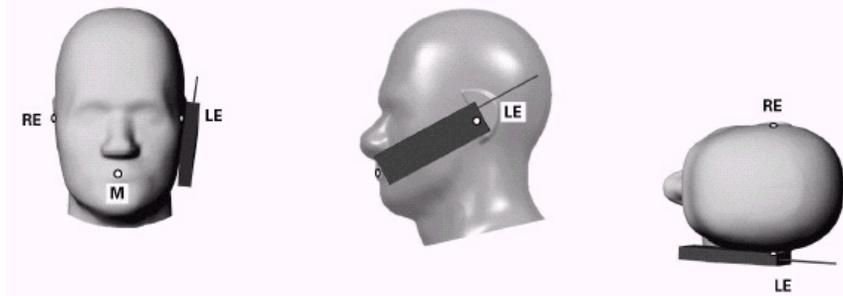


Figure 6-1 Front, Side and Top View of Cheek Position

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 6-2).

6.3 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 6-2).

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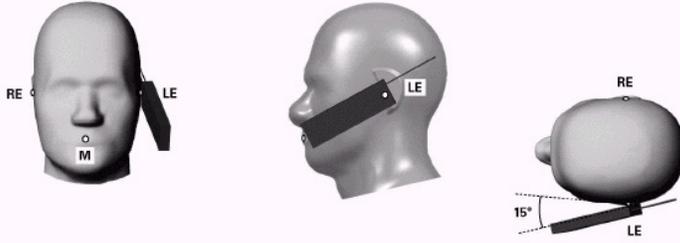


Figure 6-2 Front, Side and Top View of Ear/15° Tilt Position

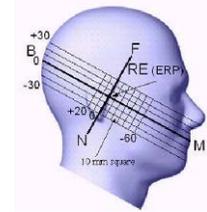


Figure 6-3 Side view w/ relevant markings

6.4 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 6-5). 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 $> 1.2 \text{ W/kg}$, 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.

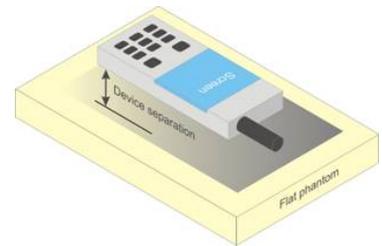


Figure 6-4 Sample Body-Worn Diagram

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.

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6.5 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.

6.6 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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7 RF EXPOSURE LIMITS

7.1 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.

7.2 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 7-1
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)
Peak Spatial Average SAR Head	1.6	8.0
Whole Body SAR	0.08	0.4
Peak Spatial Average SAR 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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8 FCC MEASUREMENT PROCEDURES

Power measurements were performed using a base station simulator under digital average power.

8.1 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.

8.2 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.

8.3 SAR Measurement Conditions for UMTS

8.3.1 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.

8.3.2 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.

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8.3.3 Body SAR Measurements

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

8.3.4 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	β_c	β_d	β_d (SF)	β_c/β_d	β_{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 $\Delta_{CQI} = 8 \Rightarrow A_{HS} = \beta_{HS}/\beta_c = 30/15 \Rightarrow \beta_{HS} = 30/15 * \beta_c$.
 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, Δ_{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 8-1
Table C.10.1.4 of TS 234.121-1

8.3.5 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	β_c	β_d	β_d (SF)	β_c/β_d	$\beta_{w(1)}$	$\beta_{w(2)}$	$\beta_{w(3)}$	$\beta_{w(4)}$	$\beta_{w(5)}$	$\beta_{w(6)}$	CM ⁽²⁾	MPR (dB)	ACI ⁽⁴⁾ Index	E-TFCl
1	11/15 ⁽³⁾	15/15 ⁽³⁾	64	11/15 ⁽³⁾	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	$\beta_{w(1)}: 47/15$ $\beta_{w(2)}: 47/15$	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 ⁽⁴⁾	15/15 ⁽⁴⁾	64	15/15 ⁽⁴⁾	30/15	24/15	134/15	4	1	1.0	0.0	21	81	

Note 1: $\Delta_{ACI} = \Delta_{MPC} = \Delta_{CCQ} = 8 \Rightarrow A_{10} = \beta_w/\beta_c = 30/15 \Rightarrow \beta_w = 30/15 * \beta_c$.
Note 2: CM = 1 for $\beta_c/\beta_d = 12/15$, $\beta_w/\beta_c = 24/15$. 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 β_c/β_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 β_c/β_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: $\beta_{w(1)}$ can not be set directly; it is set by Absolute Grant Value.

8.3.6 SAR Measurements Considerations for DC-HSDPA

SAR test exclusion for DC-HSDPA devices is determined by power measurements according to the H-Set 12, Fixed Reference Channel (FRC) configuration in Table C.8.1.12 of 3GPP TS 34.121-1. A primary and a secondary serving HS-DSCH Cell are required to perform the power measurement and for the results to qualify for SAR test exclusion. DC-HSDPA uplink maximum output power measurements using the four Rel. 5 HSDPA subtests in Table C.10.1.4 of TS 234.121-1 is required.

When the maximum average output power of each RF channel with DC-HSDPA active is $\leq 1/4$ dB higher than that measured using 12.2 kbps RMC, or the maximum reported SAR for 12.2 kbps RMC is $\leq 75\%$ of the SAR limit, SAR evaluation for DC-HSDPA is not required.

8.4 SAR Measurement Conditions for LTE

LTE modes were tested according to FCC KDB 941225 D05v02 publication. Please see notes after the tabulated SAR data for required test configurations. Establishing connections with base station simulators ensure a consistent means for testing SAR and are recommended for evaluating SAR [4]. The R&S CMW500 was used for LTE output power measurements and SAR testing. Closed loop power control was used so the UE transmits with maximum output power during SAR testing.

8.4.1 Spectrum Plots for RB Configurations

A properly configured base station simulator was used for SAR tests and power measurements. Therefore, spectrum plots for RB configurations were not required to be included in this report.

8.4.2 MPR

MPR is permanently implemented for this device by the manufacturer. The specific manufacturer target MPR is indicated alongside the SAR results. MPR is enabled for this device, according to 3GPP TS36.101 Section 6.2.3 – 6.2.5 under Table 6.2.3-1.

8.4.3 A-MPR

A-MPR (Additional MPR) has been disabled for all SAR tests by setting NS=01 on the base station simulator.

8.4.4 Required RB Size and RB Offsets for SAR Testing

According to FCC KDB 941225 D05v02r01:

- a. Per Section 5.2.1, SAR is required for QPSK 1 RB Allocation for the largest bandwidth
 - i. The required channel and offset combination with the highest maximum output power is required for SAR.
 - ii. When the reported SAR is ≤ 0.8 W/kg, testing of the remaining RB offset configurations and required test channels is not required. Otherwise, SAR is

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- required for the remaining required test channels using the RB offset configuration with highest output power for that channel.
- iii. When the reported SAR for a required test channel is > 1.45 W/kg, SAR is required for all RB offset configurations for that channel.
 - b. Per Section 5.2.2, SAR is required for 50% RB allocation using the largest bandwidth following the same procedures outlined in Section 5.2.1.
 - c. Per Section 5.2.3, QPSK SAR is not required for the 100% allocation when the highest maximum output power for the 100% allocation is less than the highest maximum output power of the 1 RB and 50% RB allocations and the reported SAR for the 1 RB and 50% RB allocations is < 0.8 W/kg.
 - d. Per Section 5.2.4 and 5.3, SAR tests for higher order modulations and lower bandwidths configurations are not required when the conducted power of the required test configurations determined by Sections 5.2.1 through 5.2.3 is less than or equal to ½ dB higher than the equivalent configuration using QPSK modulation and when the QPSK SAR for those configurations is <1.45 W/kg.

8.5 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.

8.5.1 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.

8.5.2 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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9 RF CONDUCTED POWERS

9.1 GSM Conducted Powers

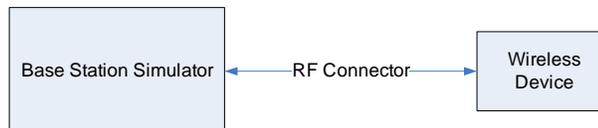
		Maximum Burst-Averaged Output Power								
		Voice	GPRS/EDGE Data (GMSK)				EDGE Data (8-PSK)			
Band	Channel	GSM [dBm] CS (1 Slot)	GPRS [dBm] 1 Tx Slot	GPRS [dBm] 2 Tx Slot	GPRS [dBm] 3 Tx Slot	GPRS [dBm] 4 Tx Slot	EDGE [dBm] 1 Tx Slot	EDGE [dBm] 2 Tx Slot	EDGE [dBm] 3 Tx Slot	EDGE [dBm] 4 Tx Slot
GSM 850	128	32.99	33.05	30.80	29.80	28.72	27.23	25.27	24.05	23.04
	190	32.93	33.00	30.75	29.71	28.62	27.21	25.25	23.92	22.97
	251	32.88	32.94	30.71	29.60	28.50	27.20	25.15	23.87	22.88
GSM 1900	512	31.12	30.92	28.12	27.01	25.87	26.12	23.98	22.86	21.91
	661	31.03	30.90	28.03	26.97	26.01	26.05	24.05	22.80	21.99
	810	31.00	30.86	28.17	26.99	25.97	25.99	24.13	22.85	21.93

		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	GPRS [dBm] 3 Tx Slot	GPRS [dBm] 4 Tx Slot	EDGE [dBm] 1 Tx Slot	EDGE [dBm] 2 Tx Slot	EDGE [dBm] 3 Tx Slot	EDGE [dBm] 4 Tx Slot
GSM 850	128	23.96	24.02	24.78	25.54	25.71	18.20	19.25	19.79	20.03
	190	23.90	23.97	24.73	25.45	25.61	18.18	19.23	19.66	19.96
	251	23.85	23.91	24.69	25.34	25.49	18.17	19.13	19.61	19.87
GSM 1900	512	22.09	21.89	22.10	22.75	22.86	17.09	17.96	18.60	18.90
	661	22.00	21.87	22.01	22.71	23.00	17.02	18.03	18.54	18.98
	810	21.97	21.83	22.15	22.73	22.96	16.96	18.11	18.59	18.92

Notes:

- 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 bolded GPRS modes were selected for SAR testing according to the highest frame-averaged output power table according to KDB 941225 D03v01.
- 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: 12 (Max 4 Tx uplink slots)
EDGE Multislot class: 12 (Max 4 Tx uplink slots)
DTM Multislot Class: N/A



**Figure 9-1
Power Measurement Setup**

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9.2 UMTS Conducted Powers

3GPP Release Version	Mode	3GPP 34.121 Subtest	Cellular Band [dBm]			AWS Band [dBm]			PCS Band [dBm]			3GPP MPR [dB]
			4132	4183	4233	1312	1412	1862	9262	9400	9538	
99	WCDMA	12.2 kbps RMC	23.21	23.67	23.53	24.12	24.37	24.20	23.42	23.60	23.46	-
99		12.2 kbps AMR	23.00	23.30	23.31	23.89	23.96	24.02	23.23	23.34	23.28	-
6	HSDPA	Subtest 1	23.13	23.63	23.50	24.21	24.13	24.19	23.39	23.55	23.41	0
6		Subtest 2	23.25	23.66	23.61	24.17	24.25	24.16	23.33	23.48	23.30	0
6		Subtest 3	22.72	23.15	23.07	23.88	24.00	24.00	22.88	22.98	22.79	0.5
6		Subtest 4	22.67	23.14	23.05	23.85	23.98	23.92	22.82	23.05	22.80	0.5
6	HSUPA	Subtest 1	21.92	21.72	22.60	23.27	23.25	23.30	23.20	23.06	22.77	0
6		Subtest 2	21.47	22.01	21.85	22.12	22.21	22.56	21.79	22.12	21.81	2
6		Subtest 3	21.68	22.50	21.81	22.66	23.39	22.66	22.15	22.04	22.05	1
6		Subtest 4	21.36	22.36	22.10	23.85	22.85	23.82	22.14	22.09	21.87	2
6		Subtest 5	22.12	23.08	23.20	23.48	23.55	23.30	23.41	23.35	22.97	0
8	DC-HSDPA	Subtest 1	23.03	23.49	23.49	24.03	24.00	24.10	22.99	23.20	23.07	0
8		Subtest 2	22.52	22.99	22.67	23.82	23.97	23.82	22.91	23.15	23.13	0
8		Subtest 3	22.34	22.59	22.58	23.04	23.24	23.10	22.56	22.65	22.51	0.5
8		Subtest 4	22.34	22.54	22.24	22.75	22.94	23.00	22.13	21.89	22.13	0.5

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.

DC-HSDPA considerations

- 3GPP Specification 34.121-1 Release 8 Ver 8.10.0 was used for DC-HSDPA guidance
- H-Set 12 (QPSK) was confirmed to be used during DC-HSDPA measurements
- Measured maximum output powers for DC-HSDPA were not greater than 1/4 dB higher than the WCDMA 12.2 kbps RMC maximum output, as a result, SAR is not required for DC-HSDPA
- The DUT supports UE category 24 for HSDPA

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



Figure 9-2
Power Measurement Setup

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9.3 LTE Conducted Powers

9.3.1 LTE Band 17

Table 9-1
LTE Band 17 Conducted Powers - 10 MHz Bandwidth

Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	Target MPR [dB]	MPR Allowed per 3GPP [dB]
710.0	23790	10	QPSK	1	0	23.20	0	0
710.0	23790	10	QPSK	1	25	23.56	0	0
710.0	23790	10	QPSK	1	49	23.69	0	0
710.0	23790	10	QPSK	25	0	22.29	1	0-1
710.0	23790	10	QPSK	25	12	22.34	1	0-1
710.0	23790	10	QPSK	25	25	22.21	1	0-1
710.0	23790	10	QPSK	50	0	22.20	1	0-1
710.0	23790	10	16QAM	1	0	21.83	1	0-1
710.0	23790	10	16QAM	1	25	22.08	1	0-1
710.0	23790	10	16QAM	1	49	22.20	1	0-1
710.0	23790	10	16QAM	25	0	21.31	2	0-2
710.0	23790	10	16QAM	25	12	21.33	2	0-2
710.0	23790	10	16QAM	25	25	21.34	2	0-2
710.0	23790	10	16QAM	50	0	21.20	2	0-2

Note: LTE Band 17 at 10 MHz bandwidth does not support three non-overlapping channels. Per KDB Publication 941225 D05v02, when a device supports overlapping channel assignment in a channel bandwidth configuration, the middle channel of the group of overlapping channels should be selected for testing.

Table 9-2
LTE Band 17 Conducted Powers - 5 MHz Bandwidth

Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	Target MPR [dB]	MPR Allowed per 3GPP [dB]
710.0	23790	5	QPSK	1	0	23.49	0	0
710.0	23790	5	QPSK	1	12	23.61	0	0
710.0	23790	5	QPSK	1	24	23.62	0	0
710.0	23790	5	QPSK	12	0	22.38	1	0-1
710.0	23790	5	QPSK	12	6	22.47	1	0-1
710.0	23790	5	QPSK	12	13	22.58	1	0-1
710.0	23790	5	QPSK	25	0	22.34	1	0-1
710.0	23790	5	16-QAM	1	0	21.81	1	0-1
710.0	23790	5	16-QAM	1	12	21.90	1	0-1
710.0	23790	5	16-QAM	1	24	22.02	1	0-1
710.0	23790	5	16-QAM	12	0	21.41	2	0-2
710.0	23790	5	16-QAM	12	6	21.50	2	0-2
710.0	23790	5	16-QAM	12	13	21.55	2	0-2
710.0	23790	5	16-QAM	25	0	21.27	2	0-2

Note: LTE Band 17 at 5 MHz bandwidth does not support three non-overlapping channels. Per KDB Publication 941225 D05v02, when a device supports overlapping channel assignment in a channel bandwidth configuration, the middle channel of the group of overlapping channels should be selected for testing.

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LTE Band 4 (AWS)

Table 9-3

LTE Band 4 (AWS) Conducted Powers - 20 MHz Bandwidth

Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	Target MPR [dB]	MPR Allowed per 3GPP [dB]
1732.5	20175	20	QPSK	1	0	24.05	0	0
1732.5	20175	20	QPSK	1	50	24.07	0	0
1732.5	20175	20	QPSK	1	99	24.03	0	0
1732.5	20175	20	QPSK	50	0	23.01	1	0-1
1732.5	20175	20	QPSK	50	25	23.00	1	0-1
1732.5	20175	20	QPSK	50	50	23.00	1	0-1
1732.5	20175	20	QPSK	100	0	23.00	1	0-1
1732.5	20175	20	16QAM	1	0	22.85	1	0-1
1732.5	20175	20	16QAM	1	50	23.08	1	0-1
1732.5	20175	20	16QAM	1	99	23.02	1	0-1
1732.5	20175	20	16QAM	50	0	21.86	2	0-2
1732.5	20175	20	16QAM	50	25	21.76	2	0-2
1732.5	20175	20	16QAM	50	50	21.75	2	0-2
1732.5	20175	20	16QAM	100	0	21.80	2	0-2

Note: LTE Band 4 (AWS) at 20 MHz bandwidth does not support three non-overlapping channels. Per KDB Publication 941225 D05v02, when a device supports overlapping channel assignment in a channel bandwidth configuration, the middle channel of the group of overlapping channels should be selected for testing.

Table 9-4

LTE Band 4 (AWS) Conducted Powers - 15 MHz Bandwidth

Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	Target MPR [dB]	MPR Allowed per 3GPP [dB]
1717.5	20025	15	QPSK	1	0	24.31	0	0
1717.5	20025	15	QPSK	1	36	24.15	0	0
1717.5	20025	15	QPSK	1	74	24.26	0	0
1717.5	20025	15	QPSK	36	0	23.02	1	0-1
1717.5	20025	15	QPSK	36	18	23.01	1	0-1
1717.5	20025	15	QPSK	36	37	23.01	1	0-1
1717.5	20025	15	QPSK	75	0	23.02	1	0-1
1717.5	20025	15	16QAM	1	0	23.23	1	0-1
1717.5	20025	15	16QAM	1	36	23.21	1	0-1
1717.5	20025	15	16QAM	1	74	23.19	1	0-1
1717.5	20025	15	16QAM	36	0	22.00	2	0-2
1717.5	20025	15	16QAM	36	18	22.02	2	0-2
1717.5	20025	15	16QAM	36	37	22.01	2	0-2
1717.5	20025	15	16QAM	75	0	22.01	2	0-2
1732.5	20175	15	QPSK	1	0	24.49	0	0
1732.5	20175	15	QPSK	1	36	24.47	0	0
1732.5	20175	15	QPSK	1	74	24.47	0	0
1732.5	20175	15	QPSK	36	0	23.22	1	0-1
1732.5	20175	15	QPSK	36	18	23.14	1	0-1
1732.5	20175	15	QPSK	36	37	23.11	1	0-1
1732.5	20175	15	QPSK	75	0	23.02	1	0-1
1732.5	20175	15	16QAM	1	0	23.03	1	0-1
1732.5	20175	15	16QAM	1	36	22.85	1	0-1
1732.5	20175	15	16QAM	1	74	22.90	1	0-1
1732.5	20175	15	16QAM	36	0	22.15	2	0-2
1732.5	20175	15	16QAM	36	18	22.06	2	0-2
1732.5	20175	15	16QAM	36	37	22.07	2	0-2
1732.5	20175	15	16QAM	75	0	22.03	2	0-2
1747.5	20325	15	QPSK	1	0	24.32	0	0
1747.5	20325	15	QPSK	1	36	24.36	0	0
1747.5	20325	15	QPSK	1	74	24.28	0	0
1747.5	20325	15	QPSK	36	0	23.12	1	0-1
1747.5	20325	15	QPSK	36	18	23.08	1	0-1
1747.5	20325	15	QPSK	36	37	23.12	1	0-1
1747.5	20325	15	QPSK	75	0	23.04	1	0-1
1747.5	20325	15	16QAM	1	0	23.33	1	0-1
1747.5	20325	15	16QAM	1	36	23.23	1	0-1
1747.5	20325	15	16QAM	1	74	23.18	1	0-1
1747.5	20325	15	16QAM	36	0	22.07	2	0-2
1747.5	20325	15	16QAM	36	18	22.07	2	0-2
1747.5	20325	15	16QAM	36	37	22.06	2	0-2
1747.5	20325	15	16QAM	75	0	22.01	2	0-2

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**Table 9-5
LTE Band 4 (AWS) Conducted Powers - 10 MHz Bandwidth**

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	Target MPR [dB]	MPR Allowed per 3GPP [dB]
Low	1715	20000	10	QPSK	1	0	24.31	0	0
	1715	20000	10	QPSK	1	25	24.10	0	0
	1715	20000	10	QPSK	1	49	24.21	0	0
	1715	20000	10	QPSK	25	0	23.02	1	0-1
	1715	20000	10	QPSK	25	12	23.00	1	0-1
	1715	20000	10	QPSK	25	25	23.01	1	0-1
	1715	20000	10	QPSK	50	0	22.75	1	0-1
	1715	20000	10	16QAM	1	0	22.87	1	0-1
	1715	20000	10	16QAM	1	25	22.77	1	0-1
	1715	20000	10	16QAM	1	49	22.61	1	0-1
	1715	20000	10	16QAM	25	0	21.91	2	0-2
	1715	20000	10	16QAM	25	12	21.81	2	0-2
Mid	1732.5	20175	10	QPSK	1	0	24.11	0	0
	1732.5	20175	10	QPSK	1	25	24.11	0	0
	1732.5	20175	10	QPSK	1	49	24.07	0	0
	1732.5	20175	10	QPSK	25	0	23.01	1	0-1
	1732.5	20175	10	QPSK	25	12	23.00	1	0-1
	1732.5	20175	10	QPSK	25	25	23.01	1	0-1
	1732.5	20175	10	QPSK	50	0	23.01	1	0-1
	1732.5	20175	10	16QAM	1	0	23.03	1	0-1
	1732.5	20175	10	16QAM	1	25	23.01	1	0-1
	1732.5	20175	10	16QAM	1	49	23.06	1	0-1
	1732.5	20175	10	16QAM	25	0	22.00	2	0-2
	1732.5	20175	10	16QAM	25	12	21.88	2	0-2
High	1750	20350	10	QPSK	1	0	24.38	0	0
	1750	20350	10	QPSK	1	25	24.18	0	0
	1750	20350	10	QPSK	1	49	24.15	0	0
	1750	20350	10	QPSK	25	0	23.01	1	0-1
	1750	20350	10	QPSK	25	12	23.01	1	0-1
	1750	20350	10	QPSK	25	25	23.10	1	0-1
	1750	20350	10	QPSK	50	0	23.00	1	0-1
	1750	20350	10	16QAM	1	0	23.00	1	0-1
	1750	20350	10	16QAM	1	25	22.78	1	0-1
	1750	20350	10	16QAM	1	49	22.87	1	0-1
	1750	20350	10	16QAM	25	0	21.98	2	0-2
	1750	20350	10	16QAM	25	12	21.94	2	0-2
1750	20350	10	16QAM	25	25	21.91	2	0-2	
1750	20350	10	16QAM	50	0	21.82	2	0-2	

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**Table 9-6
LTE Band 4 (AWS) Conducted Powers - 5 MHz Bandwidth**

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	Target MPR [dB]	MPR Allowed per 3GPP [dB]
Low	1712.5	19975	5	QPSK	1	0	24.25	0	0
	1712.5	19975	5	QPSK	1	12	24.10	0	0
	1712.5	19975	5	QPSK	1	24	24.09	0	0
	1712.5	19975	5	QPSK	12	0	23.04	1	0-1
	1712.5	19975	5	QPSK	12	6	23.00	1	0-1
	1712.5	19975	5	QPSK	12	13	23.01	1	0-1
	1712.5	19975	5	QPSK	25	0	23.02	1	0-1
	1712.5	19975	5	16-QAM	1	0	23.13	1	0-1
	1712.5	19975	5	16-QAM	1	12	23.01	1	0-1
	1712.5	19975	5	16-QAM	1	24	23.02	1	0-1
	1712.5	19975	5	16-QAM	12	0	22.09	2	0-2
	1712.5	19975	5	16-QAM	12	6	22.06	2	0-2
1712.5	19975	5	16-QAM	12	13	22.04	2	0-2	
1712.5	19975	5	16-QAM	25	0	21.87	2	0-2	
Mid	1732.5	20175	5	QPSK	1	0	24.14	0	0
	1732.5	20175	5	QPSK	1	12	24.04	0	0
	1732.5	20175	5	QPSK	1	24	24.04	0	0
	1732.5	20175	5	QPSK	12	0	23.00	1	0-1
	1732.5	20175	5	QPSK	12	6	23.03	1	0-1
	1732.5	20175	5	QPSK	12	13	23.01	1	0-1
	1732.5	20175	5	QPSK	25	0	23.00	1	0-1
	1732.5	20175	5	16-QAM	1	0	23.33	1	0-1
	1732.5	20175	5	16-QAM	1	12	23.24	1	0-1
	1732.5	20175	5	16-QAM	1	24	23.21	1	0-1
	1732.5	20175	5	16-QAM	12	0	22.11	2	0-2
	1732.5	20175	5	16-QAM	12	6	22.09	2	0-2
1732.5	20175	5	16-QAM	12	13	22.06	2	0-2	
1732.5	20175	5	16-QAM	25	0	22.01	2	0-2	
High	1752.5	20375	5	QPSK	1	0	24.10	0	0
	1752.5	20375	5	QPSK	1	12	24.12	0	0
	1752.5	20375	5	QPSK	1	24	24.17	0	0
	1752.5	20375	5	QPSK	12	0	23.17	1	0-1
	1752.5	20375	5	QPSK	12	6	23.16	1	0-1
	1752.5	20375	5	QPSK	12	13	23.09	1	0-1
	1752.5	20375	5	QPSK	25	0	23.06	1	0-1
	1752.5	20375	5	16-QAM	1	0	22.87	1	0-1
	1752.5	20375	5	16-QAM	1	12	22.92	1	0-1
	1752.5	20375	5	16-QAM	1	24	22.87	1	0-1
	1752.5	20375	5	16-QAM	12	0	22.21	2	0-2
	1752.5	20375	5	16-QAM	12	6	22.22	2	0-2
1752.5	20375	5	16-QAM	12	13	22.19	2	0-2	
1752.5	20375	5	16-QAM	25	0	22.05	2	0-2	

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LTE Band 2 (PCS)

Table 9-7
LTE Band 2 (PCS) Conducted Powers - 10 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	Target MPR [dB]	MPR Allowed per 3GPP [dB]
Low	1855	18650	10	QPSK	1	0	23.48	0	0
	1855	18650	10	QPSK	1	25	23.53	0	0
	1855	18650	10	QPSK	1	49	23.34	0	0
	1855	18650	10	QPSK	25	0	22.28	1	0-1
	1855	18650	10	QPSK	25	12	22.20	1	0-1
	1855	18650	10	QPSK	25	25	22.24	1	0-1
	1855	18650	10	QPSK	50	0	22.22	1	0-1
	1855	18650	10	16QAM	1	0	22.23	1	0-1
	1855	18650	10	16QAM	1	25	22.28	1	0-1
	1855	18650	10	16QAM	1	49	22.27	1	0-1
	1855	18650	10	16QAM	25	0	21.33	2	0-2
	1855	18650	10	16QAM	25	12	21.22	2	0-2
	1855	18650	10	16QAM	25	25	21.26	2	0-2
1855	18650	10	16QAM	50	0	21.25	2	0-2	
Mid	1880.0	18900	10	QPSK	1	0	23.54	0	0
	1880.0	18900	10	QPSK	1	25	23.65	0	0
	1880.0	18900	10	QPSK	1	49	23.51	0	0
	1880.0	18900	10	QPSK	25	0	22.31	1	0-1
	1880.0	18900	10	QPSK	25	12	22.32	1	0-1
	1880.0	18900	10	QPSK	25	25	22.21	1	0-1
	1880.0	18900	10	QPSK	50	0	22.20	1	0-1
	1880.0	18900	10	16QAM	1	0	22.43	1	0-1
	1880.0	18900	10	16QAM	1	25	22.44	1	0-1
	1880.0	18900	10	16QAM	1	49	22.41	1	0-1
	1880.0	18900	10	16QAM	25	0	21.39	2	0-2
	1880.0	18900	10	16QAM	25	12	21.45	2	0-2
	1880.0	18900	10	16QAM	25	25	21.28	2	0-2
1880.0	18900	10	16QAM	50	0	21.25	2	0-2	
High	1905	19150	10	QPSK	1	0	23.60	0	0
	1905	19150	10	QPSK	1	25	23.56	0	0
	1905	19150	10	QPSK	1	49	23.48	0	0
	1905	19150	10	QPSK	25	0	22.25	1	0-1
	1905	19150	10	QPSK	25	12	22.21	1	0-1
	1905	19150	10	QPSK	25	25	22.22	1	0-1
	1905	19150	10	QPSK	50	0	22.20	1	0-1
	1905	19150	10	16QAM	1	0	22.30	1	0-1
	1905	19150	10	16QAM	1	25	22.31	1	0-1
	1905	19150	10	16QAM	1	49	22.29	1	0-1
	1905	19150	10	16QAM	25	0	21.39	2	0-2
	1905	19150	10	16QAM	25	12	21.25	2	0-2
	1905	19150	10	16QAM	25	25	21.26	2	0-2
1905	19150	10	16QAM	50	0	21.23	2	0-2	

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**Table 9-8
LTE Band 2 (PCS) Conducted Powers - 5 MHz Bandwidth**

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	Target MPR [dB]	MPR Allowed per 3GPP [dB]
Low	1852.5	18625	5	QPSK	1	0	23.61	0	0
	1852.5	18625	5	QPSK	1	12	23.54	0	0
	1852.5	18625	5	QPSK	1	24	23.51	0	0
	1852.5	18625	5	QPSK	12	0	22.44	1	0-1
	1852.5	18625	5	QPSK	12	6	22.40	1	0-1
	1852.5	18625	5	QPSK	12	13	22.45	1	0-1
	1852.5	18625	5	QPSK	25	0	22.42	1	0-1
	1852.5	18625	5	16-QAM	1	0	22.22	1	0-1
	1852.5	18625	5	16-QAM	1	12	22.31	1	0-1
	1852.5	18625	5	16-QAM	1	24	22.26	1	0-1
	1852.5	18625	5	16-QAM	12	0	21.43	2	0-2
	1852.5	18625	5	16-QAM	12	6	21.47	2	0-2
	1852.5	18625	5	16-QAM	12	13	21.44	2	0-2
1852.5	18625	5	16-QAM	25	0	21.30	2	0-2	
Mid	1880.0	18900	5	QPSK	1	0	23.70	0	0
	1880.0	18900	5	QPSK	1	12	23.59	0	0
	1880.0	18900	5	QPSK	1	24	23.47	0	0
	1880.0	18900	5	QPSK	12	0	22.48	1	0-1
	1880.0	18900	5	QPSK	12	6	22.47	1	0-1
	1880.0	18900	5	QPSK	12	13	22.45	1	0-1
	1880.0	18900	5	QPSK	25	0	22.43	1	0-1
	1880.0	18900	5	16-QAM	1	0	22.20	1	0-1
	1880.0	18900	5	16-QAM	1	12	22.32	1	0-1
	1880.0	18900	5	16-QAM	1	24	22.31	1	0-1
	1880.0	18900	5	16-QAM	12	0	21.46	2	0-2
	1880.0	18900	5	16-QAM	12	6	21.42	2	0-2
	1880.0	18900	5	16-QAM	12	13	21.47	2	0-2
1880.0	18900	5	16-QAM	25	0	21.40	2	0-2	
High	1907.5	19175	5	QPSK	1	0	23.62	0	0
	1907.5	19175	5	QPSK	1	12	23.63	0	0
	1907.5	19175	5	QPSK	1	24	23.51	0	0
	1907.5	19175	5	QPSK	12	0	22.39	1	0-1
	1907.5	19175	5	QPSK	12	6	22.33	1	0-1
	1907.5	19175	5	QPSK	12	13	22.36	1	0-1
	1907.5	19175	5	QPSK	25	0	22.30	1	0-1
	1907.5	19175	5	16-QAM	1	0	22.21	1	0-1
	1907.5	19175	5	16-QAM	1	12	22.20	1	0-1
	1907.5	19175	5	16-QAM	1	24	22.26	1	0-1
	1907.5	19175	5	16-QAM	12	0	21.35	2	0-2
	1907.5	19175	5	16-QAM	12	6	21.36	2	0-2
	1907.5	19175	5	16-QAM	12	13	21.33	2	0-2
1907.5	19175	5	16-QAM	25	0	21.37	2	0-2	

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9.4 WLAN Conducted Powers

Table 9-9
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*	16.31	16.35	16.45	16.43
802.11b	2437	6*	16.40	16.35	16.39	16.42
802.11b	2462	11*	16.46	16.44	16.47	16.43

Table 9-10
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	14.53	14.46	14.49	14.53	14.48	14.48	14.52	14.51
802.11g	2437	6	14.40	14.44	14.48	14.36	14.41	14.40	14.40	14.38
802.11g	2462	11	14.61	14.55	14.59	14.57	14.56	14.52	14.47	14.49

Table 9-11
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	12.57	12.65	12.50	12.56	12.54	12.56	12.53	12.57
802.11n	2437	6	12.47	12.45	12.43	12.46	12.47	12.46	12.51	12.52
802.11n	2462	11	12.66	12.61	12.61	12.66	12.60	12.69	12.60	12.63

Table 9-12
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*	12.24	12.28	12.29	12.24	12.23	12.18	12.17	12.23
802.11a	5200	40	12.30	12.33	12.43	12.34	12.35	12.33	12.22	12.30
802.11a	5220	44	12.50	12.44	12.44	12.28	12.37	12.34	12.34	12.40
802.11a	5240	48*	12.53	12.53	12.41	12.50	12.42	12.41	12.40	12.38
802.11a	5260	52*	12.27	12.42	12.20	12.53	12.65	12.07	12.45	12.49
802.11a	5280	56	12.64	12.55	12.13	12.55	12.60	12.43	12.51	12.34
802.11a	5300	60	12.61	12.34	12.18	12.14	12.15	12.12	12.13	12.03
802.11a	5320	64*	12.09	12.66	12.69	12.60	12.63	12.66	12.65	12.55
802.11a	5500	100	12.30	12.26	12.28	12.67	12.14	12.36	12.44	12.51
802.11a	5520	104*	12.48	12.36	12.31	12.06	12.42	12.34	12.04	12.32
802.11a	5540	108	12.31	12.06	12.48	12.38	12.51	12.21	12.36	12.18
802.11a	5560	112	12.69	12.63	12.06	12.15	12.31	12.21	12.20	12.25
802.11a	5580	116*	12.53	12.06	12.01	12.21	12.01	12.04	12.22	12.16
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	12.27	12.08	12.05	12.16	12.22	12.13	12.19	11.83
802.11a	5680	136*	12.41	12.39	12.41	12.55	12.50	12.50	12.38	12.25
802.11a	5700	140	12.35	12.30	12.50	12.44	12.49	12.37	12.39	12.42
802.11a	5745	149*	11.94	12.02	12.01	11.90	11.89	11.82	11.89	12.00
802.11a	5765	153	11.98	12.05	12.10	11.87	12.00	12.08	12.04	11.96
802.11a	5785	157*	11.69	11.95	12.14	12.09	12.10	12.01	12.07	12.00
802.11a	5805	161*	12.08	12.12	12.11	12.05	12.26	12.05	12.12	11.68
802.11a	5825	165	12.02	12.10	11.63	12.09	12.01	12.04	12.09	12.10

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 9-13
IEEE 802.11n Average RF Power – 20 MHz Bandwidth

Mode	Freq	Channel	20MHz BW 802.11n (5GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
	[MHz]		6.5	13	19.5	26	39	52	58.5	65
802.11n	5180	36	10.51	10.50	10.46	10.43	10.42	10.43	10.41	9.91
802.11n	5200	40	10.36	10.16	10.40	10.30	10.22	10.29	10.18	10.19
802.11n	5220	44	10.45	10.44	10.31	10.24	10.30	10.27	10.42	10.25
802.11n	5240	48	10.46	10.67	10.08	10.34	10.24	10.19	10.65	10.41
802.11n	5260	52	10.45	10.42	10.40	10.31	10.25	10.29	10.10	10.33
802.11n	5280	56	10.45	10.49	10.48	10.40	10.29	10.42	10.28	10.42
802.11n	5300	60	10.69	10.68	10.68	10.55	10.43	10.39	10.31	10.43
802.11n	5320	64	10.57	10.56	10.63	10.50	10.41	10.38	10.41	10.40
802.11n	5500	100	9.75	10.29	10.39	10.40	10.33	10.26	10.26	10.26
802.11n	5520	104	9.75	10.42	10.41	10.37	9.96	10.27	10.29	10.25
802.11n	5540	108	10.28	10.32	10.30	10.07	10.26	10.28	10.30	10.24
802.11n	5560	112	10.33	10.36	10.03	10.16	10.26	10.28	10.34	10.11
802.11n	5580	116	9.89	10.31	10.37	10.42	10.34	10.33	10.35	10.27
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	10.43	10.21	10.19	10.35	10.36	10.41	10.37	10.33
802.11n	5680	136	10.52	10.39	10.45	10.48	10.35	10.43	10.39	10.36
802.11n	5700	140	9.99	9.83	10.41	10.52	10.46	10.44	10.55	10.43
802.11n	5745	149	10.07	10.00	9.92	9.98	9.90	9.90	9.83	9.79
802.11n	5765	153	10.01	10.06	10.07	10.06	9.94	9.95	9.97	9.92
802.11n	5785	157	10.11	10.05	10.06	10.05	10.00	10.05	9.97	9.93
802.11n	5805	161	9.96	10.13	10.04	10.13	10.03	10.10	9.57	9.51
802.11n	5825	165	9.88	9.98	10.03	10.10	10.07	10.05	10.07	10.10

Table 9-14
IEEE 802.11n Average RF Power – 40 MHz Bandwidth

Mode	Freq	Channel	40MHz BW 802.11n (5GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
	[MHz]		13.5	27	40.5	54	81	108	121.5	135
802.11n	5190	38	9.98	9.75	9.82	9.94	9.84	9.98	9.55	9.66
802.11n	5230	46	10.00	10.00	9.87	9.79	9.88	9.87	9.79	9.86
802.11n	5270	54	10.03	10.12	9.94	10.13	9.83	9.92	9.86	9.85
802.11n	5310	62	10.02	10.07	9.96	9.98	9.89	9.97	9.86	9.81
802.11n	5510	102	10.03	9.96	10.01	9.82	9.79	9.78	9.77	9.76
802.11n	5550	110	10.02	9.99	9.91	9.92	9.84	9.72	9.78	9.74
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	10.21	10.09	10.04	10.05	10.01	9.98	9.94	9.93
802.11n	5755	151	9.79	9.74	9.71	9.64	9.66	9.63	9.60	9.60
802.11n	5795	159	10.03	9.85	9.90	9.78	9.75	9.73	9.70	9.75

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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 <math><1.6\text{ W/kg}</math> and the reported 1g averaged SAR is <math><0.8\text{ W/kg}</math>, 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.

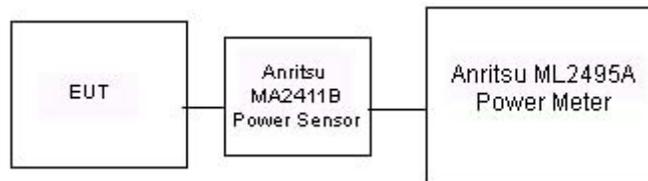


Figure 9-3
Power Measurement Setup

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10 SYSTEM VERIFICATION

10.1 Tissue Verification

**Table 10-1
Measured Tissue Properties**

Calibrated for Tests Performed on:	Tissue Type	Tissue Temp During Calibration (C°)	Measured Frequency (MHz)	Measured Conductivity, σ (S/m)	Measured Dielectric Constant, ϵ	TARGET Conductivity, σ (S/m)	TARGET Dielectric Constant, ϵ	% dev σ	% dev ϵ
10/17/2013	750H	22.8	710	0.883	42.045	0.890	42.149	-0.79%	-0.25%
			725	0.897	41.821	0.891	42.071	0.67%	-0.59%
			740	0.908	41.659	0.893	41.994	1.68%	-0.80%
			755	0.922	41.499	0.894	41.916	3.13%	-0.99%
10/21/2013	835H	20.7	820	0.892	41.432	0.899	41.578	-0.78%	-0.35%
			835	0.907	41.248	0.900	41.500	0.78%	-0.61%
			850	0.920	41.051	0.916	41.500	0.44%	-1.08%
10/22/2013	1750H	22.6	1710	1.371	40.507	1.348	40.142	1.71%	0.91%
			1750	1.402	40.312	1.371	40.079	2.26%	0.58%
			1790	1.443	40.002	1.394	40.016	3.52%	-0.03%
10/17/2013	1900H	23.4	1850	1.377	39.342	1.400	40.000	-1.64%	-1.65%
			1880	1.404	39.183	1.400	40.000	0.29%	-2.04%
			1910	1.437	39.083	1.400	40.000	2.64%	-2.29%
10/21/2013	2450H	20.1	2401	1.702	39.142	1.756	39.287	-3.08%	-0.37%
			2450	1.757	38.978	1.800	39.200	-2.39%	-0.57%
			2499	1.816	38.827	1.853	39.138	-2.00%	-0.79%
			5200	4.626	35.297	4.655	35.986	-0.62%	-1.91%
10/29/2013	5200H-5800H	23.1	5240	4.626	35.338	4.696	35.940	-1.49%	-1.68%
			5280	4.645	35.366	4.737	35.894	-1.94%	-1.47%
			5300	4.709	35.188	4.758	35.871	-1.03%	-1.90%
			5500	4.851	35.056	4.963	35.643	-2.26%	-1.65%
			5560	4.867	34.988	5.024	35.574	-3.13%	-1.65%
			5600	4.920	34.952	5.065	35.529	-2.86%	-1.62%
			5745	5.052	34.681	5.214	35.363	-3.11%	-1.93%
			5765	5.070	34.701	5.234	35.340	-3.13%	-1.81%
			5800	5.123	34.671	5.270	35.300	-2.79%	-1.78%
			5805	5.136	34.651	5.275	35.294	-2.64%	-1.82%
			10/18/2013	750B	22.2	710	0.934	55.964	0.960
725	0.949	55.821				0.961	55.629	-1.25%	0.35%
740	0.964	55.576				0.963	55.570	0.10%	0.01%
755	0.977	55.474				0.964	55.512	1.35%	-0.07%
10/15/2013	835B	22.9	820	0.982	54.056	0.969	55.258	1.34%	-2.18%
			835	0.996	53.932	0.970	55.200	2.68%	-2.30%
			850	1.012	53.756	0.988	55.154	2.43%	-2.53%
10/18/2013	1750B	22.4	1710	1.393	52.414	1.463	53.537	-4.78%	-2.10%
			1750	1.444	52.334	1.488	53.432	-2.96%	-2.05%
			1790	1.488	52.290	1.514	53.326	-1.72%	-1.94%
10/28/2013	1750B	20.7	1710	1.477	53.674	1.463	53.537	0.96%	0.26%
			1750	1.535	53.664	1.488	53.432	3.16%	0.43%
			1790	1.585	53.482	1.514	53.326	4.69%	0.29%
10/21/2013	1900B	20.3	1850	1.508	54.132	1.520	53.300	-0.79%	1.56%
			1880	1.545	54.051	1.520	53.300	1.64%	1.41%
			1910	1.581	53.955	1.520	53.300	4.01%	1.23%
10/16/2013	2450B	24.1	2401	1.886	51.370	1.903	52.765	-0.89%	-2.64%
			2450	1.954	51.260	1.950	52.700	0.21%	-2.73%
			2499	2.036	51.157	2.019	52.638	0.84%	-2.81%
			5200	5.380	46.873	5.299	49.014	1.53%	-4.37%
10/29/2013	5200B-5800B	22.3	5240	5.422	46.792	5.346	48.960	1.42%	-4.43%
			5280	5.514	46.618	5.393	48.906	2.24%	-4.68%
			5300	5.553	46.583	5.416	48.879	2.53%	-4.70%
			5500	5.887	46.276	5.650	48.607	4.19%	-4.80%
			5560	5.976	46.172	5.720	48.526	4.48%	-4.85%
			5600	6.035	46.139	5.766	48.471	4.67%	-4.81%
			5800	6.226	46.021	6.000	48.200	3.77%	-4.52%
			5805	6.233	46.020	6.006	48.193	3.78%	-4.51%

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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10.2 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 10-2
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 SAR _{1g} (W/kg)	1 W Target SAR _{1g} (W/kg)	1 W Normalized SAR _{1g} (W/kg)	Deviation _{1g} (%)
F	750	HEAD	10/17/2013	23.5	22.3	0.100	1003	3213	0.851	8.460	8.510	0.59%
E	835	HEAD	10/21/2013	23.2	20.7	0.100	4d119	3920	0.914	9.680	9.140	-5.58%
B	1750	HEAD	10/22/2013	23.4	22.8	0.100	1008	3287	3.780	36.800	37.800	2.72%
G	1900	HEAD	10/17/2013	23.0	22.8	0.100	5d141	3209	4.050	40.800	40.500	-0.74%
I	2450	HEAD	10/21/2013	21.4	21.2	0.040	882	3319	2.010	51.700	50.250	-2.80%
E	5200	HEAD	10/29/2013	24.5	23.1	0.100	1120	3920	7.790	76.000	77.900	2.50%
E	5300	HEAD	10/29/2013	24.5	23.1	0.100	1120	3920	7.740	78.700	77.400	-1.65%
E	5500	HEAD	10/29/2013	24.5	23.1	0.100	1120	3920	7.510	80.100	75.100	-6.24%
E	5600	HEAD	10/29/2013	24.5	23.1	0.100	1120	3920	7.690	79.900	76.900	-3.75%
E	5800	HEAD	10/29/2013	24.5	23.1	0.100	1120	3920	7.480	74.900	74.800	-0.13%
F	750	BODY	10/18/2013	23.8	22.2	0.100	1003	3213	0.843	8.830	8.430	-4.53%
D	835	BODY	10/15/2013	23.1	22.9	0.100	4d119	3022	0.966	9.540	9.660	1.26%
D	1750	BODY	10/18/2013	23.3	22.5	0.100	1051	3022	3.530	37.800	35.300	-6.61%
E	1750	BODY	10/28/2013	23.4	20.9	0.100	1051	3920	3.760	37.800	37.600	-0.53%
C	1900	BODY	10/21/2013	21.8	20.0	0.100	5d141	3263	3.970	41.500	39.700	-4.34%
G	2450	BODY	10/16/2013	24.5	24.1	0.100	882	3209	4.770	49.900	47.700	-4.41%
A	5200	BODY	10/29/2013	22.6	21.4	0.100	1057	3589	7.380	75.500	73.800	-2.25%
A	5300	BODY	10/29/2013	22.6	21.4	0.100	1057	3589	7.880	75.300	78.800	4.65%
A	5500	BODY	10/29/2013	22.6	21.4	0.100	1057	3589	7.990	80.800	79.900	-1.11%
A	5600	BODY	10/29/2013	22.6	21.4	0.100	1057	3589	8.360	80.300	83.600	4.11%
A	5800	BODY	10/29/2013	22.6	21.4	0.100	1057	3589	7.430	75.100	74.300	-1.07%

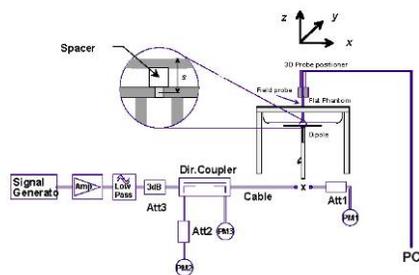


Figure 10-1
System Verification Setup Diagram



Figure 10-2
System Verification Setup Photo

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11 SAR DATA SUMMARY

11.1 Standalone Head SAR Data

**Table 11-1
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	33.2	32.93	-0.03	Right	Cheek	1610-5	1	1:8.3	0.169	1.064	0.180	
836.60	190	GSM 850	GSM	33.2	32.93	0.14	Right	Tilt	1610-5	1	1:8.3	0.145	1.064	0.154	
836.60	190	GSM 850	GSM	33.2	32.93	0.06	Left	Cheek	1610-5	1	1:8.3	0.230	1.064	0.245	
836.60	190	GSM 850	GSM	33.2	32.93	0.01	Left	Tilt	1610-5	1	1:8.3	0.162	1.064	0.172	
836.60	190	GSM 850	GPRS	29.2	28.62	-0.04	Right	Cheek	1610-5	4	1:2.076	0.198	1.143	0.226	
836.60	190	GSM 850	GPRS	29.2	28.62	0.04	Right	Tilt	1610-5	4	1:2.076	0.194	1.143	0.222	
836.60	190	GSM 850	GPRS	29.2	28.62	0.21	Left	Cheek	1610-5	4	1:2.076	0.291	1.143	0.333	A1
836.60	190	GSM 850	GPRS	29.2	28.62	-0.10	Left	Tilt	1610-5	4	1:2.076	0.183	1.143	0.209	
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 11-2
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	23.7	23.67	0.01	Right	Cheek	1610-5	1:1	0.168	1.007	0.169		
836.60	4183	UMTS 850	RMC	23.7	23.67	0.06	Right	Tilt	1610-5	1:1	0.127	1.007	0.128		
836.60	4183	UMTS 850	RMC	23.7	23.67	-0.09	Left	Cheek	1610-5	1:1	0.209	1.007	0.210	A2	
836.60	4183	UMTS 850	RMC	23.7	23.67	0.08	Left	Tilt	1610-5	1:1	0.145	1.007	0.146		
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 11-3
UMTS 1750 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)		
1732.40	1412	UMTS 1750	RMC	24.5	24.37	-0.18	Right	Cheek	1610-4	1:1	0.440	1.030	0.453	A3	
1732.40	1412	UMTS 1750	RMC	24.5	24.37	-0.03	Right	Tilt	1610-4	1:1	0.317	1.030	0.327		
1732.40	1412	UMTS 1750	RMC	24.5	24.37	-0.04	Left	Cheek	1610-4	1:1	0.341	1.030	0.351		
1732.40	1412	UMTS 1750	RMC	24.5	24.37	0.03	Left	Tilt	1610-4	1:1	0.264	1.030	0.272		
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 11-4
GSM 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	# 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	31.7	31.03	0.01	Right	Cheek	1610-5	1	1:8.3	0.147	1.167	0.172	
1880.00	661	GSM 1900	GSM	31.7	31.03	-0.02	Right	Tilt	1610-5	1	1:8.3	0.173	1.167	0.202	
1880.00	661	GSM 1900	GSM	31.7	31.03	0.00	Left	Cheek	1610-5	1	1:8.3	0.200	1.167	0.233	A4
1880.00	661	GSM 1900	GSM	31.7	31.03	0.02	Left	Tilt	1610-5	1	1:8.3	0.132	1.167	0.154	
1880.00	661	GSM 1900	GPRS	26.7	26.01	0.11	Right	Cheek	1610-5	4	1:2.076	0.152	1.172	0.178	
1880.00	661	GSM 1900	GPRS	26.7	26.01	0.02	Right	Tilt	1610-5	4	1:2.076	0.144	1.172	0.169	
1880.00	661	GSM 1900	GPRS	26.7	26.01	-0.02	Left	Cheek	1610-5	4	1:2.076	0.189	1.172	0.222	
1880.00	661	GSM 1900	GPRS	26.7	26.01	-0.02	Left	Tilt	1610-5	4	1:2.076	0.119	1.172	0.139	
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 11-5
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)		
1880.00	9400	UMTS 1900	RMC	23.7	23.60	0.00	Right	Cheek	1610-5	1:1	0.198	1.023	0.203		
1880.00	9400	UMTS 1900	RMC	23.7	23.60	0.03	Right	Tilt	1610-5	1:1	0.284	1.023	0.291	A5	
1880.00	9400	UMTS 1900	RMC	23.7	23.60	0.09	Left	Cheek	1610-5	1:1	0.249	1.023	0.255		
1880.00	9400	UMTS 1900	RMC	23.7	23.60	-0.05	Left	Tilt	1610-5	1:1	0.194	1.023	0.198		
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 11-6
LTE Band 17 Head SAR**

MEASUREMENT RESULTS																			
FREQUENCY		Mode	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Side	Test Position	Modulation	RB Size	RB Offset	Device Serial Number	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #	
MHz	Ch.														(W/kg)		(W/kg)		
710.00	23790	Mid	LTE Band 17	10	23.7	23.69	-0.06	0	Right	Cheek	QPSK	1	49	1610-9	1:1	0.275	1.002	0.276	A6
710.00	23790	Mid	LTE Band 17	10	22.7	22.34	0.03	1	Right	Cheek	QPSK	25	12	1610-9	1:1	0.198	1.086	0.215	
710.00	23790	Mid	LTE Band 17	10	23.7	23.69	-0.08	0	Right	Tilt	QPSK	1	49	1610-9	1:1	0.143	1.002	0.143	
710.00	23790	Mid	LTE Band 17	10	22.7	22.34	0.04	1	Right	Tilt	QPSK	25	12	1610-9	1:1	0.108	1.086	0.117	
710.00	23790	Mid	LTE Band 17	10	23.7	23.69	-0.01	0	Left	Cheek	QPSK	1	49	1610-9	1:1	0.178	1.002	0.178	
710.00	23790	Mid	LTE Band 17	10	22.7	22.34	0.07	1	Left	Cheek	QPSK	25	12	1610-9	1:1	0.130	1.086	0.141	
710.00	23790	Mid	LTE Band 17	10	23.7	23.69	0.06	0	Left	Tilt	QPSK	1	49	1610-9	1:1	0.117	1.002	0.117	
710.00	23790	Mid	LTE Band 17	10	22.7	22.34	0.01	1	Left	Tilt	QPSK	25	12	1610-9	1:1	0.093	1.086	0.101	
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 11-7
LTE Band 4 (AWS) Head SAR**

MEASUREMENT RESULTS																			
FREQUENCY		Mode	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Side	Test Position	Modulation	RB Size	RB Offset	Device Serial Number	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #	
MHz	Ch.														(W/kg)		(W/kg)		
1732.50	20175	Mid	LTE Band 4 (AWS)	20	24.5	24.07	-0.02	0	Right	Cheek	QPSK	1	50	1610-9	1:1	0.387	1.104	0.427	A7
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.5	23.01	0.00	1	Right	Cheek	QPSK	50	0	1610-9	1:1	0.300	1.119	0.336	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	24.5	24.07	-0.18	0	Right	Tilt	QPSK	1	50	1610-9	1:1	0.282	1.104	0.311	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.5	23.01	0.00	1	Right	Tilt	QPSK	50	0	1610-9	1:1	0.230	1.119	0.257	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	24.5	24.07	-0.21	0	Left	Cheek	QPSK	1	50	1610-9	1:1	0.332	1.104	0.367	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.5	23.01	-0.03	1	Left	Cheek	QPSK	50	0	1610-9	1:1	0.279	1.119	0.312	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	24.5	24.07	-0.01	0	Left	Tilt	QPSK	1	50	1610-9	1:1	0.219	1.104	0.242	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.5	23.01	0.06	1	Left	Tilt	QPSK	50	0	1610-9	1:1	0.180	1.119	0.201	
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 11-8
LTE Band 2 (PCS) Head SAR**

MEASUREMENT RESULTS																			
FREQUENCY		Mode	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Side	Test Position	Modulation	RB Size	RB Offset	Device Serial Number	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #	
MHz	Ch.														(W/kg)		(W/kg)		
1880.00	18900	Mid	LTE Band 2 (PCS)	10	23.7	23.65	0.09	0	Right	Cheek	QPSK	1	25	1610-8	1:1	0.261	1.012	0.264	
1880.00	18900	Mid	LTE Band 2 (PCS)	10	22.7	22.32	0.03	1	Right	Cheek	QPSK	25	12	1610-8	1:1	0.196	1.091	0.214	
1880.00	18900	Mid	LTE Band 2 (PCS)	10	23.7	23.65	0.11	0	Right	Tilt	QPSK	1	25	1610-8	1:1	0.295	1.012	0.299	A8
1880.00	18900	Mid	LTE Band 2 (PCS)	10	22.7	22.32	0.07	1	Right	Tilt	QPSK	25	12	1610-8	1:1	0.220	1.091	0.240	
1880.00	18900	Mid	LTE Band 2 (PCS)	10	23.7	23.65	0.03	0	Left	Cheek	QPSK	1	25	1610-8	1:1	0.282	1.012	0.285	
1880.00	18900	Mid	LTE Band 2 (PCS)	10	22.7	22.32	-0.05	1	Left	Cheek	QPSK	25	12	1610-8	1:1	0.211	1.091	0.230	
1880.00	18900	Mid	LTE Band 2 (PCS)	10	23.7	23.65	0.06	0	Left	Tilt	QPSK	1	25	1610-8	1:1	0.191	1.012	0.193	
1880.00	18900	Mid	LTE Band 2 (PCS)	10	22.7	22.32	0.04	1	Left	Tilt	QPSK	25	12	1610-8	1:1	0.144	1.091	0.157	
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 11-9
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	16.7	16.46	0.09	Right	Cheek	1610-1	1	1:1	0.202	1.057	0.214	A9
2462	11	IEEE 802.11b	DSSS	16.7	16.46	0.15	Right	Tilt	1610-1	1	1:1	0.130	1.057	0.137	
2462	11	IEEE 802.11b	DSSS	16.7	16.46	0.03	Left	Cheek	1610-1	1	1:1	0.144	1.057	0.152	
2462	11	IEEE 802.11b	DSSS	16.7	16.46	0.21	Left	Tilt	1610-1	1	1:1	0.127	1.057	0.134	
5745	149	IEEE 802.11a	OFDM	12.7	11.94	0.20	Right	Cheek	2510-1	6	1:1	0.420	1.191	0.500	
5765	153	IEEE 802.11a	OFDM	12.7	11.98	0.03	Right	Cheek	2510-1	6	1:1	0.404	1.180	0.477	
5805	161	IEEE 802.11a	OFDM	12.7	12.08	0.03	Right	Cheek	2510-1	6	1:1	0.364	1.153	0.420	
5745	149	IEEE 802.11a	OFDM	12.7	11.94	0.03	Right	Tilt	2510-1	6	1:1	0.526	1.191	0.626	A10
5765	153	IEEE 802.11a	OFDM	12.7	11.98	0.03	Right	Tilt	2510-1	6	1:1	0.511	1.180	0.603	
5805	161	IEEE 802.11a	OFDM	12.7	12.08	0.03	Right	Tilt	2510-1	6	1:1	0.347	1.153	0.400	
5805	161	IEEE 802.11a	OFDM	12.7	12.08	0.03	Left	Cheek	2510-1	6	1:1	0.256	1.153	0.295	
5805	161	IEEE 802.11a	OFDM	12.7	12.08	0.08	Left	Tilt	2510-1	6	1:1	0.272	1.153	0.314	
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 11-10
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	12.7	12.53	0.10	Right	Cheek	2510-1	6	1:1	0.121	1.040	0.126	
5240	48	IEEE 802.11a	OFDM	12.7	12.53	0.06	Right	Tilt	2510-1	6	1:1	0.132	1.040	0.137	
5240	48	IEEE 802.11a	OFDM	12.7	12.53	0.06	Left	Cheek	2510-1	6	1:1	0.155	1.040	0.161	
5240	48	IEEE 802.11a	OFDM	12.7	12.53	0.14	Left	Tilt	2510-1	6	1:1	0.117	1.040	0.122	
5280	56	IEEE 802.11a	OFDM	12.7	12.64	0.12	Right	Cheek	2510-1	6	1:1	0.129	1.014	0.131	
5280	56	IEEE 802.11a	OFDM	12.7	12.64	0.20	Right	Tilt	2510-1	6	1:1	0.148	1.014	0.150	
5280	56	IEEE 802.11a	OFDM	12.7	12.64	0.03	Left	Cheek	2510-1	6	1:1	0.119	1.014	0.121	
5280	56	IEEE 802.11a	OFDM	12.7	12.64	0.05	Left	Tilt	2510-1	6	1:1	0.117	1.014	0.119	
5560	112	IEEE 802.11a	OFDM	12.7	12.69	0.13	Right	Cheek	2510-1	6	1:1	0.184	1.002	0.184	
5560	112	IEEE 802.11a	OFDM	12.7	12.69	0.04	Right	Tilt	2510-1	6	1:1	0.207	1.002	0.207	A11
5560	112	IEEE 802.11a	OFDM	12.7	12.69	0.04	Left	Cheek	2510-1	6	1:1	0.121	1.002	0.121	
5560	112	IEEE 802.11a	OFDM	12.7	12.69	0.12	Left	Tilt	2510-1	6	1:1	0.152	1.002	0.152	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population								Head 1.6 W/kg (mW/g) averaged over 1 gram							

11.2 Standalone Body-Worn SAR Data

**Table 11-11
GSM/UMTS Body-Worn SAR Data**

MEASUREMENT RESULTS															
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	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	33.2	32.93	0.02	10 mm	1610-5	1	1:8.3	back	0.479	1.064	0.510	
836.60	190	GSM 850	GPRS	29.2	28.62	0.07	10 mm	1610-5	4	1:2.076	back	0.573	1.143	0.655	A12
836.60	4183	UMTS 850	RMC	23.7	23.67	0.10	10 mm	1610-5	N/A	1:1	back	0.460	1.007	0.463	A13
1732.40	1412	UMTS 1750	RMC	24.5	24.37	-0.05	10 mm	1610-4	N/A	1:1	back	0.649	1.030	0.668	A14
1880.00	661	GSM 1900	GSM	31.7	31.03	0.16	10 mm	1610-5	1	1:8.3	back	0.462	1.167	0.539	A15
1880.00	661	GSM 1900	GPRS	26.7	26.01	-0.17	10 mm	1610-5	4	1:2.076	back	0.458	1.172	0.537	
1880.00	9400	UMTS 1900	RMC	23.7	23.60	-0.03	10 mm	1610-5	N/A	1:1	back	0.696	1.023	0.712	A17
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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**Table 11-12
LTE Body-Worn SAR**

MEASUREMENT RESULTS																			
FREQUENCY		Mode	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Device Serial Number	Modulation	RB Size	RB Offset	Spacing	Side	Duty Cycle	SAR (1g) (W/kg)	Scaling Factor	Scaled SAR (1g) (W/kg)	Plot #	
MHz	Ch.																		
710.00	23790	Mid	LTE Band 17	10	23.7	23.69	-0.06	0	1610-9	QPSK	1	49	10 mm	back	1:1	0.611	1.002	0.612	A18
710.00	23790	Mid	LTE Band 17	10	22.7	22.34	-0.07	1	1610-9	QPSK	25	12	10 mm	back	1:1	0.407	1.086	0.442	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	24.5	24.07	-0.01	0	1610-9	QPSK	1	50	10 mm	back	1:1	0.826	1.104	0.912	A19
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.5	23.01	0.10	1	1610-9	QPSK	50	0	10 mm	back	1:1	0.603	1.119	0.675	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.5	23.00	-0.06	1	1610-9	QPSK	100	0	10 mm	back	1:1	0.609	1.122	0.683	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	24.5	24.07	-0.01	0	1610-9	QPSK	1	50	10 mm	back	1:1	0.818	1.104	0.903	
1880.00	18900	Mid	LTE Band 2 (PCS)	10	23.7	23.65	0.05	0	1610-8	QPSK	1	25	10 mm	back	1:1	0.541	1.012	0.547	A20
1880.00	18900	Mid	LTE Band 2 (PCS)	10	22.7	22.32	0.09	1	1610-8	QPSK	25	12	10 mm	back	1:1	0.405	1.091	0.442	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population										Body 1.6 W/kg (mW/g) averaged over 1 gram									

Note: Blue entry in the above table represents variability data.

**Table 11-13
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) (W/kg)	Scaling Factor	Scaled SAR (1g) (W/kg)	Plot #	
MHz	Ch.															
2462	11	IEEE 802.11b	DSSS	16.7	16.46	-0.06	10 mm	1610-11	1	back	1:1	0.164	1.057	0.173	A21	
5805	161	IEEE 802.11a	OFDM	12.7	12.08	0.06	10 mm	2510-1	6	back	1:1	0.247	1.153	0.285	A23	
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 11-14
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) (W/kg)	Scaling Factor	Scaled SAR (1g) (W/kg)	Plot #	
MHz	Ch.															
5240	48	IEEE 802.11a	OFDM	12.7	12.53	-0.16	10 mm	2510-1	6	back	1:1	0.054	1.040	0.056		
5280	56	IEEE 802.11a	OFDM	12.7	12.64	0.08	10 mm	2510-1	6	back	1:1	0.061	1.014	0.062		
5560	112	IEEE 802.11a	OFDM	12.7	12.69	0.02	10 mm	2510-1	6	back	1:1	0.079	1.002	0.079	A24	
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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11.3 Standalone Wireless Router SAR Data

Table 11-15
GPRS/UMTS Hotspot SAR Data

MEASUREMENT RESULTS															
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	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	GPRS	29.2	28.62	0.07	10 mm	1610-5	4	1:2.076	back	0.573	1.143	0.655	A12
836.60	190	GSM 850	GPRS	29.2	28.62	0.08	10 mm	1610-5	4	1:2.076	front	0.342	1.143	0.391	
836.60	190	GSM 850	GPRS	29.2	28.62	0.15	10 mm	1610-5	4	1:2.076	bottom	0.109	1.143	0.125	
836.60	190	GSM 850	GPRS	29.2	28.62	0.03	10 mm	1610-5	4	1:2.076	left	0.442	1.143	0.505	
836.60	4183	UMTS 850	RMC	23.7	23.67	0.10	10 mm	1610-5	N/A	1:1	back	0.460	1.007	0.463	A13
836.60	4183	UMTS 850	RMC	23.7	23.67	-0.04	10 mm	1610-5	N/A	1:1	front	0.243	1.007	0.245	
836.60	4183	UMTS 850	RMC	23.7	23.67	-0.01	10 mm	1610-5	N/A	1:1	bottom	0.083	1.007	0.084	
836.60	4183	UMTS 850	RMC	23.7	23.67	-0.04	10 mm	1610-5	N/A	1:1	left	0.403	1.007	0.406	
1732.40	1412	UMTS 1750	RMC	24.5	24.37	-0.05	10 mm	1610-4	N/A	1:1	back	0.649	1.030	0.668	A14
1732.40	1412	UMTS 1750	RMC	24.5	24.37	0.03	10 mm	1610-4	N/A	1:1	front	0.347	1.030	0.357	
1732.40	1412	UMTS 1750	RMC	24.5	24.37	0.04	10 mm	1610-4	N/A	1:1	bottom	0.323	1.030	0.333	
1732.40	1412	UMTS 1750	RMC	24.5	24.37	-0.07	10 mm	1610-4	N/A	1:1	left	0.212	1.030	0.218	
1880.00	661	GSM 1900	GPRS	26.7	26.01	-0.17	10 mm	1610-5	4	1:2.076	back	0.458	1.172	0.537	A16
1880.00	661	GSM 1900	GPRS	26.7	26.01	0.13	10 mm	1610-5	4	1:2.076	front	0.143	1.172	0.168	
1880.00	661	GSM 1900	GPRS	26.7	26.01	-0.09	10 mm	1610-5	4	1:2.076	bottom	0.277	1.172	0.325	
1880.00	661	GSM 1900	GPRS	26.7	26.01	-0.07	10 mm	1610-5	4	1:2.076	left	0.056	1.172	0.066	
1880.00	9400	UMTS 1900	RMC	23.7	23.60	-0.03	10 mm	1610-5	N/A	1:1	back	0.696	1.023	0.712	A17
1880.00	9400	UMTS 1900	RMC	23.7	23.60	-0.04	10 mm	1610-5	N/A	1:1	front	0.313	1.023	0.320	
1880.00	9400	UMTS 1900	RMC	23.7	23.60	0.03	10 mm	1610-5	N/A	1:1	bottom	0.503	1.023	0.515	
1880.00	9400	UMTS 1900	RMC	23.7	23.60	-0.01	10 mm	1610-5	N/A	1:1	left	0.275	1.023	0.281	
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 11-16
LTE Band 17 Hotspot SAR

MEASUREMENT RESULTS																			
FREQUENCY		Mode	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Device Serial Number	Modulation	RB Size	RB Offset	Spacing	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #	
MHz	Ch.														(W/kg)		(W/kg)		
710.00	23790	Mid	LTE Band 17	10	23.7	23.69	-0.06	0	1610-9	QPSK	1	49	10 mm	back	1:1	0.611	1.002	0.612	A18
710.00	23790	Mid	LTE Band 17	10	22.7	22.34	-0.07	1	1610-9	QPSK	25	12	10 mm	back	1:1	0.407	1.086	0.442	
710.00	23790	Mid	LTE Band 17	10	23.7	23.69	-0.04	0	1610-9	QPSK	1	49	10 mm	front	1:1	0.280	1.002	0.281	
710.00	23790	Mid	LTE Band 17	10	22.7	22.34	0.01	1	1610-9	QPSK	25	12	10 mm	front	1:1	0.184	1.086	0.200	
710.00	23790	Mid	LTE Band 17	10	23.7	23.69	0.04	0	1610-9	QPSK	1	49	10 mm	bottom	1:1	0.124	1.002	0.124	
710.00	23790	Mid	LTE Band 17	10	22.7	22.34	-0.04	1	1610-9	QPSK	25	12	10 mm	bottom	1:1	0.086	1.086	0.093	
710.00	23790	Mid	LTE Band 17	10	23.7	23.69	0.09	0	1610-9	QPSK	1	49	10 mm	right	1:1	0.403	1.002	0.404	
710.00	23790	Mid	LTE Band 17	10	22.7	22.34	0.04	1	1610-9	QPSK	25	12	10 mm	right	1:1	0.276	1.086	0.300	
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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**Table 11-17
LTE Band 4 (AWS) Hotspot SAR**

MEASUREMENT RESULTS																			
FREQUENCY		Mode	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Device Serial Number	Modulation	RB Size	RB Offset	Spacing	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #	
MHz	Ch.														(W/kg)		(W/kg)		
1732.50	20175	Mid	LTE Band 4 (AWS)	20	24.5	24.07	-0.01	0	1610-9	QPSK	1	50	10 mm	back	1:1	0.826	1.104	0.912	A19
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.5	23.01	0.10	1	1610-9	QPSK	50	0	10 mm	back	1:1	0.603	1.119	0.675	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.5	23.00	-0.06	1	1610-9	QPSK	100	0	10 mm	back	1:1	0.609	1.122	0.683	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	24.5	24.07	-0.07	0	1610-9	QPSK	1	50	10 mm	front	1:1	0.375	1.104	0.414	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.5	23.01	0.09	1	1610-9	QPSK	50	0	10 mm	front	1:1	0.275	1.119	0.308	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	24.5	24.07	-0.01	0	1610-9	QPSK	1	50	10 mm	bottom	1:1	0.468	1.104	0.517	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.5	23.01	0.13	1	1610-9	QPSK	50	0	10 mm	bottom	1:1	0.386	1.119	0.432	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	24.5	24.07	0.06	0	1610-9	QPSK	1	50	10 mm	left	1:1	0.279	1.104	0.308	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.5	23.01	0.15	1	1610-9	QPSK	50	0	10 mm	left	1:1	0.211	1.119	0.236	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	24.5	24.07	-0.01	0	1610-9	QPSK	1	50	10 mm	back	1:1	0.818	1.104	0.903	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population										Body 1.6 W/kg (mW/g) averaged over 1 gram									

Note: Blue entry in the above table represents variability data.

**Table 11-18
LTE Band 2 (PCS) Hotspot SAR**

MEASUREMENT RESULTS																			
FREQUENCY		Mode	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Device Serial Number	Modulation	RB Size	RB Offset	Spacing	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #	
MHz	Ch.														(W/kg)		(W/kg)		
1880.00	18900	Mid	LTE Band 2 (PCS)	10	23.7	23.65	0.05	0	1610-8	QPSK	1	25	10 mm	back	1:1	0.541	1.012	0.547	A20
1880.00	18900	Mid	LTE Band 2 (PCS)	10	22.7	22.32	0.09	1	1610-8	QPSK	25	12	10 mm	back	1:1	0.405	1.091	0.442	
1880.00	18900	Mid	LTE Band 2 (PCS)	10	23.7	23.65	0.07	0	1610-8	QPSK	1	25	10 mm	front	1:1	0.298	1.012	0.302	
1880.00	18900	Mid	LTE Band 2 (PCS)	10	22.7	22.32	0.08	1	1610-8	QPSK	25	12	10 mm	front	1:1	0.220	1.091	0.240	
1880.00	18900	Mid	LTE Band 2 (PCS)	10	23.7	23.65	-0.14	0	1610-8	QPSK	1	25	10 mm	bottom	1:1	0.469	1.012	0.475	
1880.00	18900	Mid	LTE Band 2 (PCS)	10	22.7	22.32	-0.03	1	1610-8	QPSK	25	12	10 mm	bottom	1:1	0.359	1.091	0.392	
1880.00	18900	Mid	LTE Band 2 (PCS)	10	23.7	23.65	0.03	0	1610-8	QPSK	1	25	10 mm	left	1:1	0.253	1.012	0.256	
1880.00	18900	Mid	LTE Band 2 (PCS)	10	22.7	22.32	0.08	1	1610-8	QPSK	25	12	10 mm	left	1:1	0.195	1.091	0.213	
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 11-19
Wireless Router 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	16.7	16.46	-0.06	10 mm	1610-11	1	back	1:1	0.164	1.057	0.173		
2462	11	IEEE 802.11b	DSSS	16.7	16.46	0.04	10 mm	1610-11	1	front	1:1	0.069	1.057	0.073		
2462	11	IEEE 802.11b	DSSS	16.7	16.46	-0.03	10 mm	1610-11	1	top	1:1	0.111	1.057	0.117		
2462	11	IEEE 802.11b	DSSS	16.7	16.46	-0.09	10 mm	1610-11	1	left	1:1	0.192	1.057	0.203	A22	
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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11.4 SAR Test Notes

General Notes:

1. The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2013, 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 standard 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, body-worn accessory SAR was evaluated without a headset connected to the device. Since the standalone reported SAR was ≤ 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 13 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 6.6 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.
2. This device supports GSM VOIP in the head and body-worn configurations; therefore GPRS was additionally evaluated for head and body-worn compliance.
3. Justification for reduced test configurations per KDB Publication 941225 D03v01: The source-based time-averaged output power was evaluated for all multi-slot operations. The multi-slot configuration with the highest frame averaged output power was evaluated for SAR.
4. Per FCC KDB Publication 447498 D01v05, since the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is ≤ 0.8 W/kg then testing at the other channels is not required for such test configuration(s). Since the maximum output power variation across the required test channels is $< \frac{1}{2}$ dB the middle channel was used for SAR testing.

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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, when the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is ≤ 0.8 W/kg then testing at the other channels is not required for such test configuration(s). Since the maximum output power variation across the required test channels is $< \frac{1}{2}$ dB, middle channel was used for SAR testing.

LTE Notes:

1. LTE Considerations: LTE test configurations are determined according to SAR Evaluation Considerations for LTE Devices in FCC KDB Publication 941225 D05v02r01. The general test procedures used for testing can be found in Section 8.4.4.
2. MPR is permanently implemented for this device by the manufacturer. The specific manufacturer target MPR is indicated alongside the SAR results. MPR is enabled for this device, according to 3GPP TS36.101 Section 6.2.3 – 6.2.5 under Table 6.2.3-1.
3. A-MPR was disabled for all SAR tests by setting NS=01 on the base station simulator.

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. When Hotspot is enabled, all 5 GHz bands are disabled. Therefore no 5 GHz WIFI Wireless Router SAR Data was required.
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 or the reported 1g averaged SAR is >0.8 W/kg, SAR testing on other default channels was required.

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12 FCC MULTI-TX AND ANTENNA SAR CONSIDERATIONS

12.1 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.

12.2 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 ≤ 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 12-1
Estimated SAR**

Mode	Frequency	Maximum Allowed Power	Separation Distance (Body)	Estimated SAR (Body)
	[MHz]	[dBm]	[mm]	[W/kg]
Bluetooth	2441	9.20	10	0.167

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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12.3 Head SAR Simultaneous Transmission Analysis

Table 12-2
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	0.180	0.214	0.394	Head SAR	Right Cheek	0.169	0.214	0.383
	Right Tilt	0.154	0.137	0.291		Right Tilt	0.128	0.137	0.265
	Left Cheek	0.245	0.152	0.397		Left Cheek	0.210	0.152	0.362
	Left Tilt	0.172	0.134	0.306		Left Tilt	0.146	0.134	0.280
Simult Tx	Configuration	UMTS 1750 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	GSM 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.453	0.214	0.667	Head SAR	Right Cheek	0.172	0.214	0.386
	Right Tilt	0.327	0.137	0.464		Right Tilt	0.202	0.137	0.339
	Left Cheek	0.351	0.152	0.503		Left Cheek	0.233	0.152	0.385
	Left Tilt	0.272	0.134	0.406		Left Tilt	0.154	0.134	0.288
Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	LTE Band 17 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.203	0.214	0.417	Head SAR	Right Cheek	0.276	0.214	0.490
	Right Tilt	0.291	0.137	0.428		Right Tilt	0.143	0.137	0.280
	Left Cheek	0.255	0.152	0.407		Left Cheek	0.178	0.152	0.330
	Left Tilt	0.198	0.134	0.332		Left Tilt	0.117	0.134	0.251
Simult Tx	Configuration	LTE Band 4 (AWS) SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	LTE Band 2 (PCS) SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.427	0.214	0.641	Head SAR	Right Cheek	0.264	0.214	0.478
	Right Tilt	0.311	0.137	0.448		Right Tilt	0.299	0.137	0.436
	Left Cheek	0.367	0.152	0.519		Left Cheek	0.285	0.152	0.437
	Left Tilt	0.242	0.134	0.376		Left Tilt	0.193	0.134	0.327
Simult Tx	Configuration	GPRS 850 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.226	0.214	0.440	Head SAR	Right Cheek	0.178	0.214	0.392
	Right Tilt	0.222	0.137	0.359		Right Tilt	0.169	0.137	0.306
	Left Cheek	0.333	0.152	0.485		Left Cheek	0.222	0.152	0.374
	Left Tilt	0.209	0.134	0.343		Left Tilt	0.139	0.134	0.273

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Table 12-3
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	0.180	0.500	0.680	Head SAR	Right Cheek	0.169	0.500	0.669
	Right Tilt	0.154	0.626	0.780		Right Tilt	0.128	0.626	0.754
	Left Cheek	0.245	0.295	0.540		Left Cheek	0.210	0.295	0.505
	Left Tilt	0.172	0.314	0.486		Left Tilt	0.146	0.314	0.460
Simult Tx	Configuration	UMTS 1750 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	GSM 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.453	0.500	0.953	Head SAR	Right Cheek	0.172	0.500	0.672
	Right Tilt	0.327	0.626	0.953		Right Tilt	0.202	0.626	0.828
	Left Cheek	0.351	0.295	0.646		Left Cheek	0.233	0.295	0.528
	Left Tilt	0.272	0.314	0.586		Left Tilt	0.154	0.314	0.468
Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	LTE Band 17 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.203	0.500	0.703	Head SAR	Right Cheek	0.276	0.500	0.776
	Right Tilt	0.291	0.626	0.917		Right Tilt	0.143	0.626	0.769
	Left Cheek	0.255	0.295	0.550		Left Cheek	0.178	0.295	0.473
	Left Tilt	0.198	0.314	0.512		Left Tilt	0.117	0.314	0.431
Simult Tx	Configuration	LTE Band 4 (AWS) SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	LTE Band 2 (PCS) SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.427	0.500	0.927	Head SAR	Right Cheek	0.264	0.500	0.764
	Right Tilt	0.311	0.626	0.937		Right Tilt	0.299	0.626	0.925
	Left Cheek	0.367	0.295	0.662		Left Cheek	0.285	0.295	0.580
	Left Tilt	0.242	0.314	0.556		Left Tilt	0.193	0.314	0.507
Simult Tx	Configuration	GPRS 850 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.226	0.500	0.726	Head SAR	Right Cheek	0.178	0.500	0.678
	Right Tilt	0.222	0.626	0.848		Right Tilt	0.169	0.626	0.795
	Left Cheek	0.333	0.295	0.628		Left Cheek	0.222	0.295	0.517
	Left Tilt	0.209	0.314	0.523		Left Tilt	0.139	0.314	0.453

Note: The worst case 5 GHz WLAN reported SAR for each head configuration was used for SAR summation.

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12.4 Body-Worn Simultaneous Transmission Analysis

Table 12-4
Simultaneous Transmission Scenario with 2.4 GHz WLAN (Body-Worn at 10 mm)

Configuration	Mode	2G/3G/4G SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Back Side	GSM 850	0.510	0.173	0.683
Back Side	UMTS 850	0.463	0.173	0.636
Back Side	UMTS 1750	0.668	0.173	0.841
Back Side	GSM 1900	0.539	0.173	0.712
Back Side	UMTS 1900	0.712	0.173	0.885
Back Side	GPRS 850	0.655	0.173	0.828
Back Side	GPRS 1900	0.537	0.173	0.710
Back Side	LTE Band 17	0.612	0.173	0.785
Back Side	LTE Band 4 (AWS)	0.912	0.173	1.085
Back Side	LTE Band 2 (PCS)	0.547	0.173	0.720

Table 12-5
Simultaneous Transmission Scenario with 5 GHz WLAN (Body-Worn at 10 mm)

Configuration	Mode	2G/3G/4G SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Back Side	GSM 850	0.510	0.285	0.795
Back Side	UMTS 850	0.463	0.285	0.748
Back Side	UMTS 1750	0.668	0.285	0.953
Back Side	GSM 1900	0.539	0.285	0.824
Back Side	UMTS 1900	0.712	0.285	0.997
Back Side	GPRS 850	0.655	0.285	0.940
Back Side	GPRS 1900	0.537	0.285	0.822
Back Side	LTE Band 17	0.612	0.285	0.897
Back Side	LTE Band 4 (AWS)	0.912	0.285	1.197
Back Side	LTE Band 2 (PCS)	0.547	0.285	0.832

Note: The worst case 5 GHz WLAN reported SAR for body-worn configuration was used for SAR summation.

Table 12-6
Simultaneous Transmission Scenario with Bluetooth (Body-Worn at 10 mm)

Configuration	Mode	2G/3G/4G SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)
Back Side	GSM 850	0.510	0.167	0.677
Back Side	UMTS 850	0.463	0.167	0.630
Back Side	UMTS 1750	0.668	0.167	0.835
Back Side	GSM 1900	0.539	0.167	0.706
Back Side	UMTS 1900	0.712	0.167	0.879
Back Side	GPRS 850	0.655	0.167	0.822
Back Side	GPRS 1900	0.537	0.167	0.704
Back Side	LTE Band 17	0.612	0.167	0.779
Back Side	LTE Band 4 (AWS)	0.912	0.167	1.079
Back Side	LTE Band 2 (PCS)	0.547	0.167	0.714

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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12.5 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 12-7
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	0.655	0.173	0.828	Body SAR	Back	0.463	0.173	0.636
	Front	0.391	0.073	0.464		Front	0.245	0.073	0.318
	Top	-	0.117	0.117		Top	-	0.117	0.117
	Bottom	0.125	-	0.125		Bottom	0.084	-	0.084
	Right	-	-	0.000		Right	-	-	0.000
	Left	0.505	0.203	0.708		Left	0.406	0.203	0.609
Simult Tx	Configuration	UMTS 1750 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.668	0.173	0.841	Body SAR	Back	0.537	0.173	0.710
	Front	0.357	0.073	0.430		Front	0.168	0.073	0.241
	Top	-	0.117	0.117		Top	-	0.117	0.117
	Bottom	0.333	-	0.333		Bottom	0.325	-	0.325
	Right	-	-	0.000		Right	-	-	0.000
	Left	0.218	0.203	0.421		Left	0.066	0.203	0.269
Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	LTE Band 17 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.712	0.173	0.885	Body SAR	Back	0.612	0.173	0.785
	Front	0.320	0.073	0.393		Front	0.281	0.073	0.354
	Top	-	0.117	0.117		Top	-	0.117	0.117
	Bottom	0.515	-	0.515		Bottom	0.124	-	0.124
	Right	-	-	0.000		Right	0.404	-	0.404
	Left	0.281	0.203	0.484		Left	-	0.203	0.203
Simult Tx	Configuration	LTE Band 4 (AWS) SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	LTE Band 2 (PCS) SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.912	0.173	1.085	Body SAR	Back	0.547	0.173	0.720
	Front	0.414	0.073	0.487		Front	0.302	0.073	0.375
	Top	-	0.117	0.117		Top	-	0.117	0.117
	Bottom	0.517	-	0.517		Bottom	0.475	-	0.475
	Right	-	-	0.000		Right	-	-	0.000
	Left	0.308	0.203	0.511		Left	0.256	0.203	0.459

12.6 Simultaneous Transmission Conclusion

The above numerical summed SAR 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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13 SAR MEASUREMENT VARIABILITY

13.1 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 ≥ 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 ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
- 3) A third repeated measurement was performed only if the original, first or second repeated measurement was ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20 .
- 4) Repeated measurements are not required when the original highest measured SAR is < 0.80 W/kg

**Table 13-1
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)	
1750	1732.50	20175	LTE Band 4 (AWS)	QPSK, 1 RB, 50 RB Offset	back	10 mm	0.826	0.818	1.01	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						

13.2 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 1528-2013 was not required.

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14 EQUIPMENT LIST

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	8594A	(9kHz-2.9GHz) Spectrum Analyzer	N/A	N/A	N/A	3051A00187
Agilent	8753E	(30kHz-6GHz) Network Analyzer	4/16/2013	Annual	4/16/2014	JP38020182
Agilent	E8257D	(250kHz-20GHz) Signal Generator	4/16/2013	Annual	4/16/2014	MY45470194
Agilent	N9020A	MXA Signal Analyzer	11/9/2012	Annual	11/9/2013	US46470561
Agilent	8648D	(9kHz-4GHz) Signal Generator	4/17/2013	Annual	4/17/2014	3629U00687
Agilent	8753E	(30kHz-6GHz) Network Analyzer	7/23/2013	Annual	7/23/2014	US37390350
Agilent	85070C	Dielectric Probe Kit	2/14/2013	Annual	2/14/2014	MY44300633
Agilent	85047A	S-Parameter Test Set	N/A	N/A	N/A	2904A00579
Amplifier Research	5S1G4	5W, 800MHz-4.2GHz	CBT	N/A	CBT	21910
Anritsu	MA2481A	Power Sensor	2/14/2013	Annual	2/14/2014	5318
Anritsu	ML2438A	Power Meter	12/4/2012	Annual	12/4/2013	1070030
Anritsu	MA2481A	Power Sensor	2/14/2013	Annual	2/14/2014	5821
Anritsu	MA2481A	Power Sensor	2/14/2013	Annual	2/14/2014	2400
Anritsu	ML2495A	Power Meter	10/11/2013	Annual	10/11/2014	1039008
Anritsu	MT8820C	Radio Communication Tester	11/6/2012	Annual	11/6/2013	6200901190
Anritsu	MA24106A	USB Power Sensor	12/7/2012	Annual	12/7/2013	1244524
Anritsu	MA2481D	Universal Sensor	12/17/2012	Annual	12/17/2013	1204419
Anritsu	ML2496A	Power Meter	11/28/2012	Annual	11/28/2013	1138001
Anritsu	MA2411B	Pulse Power Sensor	12/4/2012	Annual	12/4/2013	1207364
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
Control Company	36934-158	Wall-Mounted Thermometer	1/4/2012	Biennial	1/4/2014	122014497
Fisher Scientific	15-07BJ	Long Stem Thermometer	1/7/2013	Biennial	1/7/2015	130018243
MCL	BW-N6W5+	6dB Attenuator	CBT	N/A	CBT	1139
MiniCircuits	SLP-2400+	Low Pass Filter	CBT	N/A	CBT	R8979500903
MiniCircuits	VLf-6000+	Low Pass Filter	CBT	N/A	CBT	N/A
MiniCircuits	VLf-6000+	Low Pass Filter	CBT	N/A	CBT	N/A
Mini-Circuits	BW-N20W5+	DC to 18 GHz Precision Fixed 20 dB Attenuator	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	NLP-1200+	Low Pass Filter DC to 1000 MHz	CBT	N/A	CBT	N/A
Mini-Circuits	BW-N20W5	Power Attenuator	CBT	N/A	CBT	1226
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Narda	BW-S3W2	Attenuator (3dB)	CBT	N/A	CBT	120
Narda	4014C-6	4 - 8 GHz SMA 6dB Directional Coupler	CBT	N/A	CBT	N/A
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	SMIQ03B	Signal Generator	4/17/2013	Annual	4/17/2014	DE27259
Rohde & Schwarz	CMW500	LTE Radio Communication Tester	6/6/2013	Annual	6/6/2014	111427
Seekonk	NC-100	Torque Wrench (8" lb)	11/29/2011	Triennial	11/29/2014	21053
SPEAG	D1750V2	1750 MHz SAR Dipole	4/30/2013	Annual	4/30/2014	1051
SPEAG	D1765V2	1765 MHz SAR Dipole	5/14/2013	Annual	5/14/2014	1008
SPEAG	D1900V2	1900 MHz SAR Dipole	5/2/2013	Annual	5/2/2014	5d141
SPEAG	D2450V2	2450 MHz SAR Dipole	2/11/2013	Annual	2/11/2014	882
SPEAG	D5GHZV2	5 GHz SAR Dipole	1/11/2013	Annual	1/11/2014	1057
SPEAG	D5GHZV2	5 GHz SAR Dipole	2/14/2013	Annual	2/14/2014	1120
SPEAG	D750V3	750 MHz Dipole	1/7/2013	Annual	1/7/2014	1003
SPEAG	D835V2	835 MHz SAR Dipole	4/25/2013	Annual	4/25/2014	4d119
SPEAG	DAE4	Dasy Data Acquisition Electronics	4/22/2013	Annual	4/22/2014	665
SPEAG	DAE4	Dasy Data Acquisition Electronics	2/6/2013	Annual	2/6/2014	649
SPEAG	DAE4	Dasy Data Acquisition Electronics	5/13/2013	Annual	5/13/2014	859
SPEAG	DAE4	Dasy Data Acquisition Electronics	1/17/2013	Annual	1/17/2014	1272
SPEAG	DAE4	Dasy Data Acquisition Electronics	11/13/2012	Annual	11/13/2013	1333
SPEAG	DAE4	Dasy Data Acquisition Electronics	8/21/2013	Annual	8/21/2014	1322
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	1368
SPEAG	DAK-3.5	Dielectric Assessment Kit	5/14/2013	Annual	5/14/2014	1070
SPEAG	DAKS-3.5	Portable Dielectric Assessment Kit	8/18/2013	Annual	8/18/2014	1009
SPEAG	ES3DV2	SAR Probe	8/22/2013	Annual	8/22/2014	3022
SPEAG	ES3DV3	SAR Probe	4/29/2013	Annual	4/29/2014	3213
SPEAG	ES3DV3	SAR Probe	3/15/2013	Annual	3/15/2014	3209
SPEAG	ES3DV3	SAR Probe	5/16/2013	Annual	5/16/2014	3263
SPEAG	ES3DV3	SAR Probe	11/15/2012	Annual	11/15/2013	3287
SPEAG	ES3DV3	SAR Probe	4/29/2013	Annual	4/29/2014	3319
SPEAG	EX3DV4	SAR Probe	1/17/2013	Annual	1/17/2014	3589
SPEAG	EX3DV4	SAR Probe	2/27/2013	Annual	2/27/2014	3920
SPEAG	GVD	Golden Validation Device	7/29/2013	Annual	7/29/2014	1055
Tektronix	RSA6114A	Real Time Spectrum Analyzer	4/17/2013	Annual	4/17/2014	B010177
VWR	23226-658	Long Stem Thermometer	5/16/2012	Biennial	5/16/2014	122295544

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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15 MEASUREMENT UNCERTAINTIES

Applicable for frequencies less than 3000 MHz.

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

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

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Applicable for frequencies up to 6 GHz.

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

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

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16 CONCLUSION

16.1 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: ZNFD520; Type: Portable Handset; Serial: 1610-5

Communication System: GSM GPRS; 4 Tx slots; Frequency: 836.6 MHz; Duty Cycle: 1:2.076

Medium: 835 Head Medium parameters used (interpolated):

$f = 836.6 \text{ MHz}$; $\sigma = 0.908 \text{ S/m}$; $\epsilon_r = 41.227$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Left Section

Test Date: 10-21-2013; Ambient Temp: 23.2°C; Tissue Temp: 20.7°C

Probe: EX3DV4 - SN3920; ConvF(9.58, 9.58, 9.58); Calibrated: 2/27/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

Phantom: SAM 5.0 front; Type: QD000P40CD; Serial: TP:-1648

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

Mode: GPRS 850, Left Head, Cheek, Mid.ch, 4 Tx slots

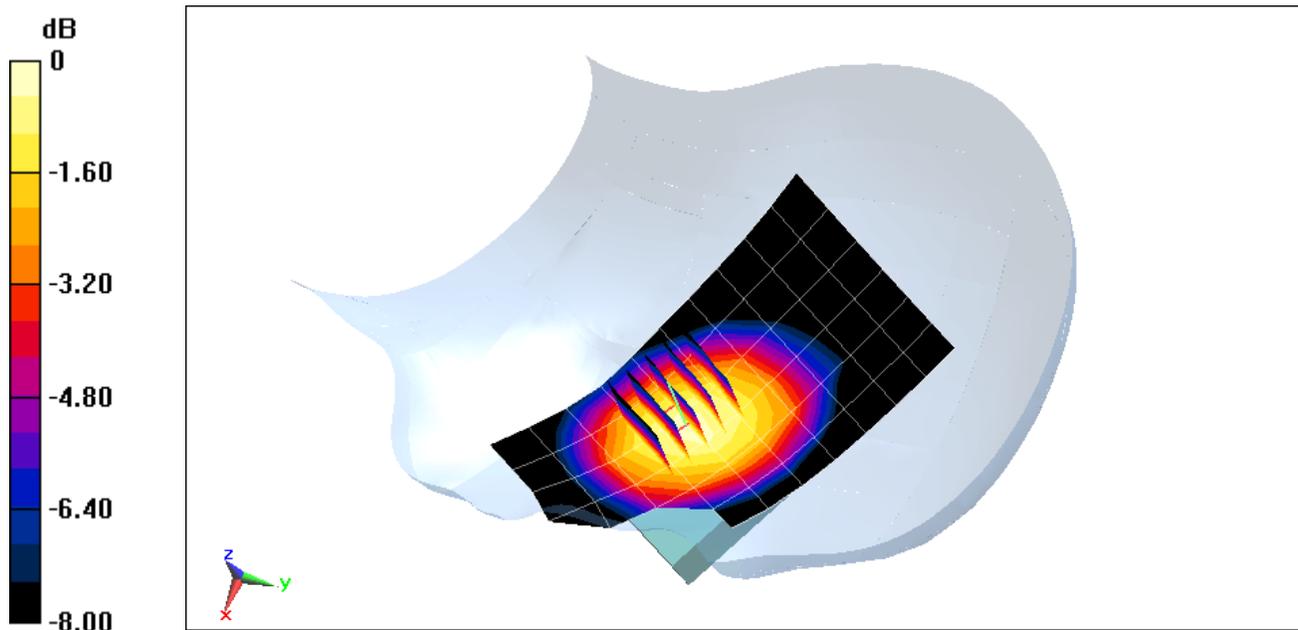
Area Scan (7x11x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 17.607 V/m; Power Drift = 0.21 dB

Peak SAR (extrapolated) = 0.388 W/kg

SAR(1 g) = 0.291 W/kg



0 dB = 0.332 W/kg = -4.79 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-5

Communication System: UMTS; Frequency: 836.6 MHz; Duty Cycle: 1:1

Medium: 835 Head Medium parameters used (interpolated):

$f = 836.6 \text{ MHz}$; $\sigma = 0.908 \text{ S/m}$; $\epsilon_r = 41.227$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Left Section

Test Date: 10-21-2013; Ambient Temp: 23.2°C; Tissue Temp: 20.7°C

Probe: EX3DV4 - SN3920; ConvF(9.58, 9.58, 9.58); Calibrated: 2/27/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

Phantom: SAM 5.0 front; Type: QD000P40CD; Serial: TP:-1648

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

Mode: UMTS 850, Left Head, Cheek, Mid.ch

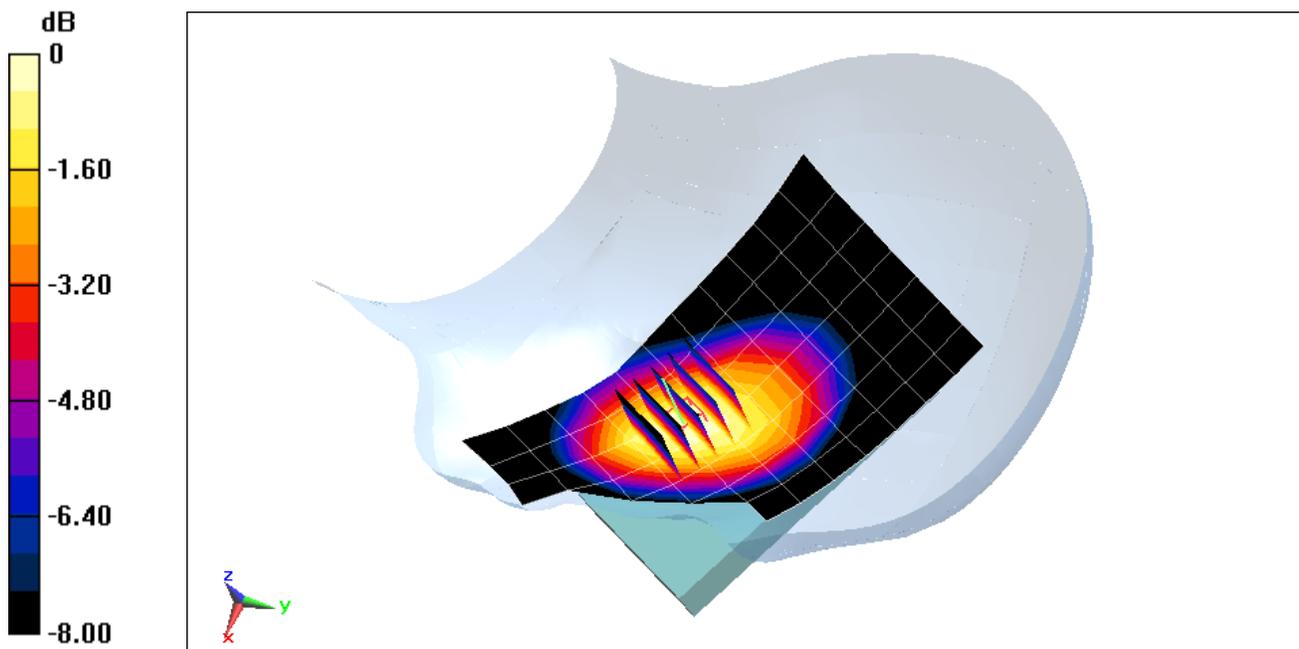
Area Scan (8x13x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 15.467 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 0.274 W/kg

SAR(1 g) = 0.209 W/kg



0 dB = 0.197 W/kg = -7.06 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-4

Communication System: AWS UMTS; Frequency: 1732.4 MHz; Duty Cycle: 1:1

Medium: 1750 Head Medium parameters used (interpolated):

$f = 1732.4 \text{ MHz}$; $\sigma = 1.388 \text{ S/m}$; $\epsilon_r = 40.398$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Test Date: 10-22-2013; Ambient Temp: 23.4°C; Tissue Temp: 22.8°C

Probe: ES3DV3 - SN3287; ConvF(5.16, 5.16, 5.16); Calibrated: 11/15/2012;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 11/13/2012

Phantom: SAM with CRP; Type: SAM 4.0; Serial: TP1375

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

Mode: UMTS 1750, Right Head, Cheek, Mid.ch

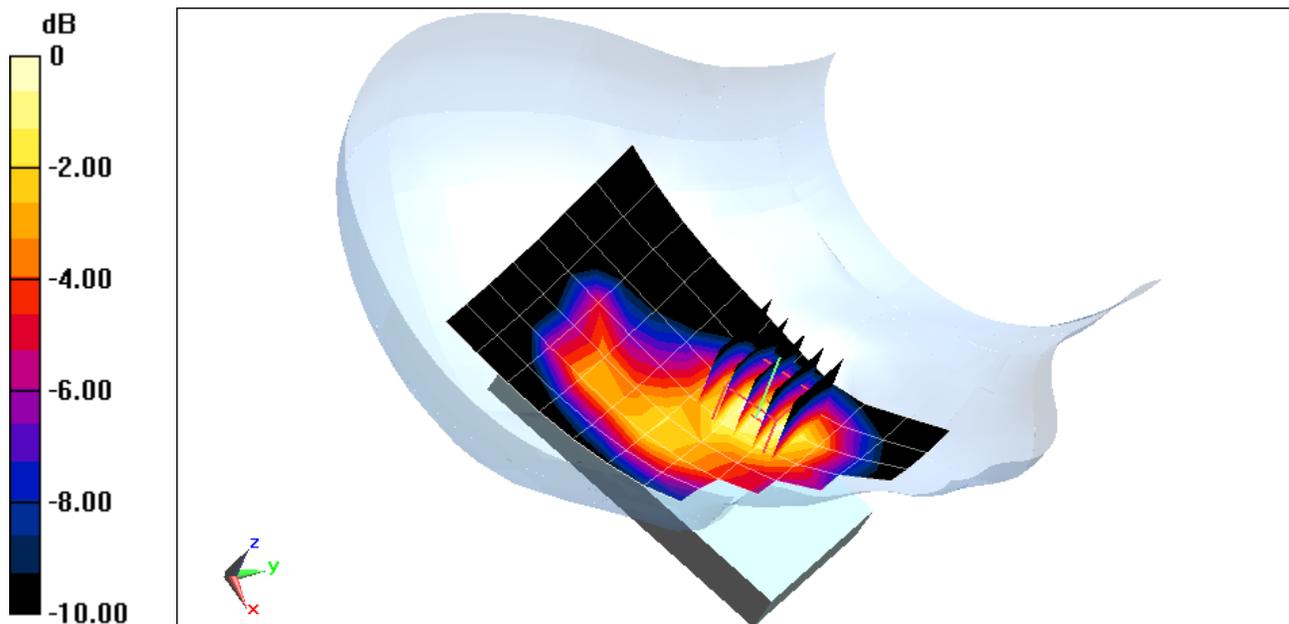
Area Scan (8x11x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 18.045 V/m; Power Drift = -0.18 dB

Peak SAR (extrapolated) = 0.670 W/kg

SAR(1 g) = 0.440 W/kg



0 dB = 0.477 W/kg = -3.21 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-5

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

Medium: 1900 Head Medium parameters used:

$f = 1880 \text{ MHz}$; $\sigma = 1.404 \text{ S/m}$; $\epsilon_r = 39.183$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Left Section

Test Date: 10-17-2013; Ambient Temp: 23.0°C; Tissue Temp: 22.8°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 Right; Type: QD000P40CD; Serial: 1686

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

Mode: GSM 1900, Left Head, Cheek, Mid.ch

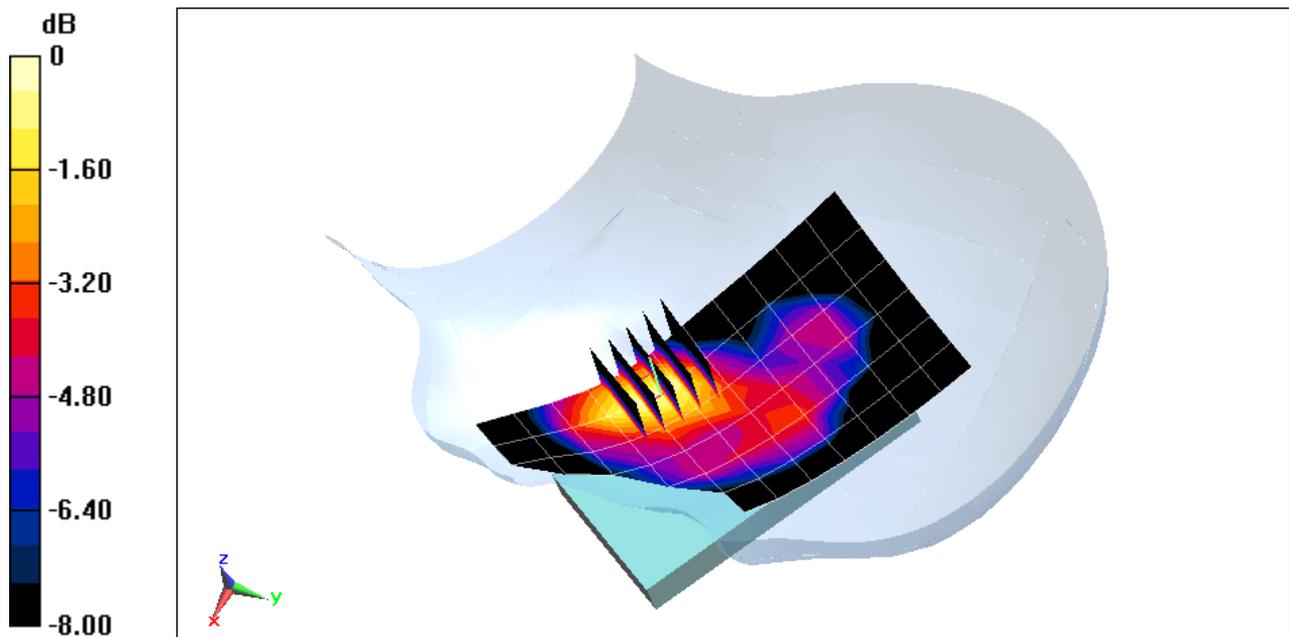
Area Scan (7x14x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 12.382 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 0.305 W/kg

SAR(1 g) = 0.200 W/kg



0 dB = 0.217 W/kg = -6.64 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-5

Communication System: UMTS; Frequency: 1880 MHz; Duty Cycle: 1:1

Medium: 1900 Head Medium parameters used:

$f = 1880 \text{ MHz}$; $\sigma = 1.404 \text{ S/m}$; $\epsilon_r = 39.183$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Test Date: 10-17-2013; Ambient Temp: 23.0°C; Tissue Temp: 22.8°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 Right; Type: QD000P40CD; Serial: 1686

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

Mode: UMTS 1900, Right Head, Tilt, Mid.ch

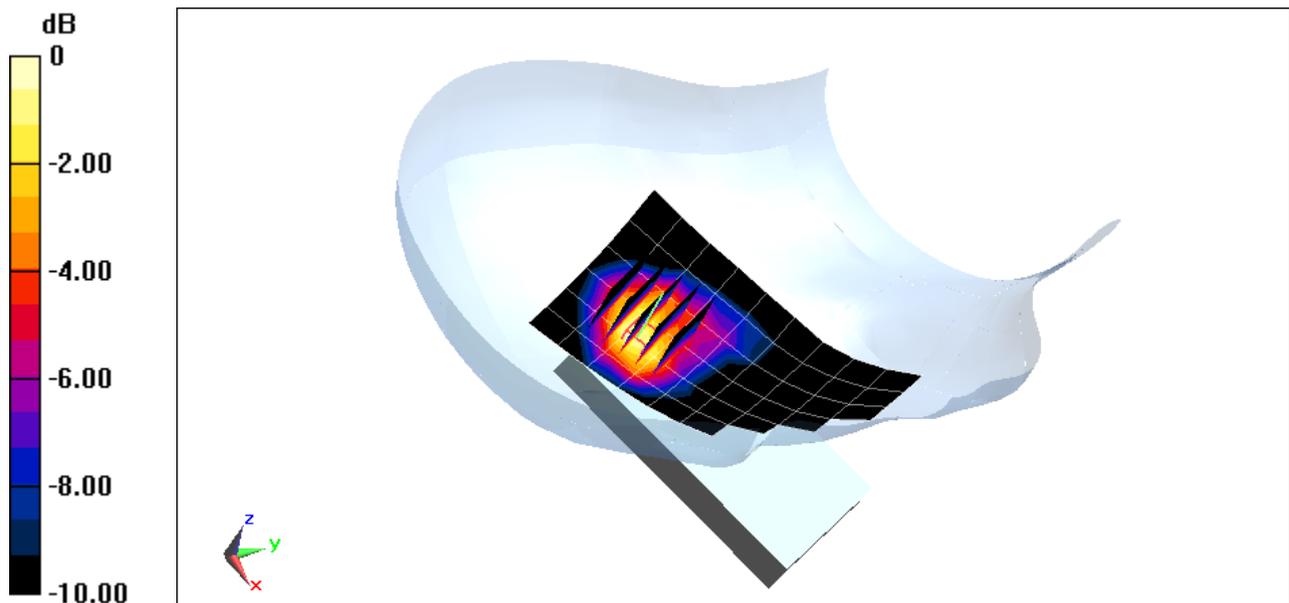
Area Scan (7x10x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 14.633 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 0.489 W/kg

SAR(1 g) = 0.284 W/kg



PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-9

Communication System: LTE Band 17; Frequency: 710 MHz; Duty Cycle: 1:1

Medium: 750 Head Medium parameters used:

$f = 710 \text{ MHz}$; $\sigma = 0.883 \text{ S/m}$; $\epsilon_r = 42.045$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Test Date: 10-17-2013; Ambient Temp: 23.5°C; Tissue Temp: 22.3°C

Probe: ES3DV3 - SN3213; ConvF(6.54, 6.54, 6.54); Calibrated: 4/29/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

Phantom: SAM Left; Type: SAM; Serial: 1688

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

Mode: LTE Band 17, Right Head, Cheek, Mid.ch
10 MHz Bandwidth, QPSK, 1 RB, 49 RB Offset

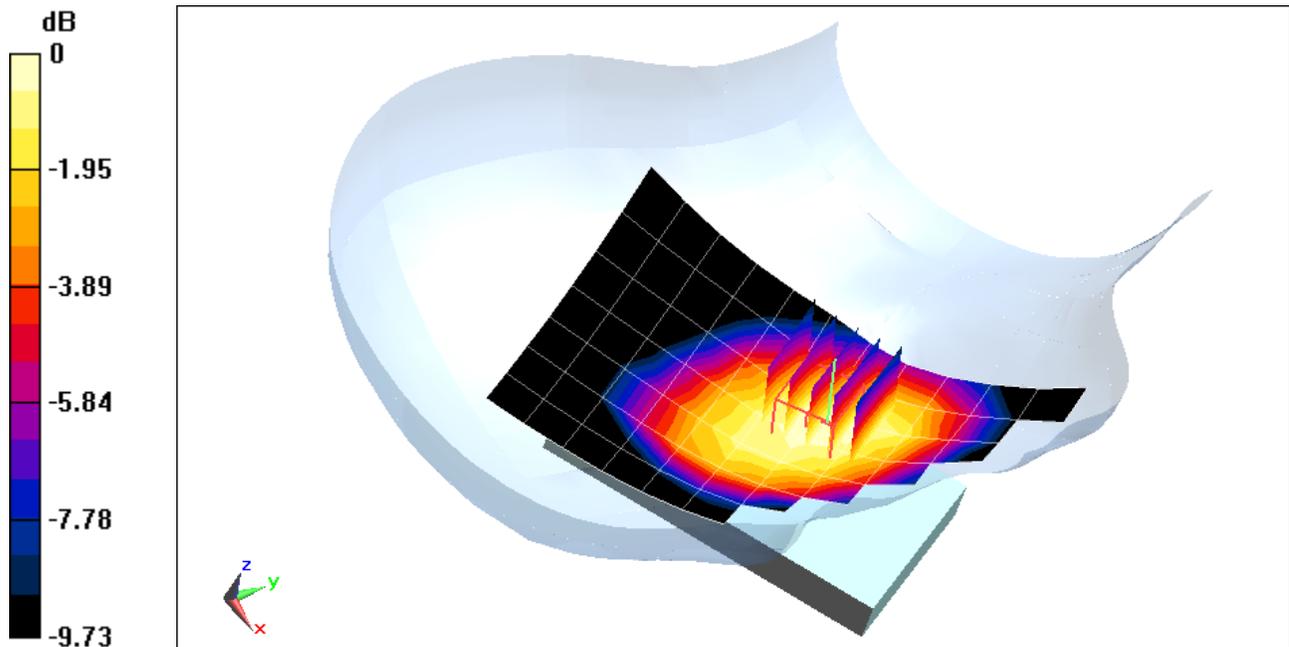
Area Scan (8x12x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 18.878 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 0.361 W/kg

SAR(1 g) = 0.275 W/kg



0 dB = 0.290 W/kg = -5.38 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-9

Communication System: LTE RF; Frequency: 1732.5 MHz; Duty Cycle: 1:1

Medium: 1750 Head Medium parameters used (interpolated):

$f = 1732.5$ MHz; $\sigma = 1.388$ S/m; $\epsilon_r = 40.397$; $\rho = 1000$ kg/m³

Phantom section: Right Section

Test Date: 10-22-2013; Ambient Temp: 23.4°C; Tissue Temp: 22.8°C

Probe: ES3DV3 - SN3287; ConvF(5.16, 5.16, 5.16); Calibrated: 11/15/2012;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 11/13/2012

Phantom: SAM with CRP; Type: SAM 4.0; Serial: TP1375

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

Mode: LTE Band 4 (AWS), Right Head, Cheek, Mid.ch
20 MHz Bandwidth, QPSK, 1 RB, 50 RB Offset

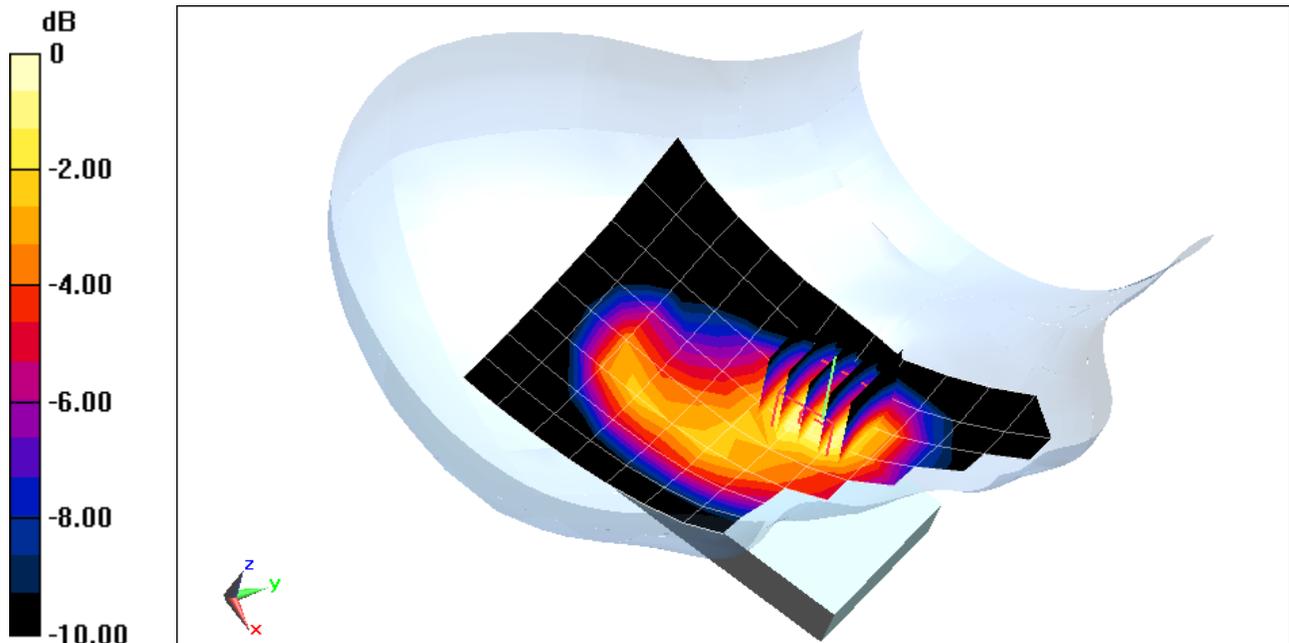
Area Scan (9x12x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 16.999 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 0.595 W/kg

SAR(1 g) = 0.387 W/kg



0 dB = 0.420 W/kg = -3.77 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-8

Communication System: LTE Band 2 (PCS); Frequency: 1880 MHz; Duty Cycle: 1:1

Medium: 1900 Head Medium parameters used:

$f = 1880 \text{ MHz}$; $\sigma = 1.404 \text{ S/m}$; $\epsilon_r = 39.183$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Test Date: 10-17-2013; Ambient Temp: 23.0°C; Tissue Temp: 22.8°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 Right; Type: QD000P40CD; Serial: 1686

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

Mode: LTE Band 2 (PCS), Right Head, Tilt, Mid.ch
10 MHz Bandwidth, QPSK, 1 RB, 25 RB Offset

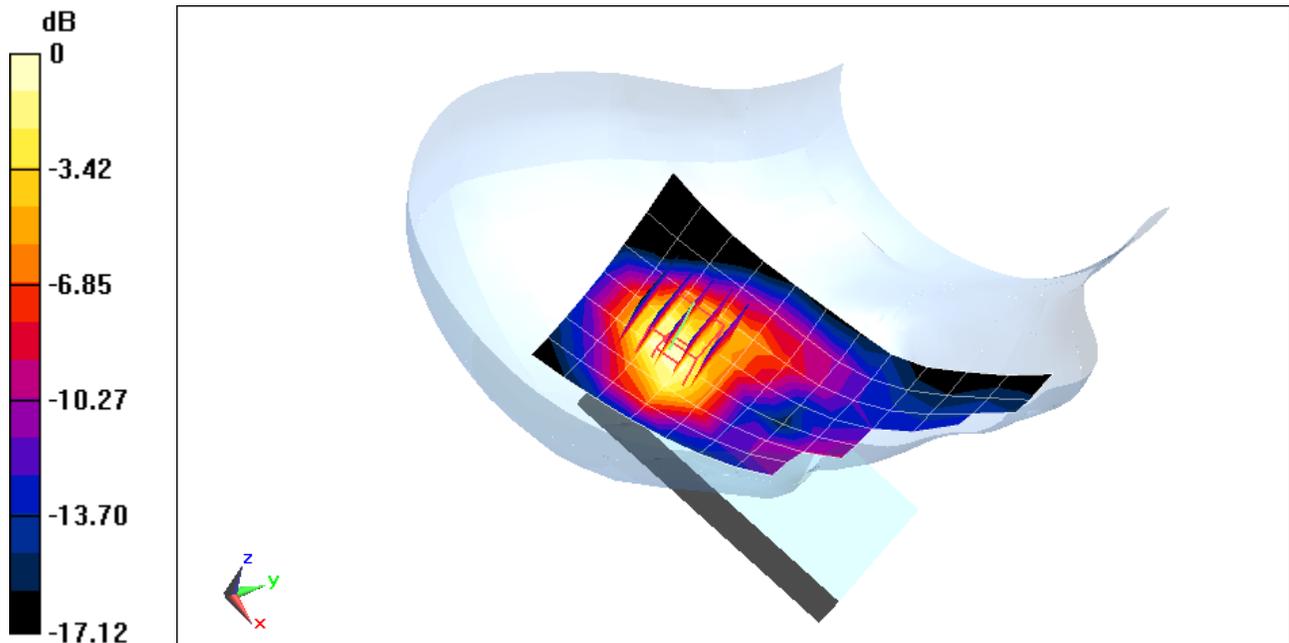
Area Scan (8x12x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 15.997 V/m; Power Drift = 0.13 dB

Peak SAR (extrapolated) = 0.514 W/kg

SAR(1 g) = 0.295 W/kg



0 dB = 0.307 W/kg = -5.13 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-1

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

Medium: 2450 Head Medium parameters used (interpolated):

$f = 2462 \text{ MHz}$; $\sigma = 1.771 \text{ S/m}$; $\epsilon_r = 38.941$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Test Date: 10-21-2013; Ambient Temp: 21.4°C; Tissue Temp: 21.2°C

Probe: ES3DV3 - SN3319; ConvF(4.57, 4.57, 4.57); Calibrated: 4/29/2013;

Sensor-Surface: 3mm (Mechanical Surface Detection)

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

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

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

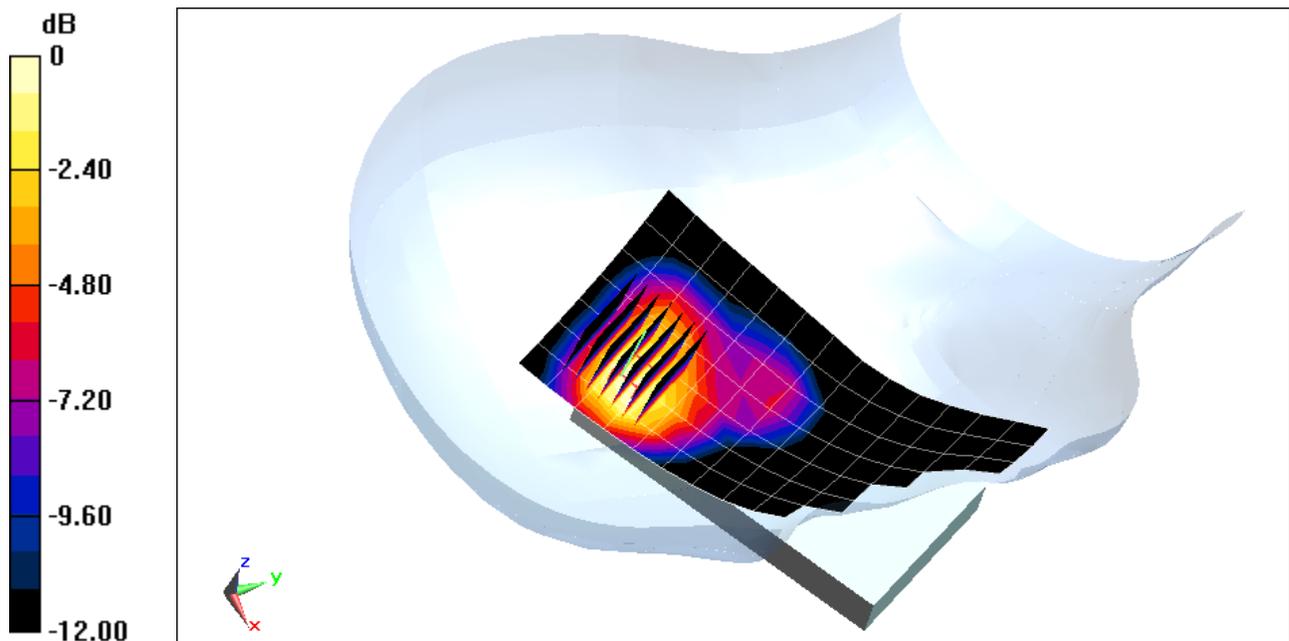
Area Scan (8x14x1): Measurement grid: dx=12mm, dy=12mm

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

Reference Value = 10.732 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 0.377 W/kg

SAR(1 g) = 0.202 W/kg



0 dB = 0.250 W/kg = -6.02 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 2510-1

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

Medium: 5 GHz Head Medium parameters used:

$f = 5745 \text{ MHz}$; $\sigma = 5.052 \text{ S/m}$; $\epsilon_r = 34.681$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Test Date: 10-29-2013; Ambient Temp: 24.5°C; Tissue Temp: 23.1°C

Probe: EX3DV4 - SN3920; ConvF(4.02, 4.02, 4.02); Calibrated: 2/27/2013;

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)

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

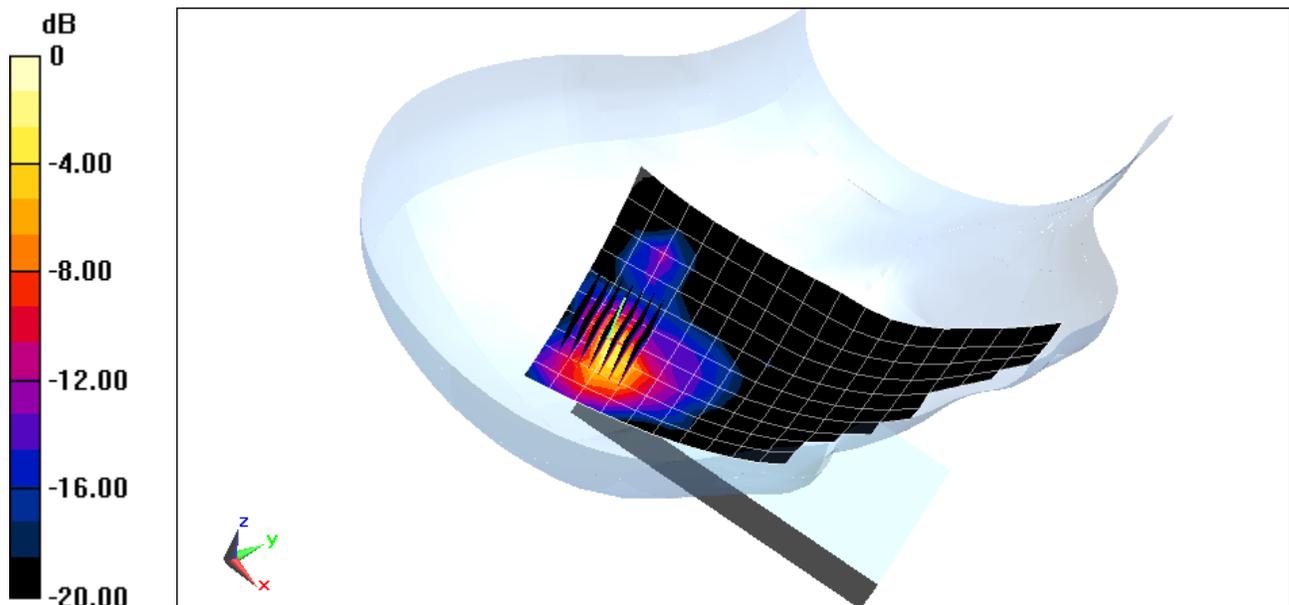
Area Scan (11x17x1): Measurement grid: dx=10mm, dy=10mm

Zoom Scan (8x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio=1.4

Reference Value = 9.080 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 2.54 W/kg

SAR(1 g) = 0.526 W/kg



0 dB = 1.41 W/kg = 1.49 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 2510-1

Communication System: IEEE 802.11a; Frequency: 5560 MHz; Duty Cycle: 1:1

Medium: 5 GHz Head Medium parameters used:

$f = 5560 \text{ MHz}$; $\sigma = 4.867 \text{ S/m}$; $\epsilon_r = 34.988$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Test Date: 10-29-2013; Ambient Temp: 24.5°C; Tissue Temp: 23.1°C

Probe: EX3DV4 - SN3920; ConvF(4.17, 4.17, 4.17); Calibrated: 2/27/2013;

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, 5.5 GHz, Right Head, Tilt, Ch 112, 6 Mbps

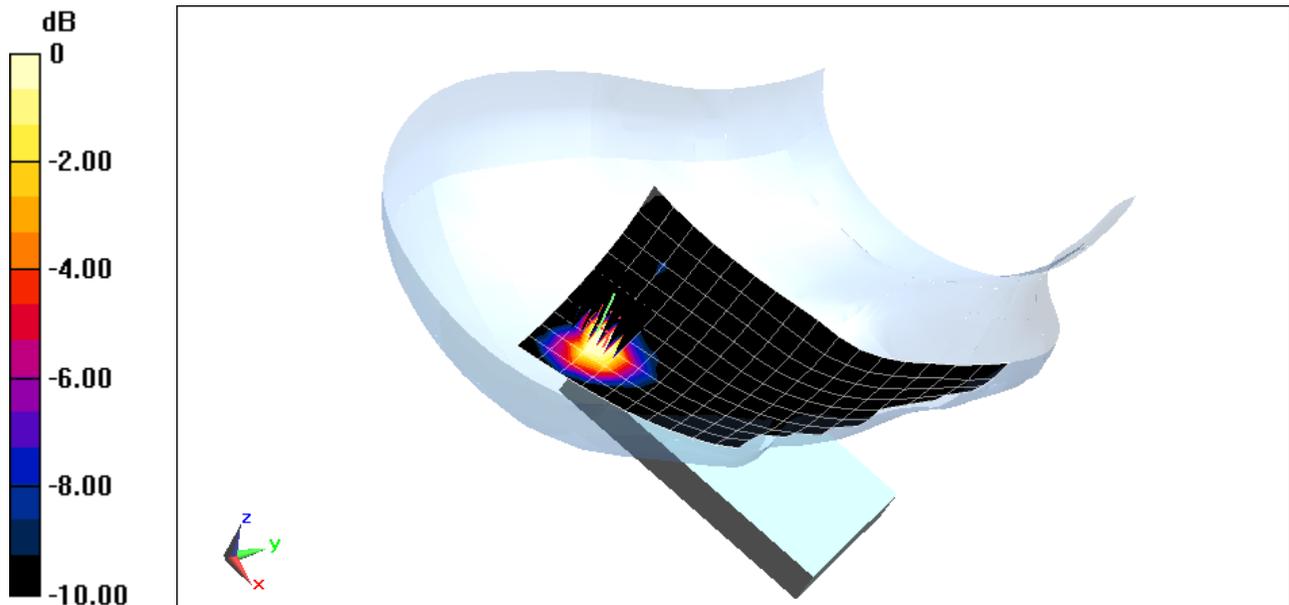
Area Scan (11x17x1): Measurement grid: dx=10mm, dy=10mm

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

Reference Value = 6.452 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 0.914 W/kg

SAR(1 g) = 0.207 W/kg



PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-5

Communication System: GSM GPRS; 4 Tx slots; Frequency: 836.6 MHz; Duty Cycle: 1:2.076

Medium: 835 Body Medium parameters used (interpolated):

$f = 836.6 \text{ MHz}$; $\sigma = 0.998 \text{ S/m}$; $\epsilon_r = 53.913$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-15-2013; Ambient Temp: 23.1°C; Tissue Temp: 22.9°C

Probe: ES3DV2 - SN3022; ConvF(5.91, 5.91, 5.91); Calibrated: 8/22/2013;

Sensor-Surface: 4mm (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: GPRS 850, Body SAR, Back side, Mid.ch, 4 Tx Slots

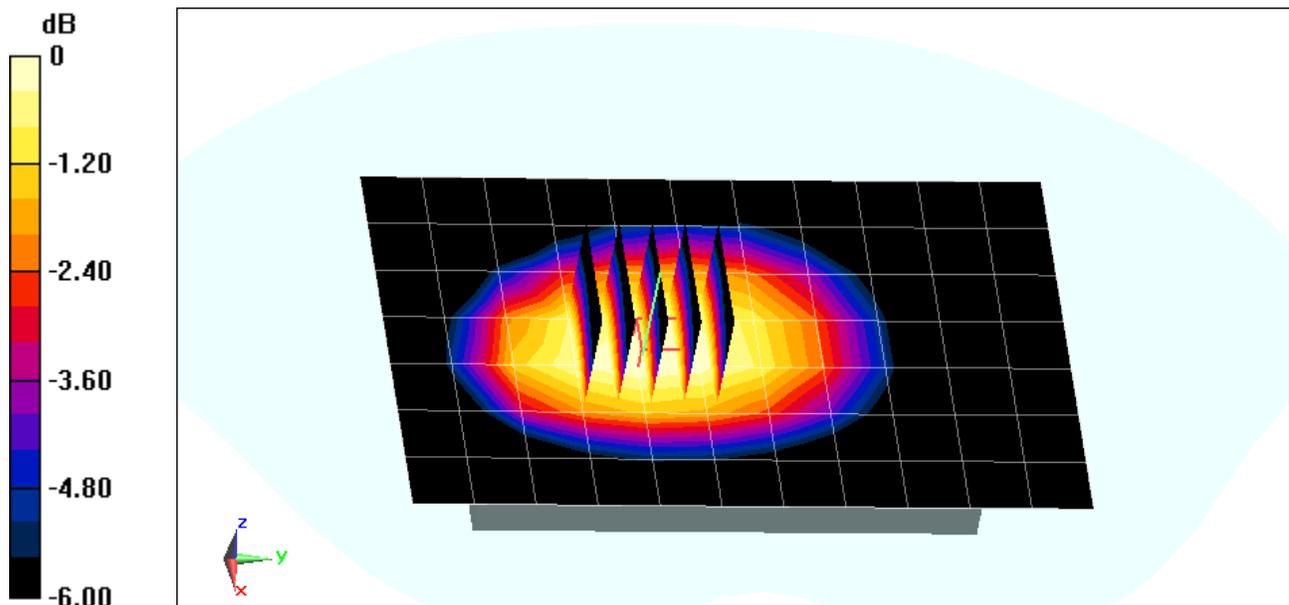
Area Scan (8x12x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 24.801 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 0.722 W/kg

SAR(1 g) = 0.573 W/kg



0 dB = 0.601 W/kg = -2.21 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-5

Communication System: UMTS; Frequency: 836.6 MHz; Duty Cycle: 1:1

Medium: 835 Body Medium parameters used (interpolated):

$f = 836.6 \text{ MHz}$; $\sigma = 0.998 \text{ S/m}$; $\epsilon_r = 53.913$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-15-2013; Ambient Temp: 23.1°C; Tissue Temp: 22.9°C

Probe: ES3DV2 - SN3022; ConvF(5.91, 5.91, 5.91); Calibrated: 8/22/2013;

Sensor-Surface: 4mm (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: UMTS 850, Body SAR, Back side, Mid.ch

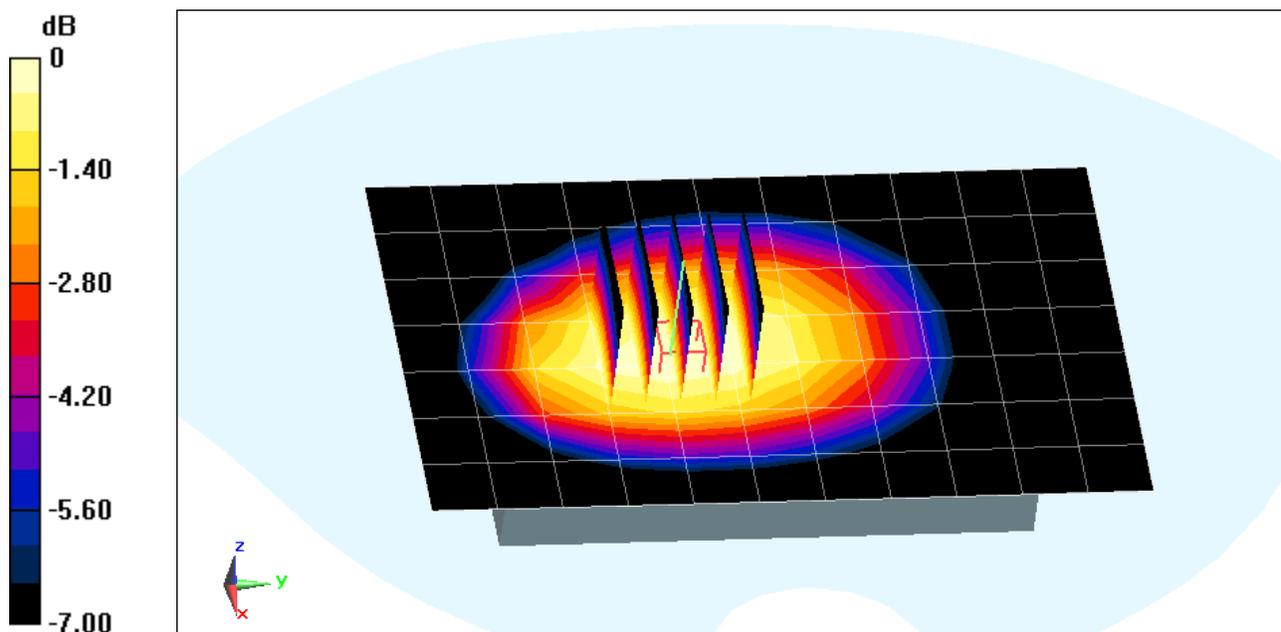
Area Scan (8x12x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 22.434 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 0.581 W/kg

SAR(1 g) = 0.460 W/kg



0 dB = 0.484 W/kg = -3.15 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-4

Communication System: UMTS; Frequency: 1732.4 MHz; Duty Cycle: 1:1

Medium: 1750 Body Medium parameters used (interpolated):

$f = 1732.4$ MHz; $\sigma = 1.422$ S/m; $\epsilon_r = 52.369$; $\rho = 1000$ kg/m³

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-18-2013; Ambient Temp: 23.3°C; Tissue Temp: 22.5°C

Probe: ES3DV2 - SN3022; ConvF(4.75, 4.75, 4.75); 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 1750, Body SAR, Back side, Mid.ch

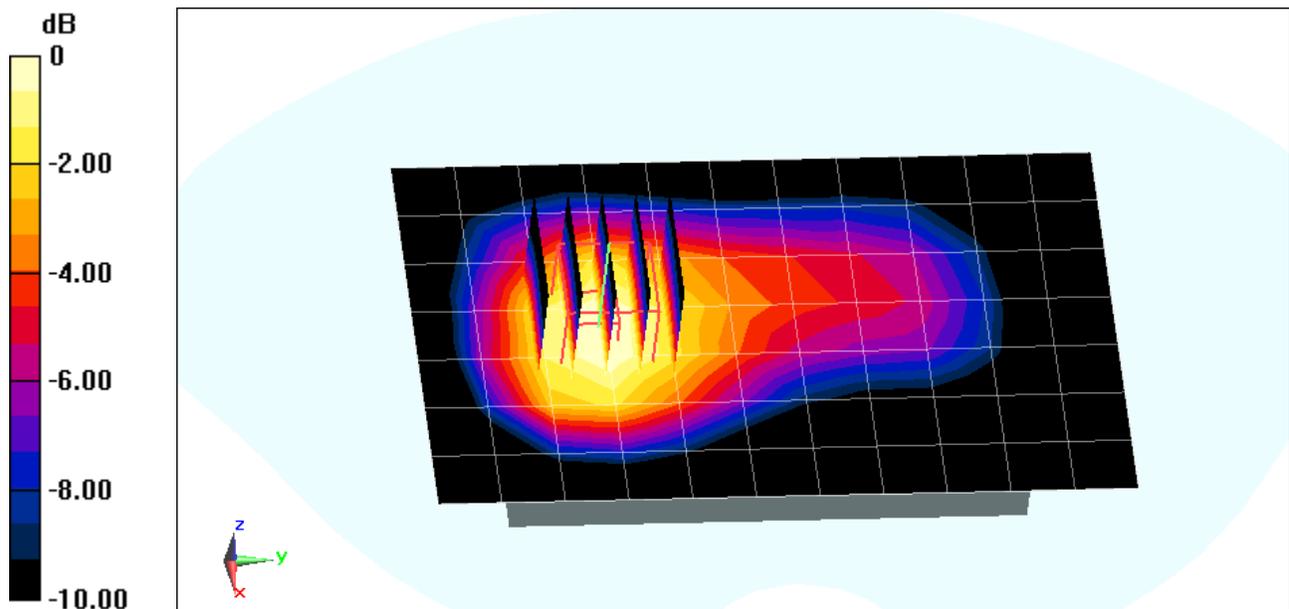
Area Scan (8x12x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 22.575 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 0.986 W/kg

SAR(1 g) = 0.649 W/kg



0 dB = 0.695 W/kg = -1.58 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-5

Communication System: GSM1900; Frequency: 1880 MHz; Duty Cycle: 1:8.3

Medium: 1900 Body Medium parameters used:

$f = 1880 \text{ MHz}$; $\sigma = 1.545 \text{ S/m}$; $\epsilon_r = 54.051$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-21-2013; Ambient Temp: 21.8°C; Tissue Temp: 20.0°C

Probe: ES3DV3 - SN3263; ConvF(4.78, 4.78, 4.78); Calibrated: 5/16/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

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: GSM 1900, Body SAR, Back side, Mid.ch

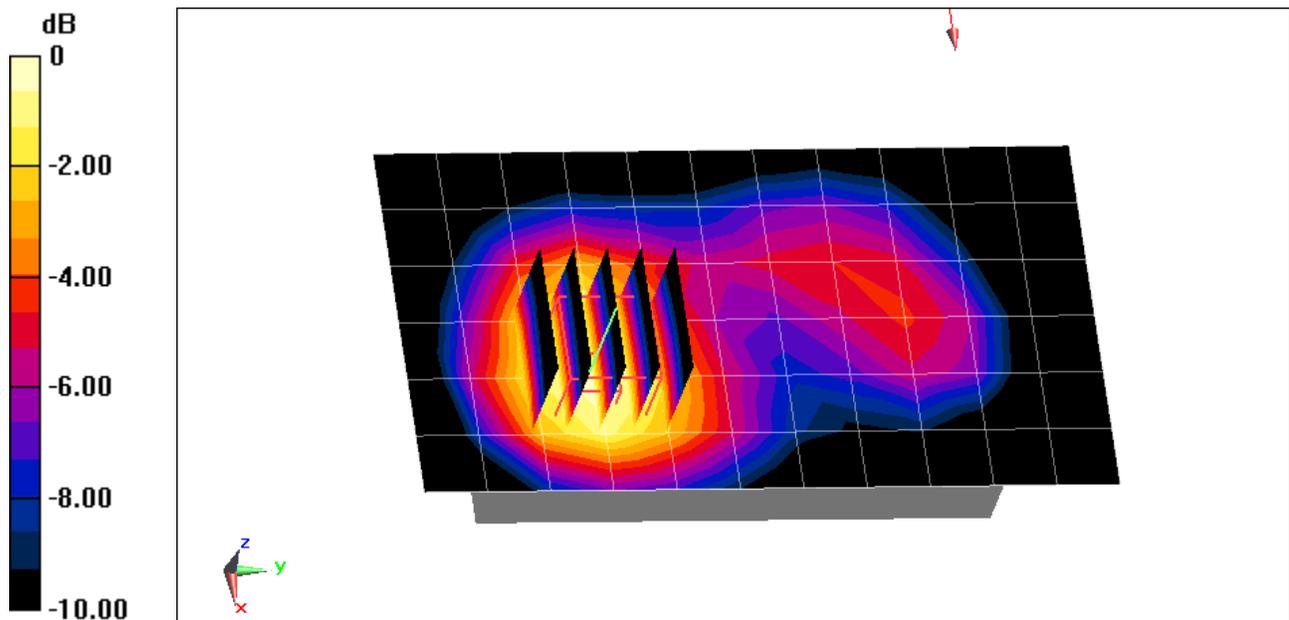
Area Scan (7x12x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 18.337 V/m; Power Drift = 0.16 dB

Peak SAR (extrapolated) = 0.740 W/kg

SAR(1 g) = 0.462 W/kg



0 dB = 0.494 W/kg = -3.06 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-5

Communication System: GSM1900 GPRS; 4 Tx slots; Frequency: 1880 MHz; Duty Cycle: 1:2.298

Medium: 1900 Body Medium parameters used:

$f = 1880 \text{ MHz}$; $\sigma = 1.545 \text{ S/m}$; $\epsilon_r = 54.051$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-21-2013; Ambient Temp: 21.8°C; Tissue Temp: 20.0°C

Probe: ES3DV3 - SN3263; ConvF(4.78, 4.78, 4.78); Calibrated: 5/16/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

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: GPRS 1900, Body SAR, Back side, Mid.ch, 4 Tx Slots

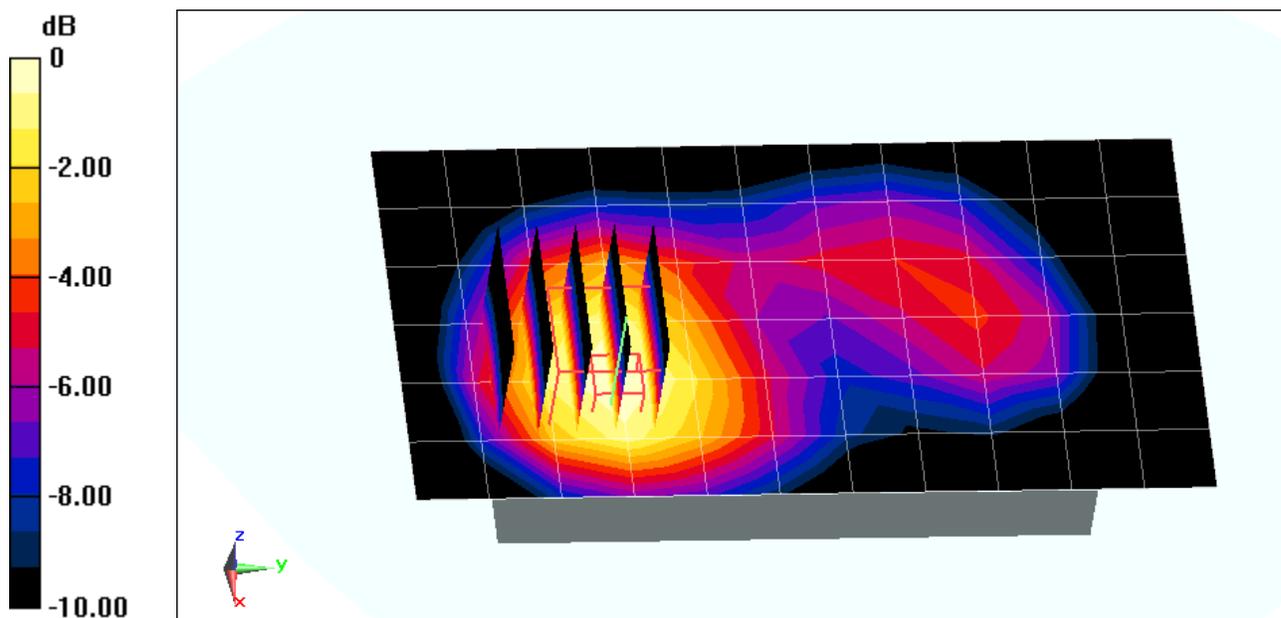
Area Scan (7x12x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 18.432 V/m; Power Drift = -0.17 dB

Peak SAR (extrapolated) = 0.748 W/kg

SAR(1 g) = 0.458 W/kg



0 dB = 0.491 W/kg = -3.09 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-5

Communication System: UMTS; Frequency: 1880 MHz; Duty Cycle: 1:1

Medium: 1900 Body Medium parameters used:

$f = 1880 \text{ MHz}$; $\sigma = 1.545 \text{ S/m}$; $\epsilon_r = 54.051$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-21-2013; Ambient Temp: 21.8°C; Tissue Temp: 20.0°C

Probe: ES3DV3 - SN3263; ConvF(4.78, 4.78, 4.78); Calibrated: 5/16/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

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: UMTS 1900, Body SAR, Back side, Mid.ch

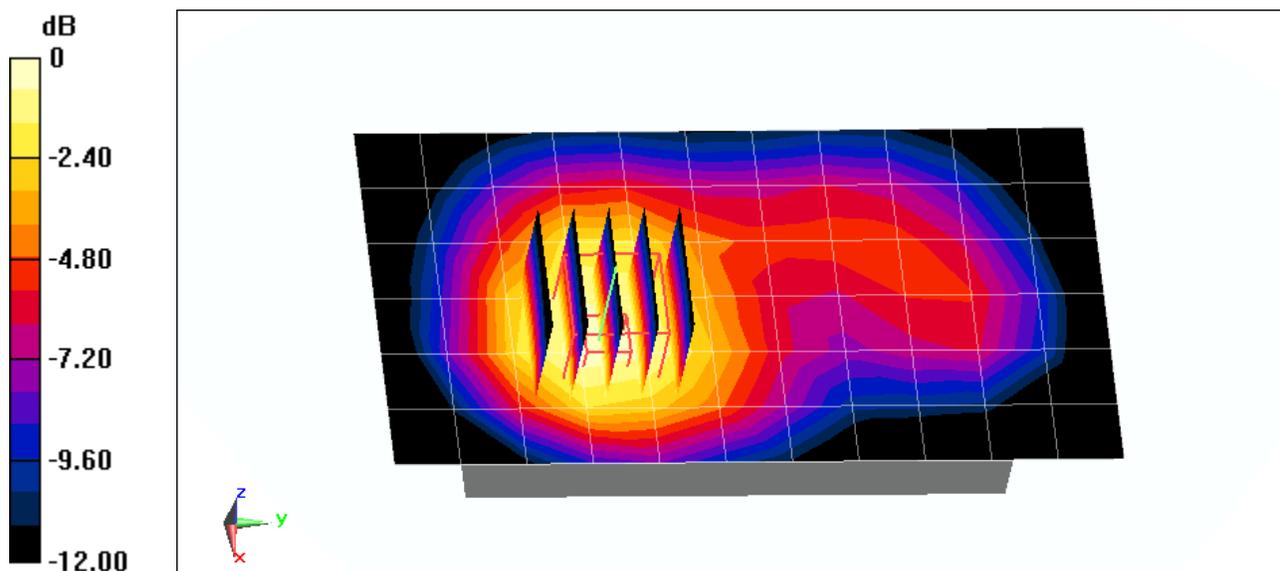
Area Scan (7x12x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 22.035 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 1.14 W/kg

SAR(1 g) = 0.696 W/kg



0 dB = 0.749 W/kg = -1.26 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-9

Communication System: LTE Band 17; Frequency: 710 MHz; Duty Cycle: 1:1

Medium: 750 Body Medium parameters used:

$f = 710 \text{ MHz}$; $\sigma = 0.934 \text{ S/m}$; $\epsilon_r = 55.964$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-18-2013; Ambient Temp: 23.8°C; Tissue Temp: 22.2°C

Probe: ES3DV3 - SN3213; ConvF(6.32, 6.32, 6.32); Calibrated: 4/29/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

Phantom: SAM Left; Type: SAM; Serial: 1688

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

Mode: LTE Band 17, Body SAR, Back side, Mid.ch

10 MHz Bandwidth, QPSK, 1 RB, 49 RB Offset

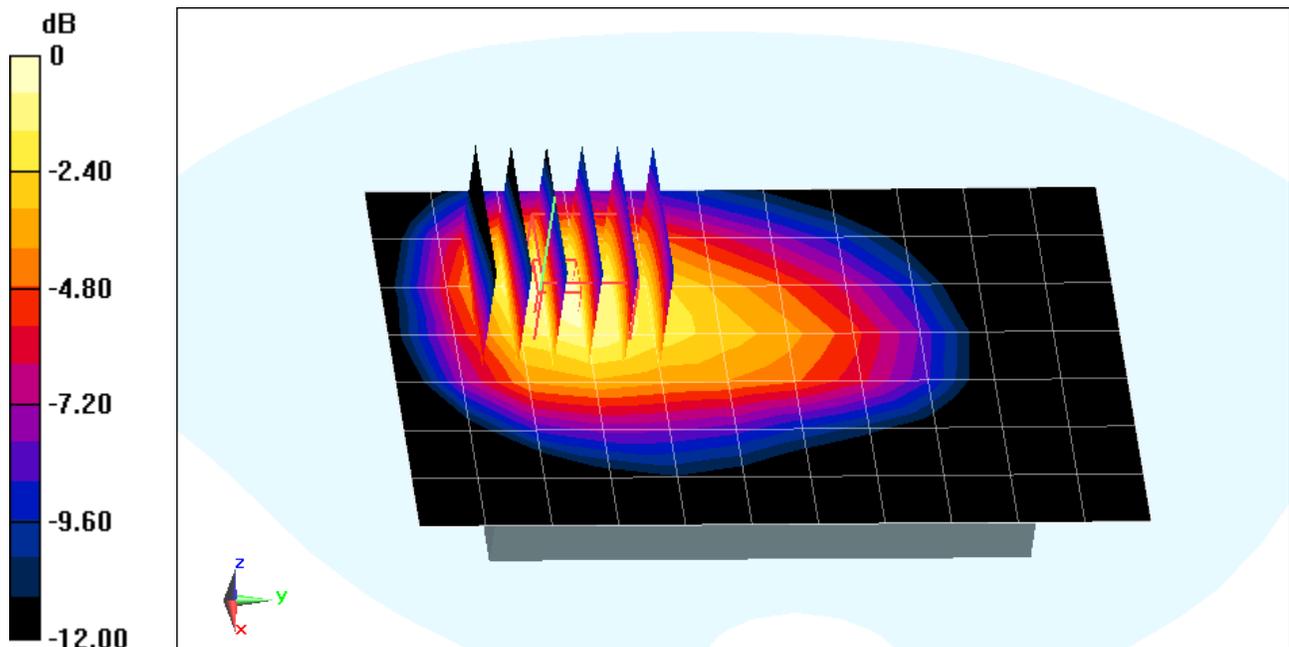
Area Scan (8x12x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 25.760 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 1.02 W/kg

SAR(1 g) = 0.611 W/kg



0 dB = 0.657 W/kg = -1.82 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-9

Communication System: LTE Band 4 (AWS); Frequency: 1732.5 MHz; Duty Cycle: 1:1

Medium: 1750 Body Medium parameters used (interpolated):

$f = 1732.5$ MHz; $\sigma = 1.422$ S/m; $\epsilon_r = 52.369$; $\rho = 1000$ kg/m³

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-18-2013; Ambient Temp: 23.3°C; Tissue Temp: 22.5°C

Probe: ES3DV2 - SN3022; ConvF(4.75, 4.75, 4.75); 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: DASYS2, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

Mode: LTE Band 4 (AWS), Body SAR, Back side, Mid.ch
20 MHz Bandwidth, QPSK, 1 RB, 50 RB Offset

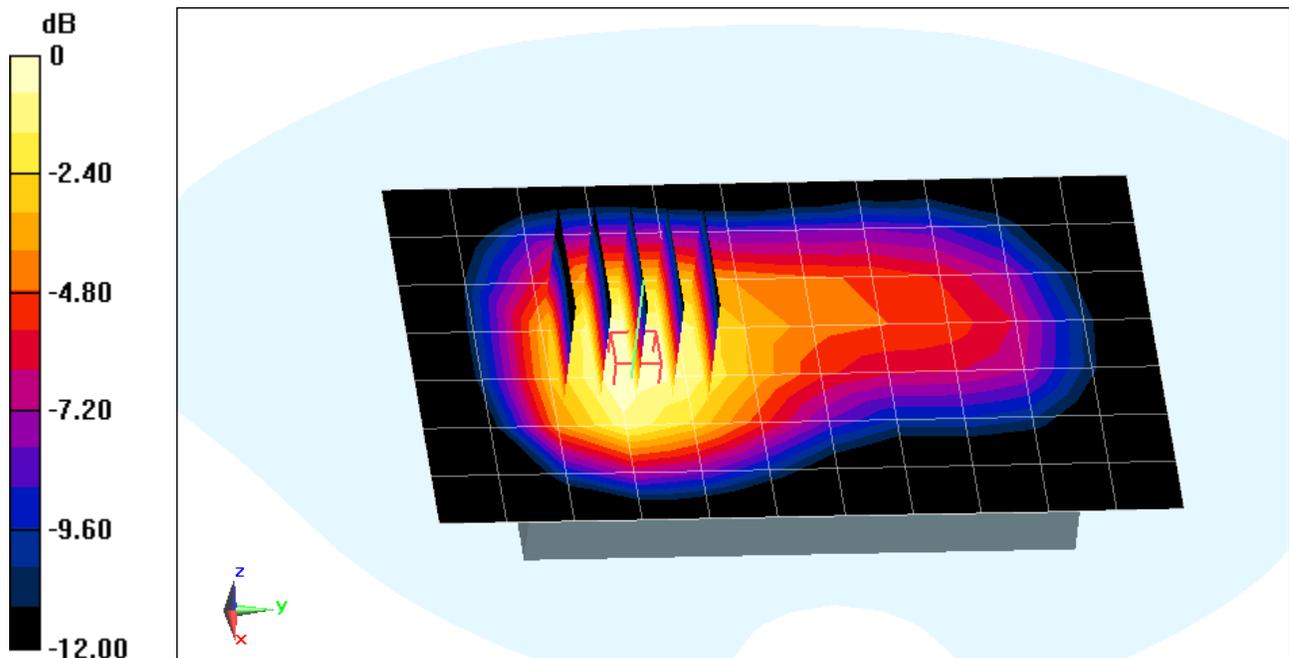
Area Scan (8x12x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 25.373 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 1.30 W/kg

SAR(1 g) = 0.826 W/kg



0 dB = 0.891 W/kg = -0.50 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-8

Communication System: LTE PCS; Frequency: 1880 MHz; Duty Cycle: 1:1

Medium: 1900 Body Medium parameters used:

$f = 1880 \text{ MHz}$; $\sigma = 1.545 \text{ S/m}$; $\epsilon_r = 54.051$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-21-2013; Ambient Temp: 21.8°C; Tissue Temp: 20.0°C

Probe: ES3DV3 - SN3263; ConvF(4.78, 4.78, 4.78); Calibrated: 5/16/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

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: LTE Band 2 (PCS), Body SAR, Back side, Mid.ch

10 MHz Bandwidth, QPSK, 1 RB, 25 RB Offset

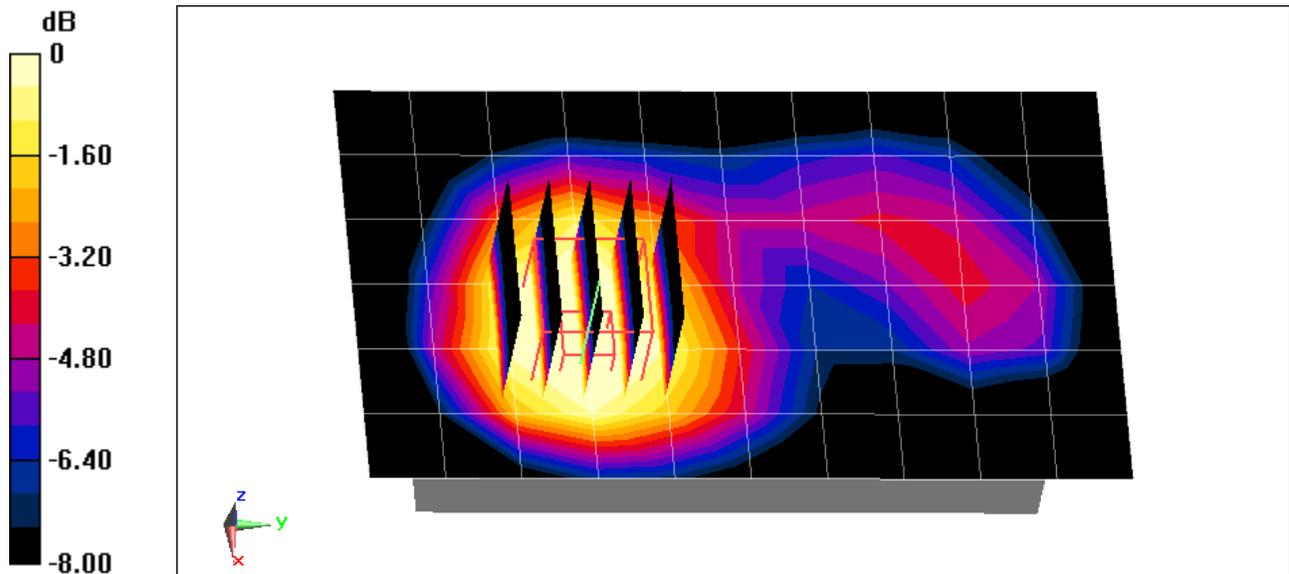
Area Scan (7x11x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 19.500 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 0.880 W/kg

SAR(1 g) = 0.541 W/kg



0 dB = 0.584 W/kg = -2.34 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-11

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

Medium: 2450 Body Medium parameters used (interpolated):

$f = 2462 \text{ MHz}$; $\sigma = 1.974 \text{ S/m}$; $\epsilon_r = 51.235$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-16-2013; Ambient Temp: 24.5°C; Tissue Temp: 24.1°C

Probe: ES3DV3 - SN3209; ConvF(4.34, 4.34, 4.34); Calibrated: 3/15/2013;

Sensor-Surface: 3mm (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: IEEE 802.11b, Body SAR, Ch 11, 1 Mbps, Back Side

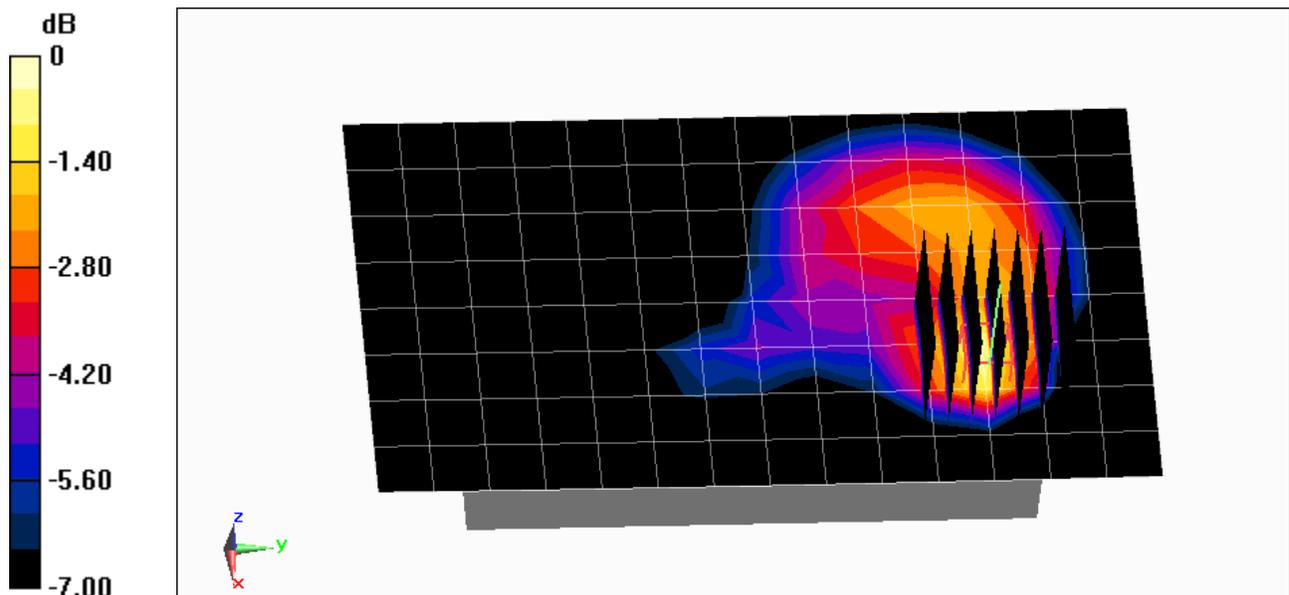
Area Scan (9x15x1): Measurement grid: dx=12mm, dy=12mm

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

Reference Value = 9.410 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 0.359 W/kg

SAR(1 g) = 0.164 W/kg



0 dB = 0.212 W/kg = -6.74 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 1610-11

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

Medium: 2450 Body Medium parameters used (interpolated):

$f = 2462 \text{ MHz}$; $\sigma = 1.974 \text{ S/m}$; $\epsilon_r = 51.235$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-16-2013; Ambient Temp: 24.5°C; Tissue Temp: 24.1°C

Probe: ES3DV3 - SN3209; ConvF(4.34, 4.34, 4.34); Calibrated: 3/15/2013;

Sensor-Surface: 3mm (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: IEEE 802.11b, Body SAR, Ch 11, 1 Mbps, Left Edge

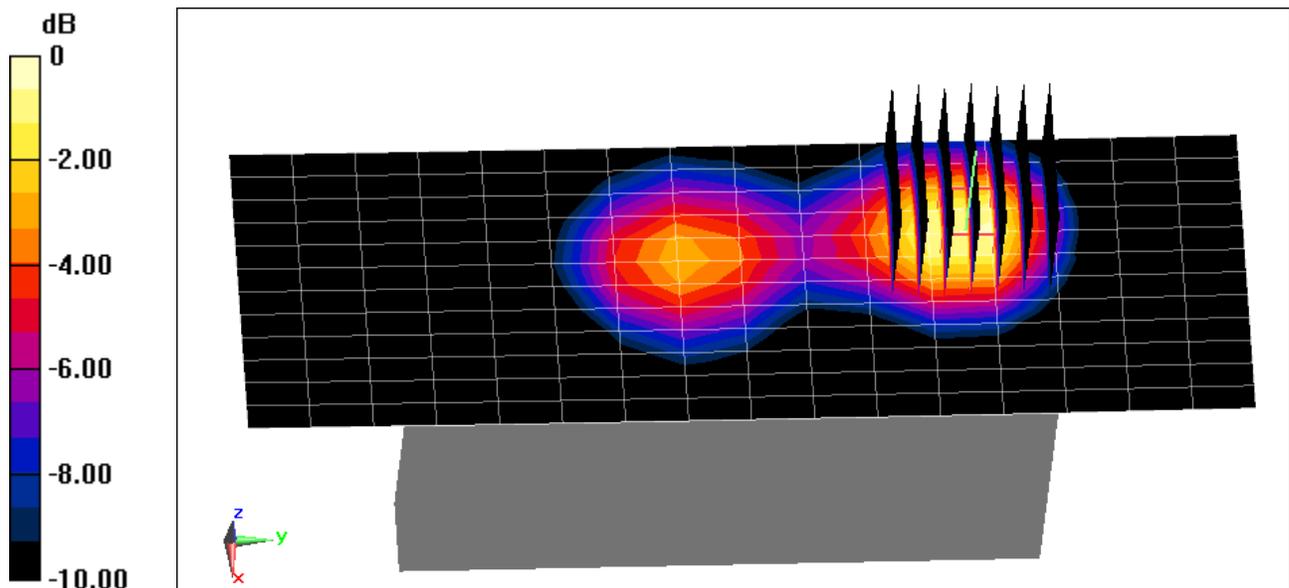
Area Scan (13x17x1): Measurement grid: dx=5mm, dy=12mm

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

Reference Value = 10.121 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 0.401 W/kg

SAR(1 g) = 0.192 W/kg



0 dB = 0.252 W/kg = -5.99 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 2510-1

Communication System: IEEE 802.11a 5.2-5.8 GHz Band; Frequency: 5805 MHz; Duty Cycle: 1:1

Medium: 5 GHz Body Medium parameters used:

$f = 5805 \text{ MHz}$; $\sigma = 6.233 \text{ S/m}$; $\epsilon_r = 46.02$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-29-2013; Ambient Temp: 22.6°C; Tissue Temp: 21.4°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 161, 6 Mbps, Back Side

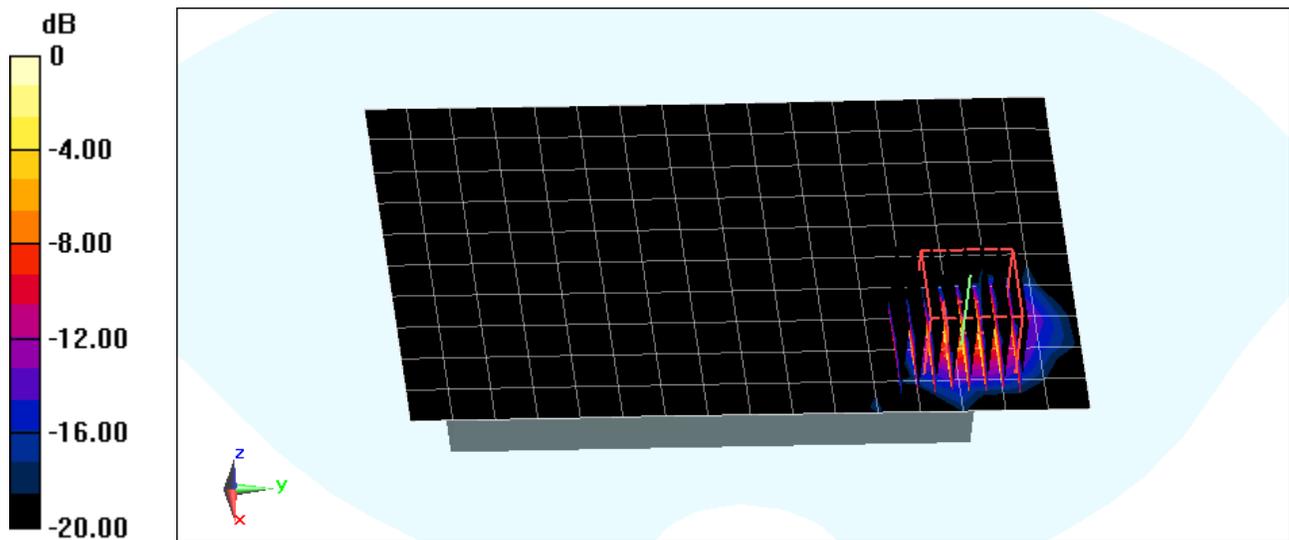
Area Scan (11x17x1): Measurement grid: dx=10mm, dy=10mm

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

Reference Value = 6.237 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 1.05 W/kg

SAR(1 g) = 0.247 W/kg



0 dB = 0.639 W/kg = -1.94 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFD520; Type: Portable Handset; Serial: 2510-1

Communication System: IEEE 802.11a 5.2-5.8 GHz Band; Frequency: 5560 MHz; Duty Cycle: 1:1

Medium: 5 GHz Body Medium parameters used:

$f = 5560 \text{ MHz}$; $\sigma = 5.976 \text{ S/m}$; $\epsilon_r = 46.172$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-29-2013; Ambient Temp: 22.6°C; Tissue Temp: 21.4°C

Probe: EX3DV4 - SN3589; ConvF(3.32, 3.32, 3.32); Calibrated: 1/17/2013;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1272; Calibrated: 1/17/2013

Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357

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

Mode: IEEE 802.11a, 5.5 GHz, Body SAR, Ch 112, 6 Mbps, Back Side

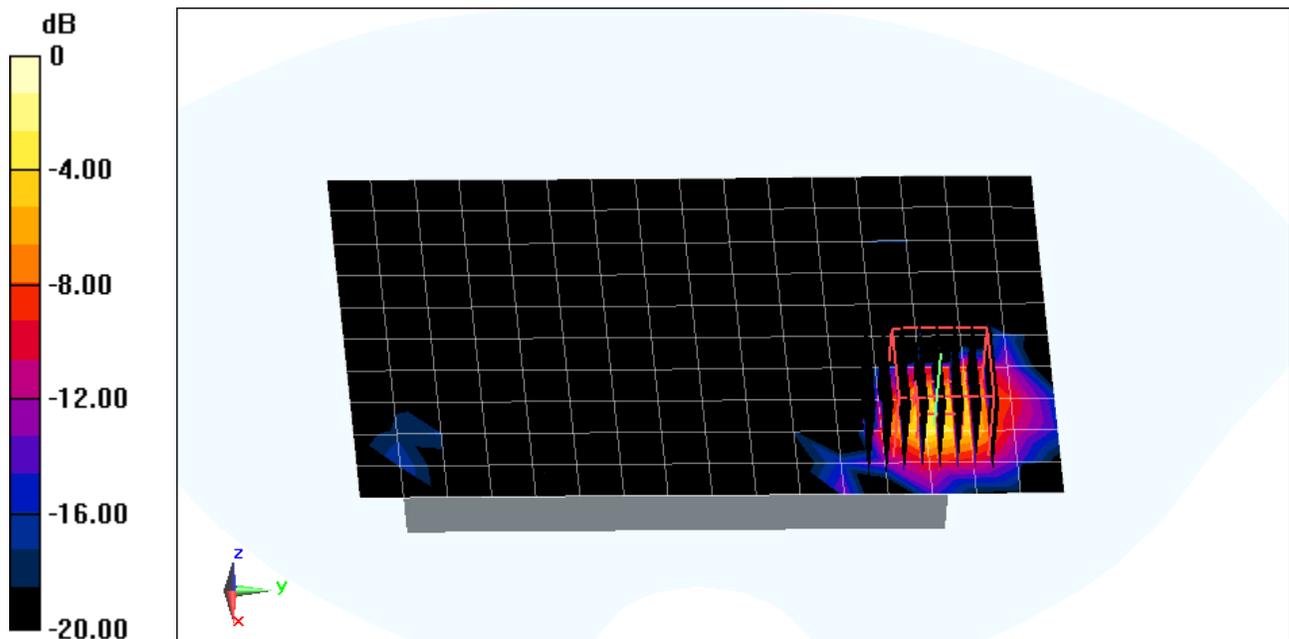
Area Scan (11x17x1): Measurement grid: dx=10mm, dy=10mm

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

Reference Value = 3.600 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 0.404 W/kg

SAR(1 g) = 0.079 W/kg



0 dB = 0.233 W/kg = -6.33 dBW/kg

APPENDIX B: SYSTEM VERIFICATION

PCTEST ENGINEERING LABORATORY, INC.

DUT: Dipole 750 MHz; Type: D750V3; Serial: 1003

Communication System: CW; Frequency: 750 MHz; Duty Cycle: 1:1

Medium: 750 Head Medium parameters used (interpolated):

$f = 750 \text{ MHz}$; $\sigma = 0.917 \text{ S/m}$; $\epsilon_r = 41.552$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.5 cm

Test Date: 10-17-2013; Ambient Temp: 23.5°C; Tissue Temp: 22.3°C

Probe: ES3DV3 - SN3213; ConvF(6.54, 6.54, 6.54); Calibrated: 4/29/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

Phantom: SAM Left; Type: SAM; Serial: 1688

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

750 MHz System Verification

Area Scan (7x15x1): Measurement grid: dx=15mm, dy=15mm

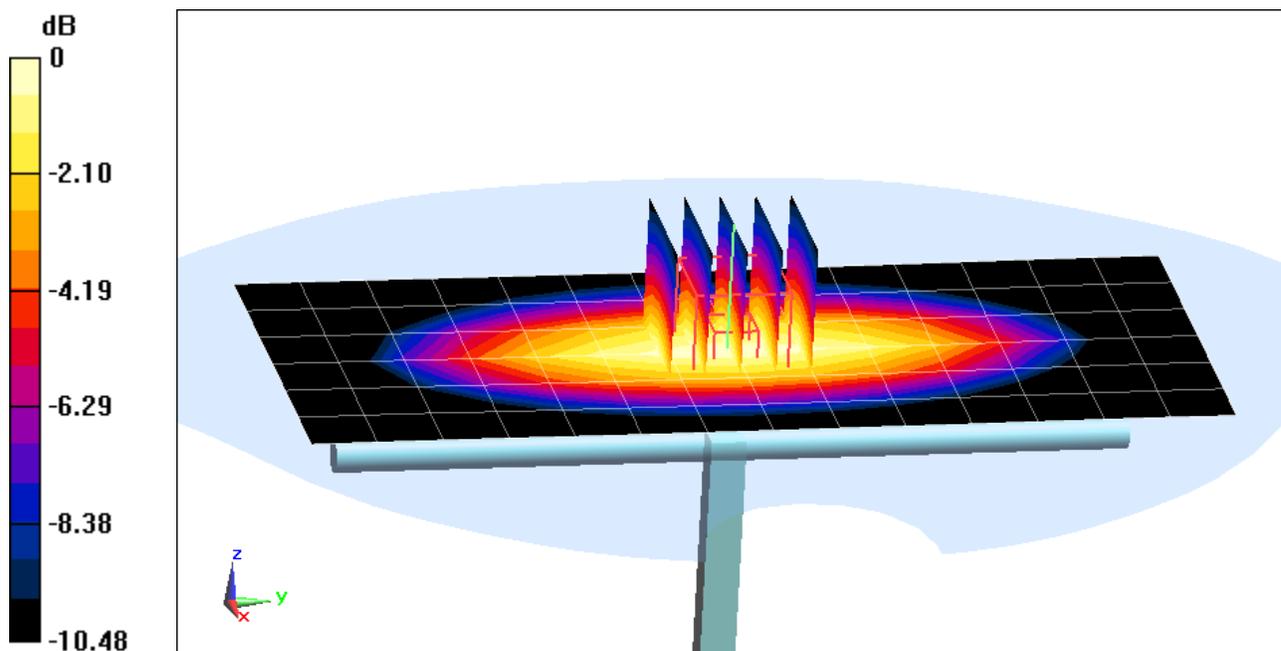
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 1.25 W/kg

SAR(1 g) = 0.851 W/kg

Deviation = 0.59 %



0 dB = 0.922 W/kg = -0.35 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium: 835 Head Medium parameters used:

$f = 835 \text{ MHz}$; $\sigma = 0.907 \text{ S/m}$; $\epsilon_r = 41.248$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.5 cm

Test Date: 10-21-2013; Ambient Temp: 23.2°C; Tissue Temp: 20.7°C

Probe: EX3DV4 - SN3920; ConvF(9.58, 9.58, 9.58); Calibrated: 2/27/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

Phantom: SAM 5.0 front; Type: QD000P40CD; Serial: TP:-1648

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

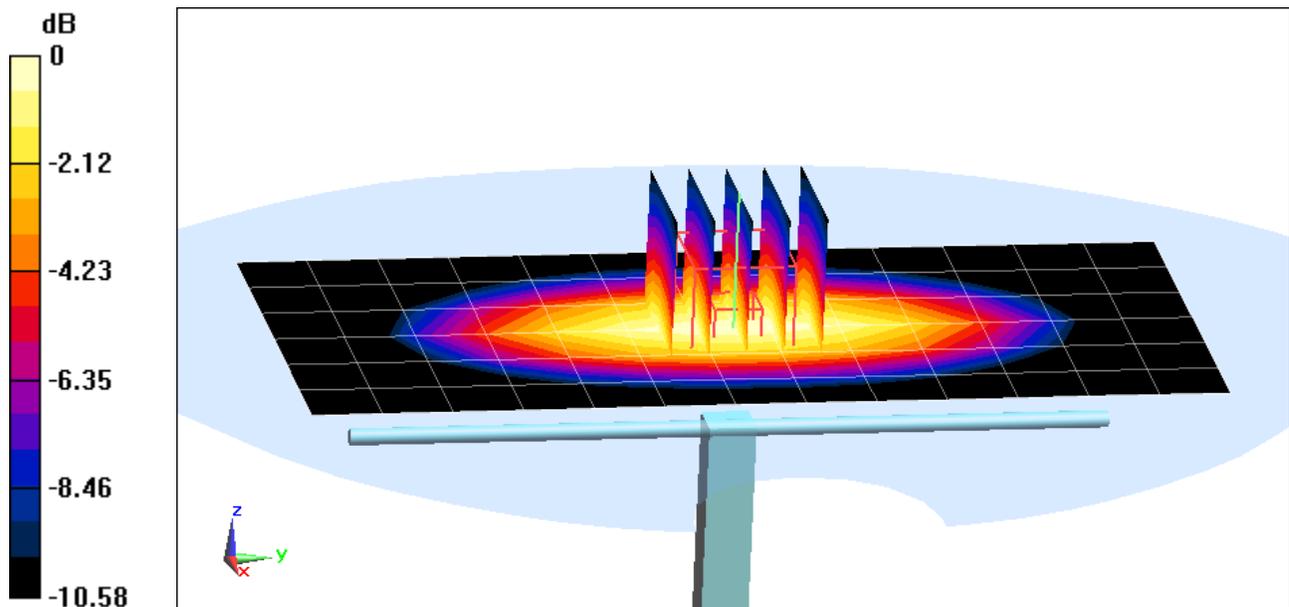
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 1.38 W/kg

SAR(1 g) = 0.914 W/kg

Deviation = -5.58 %



0 dB = 0.988 W/kg = -0.05 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: Dipole 1750 MHz; Type: D1765V2; Serial: 1008

Communication System: CW; Frequency: 1750 MHz; Duty Cycle: 1:1

Medium: 1750 Head Medium parameters used:

$f = 1750 \text{ MHz}$; $\sigma = 1.402 \text{ S/m}$; $\epsilon_r = 40.312$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-22-2013; Ambient Temp: 23.4°C; Tissue Temp: 22.8°C

Probe: ES3DV3 - SN3287; ConvF(5.16, 5.16, 5.16); Calibrated: 11/15/2012;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 11/13/2012

Phantom: SAM with CRP; Type: SAM 4.0; Serial: TP1375

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

1750 MHz System Verification

Area Scan (6x8x1): Measurement grid: dx=15mm, dy=15mm

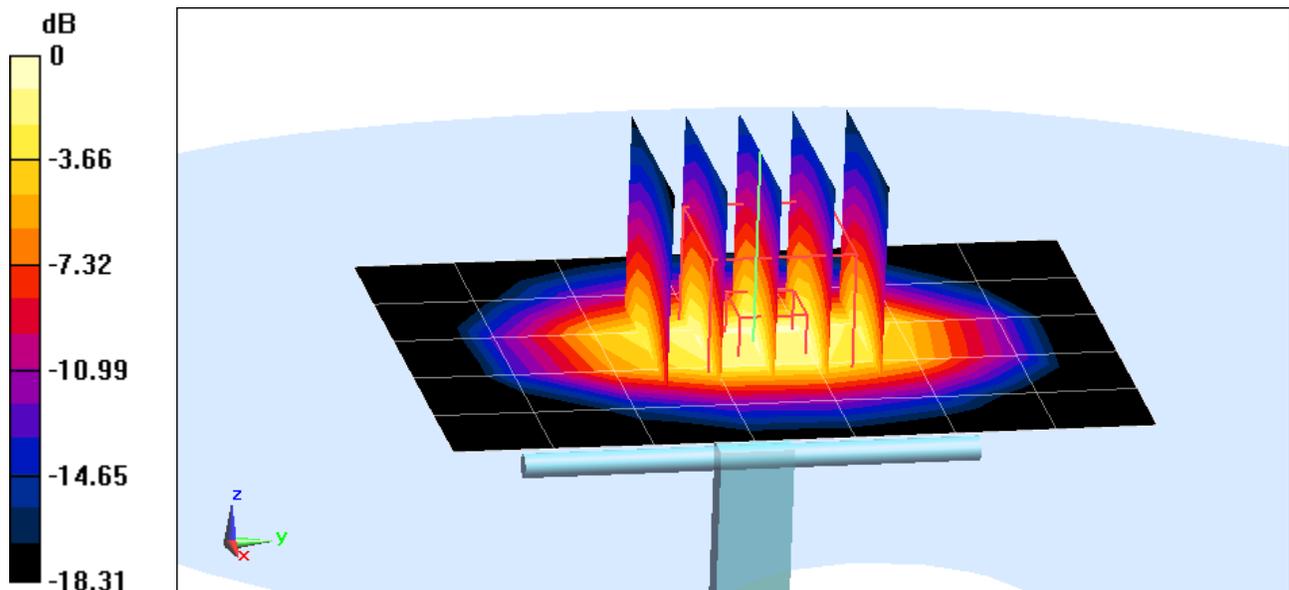
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 7.12 W/kg

SAR(1 g) = 3.78 W/kg

Deviation = 2.72 %



0 dB = 4.24 W/kg = 6.27 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: 5d141

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: 1900 Head Medium parameters used (interpolated):

$f = 1900 \text{ MHz}$; $\sigma = 1.426 \text{ S/m}$; $\epsilon_r = 39.116$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-17-2013; Ambient Temp: 23.0°C; Tissue Temp: 22.8°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 Right; Type: QD000P40CD; 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

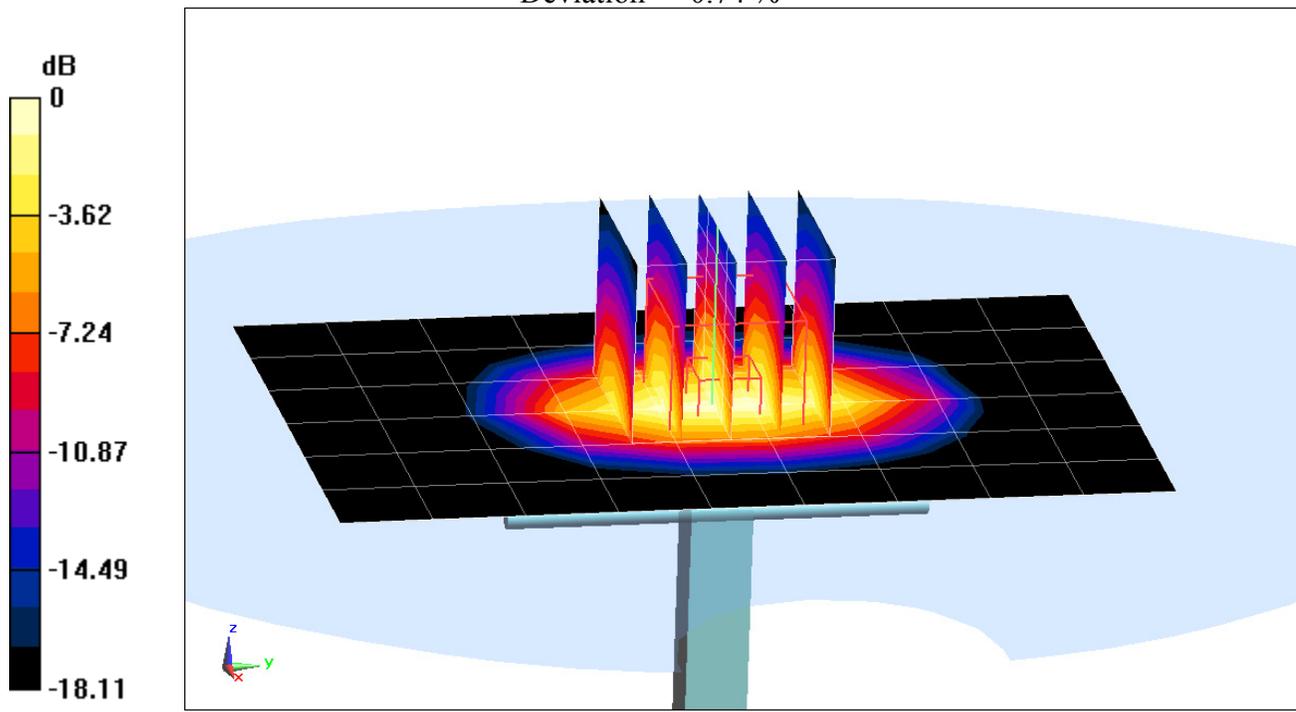
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 7.60 W/kg

SAR(1 g) = 4.05 W/kg

Deviation = -0.74 %



PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 2450 Head Medium parameters used:

$f = 2450 \text{ MHz}$; $\sigma = 1.757 \text{ S/m}$; $\epsilon_r = 38.978$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-21-2013; Ambient Temp: 21.4°C; Tissue Temp: 21.2°C

Probe: ES3DV3 - SN3319; ConvF(4.57, 4.57, 4.57); Calibrated: 4/29/2013;

Sensor-Surface: 3mm (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)

2450 MHz System Verification

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

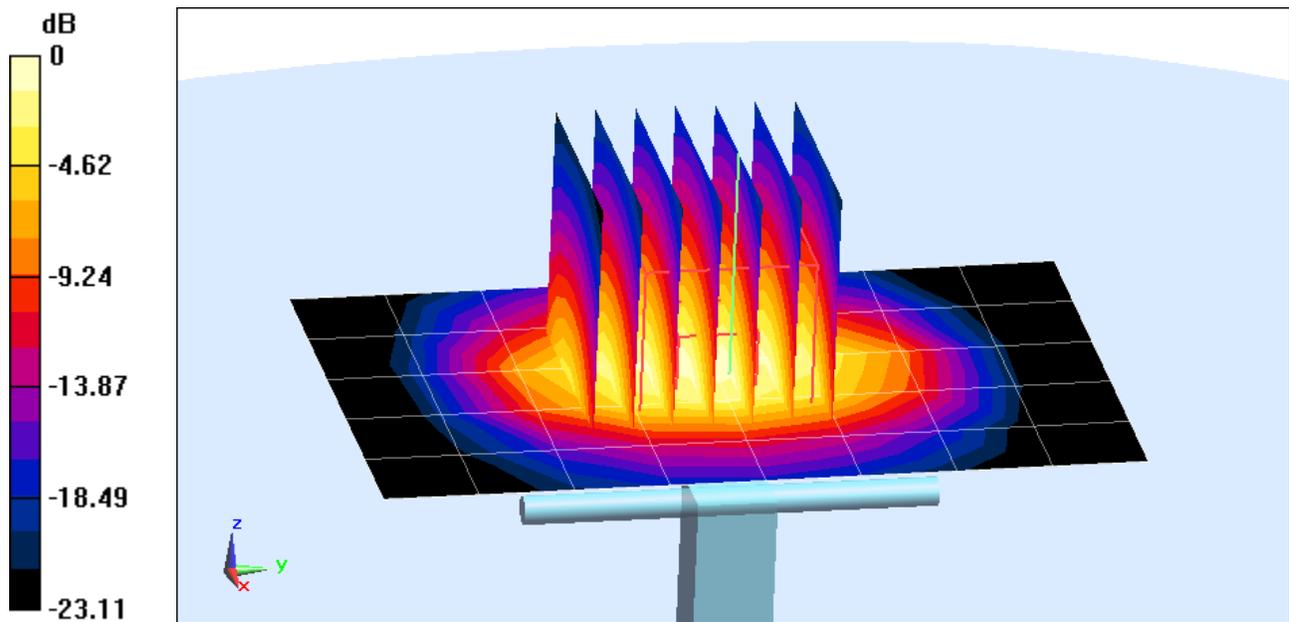
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Input Power = 16 dBm (40 mW)

Peak SAR (extrapolated) = 4.12 W/kg

SAR(1 g) = 2.01 W/kg

Deviation = -2.80 %



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

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5 GHz Head Medium parameters used:

$f = 5200 \text{ MHz}$; $\sigma = 4.626 \text{ S/m}$; $\epsilon_r = 35.297$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-29-2013; Ambient Temp: 24.5°C; Tissue Temp: 23.1°C

Probe: EX3DV4 - SN3920; ConvF(4.87, 4.87, 4.87); Calibrated: 2/27/2013;

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

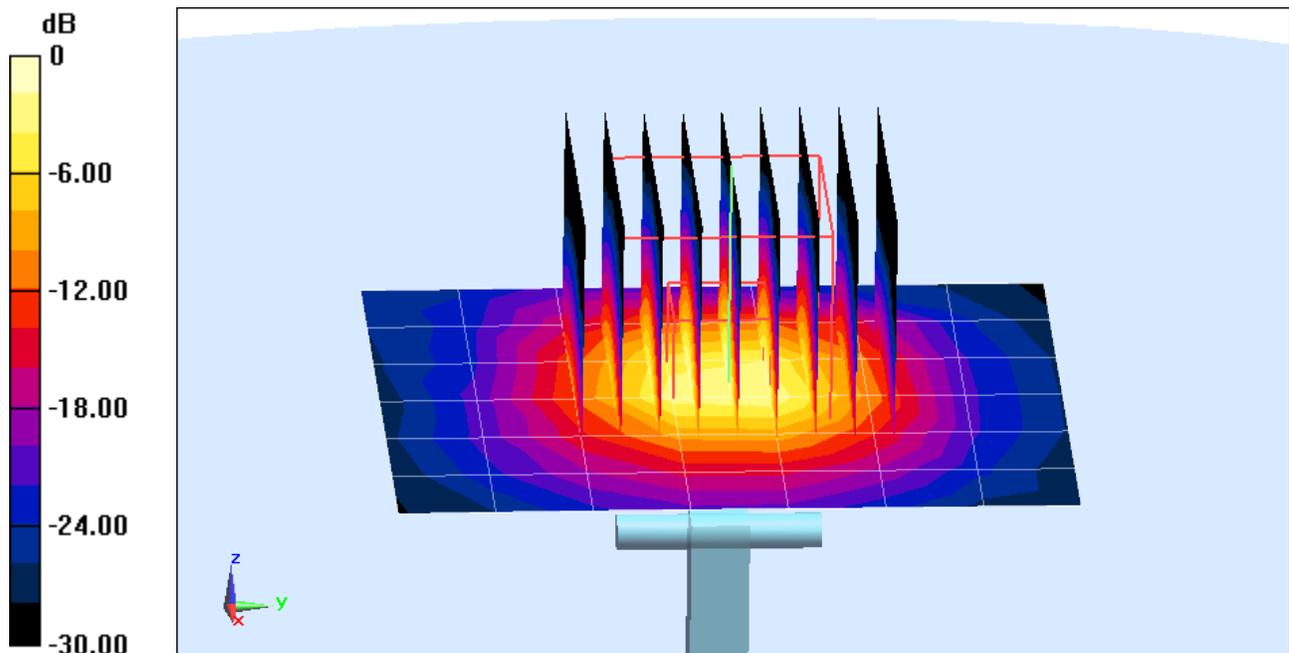
Zoom Scan (9x9x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio=1.4

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 31.4 W/kg

SAR(1 g) = 7.79 W/kg

Deviation = 2.50 %



0 dB = 19.0 W/kg = 12.79 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5 GHz Head Medium parameters used:

$f = 5300 \text{ MHz}$; $\sigma = 4.709 \text{ S/m}$; $\epsilon_r = 35.188$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-29-2013; Ambient Temp: 24.5°C; Tissue Temp: 23.1°C

Probe: EX3DV4 - SN3920; ConvF(4.73, 4.73, 4.73); Calibrated: 2/27/2013;

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

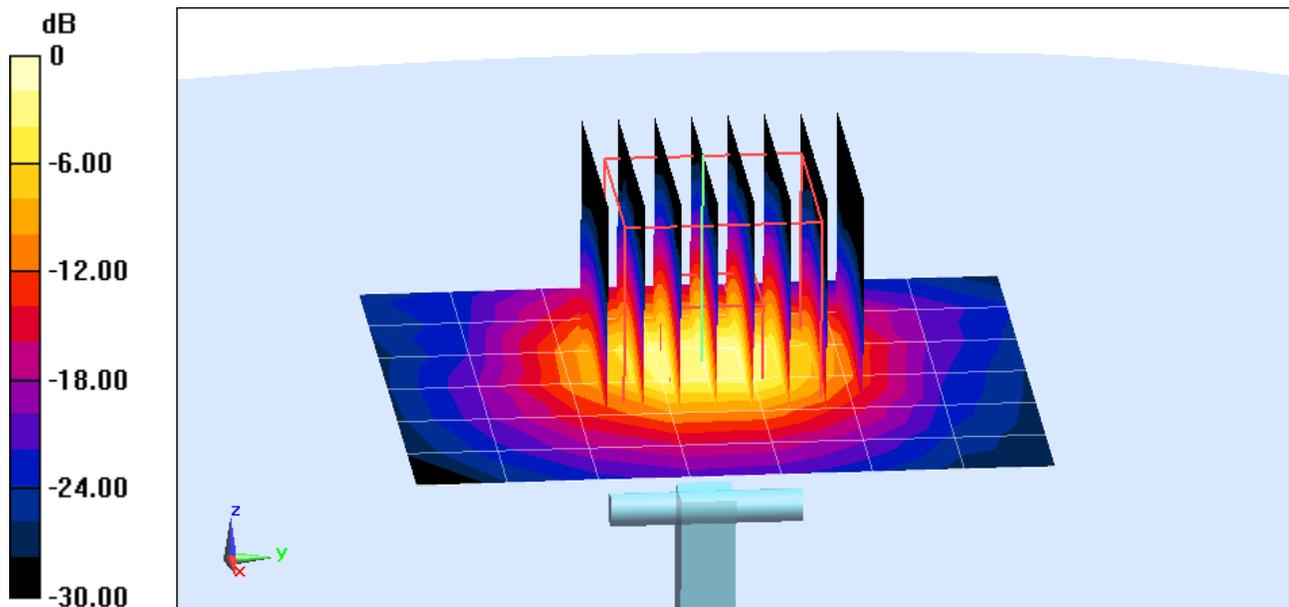
Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio=1.4

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 31.8 W/kg

SAR(1 g) = 7.74 W/kg

Deviation = -1.65 %



0 dB = 19.2 W/kg = 12.83 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5 GHz Head Medium parameters used:

$f = 5500 \text{ MHz}$; $\sigma = 4.851 \text{ S/m}$; $\epsilon_r = 35.056$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-29-2013; Ambient Temp: 24.5°C; Tissue Temp: 23.1°C

Probe: EX3DV4 - SN3920; ConvF(4.52, 4.52, 4.52); Calibrated: 2/27/2013;

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

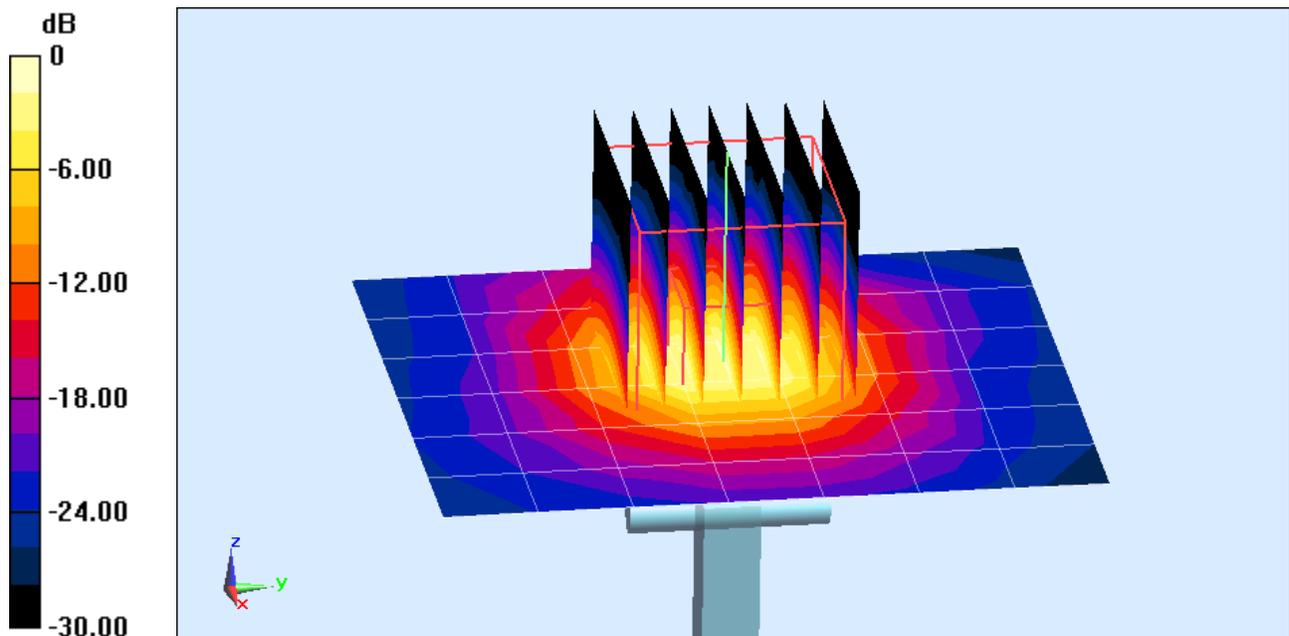
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio=1.4

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 31.9 W/kg

SAR(1 g) = 7.51 W/kg

Deviation = -6.24 %



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

PCTEST ENGINEERING LABORATORY, INC.

DUT: Dipole 5600 MHz; Type: D5GHzV2; Serial: 1120

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

Medium: 5 GHz Head Medium parameters used:

$f = 5600 \text{ MHz}$; $\sigma = 4.92 \text{ S/m}$; $\epsilon_r = 34.952$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-29-2013; Ambient Temp: 24.5°C; Tissue Temp: 23.1°C

Probe: EX3DV4 - SN3920; ConvF(4.17, 4.17, 4.17); Calibrated: 2/27/2013;

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)

5600 MHz System Verification

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

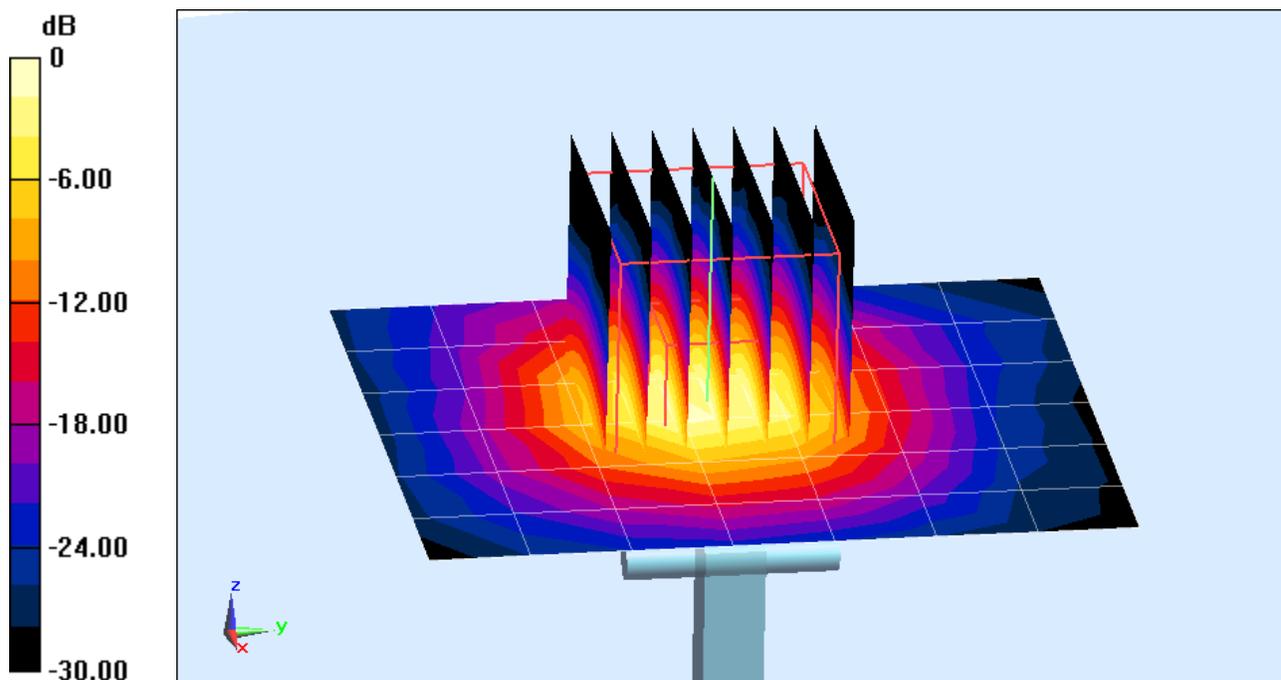
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio=1.4

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 30.5 W/kg

SAR(1 g) = 7.69 W/kg

Deviation = -3.75 %



0 dB = 19.6 W/kg = 12.92 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5 GHz Head Medium parameters used:

$f = 5800 \text{ MHz}$; $\sigma = 5.123 \text{ S/m}$; $\epsilon_r = 34.671$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-29-2013; Ambient Temp: 24.5°C; Tissue Temp: 23.1°C

Probe: EX3DV4 - SN3920; ConvF(4.02, 4.02, 4.02); Calibrated: 2/27/2013;

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

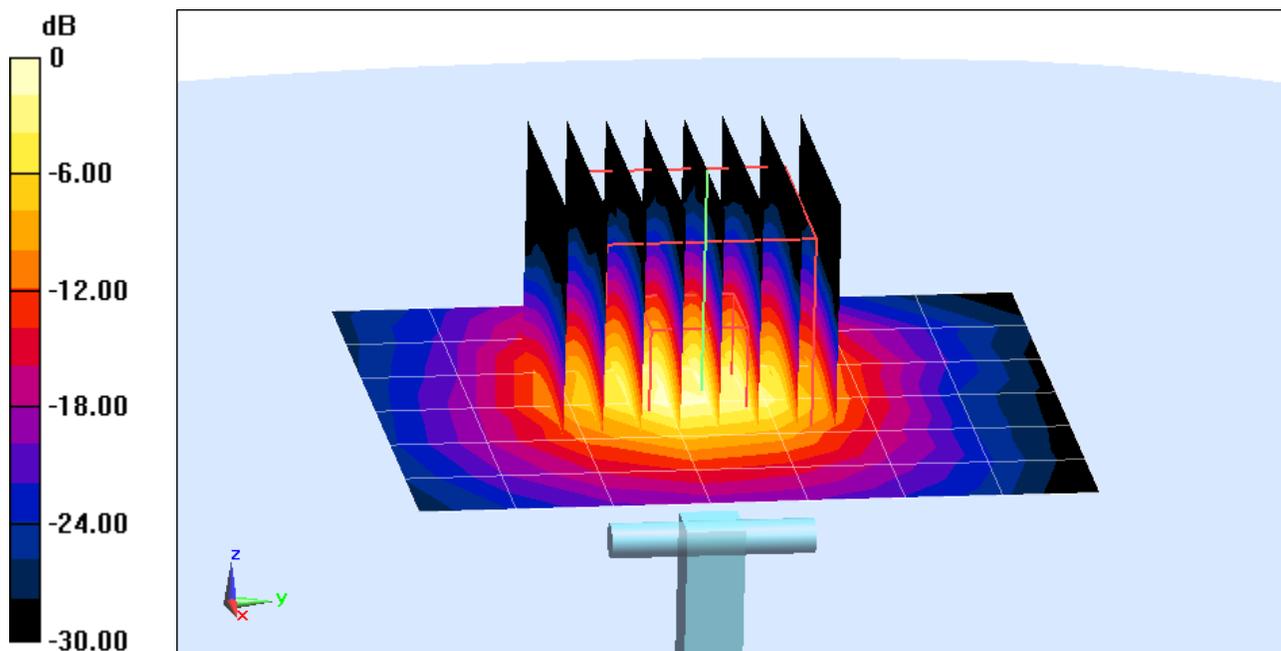
Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio=1.4

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 32.5 W/kg

SAR(1 g) = 7.48 W/kg

Deviation = -0.13 %



0 dB = 19.2 W/kg = 12.83 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: Dipole 750 MHz; Type: D750V3; Serial: 1003

Communication System: CW; Frequency: 750 MHz; Duty Cycle: 1:1

Medium: 750 Body Medium parameters used (interpolated):

$f = 750 \text{ MHz}$; $\sigma = 0.973 \text{ S/m}$; $\epsilon_r = 55.508$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.5 cm

Test Date: 10-18-2013; Ambient Temp: 23.8°C; Tissue Temp: 22.2°C

Probe: ES3DV3 - SN3213; ConvF(6.32, 6.32, 6.32); Calibrated: 4/29/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

Phantom: SAM Left; Type: SAM; Serial: 1688

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

750 MHz System Verification

Area Scan (7x15x1): Measurement grid: dx=15mm, dy=15mm

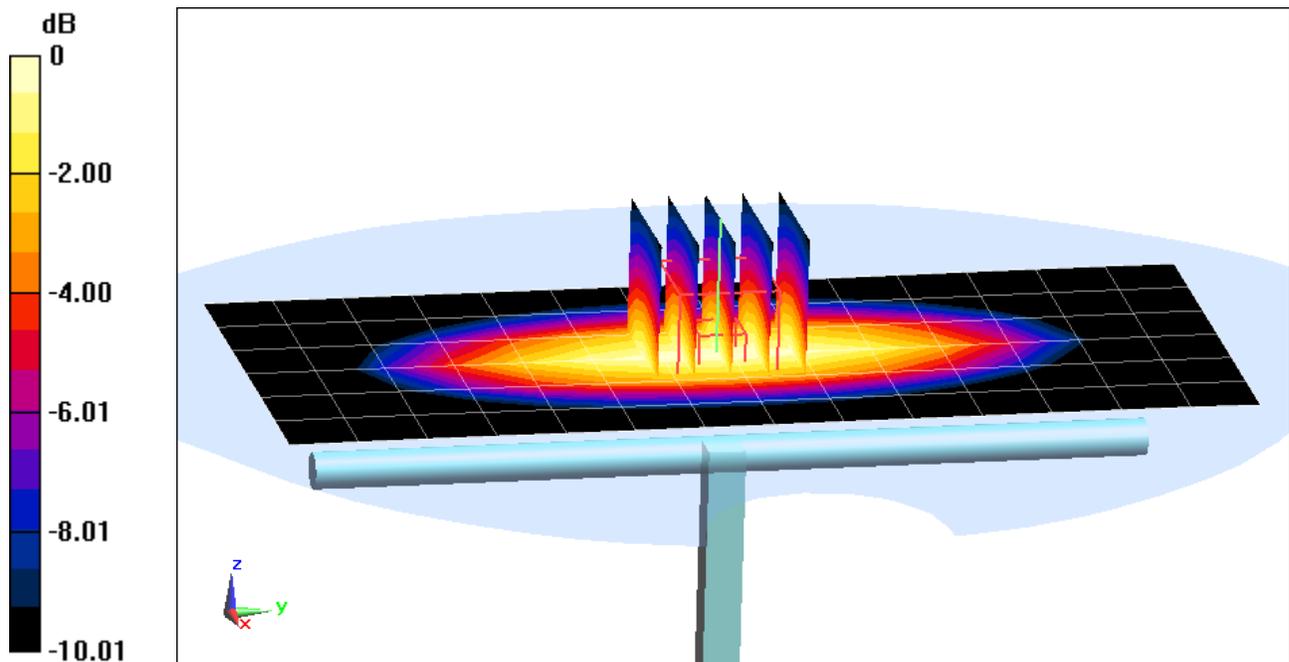
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 1.21 W/kg

SAR(1 g) = 0.843 W/kg

Deviation = -4.53 %



PCTEST ENGINEERING LABORATORY, INC.

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

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium: 835 Body Medium parameters used:

$f = 835 \text{ MHz}$; $\sigma = 0.996 \text{ S/m}$; $\epsilon_r = 53.932$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.5 cm

Test Date: 10-15-2013; Ambient Temp: 23.1°C; Tissue Temp: 22.9°C

Probe: ES3DV2 - SN3022; ConvF(5.91, 5.91, 5.91); Calibrated: 8/22/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

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

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

835 MHz System Verification

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

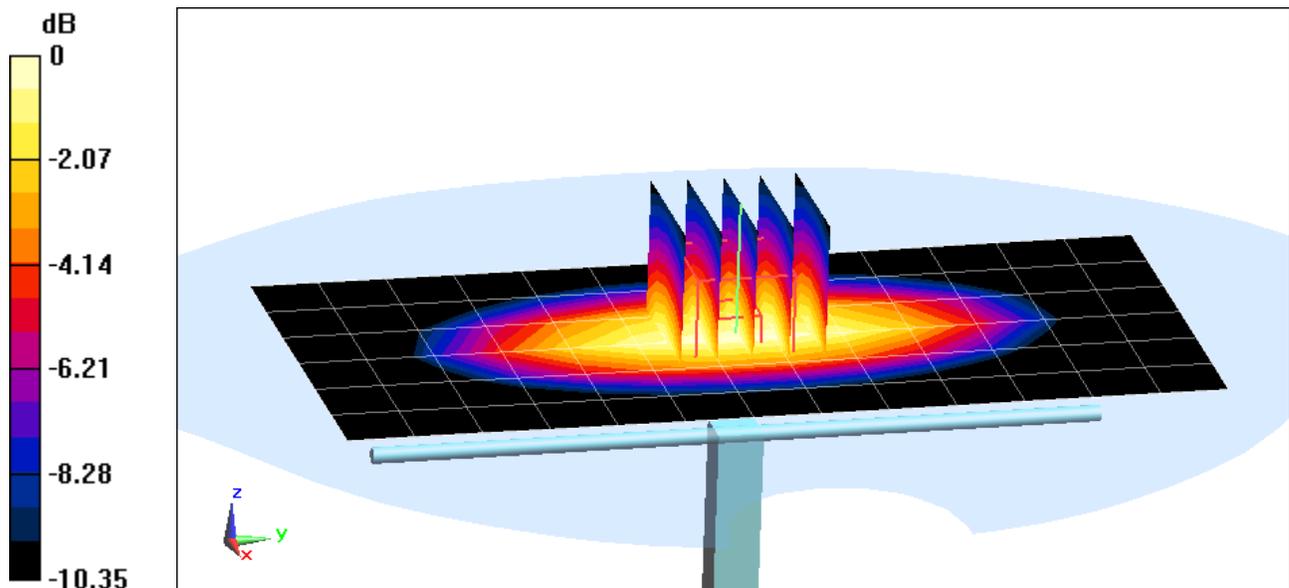
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 1.40 W/kg

SAR(1 g) = 0.966 W/kg

Deviation = 1.26 %



0 dB = 1.05 W/kg = 0.21 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: Dipole 1750 MHz; Type: D1750V2; Serial: 1051

Communication System: CW; Frequency: 1750 MHz; Duty Cycle: 1:1

Medium: 1750 Body Medium parameters used:

$f = 1750 \text{ MHz}$; $\sigma = 1.444 \text{ S/m}$; $\epsilon_r = 52.334$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-18-2013; Ambient Temp: 23.3°C; Tissue Temp: 22.5°C

Probe: ES3DV2 - SN3022; ConvF(4.75, 4.75, 4.75); 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)

1750 MHz System Verification

Area Scan (7x9x1): Measurement grid: dx=15mm, dy=15mm

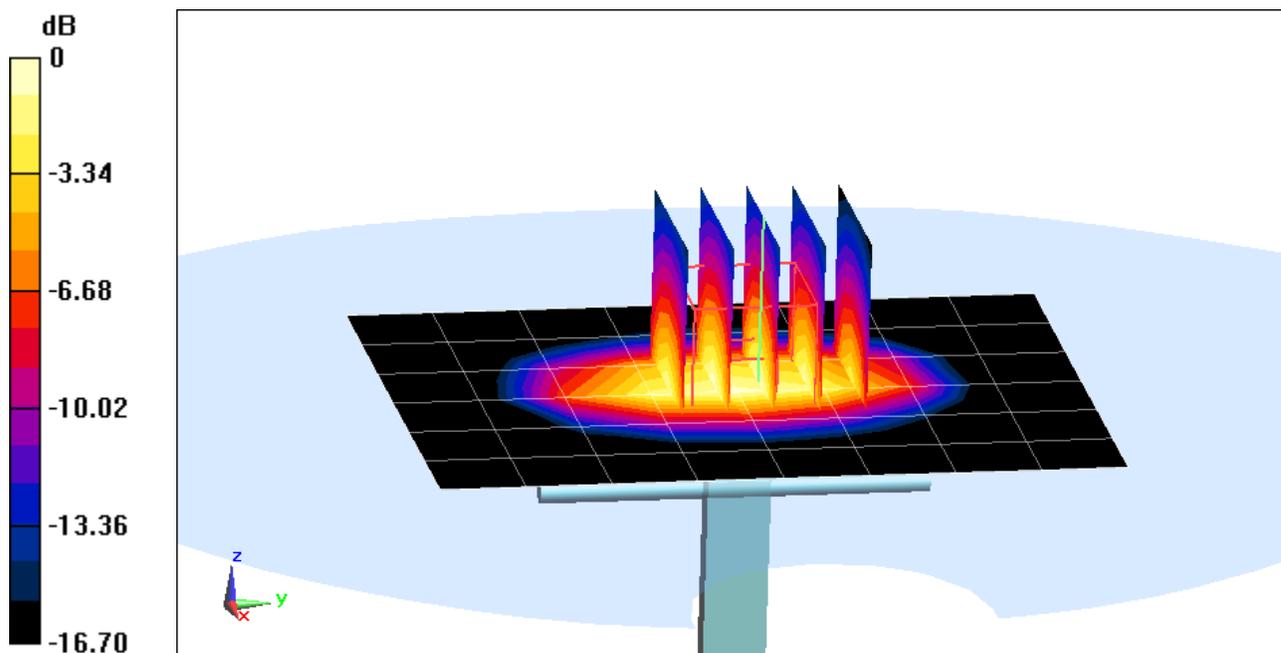
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 6.21 W/kg

SAR(1 g) = 3.53 W/kg

Deviation = -6.61 %



0 dB = 3.93 W/kg = 5.94 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: Dipole 1750 MHz; Type: D1750V2; Serial: 1051

Communication System: CW; Frequency: 1750 MHz; Duty Cycle: 1:1

Medium: 1750 Body Medium parameters used:

$f = 1750 \text{ MHz}$; $\sigma = 1.535 \text{ S/m}$; $\epsilon_r = 53.664$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-28-2013; Ambient Temp: 23.4°C; Tissue Temp: 20.9°C

Probe: EX3DV4 - SN3920; ConvF(7.59, 7.59, 7.59); Calibrated: 2/27/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

Phantom: SAM 5.0 front; Type: QD000P40CD; Serial: TP:-1648

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

1750 MHz System Verification

Area Scan (7x9x1): Measurement grid: dx=15mm, dy=15mm

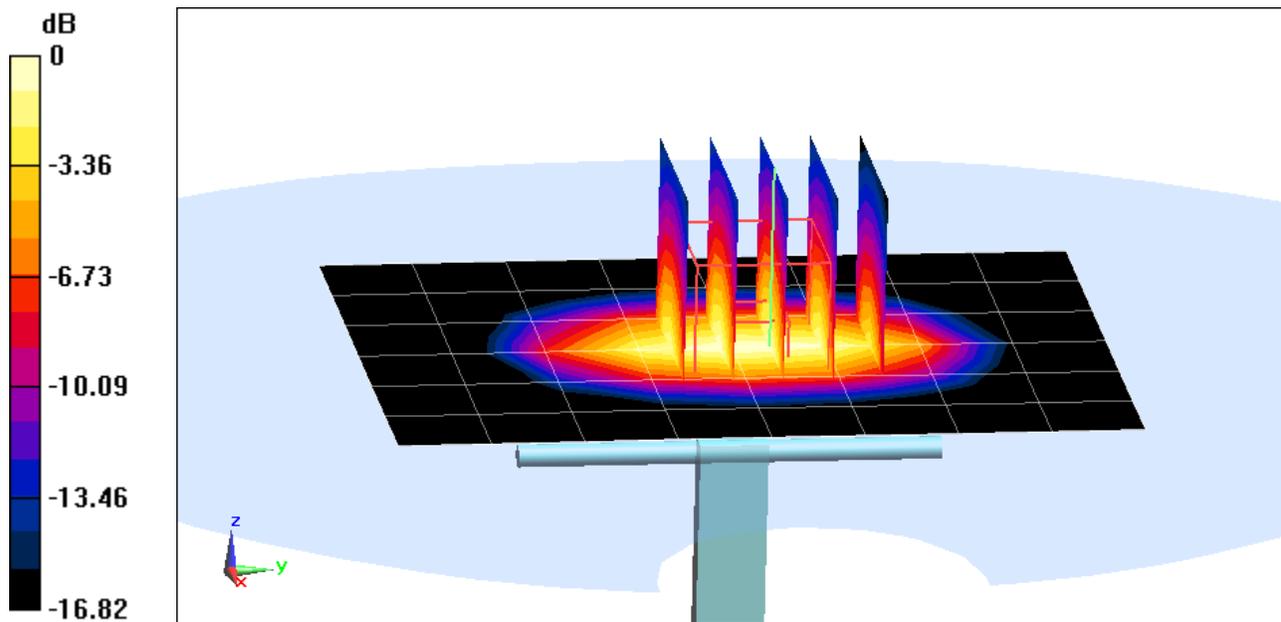
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 6.75 W/kg

SAR(1 g) = 3.76 W/kg

Deviation = -0.53 %



0 dB = 4.16 W/kg = 6.19 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: 5d141

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: 1900 Body Medium parameters used (interpolated):

$f = 1900 \text{ MHz}$; $\sigma = 1.569 \text{ S/m}$; $\epsilon_r = 53.987$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-21-2013; Ambient Temp: 21.8°C; Tissue Temp: 20.0°C

Probe: ES3DV3 - SN3263; ConvF(4.78, 4.78, 4.78); Calibrated: 5/16/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357

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

1900 MHz System Verification

Area Scan (5x7x1): Measurement grid: dx=15mm, dy=15mm

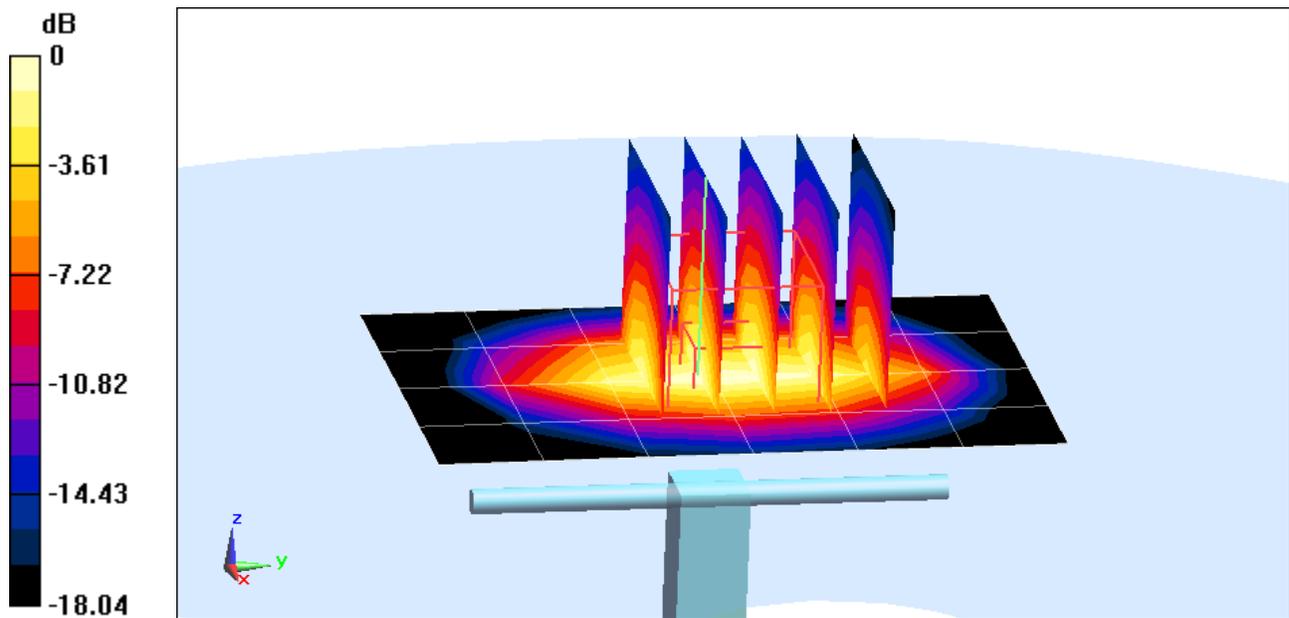
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 7.07 W/kg

SAR(1 g) = 3.97 W/kg

Deiviation = -4.34 %



0 dB = 4.41 W/kg = 6.44 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 2450 Body Medium parameters used:

$f = 2450 \text{ MHz}$; $\sigma = 1.954 \text{ S/m}$; $\epsilon_r = 51.26$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-16-2013; Ambient Temp: 24.5°C; Tissue Temp: 24.1°C

Probe: ES3DV3 - SN3209; ConvF(4.34, 4.34, 4.34); Calibrated: 3/15/2013;

Sensor-Surface: 3mm (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)

2450 MHz System Verification

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

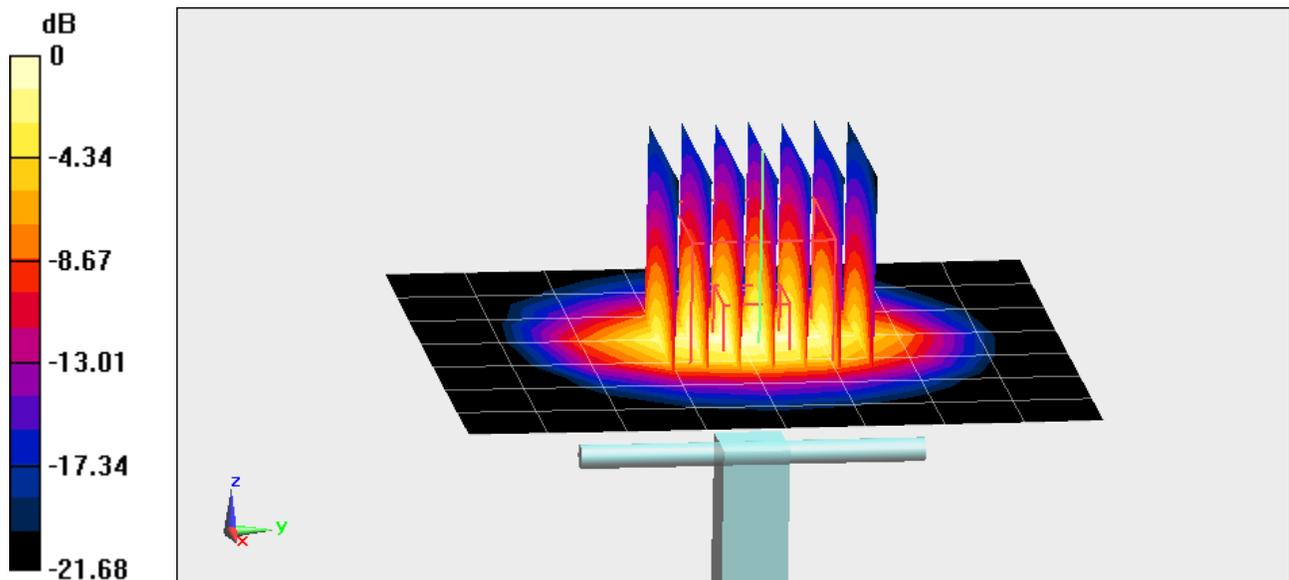
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 9.81 W/kg

SAR(1 g) = 4.77 W/kg

Deviation = -4.41 %



0 dB = 6.12 W/kg = 7.87 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5 GHz Body Medium parameters used:

$f = 5200 \text{ MHz}$; $\sigma = 5.38 \text{ S/m}$; $\epsilon_r = 46.873$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-29-2013; Ambient Temp: 22.6°C; Tissue Temp: 21.4°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

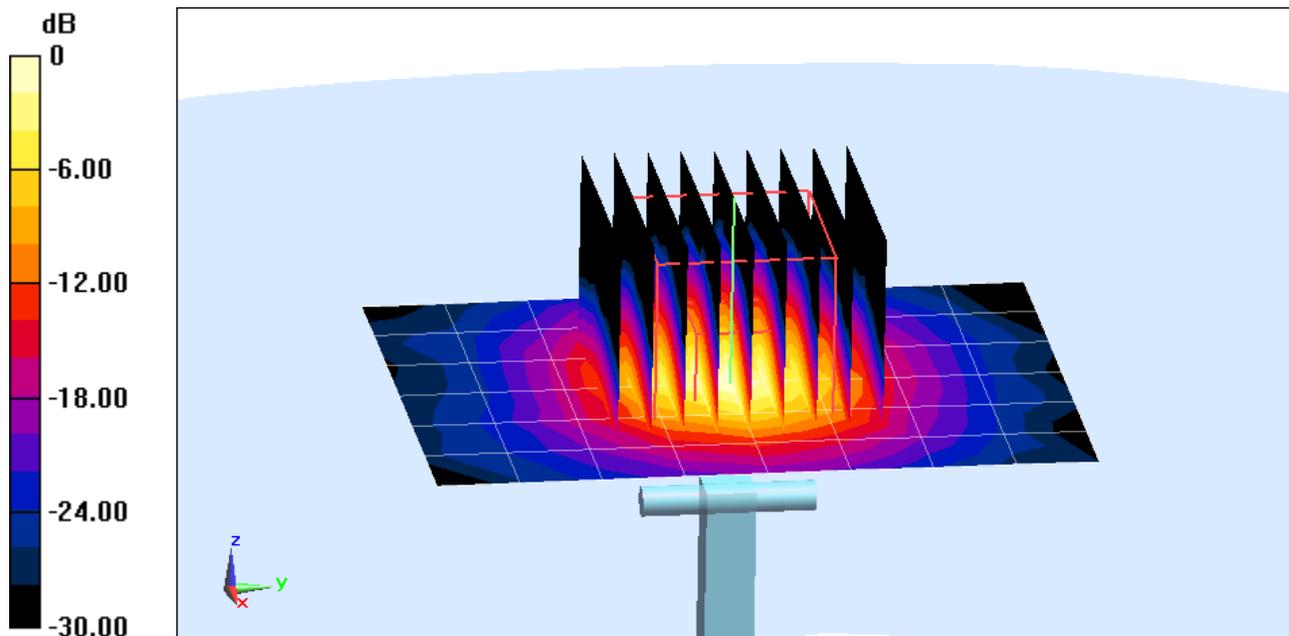
Zoom Scan (9x9x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio=1.4

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 29.2 W/kg

SAR(1 g) = 7.38 W/kg

Deviation = -2.25 %



0 dB = 18.4 W/kg = 12.65 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5 GHz Body Medium parameters used:

$f = 5300 \text{ MHz}$; $\sigma = 5.553 \text{ S/m}$; $\epsilon_r = 46.583$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-29-2013; Ambient Temp: 22.6°C; Tissue Temp: 21.4°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

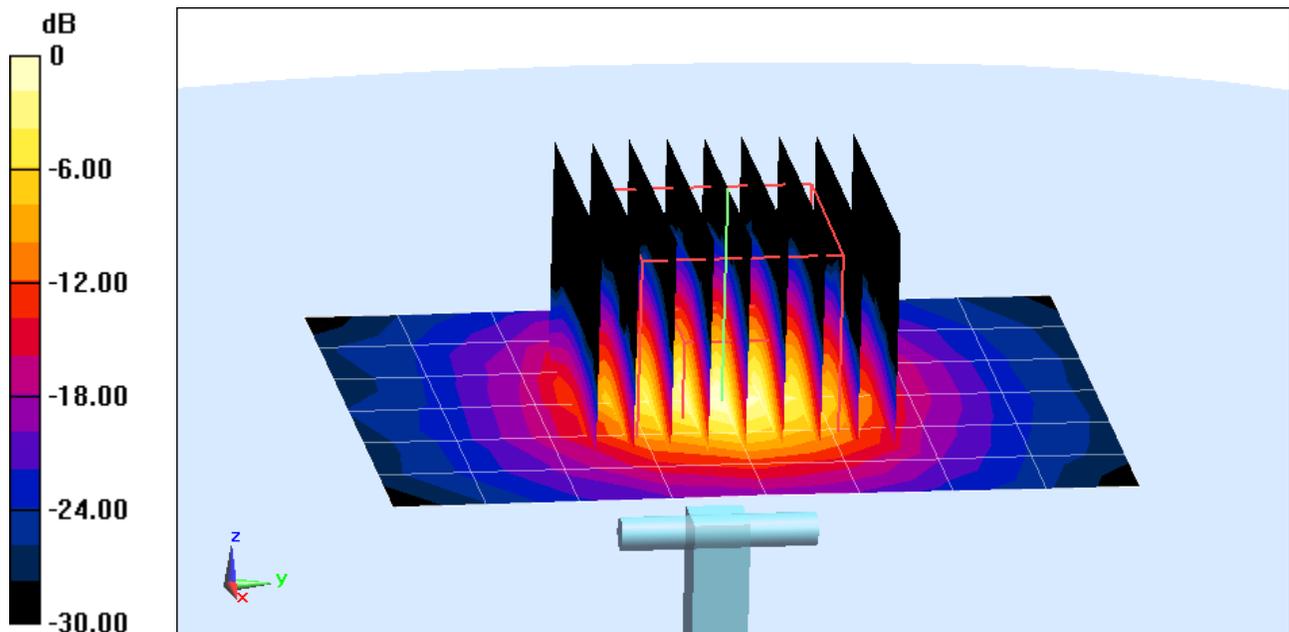
Zoom Scan (9x9x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio=1.4

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 32.8 W/kg

SAR(1 g) = 7.88 W/kg

Deviation = 4.65 %



0 dB = 19.6 W/kg = 12.92 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5 GHz Body Medium parameters used:

$f = 5500 \text{ MHz}$; $\sigma = 5.887 \text{ S/m}$; $\epsilon_r = 46.276$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-29-2013; Ambient Temp: 22.6°C; Tissue Temp: 21.4°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

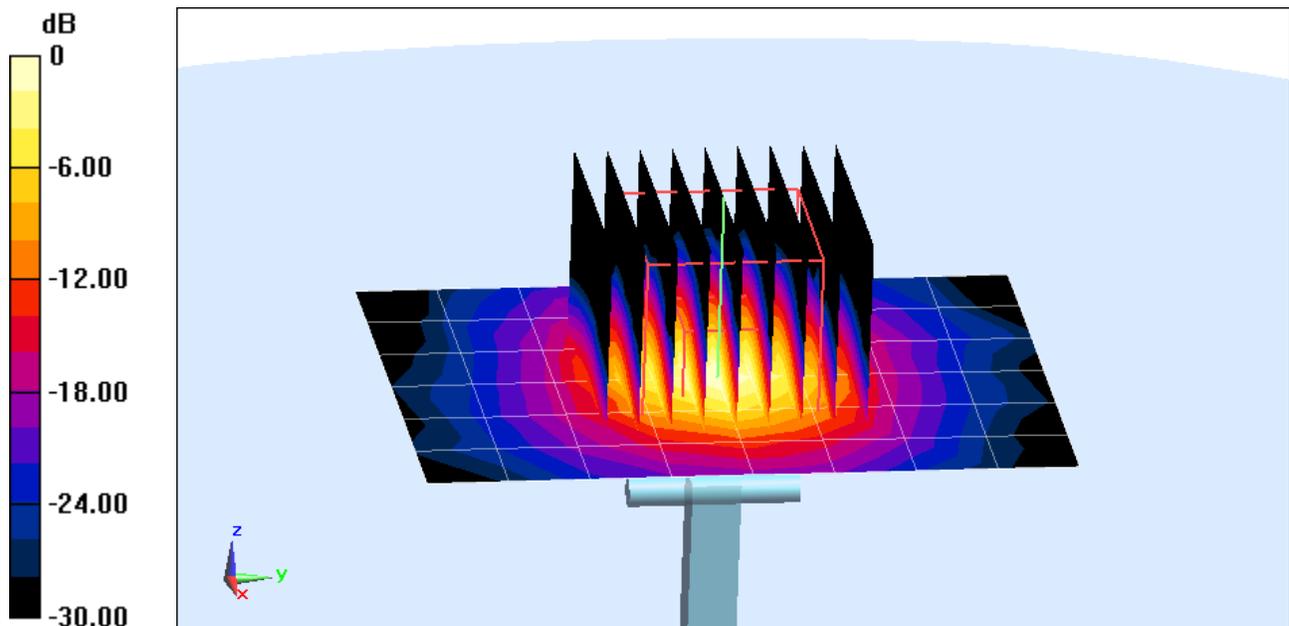
Zoom Scan (9x9x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio=1.4

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 33.7 W/kg

SAR(1 g) = 7.99 W/kg

Deviation = -1.11 %



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

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5 GHz Body Medium parameters used:

$f = 5600 \text{ MHz}$; $\sigma = 6.035 \text{ S/m}$; $\epsilon_r = 46.139$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-29-2013; Ambient Temp: 22.6°C; Tissue Temp: 21.4°C

Probe: EX3DV4 - SN3589; ConvF(3.32, 3.32, 3.32); Calibrated: 1/17/2013;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1272; Calibrated: 1/17/2013

Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357

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

5600 MHz System Verification

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

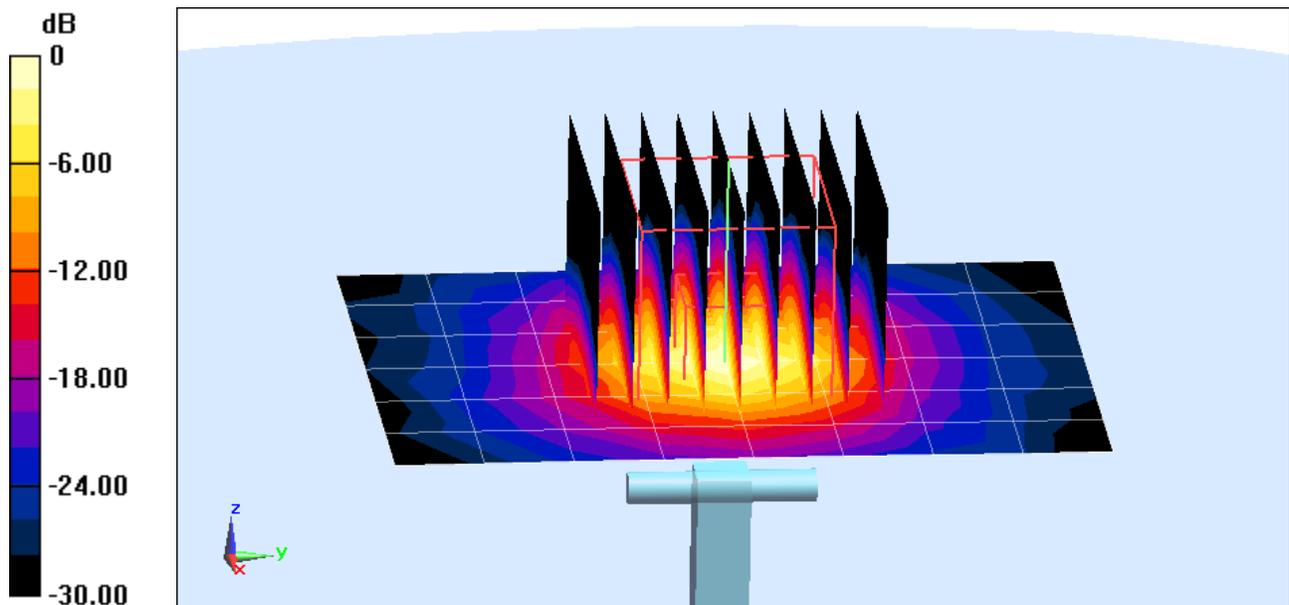
Zoom Scan (9x9x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio=1.4

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 34.4 W/kg

SAR(1 g) = 8.36 W/kg

Deviation = 4.11 %



0 dB = 21.1 W/kg = 13.24 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5 GHz Body Medium parameters used:

$f = 5800 \text{ MHz}$; $\sigma = 6.226 \text{ S/m}$; $\epsilon_r = 46.021$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-29-2013; Ambient Temp: 22.6°C; Tissue Temp: 21.4°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

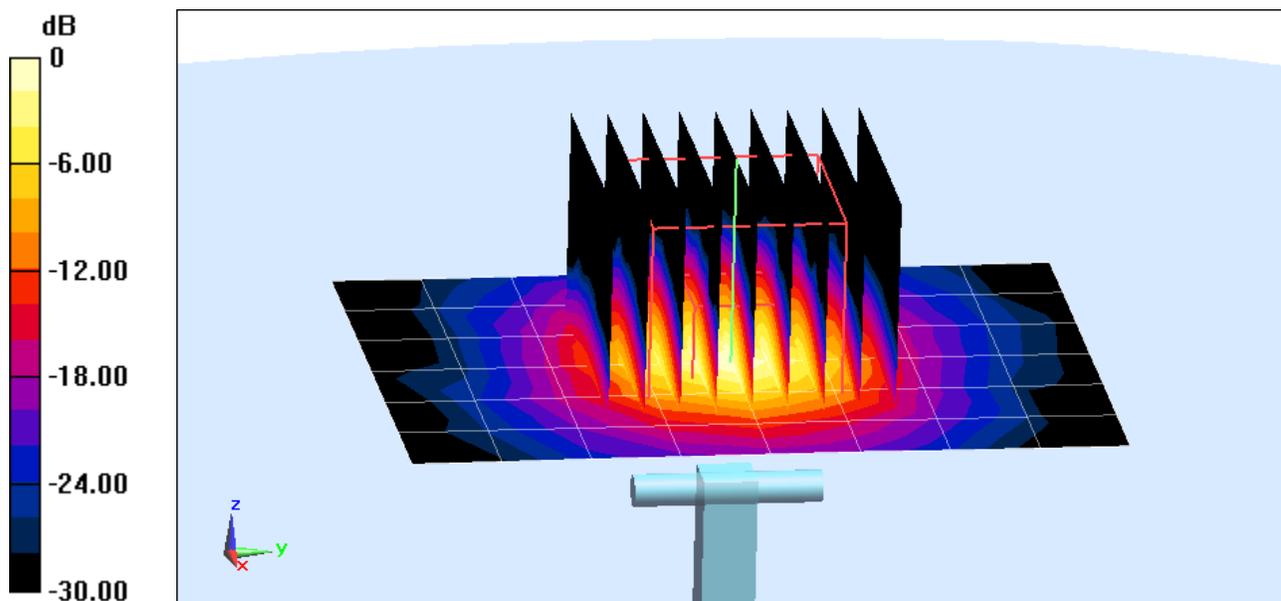
Zoom Scan (9x9x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio=1.4

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 32.5 W/kg

SAR(1 g) = 7.43 W/kg

Deviation = -1.07 %



0 dB = 19.3 W/kg = 12.86 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: **D1750V2-1051_Apr13**

CALIBRATION CERTIFICATE

Object **D1750V2 - SN: 1051**

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

Calibration date: **April 30, 2013**

✓
LOK
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: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

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

Signature

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

Issued: April 30, 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	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1750 MHz \pm 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.1	1.37 mho/m
Measured Head TSL parameters	(22.0 \pm 0.2) °C	39.1 \pm 6 %	1.33 mho/m \pm 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.01 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	36.5 W/kg \pm 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	4.83 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	19.5 W/kg \pm 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.4	1.49 mho/m
Measured Body TSL parameters	(22.0 \pm 0.2) °C	51.8 \pm 6 %	1.50 mho/m \pm 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	9.55 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	37.8 W/kg \pm 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.13 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.4 W/kg \pm 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.9 Ω + 0.3 j Ω
Return Loss	- 40.7 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.0 Ω + 0.4 j Ω
Return Loss	- 30.1 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.222 ns
----------------------------------	----------

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

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	February 19, 2010

DASY5 Validation Report for Head TSL

Date: 30.04.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1051

Communication System: UID 0 - CW; Frequency: 1750 MHz

Medium parameters used: $f = 1750$ MHz; $\sigma = 1.33$ S/m; $\epsilon_r = 39.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.18, 5.18, 5.18); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (8x7x7)/Cube 0:

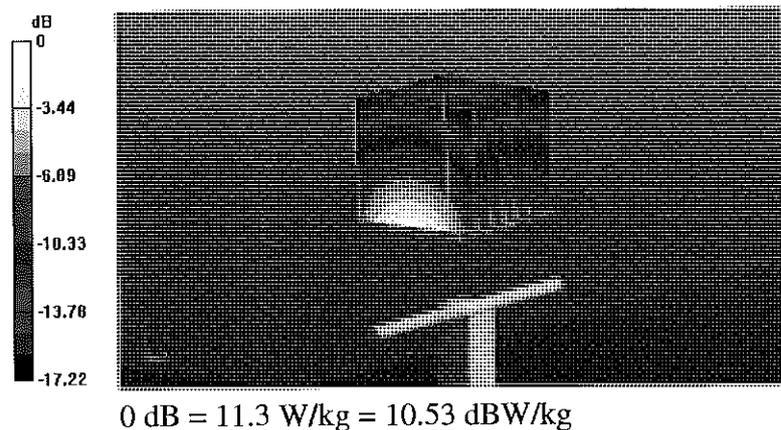
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 90.104 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 16.0 W/kg

SAR(1 g) = 9.01 W/kg; SAR(10 g) = 4.83 W/kg

Maximum value of SAR (measured) = 11.3 W/kg

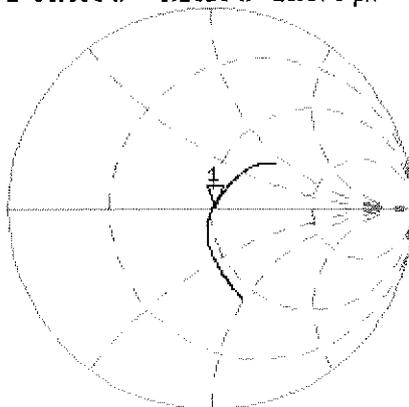


Impedance Measurement Plot for Head TSL

30 Apr 2013 12:59:57

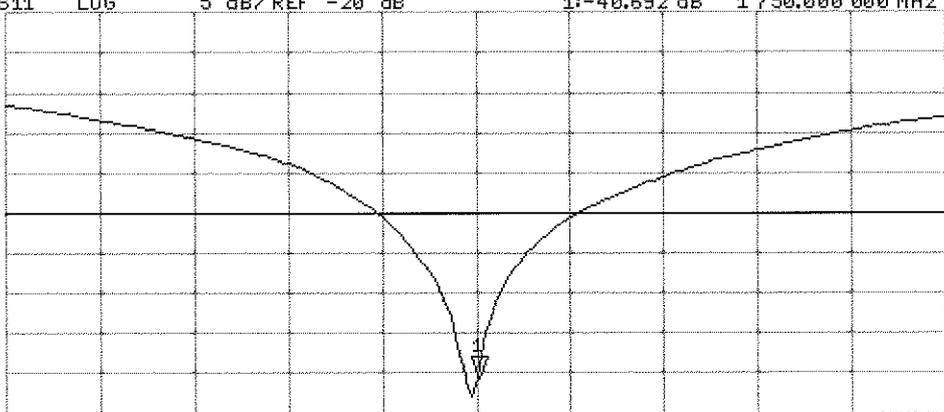
CH1 S11 1 U FS 1: 50.889 Ω 0.2813 Ω 25.578 pF 1 750.000 000 MHz

*
Del
CA
Avg
4
Hid



CH2 S11 LOG 5 dB/REF -20 dB 1:-40.692 dB 1 750.000 000 MHz

CA
Avg
4
Hid



START 1 550.000 000 MHz

STOP 1 950.000 000 MHz

DASY5 Validation Report for Body TSL

Date: 30.04.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1051

Communication System: UID 0 - CW; Frequency: 1750 MHz

Medium parameters used: $f = 1750$ MHz; $\sigma = 1.5$ S/m; $\epsilon_r = 51.8$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.83, 4.83, 4.83); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

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

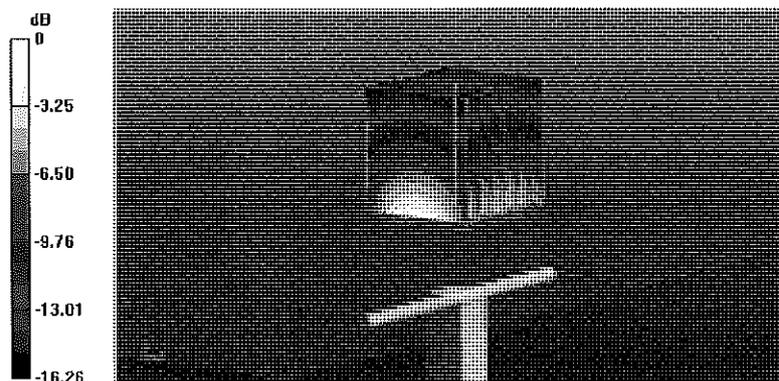
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.473 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 16.4 W/kg

SAR(1 g) = 9.55 W/kg; SAR(10 g) = 5.13 W/kg

Maximum value of SAR (measured) = 12.0 W/kg



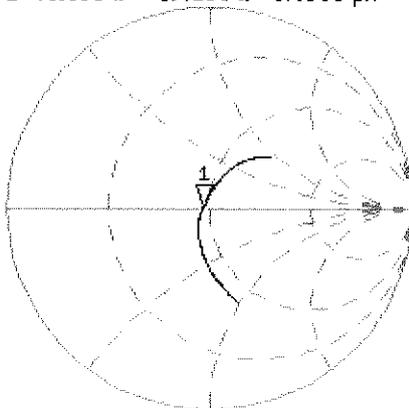
0 dB = 12.0 W/kg = 10.79 dBW/kg

Impedance Measurement Plot for Body TSL

30 Apr 2013 12:59:14

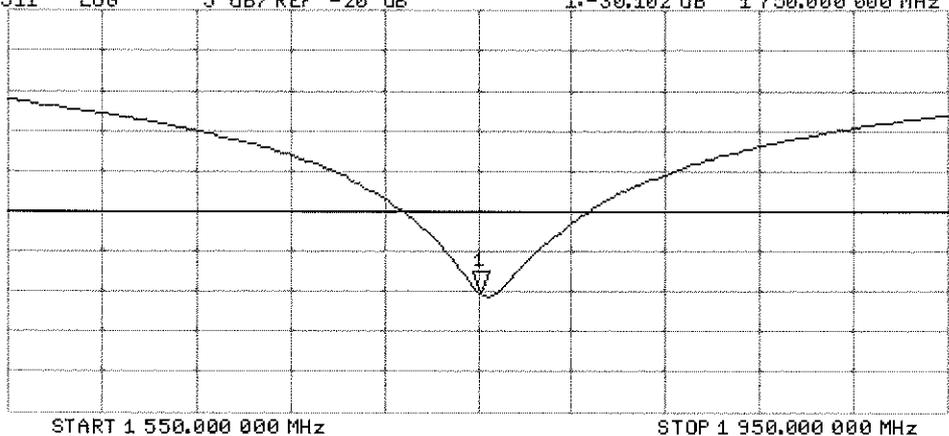
CH1 S11 1 U FS 1: 46.998 Ω 0.4160 Ω 37.835 pF 1 750.000 000 MHz

*
De1
CA
Avg
16
H1d



CH2 S11 LOG 5 dB/REF -20 dB 1:-30.102 dB 1 750.000 000 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: **D1765V2-1008_May13**

CALIBRATION CERTIFICATE

Object **D1765V2 - SN: 1008**

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

Calibration date: **May 14, 2013**

*✓ 100k
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 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: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

Calibrated by: **Jeton Kastat** Name: **Jeton Kastat** Function: **Laboratory Technician** Signature: *[Signature]*

Approved by: **Katja Pokovic** Name: **Katja Pokovic** Function: **Technical Manager** Signature: *[Signature]*

Issued: May 15, 2013

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Accreditation No.: **SCS 108**

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

Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "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	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1750 MHz \pm 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.1	1.37 mho/m
Measured Head TSL parameters	(22.0 \pm 0.2) °C	39.1 \pm 6 %	1.33 mho/m \pm 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.09 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	36.8 W/kg \pm 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	4.85 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	19.6 W/kg \pm 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.4	1.49 mho/m
Measured Body TSL parameters	(22.0 \pm 0.2) °C	51.7 \pm 6 %	1.47 mho/m \pm 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	9.53 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	38.2 W/kg \pm 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.10 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.4 W/kg \pm 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	48.3 Ω - 6.4 j Ω
Return Loss	- 23.5 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	43.8 Ω - 6.1 j Ω
Return Loss	- 20.6 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.211 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, 2005

DASY5 Validation Report for Head TSL

Date: 14.05.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1765 MHz; Type: D1765V2; Serial: D1765V2 - SN: 1008

Communication System: UID 0 - CW ; Frequency: 1750 MHz

Medium parameters used: $f = 1750$ MHz; $\sigma = 1.33$ S/m; $\epsilon_r = 39.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.18, 5.18, 5.18); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

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

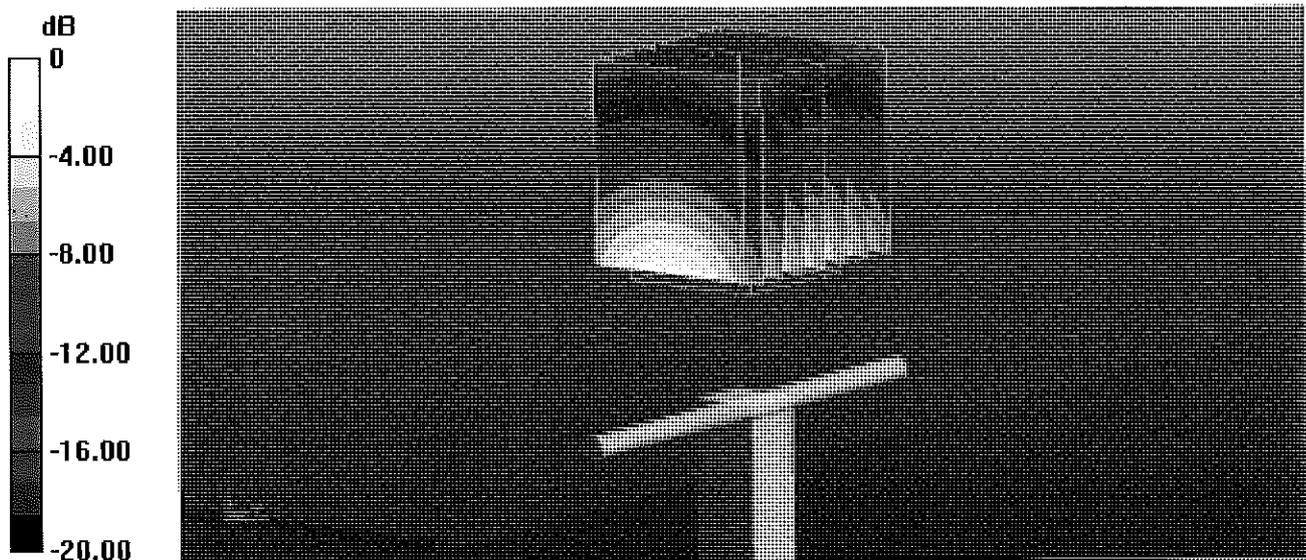
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.430 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 16.3 W/kg

SAR(1 g) = 9.09 W/kg; SAR(10 g) = 4.85 W/kg

Maximum value of SAR (measured) = 11.3 W/kg



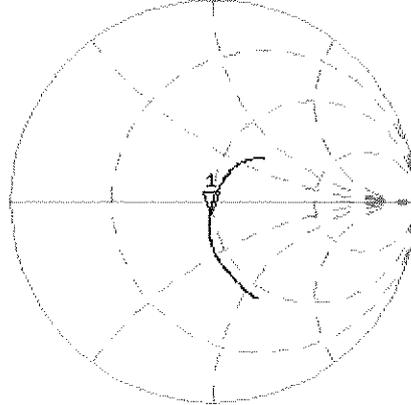
0 dB = 11.3 W/kg = 10.53 dBW/kg

Impedance Measurement Plot for Head TSL

14 May 2013 15:57:39

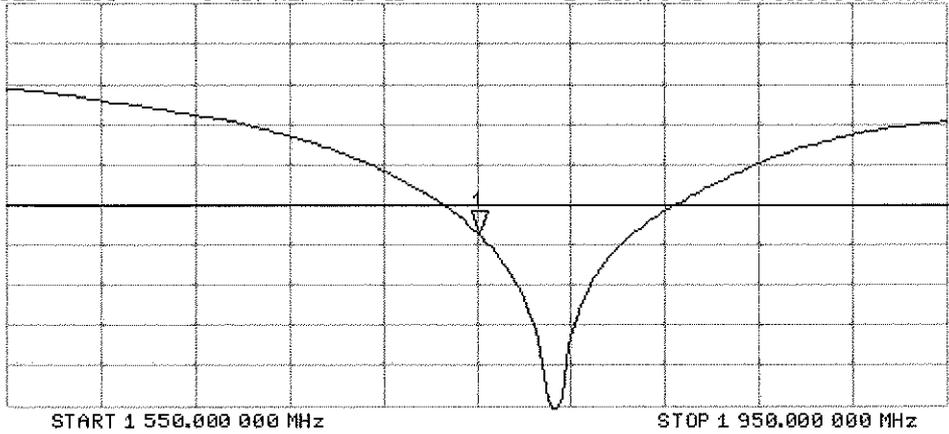
CH1 S11 1 U FS 1: 48.322 Ω -6.3848 Ω 14.244 pF 1 750.000 000 MHz

*
De1
CA
Avg
16
H1 d



CH2 S11 LOG 5 dB/REF -20 dB 1: -23.476 dB 1 750.000 000 MHz

CA
Avg
16
H1 d



DASY5 Validation Report for Body TSL

Date: 13.05.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1765 MHz; Type: D1765V2; Serial: D1765V2 - SN: 1008

Communication System: UID 0 - CW ; Frequency: 1750 MHz

Medium parameters used: $f = 1750$ MHz; $\sigma = 1.47$ S/m; $\epsilon_r = 51.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.83, 4.83, 4.83); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

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

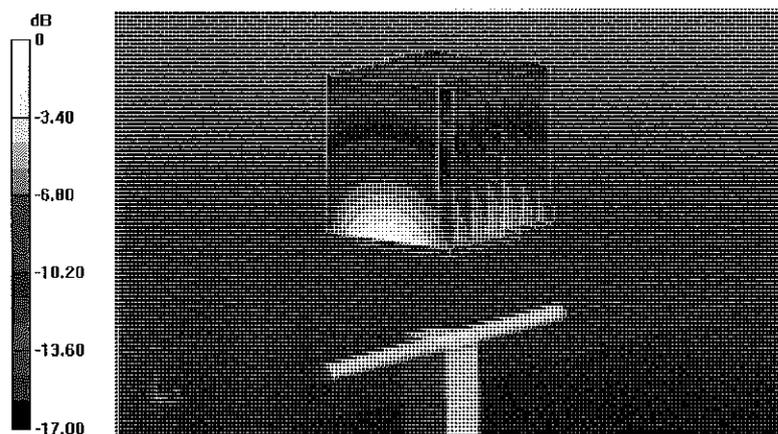
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.430 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 16.4 W/kg

SAR(1 g) = 9.53 W/kg; SAR(10 g) = 5.1 W/kg

Maximum value of SAR (measured) = 12.0 W/kg



0 dB = 12.0 W/kg = 10.79 dBW/kg

Impedance Measurement Plot for Body TSL

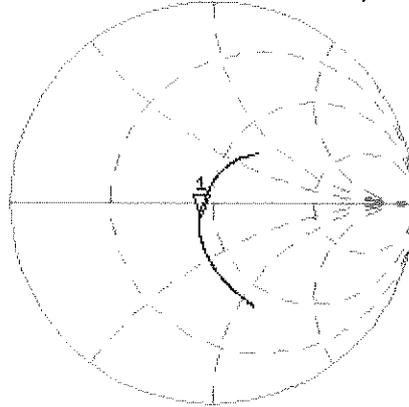
13 May 2013 15:25:53

CH1 S11 1 U FS

1: 43.775 Ω -6.1426 Ω 14.806 pF

1 750.000 000 MHz

*
De1
Cor



Avg
16

H1d

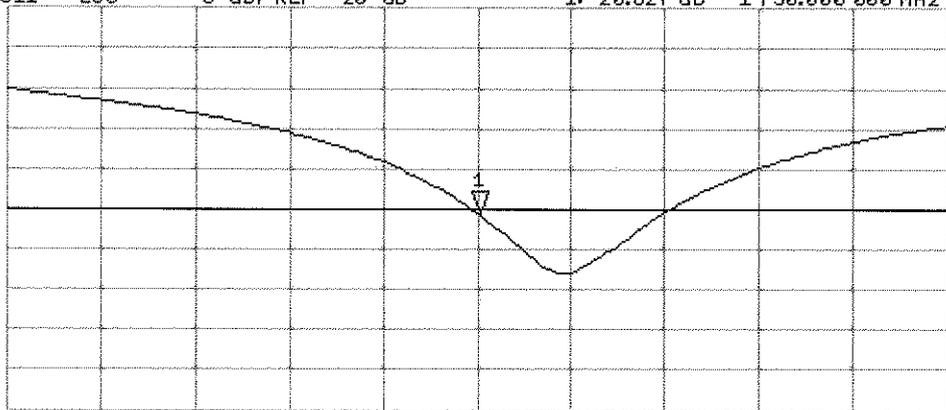
CH2 S11 LOG

5 dB/REF -20 dB

1:-20.627 dB

1 750.000 000 MHz

Cor



Avg
16

H1d

START 1 550.000 000 MHz

STOP 1 950.000 000 MHz



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D1900V2-5d141_May13**

CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d141**

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

Calibration date: **May 02, 2013**

✓
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: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

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

Signature

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

Issued: May 2, 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:

- 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	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz \pm 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 \pm 0.2) °C	39.3 \pm 6 %	1.37 mho/m \pm 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	10.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	40.8 W/kg \pm 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.3 W/kg \pm 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 \pm 0.2) °C	54.0 \pm 6 %	1.51 mho/m \pm 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.3 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	41.5 W/kg \pm 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.51 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	22.1 W/kg \pm 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.6 Ω + 4.9 j Ω
Return Loss	- 25.3 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.3 Ω + 5.9 j Ω
Return Loss	- 24.1 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: 02.05.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d141

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.37$ S/m; $\epsilon_r = 39.3$; $\rho = 1000$ kg/m³

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: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

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

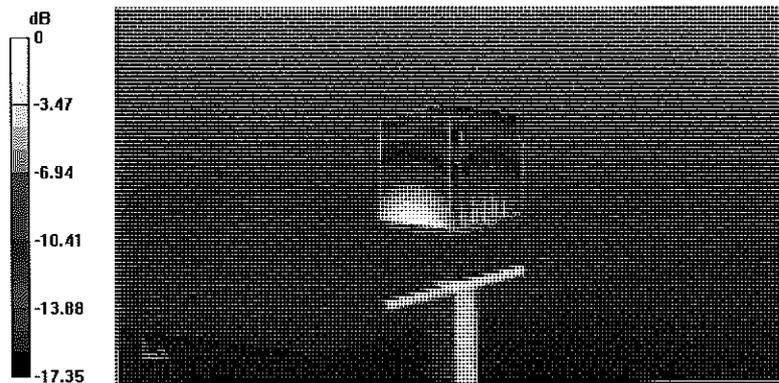
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 97.124 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 18.2 W/kg

SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.3 W/kg

Maximum value of SAR (measured) = 12.5 W/kg



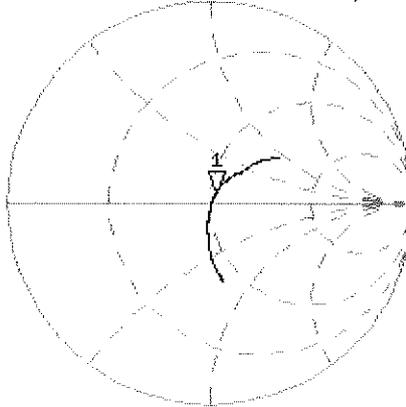
0 dB = 12.5 W/kg = 10.97 dBW/kg

Impedance Measurement Plot for Head TSL

2 May 2013 15:38:50

CH1 S11 1 U FS 1: 52.600 Ω 4.9375 Ω 413.59 μ H 1 900.000 000 MHz

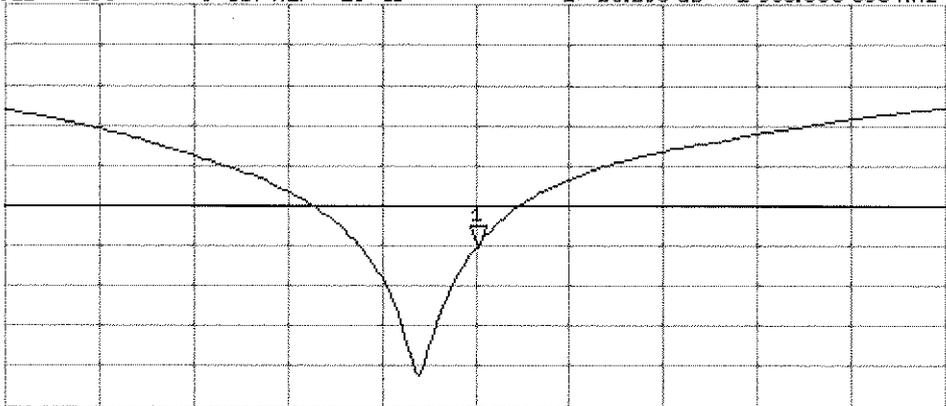
*
De1
Cor
Avg
4



H1d

CH2 S11 LOG 5 dB/REF -20 dB 1:-25.293 dB 1 900.000 000 MHz

Cor
Avg
4



START 1 700.000 000 MHz

STOP 2 100.000 000 MHz

DASY5 Validation Report for Body TSL

Date: 02.05.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d141

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.51$ S/m; $\epsilon_r = 54$; $\rho = 1000$ kg/m³

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: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

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

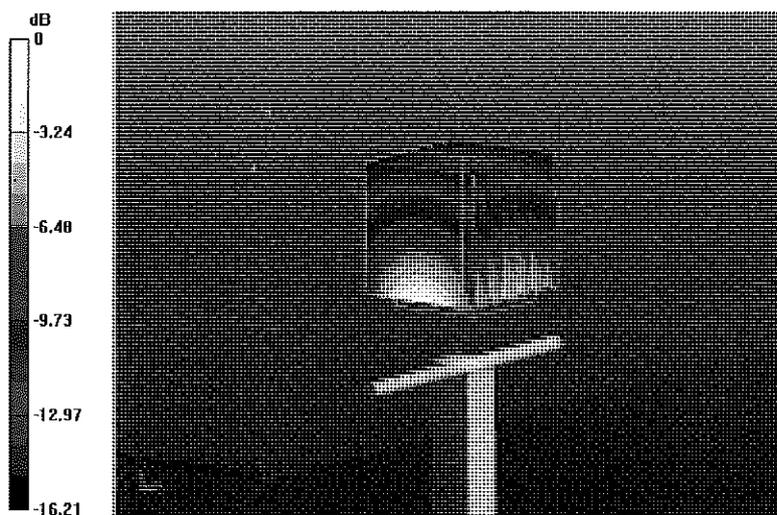
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 97.124 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 17.6 W/kg

SAR(1 g) = 10.3 W/kg; SAR(10 g) = 5.51 W/kg

Maximum value of SAR (measured) = 13.0 W/kg



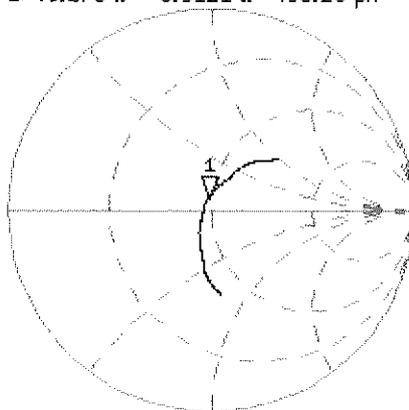
0 dB = 13.0 W/kg = 11.14 dBW/kg

Impedance Measurement Plot for Body TSL

2 May 2013 15:38:04

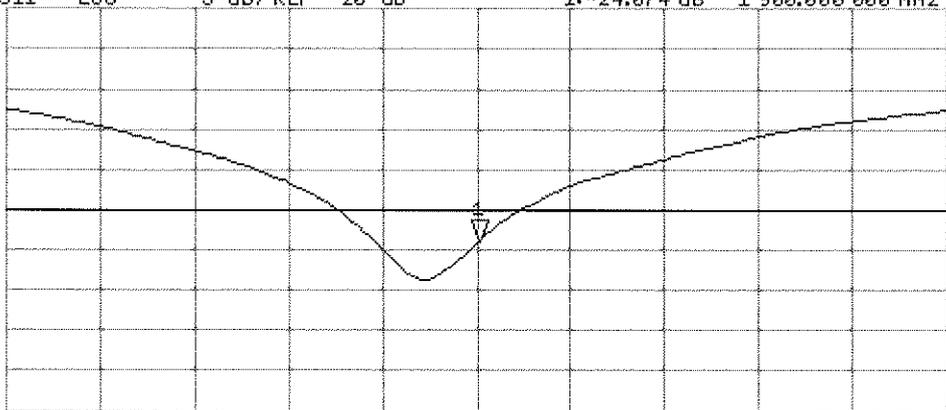
[CH1] S11 1 U FS 1: 48.273 Ω 5.9121 Ω 495.23 μ H 1 900.000 000 MHz

*
De1
Cor
Avg
16
H1d



CH2 S11 LOG 5 dB/REF -20 dB 1:-24.074 dB 1 900.000 000 MHz

Cor
Avg
16
H1d



START 1 700.000 000 MHz

STOP 2 1 00.000 000 MHz



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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 ± 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*
[Signature]

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

Issued: February 11, 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:

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

Additional Documentation:

- d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.5
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz \pm 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

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

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	51.7 W/kg \pm 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.07 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.0 W/kg \pm 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 \pm 0.2) °C	50.9 \pm 6 %	2.02 mho/m \pm 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.8 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	49.9 W/kg \pm 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.91 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.3 W/kg \pm 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.6 Ω - 0.4 j Ω
Return Loss	- 29.0 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.5 Ω + 1.2 j Ω
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/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.52, 4.52, 4.52); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 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:

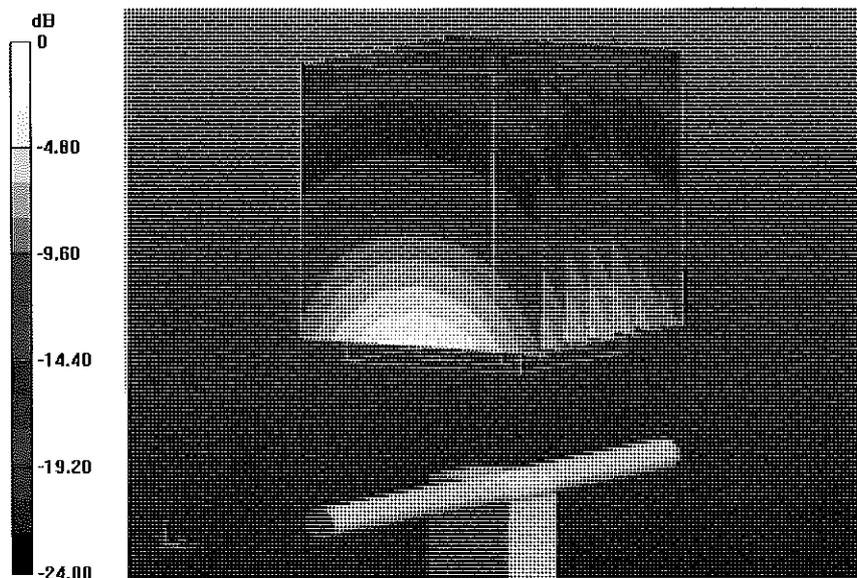
Measurement grid: dx=5mm, dy=5mm, dz=5mm

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



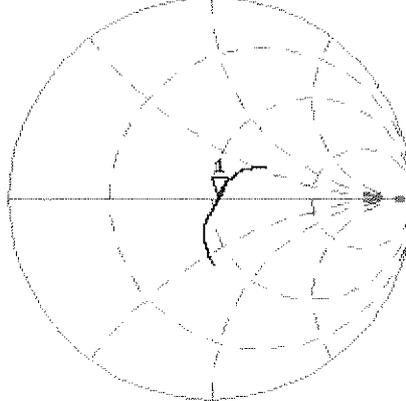
0 dB = 16.7 W/kg = 12.23 dBW/kg

Impedance Measurement Plot for Head TSL

11 Feb 2013 11:51:51

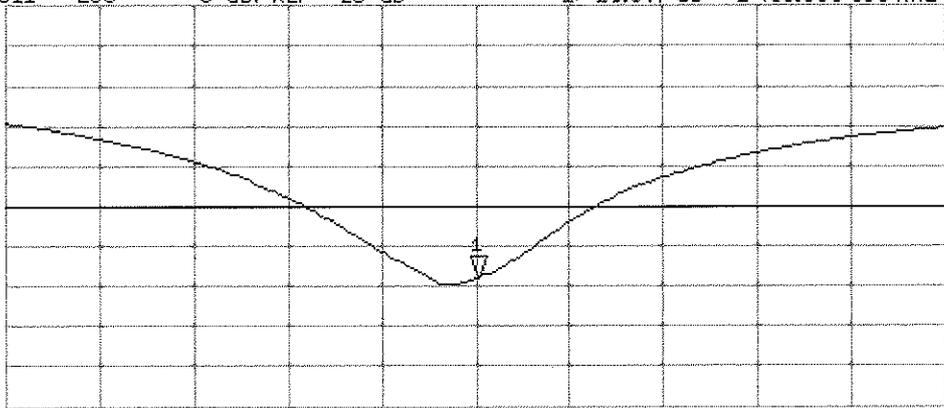
CH1 S11 1 U FS 1: 53.639 Ω -363.28 $m\Omega$ 178.82 μF 2 450.000 000 MHz

*
Del
Cor
Avg
16
H1d



CH2 S11 LOG 5 dB/REF -20 dB 1:-29.047 dB 2 450.000 000 MHz

Cor
Avg
16
H1d



START 2 250.000 000 MHz

STOP 2 650.000 000 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/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.42, 4.42, 4.42); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 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:

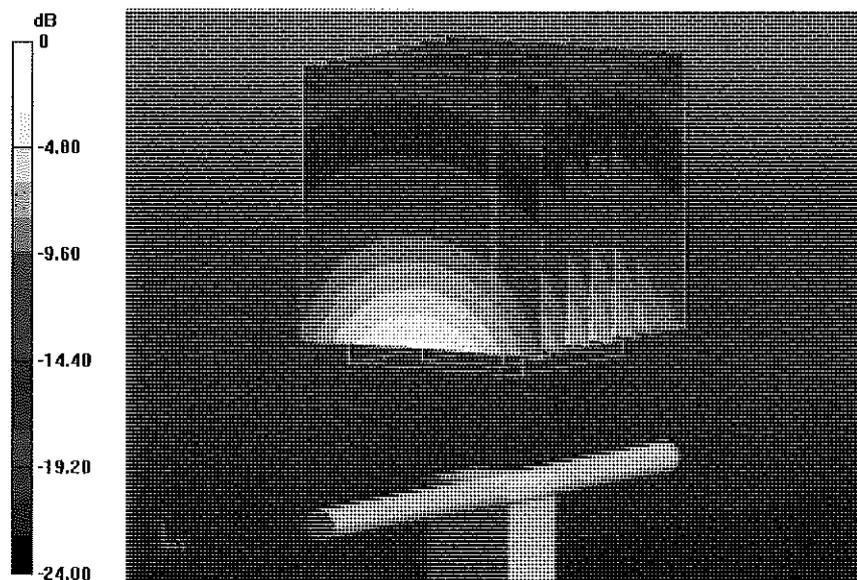
Measurement grid: dx=5mm, dy=5mm, dz=5mm

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



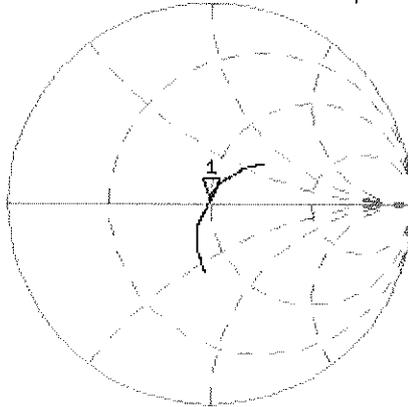
0 dB = 16.9 W/kg = 12.28 dBW/kg

Impedance Measurement Plot for Body TSL

11 Feb 2013 11:51:25

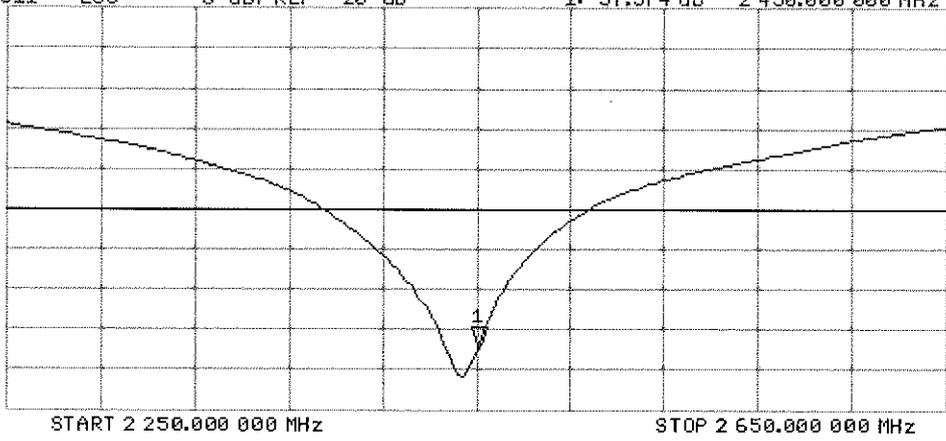
CH1 S11 1 U FS 1: 49.500 Ω 1.2461 μ 80.948 pF 2 450.000 000 MHz

*
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





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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 ± 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** Laboratory Technician

Signature

Israe El-Naouq

Approved by: **Katja Pokovic** Technical Manager

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.

DASY Version	DASY5	V52.8.5
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz ± 1 MHz 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
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.7 ± 6 %	4.47 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.67 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	76.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.5 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.5 ± 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 ³ (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	78.7 W / kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.4 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.2 ± 6 %	4.74 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 ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.09 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.1 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.6 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.1 ± 6 %	4.83 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 ³ (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	79.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.5 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	33.9 ± 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 ³ (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	74.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.13 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.0 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.9 ± 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 ³ (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	76.6 W/kg ± 19.9 % (k=2)

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

Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.42 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.7 ± 6 %	5.48 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 ³ (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	76.8 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.18 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.5 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.6	5.65 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.3 ± 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 ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.06 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	79.8 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	22.1 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.2 ± 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 ³ (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	80.7 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.26 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	22.3 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	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 ³ (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	75.5 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.12 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.9 W/kg ± 19.5 % (k=2)

Appendix

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	53.8 Ω - 6.3 j Ω
Return Loss	- 23.0 dB

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	50.1 Ω + 0.5 j Ω
Return Loss	- 45.3 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	51.0 Ω - 0.9 j Ω
Return Loss	- 37.9 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	55.3 Ω - 0.9 j Ω
Return Loss	- 25.8 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	53.5 Ω + 3.3 j Ω
Return Loss	- 26.7 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	53.7 Ω - 4.8 j Ω
Return Loss	- 24.8 dB

Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	50.2 Ω + 2.4 j Ω
Return Loss	- 32.5 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	51.6 Ω - 1.5 j Ω
Return Loss	- 33.3 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	57.4 Ω + 0.9 j Ω
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/m³, Medium parameters used: $f = 5300$ MHz; $\sigma = 4.57$ S/m; $\epsilon_r = 34.5$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5500$ MHz; $\sigma = 4.74$ S/m; $\epsilon_r = 34.2$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 4.83$ S/m; $\epsilon_r = 34.1$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 5.05$ S/m; $\epsilon_r = 33.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.41, 5.41, 5.41); Calibrated: 28.12.2012, ConvF(5.1, 5.1, 5.1); Calibrated: 28.12.2012, ConvF(4.91, 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

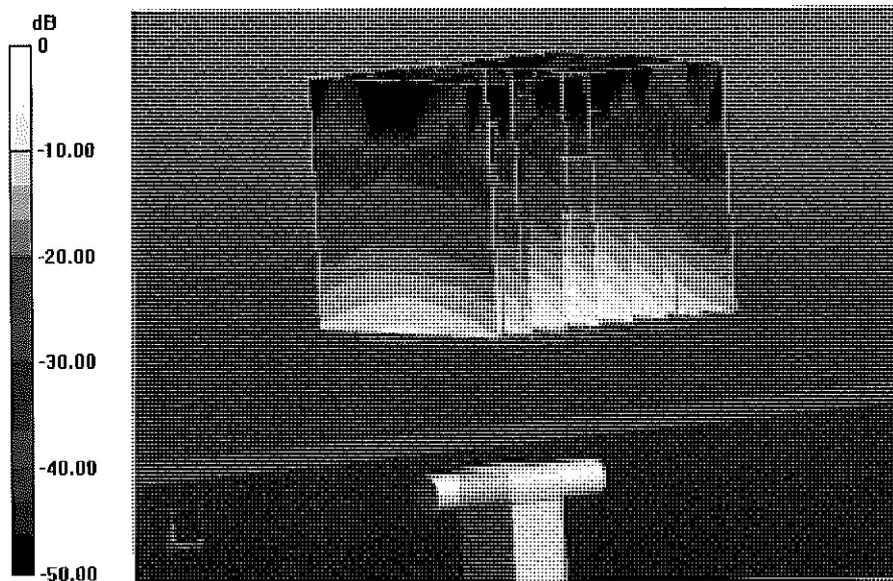
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

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



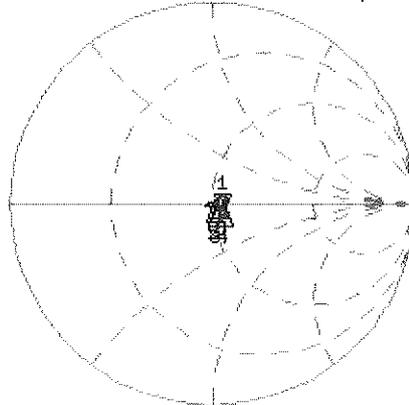
0 dB = 18.8 W/kg = 12.74 dBW/kg

Impedance Measurement Plot for Head TSL

8 Feb 2013 10:10:29

CH1 S11 1 U FS 1: 53.764 Ω -6.3086 Ω 4.8516 pF 5 200.000 000 MHz

*
De1
Cor
Avg
0
H1d

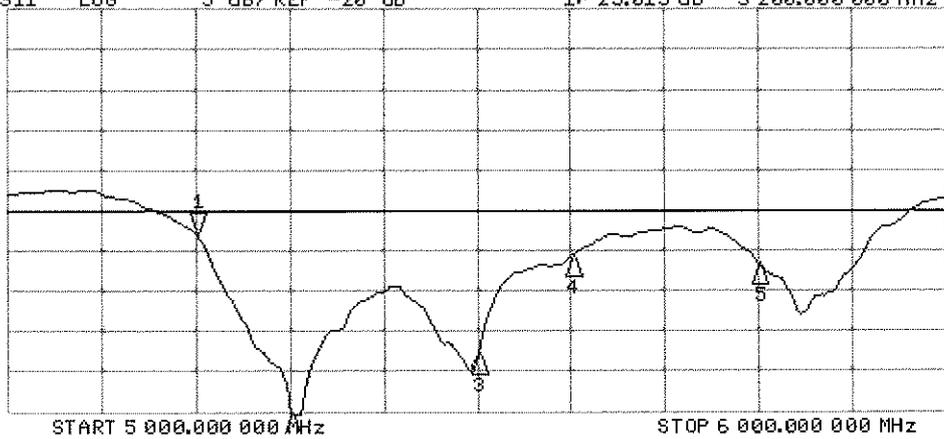


CH1 Markers

- 2: 50.104 Ω
0.5313 Ω
5.30000 GHz
- 3: 50.959 Ω
-853.52 m Ω
5.50000 GHz
- 4: 55.305 Ω
-902.34 m Ω
5.60000 GHz
- 5: 53.500 Ω
3.3027 Ω
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/m³, Medium parameters used: $f = 5300$ MHz; $\sigma = 5.48$ S/m; $\epsilon_r = 46.7$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5500$ MHz; $\sigma = 5.71$ S/m; $\epsilon_r = 46.3$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 5.83$ S/m; $\epsilon_r = 46.2$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 6.12$ S/m; $\epsilon_r = 45.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.91, 4.91, 4.91); Calibrated: 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

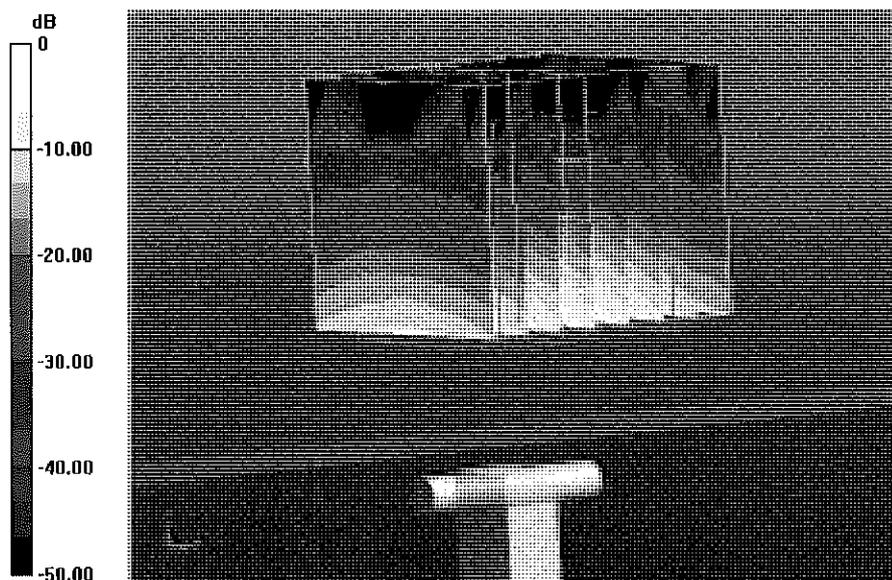
Peak SAR (extrapolated) = 35.3 W/kg

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



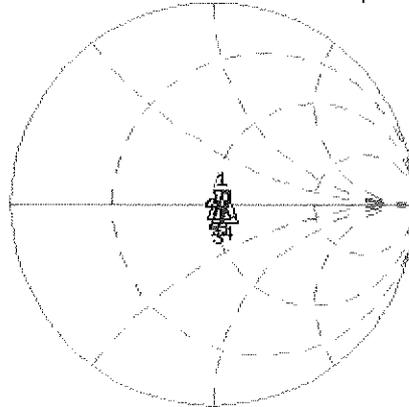
0 dB = 19.0 W/kg = 12.79 dBW/kg

Impedance Measurement Plot for Body TSL

14 Feb 2013 15:47:05

CH1 S11 1 U FS 1: 53.672 Ω -4.7539 Ω 6.4382 pF 5 200.000 000 MHz

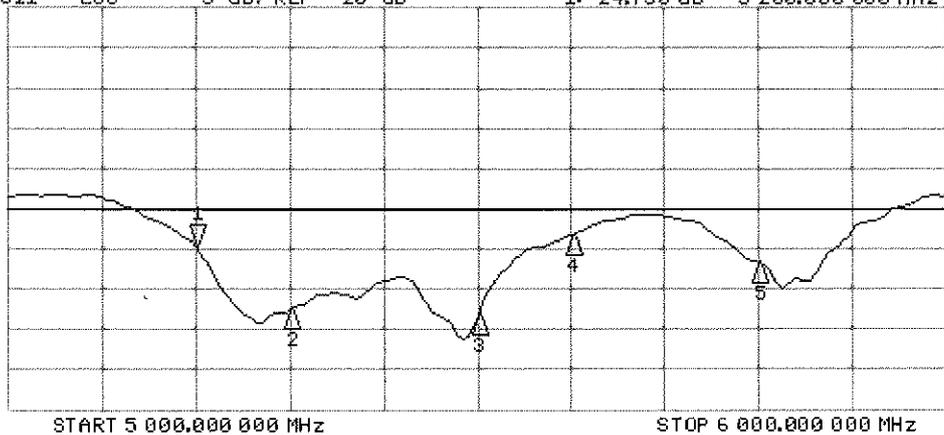
*
De1
Cor
Avg
16
H1d



CH1 Markers
2: 50.250 Ω
2.3555 Ω
5.30000 GHz
3: 51.629 Ω
-1.4824 Ω
5.50000 GHz
4: 57.389 Ω
0.9180 Ω
5.60000 GHz
5: 53.543 Ω
3.2441 Ω
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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Multilateral Agreement for the recognition of calibration certificates

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 ± 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

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:

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

Additional Documentation:

- c) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.5
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz ± 1 MHz 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
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.6 ± 6 %	4.50 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.66 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	75.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.17 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.4 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.5 ± 6 %	4.60 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.76 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	76.9 W / kg ± 19.9 % (k=2)

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

Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

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

SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.09 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.1 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.5 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.1 ± 6 %	4.88 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.12 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.4 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.7 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	33.8 ± 6 %	5.09 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.69 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	76.1 W/kg ± 19.9 % (k=2)

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

Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.0 ± 6 %	5.42 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.61 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	75.5 W/kg ± 19.9 % (k=2)

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

Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.42 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.8 ± 6 %	5.55 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5300 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.59 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	75.3 W/kg ± 19.9 % (k=2)

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

Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

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

SAR result with Body TSL at 5500 MHz

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

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

Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

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

SAR result with Body TSL at 5600 MHz

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

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

Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.0 ± 6 %	6.21 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.57 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	75.1 W/kg ± 19.9 % (k=2)

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

Appendix

Antenna Parameters with Head TSL at 5200 MHz

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

Antenna Parameters with Head TSL at 5300 MHz

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

Antenna Parameters with Head TSL at 5500 MHz

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

Antenna Parameters with Head TSL at 5600 MHz

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

Antenna Parameters with Head TSL at 5800 MHz

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

Antenna Parameters with Body TSL at 5200 MHz

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

Antenna Parameters with Body TSL at 5300 MHz

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

Antenna Parameters with Body TSL at 5500 MHz

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

Antenna Parameters with Body TSL at 5600 MHz

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

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	53.3 Ω - 2.9 j Ω
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/m³, Medium parameters used: $f = 5300$ MHz; $\sigma = 4.6$ S/m; $\epsilon_r = 34.5$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5500$ MHz; $\sigma = 4.79$ S/m; $\epsilon_r = 34.2$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 4.88$ S/m; $\epsilon_r = 34.1$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 5.09$ S/m; $\epsilon_r = 33.8$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.41, 5.41, 5.41); Calibrated: 28.12.2012, ConvF(5.1, 5.1, 5.1); Calibrated: 28.12.2012, ConvF(4.91, 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,

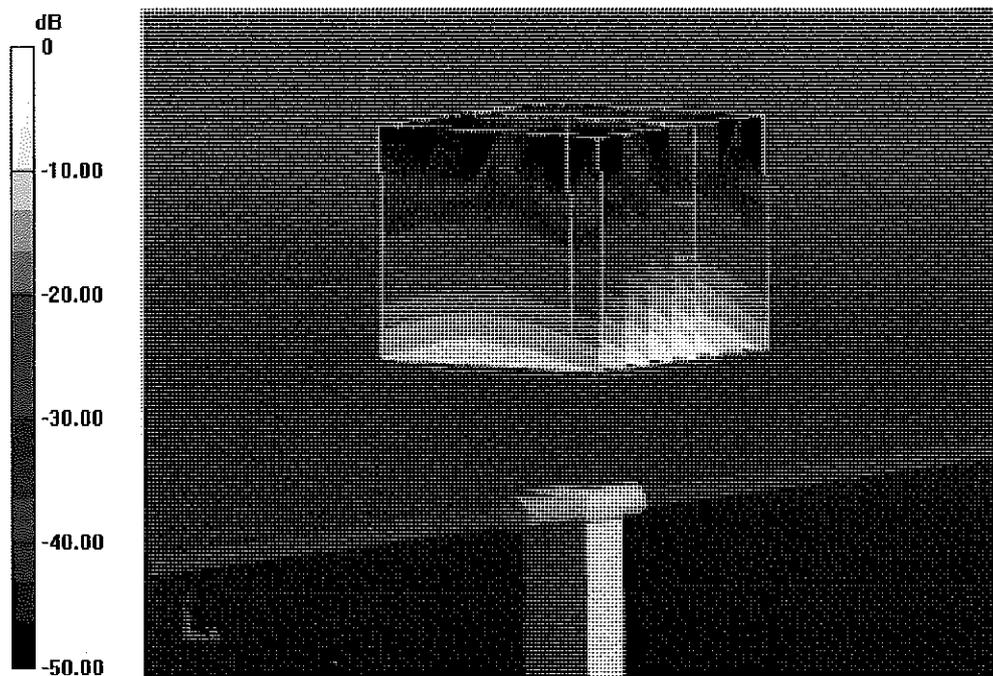
dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

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



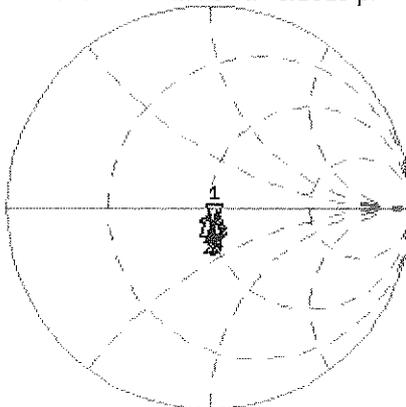
0 dB = 19.4 W/kg = 12.88 dBW/kg

Impedance Measurement Plot for Head TSL

11 Jan 2013 09:26:56

CH1 S11 1 U FS 1: 50.543 Ω -9.7754 Ω 3.1310 pF 5 200.000 000 MHz

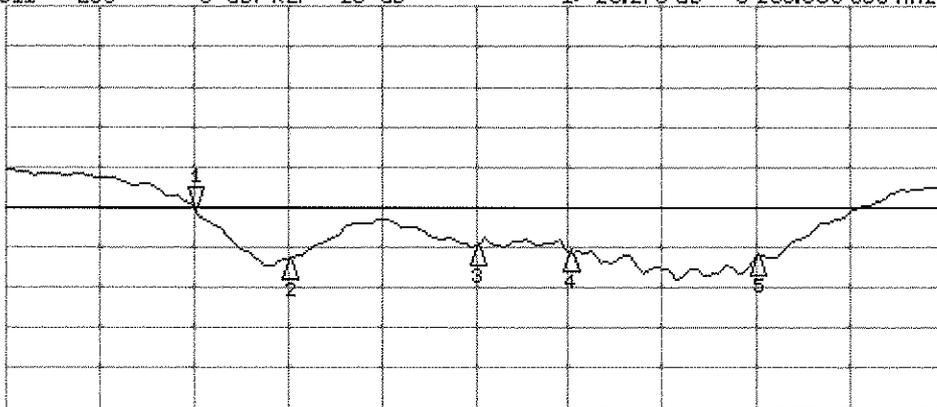
*
De1
CA
Avg
16
H1d



CH1 Markers
2: 48.508 Ω
-4.4805 Ω
5.30000 GHz
3: 50.617 Ω
-5.7559 Ω
5.50000 GHz
4: 53.891 Ω
-3.8418 Ω
5.60000 GHz
5: 52.500 Ω
-4.4160 Ω
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

START 5 000.000 000 MHz

STOP 6 000.000 000 MHz

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/m³, Medium parameters used: $f = 5300$ MHz; $\sigma = 5.55$ S/m; $\epsilon_r = 46.8$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5500$ MHz; $\sigma = 5.81$ S/m; $\epsilon_r = 46.5$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 5.94$ S/m; $\epsilon_r = 46.3$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 6.21$ S/m; $\epsilon_r = 46$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.91, 4.91, 4.91); Calibrated: 28.12.2012, ConvF(4.67, 4.67, 4.67); Calibrated: 28.12.2012, ConvF(4.43, 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,

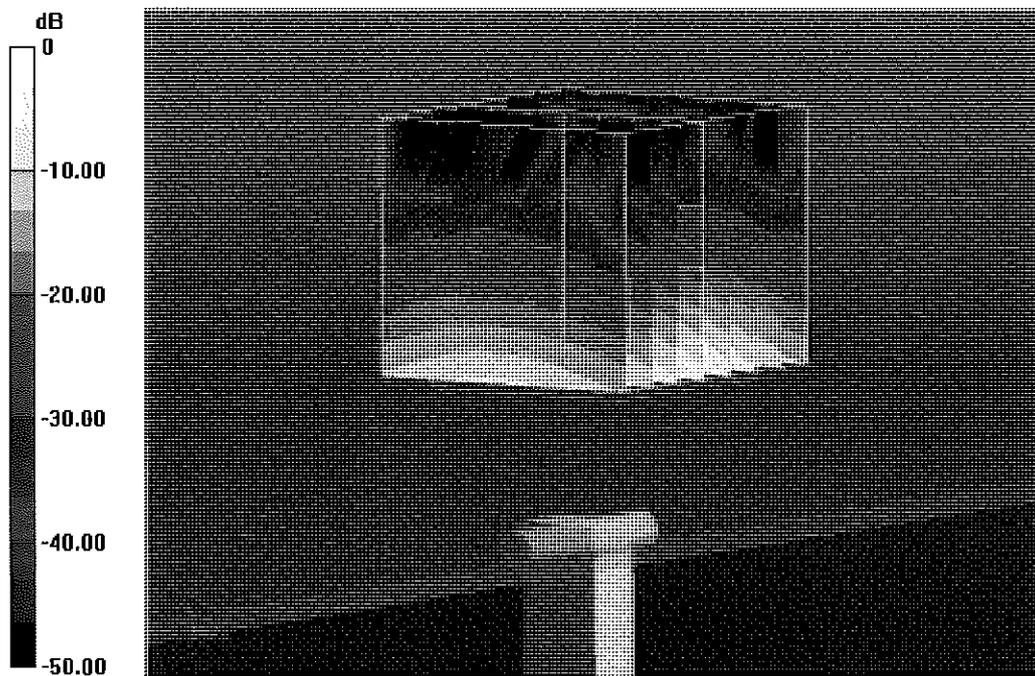
dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

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

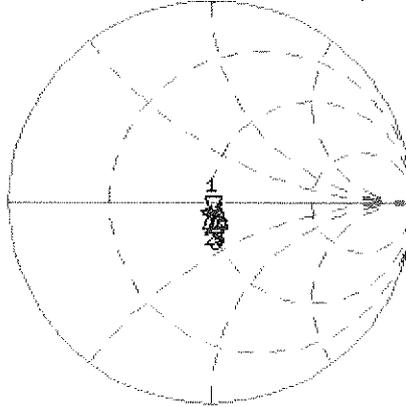
Impedance Measurement Plot for Body TSL

10 Jan 2013 13:20:10

CH1 S11 1 U FS

1: 49.311 Ω -7.8789 Ω 3.8846 pF 5 200.000 000 MHz

*
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16
H1d

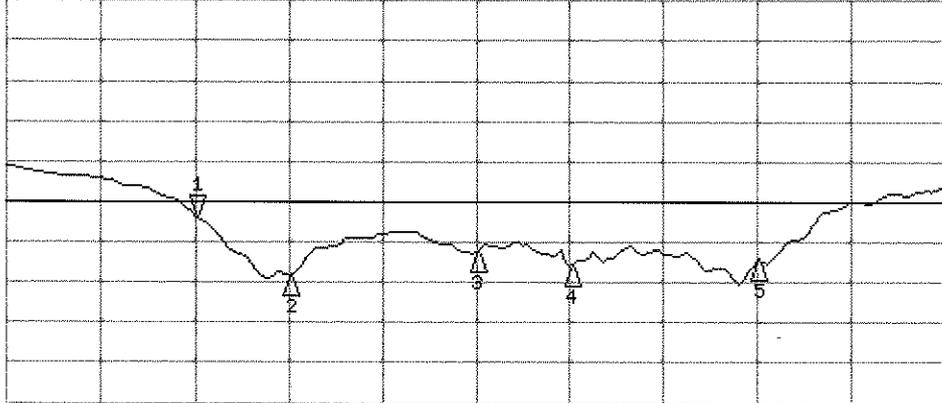


CH1 Markers

2: 48.729 Ω
-3.1895 Ω
5.30000 GHz
3: 51.209 Ω
-4.8184 Ω
5.50000 GHz
4: 53.596 Ω
-2.1113 Ω
5.60000 GHz
5: 53.314 Ω
-2.9355 Ω
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

START 5 000.000 000 MHz

STOP 6 000.000 000 MHz



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: **D750V3-1003_Jan13**

CALIBRATION CERTIFICATE

Object **D750V3 - SN: 1003**

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

Calibration date: **January 07, 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:	Name Leif Klysner	Function Laboratory Technician	Signature
Approved by:	Name Katja Pokovic	Function Technical Manager	Signature

Issued: January 8, 2013

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



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "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	V52.8.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	750 MHz \pm 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.9	0.89 mho/m
Measured Head TSL parameters	(22.0 \pm 0.2) °C	41.4 \pm 6 %	0.89 mho/m \pm 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.12 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	8.46 W/kg \pm 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.38 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	5.51 W/kg \pm 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.5	0.96 mho/m
Measured Body TSL parameters	(22.0 \pm 0.2) °C	54.8 \pm 6 %	0.97 mho/m \pm 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.23 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	8.83 W/kg \pm 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.48 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	5.87 W/kg \pm 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	56.1 Ω - 0.2 j Ω
Return Loss	- 24.8 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.6 Ω - 3.5 j Ω
Return Loss	- 29.1 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.043 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 21, 2009

DASY5 Validation Report for Head TSL

Date: 07.01.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1003

Communication System: CW; Frequency: 750 MHz

Medium parameters used: $f = 750$ MHz; $\sigma = 0.89$ S/m; $\epsilon_r = 41.4$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.28, 6.28, 6.28); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.4(1052); SEMCAD X 14.6.8(7028)

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

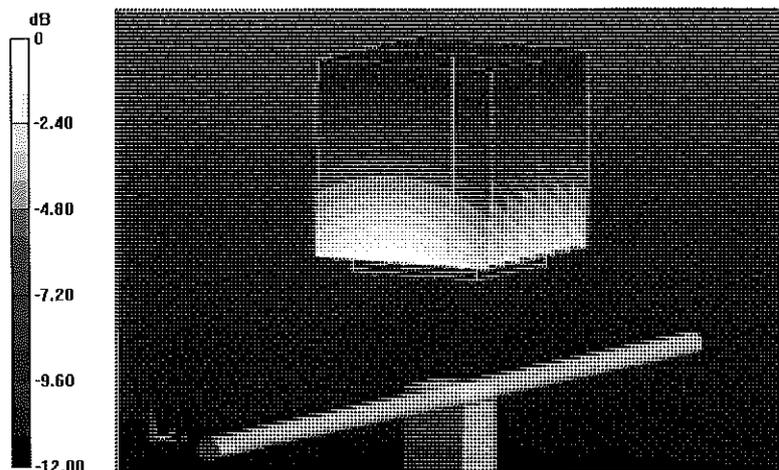
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 53.114 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 3.24 W/kg

SAR(1 g) = 2.12 W/kg; SAR(10 g) = 1.38 W/kg

Maximum value of SAR (measured) = 2.47 W/kg



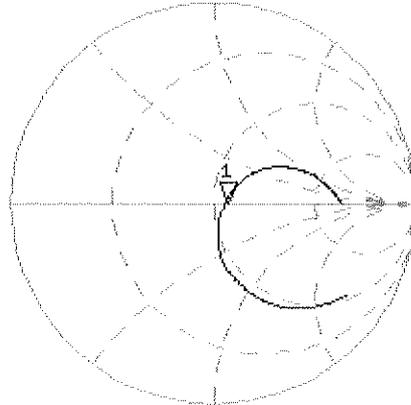
0 dB = 2.47 W/kg = 3.93 dBW/kg

Impedance Measurement Plot for Head TSL

7 Jan 2013 12:55:14

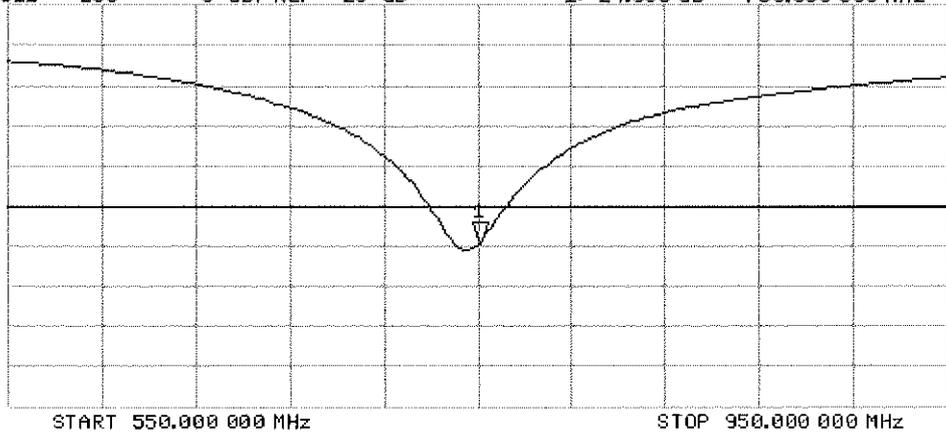
[CH1] S11 1 U FS 1: 56.100 Ω -179.69 $m\Omega$ 1.1810 nF 750.000 000 MHz

*
De1
Ca
Avg
16
H1d



CH2 S11 LOG 5 dB/REF -20 dB 1:-24.803 dB 750.000 000 MHz

Ca
Avg
16
H1d



DASY5 Validation Report for Body TSL

Date: 07.01.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1003

Communication System: CW; Frequency: 750 MHz

Medium parameters used: $f = 750$ MHz; $\sigma = 0.97$ S/m; $\epsilon_r = 54.8$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.11, 6.11, 6.11); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.4(1052); SEMCAD X 14.6.8(7028)

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

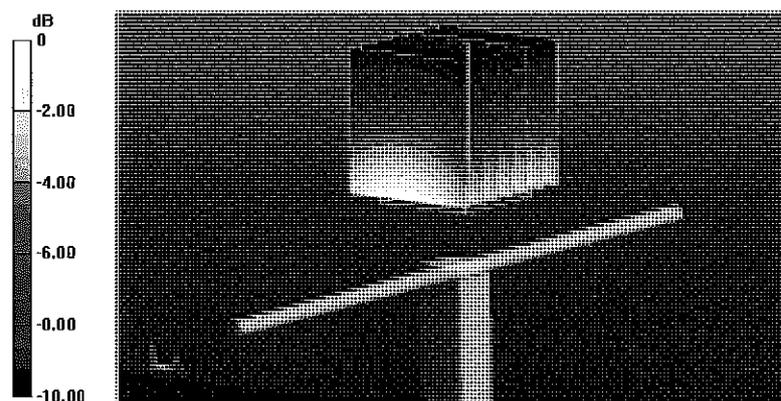
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 53.114 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 3.25 W/kg

SAR(1 g) = 2.23 W/kg; SAR(10 g) = 1.48 W/kg

Maximum value of SAR (measured) = 2.57 W/kg



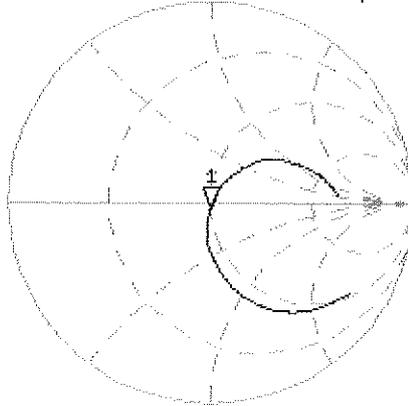
0 dB = 2.57 W/kg = 4.10 dBW/kg

Impedance Measurement Plot for Body TSL

7 Jan 2013 09:57:48

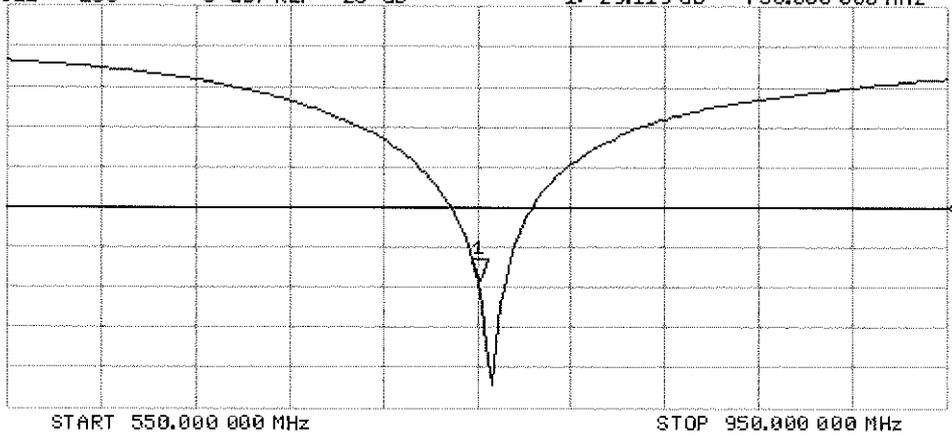
CH1 S11 1 U FS 1: 49.554 Ω -3.4629 Ω 61.280 pF 750.000 000 MHz

*
De1
Ca
Avg
16
H1d



CH2 S11 LOG 5 dB/REF -20 dB 1:-29.119 dB 750.000 000 MHz

Ca
Avg
16
H1d





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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

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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:

- 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 ³ (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	9.68 W/kg \pm 17.0 % (k=2)

SAR averaged over 10 cm ³ (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	6.30 W/kg \pm 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	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 ³ (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	9.54 W/kg \pm 17.0 % (k=2)

SAR averaged over 10 cm ³ (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	6.31 W/kg \pm 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.1 Ω - 4.7 j Ω
Return Loss	- 26.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.8 Ω - 6.3 j Ω
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/m³

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:

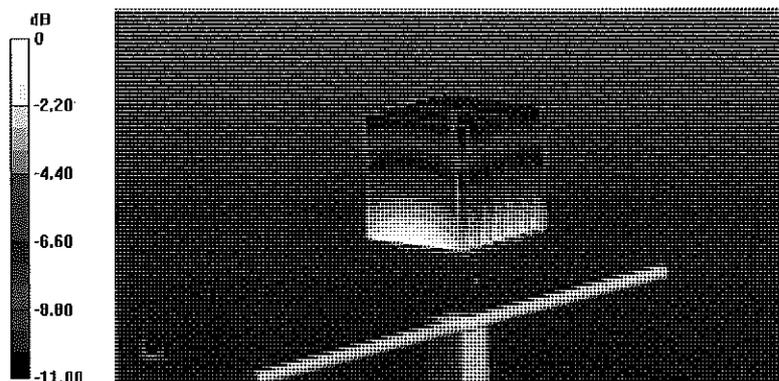
Measurement grid: dx=5mm, dy=5mm, dz=5mm

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 Ω -4.6621 Ω 40.884 pF

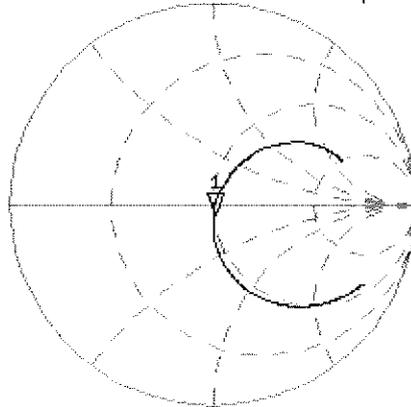
835.000 000 MHz

*
Del

CA

Avg
16

H1 d



CH2 S11 LOG

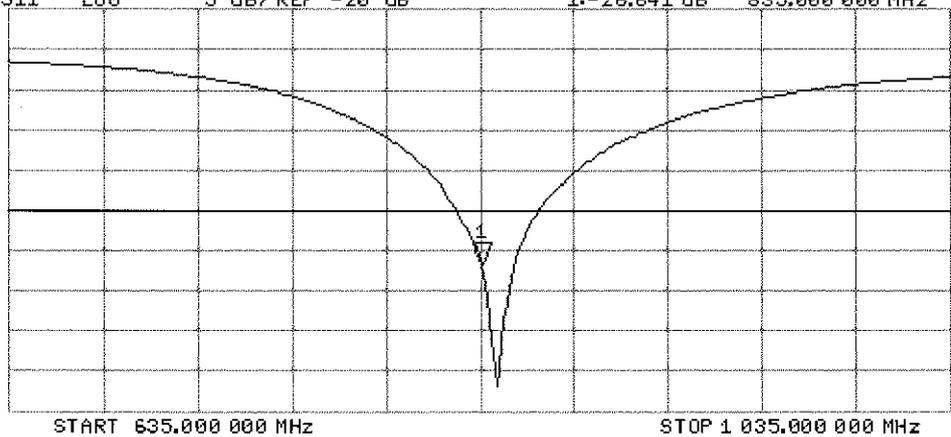
5 dB/REF -20 dB

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/m³

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:

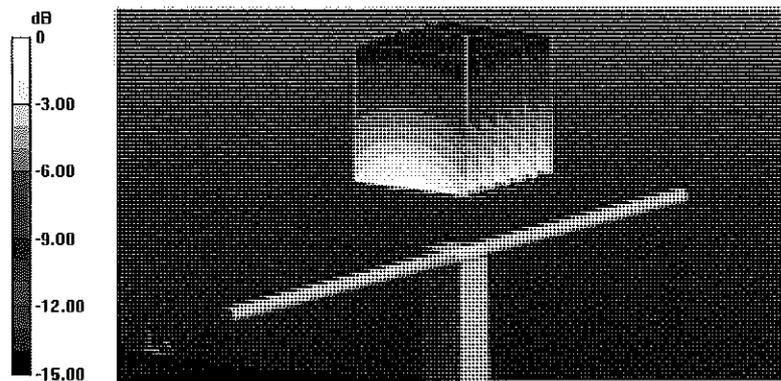
Measurement grid: dx=5mm, dy=5mm, dz=5mm

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 Ω -6.2773 Δ 30.364 pF

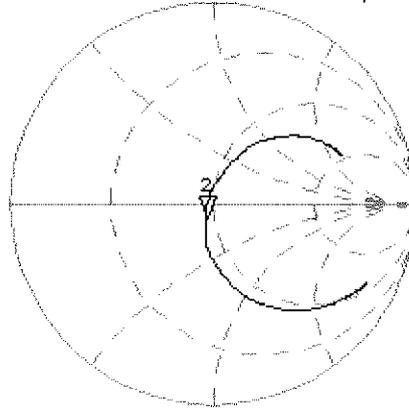
835.000 000 MHz

*
DeI

CΔ

Avg
16

H1d



CH2 S11 LOG

5 dB/REF -20 dB

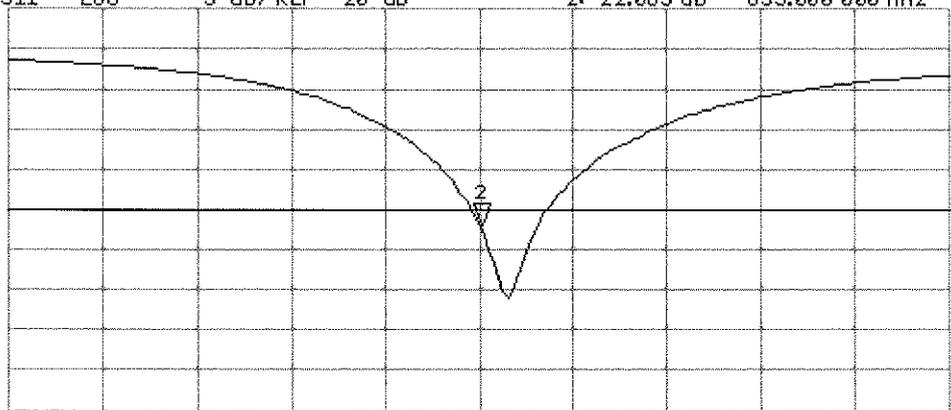
2: -22.065 dB

835.000 000 MHz

CΔ

Avg
16

H1d



START 635.000 000 MHz

STOP 1 035.000 000 MHz



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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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Glossary:

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

Probe 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 ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	1.00	1.04	0.99	± 10.1 %
DCP (mV) ^B	100.7	97.4	99.7	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB/μV	C	D dB	VR mV	Unc ^E (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%.

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

^B Numerical linearization parameter: uncertainty not required.

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

DASY/EASY - Parameters of Probe: ES3DV2 - SN:3022

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	6.21	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 %

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

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

DASY/EASY - Parameters of Probe: ES3DV2 - SN:3022

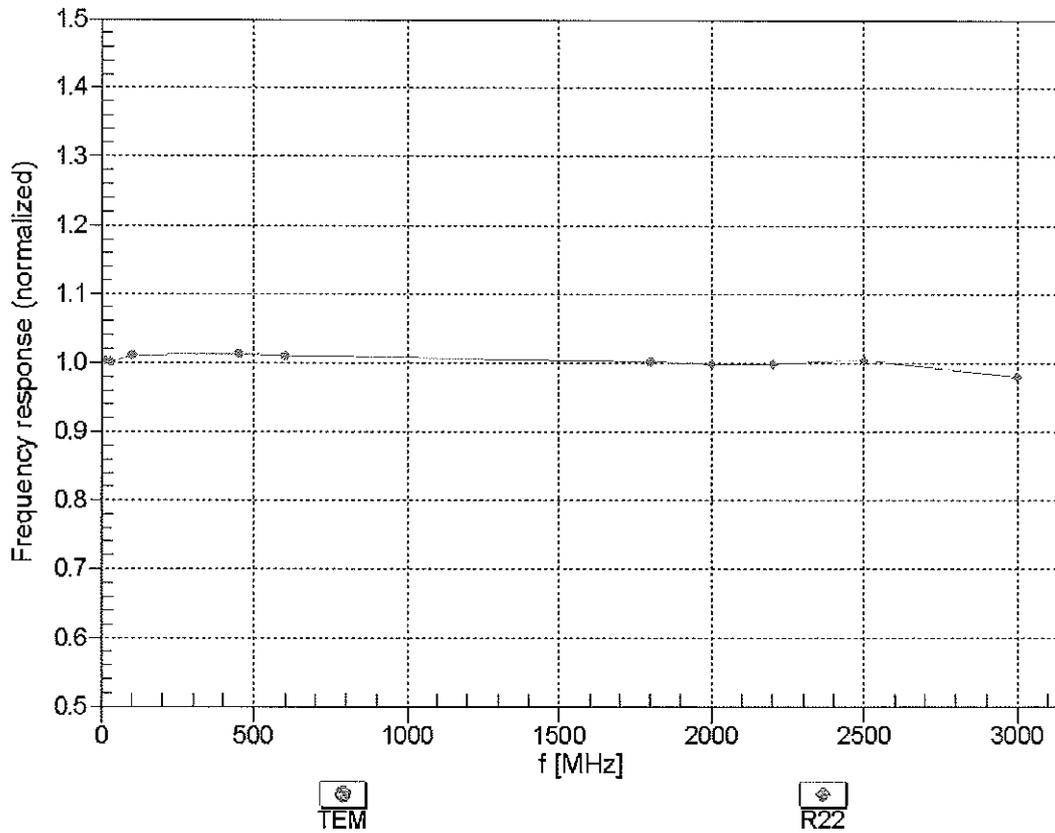
Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	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 %

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

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

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

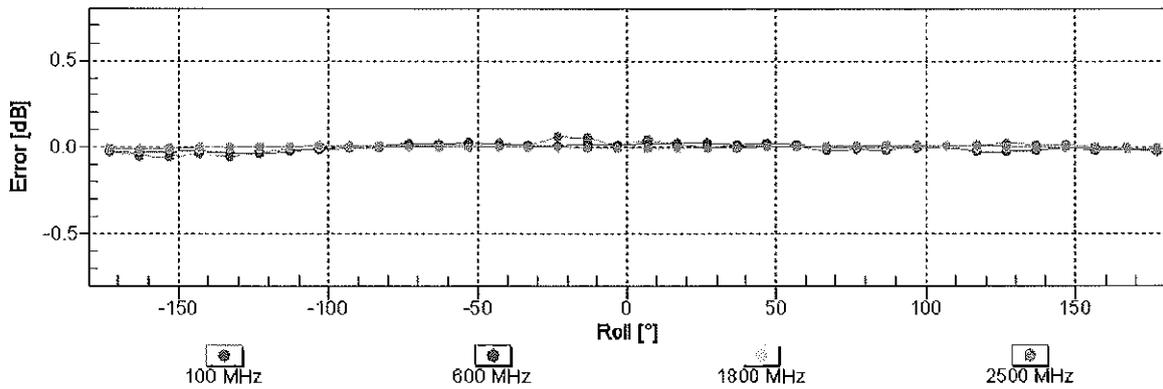
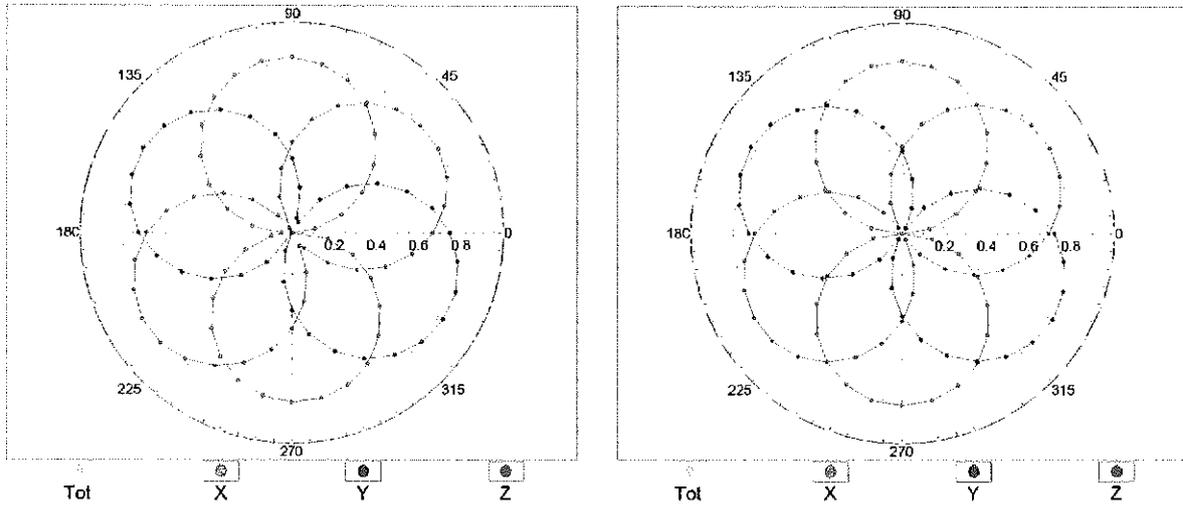


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

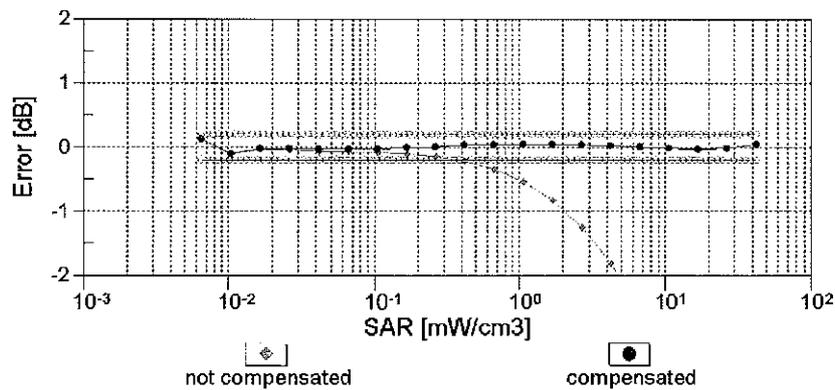
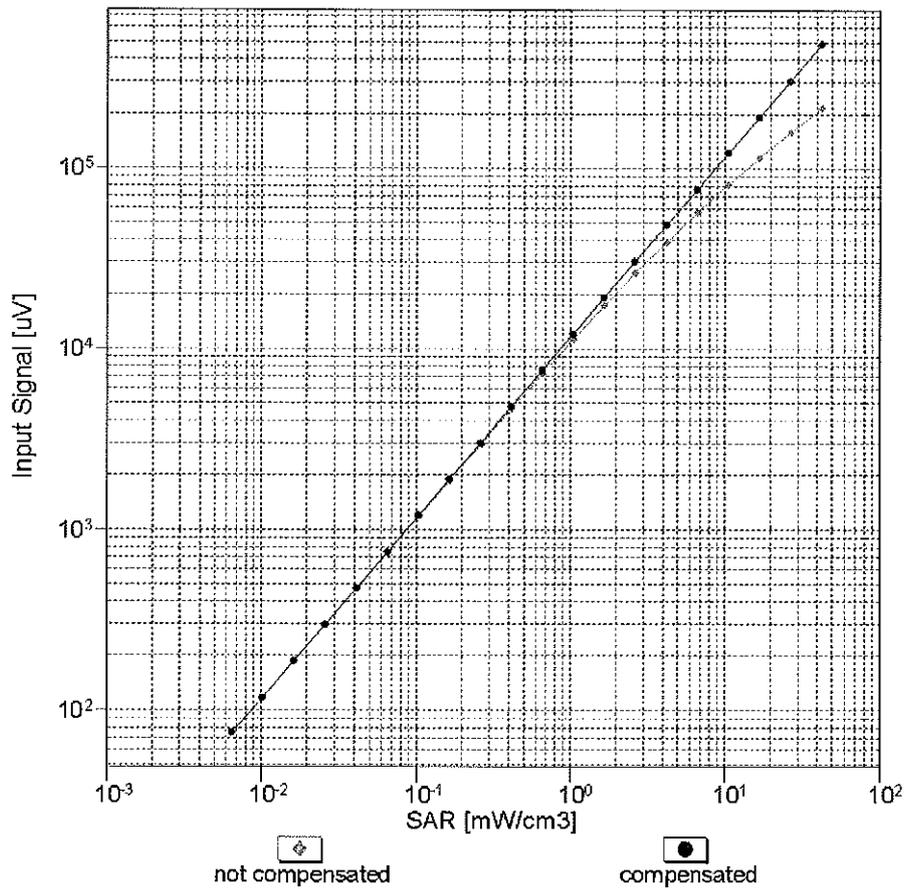
f=600 MHz,TEM

f=1800 MHz,R22



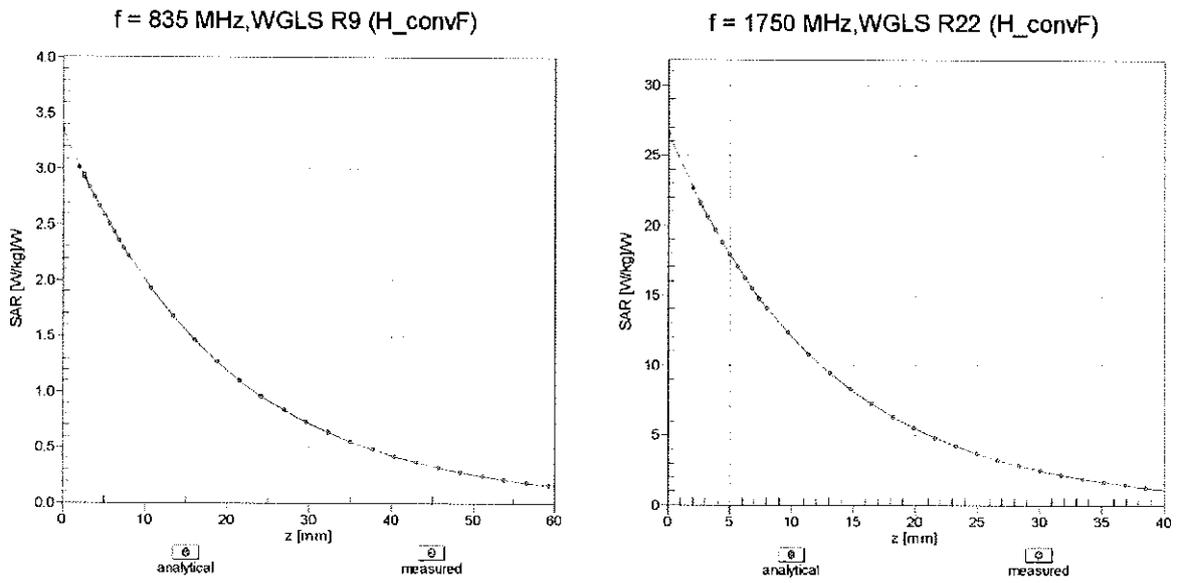
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

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

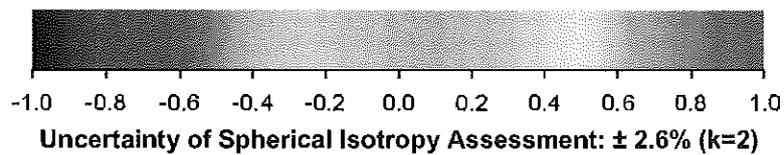
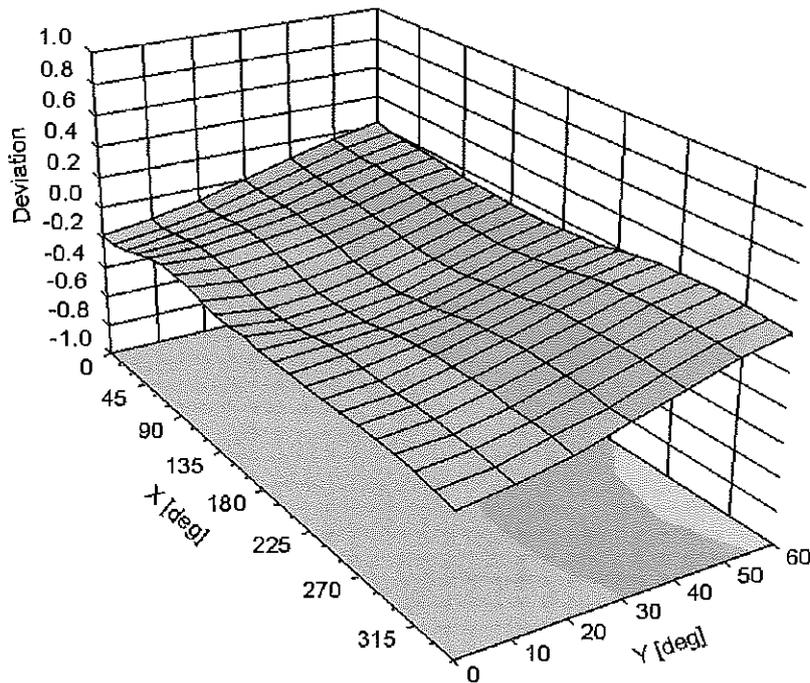


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment



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



DASY/EASY - Parameters of Probe: 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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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: **ES3-3319_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

	Name	Function	Signature
Calibrated by:	Dimce Iliev	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
			Issued: April 29, 2013

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



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Accreditation No.: **SCS 108**

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Multilateral Agreement for the recognition of calibration certificates

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}; A, B, C, D** are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

Probe 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 ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	1.12	1.20	1.22	$\pm 10.1 \%$
DCP (mV) ^B	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 ^E (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%.

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

^B Numerical linearization parameter: uncertainty not required.

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3319

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	6.49	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 %

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

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3319

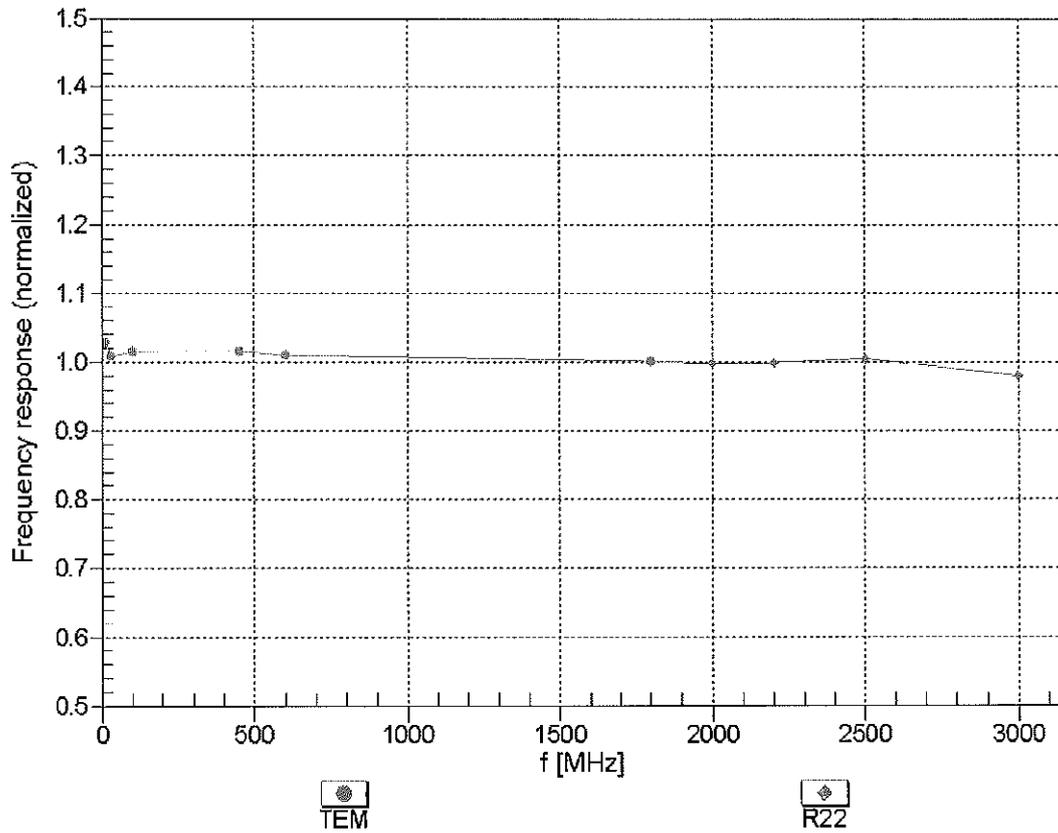
Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	6.30	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 %

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

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

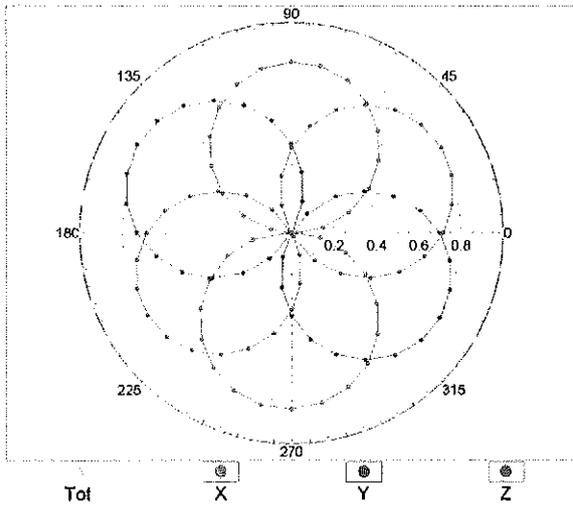
Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



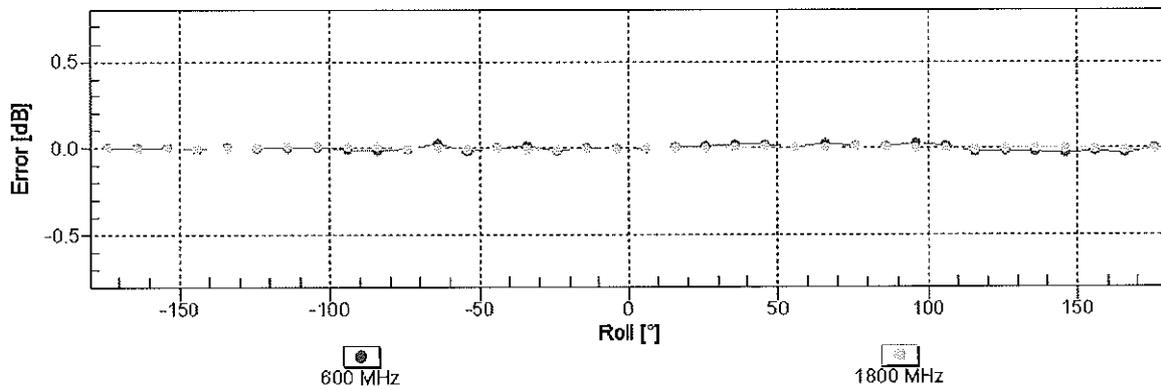
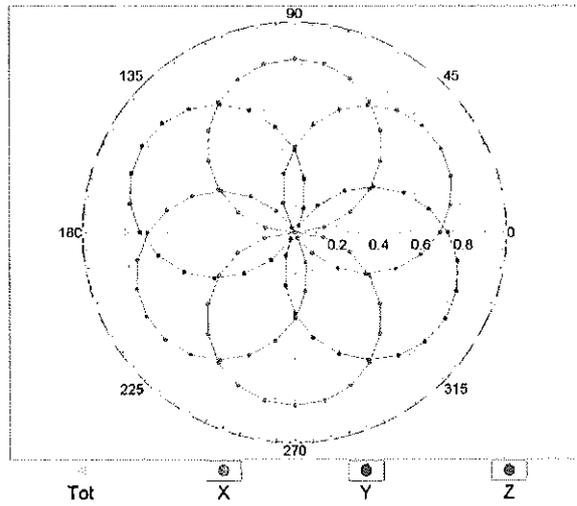
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz,TEM

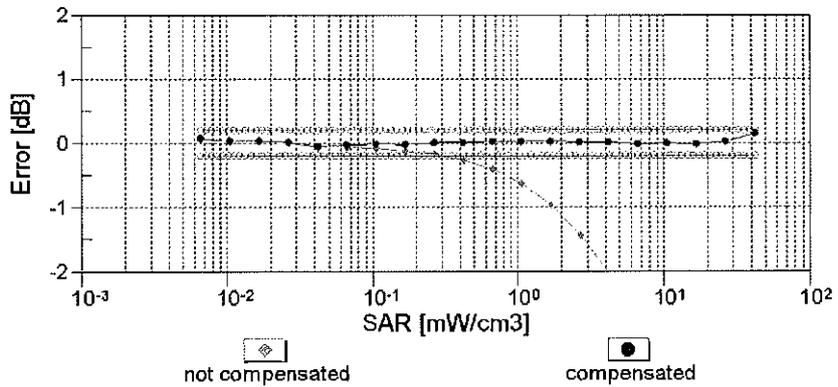
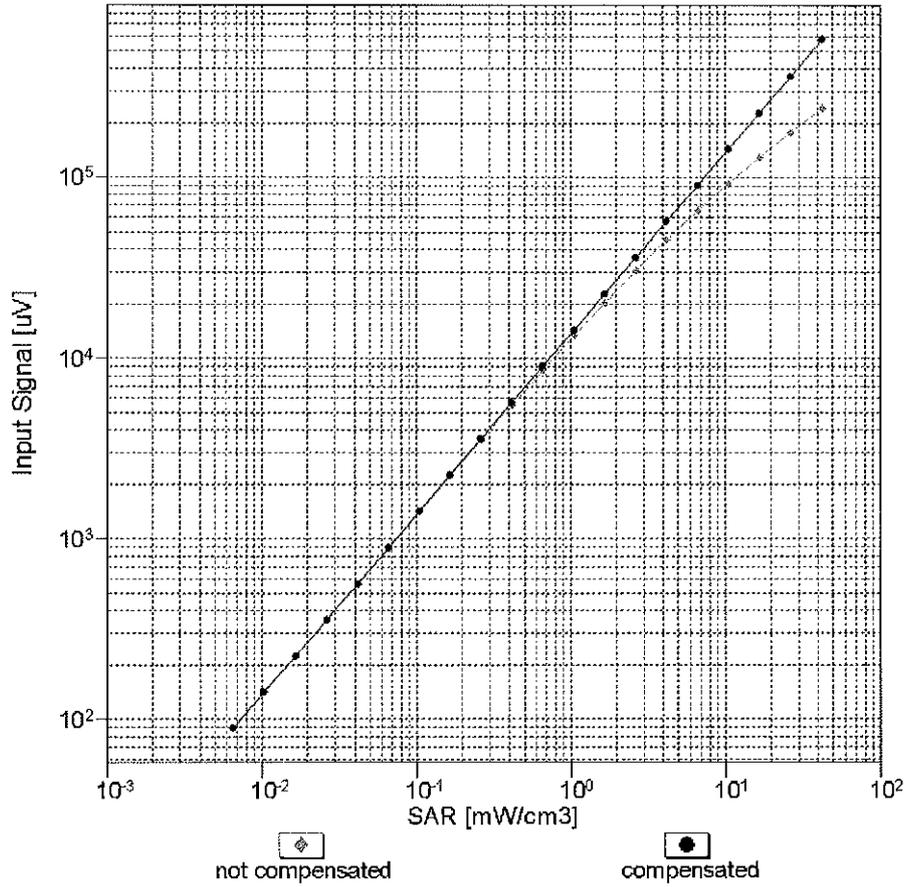


f=1800 MHz,R22



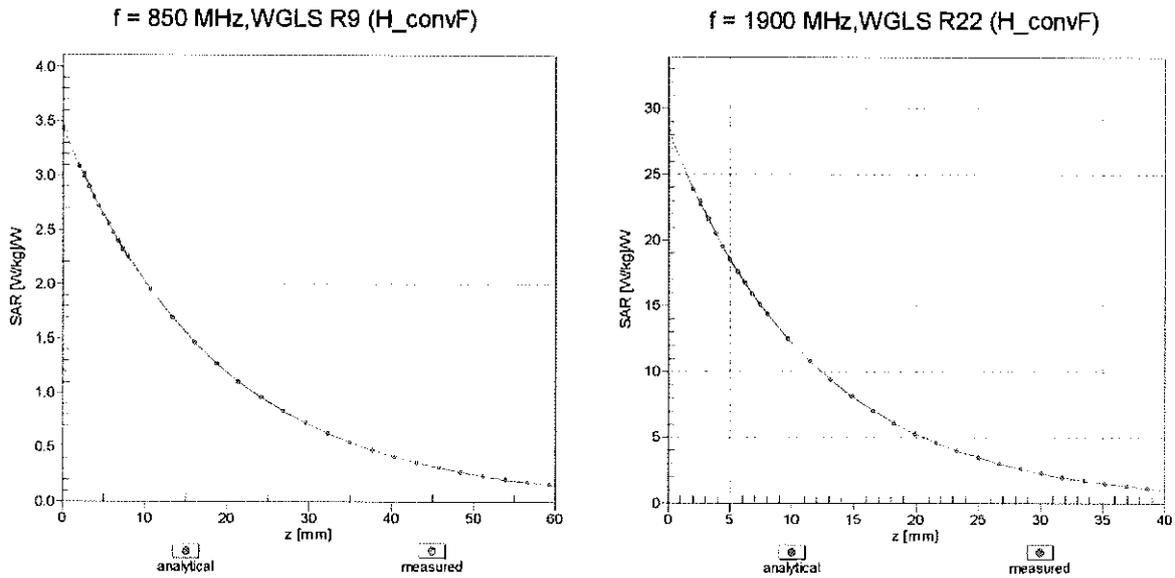
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell , $f = 900 \text{ MHz}$)

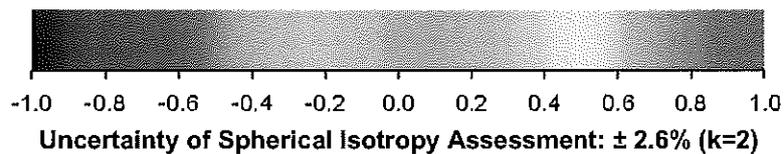
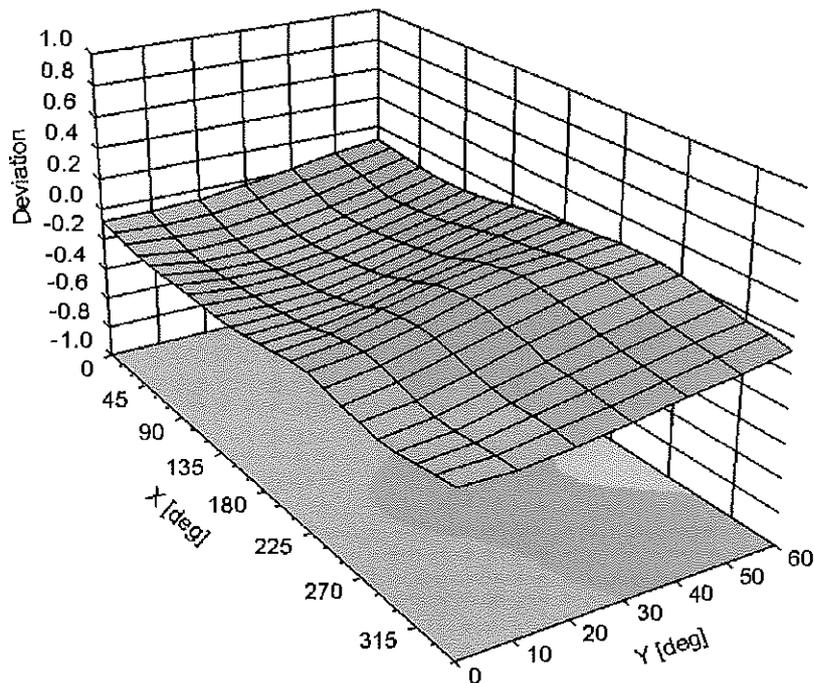


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



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



DASY/EASY - Parameters of Probe: ES3DV3 - SN:3319

Other Probe Parameters

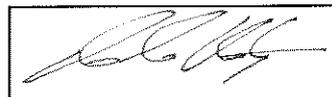
Sensor Arrangement	Triangular
Connector Angle (°)	-104.1
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration 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:	ES3DV3
Serial Number:	3319
Place of Assessment:	Zurich
Date of Assessment:	June 19, 2013
Probe Calibration Date:	April 29, 2013

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:3319Conversion 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.