



SAR EVALUATION REPORT

Applicant Name:

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

Date of Testing:

01/19/15 - 01/23/15

Test Site/Location:

PCTEST Lab, Columbia, MD, USA

Document Serial No.:

0Y1501140074.ZNF

FCC ID:

ZNFH631

APPLICANT:

LG ELECTRONICS MOBILECOMM U.S.A., INC.

DUT Type:

Portable Handset

Application Type:

Certification

FCC Rule Part(s):

CFR §2.1093

Model(s):

H631TN, LGH631TN, LG-H631TN, MS631, LGMS631, LG-MS631

Equipment Class	Band & Mode	Tx Frequency	SAR			
			1 gm Head (W/kg)	1 gm Body-Worn (W/kg)	1 gm Hotspot (W/kg)	10 gm Extremity (W/kg)
PCE	GSM/GPRS/EDGE 850	824.20 - 848.80 MHz	0.32	0.35	0.35	
PCE	UMTS 850	826.40 - 846.60 MHz	0.57	0.72	0.77	
PCE	UMTS 1750	1712.4 - 1752.5 MHz	0.64	0.79	0.79	
PCE	GSM/GPRS/EDGE 1900	1850.20 - 1909.80 MHz	0.35	0.61	0.61	
PCE	UMTS 1900	1852.4 - 1907.6 MHz	0.63	0.48	0.72	
PCE	LTE Band 12	699.7 - 715.3 MHz	0.24	0.44	0.56	
PCE	LTE Band 4 (AWS)	1710.7 - 1754.3 MHz	0.54	0.75	0.75	
PCE	LTE Band 2 (PCS)	1850.7 - 1909.3 MHz	0.71	0.64	0.69	
DTS	2.4 GHz WLAN	2412 - 2462 MHz	0.52	0.27	0.27	
NII	5.8 GHz WLAN	5745 - 5825 MHz	0.66	0.30	0.32	
NII	5.2 GHz WLAN	5180 - 5240 MHz	0.61	0.31		0.94
NII	5.3 GHz WLAN	5260 - 5320 MHz	0.69	0.37		0.96
NII	5.5 GHz WLAN	5500 - 5700 MHz	0.64	0.52		0.65
DSS/DTS	Bluetooth	2402 - 2480 MHz	N/A			
Simultaneous SAR per KDB 690783 D01v01r03:			1.40	1.31	1.10	0.96

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 12	Voice/Data	699.7 - 715.3 MHz
LTE Band 4 (AWS)	Voice/Data	1710.7 - 1754.3 MHz
LTE Band 2 (PCS)	Voice/Data	1850.7 - 1909.3 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	4 TX Slots
GSM/GPRS/EDGE 850	Maximum	32.7	32.7	29.7	27.7	26.7	26.7	26.7	24.7	23.7
	Nominal	32.2	32.2	29.2	27.2	26.2	26.2	26.2	24.2	23.2
GSM/GPRS/EDGE 1900	Maximum	30.7	30.7	27.7	26.7	24.7	25.7	25.7	24.7	23.7
	Nominal	30.2	30.2	27.2	26.2	24.2	25.2	25.2	24.2	23.2

Mode / Band		Modulated Average (dBm)
		3GPP UMTS
UMTS Band 5 (850 MHz)	Maximum	24.7
	Nominal	24.2
UMTS Band 4 (1750 MHz)	Maximum	24.7
	Nominal	24.2
UMTS Band 2 (1900 MHz)	Maximum	24.7
	Nominal	24.2

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Mode / Band		Modulated Average (dBm)
LTE Band 12	Maximum	24.7
	Nominal	24.2
LTE Band 4 (AWS)	Maximum	24.7
	Nominal	24.2
LTE Band 2 (PCS)	Maximum	24.7
	Nominal	24.2

Mode / Band		Modulated Average (dBm)
IEEE 802.11b (2.4 GHz)	Maximum	17.0
	Nominal	16.0
IEEE 802.11g (2.4 GHz)	Maximum	15.0
	Nominal	14.0
IEEE 802.11n (2.4 GHz)	Maximum	15.0
	Nominal	14.0
IEEE 802.11a (5 GHz)	Maximum	16.0
	Nominal	15.0
IEEE 802.11n (5 GHz)	Maximum	16.0
	Nominal	15.0
Bluetooth	Maximum	9.0
	Nominal	8.0
Bluetooth LE	Maximum	1.0
	Nominal	0.0

1.3 DUT Sides for SAR testing

A diagram showing the location of the device antennas can be found in Appendix F. Since the diagonal dimension of this device is > 160 mm and <200 mm, it is considered a "phablet."

Table 1-1
Sides for SAR Testing

Mode	Back	Front	Top	Bottom	Right	Left
GPRS 850	Yes	Yes	No	Yes	Yes	No
UMTS 850	Yes	Yes	No	Yes	Yes	No
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 12	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	Yes	No
5 GHz WLAN	Yes	Yes	Yes	No	Yes	No

Note: Particular DUT edges were not required to be evaluated for Wireless Router SAR or Extremity SAR if the edges were greater than 2.5 cm from the transmitting antenna according to FCC KDB Publication 941225 D06 guidance, page 2 and FCC KDB 648474 D04v01r01. The distances between the transmit antennas and the edges of the device are included in the filing.

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1.4 Near Field Communications (NFC) Antenna

This DUT has NFC operations. The NFC antenna is integrated into the battery cover. All SAR tests were performed with the specialized battery cover. A diagram showing the location of the NFC antenna can be found in Appendix F.

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 1-1 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 1-1
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 Transmit Configuration	Head	Body-Worn Accessory	Wireless Router	Extremity	Notes
1	GSM voice + 2.4 GHz Wi-Fi	Yes	Yes	N/A	Yes	
2	GSM voice + 5 GHz Wi-Fi	Yes	Yes	N/A	Yes	
3	GSM voice + 2.4 GHz Bluetooth	N/A	Yes	N/A	Yes	
4	UMTS + 2.4 GHz Wi-Fi	Yes	Yes	Yes	Yes	
5	UMTS + 5 GHz Wi-Fi	Yes	Yes	Yes	Yes	
6	UMTS + 2.4 GHz Bluetooth	N/A	Yes	N/A	Yes	
7	LTE + 2.4 GHz Wi-Fi	Yes	Yes	Yes	Yes	
8	LTE + 5 GHz Wi-Fi	Yes	Yes	Yes	Yes	
9	LTE + 2.4 GHz Bluetooth	N/A	Yes	N/A	Yes	
10	GPRS/EDGE + 2.4 GHz Wi-Fi	Yes*	Yes*	Yes	Yes	*-Pre-installed VOIP applications are considered.
11	GPRS/EDGE + 5 GHz Wi-Fi	Yes*	Yes*	Yes	Yes	*-Pre-installed VOIP applications are considered.
12	GPRS/EDGE + 2.4 GHz Bluetooth	N/A	Yes*	N/A	Yes	*-Pre-installed VOIP applications are considered.

- 2.4 GHz WLAN, 5 GHz WLAN, and 2.4 GHz Bluetooth share the same antenna path and cannot transmit simultaneously.
- All licensed modes share the same antenna path and cannot transmit simultaneously.
- 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.
- Per the manufacturer, WIFI Direct is expected to be used in conjunction with a held-to-ear or body-worn accessory voice call. Simultaneous transmission scenarios involving WIFI direct are specified in the above table.
- 5 GHz Wireless Router is only supported for the 5.8 GHz Band by S/W, therefore 5.2-5.7 GHz Bands were not evaluated for wireless router conditions.
- VoLTE is supported.

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1.6 SAR Test Exclusions Applied

(A) WIFI/BT

Since Wireless Router operations are not allowed by the chipset firmware using 5.2-5.7 GHz WIFI, only 2.4 GHz and 5.8 GHz WIFI Hotspot SAR tests and combinations are considered for SAR with respect to Wireless Router configurations according to FCC KDB 941225 D06.

Per FCC KDB 447498 D01v05, the 1g 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, body-worn Bluetooth SAR was not required; $[(8/10) * \sqrt{2.480}] = 1.3 < 3.0$. Per KDB Publication 447498 D01v05, the maximum power of the channel was rounded to the nearest mW before calculation.

Per FCC KDB 447498 D01v05, the 10g SAR exclusion threshold for distances <50mm is defined by the following equation:

$$\frac{\text{Max Power of Channel (mW)}}{\text{Test Separation Dist (mm)}} * \sqrt{\text{Frequency(GHz)}} \leq 7.5$$

Based on the maximum conducted power of Bluetooth (rounded to the nearest mW) and the antenna to user separation distance, extremity Bluetooth SAR was not required; $[(8/5) * \sqrt{2.480}] = 2.5 < 7.5$. 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.

Per FCC KDB Publication 648474 D04v01r01, this device is considered a "phablet" since the diagonal dimension is greater than 160mm and less than 200mm. Extremity SAR tests are required when wireless router mode does not apply or if wireless router 1g SAR > 1.2 W/kg. Because wireless router operations are not supported for 5.2 – 5.7 GHz WLAN, extremity SAR tests were performed. Extremity SAR was not evaluated for 2.4 GHz and 5.8 GHz WLAN operations since wireless router 1g SAR was < 1.2 W/kg.

(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.

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 D01.

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.

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Per FCC KDB Publication 648474 D04v01r01, this device is considered a "phablet" since the diagonal dimension is greater than 160mm and less than 200mm. Therefore, extremity SAR tests are required when wireless router mode does not apply or if wireless router 1g SAR > 1.2 W/kg. Extremity SAR was not evaluated for licensed technologies since wireless router 1g SAR was < 1.2 W/kg for these modes.

1.7 Power Reduction for SAR

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

1.8 Guidance Applied

- IEEE 1528-2003
- FCC KDB Publication 941225 D01, D05, D06 (2G/3G/4G and Hotspot)
- FCC KDB Publication 248227 D01v01r02 (SAR Considerations for 802.11 Devices)
- FCC KDB Publication 447498 D01v05r02 (General SAR Guidance)
- FCC KDB Publication 865664 D01v01r03, D02v01r01 (SAR Measurements up to 6 GHz)
- FCC KDB Publication 648474 D03-D04 (Phablet Procedures)
- October 2013 TCB Workshop Notes (GPRS Testing Considerations)

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	Extremity Serial Number
GSM/GPRS/EDGE 850	1401-12	1401-12	1401-12	-
UMTS 850	1401-12	1401-12	1401-12	-
UMTS 1750	1401-12	1401-12	1401-12	-
GSM/GPRS/EDGE 1900	1401-12	1401-12	1401-12	-
UMTS 1900	1401-12	1401-12	1401-12	-
LTE Band 12	1401-7	1401-7	1401-7	-
LTE Band 4 (AWS)	1401-7	1401-7	1401-7	-
LTE Band 2 (PCS)	1401-7	1401-7	1401-7	-
2.4 GHz WLAN	1401-8	1401-8	1401-8	-
5 GHz WLAN	1401-8	1401-8	1401-8	1401-8

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LTE INFORMATION

LTE Information			
FCC ID	ZNFH631		
Form Factor	Portable Handset		
Frequency Range of each LTE transmission band	LTE Band 12 (699.7 - 715.3 MHz)		
	LTE Band 4 (AWS) (1710.7 - 1754.3 MHz)		
	LTE Band 2 (PCS) (1850.7 - 1909.3 MHz)		
Channel Bandwidths	LTE Band 12: 1.4 MHz, 3 MHz, 5 MHz, 10 MHz		
	LTE Band 4 (AWS): 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz		
	LTE Band 2 (PCS): 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz		
Channel Numbers and Frequencies (MHz)	Low	Mid	High
LTE Band 12: 1.4 MHz	699.7 (23017)	707.5 (23095)	715.3 (23173)
LTE Band 12: 3 MHz	700.5 (23025)	707.5 (23095)	714.5 (23165)
LTE Band 12: 5 MHz	701.5 (23035)	707.5 (23095)	713.5 (23155)
LTE Band 12: 10 MHz	704 (23060)	707.5 (23095)	711 (23130)
LTE Band 4 (AWS): 1.4 MHz	1710.7 (19957)	1732.5 (20175)	1754.3 (20393)
LTE Band 4 (AWS): 3 MHz	1711.5 (19965)	1732.5 (20175)	1753.5 (20385)
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): 1.4 MHz	1850.7 (18607)	1880 (18900)	1909.3 (19193)
LTE Band 2 (PCS): 3 MHz	1851.5 (18615)	1880 (18900)	1908.5 (19185)
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)
LTE Band 2 (PCS): 15 MHz	1857.5 (18675)	1880 (18900)	1902.5 (19125)
LTE Band 2 (PCS): 20 MHz	1860 (18700)	1880 (18900)	1900 (19100)
UE Category	4		
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 [22]. 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 compliant to FCC KDB Publication 865664 D01v01 and IEEE 1528-2013:

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) and IEEE 1528-2013.
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) and IEEE 1528-2013. On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the DASY manual online for more details):
 - a. SAR values at the inner surface of the phantom are extrapolated from the measured values along the line away from the surface with spacing no greater than that in Table 4-1. 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.

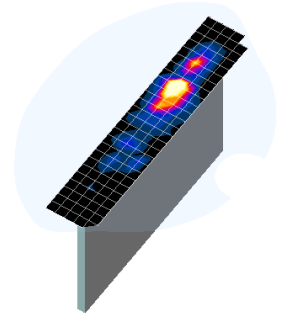


Figure 4-1
Sample SAR Area
Scan

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		
				$\Delta z_{zoom}(n)$	$\Delta z_{zoom}(1)^*$	
≤ 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

*Also compliant to IEEE 1528-2013 Table 6

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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), also called the Reference Pivoting Line, is not perpendicular to the reference plane (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].

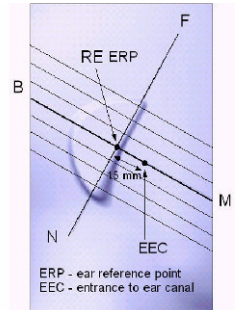


Figure 5-1
Close-Up Side view
of ERP

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 acoustic output located along the “vertical centerline” on the front of the device aligned to the “ear reference point” (See Figure 5-3). The acoustic output 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.

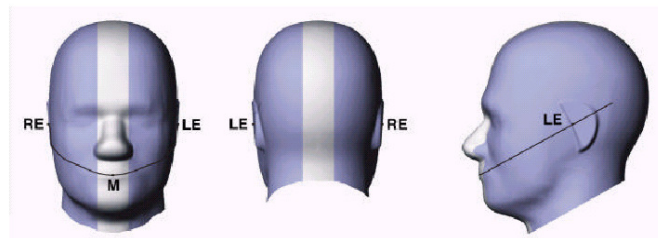


Figure 5-2
Front, back and side view of SAM Twin Phantom

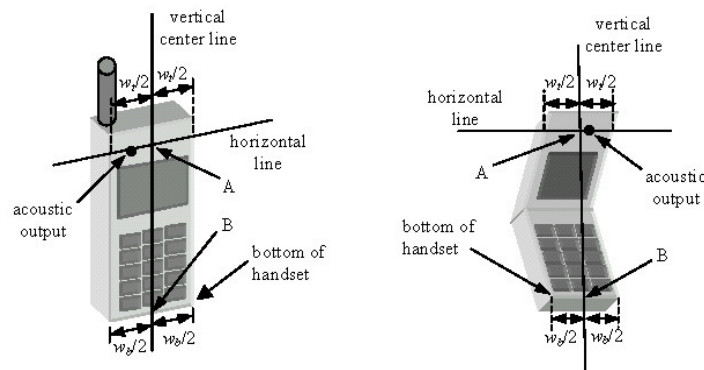


Figure 5-3
Handset Vertical Center & Horizontal Line Reference Points

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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.

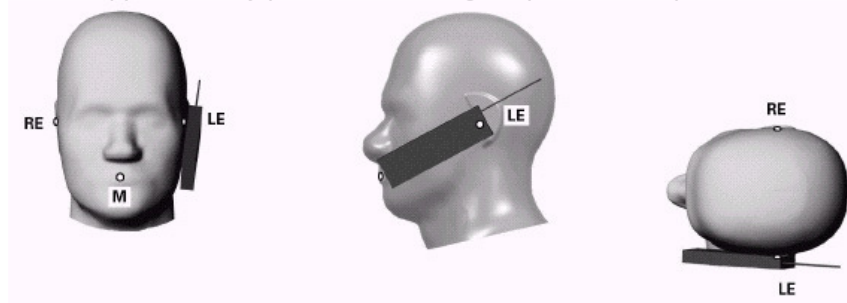


Figure 6-1 Front, Side and Top View of Cheek Position

2. The handset was translated towards the phantom along the line passing through RE & LE until the handset touches the pinna.
3. While maintaining the handset in this plane, the handset was rotated around the LE-RE line until the vertical centerline was in the 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. In this situation, 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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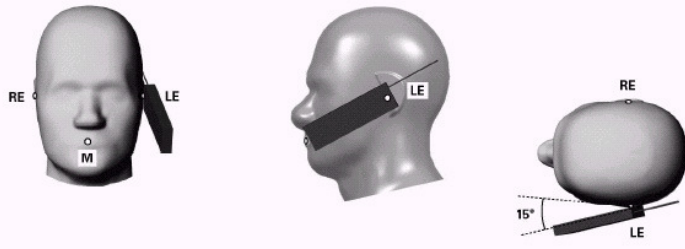


Figure 6-2 Front, Side and Top View of Ear/15° Tilt Position

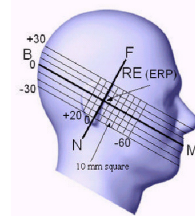


Figure 6-3 Side view w/ relevant markings

6.4 SAR Evaluations near the Mouth/Jaw Regions of the SAM Phantom

Antennas located near the bottom of a phone may require SAR measurements around the mouth and jaw regions of the SAM head phantom. This typically applies to clam-shell style phones that are generally longer in the unfolded normal use positions or to certain older style long rectangular phones. Per IEEE 1528-2013, a rotated SAM phantom is necessary to allow probe access to such regions. Both SAM heads of the TwinSAM-Chin20 are rotated 20 degrees around the NF line. Each head can be removed from the table for emptying and cleaning.

Under these circumstances, the following procedures apply, adopted from the FCC guidance on SAR handsets document FCC KDB Publication 648474 D04_v01. The SAR required in these regions of SAM should be measured using a flat phantom. The phone should be positioned with a separation distance of 4 mm between the ear reference point (ERP) and the outer surface of the flat phantom shell. While maintaining this distance at the ERP location, the low (bottom) edge of the phone should be lowered from the phantom to establish the same separation distance between the peak SAR location identified by the truncated partial SAR distribution measured with the SAM phantom. The distance from the peak SAR location to the phone is determined by the straight line passing perpendicularly through the phantom surface. When it is not feasible to maintain 4 mm separation at the ERP while also establishing the required separation at the peak SAR location, the top edge of the phone will be allowed to touch the phantom with a separation < 4 mm at the ERP. The phone should not be tilted to the left or right while placed in this inclined position to the flat phantom.

6.5 Body-Worn Accessory Configurations

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration (see Figure 6-4). Per FCC KDB Publication 648474 D04v01, Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in FCC KDB Publication 447498 D01v05 should be used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode, when applicable. When the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

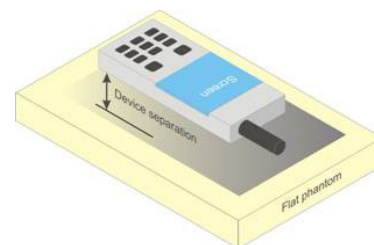


Figure 6-4 Sample Body-Worn Diagram

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

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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.

6.6 Extremity Exposure Configurations

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

For smart phones with a display diagonal dimension > 15.0 cm or an overall diagonal dimension > 16.0 cm that provide similar mobile web access and multimedia support found in mini-tablets or UMPC minitables that support voice calls next to the ear, the phablets procedures outlined in KDB Publication 648474 D04 v01r01DR04 should be applied to evaluate SAR compliance. A device marketed as phablets, regardless of form factors and operating characteristics must be tested as a phablet to determine SAR compliance. In addition to the normally required head and body-worn accessory SAR test procedures required for handsets, the UMPC mini-tablet procedures must also be applied to test the SAR of all surfaces and edges with an antenna ≤ 25 mm from that surface or edge, in direct contact with the phantom, for 10-g SAR. The UMPC mini-tablet 1-g SAR at 5 mm is not required. When hotspot mode applies, 10-g SAR is required only for the surfaces and edges with hotspot mode 1-g SAR > 1.2 W/kg.

6.7 Wireless Router Configurations

Some battery-operated handsets have the capability to transmit and receive user data through simultaneous transmission of WIFI simultaneously with a separate licensed transmitter. The FCC has provided guidance in FCC KDB Publication 941225 D06 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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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

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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.

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

Note 2: For the HS-DPCCH power mask requirement test in clause 5.2C, 5.7A, and the Error Vector Magnitude (EVM) with HS-DPCCH test in clause 5.13.1A, and HSDPA EVM with phase discontinuity in clause 5.13.1AA, 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”

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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.

Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	$\beta_{15}^{(1)}$	β_{ec}	β_{ed}	β_{ed} (SF)	β_{ed} (codes)	CM ⁽²⁾ (dB)	MPR (dB)	AG ⁽⁴⁾ Index	E-TFCI
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	$\beta_{ed1}: 47/15$ $\beta_{ed2}: 47/15$	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: $\Delta_{ACK} \Delta_{NACK}$ and $\Delta_{CQI} = 8 \Rightarrow A_{15} = \beta_{15}/\beta_c = 30/15 \Rightarrow \beta_{15} = 30/15 * \beta_c$.

Note 2: CM = 1 for $\beta_c/\beta_d = 12/15$, $\beta_{15}/\beta_c = 24/15$. 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: β_{ed} can not be set directly; it is set by Absolute Grant Value.

8.3.6 SAR Measurement Conditions 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 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. SAR tests were performed with the same number of RB and RB offsets transmitting on all TTI frames (maximum TTI).

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.

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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:

- 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 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 $\frac{1}{2}$ 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 [24]

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.

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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 higher than 0.25 dB or more 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	32.49	32.50	29.22	27.35	26.32	26.22	26.21	24.23	23.31
	190	32.66	32.69	29.44	27.62	26.51	26.34	26.38	24.39	23.42
	251	32.69	32.70	29.65	27.69	26.68	26.35	26.31	24.40	23.35
GSM 1900	512	30.25	30.22	27.21	26.25	24.29	25.56	25.49	24.24	23.45
	661	30.20	30.20	27.29	26.44	24.40	25.58	25.26	24.26	23.39
	810	30.31	30.26	27.20	26.22	24.38	25.51	25.31	24.21	23.36

		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	23.46	23.47	23.20	23.09	23.31	17.19	20.19	19.97	20.30
	190	23.63	23.66	23.42	23.36	23.50	17.31	20.36	20.13	20.41
	251	23.66	23.67	23.63	23.43	23.67	17.32	20.29	20.14	20.34
GSM 1900	512	21.22	21.19	21.19	21.99	21.28	16.53	19.47	19.98	20.44
	661	21.17	21.17	21.27	22.18	21.39	16.55	19.24	20.00	20.38
	810	21.28	21.23	21.18	21.96	21.37	16.48	19.29	19.95	20.35

GSM 850	Frame Avg.Targets:	23.17	23.17	23.18	22.94	23.19	17.17	20.18	19.94	20.19
GSM 1900		21.17	21.17	21.18	21.94	21.19	16.17	19.18	19.94	20.19

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

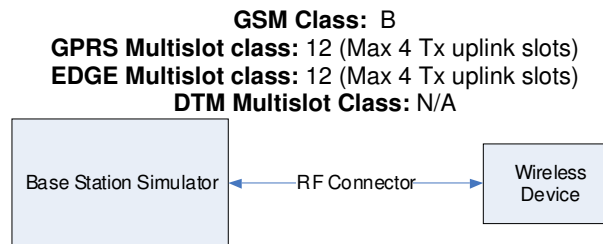


Figure 9-1
Power Measurement Setup

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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	24.52	24.46	24.50	24.42	24.44	24.51	24.31	24.56	24.47	-
99		12.2 kbps AMR	24.49	24.48	24.46	24.39	24.34	24.46	24.33	24.58	24.46	-
6	HSDPA	Subtest 1	24.40	24.39	24.38	24.37	24.34	24.39	24.16	24.40	24.48	0
6		Subtest 2	24.45	24.37	24.39	24.52	24.35	24.42	24.30	24.31	24.47	0
6		Subtest 3	24.02	23.96	23.86	24.02	23.89	23.91	23.76	23.93	23.97	0.5
6		Subtest 4	23.92	23.95	23.98	24.03	23.87	23.99	23.80	23.94	24.03	0.5
6	HSUPA	Subtest 1	23.96	23.94	24.01	23.69	23.70	23.69	23.90	23.63	23.45	0
6		Subtest 2	22.30	22.24	22.53	22.85	22.23	22.84	22.55	22.74	22.54	2
6		Subtest 3	23.02	22.88	23.14	23.23	22.95	22.80	22.80	22.70	22.81	1
6		Subtest 4	22.88	23.08	22.69	22.74	22.80	23.14	22.62	22.92	22.70	2
6		Subtest 5	24.06	23.80	24.16	23.56	24.02	23.82	24.02	23.70	24.12	0
8	DC-HSDPA	Subtest 1	24.40	24.35	24.44	24.53	24.58	24.59	24.41	24.54	24.58	0
8		Subtest 2	24.46	24.38	24.41	24.55	24.59	24.50	24.48	24.55	24.60	0
8		Subtest 3	24.08	23.97	23.92	24.11	24.03	24.02	24.06	24.14	24.16	0.5
8		Subtest 4	24.02	23.98	23.91	24.13	24.04	24.01	24.05	24.14	24.15	0.5

UMTS SAR was tested under RMC 12.2 kbps with HSPA Inactive per KDB Publication 941225 D01. 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.

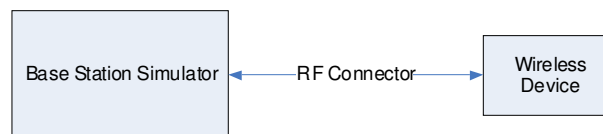


Figure 9-2
Power Measurement Setup

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9.3 LTE Conducted Powers

9.3.1 LTE Band 12

Table 9-1
LTE Band 12 Conducted Powers - 10 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Mid	707.5	23095	10	QPSK	1	0	24.35	0	0
	707.5	23095	10	QPSK	1	25	24.38	0	0
	707.5	23095	10	QPSK	1	49	24.59	0	0
	707.5	23095	10	QPSK	25	0	23.39	0-1	1
	707.5	23095	10	QPSK	25	12	23.44	0-1	1
	707.5	23095	10	QPSK	25	25	23.47	0-1	1
	707.5	23095	10	QPSK	50	0	23.34	0-1	1
	707.5	23095	10	16QAM	1	0	23.21	0-1	1
	707.5	23095	10	16QAM	1	25	23.40	0-1	1
	707.5	23095	10	16QAM	1	49	23.40	0-1	1
	707.5	23095	10	16QAM	25	0	22.35	0-2	2
	707.5	23095	10	16QAM	25	12	22.32	0-2	2
	707.5	23095	10	16QAM	25	25	22.20	0-2	2
	707.5	23095	10	16QAM	50	0	22.20	0-2	2

Note: LTE Band 12 at 10 MHz bandwidth does not support three non-overlapping channels. Per KDB Publication 941225, 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 12 Conducted Powers - 5 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	701.5	23035	5	QPSK	1	0	24.47	0	0
	701.5	23035	5	QPSK	1	12	24.46	0	0
	701.5	23035	5	QPSK	1	24	24.20	0	0
	701.5	23035	5	QPSK	12	0	23.44	0-1	1
	701.5	23035	5	QPSK	12	6	23.50	0-1	1
	701.5	23035	5	QPSK	12	13	23.38	0-1	1
	701.5	23035	5	QPSK	25	0	23.25	0-1	1
	701.5	23035	5	16-QAM	1	0	23.28	0-1	1
	701.5	23035	5	16-QAM	1	12	23.41	0-1	1
	701.5	23035	5	16-QAM	1	24	23.21	0-1	1
	701.5	23035	5	16-QAM	12	0	22.42	0-2	2
	701.5	23035	5	16-QAM	12	6	22.22	0-2	2
	701.5	23035	5	16-QAM	12	13	22.49	0-2	2
	701.5	23035	5	16-QAM	25	0	22.30	0-2	2
Mid	707.5	23095	5	QPSK	1	0	24.22	0	0
	707.5	23095	5	QPSK	1	12	24.23	0	0
	707.5	23095	5	QPSK	1	24	24.29	0	0
	707.5	23095	5	QPSK	12	0	23.45	0-1	1
	707.5	23095	5	QPSK	12	6	23.32	0-1	1
	707.5	23095	5	QPSK	12	13	23.32	0-1	1
	707.5	23095	5	QPSK	25	0	23.29	0-1	1
	707.5	23095	5	16-QAM	1	0	23.41	0-1	1
	707.5	23095	5	16-QAM	1	12	23.20	0-1	1
	707.5	23095	5	16-QAM	1	24	23.25	0-1	1
	707.5	23095	5	16-QAM	12	0	22.38	0-2	2
	707.5	23095	5	16-QAM	12	6	22.45	0-2	2
	707.5	23095	5	16-QAM	12	13	22.45	0-2	2
	707.5	23095	5	16-QAM	25	0	22.40	0-2	2
High	713.5	23155	5	QPSK	1	0	24.29	0	0
	713.5	23155	5	QPSK	1	12	24.33	0	0
	713.5	23155	5	QPSK	1	24	24.24	0	0
	713.5	23155	5	QPSK	12	0	23.32	0-1	1
	713.5	23155	5	QPSK	12	6	23.26	0-1	1
	713.5	23155	5	QPSK	12	13	23.46	0-1	1
	713.5	23155	5	QPSK	25	0	23.45	0-1	1
	713.5	23155	5	16-QAM	1	0	23.37	0-1	1
	713.5	23155	5	16-QAM	1	12	23.20	0-1	1
	713.5	23155	5	16-QAM	1	24	23.38	0-1	1
	713.5	23155	5	16-QAM	12	0	22.25	0-2	2
	713.5	23155	5	16-QAM	12	6	22.37	0-2	2
	713.5	23155	5	16-QAM	12	13	22.20	0-2	2
	713.5	23155	5	16-QAM	25	0	22.24	0-2	2

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Table 9-3
LTE Band 12 Conducted Powers - 3 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	700.5	23025	3	QPSK	1	0	24.25	0	0
	700.5	23025	3	QPSK	1	7	24.36	0	0
	700.5	23025	3	QPSK	1	14	24.31	0	0
	700.5	23025	3	QPSK	8	0	23.31	0-1	1
	700.5	23025	3	QPSK	8	4	23.35	0-1	1
	700.5	23025	3	QPSK	8	7	23.21	0-1	1
	700.5	23025	3	QPSK	15	0	23.25	0-1	1
	700.5	23025	3	16-QAM	1	0	23.26	0-1	1
	700.5	23025	3	16-QAM	1	7	23.24	0-1	1
	700.5	23025	3	16-QAM	1	14	23.22	0-1	1
	700.5	23025	3	16-QAM	8	0	22.25	0-2	2
	700.5	23025	3	16-QAM	8	4	22.21	0-2	2
	700.5	23025	3	16-QAM	8	7	22.20	0-2	2
	700.5	23025	3	16-QAM	15	0	22.26	0-2	2
	700.5	23025	3	16-QAM	15	0	22.26	0-2	2
Mid	707.5	23095	3	QPSK	1	0	24.25	0	0
	707.5	23095	3	QPSK	1	7	24.29	0	0
	707.5	23095	3	QPSK	1	14	24.22	0	0
	707.5	23095	3	QPSK	8	0	23.29	0-1	1
	707.5	23095	3	QPSK	8	4	23.33	0-1	1
	707.5	23095	3	QPSK	8	7	23.38	0-1	1
	707.5	23095	3	QPSK	15	0	23.35	0-1	1
	707.5	23095	3	16-QAM	1	0	23.31	0-1	1
	707.5	23095	3	16-QAM	1	7	23.28	0-1	1
	707.5	23095	3	16-QAM	1	14	23.30	0-1	1
	707.5	23095	3	16-QAM	8	0	22.26	0-2	2
	707.5	23095	3	16-QAM	8	4	22.25	0-2	2
	707.5	23095	3	16-QAM	8	7	22.29	0-2	2
	707.5	23095	3	16-QAM	15	0	22.31	0-2	2
	707.5	23095	3	16-QAM	15	0	22.31	0-2	2
High	714.5	23165	3	QPSK	1	0	24.29	0	0
	714.5	23165	3	QPSK	1	7	24.28	0	0
	714.5	23165	3	QPSK	1	14	24.26	0	0
	714.5	23165	3	QPSK	8	0	23.35	0-1	1
	714.5	23165	3	QPSK	8	4	23.36	0-1	1
	714.5	23165	3	QPSK	8	7	23.31	0-1	1
	714.5	23165	3	QPSK	15	0	23.29	0-1	1
	714.5	23165	3	16-QAM	1	0	23.20	0-1	1
	714.5	23165	3	16-QAM	1	7	23.22	0-1	1
	714.5	23165	3	16-QAM	1	14	23.36	0-1	1
	714.5	23165	3	16-QAM	8	0	22.29	0-2	2
	714.5	23165	3	16-QAM	8	4	22.25	0-2	2
	714.5	23165	3	16-QAM	8	7	22.26	0-2	2
	714.5	23165	3	16-QAM	15	0	22.22	0-2	2
	714.5	23165	3	16-QAM	15	0	22.22	0-2	2

Table 9-4
LTE Band 12 Conducted Powers -1.4 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	699.7	23017	1.4	QPSK	1	0	24.23	0	0
	699.7	23017	1.4	QPSK	1	2	24.23	0	0
	699.7	23017	1.4	QPSK	1	5	24.35	0	0
	699.7	23017	1.4	QPSK	3	0	24.26	0	0
	699.7	23017	1.4	QPSK	3	2	24.25	0	0
	699.7	23017	1.4	QPSK	3	3	24.29	0	0
	699.7	23017	1.4	QPSK	6	0	23.31	0-1	1
	699.7	23017	1.4	16-QAM	1	0	23.38	0-1	1
	699.7	23017	1.4	16-QAM	1	2	23.34	0-1	1
	699.7	23017	1.4	16-QAM	1	5	23.21	0-1	1
	699.7	23017	1.4	16-QAM	3	0	23.29	0-1	1
	699.7	23017	1.4	16-QAM	3	2	23.24	0-1	1
	699.7	23017	1.4	16-QAM	3	3	23.34	0-1	1
	699.7	23017	1.4	16-QAM	6	0	22.26	0-2	2
	699.7	23017	1.4	16-QAM	6	0	22.26	0-2	2
Mid	707.5	23095	1.4	QPSK	1	0	24.29	0	0
	707.5	23095	1.4	QPSK	1	2	24.33	0	0
	707.5	23095	1.4	QPSK	1	5	24.31	0	0
	707.5	23095	1.4	QPSK	3	0	24.30	0	0
	707.5	23095	1.4	QPSK	3	2	24.28	0	0
	707.5	23095	1.4	QPSK	3	3	24.29	0	0
	707.5	23095	1.4	QPSK	6	0	23.29	0-1	1
	707.5	23095	1.4	16-QAM	1	0	23.35	0-1	1
	707.5	23095	1.4	16-QAM	1	2	23.35	0-1	1
	707.5	23095	1.4	16-QAM	1	5	23.31	0-1	1
	707.5	23095	1.4	16-QAM	3	0	23.20	0-1	1
	707.5	23095	1.4	16-QAM	3	2	23.22	0-1	1
	707.5	23095	1.4	16-QAM	3	3	23.26	0-1	1
	707.5	23095	1.4	16-QAM	6	0	22.31	0-2	2
	707.5	23095	1.4	16-QAM	6	0	22.31	0-2	2
High	715.3	23173	1.4	QPSK	1	0	24.29	0	0
	715.3	23173	1.4	QPSK	1	2	24.35	0	0
	715.3	23173	1.4	QPSK	1	5	24.33	0	0
	715.3	23173	1.4	QPSK	3	0	24.20	0	0
	715.3	23173	1.4	QPSK	3	2	24.29	0	0
	715.3	23173	1.4	QPSK	3	3	24.38	0	0
	715.3	23173	1.4	QPSK	6	0	23.35	0-1	1
	715.3	23173	1.4	16-QAM	1	0	23.36	0-1	1
	715.3	23173	1.4	16-QAM	1	2	23.24	0-1	1
	715.3	23173	1.4	16-QAM	1	5	23.33	0-1	1
	715.3	23173	1.4	16-QAM	3	0	23.35	0-1	1
	715.3	23173	1.4	16-QAM	3	2	23.21	0-1	1
	715.3	23173	1.4	16-QAM	3	3	23.22	0-1	1
	715.3	23173	1.4	16-QAM	6	0	22.26	0-2	2
	715.3	23173	1.4	16-QAM	6	0	22.26	0-2	2

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9.3.2

LTE Band 4 (AWS)

Table 9-5

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

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Mid	1732.5	20175	20	QPSK	1	0	24.70	0	0
	1732.5	20175	20	QPSK	1	50	24.54	0	0
	1732.5	20175	20	QPSK	1	99	24.43	0	0
	1732.5	20175	20	QPSK	50	0	23.68	0-1	1
	1732.5	20175	20	QPSK	50	25	23.45	0-1	1
	1732.5	20175	20	QPSK	50	50	23.51	0-1	1
	1732.5	20175	20	QPSK	100	0	23.38	0-1	1
	1732.5	20175	20	16QAM	1	0	23.44	0-1	1
	1732.5	20175	20	16QAM	1	50	23.52	0-1	1
	1732.5	20175	20	16QAM	1	99	23.53	0-1	1
	1732.5	20175	20	16QAM	50	0	22.55	0-2	2
	1732.5	20175	20	16QAM	50	25	22.67	0-2	2
	1732.5	20175	20	16QAM	50	50	22.59	0-2	2
	1732.5	20175	20	16QAM	100	0	22.55	0-2	2

Note: LTE Band 4 (AWS) at 20 MHz bandwidth does not support three non-overlapping channels. Per KDB Publication 941225, 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 9-6

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

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1717.5	20025	15	QPSK	1	0	24.54	0	0
	1717.5	20025	15	QPSK	1	36	24.54	0	0
	1717.5	20025	15	QPSK	1	74	24.40	0	0
	1717.5	20025	15	QPSK	36	0	23.28	0-1	1
	1717.5	20025	15	QPSK	36	18	23.22	0-1	1
	1717.5	20025	15	QPSK	36	37	23.49	0-1	1
	1717.5	20025	15	QPSK	75	0	23.25	0-1	1
	1717.5	20025	15	16QAM	1	0	23.38	0-1	1
	1717.5	20025	15	16QAM	1	36	23.39	0-1	1
	1717.5	20025	15	16QAM	1	74	23.56	0-1	1
	1717.5	20025	15	16QAM	36	0	22.59	0-2	2
	1717.5	20025	15	16QAM	36	18	22.46	0-2	2
	1717.5	20025	15	16QAM	36	37	22.41	0-2	2
	1717.5	20025	15	16QAM	75	0	22.63	0-2	2
Mid	1732.5	20175	15	QPSK	1	0	24.32	0	0
	1732.5	20175	15	QPSK	1	36	24.26	0	0
	1732.5	20175	15	QPSK	1	74	24.39	0	0
	1732.5	20175	15	QPSK	36	0	23.44	0-1	1
	1732.5	20175	15	QPSK	36	18	23.27	0-1	1
	1732.5	20175	15	QPSK	36	37	23.42	0-1	1
	1732.5	20175	15	QPSK	75	0	23.47	0-1	1
	1732.5	20175	15	16QAM	1	0	23.28	0-1	1
	1732.5	20175	15	16QAM	1	36	23.40	0-1	1
	1732.5	20175	15	16QAM	1	74	23.27	0-1	1
	1732.5	20175	15	16QAM	36	0	22.32	0-2	2
	1732.5	20175	15	16QAM	36	18	22.37	0-2	2
	1732.5	20175	15	16QAM	36	37	22.56	0-2	2
	1732.5	20175	15	16QAM	75	0	22.46	0-2	2
High	1747.5	20325	15	QPSK	1	0	24.46	0	0
	1747.5	20325	15	QPSK	1	36	24.53	0	0
	1747.5	20325	15	QPSK	1	74	24.35	0	0
	1747.5	20325	15	QPSK	36	0	23.27	0-1	1
	1747.5	20325	15	QPSK	36	18	23.44	0-1	1
	1747.5	20325	15	QPSK	36	37	23.36	0-1	1
	1747.5	20325	15	QPSK	75	0	23.40	0-1	1
	1747.5	20325	15	16QAM	1	0	23.52	0-1	1
	1747.5	20325	15	16QAM	1	36	23.47	0-1	1
	1747.5	20325	15	16QAM	1	74	23.42	0-1	1
	1747.5	20325	15	16QAM	36	0	22.37	0-2	2
	1747.5	20325	15	16QAM	36	18	22.33	0-2	2
	1747.5	20325	15	16QAM	36	37	22.41	0-2	2
	1747.5	20325	15	16QAM	75	0	22.37	0-2	2

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Table 9-7
LTE Band 4 (AWS) Conducted Powers - 10 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1715	20000	10	QPSK	1	0	24.58	0	0
	1715	20000	10	QPSK	1	25	24.37	0	0
	1715	20000	10	QPSK	1	49	24.30	0	0
	1715	20000	10	QPSK	25	0	23.44	0-1	1
	1715	20000	10	QPSK	25	12	23.27	0-1	1
	1715	20000	10	QPSK	25	25	23.48	0-1	1
	1715	20000	10	QPSK	50	0	23.34	0-1	1
	1715	20000	10	16QAM	1	0	23.28	0-1	1
	1715	20000	10	16QAM	1	25	23.36	0-1	1
	1715	20000	10	16QAM	1	49	23.31	0-1	1
	1715	20000	10	16QAM	25	0	22.26	0-2	2
	1715	20000	10	16QAM	25	12	22.46	0-2	2
	1715	20000	10	16QAM	25	25	22.53	0-2	2
	1715	20000	10	16QAM	50	0	22.50	0-2	2
	1732.5	20175	10	QPSK	1	0	24.42	0	0
Mid	1732.5	20175	10	QPSK	1	25	24.40	0	0
	1732.5	20175	10	QPSK	1	49	24.48	0	0
	1732.5	20175	10	QPSK	25	0	23.46	0-1	1
	1732.5	20175	10	QPSK	25	12	23.30	0-1	1
	1732.5	20175	10	QPSK	25	25	23.40	0-1	1
	1732.5	20175	10	QPSK	50	0	23.24	0-1	1
	1732.5	20175	10	16QAM	1	0	23.27	0-1	1
	1732.5	20175	10	16QAM	1	25	23.40	0-1	1
	1732.5	20175	10	16QAM	1	49	23.55	0-1	1
	1732.5	20175	10	16QAM	25	0	22.29	0-2	2
	1732.5	20175	10	16QAM	25	12	22.41	0-2	2
	1732.5	20175	10	16QAM	25	25	22.48	0-2	2
	1732.5	20175	10	16QAM	50	0	22.36	0-2	2
	1750	20350	10	QPSK	1	0	24.40	0	0
	1750	20350	10	QPSK	1	25	24.47	0	0
High	1750	20350	10	QPSK	1	49	24.24	0	0
	1750	20350	10	QPSK	25	0	23.42	0-1	1
	1750	20350	10	QPSK	25	12	23.28	0-1	1
	1750	20350	10	QPSK	25	25	23.32	0-1	1
	1750	20350	10	QPSK	50	0	23.52	0-1	1
	1750	20350	10	16QAM	1	0	23.52	0-1	1
	1750	20350	10	16QAM	1	25	23.52	0-1	1
	1750	20350	10	16QAM	1	49	23.52	0-1	1
	1750	20350	10	16QAM	25	0	22.37	0-2	2
	1750	20350	10	16QAM	25	12	22.51	0-2	2
	1750	20350	10	16QAM	25	25	22.45	0-2	2
	1750	20350	10	16QAM	50	0	22.22	0-2	2

Table 9-8
LTE Band 4 (AWS) Conducted Powers - 5 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1712.5	19975	5	QPSK	1	0	24.50	0	0
	1712.5	19975	5	QPSK	1	12	24.43	0	0
	1712.5	19975	5	QPSK	1	24	24.34	0	0
	1712.5	19975	5	QPSK	12	0	23.34	0-1	1
	1712.5	19975	5	QPSK	12	6	23.51	0-1	1
	1712.5	19975	5	QPSK	12	13	23.37	0-1	1
	1712.5	19975	5	QPSK	25	0	23.54	0-1	1
	1712.5	19975	5	16-QAM	1	0	23.50	0-1	1
	1712.5	19975	5	16-QAM	1	12	23.33	0-1	1
	1712.5	19975	5	16-QAM	1	24	23.36	0-1	1
	1712.5	19975	5	16-QAM	12	0	22.20	0-2	2
	1712.5	19975	5	16-QAM	12	6	22.43	0-2	2
	1712.5	19975	5	16-QAM	12	13	22.47	0-2	2
	1712.5	19975	5	16-QAM	25	0	22.44	0-2	2
Mid	1732.5	20175	5	QPSK	1	0	24.32	0	0
	1732.5	20175	5	QPSK	1	12	24.59	0	0
	1732.5	20175	5	QPSK	1	24	24.48	0	0
	1732.5	20175	5	QPSK	12	0	23.32	0-1	1
	1732.5	20175	5	QPSK	12	6	23.31	0-1	1
	1732.5	20175	5	QPSK	12	13	23.39	0-1	1
	1732.5	20175	5	QPSK	25	0	23.30	0-1	1
	1732.5	20175	5	16-QAM	1	0	23.43	0-1	1
	1732.5	20175	5	16-QAM	1	12	23.46	0-1	1
	1732.5	20175	5	16-QAM	1	24	23.36	0-1	1
	1732.5	20175	5	16-QAM	12	0	22.24	0-2	2
	1732.5	20175	5	16-QAM	12	6	22.51	0-2	2
	1732.5	20175	5	16-QAM	12	13	22.50	0-2	2
	1732.5	20175	5	16-QAM	25	0	22.40	0-2	2
High	1752.5	20375	5	QPSK	1	0	24.56	0	0
	1752.5	20375	5	QPSK	1	12	24.52	0	0
	1752.5	20375	5	QPSK	1	24	24.51	0	0
	1752.5	20375	5	QPSK	12	0	23.39	0-1	1
	1752.5	20375	5	QPSK	12	6	23.37	0-1	1
	1752.5	20375	5	QPSK	12	13	23.35	0-1	1
	1752.5	20375	5	QPSK	25	0	23.20	0-1	1
	1752.5	20375	5	16-QAM	1	0	23.31	0-1	1
	1752.5	20375	5	16-QAM	1	12	23.54	0-1	1
	1752.5	20375	5	16-QAM	1	24	23.50	0-1	1
	1752.5	20375	5	16-QAM	12	0	22.52	0-2	2
	1752.5	20375	5	16-QAM	12	6	22.30	0-2	2
	1752.5	20375	5	16-QAM	12	13	22.45	0-2	2
	1752.5	20375	5	16-QAM	25	0	22.55	0-2	2

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Table 9-9
LTE Band 4 (AWS) Conducted Powers - 3 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1711.5	19965	3	QPSK	1	0	24.25	0	0
	1711.5	19965	3	QPSK	1	7	24.26	0	0
	1711.5	19965	3	QPSK	1	14	24.23	0	0
	1711.5	19965	3	QPSK	8	0	23.35	0-1	1
	1711.5	19965	3	QPSK	8	4	23.31	0-1	1
	1711.5	19965	3	QPSK	8	7	23.34	0-1	1
	1711.5	19965	3	QPSK	15	0	23.21	0-1	1
	1711.5	19965	3	16-QAM	1	0	23.23	0-1	1
	1711.5	19965	3	16-QAM	1	7	23.25	0-1	1
	1711.5	19965	3	16-QAM	1	14	23.23	0-1	1
	1711.5	19965	3	16-QAM	8	0	22.29	0-2	2
	1711.5	19965	3	16-QAM	8	4	22.29	0-2	2
	1711.5	19965	3	16-QAM	8	7	22.29	0-2	2
	1711.5	19965	3	16-QAM	15	0	22.24	0-2	2
	1732.5	20175	3	QPSK	1	0	24.25	0	0
Mid	1732.5	20175	3	QPSK	1	7	24.26	0	0
	1732.5	20175	3	QPSK	1	14	24.23	0	0
	1732.5	20175	3	QPSK	8	0	23.31	0-1	1
	1732.5	20175	3	QPSK	8	4	23.25	0-1	1
	1732.5	20175	3	QPSK	8	7	23.31	0-1	1
	1732.5	20175	3	QPSK	15	0	23.26	0-1	1
	1732.5	20175	3	16-QAM	1	0	23.25	0-1	1
	1732.5	20175	3	16-QAM	1	7	23.35	0-1	1
	1732.5	20175	3	16-QAM	1	14	23.25	0-1	1
	1732.5	20175	3	16-QAM	8	0	22.25	0-2	2
	1732.5	20175	3	16-QAM	8	4	22.20	0-2	2
	1732.5	20175	3	16-QAM	8	7	22.21	0-2	2
	1732.5	20175	3	16-QAM	15	0	22.25	0-2	2
	1753.5	20385	3	QPSK	1	0	24.26	0	0
	1753.5	20385	3	QPSK	1	7	24.25	0	0
High	1753.5	20385	3	QPSK	1	14	24.20	0	0
	1753.5	20385	3	QPSK	8	0	23.35	0-1	1
	1753.5	20385	3	QPSK	8	4	23.25	0-1	1
	1753.5	20385	3	QPSK	8	7	23.26	0-1	1
	1753.5	20385	3	QPSK	15	0	23.20	0-1	1
	1753.5	20385	3	16-QAM	1	0	23.40	0-1	1
	1753.5	20385	3	16-QAM	1	7	23.24	0-1	1
	1753.5	20385	3	16-QAM	1	14	23.25	0-1	1
	1753.5	20385	3	16-QAM	8	0	22.26	0-2	2
	1753.5	20385	3	16-QAM	8	4	22.20	0-2	2
	1753.5	20385	3	16-QAM	8	7	22.25	0-2	2
	1753.5	20385	3	16-QAM	15	0	22.30	0-2	2

Table 9-10
LTE Band 4 (AWS) Conducted Powers -1.4 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1710.7	19957	1.4	QPSK	1	0	24.46	0	0
	1710.7	19957	1.4	QPSK	1	2	24.44	0	0
	1710.7	19957	1.4	QPSK	1	5	24.31	0	0
	1710.7	19957	1.4	QPSK	3	0	24.20	0	0
	1710.7	19957	1.4	QPSK	3	2	24.26	0	0
	1710.7	19957	1.4	QPSK	3	3	24.31	0	0
	1710.7	19957	1.4	QPSK	6	0	23.26	0-1	1
	1710.7	19957	1.4	16-QAM	1	0	23.29	0-1	1
	1710.7	19957	1.4	16-QAM	1	2	23.34	0-1	1
	1710.7	19957	1.4	16-QAM	1	5	23.40	0-1	1
	1710.7	19957	1.4	16-QAM	3	0	23.21	0-1	1
	1710.7	19957	1.4	16-QAM	3	2	23.26	0-1	1
	1710.7	19957	1.4	16-QAM	3	3	23.30	0-1	1
	1710.7	19957	1.4	16-QAM	6	0	22.25	0-2	2
	1732.5	20175	1.4	QPSK	1	0	24.25	0	0
Mid	1732.5	20175	1.4	QPSK	1	2	24.23	0	0
	1732.5	20175	1.4	QPSK	1	5	24.26	0	0
	1732.5	20175	1.4	QPSK	3	0	24.31	0	0
	1732.5	20175	1.4	QPSK	3	2	24.35	0	0
	1732.5	20175	1.4	QPSK	3	3	24.31	0	0
	1732.5	20175	1.4	QPSK	6	0	23.21	0-1	1
	1732.5	20175	1.4	16-QAM	1	0	23.22	0-1	1
	1732.5	20175	1.4	16-QAM	1	2	23.26	0-1	1
	1732.5	20175	1.4	16-QAM	1	5	23.30	0-1	1
	1732.5	20175	1.4	16-QAM	3	0	23.25	0-1	1
	1732.5	20175	1.4	16-QAM	3	2	23.25	0-1	1
	1732.5	20175	1.4	16-QAM	3	3	23.20	0-1	1
	1732.5	20175	1.4	16-QAM	6	0	22.21	0-2	2
	1754.3	20393	1.4	QPSK	1	0	24.23	0	0
	1754.3	20393	1.4	QPSK	1	2	24.21	0	0
High	1754.3	20393	1.4	QPSK	1	5	24.25	0	0
	1754.3	20393	1.4	QPSK	3	0	24.30	0	0
	1754.3	20393	1.4	QPSK	3	2	24.31	0	0
	1754.3	20393	1.4	QPSK	3	3	24.25	0	0
	1754.3	20393	1.4	QPSK	6	0	23.30	0-1	1
	1754.3	20393	1.4	16-QAM	1	0	23.21	0-1	1
	1754.3	20393	1.4	16-QAM	1	2	23.26	0-1	1
	1754.3	20393	1.4	16-QAM	1	5	23.29	0-1	1
	1754.3	20393	1.4	16-QAM	3	0	23.25	0-1	1
	1754.3	20393	1.4	16-QAM	3	2	23.24	0-1	1
	1754.3	20393	1.4	16-QAM	3	3	23.27	0-1	1
	1754.3	20393	1.4	16-QAM	6	0	22.26	0-2	2

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LTE Band 2 (PCS)

Table 9-11

LTE Band 2 (PCS) Conducted Powers - 20 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1860	18700	20	QPSK	1	0	24.70	0	0
	1860	18700	20	QPSK	1	50	24.69	0	0
	1860	18700	20	QPSK	1	99	24.50	0	0
	1860	18700	20	QPSK	50	0	23.36	0-1	1
	1860	18700	20	QPSK	50	25	23.25	0-1	1
	1860	18700	20	QPSK	50	50	23.20	0-1	1
	1860	18700	20	QPSK	100	0	23.20	0-1	1
	1860	18700	20	16QAM	1	0	23.19	0-1	1
	1860	18700	20	16QAM	1	50	23.05	0-1	1
	1860	18700	20	16QAM	1	99	23.00	0-1	1
	1860	18700	20	16QAM	50	0	22.05	0-2	2
	1860	18700	20	16QAM	50	25	22.02	0-2	2
	1860	18700	20	16QAM	50	50	22.08	0-2	2
	1860	18700	20	16QAM	100	0	22.00	0-2	2
	1880.0	18900	20	QPSK	1	0	24.57	0	0
	1880.0	18900	20	QPSK	1	50	24.44	0	0
Mid	1880.0	18900	20	QPSK	1	99	24.38	0	0
	1880.0	18900	20	QPSK	50	0	23.23	0-1	1
	1880.0	18900	20	QPSK	50	25	23.20	0-1	1
	1880.0	18900	20	QPSK	50	50	23.22	0-1	1
	1880.0	18900	20	QPSK	100	0	23.20	0-1	1
	1880.0	18900	20	16QAM	1	0	23.57	0-1	1
	1880.0	18900	20	16QAM	1	50	23.48	0-1	1
	1880.0	18900	20	16QAM	1	99	23.49	0-1	1
	1880.0	18900	20	16QAM	50	0	22.08	0-2	2
	1880.0	18900	20	16QAM	50	25	22.04	0-2	2
	1880.0	18900	20	16QAM	50	50	22.02	0-2	2
	1880.0	18900	20	16QAM	100	0	22.04	0-2	2
	1900	19100	20	QPSK	1	0	24.55	0	0
	1900	19100	20	QPSK	1	50	24.44	0	0
	1900	19100	20	QPSK	1	99	24.43	0	0
	1900	19100	20	QPSK	50	0	23.34	0-1	1
High	1900	19100	20	QPSK	50	25	23.26	0-1	1
	1900	19100	20	QPSK	50	50	23.28	0-1	1
	1900	19100	20	QPSK	100	0	23.20	0-1	1
	1900	19100	20	16QAM	1	0	23.05	0-1	1
	1900	19100	20	16QAM	1	50	23.03	0-1	1
	1900	19100	20	16QAM	1	99	23.00	0-1	1
	1900	19100	20	16QAM	50	0	22.01	0-2	2
	1900	19100	20	16QAM	50	25	22.04	0-2	2
	1900	19100	20	16QAM	50	50	22.08	0-2	2
	1900	19100	20	16QAM	100	0	22.03	0-2	2

Table 9-12

LTE Band 2 (PCS) Conducted Powers - 15 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1857.5	18675	15	QPSK	1	0	24.54	0	0
	1857.5	18675	15	QPSK	1	36	24.40	0	0
	1857.5	18675	15	QPSK	1	74	24.58	0	0
	1857.5	18675	15	QPSK	36	0	23.38	0-1	1
	1857.5	18675	15	QPSK	36	18	23.49	0-1	1
	1857.5	18675	15	QPSK	36	37	23.41	0-1	1
	1857.5	18675	15	QPSK	75	0	23.24	0-1	1
	1857.5	18675	15	16QAM	1	0	23.30	0-1	1
	1857.5	18675	15	16QAM	1	36	23.21	0-1	1
	1857.5	18675	15	16QAM	1	74	23.18	0-1	1
	1857.5	18675	15	16QAM	36	0	22.14	0-2	2
	1857.5	18675	15	16QAM	36	18	22.18	0-2	2
	1857.5	18675	15	16QAM	36	37	22.19	0-2	2
	1857.5	18675	15	16QAM	75	0	22.10	0-2	2
	1880.0	18900	15	QPSK	1	0	24.68	0	0
	1880.0	18900	15	QPSK	1	36	24.45	0	0
Mid	1880.0	18900	15	QPSK	1	74	24.50	0	0
	1880.0	18900	15	QPSK	36	0	23.40	0-1	1
	1880.0	18900	15	QPSK	36	18	23.33	0-1	1
	1880.0	18900	15	QPSK	36	37	23.38	0-1	1
	1880.0	18900	15	QPSK	75	0	23.24	0-1	1
	1880.0	18900	15	16QAM	1	0	23.17	0-1	1
	1880.0	18900	15	16QAM	1	36	23.22	0-1	1
	1880.0	18900	15	16QAM	1	74	23.19	0-1	1
	1880.0	18900	15	16QAM	36	0	22.15	0-2	2
	1880.0	18900	15	16QAM	36	18	22.20	0-2	2
	1880.0	18900	15	16QAM	36	37	22.14	0-2	2
	1880.0	18900	15	16QAM	75	0	22.15	0-2	2
	1902.5	19125	15	QPSK	1	0	24.48	0	0
	1902.5	19125	15	QPSK	1	36	24.50	0	0
	1902.5	19125	15	QPSK	1	74	24.58	0	0
	1902.5	19125	15	QPSK	36	0	23.44	0-1	1
High	1902.5	19125	15	QPSK	36	18	23.39	0-1	1
	1902.5	19125	15	QPSK	36	37	23.45	0-1	1
	1902.5	19125	15	QPSK	75	0	23.30	0-1	1
	1902.5	19125	15	16QAM	1	0	23.25	0-1	1
	1902.5	19125	15	16QAM	1	36	23.21	0-1	1
	1902.5	19125	15	16QAM	1	74	23.27	0-1	1
	1902.5	19125	15	16QAM	36	0	22.18	0-2	2
	1902.5	19125	15	16QAM	36	18	22.19	0-2	2
	1902.5	19125	15	16QAM	36	37	22.15	0-2	2
	1902.5	19125	15	16QAM	75	0	22.19	0-2	2

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Table 9-13
LTE Band 2 (PCS) Conducted Powers - 10 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1855	18650	10	QPSK	1	0	24.45	0	0
	1855	18650	10	QPSK	1	25	24.39	0	0
	1855	18650	10	QPSK	1	49	24.51	0	0
	1855	18650	10	QPSK	25	0	23.39	0-1	1
	1855	18650	10	QPSK	25	12	23.28	0-1	1
	1855	18650	10	QPSK	25	25	23.44	0-1	1
	1855	18650	10	QPSK	50	0	23.28	0-1	1
	1855	18650	10	16QAM	1	0	23.24	0-1	1
	1855	18650	10	16QAM	1	25	23.19	0-1	1
	1855	18650	10	16QAM	1	49	23.21	0-1	1
	1855	18650	10	16QAM	25	0	22.30	0-2	2
	1855	18650	10	16QAM	25	12	22.25	0-2	2
	1855	18650	10	16QAM	25	25	22.14	0-2	2
	1855	18650	10	16QAM	50	0	22.18	0-2	2
	1880.0	18900	10	QPSK	1	0	24.50	0	0
Mid	1880.0	18900	10	QPSK	1	25	24.35	0	0
	1880.0	18900	10	QPSK	1	49	24.33	0	0
	1880.0	18900	10	QPSK	25	0	23.30	0-1	1
	1880.0	18900	10	QPSK	25	12	23.20	0-1	1
	1880.0	18900	10	QPSK	25	25	23.28	0-1	1
	1880.0	18900	10	QPSK	50	0	23.29	0-1	1
	1880.0	18900	10	16QAM	1	0	23.30	0-1	1
	1880.0	18900	10	16QAM	1	25	23.18	0-1	1
	1880.0	18900	10	16QAM	1	49	23.11	0-1	1
	1880.0	18900	10	16QAM	25	0	22.10	0-2	2
	1880.0	18900	10	16QAM	25	12	22.21	0-2	2
	1880.0	18900	10	16QAM	25	25	22.18	0-2	2
	1880.0	18900	10	16QAM	50	0	22.19	0-2	2
	1905	19150	10	QPSK	1	0	24.35	0	0
	1905	19150	10	QPSK	1	25	24.50	0	0
High	1905	19150	10	QPSK	1	49	24.55	0	0
	1905	19150	10	QPSK	25	0	23.40	0-1	1
	1905	19150	10	QPSK	25	12	23.31	0-1	1
	1905	19150	10	QPSK	25	25	23.35	0-1	1
	1905	19150	10	QPSK	50	0	23.25	0-1	1
	1905	19150	10	16QAM	1	0	23.30	0-1	1
	1905	19150	10	16QAM	1	25	23.15	0-1	1
	1905	19150	10	16QAM	1	49	23.20	0-1	1
	1905	19150	10	16QAM	25	0	22.21	0-2	2
	1905	19150	10	16QAM	25	12	22.23	0-2	2
	1905	19150	10	16QAM	25	25	22.16	0-2	2
	1905	19150	10	16QAM	50	0	22.14	0-2	2

Table 9-14
LTE Band 2 (PCS) Conducted Powers - 5 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1852.5	18625	5	QPSK	1	0	24.60	0	0
	1852.5	18625	5	QPSK	1	12	24.45	0	0
	1852.5	18625	5	QPSK	1	24	24.47	0	0
	1852.5	18625	5	QPSK	12	0	23.25	0-1	1
	1852.5	18625	5	QPSK	12	6	23.33	0-1	1
	1852.5	18625	5	QPSK	12	13	23.24	0-1	1
	1852.5	18625	5	QPSK	25	0	23.21	0-1	1
	1852.5	18625	5	16-QAM	1	0	23.18	0-1	1
	1852.5	18625	5	16-QAM	1	12	23.03	0-1	1
	1852.5	18625	5	16-QAM	1	24	23.11	0-1	1
	1852.5	18625	5	16-QAM	12	0	22.19	0-2	2
	1852.5	18625	5	16-QAM	12	6	22.32	0-2	2
	1852.5	18625	5	16-QAM	12	13	22.21	0-2	2
	1852.5	18625	5	16-QAM	25	0	22.20	0-2	2
	1880.0	18900	5	QPSK	1	0	24.33	0	0
Mid	1880.0	18900	5	QPSK	1	12	24.65	0	0
	1880.0	18900	5	QPSK	1	24	24.40	0	0
	1880.0	18900	5	QPSK	12	0	23.33	0-1	1
	1880.0	18900	5	QPSK	12	6	23.25	0-1	1
	1880.0	18900	5	QPSK	12	13	23.25	0-1	1
	1880.0	18900	5	QPSK	25	0	23.20	0-1	1
	1880.0	18900	5	16-QAM	1	0	23.19	0-1	1
	1880.0	18900	5	16-QAM	1	12	23.16	0-1	1
	1880.0	18900	5	16-QAM	1	24	23.22	0-1	1
	1880.0	18900	5	16-QAM	12	0	22.25	0-2	2
	1880.0	18900	5	16-QAM	12	6	22.20	0-2	2
	1880.0	18900	5	16-QAM	12	13	22.13	0-2	2
	1880.0	18900	5	16-QAM	25	0	22.14	0-2	2
	1907.5	19175	5	QPSK	1	0	24.56	0	0
	1907.5	19175	5	QPSK	1	12	24.61	0	0
High	1907.5	19175	5	QPSK	1	24	24.46	0	0
	1907.5	19175	5	QPSK	12	0	23.39	0-1	1
	1907.5	19175	5	QPSK	12	6	23.40	0-1	1
	1907.5	19175	5	QPSK	12	13	23.26	0-1	1
	1907.5	19175	5	QPSK	25	0	23.25	0-1	1
	1907.5	19175	5	16-QAM	1	0	23.20	0-1	1
	1907.5	19175	5	16-QAM	1	12	23.28	0-1	1
	1907.5	19175	5	16-QAM	1	24	23.21	0-1	1
	1907.5	19175	5	16-QAM	12	0	22.18	0-2	2
	1907.5	19175	5	16-QAM	12	6	22.16	0-2	2
	1907.5	19175	5	16-QAM	12	13	22.24	0-2	2
	1907.5	19175	5	16-QAM	25	0	22.19	0-2	2

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Table 9-15
LTE Band 2 (PCS) Conducted Powers - 3 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1851.5	18615	3	QPSK	1	0	24.26	0	0
	1851.5	18615	3	QPSK	1	7	24.34	0	0
	1851.5	18615	3	QPSK	1	14	24.31	0	0
	1851.5	18615	3	QPSK	8	0	23.20	0	1
	1851.5	18615	3	QPSK	8	4	23.24	0.1	1
	1851.5	18615	3	QPSK	8	7	23.22	0.1	1
	1851.5	18615	3	QPSK	15	0	23.16	0.1	1
	1851.5	18615	3	16-QAM	1	0	23.15	0.1	1
	1851.5	18615	3	16-QAM	1	7	23.11	0.1	1
	1851.5	18615	3	16-QAM	1	14	23.01	0.1	1
	1851.5	18615	3	16-QAM	8	0	22.16	0.2	2
	1851.5	18615	3	16-QAM	8	4	22.13	0.2	2
	1851.5	18615	3	16-QAM	8	7	22.16	0.2	2
	1851.5	18615	3	16-QAM	15	0	22.10	0.2	2
	1880.0	18900	3	QPSK	1	0	24.20	0	0
	1880.0	18900	3	QPSK	1	7	24.26	0	0
	1880.0	18900	3	QPSK	1	14	24.36	0	0
Mid	1880.0	18900	3	QPSK	8	0	23.25	0.1	1
	1880.0	18900	3	QPSK	8	4	23.21	0.1	1
	1880.0	18900	3	QPSK	8	7	23.16	0.1	1
	1880.0	18900	3	QPSK	15	0	23.20	0.1	1
	1880.0	18900	3	16-QAM	1	0	23.23	0.1	1
	1880.0	18900	3	16-QAM	1	7	23.15	0.1	1
	1880.0	18900	3	16-QAM	1	14	23.11	0.1	1
	1880.0	18900	3	16-QAM	8	0	22.16	0.2	2
	1880.0	18900	3	16-QAM	8	4	22.19	0.2	2
	1880.0	18900	3	16-QAM	8	7	22.17	0.2	2
	1880.0	18900	3	16-QAM	15	0	22.10	0.2	2
	1908.5	19185	3	QPSK	1	0	24.26	0	0
	1908.5	19185	3	QPSK	1	7	24.35	0	0
	1908.5	19185	3	QPSK	1	14	24.26	0	0
	1908.5	19185	3	QPSK	8	0	23.16	0.1	1
	1908.5	19185	3	QPSK	8	4	23.18	0.1	1
	1908.5	19185	3	QPSK	8	7	23.26	0.1	1
	1908.5	19185	3	QPSK	15	0	23.20	0.1	1
	1908.5	19185	3	16-QAM	1	0	23.22	0.1	1
High	1908.5	19185	3	16-QAM	1	7	23.18	0.1	1
	1908.5	19185	3	16-QAM	1	14	23.10	0.1	1
	1908.5	19185	3	16-QAM	8	0	22.16	0.2	2
	1908.5	19185	3	16-QAM	8	4	22.20	0.2	2
	1908.5	19185	3	16-QAM	8	7	22.11	0.2	2
	1908.5	19185	3	16-QAM	15	0	22.15	0.2	2

Table 9-16
LTE Band 2 (PCS) Conducted Powers - 1.4 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1850.7	18607	1.4	QPSK	1	0	24.26	0	0
	1850.7	18607	1.4	QPSK	1	2	24.22	0	0
	1850.7	18607	1.4	QPSK	1	5	24.23	0	0
	1850.7	18607	1.4	QPSK	3	0	24.25	0	0
	1850.7	18607	1.4	QPSK	3	2	24.16	0	0
	1850.7	18607	1.4	QPSK	3	3	24.25	0	0
	1850.7	18607	1.4	QPSK	6	0	23.22	0.1	1
	1850.7	18607	1.4	16-QAM	1	0	23.13	0.1	1
	1850.7	18607	1.4	16-QAM	1	2	23.16	0.1	1
	1850.7	18607	1.4	16-QAM	1	5	23.14	0.1	1
	1850.7	18607	1.4	16-QAM	3	0	23.06	0.1	1
	1850.7	18607	1.4	16-QAM	3	2	23.16	0.1	1
	1850.7	18607	1.4	16-QAM	3	3	23.19	0.1	1
	1850.7	18607	1.4	16-QAM	6	0	22.20	0.2	2
	1880.0	18900	1.4	QPSK	1	0	24.26	0	0
	1880.0	18900	1.4	QPSK	1	2	24.33	0	0
	1880.0	18900	1.4	QPSK	1	5	24.26	0	0
Mid	1880.0	18900	1.4	QPSK	3	0	24.31	0	0
	1880.0	18900	1.4	QPSK	3	2	24.26	0	0
	1880.0	18900	1.4	QPSK	3	3	24.20	0	0
	1880.0	18900	1.4	QPSK	6	0	23.16	0.1	1
	1880.0	18900	1.4	16-QAM	1	0	23.09	0.1	1
	1880.0	18900	1.4	16-QAM	1	2	23.15	0.1	1
	1880.0	18900	1.4	16-QAM	1	5	23.20	0.1	1
	1880.0	18900	1.4	16-QAM	3	0	23.18	0.1	1
	1880.0	18900	1.4	16-QAM	3	2	23.17	0.1	1
	1880.0	18900	1.4	16-QAM	3	3	23.09	0.1	1
	1880.0	18900	1.4	16-QAM	6	0	22.16	0.2	2
	1909.3	19193	1.4	QPSK	1	0	24.26	0	0
	1909.3	19193	1.4	QPSK	1	2	24.29	0	0
	1909.3	19193	1.4	QPSK	1	5	24.33	0	0
	1909.3	19193	1.4	QPSK	3	0	24.26	0	0
	1909.3	19193	1.4	QPSK	3	2	24.16	0	0
	1909.3	19193	1.4	QPSK	3	3	24.23	0	0
	1909.3	19193	1.4	QPSK	6	0	23.26	0.1	1
High	1909.3	19193	1.4	16-QAM	1	0	23.15	0.1	1
	1909.3	19193	1.4	16-QAM	1	2	23.11	0.1	1
	1909.3	19193	1.4	16-QAM	1	5	23.16	0.1	1
	1909.3	19193	1.4	16-QAM	3	0	23.20	0.1	1
	1909.3	19193	1.4	16-QAM	3	2	23.19	0.1	1
	1909.3	19193	1.4	16-QAM	3	3	23.21	0.1	1
	1909.3	19193	1.4	16-QAM	6	0	22.26	0.2	2

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9.4 WLAN Conducted Powers

Table 9-17
IEEE 802.11b Average RF Power

Mode	Freq [MHz]	Channel	802.11b Conducted Power [dBm]			
			Data Rate [Mbps]			
			1	2	5.5	11
802.11b	2412	1*	16.06	15.78	15.91	15.95
802.11b	2437	6*	16.07	15.81	15.89	15.98
802.11b	2462	11*	16.03	15.75	15.88	15.97

Table 9-18
IEEE 802.11g Average RF Power

Mode	Freq [MHz]	Channel	802.11g Conducted Power [dBm]							
			Data Rate [Mbps]							
			6	9	12	18	24	36	48	54
802.11g	2412	1	13.55	13.73	13.75	13.65	13.43	13.41	13.68	13.41
802.11g	2437	6	14.34	14.33	14.44	14.43	14.24	14.16	14.14	14.12
802.11g	2462	11	14.02	14.22	14.20	14.10	13.90	13.86	14.13	13.82

Table 9-19
IEEE 802.11n Average RF Power

Mode	Freq [MHz]	Channel	802.11n (2.4GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			6.5	13	19.5	26	39	52	58.5	65
802.11n	2412	1	13.79	13.71	13.41	13.35	13.45	13.34	13.44	13.35
802.11n	2437	6	14.02	13.95	13.61	13.49	13.72	13.53	13.63	13.52
802.11n	2462	11	14.10	14.05	13.74	13.58	13.76	13.64	13.74	13.74

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Table 9-20
IEEE 802.11a Average RF Power

Mode	Freq [MHz]	Channel	802.11a Conducted Power [dBm]							
			Data Rate [Mbps]							
			6	9	12	18	24	36	48	54
802.11a	5180	36*	15.44	15.26	15.16	15.18	15.17	15.31	15.20	15.27
802.11a	5200	40	15.33	15.13	15.00	15.06	15.09	15.24	15.11	15.16
802.11a	5220	44	15.48	15.25	15.20	15.16	15.19	15.32	15.25	15.32
802.11a	5240	48*	15.45	15.26	15.14	15.25	15.20	15.26	15.19	15.35
802.11a	5260	52*	15.77	15.63	15.71	15.63	15.65	15.57	15.47	15.55
802.11a	5280	56	15.81	15.58	15.76	15.64	15.65	15.64	15.55	15.58
802.11a	5300	60	15.60	15.45	15.50	15.39	15.53	15.42	15.29	15.36
802.11a	5320	64*	15.66	15.46	15.63	15.50	15.56	15.49	15.31	15.46
802.11a	5500	100	15.70	15.19	15.14	15.39	15.41	15.25	15.23	15.36
802.11a	5520	104*	15.59	15.06	15.04	15.27	15.23	15.14	15.12	15.27
802.11a	5540	108	15.51	14.99	14.88	15.27	15.26	15.08	14.97	15.20
802.11a	5560	112	15.36	14.88	14.83	15.08	15.09	14.98	14.91	15.06
802.11a	5580	116*	15.37	14.85	14.85	15.02	15.07	14.91	14.91	15.03
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	15.35	14.82	14.88	15.04	15.07	14.92	14.87	14.99
802.11a	5680	136*	15.23	14.70	14.66	14.90	14.96	14.85	14.84	14.82
802.11a	5700	140	15.22	14.77	14.65	14.90	14.99	14.82	14.78	14.98
802.11a	5745	149*	14.77	14.12	14.17	14.25	14.16	14.19	14.07	14.06
802.11a	5765	153	14.69	14.04	14.14	14.20	14.09	14.12	13.94	14.04
802.11a	5785	157*	14.60	13.88	14.02	14.11	13.92	14.02	13.91	13.86
802.11a	5805	161	14.63	14.03	14.10	14.18	14.03	14.02	13.97	13.87
802.11a	5825	165*	14.74	14.06	14.15	14.20	14.12	14.14	14.04	14.01

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

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

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Table 9-21
IEEE 802.11n Average RF Power – 20 MHz Bandwidth

Mode	Freq [MHz]	Channel	20MHz BW 802.11n (5GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			6.5	13	19.5	26	39	52	58.5	65
802.11n	5180	36	15.29	14.92	14.98	14.93	14.97	15.03	15.01	15.13
802.11n	5200	40	15.20	14.83	14.86	14.79	14.95	14.91	14.87	14.98
802.11n	5220	44	15.28	14.93	14.99	14.86	14.93	15.01	15.06	15.14
802.11n	5240	48	15.19	14.83	14.89	14.89	14.83	14.93	14.93	15.06
802.11n	5260	52	15.62	15.49	15.53	15.49	15.48	15.37	15.40	15.43
802.11n	5280	56	15.56	15.35	15.47	15.44	15.39	15.30	15.36	15.35
802.11n	5300	60	15.46	15.31	15.30	15.31	15.33	15.17	15.26	15.31
802.11n	5320	64	15.55	15.39	15.43	15.38	15.37	15.30	15.37	15.34
802.11n	5500	100	15.60	15.39	15.40	15.20	15.35	15.18	15.26	15.23
802.11n	5520	104	15.47	15.25	15.20	15.15	15.19	15.00	15.09	15.16
802.11n	5540	108	15.45	15.25	15.30	15.04	15.18	14.98	15.12	15.16
802.11n	5560	112	15.34	15.15	15.08	14.91	15.08	14.91	15.07	14.96
802.11n	5580	116	15.23	15.03	15.05	14.85	14.96	14.84	14.94	14.87
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	15.20	15.08	15.06	14.82	14.98	14.71	14.91	14.87
802.11n	5680	136	15.22	15.03	15.03	14.86	14.97	14.78	14.91	14.84
802.11n	5700	140	15.27	15.08	15.08	14.88	14.99	14.82	14.92	14.87
802.11n	5745	149	14.82	14.25	14.22	14.27	14.19	14.05	14.10	14.19
802.11n	5765	153	14.79	14.25	14.21	14.19	14.17	14.00	14.02	14.18
802.11n	5785	157	14.55	13.94	13.99	14.00	13.97	13.84	13.82	13.87
802.11n	5805	161	14.68	14.13	14.06	14.15	13.98	13.90	13.88	13.99
802.11n	5825	165	14.60	14.07	14.06	14.10	13.90	13.87	13.91	13.98

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.

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Table 9-22
IEEE 802.11n Average RF Power – 40 MHz Bandwidth

Mode	Freq [MHz]	Channel	40MHz BW 802.11n (5GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			13.5	27	40.5	54	81	108	121.5	135
802.11n	5190	38	15.31	15.30	15.33	15.42	15.20	15.24	15.17	15.24
802.11n	5230	46	15.16	15.12	15.26	15.31	15.01	15.08	15.03	15.06
802.11n	5270	54	15.28	15.17	15.14	15.16	15.12	15.18	15.12	15.10
802.11n	5310	62	15.01	14.88	14.79	14.89	14.82	14.91	14.92	14.75
802.11n	5510	102	15.44	14.97	15.01	15.02	14.87	14.17	13.74	13.16
802.11n	5550	110	15.48	15.00	15.03	15.08	14.89	14.14	13.71	13.20
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	15.32	14.81	14.90	14.88	14.81	13.97	13.71	13.02
802.11n	5755	151	14.75	14.70	14.71	14.73	14.66	14.60	14.35	14.30
802.11n	5795	159	14.68	14.65	14.63	14.66	14.61	13.93	13.90	13.91

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.

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 operations, 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 operations, highest average RF output power channel for the lowest data rate for IEEE 802.11a were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11n 20 MHz and 40 MHz) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11a mode.
- When the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is <1.6 W/kg and the reported 1g averaged SAR is <0.8 W/kg, SAR testing on other channels is not required. Otherwise, the other default (or corresponding required) test channels were additionally tested using the lowest data rate.
- The bolded data rate and channel above were tested for SAR.

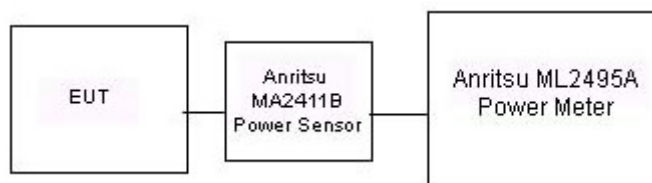


Figure 9-3
Power Measurement Setup

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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
01/22/2015	740H	19.5	695	0.852	41.651	0.889	42.227	-4.16%	-1.36%
			710	0.867	41.436	0.890	42.149	-2.58%	-1.69%
			725	0.881	41.203	0.891	42.071	-1.12%	-2.06%
			740	0.895	41.012	0.893	41.994	0.22%	-2.34%
			755	0.911	40.814	0.894	41.916	1.90%	-2.63%
01/19/2015	835H	21.1	820	0.885	41.221	0.899	41.578	-1.56%	-0.86%
			835	0.900	41.034	0.900	41.500	0.00%	-1.12%
			850	0.915	40.822	0.916	41.500	-0.11%	-1.63%
01/21/2015	1750H	22.4	1710	1.322	39.356	1.348	40.142	-1.93%	-1.96%
			1750	1.361	39.194	1.371	40.079	-0.73%	-2.21%
			1790	1.396	38.996	1.394	40.016	0.14%	-2.55%
01/20/2015	1900H	22.8	1850	1.388	38.916	1.400	40.000	-0.86%	-2.71%
			1880	1.419	38.785	1.400	40.000	1.36%	-3.04%
			1910	1.450	38.648	1.400	40.000	3.57%	-3.38%
01/20/2015	2450H	23.0	2401	1.794	40.670	1.756	39.287	2.16%	3.52%
			2450	1.849	40.470	1.800	39.200	2.72%	3.24%
			2499	1.903	40.278	1.853	39.138	2.70%	2.91%
01/23/2015	5200H-5800H	20.1	5180	4.432	35.745	4.635	36.009	-4.38%	-0.73%
			5200	4.449	35.741	4.655	35.986	-4.43%	-0.68%
			5220	4.468	35.684	4.676	35.963	-4.45%	-0.78%
			5280	4.530	35.583	4.737	35.894	-4.37%	-0.87%
			5300	4.549	35.571	4.758	35.871	-4.39%	-0.84%
			5320	4.575	35.543	4.778	35.849	-4.25%	-0.85%
			5500	4.748	35.287	4.963	35.643	-4.33%	-1.00%
			5580	4.831	35.188	5.045	35.551	-4.24%	-1.02%
			5600	4.849	35.184	5.065	35.529	-4.26%	-0.97%
			5660	4.914	35.088	5.127	35.460	-4.15%	-1.05%
			5745	5.003	34.976	5.214	35.363	-4.05%	-1.09%
			5765	5.026	34.989	5.234	35.340	-3.97%	-0.99%
			5800	5.054	34.890	5.270	35.300	-4.10%	-1.16%
			5825	5.079	34.856	5.296	35.271	-4.10%	-1.18%
01/22/2015	740B	24.3	695	0.912	53.856	0.959	55.745	-4.90%	-3.39%
			710	0.926	53.688	0.960	55.687	-3.54%	-3.59%
			725	0.940	53.555	0.961	55.629	-2.19%	-3.73%
			740	0.955	53.372	0.963	55.570	-0.83%	-3.96%
			755	0.968	53.254	0.964	55.512	0.41%	-4.07%
01/20/2015	835B	20.1	820	0.940	54.370	0.969	55.258	-2.99%	-1.61%
			835	0.956	54.224	0.970	55.200	-1.44%	-1.77%
			850	0.971	54.072	0.988	55.154	-1.72%	-1.96%
01/21/2015	1750B	22.4	1710	1.493	51.087	1.463	53.537	2.05%	-4.58%
			1750	1.534	50.966	1.488	53.432	3.09%	-4.62%
			1790	1.573	50.780	1.514	53.326	3.90%	-4.77%
01/20/2015	1900B	22.8	1850	1.485	51.142	1.520	53.300	-2.30%	-4.05%
			1880	1.519	51.052	1.520	53.300	-0.07%	-4.22%
			1910	1.552	50.961	1.520	53.300	2.11%	-4.39%
01/19/2015	2450B	22.8	2401	1.956	51.267	1.903	52.765	2.79%	-2.84%
			2450	2.031	51.040	1.950	52.700	4.15%	-3.15%
			2499	2.092	50.858	2.019	52.638	3.62%	-3.38%
01/20/2015	5200B-5800B	22.8	5200	5.308	48.366	5.299	49.014	0.17%	-1.32%
			5220	5.332	48.246	5.323	48.987	0.17%	-1.51%
			5280	5.424	48.093	5.393	48.906	0.57%	-1.66%
			5300	5.452	48.044	5.416	48.879	0.66%	-1.71%
			5500	5.772	47.649	5.650	48.607	2.16%	-1.97%
			5580	5.899	47.465	5.743	48.499	2.72%	-2.13%
			5600	5.928	47.449	5.766	48.471	2.81%	-2.11%
			5660	6.013	47.301	5.837	48.390	3.02%	-2.25%
			5745	6.128	47.082	5.936	48.275	3.23%	-2.47%
			5800	6.220	46.948	6.000	48.200	3.67%	-2.60%

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 KDB Publication 865664 and IEEE 1528-2013 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 – 1g

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} (%)
K	750	HEAD	01/22/2015	24.0	21.2	0.100	1054	3288	0.826	8.330	8.260	-0.84%
J	835	HEAD	01/19/2015	23.1	23.0	0.100	4d133	3022	0.918	9.200	9.180	-0.22%
A	1750	HEAD	01/21/2015	24.0	22.4	0.100	1051	3331	3.650	36.200	36.500	0.83%
C	1900	HEAD	01/20/2015	21.6	21.0	0.100	5d148	3333	3.980	40.700	39.800	-2.21%
I	2450	HEAD	01/20/2015	21.9	23.0	0.100	719	3209	4.860	52.100	48.600	-6.72%
H	5200	HEAD	01/23/2015	23.9	21.5	0.100	1120	3920	7.540	79.100	75.400	-4.68%
H	5300	HEAD	01/23/2015	23.9	21.5	0.100	1120	3920	8.030	83.400	80.300	-3.72%
H	5500	HEAD	01/23/2015	23.9	21.6	0.100	1120	3920	8.190	84.900	81.900	-3.53%
H	5600	HEAD	01/23/2015	24.0	21.6	0.100	1120	3920	7.910	82.200	79.100	-3.77%
H	5800	HEAD	01/23/2015	23.9	21.6	0.100	1120	3920	7.800	79.100	78.000	-1.39%
E	750	BODY	01/22/2015	23.2	23.4	0.100	1054	3332	0.855	8.640	8.550	-1.04%
B	835	BODY	01/20/2015	22.6	20.0	0.100	4d119	3334	0.910	9.340	9.100	-2.57%
C	1750	BODY	01/21/2015	21.5	21.4	0.100	1051	3333	3.650	37.400	36.500	-2.41%
J	1900	BODY	01/20/2015	23.4	22.8	0.100	5d141	3022	3.940	40.600	39.400	-2.96%
I	2450	BODY	01/19/2015	24.0	22.8	0.100	719	3209	5.150	51.800	51.500	-0.58%
A	5200	BODY	01/20/2015	22.8	21.2	0.100	1120	3949	7.800	74.000	78.000	5.41%
A	5300	BODY	01/20/2015	22.8	21.2	0.100	1120	3949	8.010	75.800	80.100	5.67%
A	5500	BODY	01/20/2015	22.8	21.2	0.100	1120	3949	8.510	79.200	85.100	7.45%
A	5600	BODY	01/20/2015	22.8	21.2	0.100	1120	3949	8.640	79.400	86.400	8.82%
A	5800	BODY	01/20/2015	22.8	21.2	0.100	1120	3949	7.810	74.400	78.100	4.97%

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Table 10-3
System Verification Results – 10g

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 _{10g} (W/kg)	1 W Target SAR _{10g} (W/kg)	1 W Normalized SAR _{10g} (W/kg)	Deviation _{10g} (%)
A	5200	BODY	01/20/2015	22.8	21.2	0.100	1120	3949	2.180	20.700	21.800	5.31%
A	5300	BODY	01/20/2015	22.8	21.2	0.100	1120	3949	2.200	21.300	22.000	3.29%
A	5500	BODY	01/20/2015	22.8	21.2	0.100	1120	3949	2.330	22.000	23.300	5.91%
A	5600	BODY	01/20/2015	22.8	21.2	0.100	1120	3949	2.360	22.000	23.600	7.27%

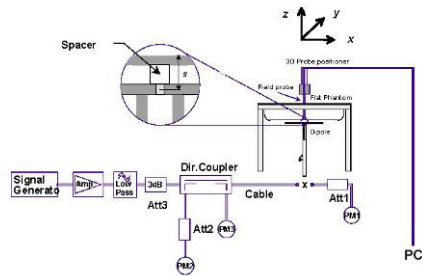


Figure 10-1
System Verification Setup Diagram



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	32.7	32.66	0.01	Right	Cheek	1401-12	1	1:8.3	0.319	1.009	0.322	A1
836.60	190	GSM 850	GSM	32.7	32.66	0.08	Right	Tilt	1401-12	1	1:8.3	0.195	1.009	0.197	
836.60	190	GSM 850	GSM	32.7	32.66	0.16	Left	Cheek	1401-12	1	1:8.3	0.243	1.009	0.245	
836.60	190	GSM 850	GSM	32.7	32.66	0.04	Left	Tilt	1401-12	1	1:8.3	0.161	1.009	0.162	
836.60	190	GSM 850	GPRS	26.7	26.51	0.12	Right	Cheek	1401-12	4	1:2.076	0.285	1.045	0.298	
836.60	190	GSM 850	GPRS	26.7	26.51	-0.11	Right	Tilt	1401-12	4	1:2.076	0.170	1.045	0.178	
836.60	190	GSM 850	GPRS	26.7	26.51	0.04	Left	Cheek	1401-12	4	1:2.076	0.219	1.045	0.229	
836.60	190	GSM 850	GPRS	26.7	26.51	0.03	Left	Tilt	1401-12	4	1:2.076	0.154	1.045	0.161	
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	24.7	24.46	-0.10	Right	Cheek	1401-12	1:1	0.543	1.057	0.574	A2
836.60	4183	UMTS 850	RMC	24.7	24.46	-0.11	Right	Tilt	1401-12	1:1	0.319	1.057	0.337	
836.60	4183	UMTS 850	RMC	24.7	24.46	-0.09	Left	Cheek	1401-12	1:1	0.392	1.057	0.414	
836.60	4183	UMTS 850	RMC	24.7	24.46	0.00	Left	Tilt	1401-12	1:1	0.277	1.057	0.293	
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	24.7	24.44	-0.01	Right	Cheek	1401-12	1:1	0.345	1.062	0.366	
1732.40	1412	UMTS 1750	RMC	24.7	24.44	0.03	Right	Tilt	1401-12	1:1	0.376	1.062	0.399	
1732.40	1412	UMTS 1750	RMC	24.7	24.44	0.00	Left	Cheek	1401-12	1:1	0.602	1.062	0.639	A3
1732.40	1412	UMTS 1750	RMC	24.7	24.44	0.09	Left	Tilt	1401-12	1:1	0.391	1.062	0.415	
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	Maxim um Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Side	Test Position	Device Serial Number	# of Time Slots	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
1880.00	661	GSM 1900	GSM	30.7	30.20	-0.02	Right	Cheek	1401-12	1	1:8.3	0.166	1.122	0.186	
1880.00	661	GSM 1900	GSM	30.7	30.20	0.17	Right	Tilt	1401-12	1	1:8.3	0.148	1.122	0.166	
1880.00	661	GSM 1900	GSM	30.7	30.20	-0.14	Left	Cheek	1401-12	1	1:8.3	0.290	1.122	0.325	
1880.00	661	GSM 1900	GSM	30.7	30.20	0.08	Left	Tilt	1401-12	1	1:8.3	0.162	1.122	0.182	
1880.00	661	GSM 1900	GPRS	26.7	26.44	0.00	Right	Cheek	1401-12	3	1:2.76	0.180	1.062	0.191	
1880.00	661	GSM 1900	GPRS	26.7	26.44	-0.09	Right	Tilt	1401-12	3	1:2.76	0.159	1.062	0.169	
1880.00	661	GSM 1900	GPRS	26.7	26.44	-0.17	Left	Cheek	1401-12	3	1:2.76	0.328	1.062	0.348	A4
1880.00	661	GSM 1900	GPRS	26.7	26.44	-0.07	Left	Tilt	1401-12	3	1:2.76	0.164	1.062	0.174	
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	24.7	24.56	-0.06	Right	Cheek	1401-12	1:1	0.324	1.033	0.335	
1880.00	9400	UMTS 1900	RMC	24.7	24.56	0.02	Right	Tilt	1401-12	1:1	0.325	1.033	0.336	
1880.00	9400	UMTS 1900	RMC	24.7	24.56	-0.02	Left	Cheek	1401-12	1:1	0.613	1.033	0.633	A5
1880.00	9400	UMTS 1900	RMC	24.7	24.56	-0.08	Left	Tilt	1401-12	1:1	0.356	1.033	0.368	
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 12 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)			
707.50	23095	Mid	LTE Band 12	10	24.7	24.59	-0.16	0	Right	Cheek	QPSK	1	49	1401-7	1:1	0.229	1.026	0.235	A6
707.50	23095	Mid	LTE Band 12	10	23.7	23.47	0.14	1	Right	Cheek	QPSK	25	25	1401-7	1:1	0.171	1.054	0.180	
707.50	23095	Mid	LTE Band 12	10	24.7	24.59	0.11	0	Right	Tilt	QPSK	1	49	1401-7	1:1	0.119	1.026	0.122	
707.50	23095	Mid	LTE Band 12	10	23.7	23.47	0.15	1	Right	Tilt	QPSK	25	25	1401-7	1:1	0.084	1.054	0.089	
707.50	23095	Mid	LTE Band 12	10	24.7	24.59	-0.15	0	Left	Cheek	QPSK	1	49	1401-7	1:1	0.203	1.026	0.208	
707.50	23095	Mid	LTE Band 12	10	23.7	23.47	0.02	1	Left	Cheek	QPSK	25	25	1401-7	1:1	0.138	1.054	0.145	
707.50	23095	Mid	LTE Band 12	10	24.7	24.59	-0.05	0	Left	Tilt	QPSK	1	49	1401-7	1:1	0.131	1.026	0.134	
707.50	23095	Mid	LTE Band 12	10	23.7	23.47	0.11	1	Left	Tilt	QPSK	25	25	1401-7	1:1	0.079	1.054	0.083	
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	24.7	0.03	0	Right	Cheek	QPSK	1	0	1401-7	1:1	0.364	1.000	0.364		
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.7	0.07	1	Right	Cheek	QPSK	50	0	1401-7	1:1	0.261	1.005	0.262		
1732.50	20175	Mid	LTE Band 4 (AWS)	20	24.7	0.08	0	Right	Tilt	QPSK	1	0	1401-7	1:1	0.363	1.000	0.363		
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.7	-0.01	1	Right	Tilt	QPSK	50	0	1401-7	1:1	0.273	1.005	0.274		
1732.50	20175	Mid	LTE Band 4 (AWS)	20	24.7	0.02	0	Left	Cheek	QPSK	1	0	1401-7	1:1	0.535	1.000	0.535	A7	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.7	-0.04	1	Left	Cheek	QPSK	50	0	1401-7	1:1	0.410	1.005	0.412		
1732.50	20175	Mid	LTE Band 4 (AWS)	20	24.7	-0.02	0	Left	Tilt	QPSK	1	0	1401-7	1:1	0.382	1.000	0.382		
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.7	-0.04	1	Left	Tilt	QPSK	50	0	1401-7	1:1	0.296	1.005	0.297		
ANSI / IEEE C95.1 1992 - SAFETY LIMIT									Head										
Spatial Peak									1.6 W/kg (mW/g)										
Uncontrolled Exposure/General Population									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)			
1860.00	18700	Low	LTE Band 2 (PCS)	20	24.7	24.70	0.00	0	Right	Cheek	QPSK	1	0	1401-7	1:1	0.384	1.000	0.384	
1860.00	18700	Low	LTE Band 2 (PCS)	20	23.7	23.36	-0.02	1	Right	Cheek	QPSK	50	0	1401-7	1:1	0.270	1.081	0.292	
1860.00	18700	Low	LTE Band 2 (PCS)	20	24.7	24.70	-0.05	0	Right	Tilt	QPSK	1	0	1401-7	1:1	0.388	1.000	0.388	
1860.00	18700	Low	LTE Band 2 (PCS)	20	23.7	23.36	0.10	1	Right	Tilt	QPSK	50	0	1401-7	1:1	0.263	1.081	0.284	
1860.00	18700	Low	LTE Band 2 (PCS)	20	24.7	24.70	-0.03	0	Left	Cheek	QPSK	1	0	1401-7	1:1	0.705	1.000	0.705	A8
1860.00	18700	Low	LTE Band 2 (PCS)	20	23.7	23.36	0.04	1	Left	Cheek	QPSK	50	0	1401-7	1:1	0.485	1.081	0.524	
1860.00	18700	Low	LTE Band 2 (PCS)	20	24.7	24.70	0.03	0	Left	Tilt	QPSK	1	0	1401-7	1:1	0.358	1.000	0.358	
1860.00	18700	Low	LTE Band 2 (PCS)	20	23.7	23.36	-0.06	1	Left	Tilt	QPSK	50	0	1401-7	1:1	0.274	1.081	0.296	
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)	
2437	6	IEEE 802.11b	DSSS	17.0	16.07	0.06	Right	Cheek	1401-8	1	1:1	0.149	1.239	0.185	
2437	6	IEEE 802.11b	DSSS	17.0	16.07	0.06	Right	Tilt	1401-8	1	1:1	0.107	1.239	0.133	
2437	6	IEEE 802.11b	DSSS	17.0	16.07	0.06	Left	Cheek	1401-8	1	1:1	0.416	1.239	0.515	A9
2437	6	IEEE 802.11b	DSSS	17.0	16.07	0.09	Left	Tilt	1401-8	1	1:1	0.298	1.239	0.369	
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)	
5220	44	IEEE 802.11a	OFDM	16.0	15.48	-0.02	Right	Cheek	1401-8	6	1:1	0.236	1.127	0.266	
5220	44	IEEE 802.11a	OFDM	16.0	15.48	0.20	Right	Tilt	1401-8	6	1:1	0.144	1.127	0.162	
5180	36	IEEE 802.11a	OFDM	16.0	15.44	0.08	Left	Cheek	1401-8	6	1:1	0.442	1.138	0.503	
5220	44	IEEE 802.11a	OFDM	16.0	15.48	0.08	Left	Cheek	1401-8	6	1:1	0.543	1.127	0.612	
5220	44	IEEE 802.11a	OFDM	16.0	15.48	0.07	Left	Tilt	1401-8	6	1:1	0.374	1.127	0.421	
5280	56	IEEE 802.11a	OFDM	16.0	15.81	0.08	Right	Cheek	1401-8	6	1:1	0.260	1.045	0.272	
5280	56	IEEE 802.11a	OFDM	16.0	15.81	0.03	Right	Tilt	1401-8	6	1:1	0.164	1.045	0.171	
5280	56	IEEE 802.11a	OFDM	16.0	15.81	0.09	Left	Cheek	1401-8	6	1:1	0.540	1.045	0.564	
5320	64	IEEE 802.11a	OFDM	16.0	15.66	0.08	Left	Cheek	1401-8	6	1:1	0.642	1.081	0.694	A10
5280	56	IEEE 802.11a	OFDM	16.0	15.81	0.02	Left	Tilt	1401-8	6	1:1	0.413	1.045	0.432	
5320	64	IEEE 802.11a	OFDM	16.0	15.66	0.04	Left	Tilt	1401-8	6	1:1	0.458	1.081	0.495	
5500	100	IEEE 802.11a	OFDM	16.0	15.70	-0.01	Right	Cheek	1401-8	6	1:1	0.220	1.072	0.236	
5500	100	IEEE 802.11a	OFDM	16.0	15.70	0.19	Right	Tilt	1401-8	6	1:1	0.137	1.072	0.147	
5500	100	IEEE 802.11a	OFDM	16.0	15.70	0.02	Left	Cheek	1401-8	6	1:1	0.601	1.072	0.644	
5580	116	IEEE 802.11a	OFDM	16.0	15.37	0.20	Left	Cheek	1401-8	6	1:1	0.548	1.156	0.633	
5660	132	IEEE 802.11a	OFDM	16.0	15.35	0.08	Left	Cheek	1401-8	6	1:1	0.542	1.161	0.629	
5500	100	IEEE 802.11a	OFDM	16.0	15.70	-0.20	Left	Tilt	1401-8	6	1:1	0.360	1.072	0.386	
5745	149	IEEE 802.11a	OFDM	16.0	14.77	0.12	Right	Cheek	1401-8	6	1:1	0.271	1.327	0.360	
5765	153	IEEE 802.11a	OFDM	16.0	14.69	0.19	Right	Cheek	1401-8	6	1:1	0.277	1.352	0.375	
5825	165	IEEE 802.11a	OFDM	16.0	14.74	0.15	Right	Cheek	1401-8	6	1:1	0.244	1.337	0.326	
5745	149	IEEE 802.11a	OFDM	16.0	14.77	-0.02	Right	Tilt	1401-8	6	1:1	0.136	1.327	0.180	
5745	149	IEEE 802.11a	OFDM	16.0	14.77	0.07	Left	Cheek	1401-8	6	1:1	0.500	1.327	0.664	
5765	153	IEEE 802.11a	OFDM	16.0	14.69	0.15	Left	Cheek	1401-8	6	1:1	0.473	1.352	0.639	
5825	165	IEEE 802.11a	OFDM	16.0	14.74	0.16	Left	Cheek	1401-8	6	1:1	0.462	1.337	0.618	
5745	149	IEEE 802.11a	OFDM	16.0	14.77	0.02	Left	Tilt	1401-8	6	1:1	0.314	1.327	0.417	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT								Head							
Spatial Peak								1.6 W/kg (mW/g)							
Uncontrolled Exposure/General Population								averaged over 1 gram							

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11.2 Standalone Body-Worn SAR Data

Table 11-11
GSM/GPRS/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	GSM850	GSM	32.7	32.66	-0.02	10 mm	1401-12	1	1:8.3	back	0.320	1.009	0.323	
836.60	190	GSM850	GPRS	26.7	26.51	-0.15	10 mm	1401-12	4	1:2.076	back	0.336	1.045	0.351	A11
836.60	4183	UMTS 850	RMC	24.7	24.46	-0.03	10 mm	1401-12	N/A	1:1	back	0.679	1.057	0.718	A12
1732.40	1412	UMTS 1750	RMC	24.7	24.44	0.10	10 mm	1401-12	N/A	1:1	back	0.746	1.062	0.792	A14
1880.00	661	GSM 1900	GSM	30.7	30.20	-0.02	10 mm	1401-12	1	1:8.3	back	0.202	1.122	0.227	
1880.00	661	GSM 1900	GPRS	26.7	26.44	-0.05	10 mm	1401-12	3	1:2.76	back	0.574	1.062	0.610	A15
1880.00	9400	UMTS 1900	RMC	24.7	24.56	0.08	10 mm	1401-12	N/A	1:1	back	0.468	1.033	0.483	A16
ANSI / IEEE C95.1 1992 - SAFETY LIMIT							Body								
Spatial Peak							1.6 W/kg (mW/g)								
Uncontrolled Exposure/General Population							averaged over 1 gram								

Table 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)	Scaling Factor	Scaled SAR (1g) (W/kg)	Plot #	
MHz	Ch.														(W/kg)				
707.50	23095	Mid	LTE Band 12	10	24.7	24.59	-0.14	0	1401-7	QPSK	1	49	10 mm	back	1:1	0.430	1.026	0.441	A18
707.50	23095	Mid	LTE Band 12	10	23.7	23.47	-0.10	1	1401-7	QPSK	25	25	10 mm	back	1:1	0.341	1.054	0.359	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	24.7	24.70	0.07	0	1401-7	QPSK	1	0	10 mm	back	1:1	0.749	1.000	0.749	A20
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.7	23.68	0.03	1	1401-7	QPSK	50	0	10 mm	back	1:1	0.528	1.005	0.531	
1860.00	18700	Low	LTE Band 2 (PCS)	20	24.7	24.70	0.02	0	1401-7	QPSK	1	0	10 mm	back	1:1	0.637	1.000	0.637	A21
1860.00	18700	Low	LTE Band 2 (PCS)	20	23.7	23.36	-0.20	1	1401-7	QPSK	50	0	10 mm	back	1:1	0.436	1.081	0.471	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT									Body										
Spatial Peak									1.6 W/kg (mW/g)										
Uncontrolled Exposure/General Population									averaged over 1 gram										

Table 11-13
WLAN Body-Worn SAR

MEASUREMENT RESULTS															
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
2437	6	IEEE 802.11b	DSSS	17.0	16.07	-0.09	10 mm	1401-8	1	back	1:1	0.216	1.239	0.268	A23
5220	44	IEEE 802.11a	OFDM	16.0	15.48	0.06	10 mm	1401-8	6	back	1:1	0.275	1.127	0.310	
5280	56	IEEE 802.11a	OFDM	16.0	15.81	0.15	10 mm	1401-8	6	back	1:1	0.358	1.045	0.374	
5500	100	IEEE 802.11a	OFDM	16.0	15.70	0.12	10 mm	1401-8	6	back	1:1	0.404	1.072	0.433	
5580	116	IEEE 802.11a	OFDM	16.0	15.37	-0.02	10 mm	1401-8	6	back	1:1	0.334	1.156	0.386	
5660	132	IEEE 802.11a	OFDM	16.0	15.35	0.03	10 mm	1401-8	6	back	1:1	0.445	1.161	0.517	A24
5745	149	IEEE 802.11a	OFDM	16.0	14.77	0.02	10 mm	1401-8	6	back	1:1	0.228	1.327	0.303	
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 11-14
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	26.7	26.51	-0.15	10 mm	1401-12	4	1:2.076	back	0.336	1.045	0.351	A11
836.60	190	GSM 850	GPRS	26.7	26.51	0.01	10 mm	1401-12	4	1:2.076	front	0.278	1.045	0.291	
836.60	190	GSM 850	GPRS	26.7	26.51	-0.07	10 mm	1401-12	4	1:2.076	bottom	0.240	1.045	0.251	
836.60	190	GSM 850	GPRS	26.7	26.51	-0.09	10 mm	1401-12	4	1:2.076	right	0.288	1.045	0.301	
836.60	4183	UMTS 850	RMC	24.7	24.46	-0.03	10 mm	1401-12	N/A	1:1	back	0.679	1.057	0.718	
836.60	4183	UMTS 850	RMC	24.7	24.46	0.09	10 mm	1401-12	N/A	1:1	front	0.548	1.057	0.579	
836.60	4183	UMTS 850	RMC	24.7	24.46	0.00	10 mm	1401-12	N/A	1:1	bottom	0.497	1.057	0.525	
836.60	4183	UMTS 850	RMC	24.7	24.46	-0.06	10 mm	1401-12	N/A	1:1	right	0.724	1.057	0.765	A13
1732.40	1412	UMTS 1750	RMC	24.7	24.44	0.10	10 mm	1401-12	N/A	1:1	back	0.746	1.062	0.792	A14
1732.40	1412	UMTS 1750	RMC	24.7	24.44	0.13	10 mm	1401-12	N/A	1:1	front	0.711	1.062	0.755	
1732.40	1412	UMTS 1750	RMC	24.7	24.44	0.00	10 mm	1401-12	N/A	1:1	bottom	0.473	1.062	0.502	
1732.40	1412	UMTS 1750	RMC	24.7	24.44	0.04	10 mm	1401-12	N/A	1:1	left	0.657	1.062	0.698	
1880.00	661	GSM 1900	GPRS	26.7	26.44	-0.05	10 mm	1401-12	3	1:2.76	back	0.574	1.062	0.610	A15
1880.00	661	GSM 1900	GPRS	26.7	26.44	0.02	10 mm	1401-12	3	1:2.76	front	0.553	1.062	0.587	
1880.00	661	GSM 1900	GPRS	26.7	26.44	0.20	10 mm	1401-12	3	1:2.76	bottom	0.485	1.062	0.515	
1880.00	661	GSM 1900	GPRS	26.7	26.44	0.01	10 mm	1401-12	3	1:2.76	left	0.565	1.062	0.600	
1880.00	9400	UMTS 1900	RMC	24.7	24.56	0.08	10 mm	1401-12	N/A	1:1	back	0.468	1.033	0.483	
1880.00	9400	UMTS 1900	RMC	24.7	24.56	0.02	10 mm	1401-12	N/A	1:1	front	0.698	1.033	0.721	A17
1880.00	9400	UMTS 1900	RMC	24.7	24.56	0.06	10 mm	1401-12	N/A	1:1	bottom	0.356	1.033	0.368	
1880.00	9400	UMTS 1900	RMC	24.7	24.56	-0.01	10 mm	1401-12	N/A	1:1	left	0.651	1.033	0.672	
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 11-15
LTE Band 12 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)		
707.50	23095	Md	LTE Band 12	10	24.7	24.59	-0.14	0	1401-7	QPSK	1	49	10 mm	back	1:1	0.430	1.026	0.441	
707.50	23095	Md	LTE Band 12	10	23.7	23.47	-0.10	1	1401-7	QPSK	25	25	10 mm	back	1:1	0.341	1.054	0.359	
707.50	23095	Md	LTE Band 12	10	24.7	24.59	0.06	0	1401-7	QPSK	1	49	10 mm	front	1:1	0.331	1.026	0.340	
707.50	23095	Md	LTE Band 12	10	23.7	23.47	-0.01	1	1401-7	QPSK	25	25	10 mm	front	1:1	0.259	1.054	0.273	
707.50	23095	Md	LTE Band 12	10	24.7	24.59	-0.08	0	1401-7	QPSK	1	49	10 mm	bottom	1:1	0.170	1.026	0.174	
707.50	23095	Md	LTE Band 12	10	23.7	23.47	0.03	1	1401-7	QPSK	25	25	10 mm	bottom	1:1	0.130	1.054	0.137	
707.50	23095	Md	LTE Band 12	10	24.7	24.59	-0.16	0	1401-7	QPSK	1	49	10 mm	right	1:1	0.548	1.026	0.562	A19
707.50	23095	Md	LTE Band 12	10	23.7	23.47	-0.02	1	1401-7	QPSK	25	25	10 mm	right	1:1	0.407	1.054	0.429	
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 11-16
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	24.7	24.70	0.07	0	1401-7	QPSK	1	0	10 mm	back	1:1	0.749	1.000	0.749	A20
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.7	23.68	0.03	1	1401-7	QPSK	50	0	10 mm	back	1:1	0.528	1.005	0.531	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	24.7	24.70	-0.03	0	1401-7	QPSK	1	0	10 mm	front	1:1	0.671	1.000	0.671	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.7	23.68	0.08	1	1401-7	QPSK	50	0	10 mm	front	1:1	0.510	1.005	0.513	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	24.7	24.70	0.02	0	1401-7	QPSK	1	0	10 mm	bottom	1:1	0.487	1.000	0.487	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.7	23.68	-0.05	1	1401-7	QPSK	50	0	10 mm	bottom	1:1	0.336	1.005	0.338	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	24.7	24.70	-0.03	0	1401-7	QPSK	1	0	10 mm	left	1:1	0.609	1.000	0.609	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.7	23.68	0.05	1	1401-7	QPSK	50	0	10 mm	left	1:1	0.457	1.005	0.459	
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 11-17
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)		
1860.00	18700	Low	LTE Band 2 (PCS)	20	24.7	24.70	0.02	0	1401-7	QPSK	1	0	10 mm	back	1:1	0.637	1.000	0.637	
1860.00	18700	Low	LTE Band 2 (PCS)	20	23.7	23.36	-0.20	1	1401-7	QPSK	50	0	10 mm	back	1:1	0.436	1.081	0.471	
1860.00	18700	Low	LTE Band 2 (PCS)	20	24.7	24.70	0.03	0	1401-7	QPSK	1	0	10 mm	front	1:1	0.633	1.000	0.633	
1860.00	18700	Low	LTE Band 2 (PCS)	20	23.7	23.36	-0.12	1	1401-7	QPSK	50	0	10 mm	front	1:1	0.459	1.081	0.496	
1860.00	18700	Low	LTE Band 2 (PCS)	20	24.7	24.70	-0.06	0	1401-7	QPSK	1	0	10 mm	bottom	1:1	0.292	1.000	0.292	
1860.00	18700	Low	LTE Band 2 (PCS)	20	23.7	23.36	-0.06	1	1401-7	QPSK	50	0	10 mm	bottom	1:1	0.235	1.081	0.254	
1860.00	18700	Low	LTE Band 2 (PCS)	20	24.7	24.70	0.20	0	1401-7	QPSK	1	0	10 mm	left	1:1	0.690	1.000	0.690	A22
1860.00	18700	Low	LTE Band 2 (PCS)	20	23.7	23.36	0.05	1	1401-7	QPSK	50	0	10 mm	left	1:1	0.486	1.081	0.525	
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 11-18
WLAN Hotspot SAR

MEASUREMENT RESULTS															
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
2437	6	IEEE 802.11b	DSSS	17.0	16.07	-0.09	10 mm	1401-8	1	back	1:1	0.216	1.239	0.268	A24
2437	6	IEEE 802.11b	DSSS	17.0	16.07	0.16	10 mm	1401-8	1	front	1:1	0.078	1.239	0.097	
2437	6	IEEE 802.11b	DSSS	17.0	16.07	0.09	10 mm	1401-8	1	top	1:1	0.069	1.239	0.085	
2437	6	IEEE 802.11b	DSSS	17.0	16.07	0.07	10 mm	1401-8	1	right	1:1	0.094	1.239	0.116	
5745	149	IEEE 802.11a	OFDM	16.0	14.77	0.02	10 mm	1401-8	6	back	1:1	0.228	1.327	0.303	
5745	149	IEEE 802.11a	OFDM	16.0	14.77	-0.01	10 mm	1401-8	6	front	1:1	0.178	1.327	0.236	
5745	149	IEEE 802.11a	OFDM	16.0	14.77	0.02	10 mm	1401-8	6	top	1:1	0.084	1.327	0.111	
5745	149	IEEE 802.11a	OFDM	16.0	14.77	0.11	10 mm	1401-8	6	right	1:1	0.239	1.327	0.317	A25
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 Standalone Hand SAR Data

Table 11-19
WLAN Hand 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 (10g)	Scaling Factor	Scaled SAR (10g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
5220	44	IEEE 802.11a	OFDM	16.0	15.48	-0.06	0 mm	1401-8	6	back	1:1	0.791	1.127	0.891	
5220	44	IEEE 802.11a	OFDM	16.0	15.48	0.01	0 mm	1401-8	6	front	1:1	0.568	1.127	0.640	
5220	44	IEEE 802.11a	OFDM	16.0	15.48	0.03	0 mm	1401-8	6	top	1:1	0.196	1.127	0.221	
5220	44	IEEE 802.11a	OFDM	16.0	15.48	-0.09	0 mm	1401-8	6	right	1:1	0.831	1.127	0.937	
5280	56	IEEE 802.11a	OFDM	16.0	15.81	-0.03	0 mm	1401-8	6	back	1:1	0.882	1.045	0.922	
5280	56	IEEE 802.11a	OFDM	16.0	15.81	-0.02	0 mm	1401-8	6	front	1:1	0.664	1.045	0.694	
5280	56	IEEE 802.11a	OFDM	16.0	15.81	0.01	0 mm	1401-8	6	top	1:1	0.262	1.045	0.274	
5280	56	IEEE 802.11a	OFDM	16.0	15.81	-0.06	0 mm	1401-8	6	right	1:1	0.919	1.045	0.960	A26
5500	100	IEEE 802.11a	OFDM	16.0	15.70	-0.02	0 mm	1401-8	6	back	1:1	0.607	1.072	0.651	
5500	100	IEEE 802.11a	OFDM	16.0	15.70	-0.09	0 mm	1401-8	6	front	1:1	0.420	1.072	0.450	
5500	100	IEEE 802.11a	OFDM	16.0	15.70	0.16	0 mm	1401-8	6	top	1:1	0.132	1.072	0.142	
5500	100	IEEE 802.11a	OFDM	16.0	15.70	-0.08	0 mm	1401-8	6	right	1:1	0.564	1.072	0.605	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Hand 4.0 W/kg (mW/g) averaged over 10 grams								

11.5 SAR Test Notes

General Notes:

1. The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2003, and FCC KDB Publication 447498 D01v05.
2. Batteries are fully charged at the beginning of the SAR measurements.
3. Liquid tissue depth was at least 15.0 cm for all frequencies.
4. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
5. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01v05.
6. 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 SAR was evaluated without a headset connected to the device. Since the standalone reported body-worn SAR was ≤ 1.2 W/kg, no additional body-worn SAR evaluations using a headset cable were required.
8. Per FCC KDB 865664 D01 v01, variability SAR tests were not performed since the measured SAR results for all frequency bands was less than 0.8 W/kg. Please see Section 13 for variability analysis.
9. During SAR Testing for the Wireless Router conditions per FCC KDB Publication 941225 D06, the actual Portable Hotspot operation (with actual simultaneous transmission of a transmitter with WIFI) was not activated (See Section 6.7 for more details).
10. Per FCC KDB Publication 648474 D04v01r01, this device is considered a "phablet" since the diagonal dimension is > 160 mm and < 200 mm. Therefore, hand SAR tests are required when wireless router mode does not apply or if wireless router 1g SAR > 1.2 W/kg.

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GSM Test Notes:

1. Body-Worn accessory testing is typically associated with voice operations. Therefore, GSM voice was evaluated for body-worn SAR. GPRS was additionally evaluated for head and body-worn voice calls to cover VoIP.
2. Justification for reduced test configurations per KDB Publication 941225 and October 2013 TCB Workshop Notes: The source-based frame-averaged output power was evaluated for all GPRS/EDGE slot configurations. The configuration with the highest target frame averaged output power was evaluated for hotspot SAR. When the maximum frame-averaged powers are equivalent across two or more slots (within 0.25 dB), the configuration with the most number of time slots was tested.
3. Per FCC KDB Publication 447498 D01v05, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is ≤ 0.8 W/kg then testing at the other channels is not required for such test configuration(s). When the maximum output power variation across the required test channels is $> \frac{1}{2}$ dB, instead of the middle channel, the highest output power channel was used.

UMTS Notes:

1. UMTS mode in was tested under RMC 12.2 kbps with HSPA Inactive per KDB Publication 941225 D01. HSPA SAR was not required since the average output power of the HSPA subtests was not more than 0.25 dB higher than the RMC level and SAR was less than 1.2 W/kg.
2. Per FCC KDB Publication 447498 D01v05, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is ≤ 0.8 W/kg then testing at the other channels is not required for such test configuration(s). When the maximum output power variation across the required test channels is $> \frac{1}{2}$ dB, instead of the middle channel, the highest output power channel was used.

LTE Notes:

1. LTE Considerations: LTE test configurations are determined according to SAR Evaluation Considerations for LTE Devices in FCC KDB Publication 941225. 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. SAR tests were performed with the same number of RB and RB offsets transmitting on all TTI frames (maximum TTI).

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 operations: 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 operations: 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, 5.2-5.7 GHz bands are disabled. Therefore no 5.2 – 5.7 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 and 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 and IEEE 1528-2013 Section 6.3.4.1.2, 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 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	2480	9.00	10	0.168

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.

Main antenna SAR testing was not required for extremity exposure conditions per FCC KDB 648474. Therefore, no further analysis was required to determine that possible simultaneous scenarios would not exceed the SAR limit.

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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	GPRS 850 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.322	0.185	0.507	Head SAR	Right Cheek	0.298	0.185	0.483
	Right Tilt	0.197	0.133	0.330		Right Tilt	0.178	0.133	0.311
	Left Cheek	0.245	0.515	0.760		Left Cheek	0.229	0.515	0.744
	Left Tilt	0.162	0.369	0.531		Left Tilt	0.161	0.369	0.530
Simult Tx	Configuration	UMTS 850 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	UMTS 1750 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.574	0.185	0.759	Head SAR	Right Cheek	0.366	0.185	0.551
	Right Tilt	0.337	0.133	0.470		Right Tilt	0.399	0.133	0.532
	Left Cheek	0.414	0.515	0.929		Left Cheek	0.639	0.515	1.154
	Left Tilt	0.293	0.369	0.662		Left Tilt	0.415	0.369	0.784
Simult Tx	Configuration	GSM 1900 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	0.186	0.185	0.371	Head SAR	Right Cheek	0.191	0.185	0.376
	Right Tilt	0.166	0.133	0.299		Right Tilt	0.169	0.133	0.302
	Left Cheek	0.325	0.515	0.840		Left Cheek	0.348	0.515	0.863
	Left Tilt	0.182	0.369	0.551		Left Tilt	0.174	0.369	0.543
Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	LTE Band 12 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.335	0.185	0.520	Head SAR	Right Cheek	0.235	0.185	0.420
	Right Tilt	0.336	0.133	0.469		Right Tilt	0.122	0.133	0.255
	Left Cheek	0.633	0.515	1.148		Left Cheek	0.208	0.515	0.723
	Left Tilt	0.368	0.369	0.737		Left Tilt	0.134	0.369	0.503
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	0.364	0.185	0.549	Head SAR	Right Cheek	0.384	0.185	0.569
	Right Tilt	0.363	0.133	0.496		Right Tilt	0.388	0.133	0.521
	Left Cheek	0.535	0.515	1.050		Left Cheek	0.705	0.515	1.220
	Left Tilt	0.382	0.369	0.751		Left Tilt	0.358	0.369	0.727

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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	GPRS 850 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.322	0.375	0.697	Head SAR	Right Cheek	0.298	0.375	0.673
	Right Tilt	0.197	0.180	0.377		Right Tilt	0.178	0.180	0.358
	Left Cheek	0.245	0.694	0.939		Left Cheek	0.229	0.694	0.923
	Left Tilt	0.162	0.495	0.657		Left Tilt	0.161	0.495	0.656
Simult Tx	Configuration	UMTS 850 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	UMTS 1750 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.574	0.375	0.949	Head SAR	Right Cheek	0.366	0.375	0.741
	Right Tilt	0.337	0.180	0.517		Right Tilt	0.399	0.180	0.579
	Left Cheek	0.414	0.694	1.108		Left Cheek	0.639	0.694	1.333
	Left Tilt	0.293	0.495	0.788		Left Tilt	0.415	0.495	0.910
Simult Tx	Configuration	GSM 1900 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	0.186	0.375	0.561	Head SAR	Right Cheek	0.191	0.375	0.566
	Right Tilt	0.166	0.180	0.346		Right Tilt	0.169	0.180	0.349
	Left Cheek	0.325	0.694	1.019		Left Cheek	0.348	0.694	1.042
	Left Tilt	0.182	0.495	0.677		Left Tilt	0.174	0.495	0.669
Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	LTE Band 12 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.335	0.375	0.710	Head SAR	Right Cheek	0.235	0.375	0.610
	Right Tilt	0.336	0.180	0.516		Right Tilt	0.122	0.180	0.302
	Left Cheek	0.633	0.694	1.327		Left Cheek	0.208	0.694	0.902
	Left Tilt	0.368	0.495	0.863		Left Tilt	0.134	0.495	0.629
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	0.364	0.375	0.739	Head SAR	Right Cheek	0.384	0.375	0.759
	Right Tilt	0.363	0.180	0.543		Right Tilt	0.388	0.180	0.568
	Left Cheek	0.535	0.694	1.229		Left Cheek	0.705	0.694	1.399
	Left Tilt	0.382	0.495	0.877		Left Tilt	0.358	0.495	0.853

The worst case 5 GHz WIFI reported SAR for each head configuration was considered for simultaneous SAR exclusion via summation of standalone SAR, regardless of whether the WIFI channel has WIFI Hotspot capability, for simplicity to determine compliance. Please note that the actual simultaneous transmission SAR will not exceed the summed levels indicated.

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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 1.0 cm)

Configuration	Mode	2G/3G/4G SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Back Side	GSM 850	0.323	0.268	0.591
Back Side	GPRS 850	0.351	0.268	0.619
Back Side	UMTS 850	0.718	0.268	0.986
Back Side	UMTS 1750	0.792	0.268	1.060
Back Side	GSM 1900	0.227	0.268	0.495
Back Side	GPRS 1900	0.610	0.268	0.878
Back Side	UMTS 1900	0.483	0.268	0.751
Back Side	LTE Band 12	0.441	0.268	0.709
Back Side	LTE Band 4 (AWS)	0.749	0.268	1.017
Back Side	LTE Band 2 (PCS)	0.637	0.268	0.905

Table 12-5
Simultaneous Transmission Scenario with 5 GHz WLAN (Body-Worn at 1.0 cm)

Configuration	Mode	2G/3G/4G SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Back Side	GSM 850	0.323	0.517	0.840
Back Side	GPRS 850	0.351	0.517	0.868
Back Side	UMTS 850	0.718	0.517	1.235
Back Side	UMTS 1750	0.792	0.517	1.309
Back Side	GSM 1900	0.227	0.517	0.744
Back Side	GPRS 1900	0.610	0.517	1.127
Back Side	UMTS 1900	0.483	0.517	1.000
Back Side	LTE Band 12	0.441	0.517	0.958
Back Side	LTE Band 4 (AWS)	0.749	0.517	1.266
Back Side	LTE Band 2 (PCS)	0.637	0.517	1.154

The worst case 5 GHz WIFI reported SAR for each body-worn configuration was considered for simultaneous SAR exclusion via summation of standalone SAR, regardless of whether the WIFI channel has WIFI Hotspot capability, for simplicity to determine compliance. Please note that the actual simultaneous transmission SAR will not exceed the summed levels indicated.

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Table 12-6
Simultaneous Transmission Scenario with Bluetooth (Body-Worn at 1.0 cm)

Configuration	Mode	2G/3G/4G SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)
Back Side	GSM 850	0.323	0.168	0.491
Back Side	GPRS 850	0.351	0.168	0.519
Back Side	UMTS 850	0.718	0.168	0.886
Back Side	UMTS 1750	0.792	0.168	0.960
Back Side	GSM 1900	0.227	0.168	0.395
Back Side	GPRS 1900	0.610	0.168	0.778
Back Side	UMTS 1900	0.483	0.168	0.651
Back Side	LTE Band 12	0.441	0.168	0.609
Back Side	LTE Band 4 (AWS)	0.749	0.168	0.917
Back Side	LTE Band 2 (PCS)	0.637	0.168	0.805

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.

12.5 Hotspot SAR Simultaneous Transmission Analysis

Per FCC KDB Publication 941225 D06, 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	0.351	0.268	0.619	Body SAR	Back	0.718	0.268	0.986
	Front	0.291	0.097	0.388		Front	0.579	0.097	0.676
	Top	-	0.085	0.085		Top	-	0.085	0.085
	Bottom	0.251	-	0.251		Bottom	0.525	-	0.525
	Right	0.301	0.116	0.417		Right	0.765	0.116	0.881
	Left	-	-	0.000		Left	-	-	0.000
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	0.792	0.268	1.060	Body SAR	Back	0.610	0.268	0.878
	Front	0.755	0.097	0.852		Front	0.587	0.097	0.684
	Top	-	0.085	0.085		Top	-	0.085	0.085
	Bottom	0.502	-	0.502		Bottom	0.515	-	0.515
	Right	-	0.116	0.116		Right	-	0.116	0.116
	Left	0.698	-	0.698		Left	0.600	-	0.600
Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	LTE Band 12 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.483	0.268	0.751	Body SAR	Back	0.441	0.268	0.709
	Front	0.721	0.097	0.818		Front	0.340	0.097	0.437
	Top	-	0.085	0.085		Top	-	0.085	0.085
	Bottom	0.368	-	0.368		Bottom	0.174	-	0.174
	Right	-	0.116	0.116		Right	0.562	0.116	0.678
	Left	0.672	-	0.672		Left	-	-	0.000

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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	0.749	0.268	1.017	Body SAR	Back	0.637	0.268	0.905
	Front	0.671	0.097	0.768		Front	0.633	0.097	0.730
	Top	-	0.085	0.085		Top	-	0.085	0.085
	Bottom	0.487	-	0.487		Bottom	0.292	-	0.292
	Right	-	0.116	0.116		Right	-	0.116	0.116
	Left	0.609	-	0.609		Left	0.690	-	0.690

Table 12-8
Simultaneous Transmission Scenario (5 GHz WLAN at 1.0 cm)

Simult Tx	Configuration	GPRS 850 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	UMTS 850 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.351	0.303	0.654	Body SAR	Back	0.718	0.303	1.021
	Front	0.291	0.236	0.527		Front	0.579	0.236	0.815
	Top	-	0.111	0.111		Top	-	0.111	0.111
	Bottom	0.251	-	0.251		Bottom	0.525	-	0.525
	Right	0.301	0.317	0.618		Right	0.765	0.317	1.082
	Left	-	-	0.000		Left	-	-	0.000
Simult Tx	Configuration	UMTS 1750 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)
Body SAR	Back	0.792	0.303	1.095	Body SAR	Back	0.610	0.303	0.913
	Front	0.755	0.236	0.991		Front	0.587	0.236	0.823
	Top	-	0.111	0.111		Top	-	0.111	0.111
	Bottom	0.502	-	0.502		Bottom	0.515	-	0.515
	Right	-	0.317	0.317		Right	-	0.317	0.317
	Left	0.698	-	0.698		Left	0.600	-	0.600
Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	LTE Band 12 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.483	0.303	0.786	Body SAR	Back	0.441	0.303	0.744
	Front	0.721	0.236	0.957		Front	0.340	0.236	0.576
	Top	-	0.111	0.111		Top	-	0.111	0.111
	Bottom	0.368	-	0.368		Bottom	0.174	-	0.174
	Right	-	0.317	0.317		Right	0.562	0.317	0.879
	Left	0.672	-	0.672		Left	-	-	0.000
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)
Body SAR	Back	0.749	0.303	1.052	Body SAR	Back	0.637	0.303	0.940
	Front	0.671	0.236	0.907		Front	0.633	0.236	0.869
	Top	-	0.111	0.111		Top	-	0.111	0.111
	Bottom	0.487	-	0.487		Bottom	0.292	-	0.292
	Right	-	0.317	0.317		Right	-	0.317	0.317
	Left	0.609	-	0.609		Left	0.690	-	0.690

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 and IEEE 1528-2013 Section 6.3.4.1.2.

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13 SAR MEASUREMENT VARIABILITY

13.1 Measurement Variability

Per FCC KDB Publication 865664 D01v01, SAR measurement variability was not assessed since measured SAR values for all frequency bands are below 0.80 W/kg

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 1528-2003 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	8648D	(9kHz-4GHz) Signal Generator	4/15/2014	Annual	4/15/2015	3629U00687
Agilent	8753E	(30kHz-6GHz) Network Analyzer	12/30/2014	Annual	12/30/2015	JP38020182
Agilent	8753ES	S-Parameter Network Analyzer	5/22/2014	Annual	5/22/2015	US39170118
Agilent	E4438C	ESG Vector Signal Generator	4/15/2014	Annual	4/15/2015	MY45091346
Agilent	E4438C	ESG Vector Signal Generator	4/1/2014	Annual	4/1/2015	MY47270002
Agilent	E8257D	(250kHz-20GHz) Signal Generator	4/15/2014	Annual	4/15/2015	MY45470194
Agilent	N5182A	MKG Vector Signal Generator	4/15/2014	Annual	4/15/2015	MY47420651
Agilent	N5182A	MKG Vector Signal Generator	4/15/2014	Annual	4/15/2015	MY47420800
Amplifier Research	1551G6	Amplifier	CBT	N/A	CBT	433971
Amplifier Research	1551G6	Amplifier	CBT	N/A	CBT	433977
Amplifier Research	1551G6	Amplifier	CBT	N/A	CBT	433978
Anritsu	MA24106A	USB Power Sensor	5/15/2014	Annual	5/15/2015	1244524
Anritsu	MA24106A	USB Power Sensor	5/14/2014	Annual	5/14/2015	1248508
Anritsu	MA2411B	Pulse Power Sensor	11/17/2014	Annual	11/17/2015	1126066
Anritsu	MA2411B	Pulse Power Sensor	11/17/2014	Annual	11/17/2015	1207364
Anritsu	ML2496A	Power Meter	3/14/2014	Annual	3/14/2015	1306009
Anritsu	ML2495A	Power Meter	10/31/2013	Biennial	10/31/2015	941001
Anritsu	MT8820C	Radio Communication Analyzer	9/19/2014	Annual	9/19/2015	620144418
COMTECH	AR85729-5	Solid State Amplifier	CBT	N/A	CBT	M155A00-009
COMTECH	AR85729-5/5759B	Solid State Amplifier	CBT	N/A	CBT	M3W1A00-1002
Control Company	4052	Long Stem Thermometer	9/27/2013	Biennial	9/27/2015	130567447
Control Company	36934-158	Wall-Mounted Thermometer	4/29/2014	Biennial	4/29/2016	122014488
Fisher Scientific	S407993	Long Stem Thermometer	11/4/2013	Biennial	11/4/2015	130671826
Fisher Scientific	S97611	Thermometer	4/12/2013	Biennial	4/12/2015	130219303
Gigatronics	80701A	(0.05-18GHz) Power Sensor	10/30/2014	Annual	10/30/2015	1833460
Gigatronics	8651A	Universal Power Meter	10/30/2014	Annual	10/30/2015	8650319
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	Power Attenuator	CBT	N/A	CBT	1226
Mini-Circuits	BW-N20W5+	DC to 18 GHz Precision Fixed 20dB Attenuator	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-1200+	Low Pass Filter DC to 1000 MHz	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-2950+	Low Pass Filter DC to 2700 MHz	CBT	N/A	CBT	N/A
Mitutoyo	CD-6"CSX	Digital Caliper	5/8/2014	Biennial	5/8/2016	13264162
Mitutoyo	CD-6"CSX	Digital Caliper	5/8/2014	Biennial	5/8/2016	13264165
Narda	4014C-6	4 - 8 GHz SMA 6 dB Directional Coupler	CBT	N/A	CBT	N/A
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Narda	BW-53W2	Attenuator (3dB)	CBT	N/A	CBT	120
Pasternack	PE2208-6	Bidirectional Coupler	CBT	N/A	CBT	N/A
Pasternack	PE2209-10	Bidirectional Coupler	CBT	N/A	CBT	N/A
Rohde & Schwarz	CMW500	Radio Communication Tester	7/22/2014	Annual	7/22/2015	116743
Rohde & Schwarz	CMW500	Radio Communication Tester	2/20/2014	Annual	2/20/2015	128633
Seekonk	NC-100	Torque Wrench	3/18/2014	Biennial	3/18/2016	22313
Seekonk	NC-100	Torque Wrench 5/16", 8" lbs	3/18/2014	Biennial	3/18/2016	N/A
Seekonk	NC-100	Torque Wrench	3/18/2014	Biennial	3/18/2016	N/A
Seekonk	NC-100	Torque Wrench	3/18/2014	Biennial	3/18/2016	N/A
SPEAG	D1750V2	1750 MHz SAR Dipole	4/10/2014	Annual	4/10/2015	1051
SPEAG	D1900V2	1900 MHz SAR Dipole	4/9/2014	Annual	4/9/2015	5d141
SPEAG	D1900V2	1900 MHz SAR Dipole	2/27/2014	Annual	2/27/2015	5d148
SPEAG	D2450V2	2450 MHz SAR Dipole	8/11/2014	Annual	8/11/2015	719
SPEAG	D5GHzV2	5 GHz SAR Dipole	2/26/2014	Annual	2/26/2015	1120
SPEAG	D750V3	750 MHz Dipole	3/17/2014	Annual	3/17/2015	1054
SPEAG	D835V2	835 MHz SAR Dipole	4/7/2014	Annual	4/7/2015	4d119
SPEAG	D835V2	835 MHz SAR Dipole	7/24/2014	Annual	7/24/2015	4d133
SPEAG	DAE4	Dasy Data Acquisition Electronics	8/12/2014	Annual	8/12/2015	1322
SPEAG	DAE4	Dasy Data Acquisition Electronics	9/17/2014	Annual	9/17/2015	1323
SPEAG	DAE4	Dasy Data Acquisition Electronics	10/31/2014	Annual	10/31/2015	1333
SPEAG	DAE4	Dasy Data Acquisition Electronics	3/17/2014	Annual	3/17/2015	1334
SPEAG	DAE4	Dasy Data Acquisition Electronics	9/18/2014	Annual	9/18/2015	1364
SPEAG	DAE4	Dasy Data Acquisition Electronics	4/11/2014	Annual	4/11/2015	1368
SPEAG	DAE4	Dasy Data Acquisition Electronics	10/23/2014	Annual	10/23/2015	1408
SPEAG	DAE4	Dasy Data Acquisition Electronics	12/12/2014	Annual	12/12/2015	1415
SPEAG	DAK-3.5	Dielectric Assessment Kit	5/6/2014	Annual	5/6/2015	1070
SPEAG	ES3DV2	SAR Probe	8/19/2014	Annual	8/19/2015	3022
SPEAG	ES3DV3	SAR Probe	3/19/2014	Annual	3/19/2015	3209
SPEAG	ES3DV3	SAR Probe	9/24/2014	Annual	9/24/2015	3288
SPEAG	ES3DV3	SAR Probe	8/20/2014	Annual	8/20/2015	3331
SPEAG	ES3DV3	SAR Probe	9/18/2014	Annual	9/18/2015	3332
SPEAG	ES3DV3	SAR Probe	10/24/2014	Annual	10/24/2015	3333
SPEAG	ES3DV3	SAR Probe	12/16/2014	Annual	12/16/2015	3334
SPEAG	EX3DV4	SAR Probe	12/12/2014	Annual	12/12/2015	3920
SPEAG	EX3DV4	SAR Probe	8/21/2014	Annual	8/21/2015	3949
Tektronix	RSA6114A	Real Time Spectrum Analyzer	4/16/2014	Annual	4/16/2015	8010177
VWR	36934-158	Wall-Mounted Thermometer	4/29/2014	Biennial	4/29/2016	111859323
VWR	36934-158	Wall-Mounted Thermometer	8/8/2013	Biennial	8/8/2015	130477877

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
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
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: ZNFH631; Type: Portable Handset; Serial: 1401-12

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

Medium: 835 Head Medium parameters used (interpolated):

$f = 836.6 \text{ MHz}$; $\sigma = 0.902 \text{ S/m}$; $\epsilon_r = 41.011$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Test Date: 01-19-2015; Ambient Temp: 23.1°C; Tissue Temp: 23.0°C

Probe: ES3DV2 - SN3022; ConvF(6.18, 6.18, 6.18); Calibrated: 8/19/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1322; Calibrated: 8/12/2014

Phantom: SAM with CRP v4.0; Type: QD000P40CD; Serial: TP:1800

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: GSM 850, Right Head, Cheek, Mid.ch

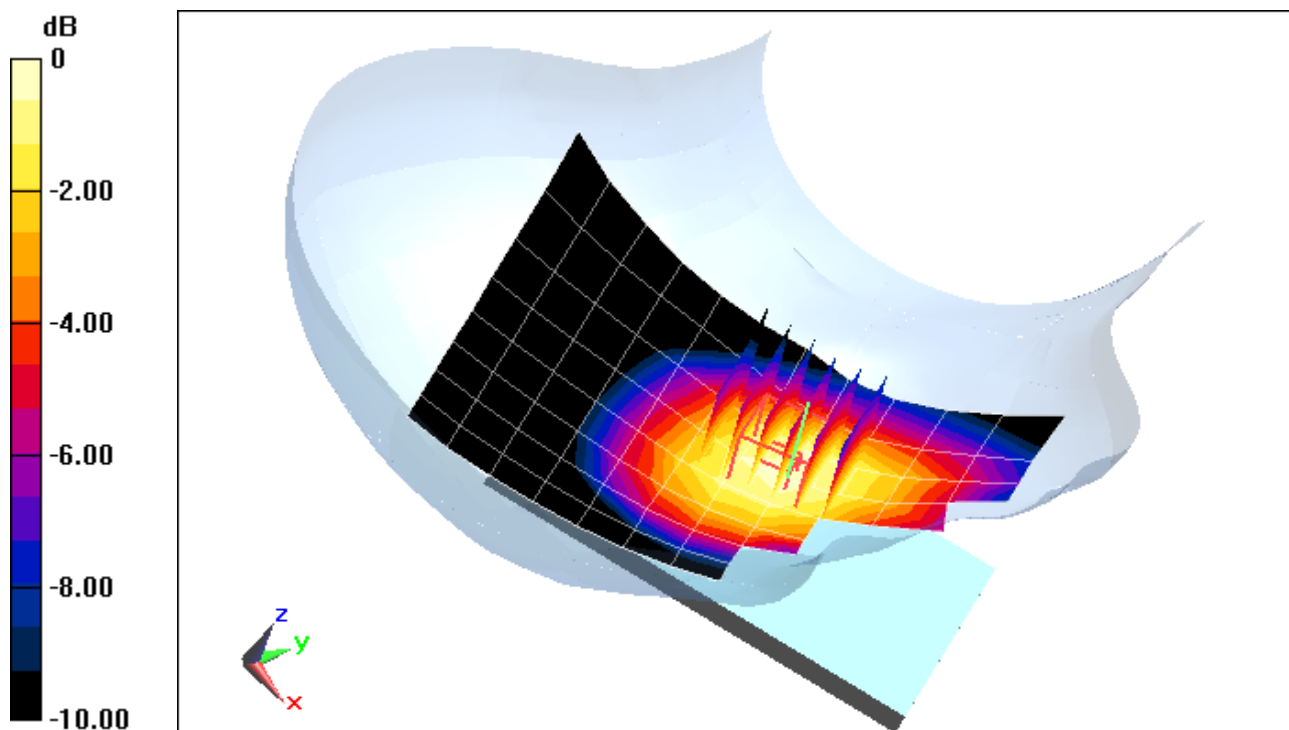
Area Scan (9x15x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 19.41 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 0.411 W/kg

SAR(1 g) = 0.319 W/kg



0 dB = 0.347 W/kg = -4.60 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-12

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

Medium: 835 Head Medium parameters used (interpolated):

$f = 836.6 \text{ MHz}$; $\sigma = 0.902 \text{ S/m}$; $\epsilon_r = 41.011$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Test Date: 01-19-2015; Ambient Temp: 23.1°C; Tissue Temp: 23.0°C

Probe: ES3DV2 - SN3022; ConvF(6.18, 6.18, 6.18); Calibrated: 8/19/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1322; Calibrated: 8/12/2014

Phantom: SAM with CRP v4.0; Type: QD000P40CD; Serial: TP:1800

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

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

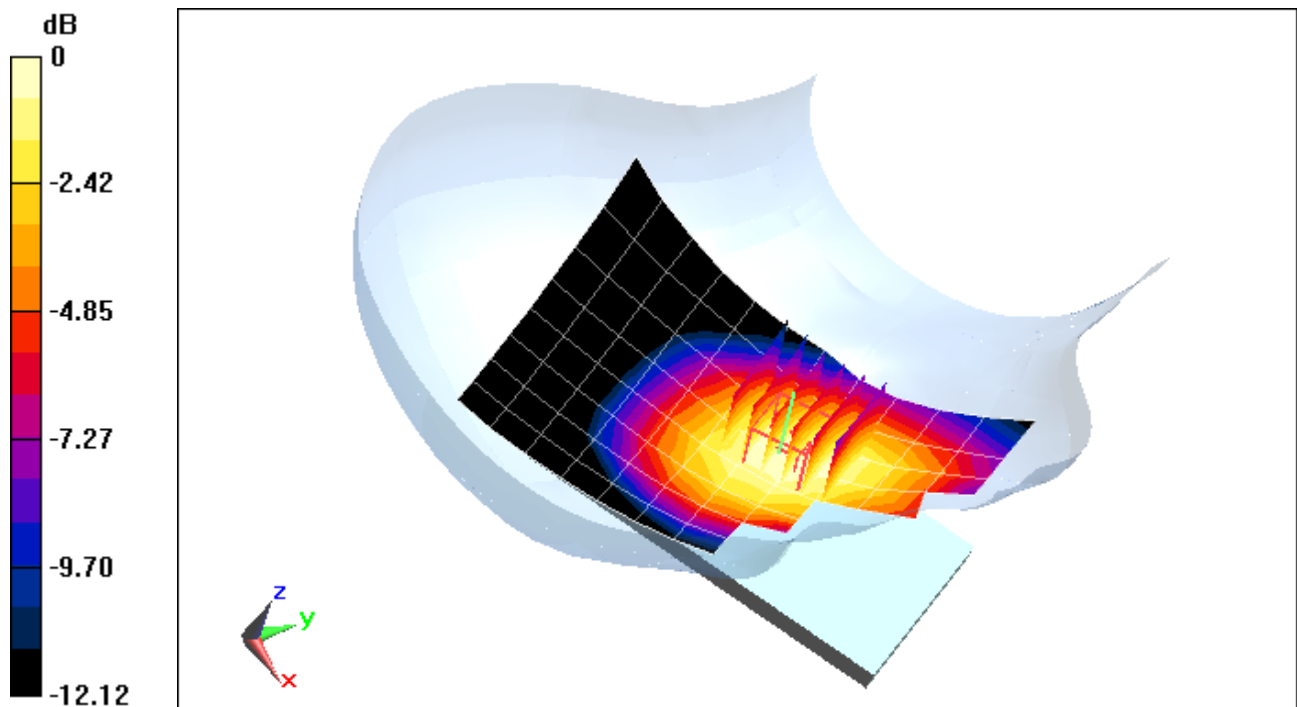
Area Scan (9x15x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 25.76 V/m; Power Drift = -0.10 dB

Peak SAR (extrapolated) = 0.706 W/kg

SAR(1 g) = 0.543 W/kg



0 dB = 0.590 W/kg = -2.29 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-12

Communication System: UID 0, UMTS (0); Frequency: 1732.4 MHz; Duty Cycle: 1:1

Medium: 1750 Head Medium parameters used (interpolated):

$f = 1732.4 \text{ MHz}$; $\sigma = 1.344 \text{ S/m}$; $\epsilon_r = 39.265$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Left Section

Test Date: 01-21-2015; Ambient Temp: 24.0°C; Tissue Temp: 22.4°C

Probe: ES3DV3 - SN3331; ConvF(5.28, 5.28, 5.28); Calibrated: 8/20/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 10/31/2014

Phantom: SAM Main ; Type: QD000P40CC; Serial: TP 1114

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

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

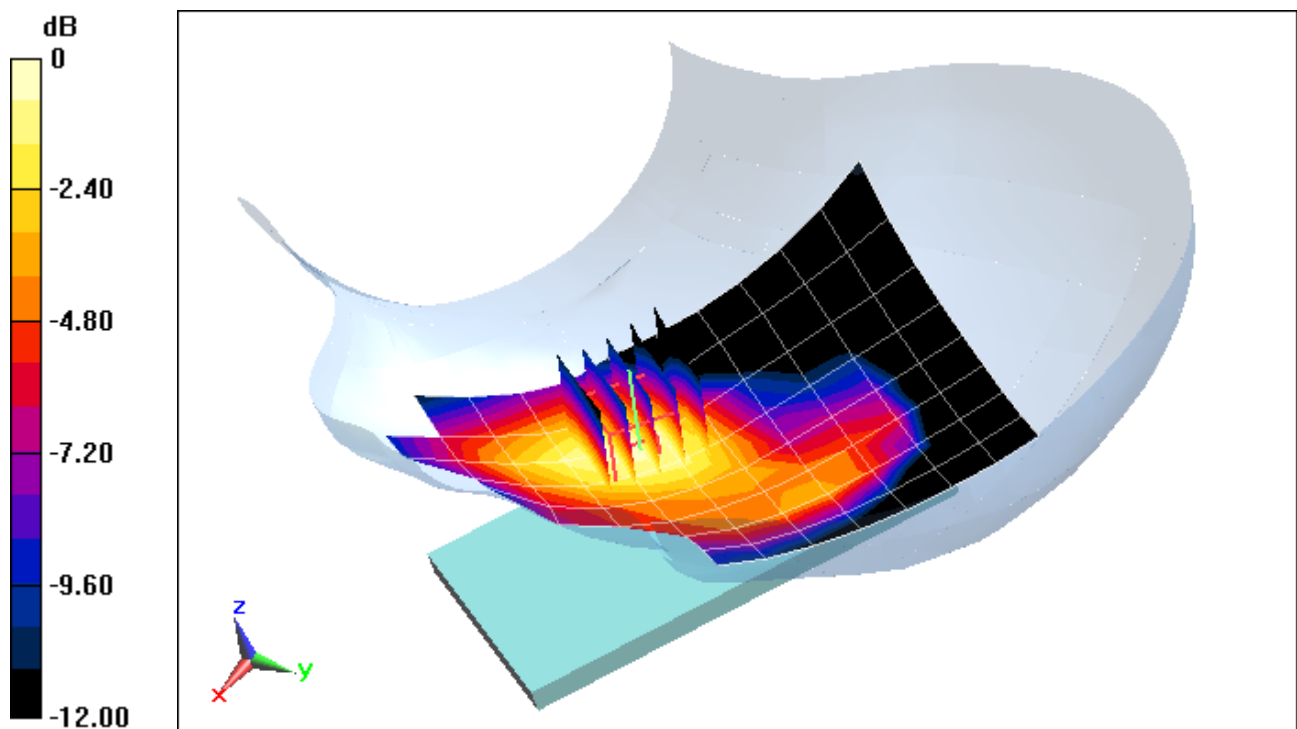
Area Scan (9x15x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 21.97 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 0.886 W/kg

SAR(1 g) = 0.602 W/kg



0 dB = 0.702 W/kg = -1.54 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-12

Communication System: UID 0, GSM1900 GPRS; 3 Tx slots; Frequency: 1880 MHz; Duty Cycle: 1:2.76

Medium: 1900 Head Medium parameters used:

$f = 1880 \text{ MHz}$; $\sigma = 1.419 \text{ S/m}$; $\epsilon_r = 38.785$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Left Section

Test Date: 01-20-2015; Ambient Temp: 21.6°C; Tissue Temp: 21.0°C

Probe: ES3DV3 - SN3333; ConvF(5.11, 5.11, 5.11); Calibrated: 10/24/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1408; Calibrated: 10/23/2014

Phantom: Sub TWIN SAM; Type: QD000P40CC; Serial: TP-1357

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: GPRS 1900, Left Head, Cheek, Mid.ch, 3 Tx slots

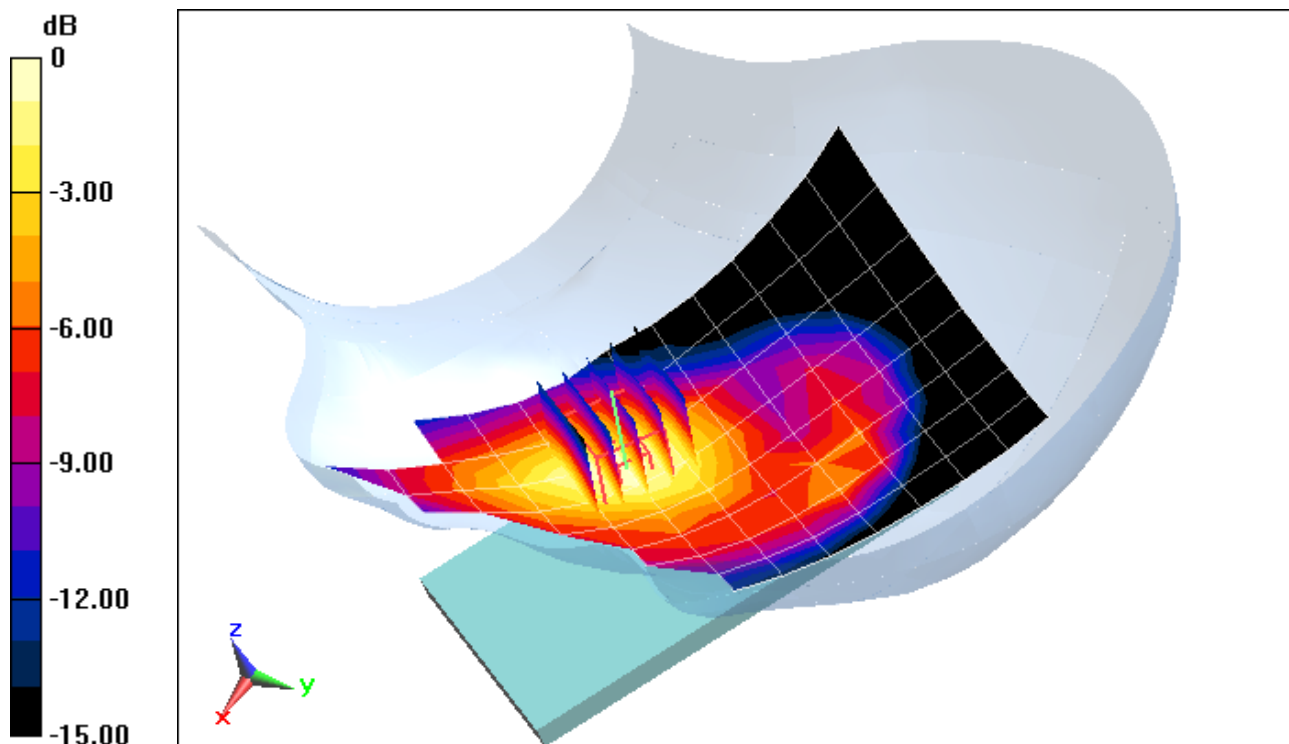
Area Scan (9x15x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 15.73 V/m; Power Drift = -0.17 dB

Peak SAR (extrapolated) = 0.506 W/kg

SAR(1 g) = 0.328 W/kg



PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-12

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

Medium: 1900 Head Medium parameters used:

$f = 1880 \text{ MHz}$; $\sigma = 1.419 \text{ S/m}$; $\epsilon_r = 38.785$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Left Section

Test Date: 01-20-2015; Ambient Temp: 21.6°C; Tissue Temp: 21.0°C

Probe: ES3DV3 - SN3333; ConvF(5.11, 5.11, 5.11); Calibrated: 10/24/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1408; Calibrated: 10/23/2014

Phantom: Sub TWIN SAM; Type: QD000P40CC; Serial: TP-1357

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

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

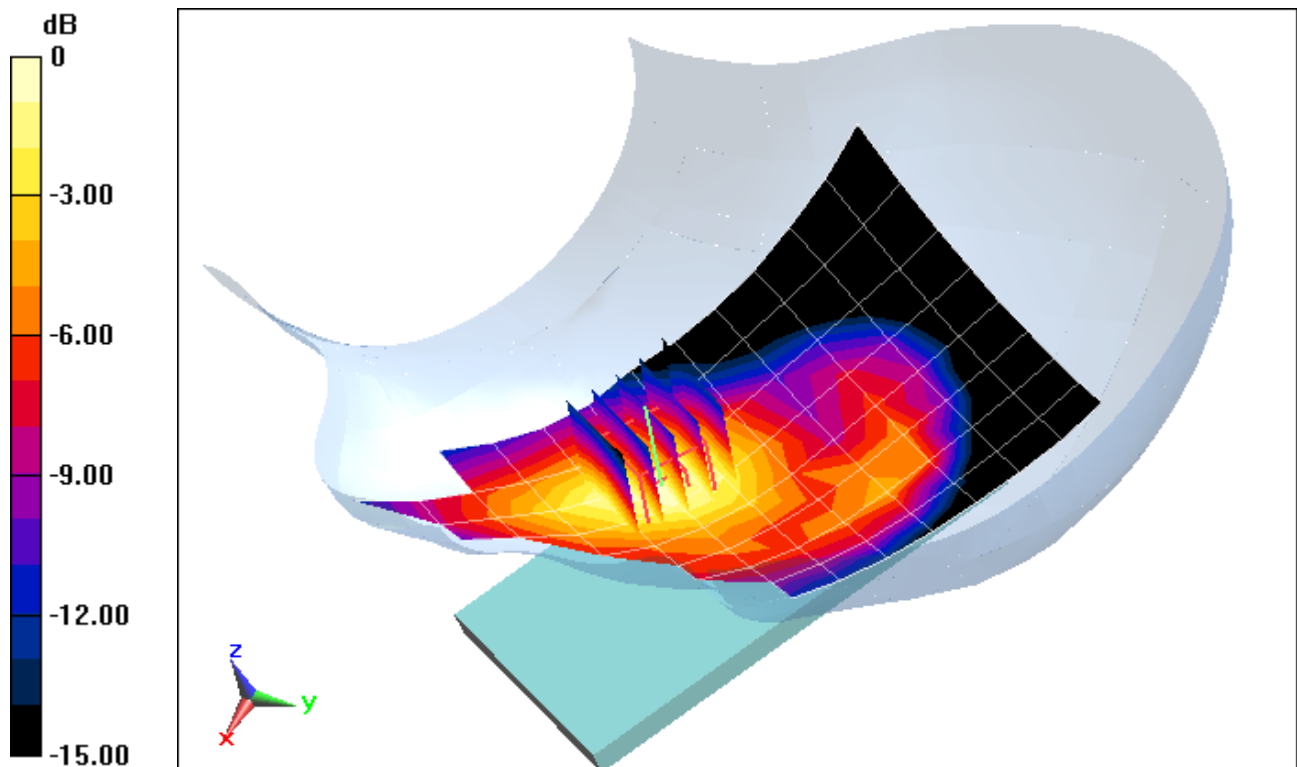
Area Scan (9x15x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 21.55 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 0.945 W/kg

SAR(1 g) = 0.613 W/kg



0 dB = 0.728 W/kg = -1.38 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-7

Communication System: UID 0, LTE Band 12 (0); Frequency: 707.5 MHz; Duty Cycle: 1:1

Medium: 740 Head Medium parameters used (interpolated):

$f = 707.5 \text{ MHz}$; $\sigma = 0.865 \text{ S/m}$; $\epsilon_r = 41.472$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Test Date: 01-22-2015; Ambient Temp: 24.0°C; Tissue Temp: 21.2°C

Probe: ES3DV3 - SN3288; ConvF(6.81, 6.81, 6.81); Calibrated: 9/24/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1364; Calibrated: 9/18/2014

Phantom: SAM with CRP v4.0; Type: QD000P40CD; Serial: TP:1797

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: LTE Band 12, Right Head, Cheek, Mid.ch

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

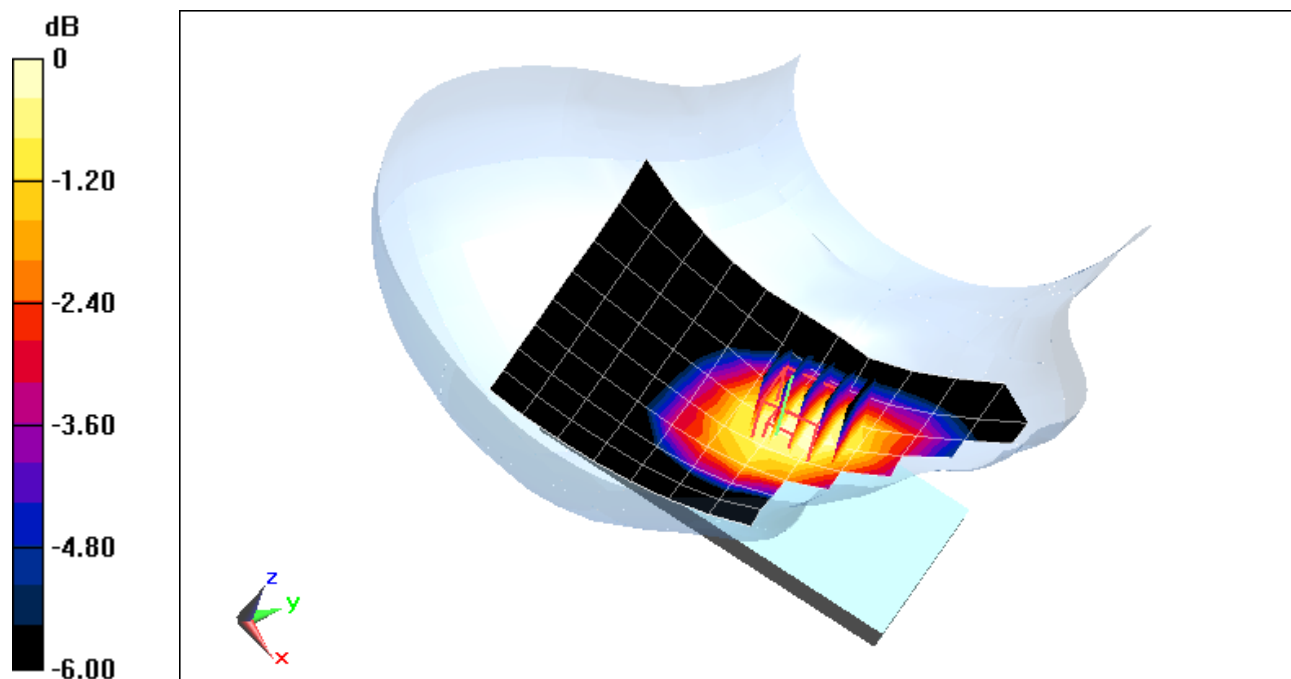
Area Scan (9x13x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 17.30 V/m; Power Drift = -0.16 dB

Peak SAR (extrapolated) = 0.290 W/kg

SAR(1 g) = 0.229 W/kg



0 dB = 0.256 W/kg = -5.92 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-7

Communication System: UID 0, LTE RF Band 4 (0); Frequency: 1732.5 MHz; Duty Cycle: 1:1

Medium: 1750 Head Medium parameters used (interpolated):

$f = 1732.5 \text{ MHz}$; $\sigma = 1.344 \text{ S/m}$; $\epsilon_r = 39.265$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Left Section

Test Date: 01-21-2015; Ambient Temp: 24.0°C; Tissue Temp: 22.4°C

Probe: ES3DV3 - SN3331; ConvF(5.28, 5.28, 5.28); Calibrated: 8/20/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 10/31/2014

Phantom: SAM Main ; Type: QD000P40CC; Serial: TP 1114

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: LTE Band 4 (AWS), Left Head, Cheek, Mid.ch

20 MHz Bandwidth, QPSK, 1 RB, 0 RB Offset

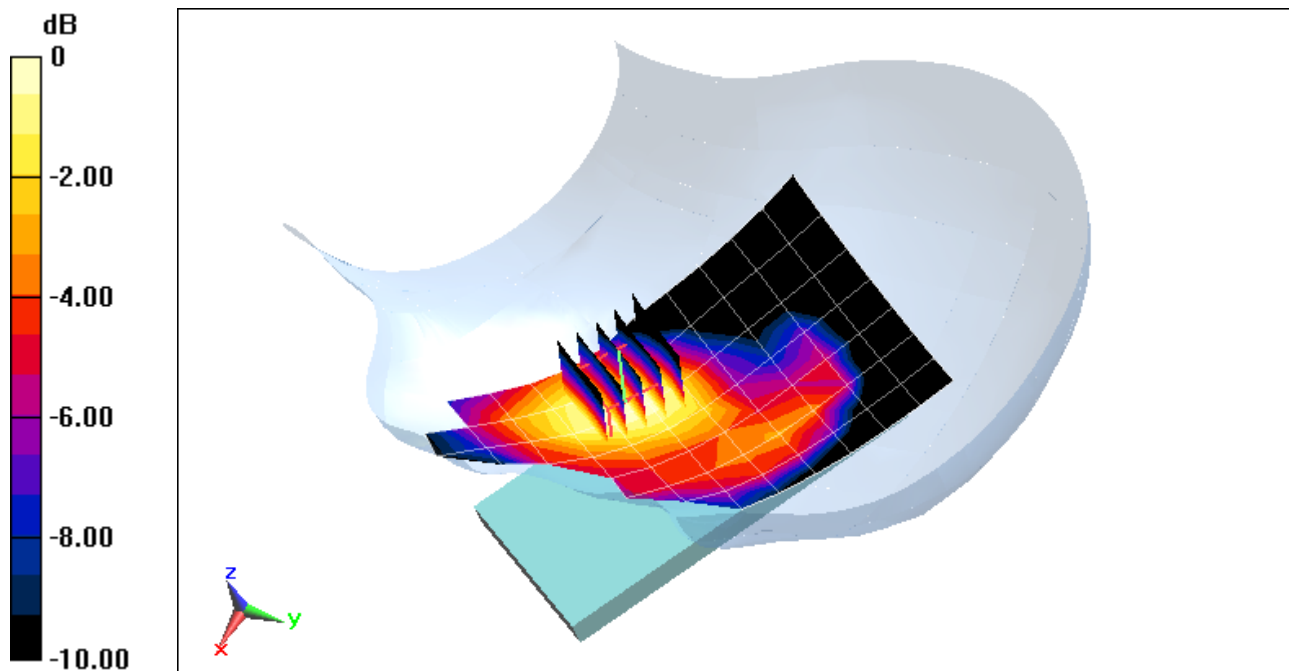
Area Scan (8x13x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 22.96 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 0.794 W/kg

SAR(1 g) = 0.535 W/kg



0 dB = 0.628 W/kg = -2.02 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-7

Communication System: UID 0, LTE Band 2 (PCS) (0); Frequency: 1860 MHz; Duty Cycle: 1:1

Medium: 1900 Head Medium parameters used (interpolated):

$f = 1860 \text{ MHz}$; $\sigma = 1.398 \text{ S/m}$; $\epsilon_r = 38.872$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Left Section

Test Date: 01-20-2015; Ambient Temp: 21.6°C; Tissue Temp: 21.0°C

Probe: ES3DV3 - SN3333; ConvF(5.11, 5.11, 5.11); Calibrated: 10/24/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1408; Calibrated: 10/23/2014

Phantom: Sub TWIN SAM; Type: QD000P40CC; Serial: TP-1357

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: LTE Band 2 (PCS), Left Head, Cheek, Low.ch
20 MHz Bandwidth, QPSK, 1 RB, 0 RB Offset

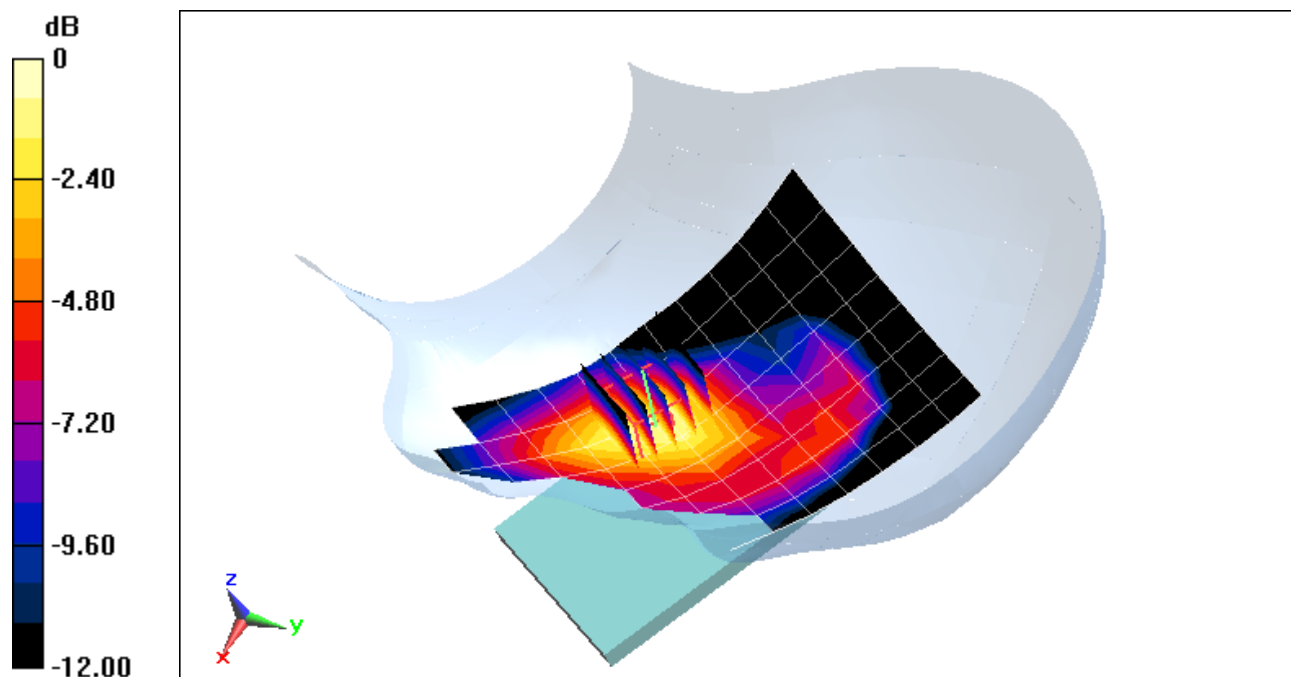
Area Scan (9x13x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 24.26 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 1.07 W/kg

SAR(1 g) = 0.705 W/kg



0 dB = 0.827 W/kg = -0.82 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-8

Communication System: UID 0, IEEE 802.11b; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium: 2450 Head Medium parameters used (interpolated):

$f = 2437 \text{ MHz}$; $\sigma = 1.834 \text{ S/m}$; $\epsilon_r = 40.523$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Left Section

Test Date: 01-20-2015; Ambient Temp: 21.9°C; Tissue Temp: 23.0°C

Probe: ES3DV3 - SN3209; ConvF(4.54, 4.54, 4.54); Calibrated: 3/19/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1334; Calibrated: 3/17/2014

Phantom: SAM Right; Type: SAM; Serial: 1757

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: IEEE 802.11b, Left Head, Cheek, Ch 06, 1 Mbps

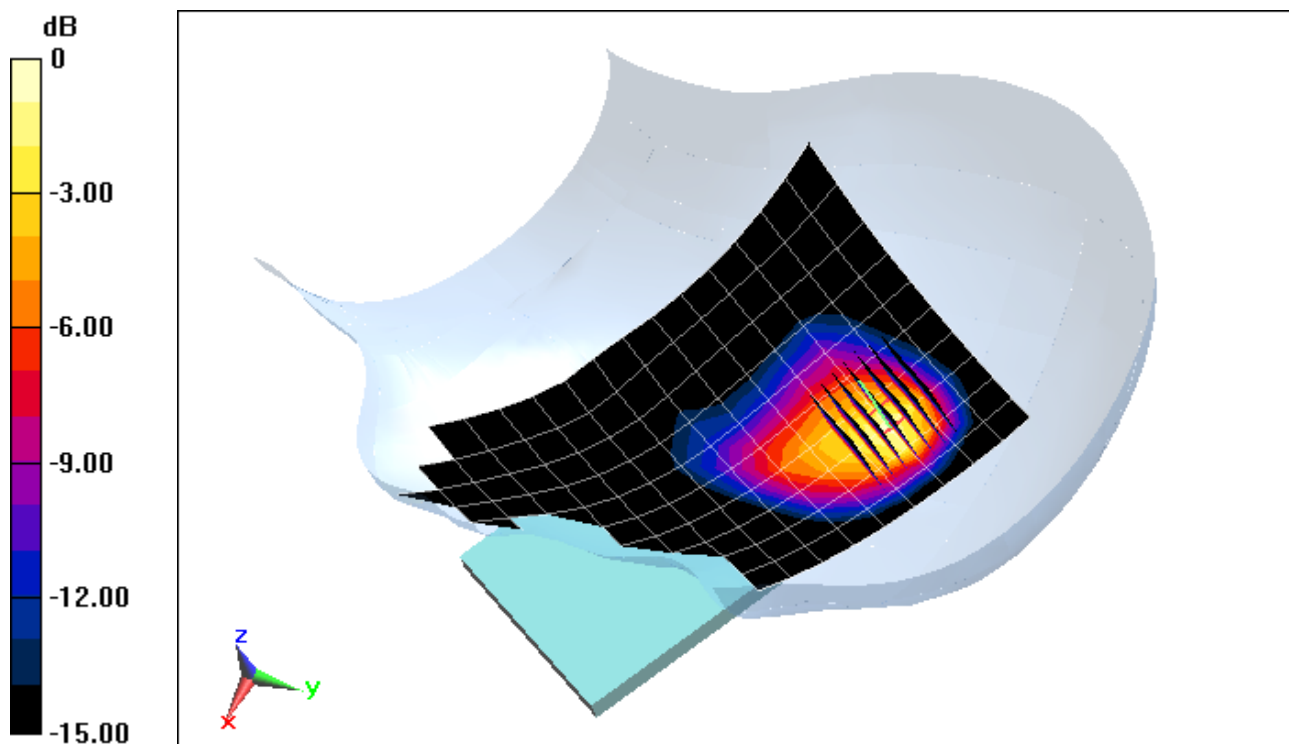
Area Scan (11x18x1): Measurement grid: $dx=12\text{mm}$, $dy=12\text{mm}$

Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 15.89 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 0.921 W/kg

SAR(1 g) = 0.416 W/kg



0 dB = 0.541 W/kg = -2.67 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-8

Communication System: UID 0, 802.11a 5.2-5.8 GHz Band (0); Frequency: 5320 MHz; Duty Cycle: 1:1

Medium: 5 GHz Head Medium parameters used:

$f = 5320 \text{ MHz}$; $\sigma = 4.575 \text{ S/m}$; $\epsilon_r = 35.543$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Left Section

Test Date: 01-23-2015; Ambient Temp: 23.9°C; Tissue Temp: 21.5°C

Probe: EX3DV4 - SN3920; ConvF(4.69, 4.69, 4.69); Calibrated: 12/12/2014;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1368; Calibrated: 4/11/2014

Phantom: SAM, Left; Type: QD000P40CD; Serial: TP:1759

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: IEEE 802.11a, 5.3 GHz, Left Head, Cheek, Ch 64, 6 Mbps

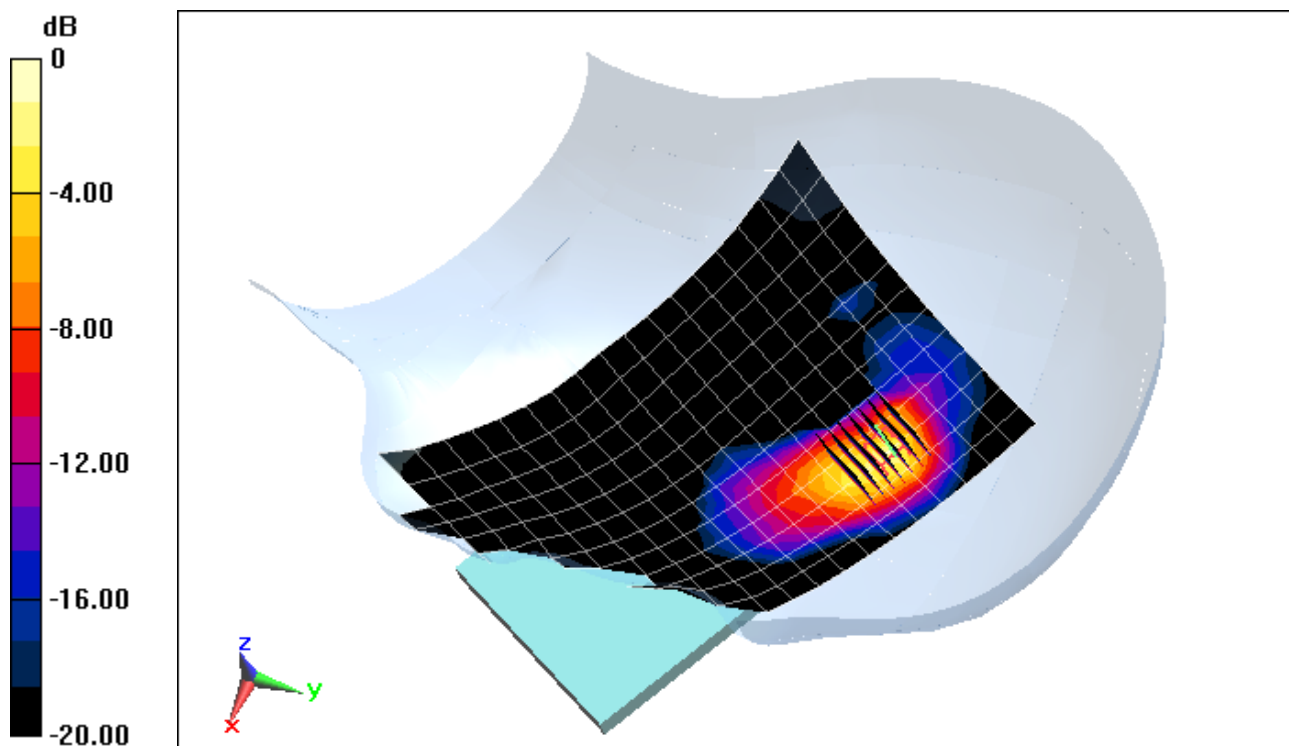
Area Scan (13x20x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

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

Reference Value = 12.28 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 2.63 W/kg

SAR(1 g) = 0.642 W/kg



0 dB = 1.57 W/kg = 1.96 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-12

Communication System: UID 0, GSM GPRS; 4 Tx slots (0); Frequency: 836.6 MHz; Duty Cycle: 1:2.076

Medium: 835 Body Medium parameters used (interpolated):

$f = 836.6 \text{ MHz}$; $\sigma = 0.958 \text{ S/m}$; $\epsilon_r = 54.208$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-20-2015; Ambient Temp: 22.6°C; Tissue Temp: 20.0°C

Probe: ES3DV3 - SN3334; ConvF(6.14, 6.14, 6.14); Calibrated: 12/16/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1415; Calibrated: 12/12/2014

Phantom: Main Twin Sam; Type: QD000P40CC; Serial: TP: 1375

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: GPRS 850, Body SAR, Back side, Mid.ch, 4 Tx Slots

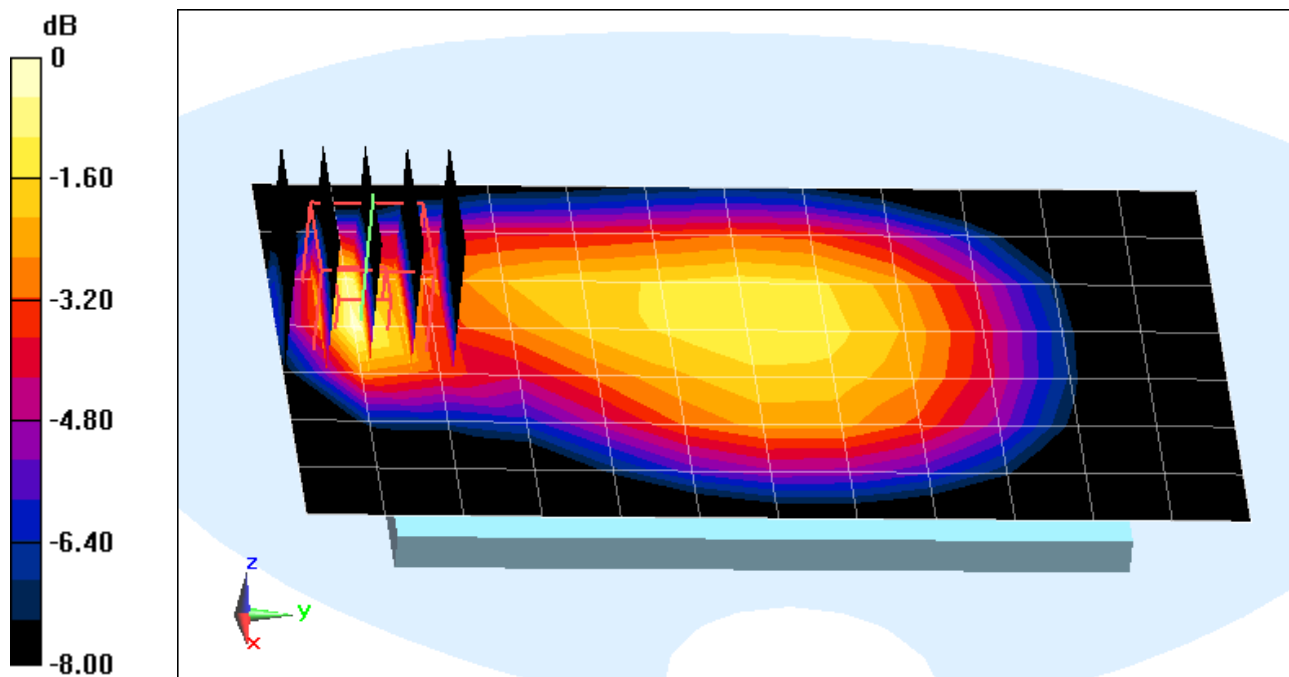
Area Scan (8x13x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 19.60 V/m; Power Drift = -0.15 dB

Peak SAR (extrapolated) = 0.591 W/kg

SAR(1 g) = 0.336 W/kg



PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-12

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

Medium: 835 Body Medium parameters used (interpolated):

$f = 836.6 \text{ MHz}$; $\sigma = 0.958 \text{ S/m}$; $\epsilon_r = 54.208$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-20-2015; Ambient Temp: 22.6°C; Tissue Temp: 20.0°C

Probe: ES3DV3 - SN3334; ConvF(6.14, 6.14, 6.14); Calibrated: 12/16/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1415; Calibrated: 12/12/2014

Phantom: Main Twin Sam; Type: QD000P40CC; Serial: TP: 1375

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

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

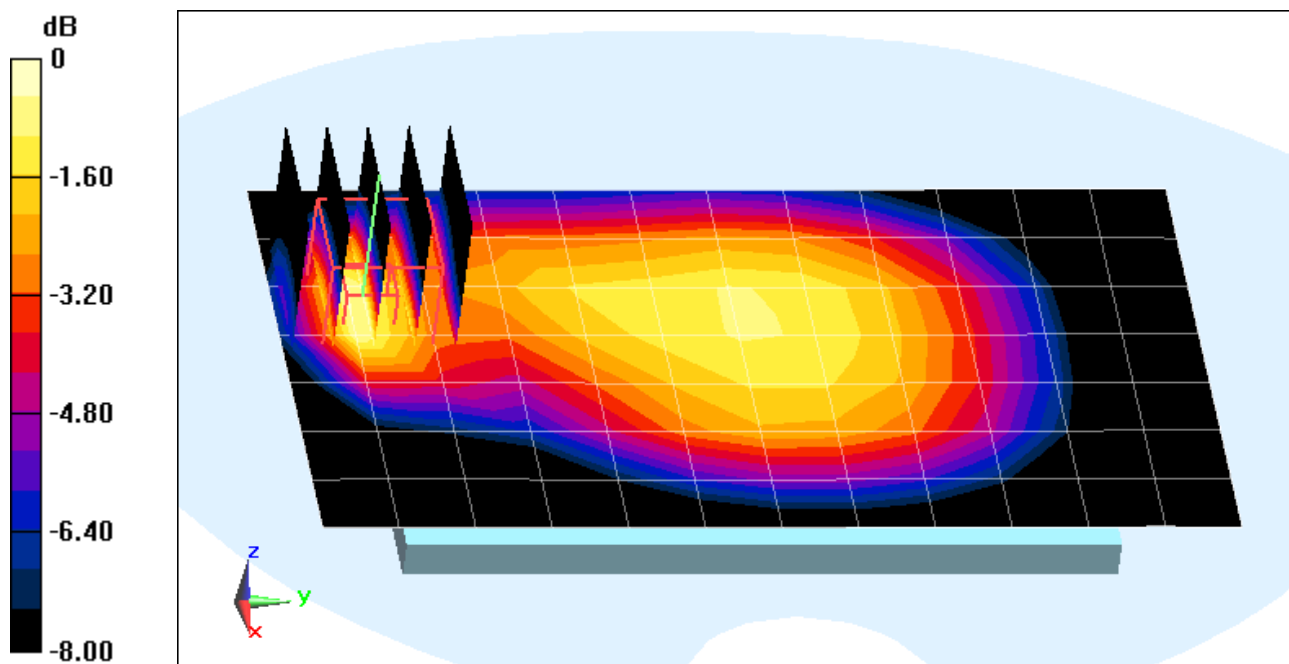
Area Scan (8x13x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 27.28 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 1.17 W/kg

SAR(1 g) = 0.679 W/kg



0 dB = 0.844 W/kg = -0.74 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-12

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

Medium: 835 Body Medium parameters used (interpolated):

$f = 836.6 \text{ MHz}$; $\sigma = 0.958 \text{ S/m}$; $\epsilon_r = 54.208$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-20-2015; Ambient Temp: 22.6°C; Tissue Temp: 20.0°C

Probe: ES3DV3 - SN3334; ConvF(6.14, 6.14, 6.14); Calibrated: 12/16/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1415; Calibrated: 12/12/2014

Phantom: Main Twin Sam; Type: QD000P40CC; Serial: TP: 1375

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: UMTS 850, Body SAR, Right Edge, Mid.ch

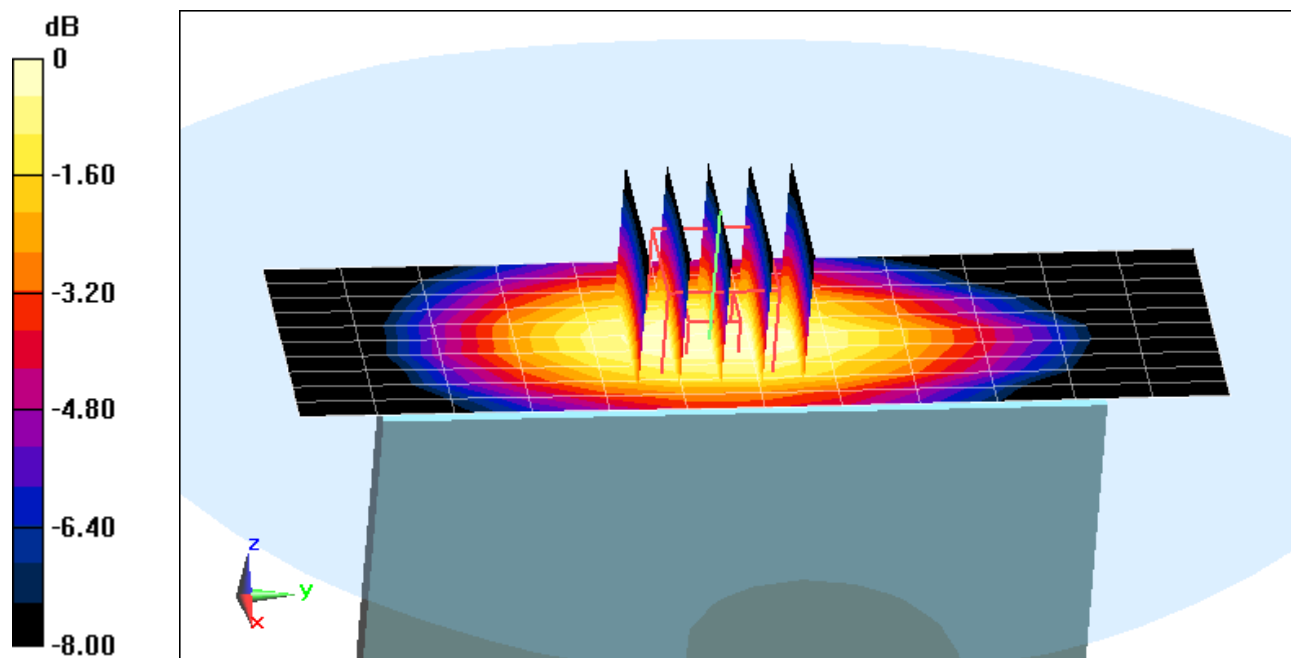
Area Scan (11x13x1): Measurement grid: $dx=5\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 28.61 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 1.00 W/kg

SAR(1 g) = 0.724 W/kg



0 dB = 0.829 W/kg = -0.81 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-12

Communication System: UID 0, UMTS (0); Frequency: 1732.4 MHz; Duty Cycle: 1:1

Medium: 1750 Body Medium parameters used (interpolated):

$f = 1732.4 \text{ MHz}$; $\sigma = 1.516 \text{ S/m}$; $\epsilon_r = 51.019$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-21-2015; Ambient Temp: 21.5°C; Tissue Temp: 21.4°C

Probe: ES3DV3 - SN3333; ConvF(4.89, 4.89, 4.89); Calibrated: 10/24/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1408; Calibrated: 10/23/2014

Phantom: Sub TWIN SAM; Type: QD000P40CC; Serial: TP-1357

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: AWS UMTS, Body SAR, Back side, Mid.ch

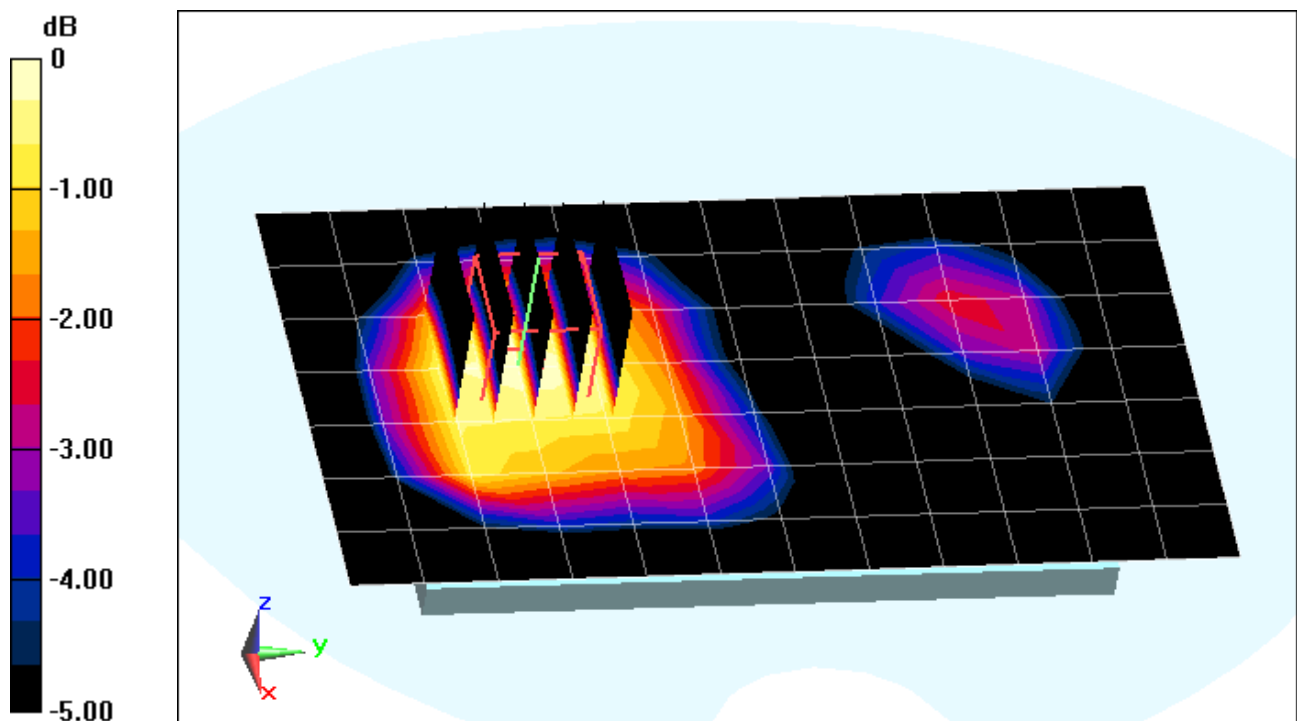
Area Scan (8x13x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 22.92 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 1.11 W/kg

SAR(1 g) = 0.746 W/kg



0 dB = 0.855 W/kg = -0.68 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-12

Communication System: UID 0, GSM GPRS; 3 Tx slots; Frequency: 1880 MHz; Duty Cycle: 1:2.76

Medium: 1900 Body Medium parameters used:

$f = 1880 \text{ MHz}$; $\sigma = 1.519 \text{ S/m}$; $\epsilon_r = 51.052$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-20-2015; Ambient Temp: 23.4°C; Tissue Temp: 22.8°C

Probe: ES3DV2 - SN3022; ConvF(4.49, 4.49, 4.49); Calibrated: 8/19/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1322; Calibrated: 8/12/2014

Phantom: ELI v5.0; Type: QDOVA001BB; Serial: 1226

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: GPRS 1900, Body SAR, Back side, Mid.ch, 3 Tx Slots

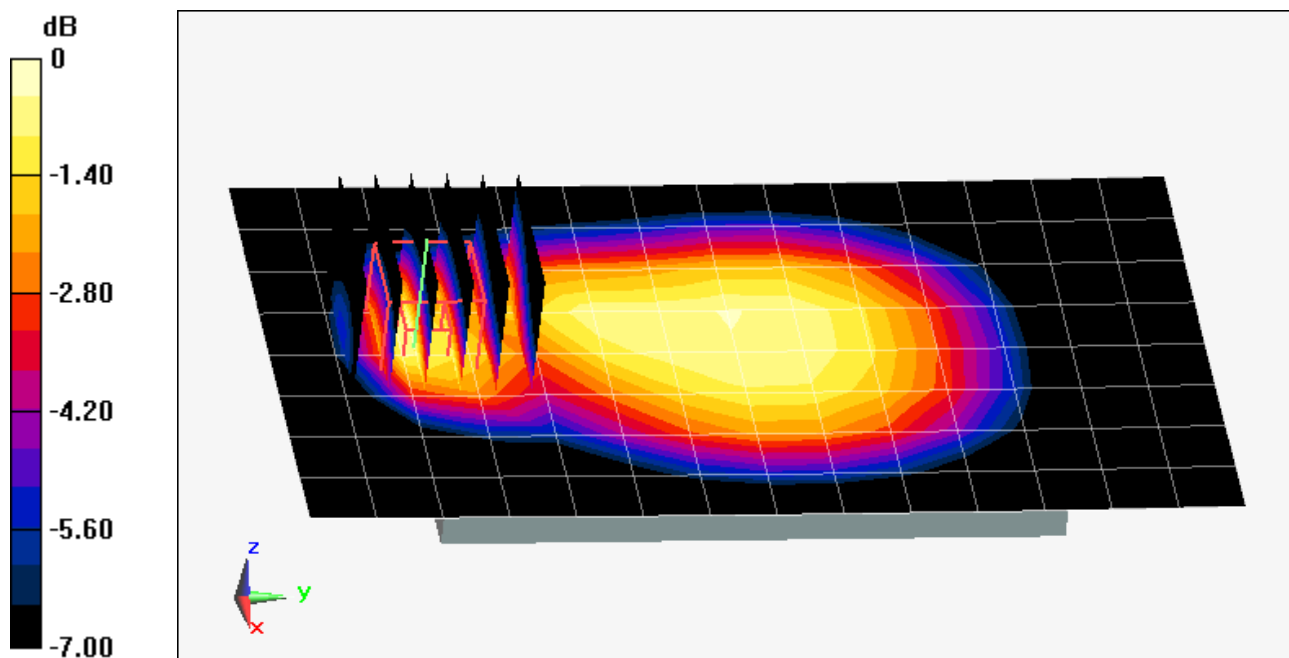
Area Scan (9x15x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 20.41 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 0.877 W/kg

SAR(1 g) = 0.574 W/kg



0 dB = 0.664 W/kg = -1.78 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-12

Communication System: UID 0, UMTS; Frequency: 1880 MHz; Duty Cycle: 1:1
Medium: 1900 Body Medium parameters used:

$f = 1880 \text{ MHz}$; $\sigma = 1.519 \text{ S/m}$; $\epsilon_r = 51.052$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-20-2015; Ambient Temp: 23.4°C; Tissue Temp: 22.8°C

Probe: ES3DV2 - SN3022; ConvF(4.49, 4.49, 4.49); Calibrated: 8/19/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1322; Calibrated: 8/12/2014

Phantom: ELI v5.0; Type: QDOVA001BB; Serial: 1226

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

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

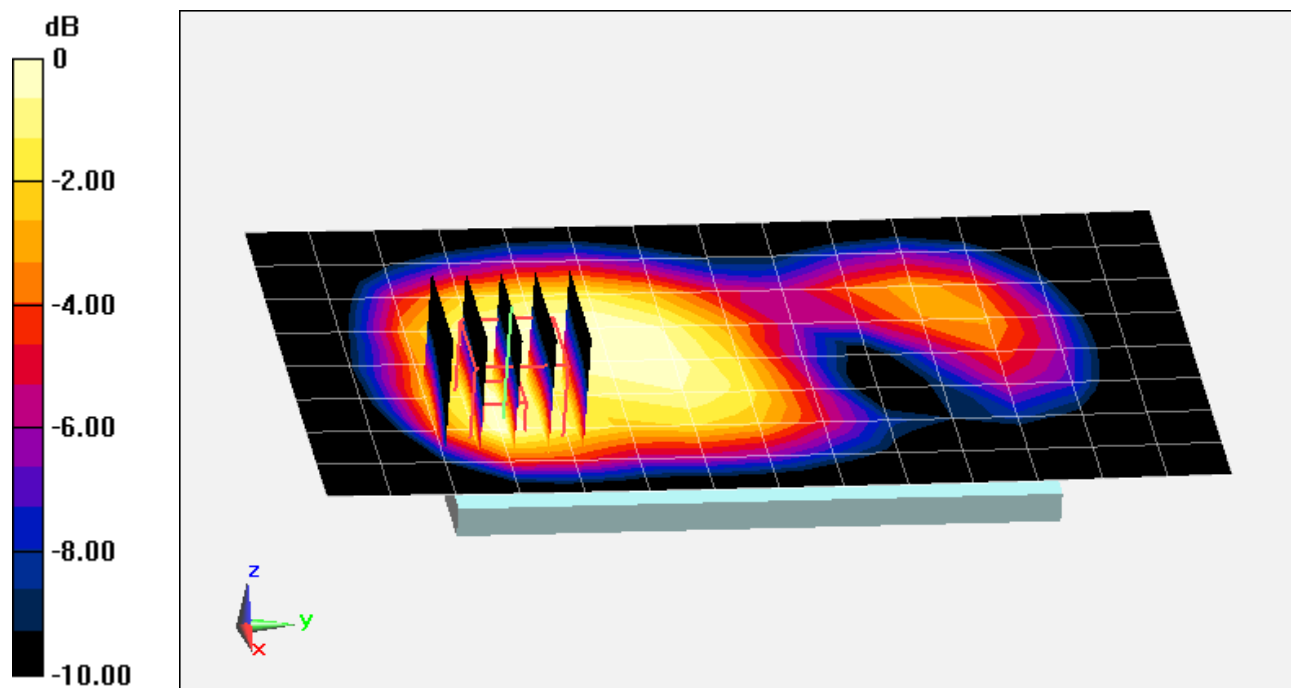
Area Scan (9x15x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 18.69 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 0.822 W/kg

SAR(1 g) = 0.468 W/kg



0 dB = 0.569 W/kg = -2.45 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-12

Communication System: UID 0, UMTS; Frequency: 1880 MHz; Duty Cycle: 1:1
Medium: 1900 Body Medium parameters used:

$f = 1880 \text{ MHz}$; $\sigma = 1.519 \text{ S/m}$; $\epsilon_r = 51.052$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-20-2015; Ambient Temp: 23.4°C; Tissue Temp: 22.8°C

Probe: ES3DV2 - SN3022; ConvF(4.49, 4.49, 4.49); Calibrated: 8/19/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1322; Calibrated: 8/12/2014

Phantom: ELI v5.0; Type: QDOVA001BB; Serial: 1226

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: UMTS 1900, Body SAR, Front side, Mid.ch

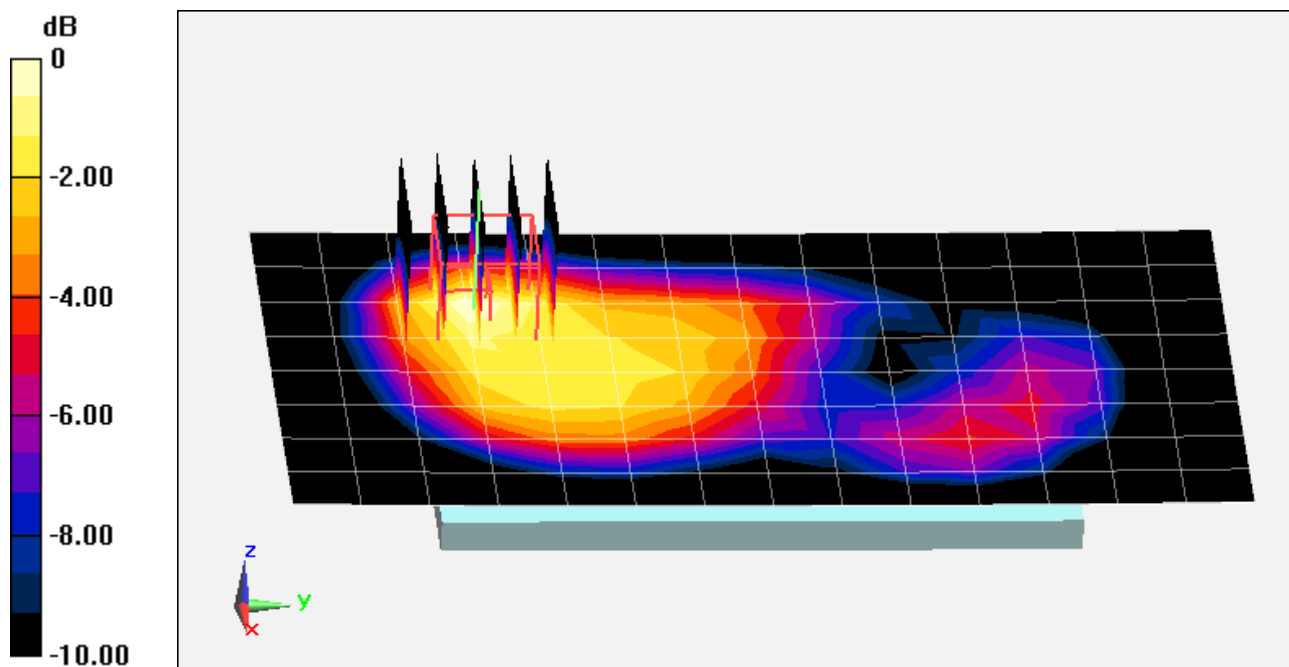
Area Scan (9x15x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 22.90 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 1.18 W/kg

SAR(1 g) = 0.698 W/kg



0 dB = 0.839 W/kg = -0.76 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-7

Communication System: UID 0, LTE Band 12 (0); Frequency: 707.5 MHz; Duty Cycle: 1:1

Medium: 740 Body Medium parameters used (interpolated):

$f = 707.5 \text{ MHz}$; $\sigma = 0.924 \text{ S/m}$; $\epsilon_r = 53.716$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-22-2015; Ambient Temp: 23.2°C; Tissue Temp: 23.4°C

Probe: ES3DV3 - SN3332; ConvF(6.24, 6.24, 6.24); Calibrated: 9/18/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1323; Calibrated: 9/17/2014

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

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: LTE Band 12, Body SAR, Back side, Mid.ch

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

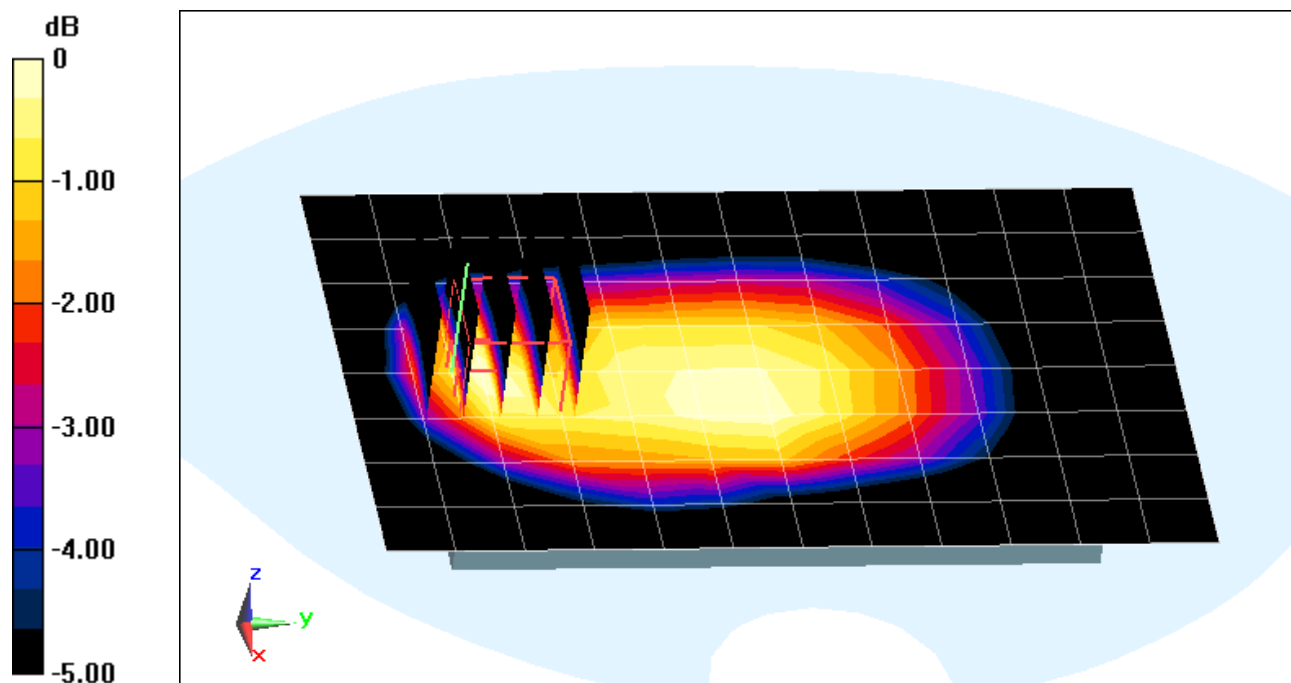
Area Scan (9x13x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 22.85 V/m; Power Drift = -0.14 dB

Peak SAR (extrapolated) = 0.695 W/kg

SAR(1 g) = 0.430 W/kg



0 dB = 0.498 W/kg = -3.03 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-7

Communication System: UID 0, LTE Band 12 (0); Frequency: 707.5 MHz; Duty Cycle: 1:1

Medium: 740 Body Medium parameters used (interpolated):

$f = 707.5 \text{ MHz}$; $\sigma = 0.924 \text{ S/m}$; $\epsilon_r = 53.716$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-22-2015; Ambient Temp: 23.2°C; Tissue Temp: 23.4°C

Probe: ES3DV3 - SN3332; ConvF(6.24, 6.24, 6.24); Calibrated: 9/18/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1323; Calibrated: 9/17/2014

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

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: LTE Band 12, Body SAR, Right Edge, Mid.ch

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

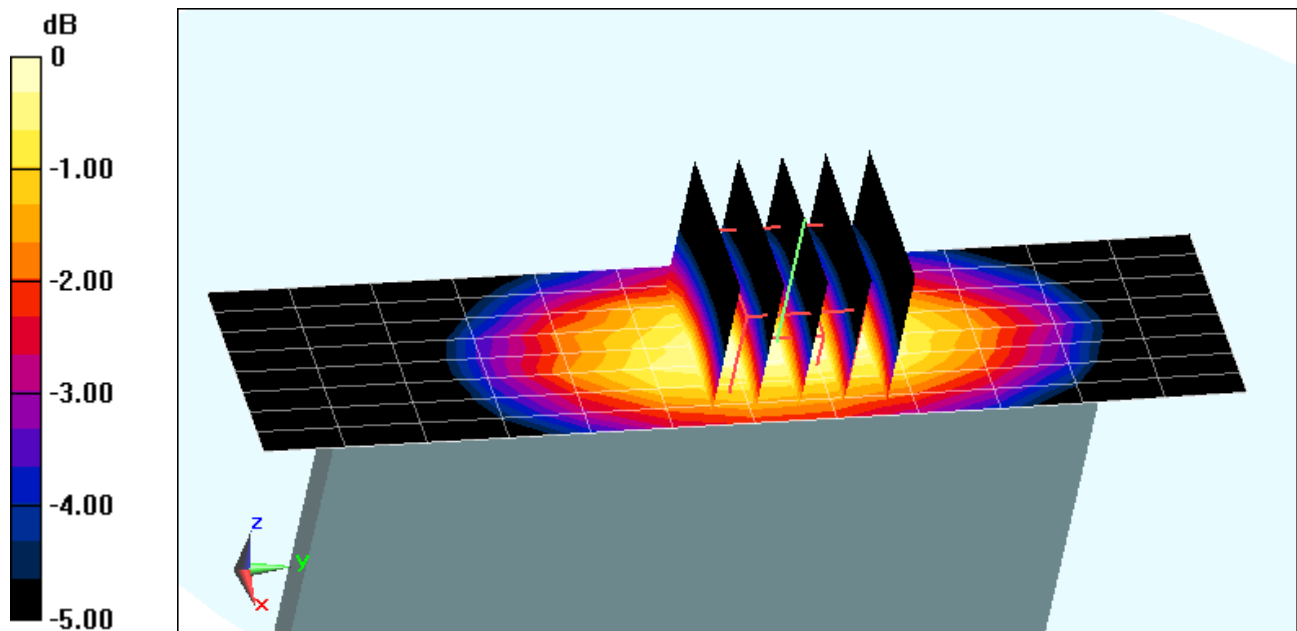
Area Scan (9x13x1): Measurement grid: dx=5mm, dy=15mm

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

Reference Value = 25.43 V/m; Power Drift = -0.16 dB

Peak SAR (extrapolated) = 0.749 W/kg

SAR(1 g) = 0.548 W/kg



0 dB = 0.627 W/kg = -2.03 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-7

Communication System: UID 0, LTE Band 4 (AWS); Frequency: 1732.5 MHz; Duty Cycle: 1:1

Medium: 1750 Body Medium parameters used (interpolated):

$f = 1732.5 \text{ MHz}$; $\sigma = 1.516 \text{ S/m}$; $\epsilon_r = 51.019$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-21-2015; Ambient Temp: 21.5°C; Tissue Temp: 21.4°C

Probe: ES3DV3 - SN3333; ConvF(4.89, 4.89, 4.89); Calibrated: 10/24/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1408; Calibrated: 10/23/2014

Phantom: Sub TWIN SAM; Type: QD000P40CC; Serial: TP-1357

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: LTE Band 4 (AWS), Body SAR, Back side, Mid.ch

20 MHz Bandwidth, QPSK, 1 RB, 0 RB Offset

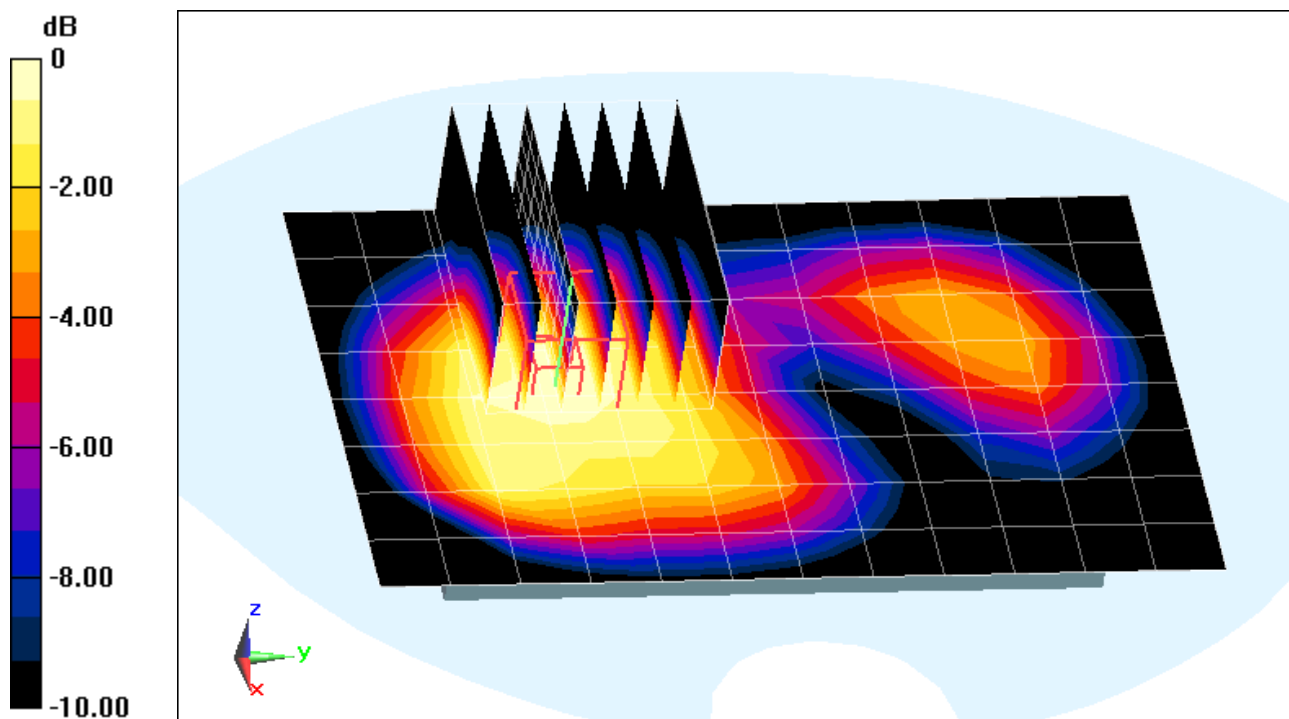
Area Scan (9x13x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

Zoom Scan (9x7x7)/Cube 1: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 20.55 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 1.12 W/kg

SAR(1 g) = 0.749 W/kg



0 dB = 0.864 W/kg = -0.63 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-7

Communication System: UID 0, LTE Band 2 (PCS) (0); Frequency: 1860 MHz; Duty Cycle: 1:1

Medium: 1900 Body Medium parameters used (interpolated):

$f = 1860 \text{ MHz}$; $\sigma = 1.496 \text{ S/m}$; $\epsilon_r = 51.112$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-20-2015; Ambient Temp: 23.4°C; Tissue Temp: 22.8°C

Probe: ES3DV2 - SN3022; ConvF(4.49, 4.49, 4.49); Calibrated: 8/19/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1322; Calibrated: 8/12/2014

Phantom: ELI v5.0; Type: QDOVA001BB; Serial: 1226

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

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

20 MHz Bandwidth, QPSK, 1 RB, 0 RB Offset

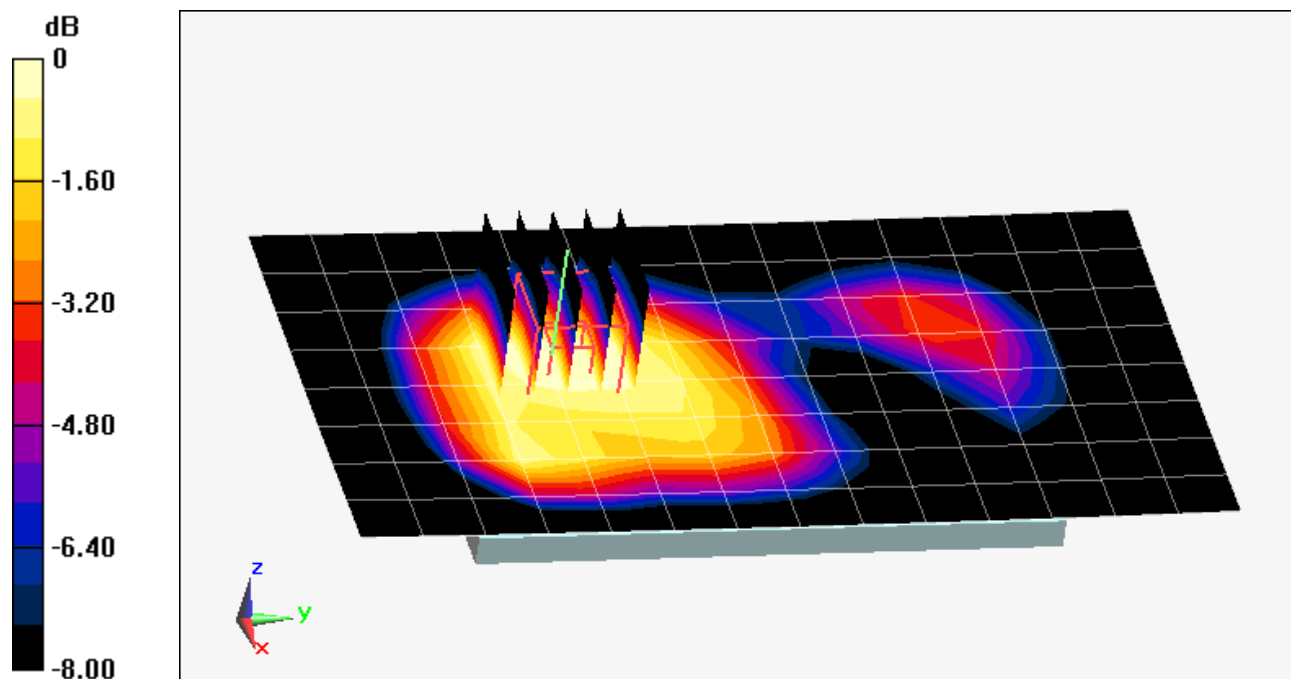
Area Scan (9x15x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 20.78 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 0.928 W/kg

SAR(1 g) = 0.637 W/kg



0 dB = 0.738 W/kg = -1.32 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-7

Communication System: UID 0, LTE Band 2 (PCS) (0); Frequency: 1860 MHz; Duty Cycle: 1:1

Medium: 1900 Body Medium parameters used (interpolated):

$f = 1860 \text{ MHz}$; $\sigma = 1.496 \text{ S/m}$; $\epsilon_r = 51.112$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-20-2015; Ambient Temp: 23.4°C; Tissue Temp: 22.8°C

Probe: ES3DV2 - SN3022; ConvF(4.49, 4.49, 4.49); Calibrated: 8/19/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1322; Calibrated: 8/12/2014

Phantom: ELI v5.0; Type: QDOVA001BB; Serial: 1226

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: LTE Band 2 (PCS), Body SAR, Left Edge, Low.ch

20 MHz Bandwidth, QPSK, 1 RB, 0 RB Offset

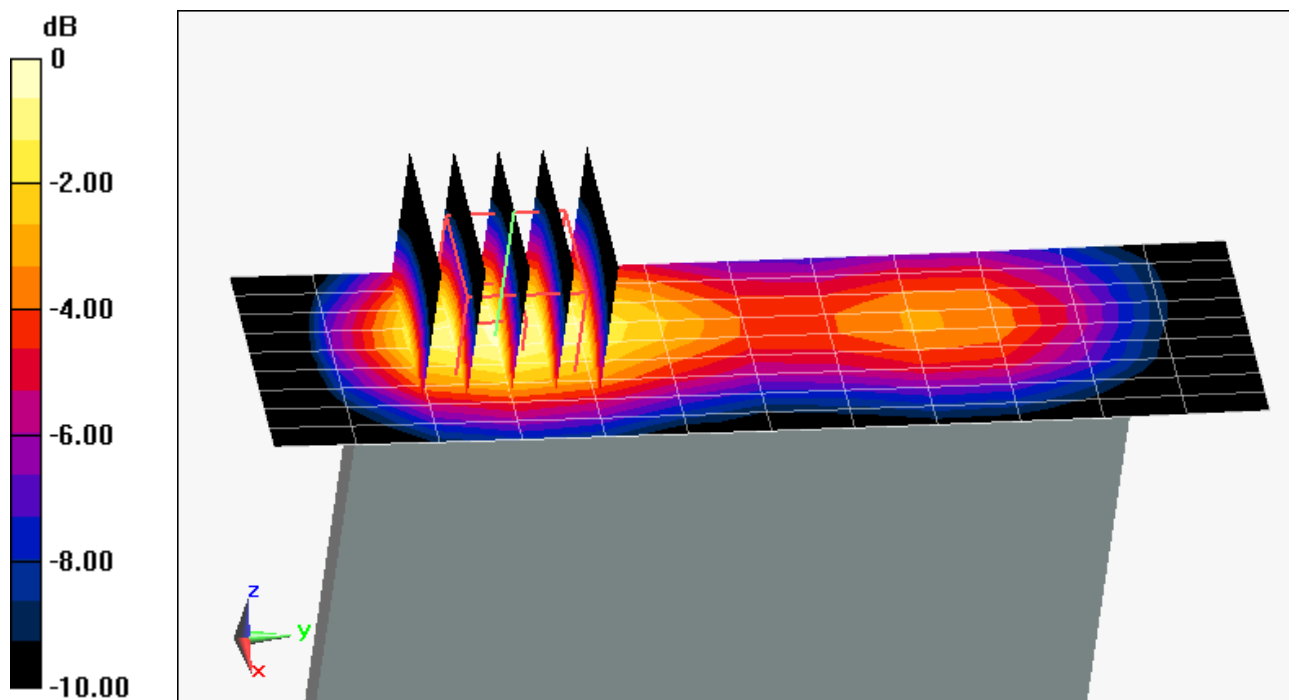
Area Scan (10x13x1): Measurement grid: $dx=5\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 22.45 V/m; Power Drift = 0.20 dB

Peak SAR (extrapolated) = 1.09 W/kg

SAR(1 g) = 0.690 W/kg



0 dB = 0.832 W/kg = -0.80 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-8

Communication System: UID 0, IEEE 802.11b; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium: 2450 Body Medium parameters used (interpolated):

$f = 2437 \text{ MHz}$; $\sigma = 2.011 \text{ S/m}$; $\epsilon_r = 51.1$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-19-2015; Ambient Temp: 24.0°C; Tissue Temp: 22.8°C

Probe: ES3DV3 - SN3209; ConvF(4.2, 4.2, 4.2); Calibrated: 3/19/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1334; Calibrated: 3/17/2014

Phantom: SAM left; Type: QD000P40CD; Serial: TP:1715

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: IEEE 802.11b, Body SAR, Ch 06, 1 Mbps, Back Side

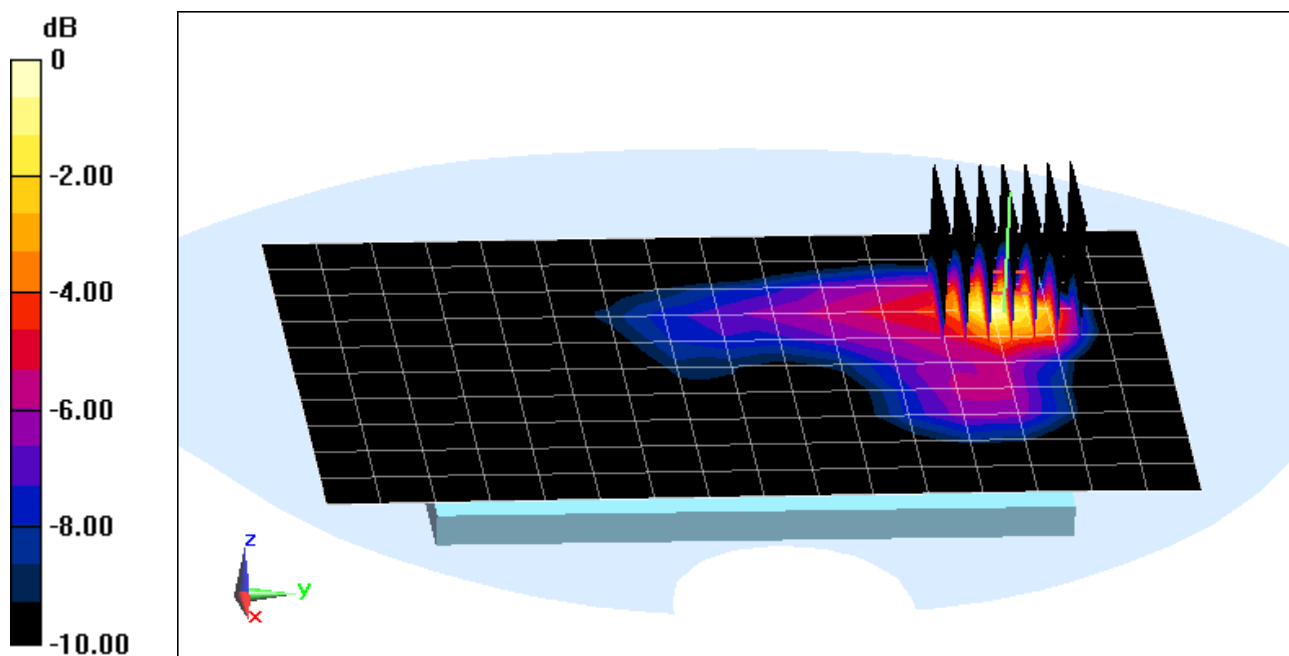
Area Scan (11x17x1): Measurement grid: $dx=12\text{mm}$, $dy=12\text{mm}$

Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 11.00 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 0.480 W/kg

SAR(1 g) = 0.216 W/kg



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

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-8

Communication System: UID 0, 802.11a 5.2-5.8 GHz Band (0); Frequency: 5660 MHz; Duty Cycle: 1:1

Medium: 5GHz Medium parameters used:

$f = 5660 \text{ MHz}$; $\sigma = 6.013 \text{ S/m}$; $\epsilon_r = 47.301$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-20-2015; Ambient Temp: 22.8°C; Tissue Temp: 21.2°C

Probe: EX3DV4 - SN3949; ConvF(3.97, 3.97, 3.97); Calibrated: 8/21/2014;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 10/31/2014

Phantom: SAM Sub ; Type: QD000P40CC; Serial: TP:1357

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: IEEE 802.11a, 5.5 GHz, Body SAR, Ch 132, 6 Mbps, Back Side

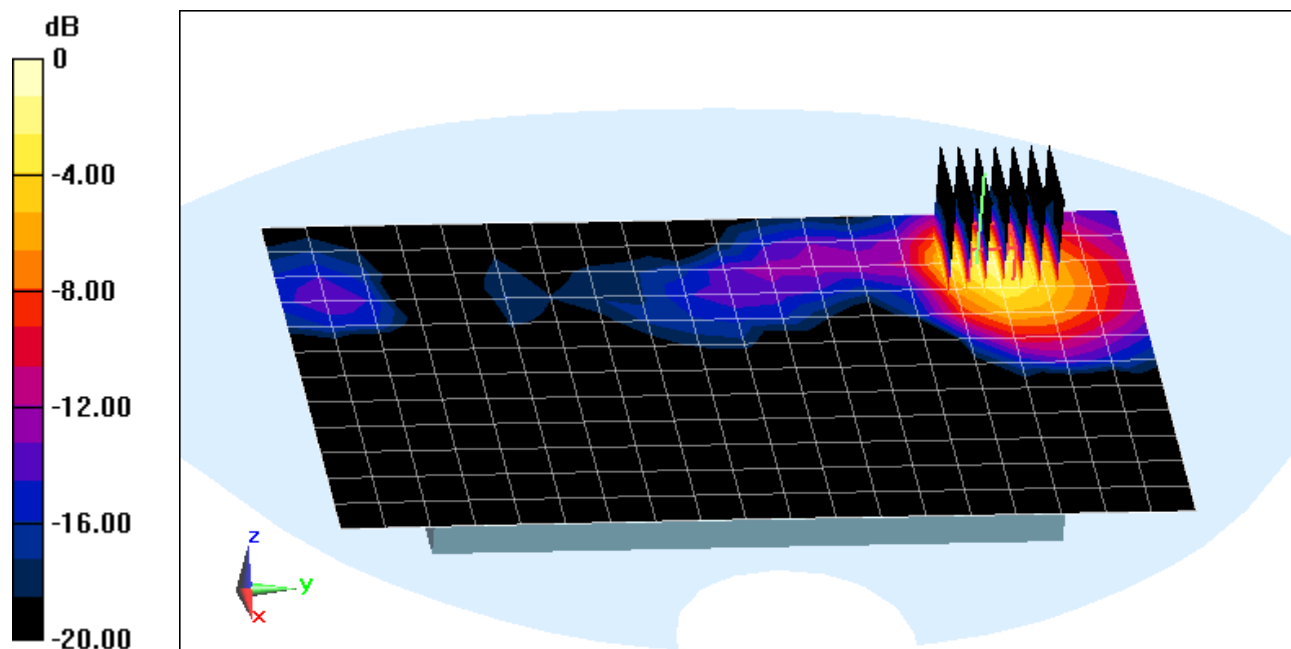
Area Scan (13x20x1): Measurement grid: dx=10mm, dy=10mm

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

Reference Value = 8.771 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 1.78 W/kg

SAR(1 g) = 0.445 W/kg



0 dB = 1.02 W/kg = 0.09 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-8

Communication System: UID 0, 802.11a 5.2-5.8 GHz Band (0); Frequency: 5745 MHz; Duty Cycle: 1:1
Medium: 5GHz Medium parameters used:

$f = 5745 \text{ MHz}$; $\sigma = 6.128 \text{ S/m}$; $\epsilon_r = 47.082$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-20-2015; Ambient Temp: 22.8°C; Tissue Temp: 21.2°C

Probe: EX3DV4 - SN3949; ConvF(4.27, 4.27, 4.27); Calibrated: 8/21/2014;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 10/31/2014

Phantom: SAM Sub ; Type: QD000P40CC; Serial: TP:1357

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: IEEE 802.11a, 5.8 GHz, Body SAR, Ch 149, 6 Mbps, Right Edge

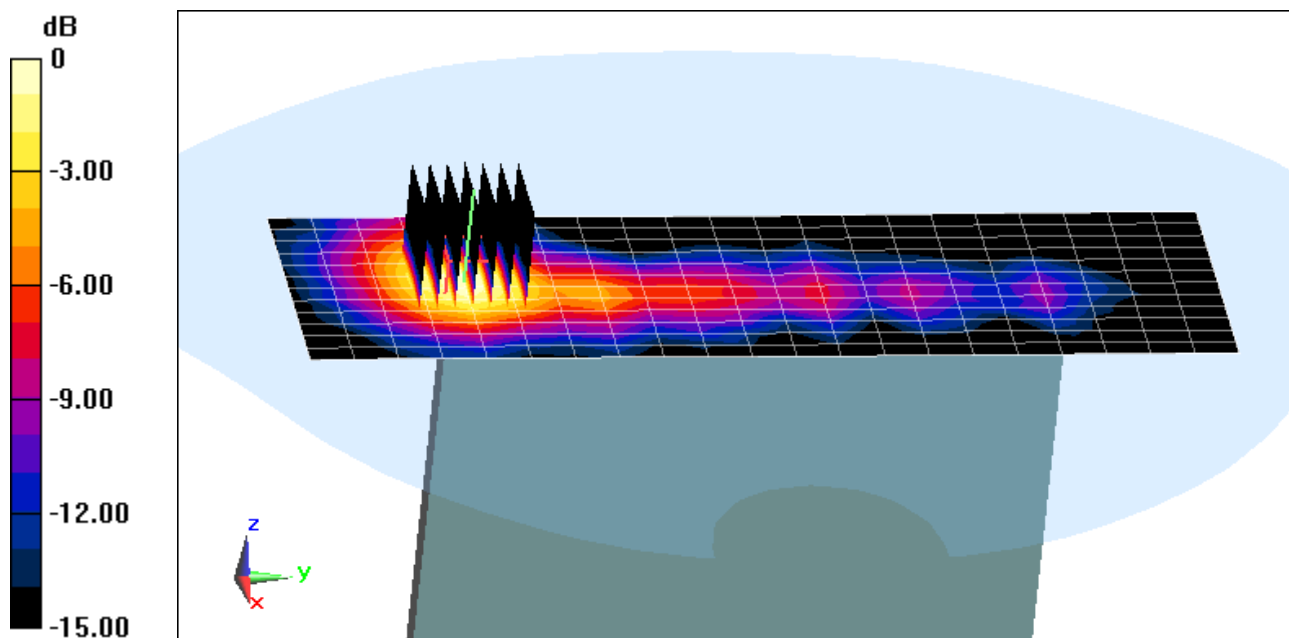
Area Scan (13x22x1): Measurement grid: $dx=5\text{mm}$, $dy=10\text{mm}$

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

Reference Value = 6.123 V/m; Power Drift = 0.11 dB

Peak SAR (extrapolated) = 1.02 W/kg

SAR(1 g) = 0.239 W/kg



0 dB = 0.564 W/kg = -2.49 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: ZNFH631; Type: Portable Handset; Serial: 1401-8

Communication System: UID 0, 802.11a 5.2-5.8 GHz Band (0); Frequency: 5280 MHz; Duty Cycle: 1:1
Medium: 5GHz Medium parameters used:

$f = 5280 \text{ MHz}$; $\sigma = 5.424 \text{ S/m}$; $\epsilon_r = 48.093$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 0.0 cm

Test Date: 01-20-2015; Ambient Temp: 22.8°C; Tissue Temp: 21.2°C

Probe: EX3DV4 - SN3949; ConvF(4.47, 4.47, 4.47); Calibrated: 8/21/2014;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 10/31/2014

Phantom: SAM Sub ; Type: QD000P40CC; Serial: TP:1357

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: IEEE 802.11a, 5.3 GHz, Hand SAR, Ch 56, 6 Mbps, Right Edge

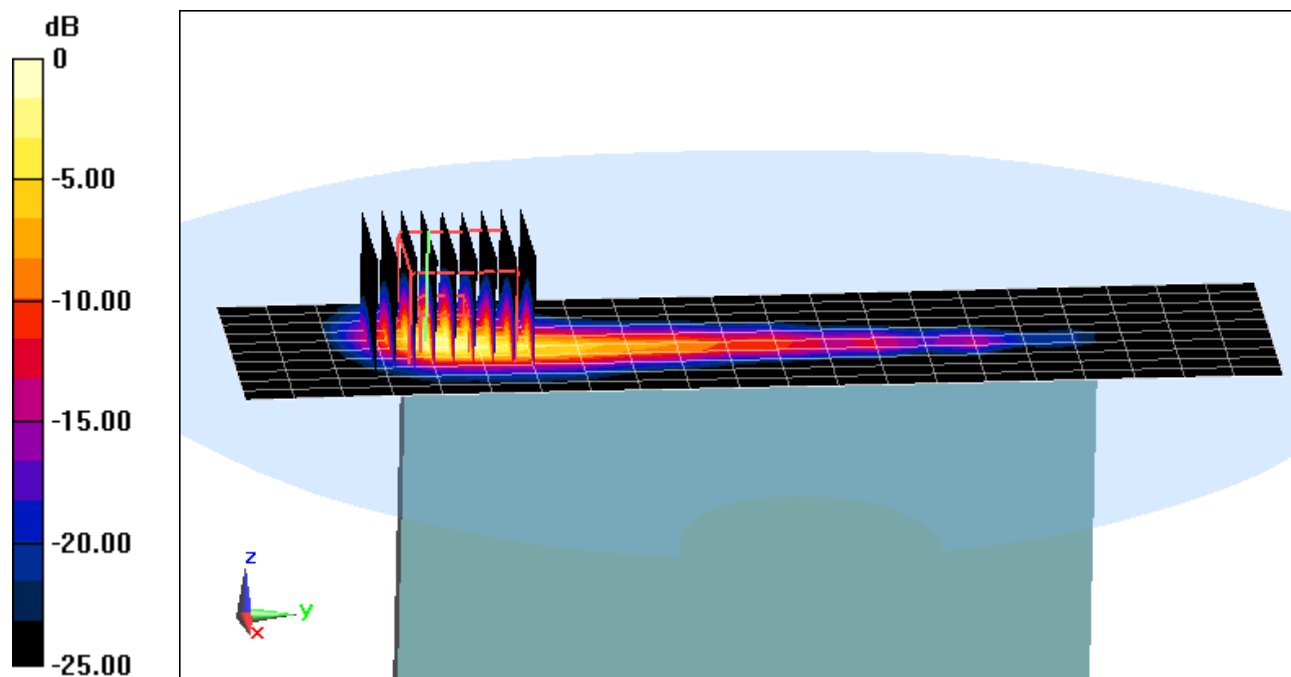
Area Scan (11x22x1): Measurement grid: $dx=5\text{mm}$, $dy=10\text{mm}$

Zoom Scan (8x9x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$; Graded Ratio=1.4

Reference Value = 26.33 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 17.2 W/kg

SAR(10 g) = 0.919 W/kg



0 dB = 8.83 W/kg = 9.46 dBW/kg

APPENDIX B: SYSTEM VERIFICATION

PCTEST ENGINEERING LABORATORY, INC.

DUT: Dipole 750 MHz; Type: D750V3; Serial: 1054

Communication System: UID 0, CW; Frequency: 750 MHz; Duty Cycle: 1:1

Medium: 740 Head Medium parameters used (interpolated):

$f = 750 \text{ MHz}$; $\sigma = 0.906 \text{ S/m}$; $\epsilon_r = 40.88$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.5 cm

Test Date: 01-22-2015; Ambient Temp: 24.0°C; Tissue Temp: 21.2°C

Probe: ES3DV3 - SN3288; ConvF(6.81, 6.81, 6.81); Calibrated: 9/24/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1364; Calibrated: 9/18/2014

Phantom: SAM with CRP v4.0; Type: QD000P40CD; Serial: TP:1797

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

750 MHz System Verification

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

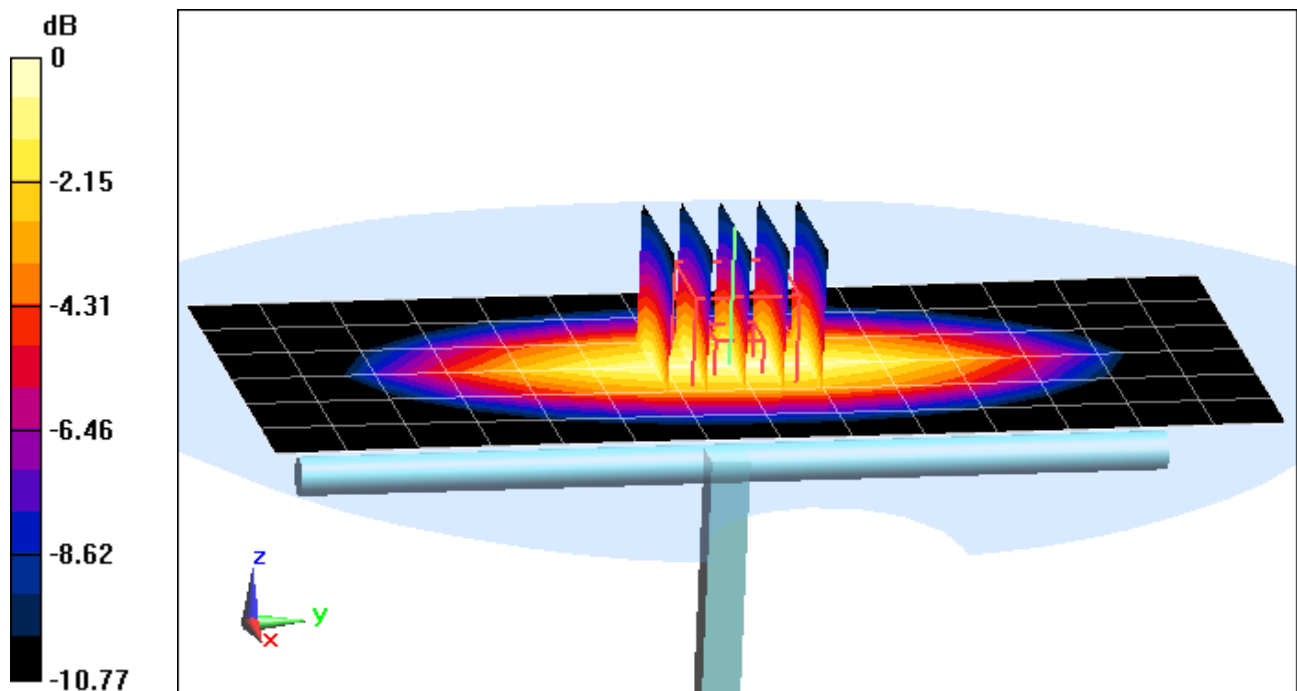
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 1.25 W/kg

SAR(1 g) = 0.826 W/kg

Deviation = -0.84 %



PCTEST ENGINEERING LABORATORY, INC.

DUT: Dipole 835 MHz; Type: D835V2; Serial: 4d133

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

Medium: 835 Head Medium parameters used:

$f = 835 \text{ MHz}$; $\sigma = 0.9 \text{ S/m}$; $\epsilon_r = 41.034$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.5 cm

Test Date: 01-19-2015; Ambient Temp: 23.1°C; Tissue Temp: 23.0°C

Probe: ES3DV2 - SN3022; ConvF(6.18, 6.18, 6.18); Calibrated: 8/19/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1322; Calibrated: 8/12/2014

Phantom: SAM with CRP v4.0; Type: QD000P40CD; Serial: TP:1800

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

835 MHz System Verification

Area Scan (7x14x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

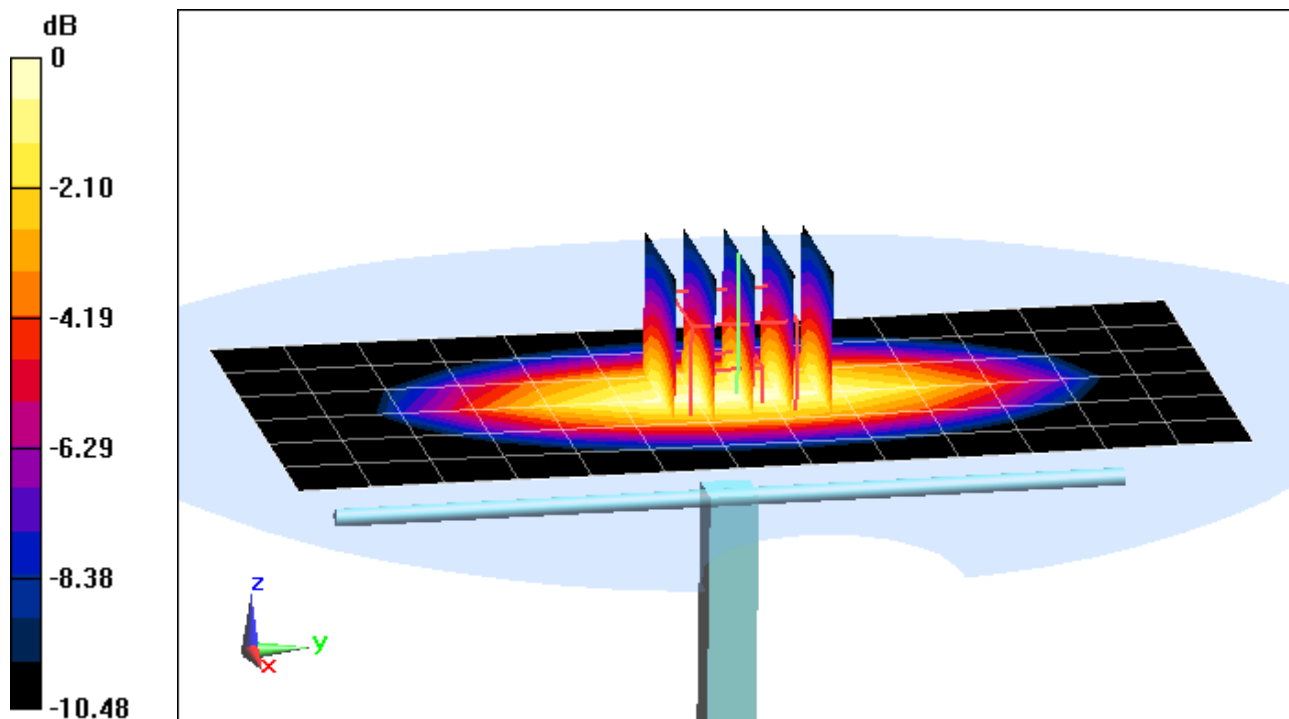
Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 1.34 W/kg

SAR(1 g) = 0.918 W/kg

Deviation = -0.22 %



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

PCTEST ENGINEERING LABORATORY, INC.

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

Communication System: UID 0, CW; Frequency: 1750 MHz; Duty Cycle: 1:1

Medium: 1750 Head Medium parameters used:

$f = 1750 \text{ MHz}$; $\sigma = 1.361 \text{ S/m}$; $\epsilon_r = 39.194$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-21-2015; Ambient Temp: 24.0°C; Tissue Temp: 22.4°C

Probe: ES3DV3 - SN3331; ConvF(5.28, 5.28, 5.28); Calibrated: 8/20/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 10/31/2014

Phantom: SAM Main ; Type: QD000P40CC; Serial: TP 1114

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

1750 MHz System Verification

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

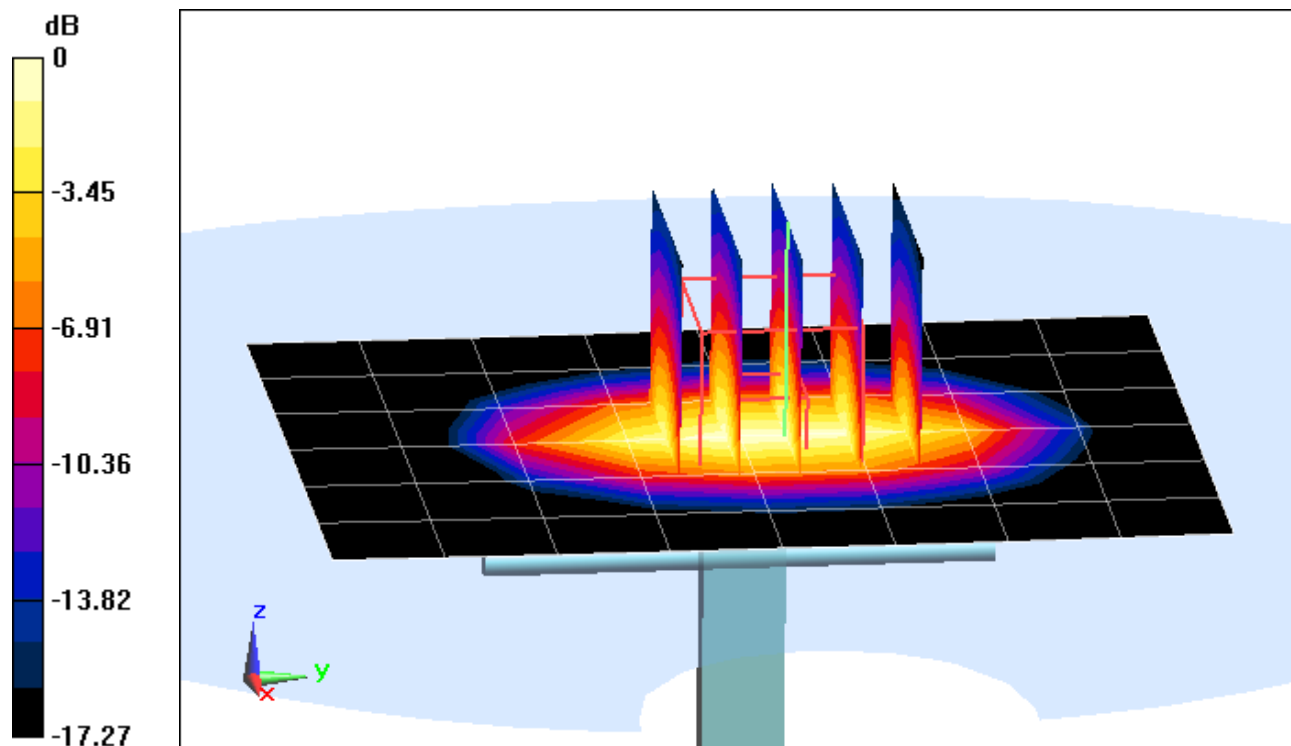
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 6.62 W/kg

SAR(1 g) = 3.65 W/kg

Deviation = 0.83 %



0 dB = 4.59 W/kg = 6.62 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 1900 Head Medium parameters used (interpolated):

$f = 1900 \text{ MHz}$; $\sigma = 1.44 \text{ S/m}$; $\epsilon_r = 38.694$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-20-2015; Ambient Temp: 21.6°C; Tissue Temp: 21.0°C

Probe: ES3DV3 - SN3333; ConvF(5.11, 5.11, 5.11); Calibrated: 10/24/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1408; Calibrated: 10/23/2014

Phantom: Sub TWIN SAM; Type: QD000P40CC; Serial: TP-1357

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

1900 MHz System Verification

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

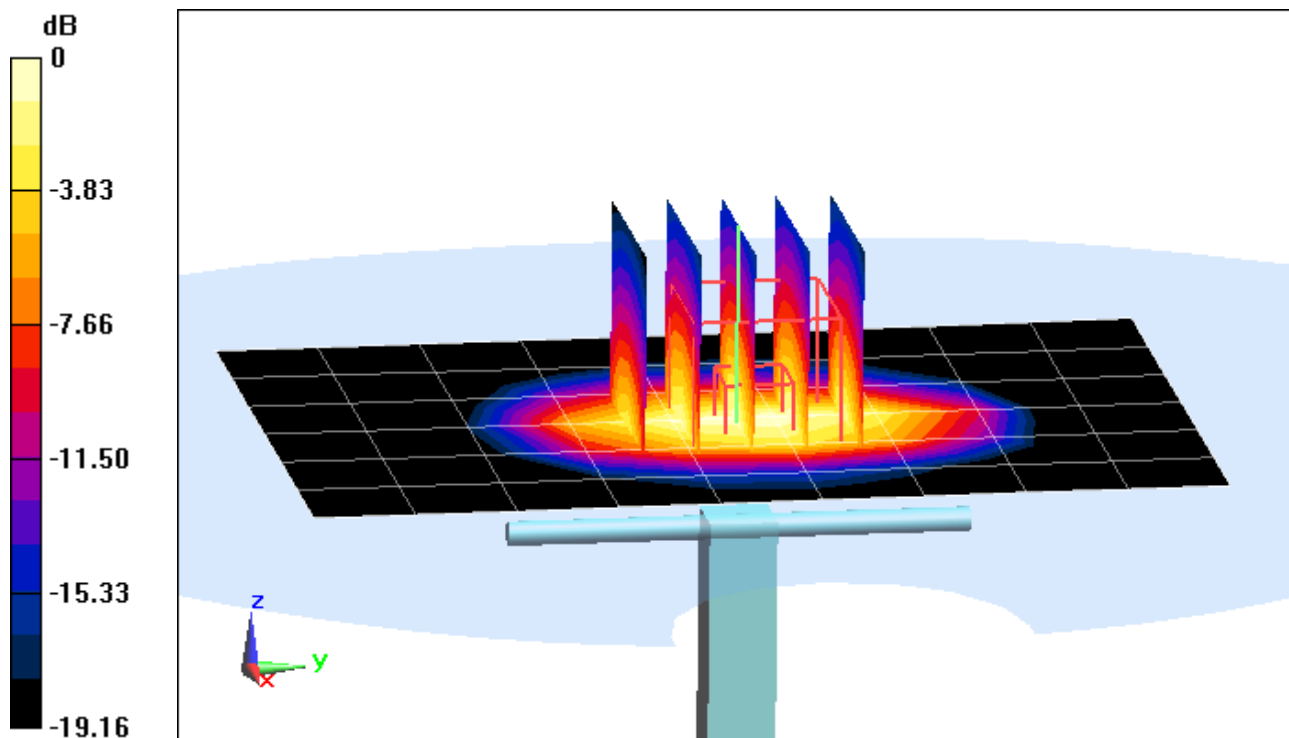
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 7.37 W/kg

SAR(1 g) = 3.98 W/kg

Deviation = -2.21 %



0 dB = 5.01 W/kg = 7.00 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 2450 Head Medium parameters used:

$f = 2450 \text{ MHz}$; $\sigma = 1.849 \text{ S/m}$; $\epsilon_r = 40.47$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-20-2015; Ambient Temp: 21.9°C; Tissue Temp: 23.0°C

Probe: ES3DV3 - SN3209; ConvF(4.54, 4.54, 4.54); Calibrated: 3/19/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1334; Calibrated: 3/17/2014

Phantom: SAM Right; Type: SAM; Serial: 1757

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

2450 MHz System Verification

Area Scan (8x9x1): Measurement grid: $dx=12\text{mm}$, $dy=12\text{mm}$

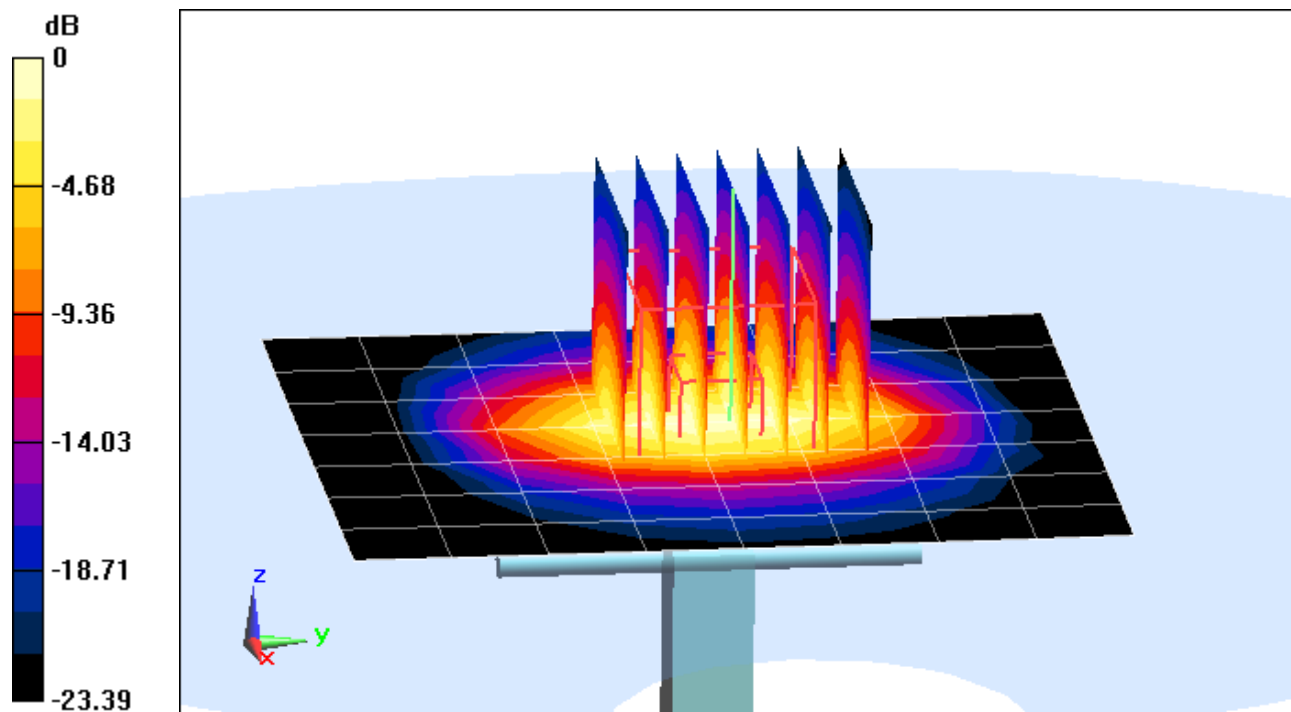
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 10.3 W/kg

SAR(1 g) = 4.86 W/kg

Deviation = -6.72 %



0 dB = 6.41 W/kg = 8.07 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5 GHz Head Medium parameters used:

$f = 5200 \text{ MHz}$; $\sigma = 4.449 \text{ S/m}$; $\epsilon_r = 35.741$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-23-2015; Ambient Temp: 23.9°C; Tissue Temp: 21.5°C

Probe: EX3DV4 - SN3920; ConvF(4.87, 4.87, 4.87); Calibrated: 12/12/2014;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1368; Calibrated: 4/11/2014

Phantom: SAM, Left; Type: QD000P40CD; Serial: TP:1759

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

5200 MHz System Verification

Area Scan (7x8x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

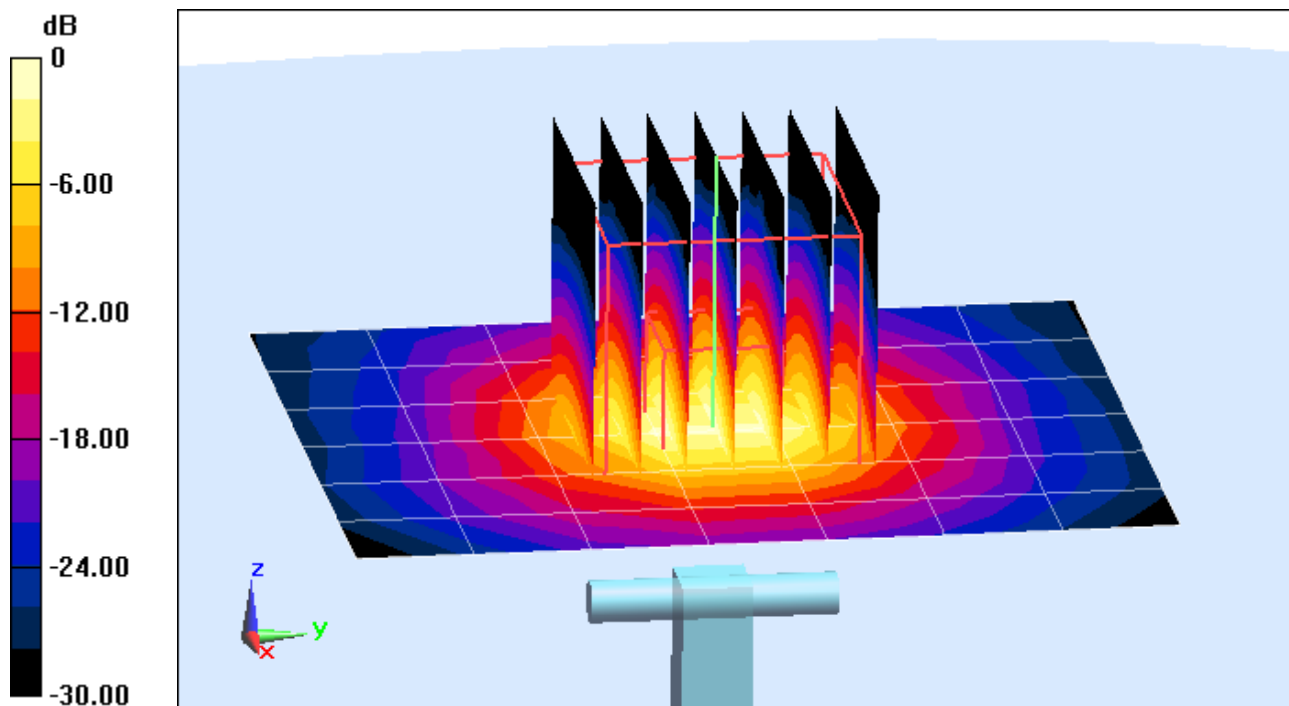
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$; Graded Ratio=1.4

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 30.0 W/kg

SAR(1 g) = 7.54 W/kg

Deviation = -4.68 %



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

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5 GHz Head Medium parameters used:

$f = 5300 \text{ MHz}$; $\sigma = 4.549 \text{ S/m}$; $\epsilon_r = 35.571$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space 1.0 cm

Test Date: 01-23-2015; Ambient Temp: 23.9°C; Tissue Temp: 21.5°C

Probe: EX3DV4 - SN3920; ConvF(4.69, 4.69, 4.69); Calibrated: 12/12/2014;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1368; Calibrated: 4/11/2014

Phantom: SAM, Left; Type: QD000P40CD; Serial: TP:1759

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

5300 MHz System Verification

Area Scan (7x8x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

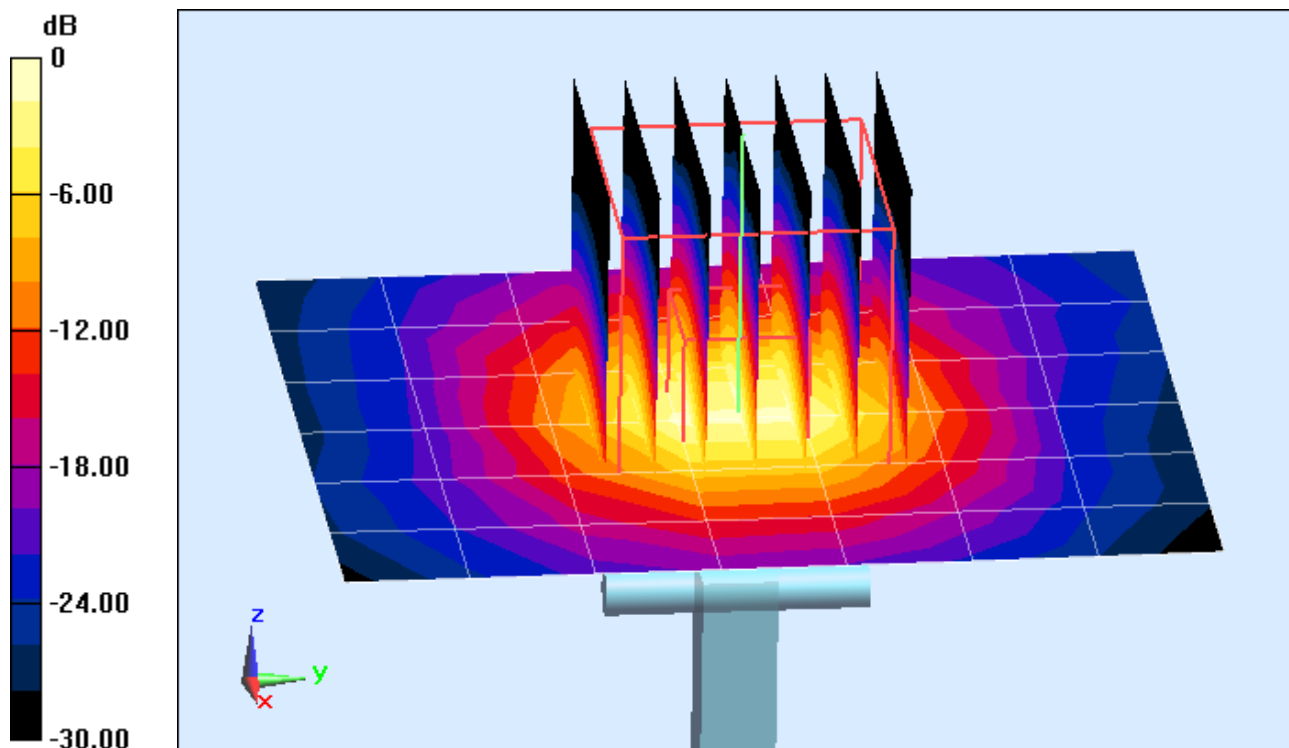
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$; Graded Ratio=1.4

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 32.4 W/kg

SAR(1 g) = 8.03 W/kg

Deviation = -3.72 %



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

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5 GHz Head Medium parameters used:

$f = 5500 \text{ MHz}$; $\sigma = 4.748 \text{ S/m}$; $\epsilon_r = 35.287$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-23-2015; Ambient Temp: 23.9°C; Tissue Temp: 21.5°C

Probe: EX3DV4 - SN3920; ConvF(4.44, 4.44, 4.44); Calibrated: 12/12/2014;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1368; Calibrated: 4/11/2014

Phantom: SAM, Left; Type: QD000P40CD; Serial: TP:1759

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

5500 MHz System Verification

Area Scan (7x8x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

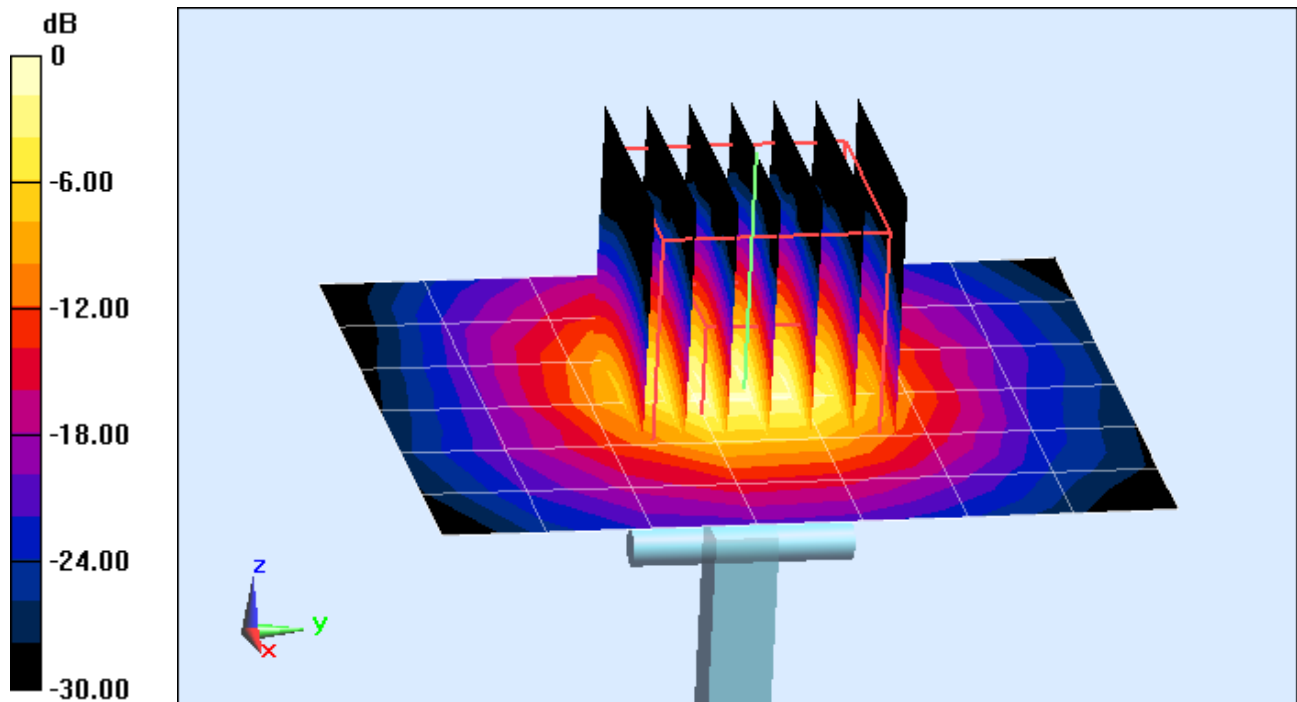
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$; Graded Ratio=1.4

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 33.1 W/kg

SAR(1 g) = 8.19 W/kg

Deviation = -3.53 %



0 dB = 21.0 W/kg = 13.22 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

Communication System: UID 0, CW; Frequency: 5600 MHz; Duty Cycle: 1:1

Medium: 5 GHz Head Medium parameters used:

$f = 5600 \text{ MHz}$; $\sigma = 4.849 \text{ S/m}$; $\epsilon_r = 35.184$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-23-2015; Ambient Temp: 24.0°C; Tissue Temp: 21.6°C

Probe: EX3DV4 - SN3920; ConvF(4.35, 4.35, 4.35); Calibrated: 12/12/2014;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1368; Calibrated: 4/11/2014

Phantom: SAM, Left; Type: QD000P40CD; Serial: TP:1759

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

5600 MHz System Verification

Area Scan (7x7x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

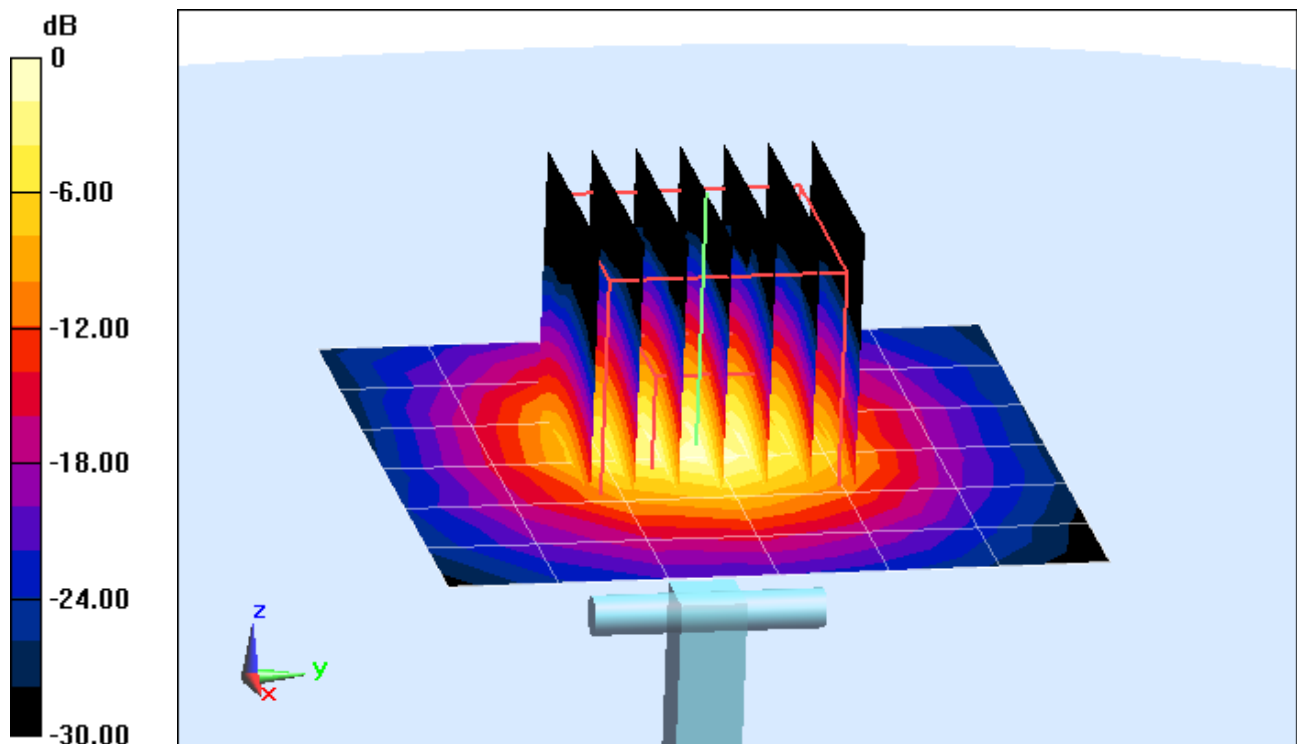
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$; Graded Ratio=1.4

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 33.0 W/kg

SAR(1 g) = 7.91 W/kg

Deviation = -3.77 %



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

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5 GHz Head Medium parameters used:

$f = 5800 \text{ MHz}$; $\sigma = 5.054 \text{ S/m}$; $\epsilon_r = 34.89$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-23-2015; Ambient Temp: 23.9°C; Tissue Temp: 21.6°C

Probe: EX3DV4 - SN3920; ConvF(4.27, 4.27, 4.27); Calibrated: 12/12/2014;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1368; Calibrated: 4/11/2014

Phantom: SAM, Left; Type: QD000P40CD; Serial: TP:1759

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

5800 MHz System Verification

Area Scan (7x7x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

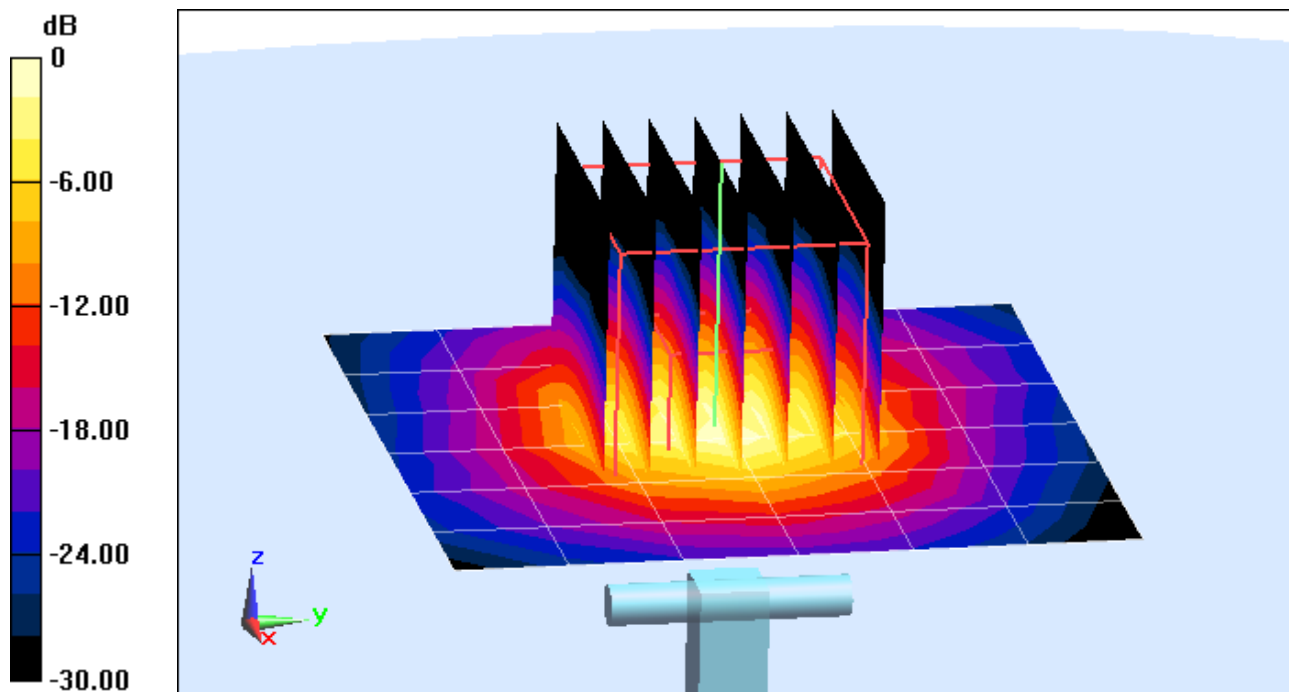
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$; Graded Ratio=1.4

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 34.3 W/kg

SAR(1 g) = 7.8 W/kg

Deviation = -1.39 %



PCTEST ENGINEERING LABORATORY, INC.

DUT: Dipole 750 MHz; Type: D750V3; Serial: 1054

Communication System: UID 0, CW; Frequency: 750 MHz; Duty Cycle: 1:1

Medium: 740 Body Medium parameters used (interpolated):

$f = 750 \text{ MHz}$; $\sigma = 0.964 \text{ S/m}$; $\epsilon_r = 53.293$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.5 cm

Test Date: 01-22-2015; Ambient Temp: 23.2°C; Tissue Temp: 23.4°C

Probe: ES3DV3 - SN3332; ConvF(6.24, 6.24, 6.24); Calibrated: 9/18/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1323; Calibrated: 9/17/2014

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

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

750 MHz System Verification

Area Scan (7x15x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

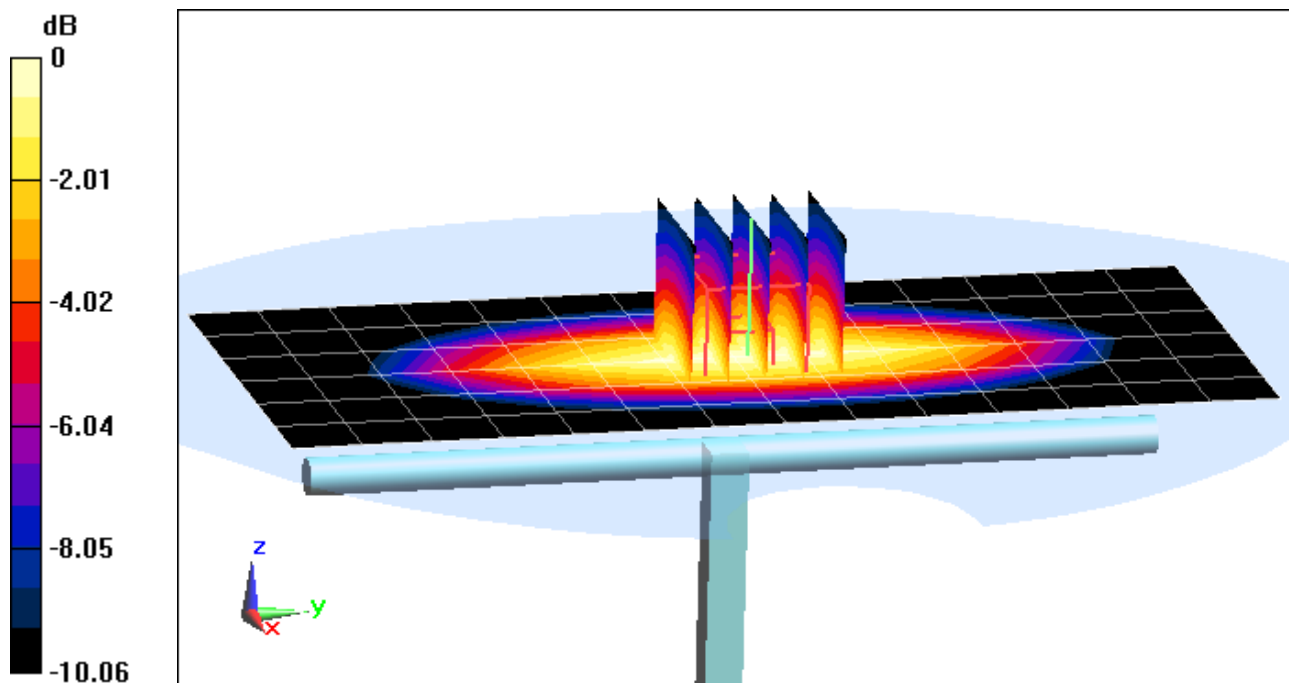
Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 1.24 W/kg

SAR(1 g) = 0.855 W/kg

Deviation = -1.04 %



0 dB = 0.996 W/kg = -0.02 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 835 Body Medium parameters used:

$f = 835 \text{ MHz}$; $\sigma = 0.956 \text{ S/m}$; $\epsilon_r = 54.224$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.5 cm

Test Date: 01-20-2015; Ambient Temp: 22.6°C; Tissue Temp: 20.0°C

Probe: ES3DV3 - SN3334; ConvF(6.14, 6.14, 6.14); Calibrated: 12/16/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1415; Calibrated: 12/12/2014

Phantom: Main Twin Sam; Type: QD000P40CC; Serial: TP: 1375

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

835 MHz System Verification

Area Scan (7x14x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

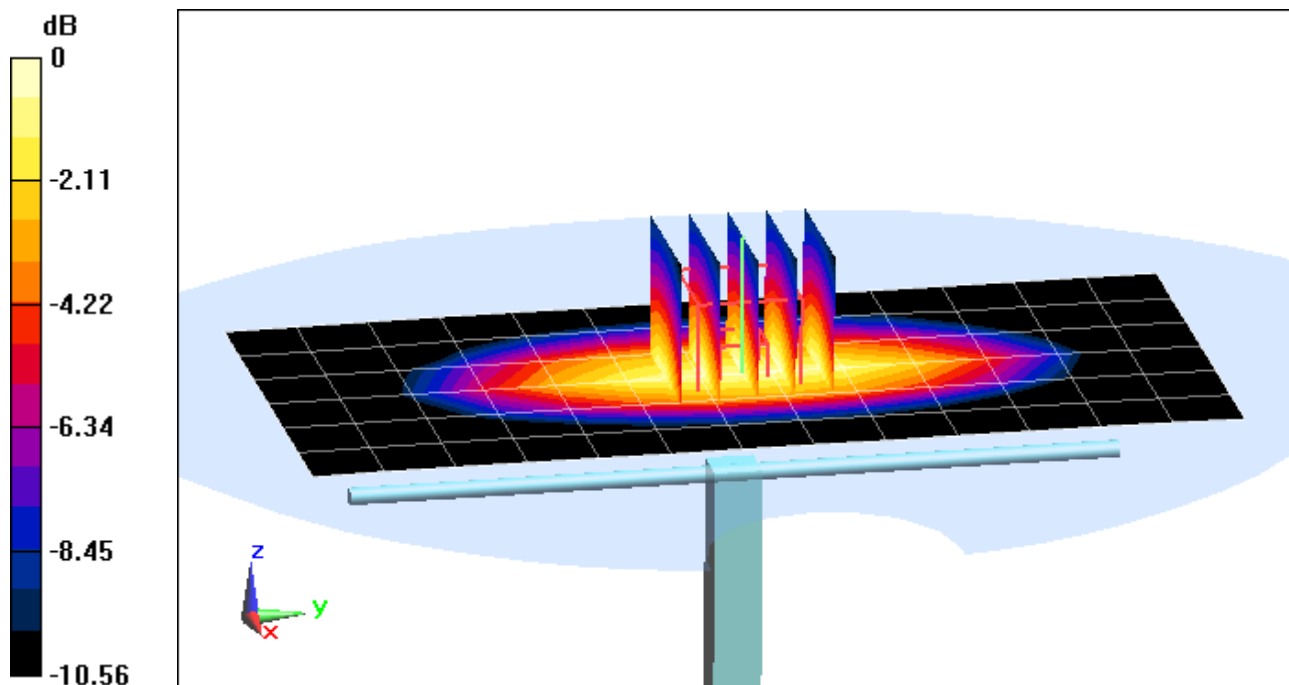
Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 1.34 W/kg

SAR(1 g) = 0.910 W/kg

Deviation = -2.57 %



0 dB = 1.04 W/kg = 0.17 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

Communication System: UID 0, CW; Frequency: 1750 MHz; Duty Cycle: 1:1

Medium: 1750 Body Medium parameters used:

$f = 1750 \text{ MHz}$; $\sigma = 1.534 \text{ S/m}$; $\epsilon_r = 50.966$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-21-2015; Ambient Temp: 21.5°C; Tissue Temp: 21.4°C

Probe: ES3DV3 - SN3333; ConvF(4.89, 4.89, 4.89); Calibrated: 10/24/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1408; Calibrated: 10/23/2014

Phantom: Sub TWIN SAM; Type: QD000P40CC; Serial: TP-1357

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

1750 MHz System Verification

Area Scan (7x9x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

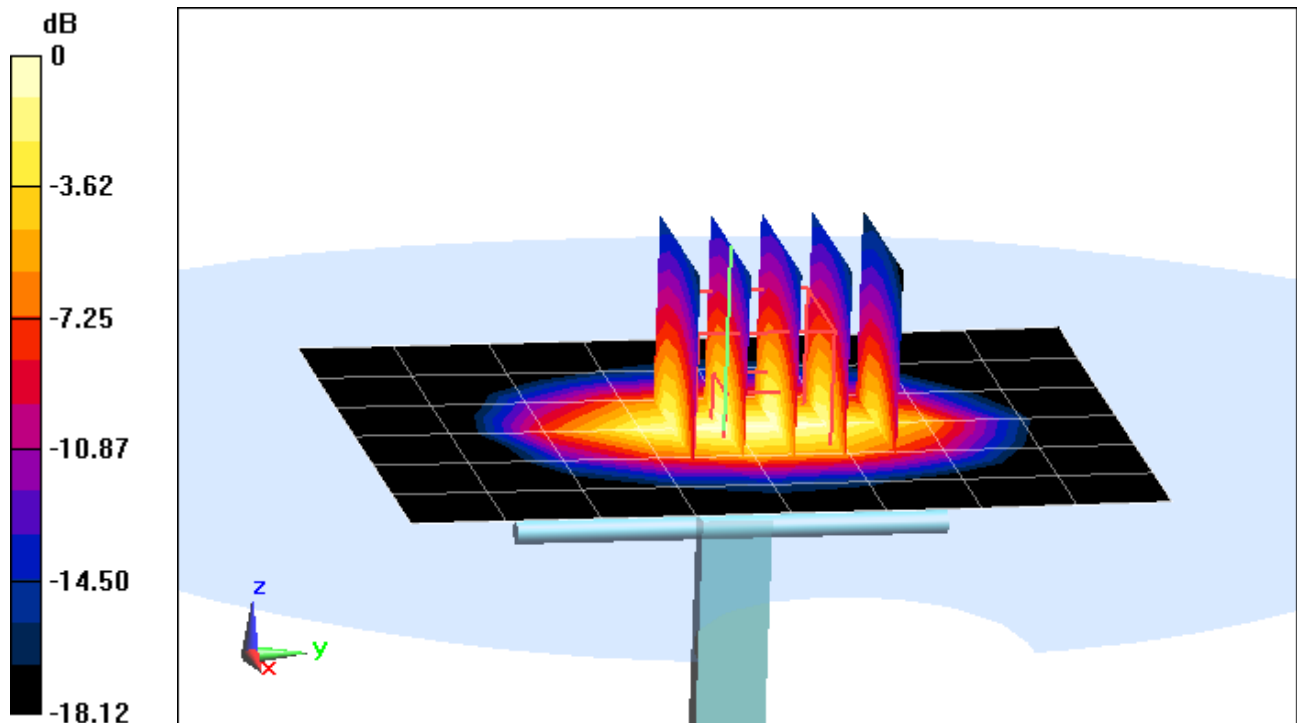
Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Input Power = 20dBm (100 mW)

Peak SAR (extrapolated) = 6.65 W/kg

SAR(1 g) = 3.65 W/kg

Deviation = -2.41 %



0 dB = 4.42 W/kg = 6.45 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 1900 Body Medium parameters used (interpolated):

$f = 1900 \text{ MHz}$; $\sigma = 1.541 \text{ S/m}$; $\epsilon_r = 50.991$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-20-2015; Ambient Temp: 23.4°C; Tissue Temp: 22.8°C

Probe: ES3DV2 - SN3022; ConvF(4.49, 4.49, 4.49); Calibrated: 8/19/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1322; Calibrated: 8/12/2014

Phantom: ELI v5.0; Type: QDOVA001BB; Serial: 1226

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

1900 MHz System Verification

Area Scan (7x10x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

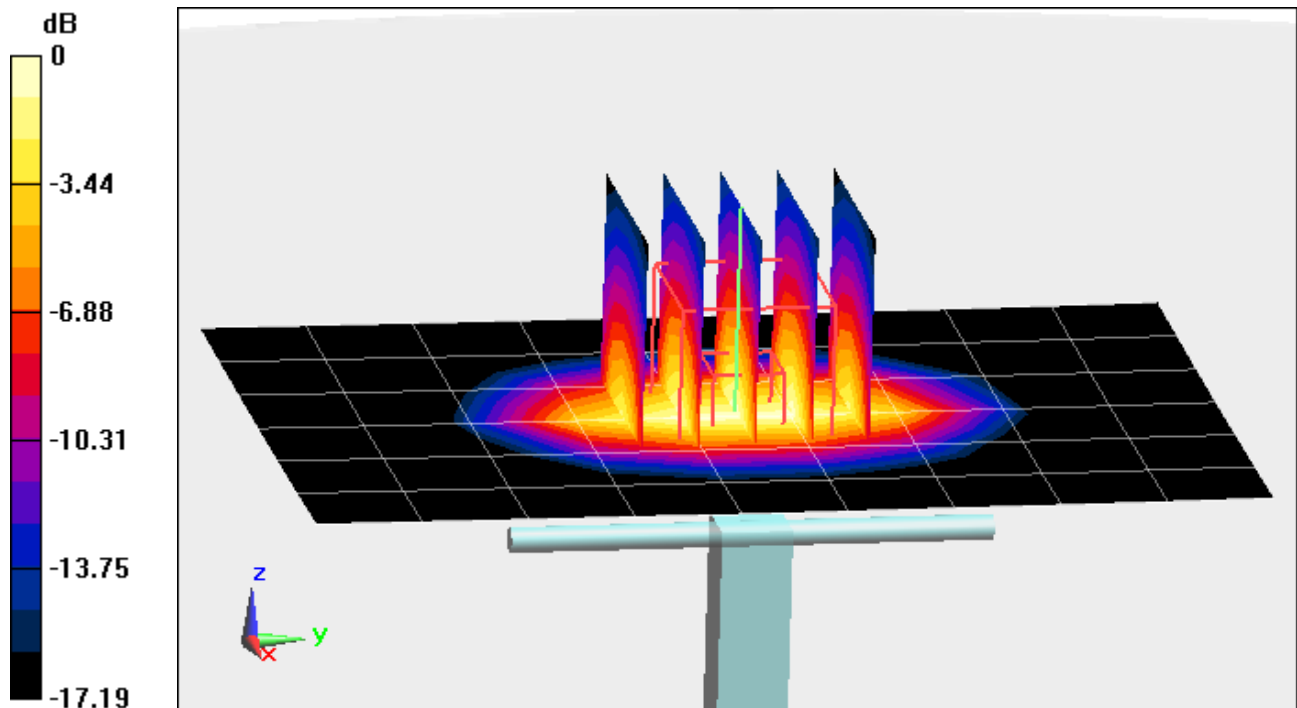
Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 6.89 W/kg

SAR(1 g) = 3.94 W/kg

Deviation = -2.96 %



0 dB = 4.97 W/kg = 6.96 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 2450 Body Medium parameters used:

$f = 2450 \text{ MHz}$; $\sigma = 2.031 \text{ S/m}$; $\epsilon_r = 51.04$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-19-2015; Ambient Temp: 24.0°C; Tissue Temp: 22.8°C

Probe: ES3DV3 - SN3209; ConvF(4.2, 4.2, 4.2); Calibrated: 3/19/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1334; Calibrated: 3/17/2014

Phantom: SAM left; Type: QD000P40CD; Serial: TP:1715

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

2450 MHz System Verification

Area Scan (8x9x1): Measurement grid: $dx=12\text{mm}$, $dy=12\text{mm}$

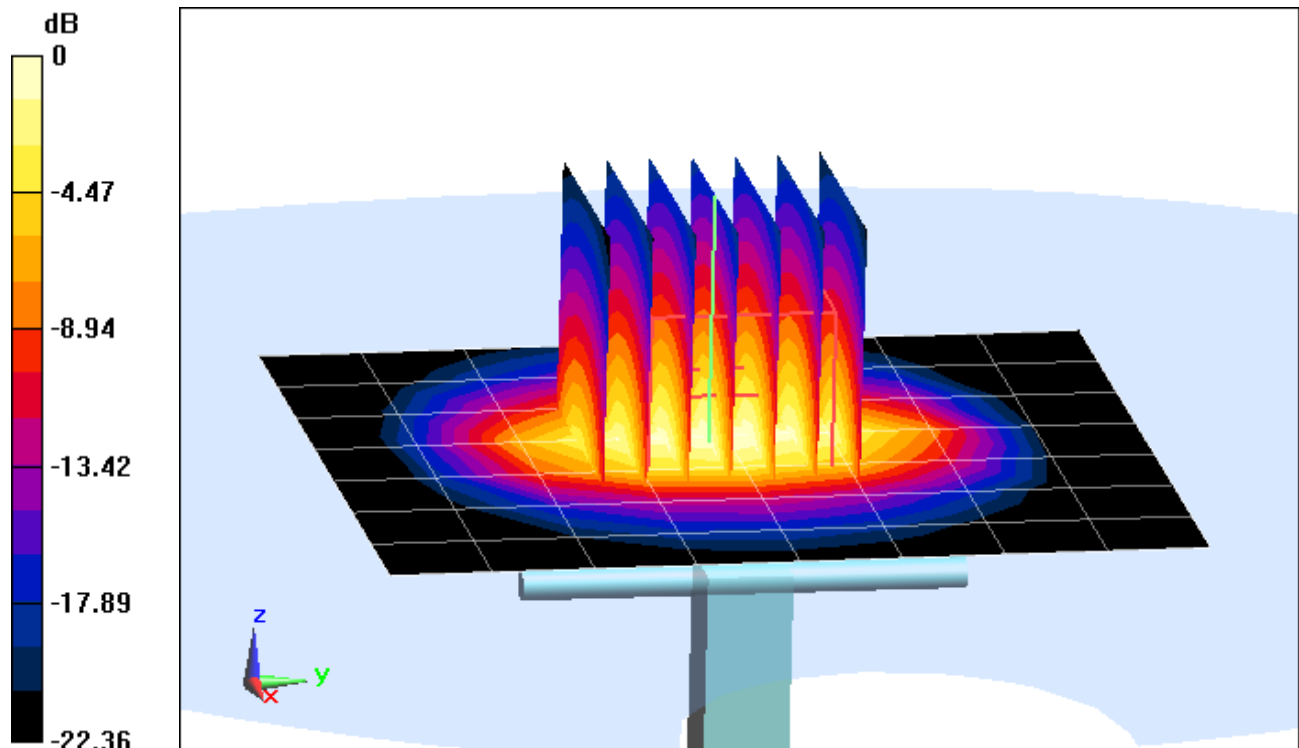
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 11.2 W/kg

SAR(1 g) = 5.15 W/kg

Deviation = -0.58 %



0 dB = 6.76 W/kg = 8.30 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5GHz Medium parameters used:

$f = 5200 \text{ MHz}$; $\sigma = 5.308 \text{ S/m}$; $\epsilon_r = 48.366$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-20-2015; Ambient Temp: 22.8°C; Tissue Temp: 21.2°C

Probe: EX3DV4 - SN3949; ConvF(4.68, 4.68, 4.68); Calibrated: 8/21/2014;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 10/31/2014

Phantom: SAM Sub ; Type: QD000P40CC; Serial: TP:1357

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

5200 MHz System Verification

Area Scan (7x9x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

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

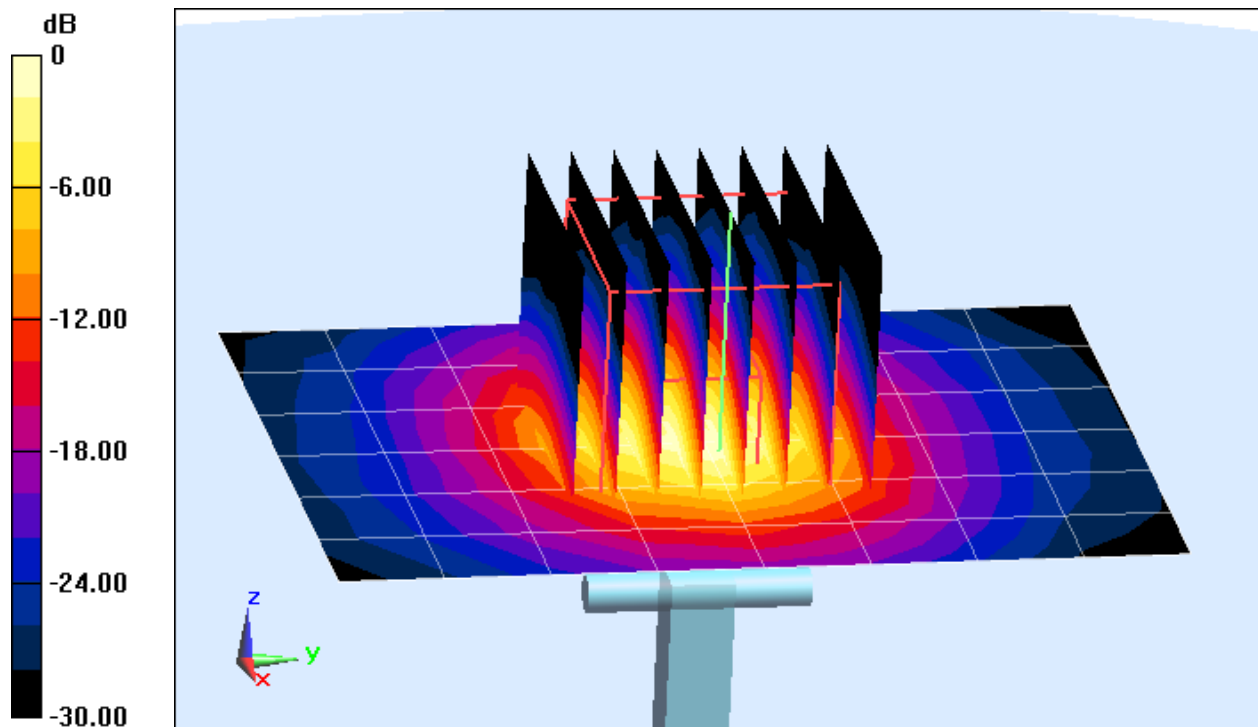
Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 31.5 W/kg

SAR(1 g) = 7.8 W/kg; SAR(10 g) = 2.18 W/kg

Deviation (1 g) = 5.41 %

Deviation (10 g) = 5.31 %



0 dB = 18.2 W/kg = 12.60 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5GHz Medium parameters used:

$f = 5300 \text{ MHz}$; $\sigma = 5.452 \text{ S/m}$; $\epsilon_r = 48.044$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-20-2015; Ambient Temp: 22.8°C; Tissue Temp: 21.2°C

Probe: EX3DV4 - SN3949; ConvF(4.47, 4.47, 4.47); Calibrated: 8/21/2014;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 10/31/2014

Phantom: SAM Sub ; Type: QD000P40CC; Serial: TP:1357

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

5300 MHz System Verification

Area Scan (7x9x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

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

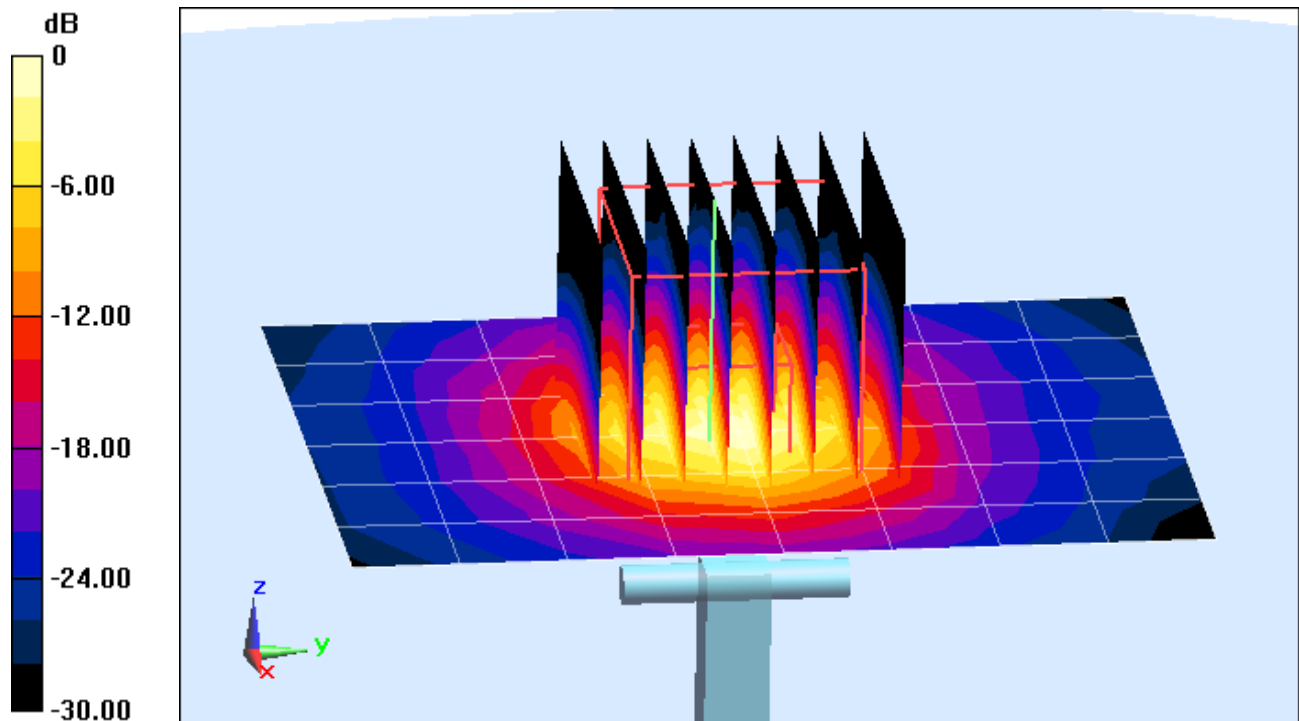
Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 33.5 W/kg

SAR(1 g) = 8.01 W/kg; SAR(10 g) = 2.2 W/kg

Deviation (1 g) = 5.67 %

Deviation (10g) = 3.29 %



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

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5GHz Medium parameters used:

$f = 5500 \text{ MHz}$; $\sigma = 5.772 \text{ S/m}$; $\epsilon_r = 47.649$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-20-2015; Ambient Temp: 22.8°C; Tissue Temp: 21.2°C

Probe: EX3DV4 - SN3949; ConvF(4.16, 4.16, 4.16); Calibrated: 8/21/2014;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 10/31/2014

Phantom: SAM Sub ; Type: QD000P40CC; Serial: TP:1357

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

5500 MHz System Verification

Area Scan (7x9x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

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

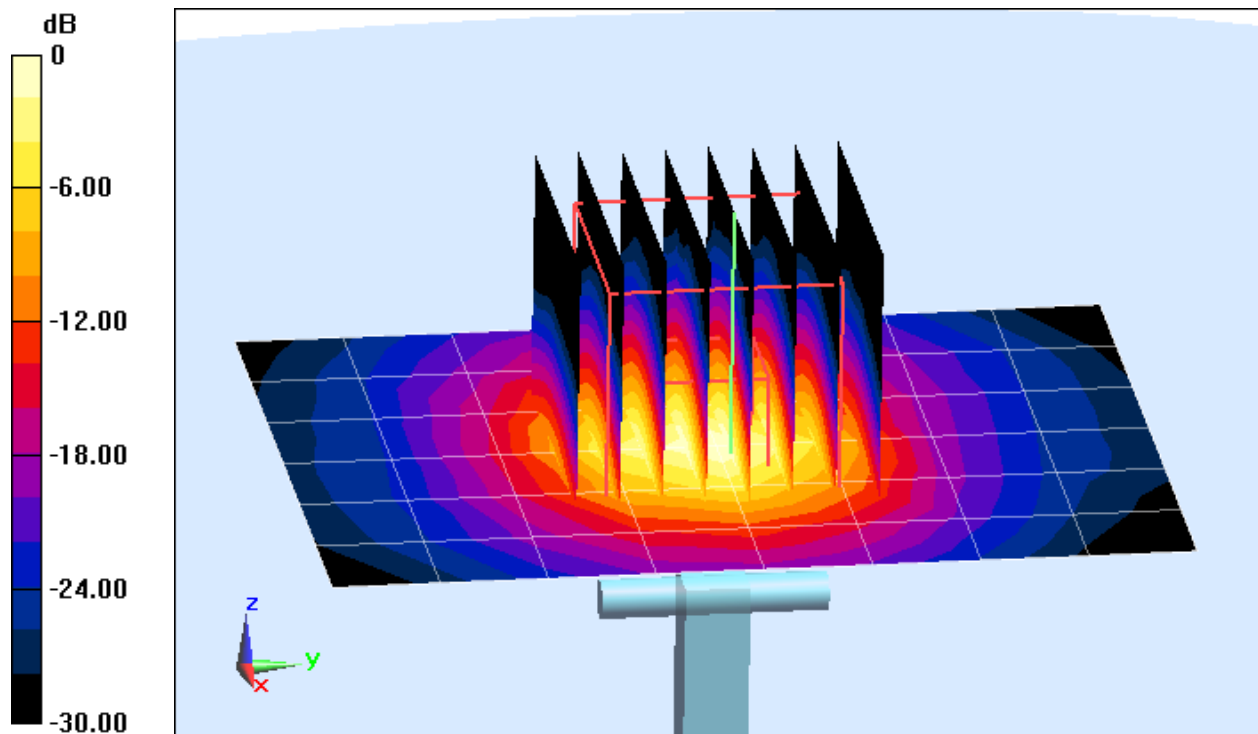
Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 36.6 W/kg

SAR(1 g) = 8.51 W/kg; SAR(10 g) = 2.33 W/kg

Deviation (1 g) = 7.45 %

Deviation (10 g) = 5.91 %



PCTEST ENGINEERING LABORATORY, INC.

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

Communication System: UID 0, CW; Frequency: 5600 MHz; Duty Cycle: 1:1

Medium: 5GHz Medium parameters used:

$f = 5600 \text{ MHz}$; $\sigma = 5.928 \text{ S/m}$; $\epsilon_r = 47.449$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-20-2015; Ambient Temp: 22.8°C; Tissue Temp: 21.2°C

Probe: EX3DV4 - SN3949; ConvF(3.97, 3.97, 3.97); Calibrated: 8/21/2014;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 10/31/2014

Phantom: SAM Sub ; Type: QD000P40CC; Serial: TP:1357

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

5600 MHz System Verification

Area Scan (7x9x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

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

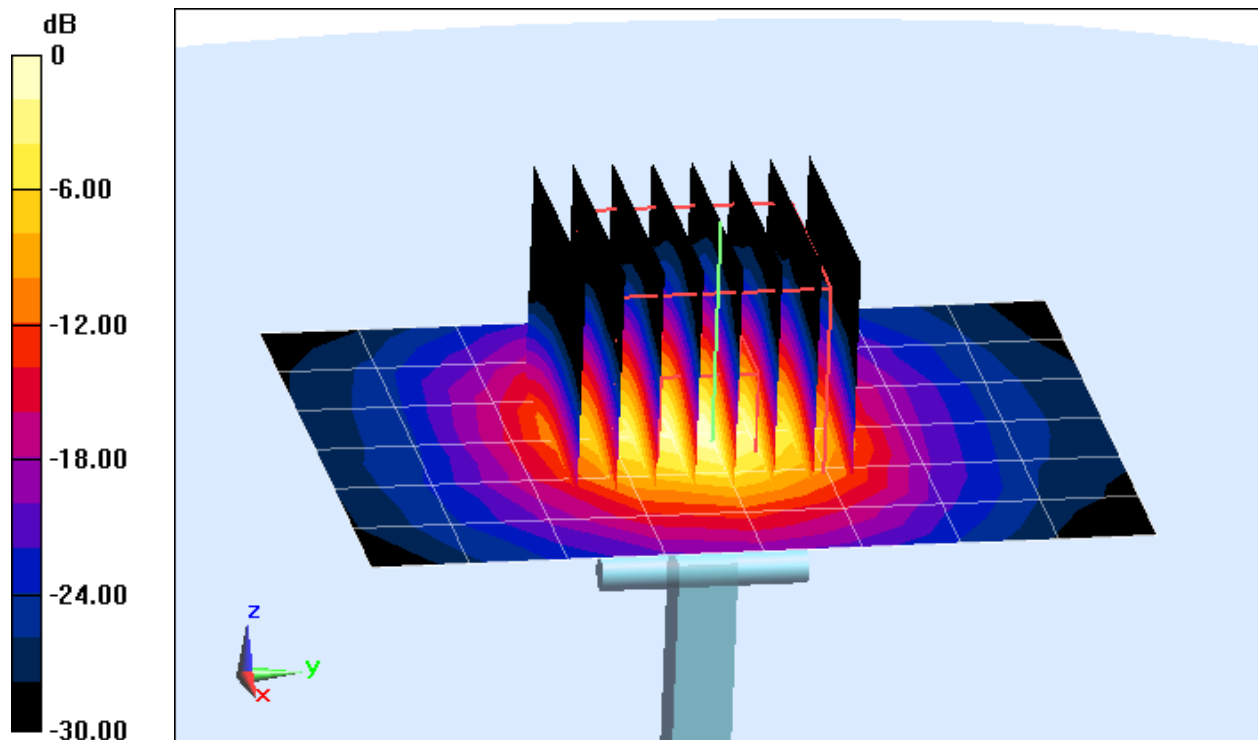
Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 38.5 W/kg

SAR(1 g) = 8.64 W/kg; SAR(10 g) = 2.36 W/kg

Deviation (1 g) = 8.82 %

Deviation (10 g) = 7.27 %



0 dB = 21.8 W/kg = 13.38 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5GHz Medium parameters used:

$f = 5800 \text{ MHz}$; $\sigma = 6.22 \text{ S/m}$; $\epsilon_r = 46.948$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 01-20-2015; Ambient Temp: 22.8°C; Tissue Temp: 21.2°C

Probe: EX3DV4 - SN3949; ConvF(4.27, 4.27, 4.27); Calibrated: 8/21/2014;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 10/31/2014

Phantom: SAM Sub ; Type: QD000P40CC; Serial: TP:1357

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

5800 MHz System Verification

Area Scan (7x9x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

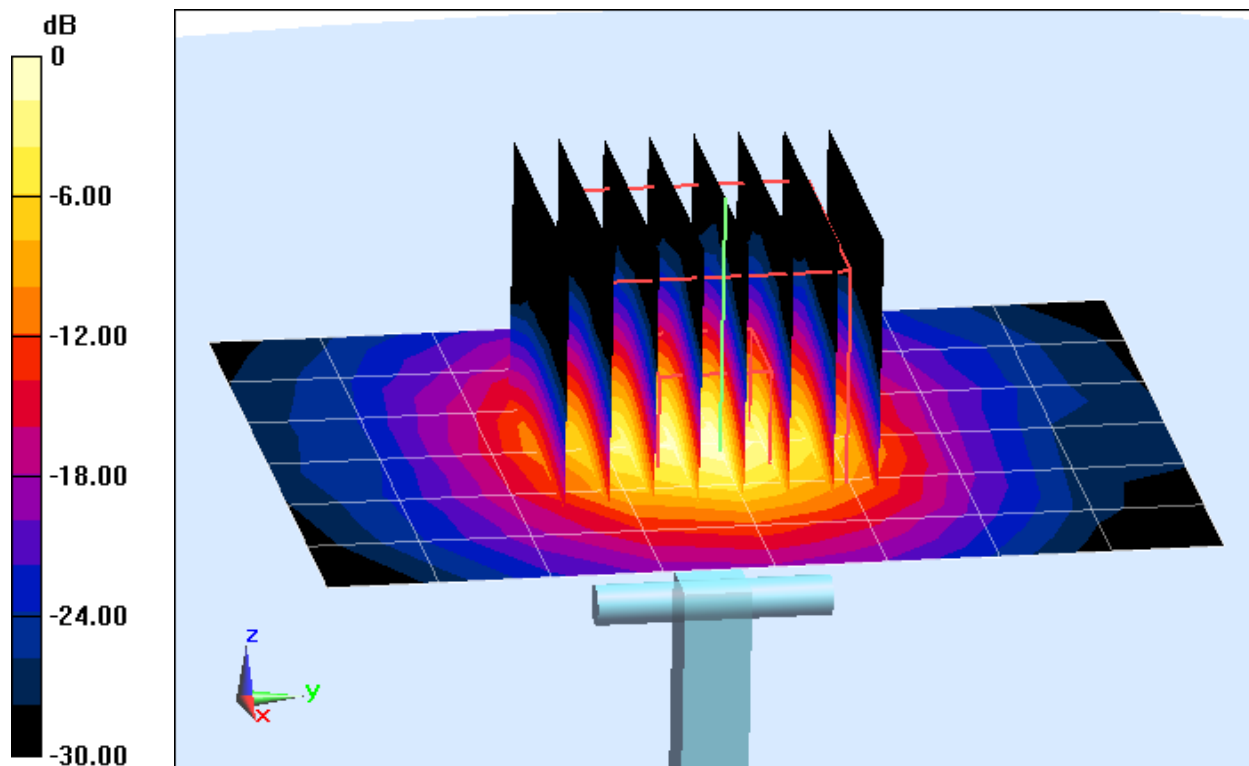
Zoom Scan (8x8x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$; Graded Ratio=1.4

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 37.1 W/kg

SAR(1 g) = 7.81 W/kg

Deviation = 4.97 %



0 dB = 19.9 W/kg = 12.99 dBW/kg

APPENDIX C: PROBE CALIBRATION

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



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

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

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **ES3-3334_Dec14**

CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3334**

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

CC
 12/31/14

Calibration date: **December 16, 2014**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	03-Apr-14 (No. 217-01911)	Apr-15
Power sensor E4412A	MY41498087	03-Apr-14 (No. 217-01911)	Apr-15
Reference 3 dB Attenuator	SN: S5054 (3c)	03-Apr-14 (No. 217-01915)	Apr-15
Reference 20 dB Attenuator	SN: S5277 (20x)	03-Apr-14 (No. 217-01919)	Apr-15
Reference 30 dB Attenuator	SN: S5129 (30b)	03-Apr-14 (No. 217-01920)	Apr-15
Reference Probe ES3DV2	SN: 3013	30-Dec-13 (No. ES3-3013_Dec13)	Dec-14
DAE4	SN: 789	30-Apr-14 (No. DAE4-789_Apr14)	Apr-15
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

Calibrated by:	Name Leif Klysner	Function Laboratory Technician	Signature
Approved by:	Katja Pokovic	Technical Manager	
Issued: December 16, 2014 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
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
Connector Angle	Information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

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

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.
- Connector Angle:** The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).

Probe ES3DV3

SN:3334

Manufactured:	January 24, 2012
Repaired:	December 9, 2014
Calibrated:	December 16, 2014

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3334

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	1.04	1.05	1.01	$\pm 10.1 \%$
DCP (mV) ^B	106.5	105.0	105.6	

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	188.0	$\pm 3.0 \%$
		Y	0.0	0.0	1.0		183.2	
		Z	0.0	0.0	1.0		181.8	
10010-CAA	SAR Validation (Square, 100ms, 10ms)	X	4.61	67.2	13.7	10.00	38.4	$\pm 1.4 \%$
		Y	20.36	82.7	18.7		38.0	
		Z	17.55	80.3	17.6		37.0	
10011-CAB	UMTS-FDD (WCDMA)	X	3.56	68.4	19.1	2.91	148.4	$\pm 0.7 \%$
		Y	3.44	68.1	19.2		146.9	
		Z	3.52	68.3	19.1		144.7	
10012-CAB	IEEE 802.11b WIFI 2.4 GHz (DSSS, 1 Mbps)	X	3.54	71.9	20.0	1.87	148.0	$\pm 0.7 \%$
		Y	3.51	72.2	20.5		148.9	
		Z	3.80	73.3	20.6		144.6	
10013-CAB	IEEE 802.11g WIFI 2.4 GHz (DSSS-OFDM, 6 Mbps)	X	11.39	71.1	23.3	9.46	149.8	$\pm 3.8 \%$
		Y	11.54	71.8	24.0		149.5	
		Z	11.11	70.5	23.0		141.6	
10021-DAB	GSM-FDD (TDMA, GMSK)	X	15.29	91.3	25.0	9.39	131.9	$\pm 1.7 \%$
		Y	24.16	100.0	28.4		142.8	
		Z	13.05	89.2	24.5		126.5	
10023-DAB	GPRS-FDD (TDMA, GMSK, TN 0)	X	16.07	91.7	25.1	9.57	144.0	$\pm 2.2 \%$
		Y	19.00	95.3	26.8		136.4	
		Z	13.93	89.8	24.6		141.0	
10024-DAB	GPRS-FDD (TDMA, GMSK, TN 0-1)	X	19.98	91.0	22.4	6.56	134.2	$\pm 1.9 \%$
		Y	34.78	99.7	25.5		145.0	
		Z	29.89	96.8	24.1		129.8	
10027-DAB	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	X	56.30	99.7	22.8	4.80	125.2	$\pm 1.9 \%$
		Y	41.16	99.6	23.9		131.2	
		Z	50.78	99.8	23.1		147.6	
10028-DAB	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	X	49.35	99.7	22.5	3.55	133.2	$\pm 2.2 \%$
		Y	46.49	99.6	22.9		139.2	
		Z	58.21	99.7	22.0		129.4	
10032-CAA	IEEE 802.15.1 Bluetooth (GFSK, DH5)	X	56.54	100.0	20.2	1.16	128.0	$\pm 1.7 \%$
		Y	20.03	99.3	22.4		130.3	
		Z	84.01	100.0	19.4		141.0	
10100-CAB	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	6.44	67.6	19.6	5.67	138.5	$\pm 1.4 \%$
		Y	6.50	67.9	20.0		142.1	
		Z	6.31	67.2	19.4		129.4	

10103-CAB	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	9.77	73.6	24.6	9.29	129.6	±3.3 %
		Y	10.52	76.0	26.3		132.1	
		Z	10.21	75.0	25.4		147.7	
10108-CAC	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	6.36	67.2	19.6	5.80	136.8	±1.4 %
		Y	6.31	67.3	19.8		137.2	
		Z	6.20	66.7	19.3		128.8	
10117-CAB	IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK)	X	9.96	68.3	20.8	8.07	126.5	±2.5 %
		Y	10.12	68.8	21.3		126.6	
		Z	10.22	69.0	21.2		143.7	
10151-CAB	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	9.29	73.0	24.4	9.28	125.3	±3.3 %
		Y	9.65	74.5	25.6		124.4	
		Z	9.65	74.3	25.2		141.1	
10164-CAC	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	6.03	66.7	19.3	5.75	132.7	±1.4 %
		Y	5.97	66.7	19.5		132.7	
		Z	6.17	67.3	19.7		148.3	
10160-CAB	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK)	X	6.47	67.2	19.5	5.82	138.1	±1.4 %
		Y	6.44	67.3	19.8		138.2	
		Z	6.27	66.6	19.2		126.8	
10169-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	5.03	66.9	19.6	5.73	137.2	±1.2 %
		Y	4.97	67.0	19.9		135.7	
		Z	4.91	66.5	19.5		127.1	
10172-CAB	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	8.53	77.4	26.9	9.21	142.4	±2.7 %
		Y	9.59	81.3	29.3		142.3	
		Z	7.78	75.0	25.7		126.7	
10175-CAC	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	5.02	67.0	19.7	5.72	131.8	±1.2 %
		Y	4.98	67.0	19.9		136.1	
		Z	4.95	66.8	19.6		128.1	
10181-CAB	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	X	4.99	66.8	19.6	5.72	131.2	±1.2 %
		Y	4.99	67.1	20.0		136.2	
		Z	4.92	66.6	19.5		127.9	
10196-CAB	IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK)	X	9.98	68.8	21.2	8.10	141.7	±2.5 %
		Y	10.14	69.5	21.8		147.2	
		Z	9.85	68.6	21.1		137.5	
10225-CAB	UMTS-FDD (HSPA+)	X	7.17	67.5	19.6	5.97	146.0	±1.4 %
		Y	7.13	67.7	19.9		149.9	
		Z	7.12	67.5	19.6		142.9	
10237-CAB	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	8.29	76.6	26.5	9.21	136.1	±2.7 %
		Y	9.60	81.4	29.3		142.3	
		Z	7.98	75.8	26.1		132.9	
10252-CAB	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	9.27	74.1	25.1	9.24	139.1	±3.3 %
		Y	10.25	77.5	27.4		146.3	
		Z	9.07	73.7	25.0		135.8	
10267-CAB	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	9.95	74.9	25.4	9.30	147.0	±3.3 %
		Y	9.80	75.0	25.9		125.9	
		Z	9.74	74.6	25.4		143.8	

10275-CAB	UMTS-FDD (HSUPA, Sublest 5, 3GPP Rel8.4)	X	4.63	67.6	19.0	3.96	147.5	±0.7 %
		Y	4.41	66.9	18.9		129.5	
		Z	4.61	67.6	19.1		148.1	
10291-AAB	CDMA2000, RC3, SO55, Full Rate	X	3.83	67.7	19.0	3.46	133.7	±0.7 %
		Y	3.71	67.4	19.0		139.0	
		Z	3.86	68.1	19.2		133.7	
10292-AAB	CDMA2000, RC3, SO32, Full Rate	X	3.85	68.2	19.2	3.39	136.7	±0.5 %
		Y	3.67	67.5	19.1		141.3	
		Z	3.75	67.8	19.0		136.2	
10297-AAA	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	6.31	67.1	19.5	5.81	130.6	±1.4 %
		Y	6.32	67.3	19.8		135.1	
		Z	6.24	66.9	19.4		129.2	
10311-AAA	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK)	X	6.85	67.5	19.8	6.06	135.1	±1.4 %
		Y	6.90	67.9	20.2		141.5	
		Z	6.82	67.5	19.8		135.1	
10403-AAB	CDMA2000 (1xEV-DO, Rev. 0)	X	5.04	69.1	19.1	3.76	126.0	±0.5 %
		Y	4.90	69.0	19.3		129.6	
		Z	5.11	69.7	19.4		125.8	
10404-AAB	CDMA2000 (1xEV-DO, Rev. A)	X	5.05	69.6	19.4	3.77	147.1	±0.7 %
		Y	4.84	69.2	19.5		127.8	
		Z	5.15	70.1	19.6		143.3	
10415-AAA	IEEE 802.11b WIFI 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle)	X	3.13	71.2	19.9	1.54	144.5	±0.5 %
		Y	2.93	70.4	19.9		149.8	
		Z	3.18	71.6	20.1		141.4	
10416-AAA	IEEE 802.11g WIFI 2.4 GHz (ERP-OFDM, 6 Mbps, 99pc duty cycle)	X	10.11	69.0	21.4	8.23	144.3	±2.5 %
		Y	10.21	69.6	21.9		148.3	
		Z	9.99	68.9	21.3		141.1	

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

^A The uncertainties of NormX,Y,Z do not affect the E^2 -field uncertainty inside TSL (see Pages 7 and 8).

^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:3334

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^e	Conductivity (S/m) ^f	ConvF X	ConvF Y	ConvF Z	Alpha ^g	Depth ^g (mm)	Unct. (k=2)
750	41.9	0.89	6.51	6.51	6.51	0.80	1.17	± 12.0 %
835	41.5	0.90	6.25	6.25	6.25	0.38	1.58	± 12.0 %
1750	40.1	1.37	5.21	5.21	5.21	0.43	1.63	± 12.0 %
1900	40.0	1.40	5.03	5.03	5.03	0.53	1.45	± 12.0 %
2450	39.2	1.80	4.51	4.51	4.51	0.80	1.26	± 12.0 %
2600	39.0	1.96	4.31	4.31	4.31	0.79	1.27	± 12.0 %

^c Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

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

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3334

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^d (mm)	Unct. (k=2)
750	55.5	0.96	6.09	6.09	6.09	0.49	1.47	± 12.0 %
835	55.2	0.97	6.14	6.14	6.14	0.69	1.27	± 12.0 %
1750	53.4	1.49	4.94	4.94	4.94	0.80	1.24	± 12.0 %
1900	53.3	1.52	4.73	4.73	4.73	0.62	1.44	± 12.0 %
2450	52.7	1.95	4.28	4.28	4.28	0.80	1.13	± 12.0 %
2600	52.5	2.16	4.16	4.16	4.16	0.75	1.25	± 12.0 %

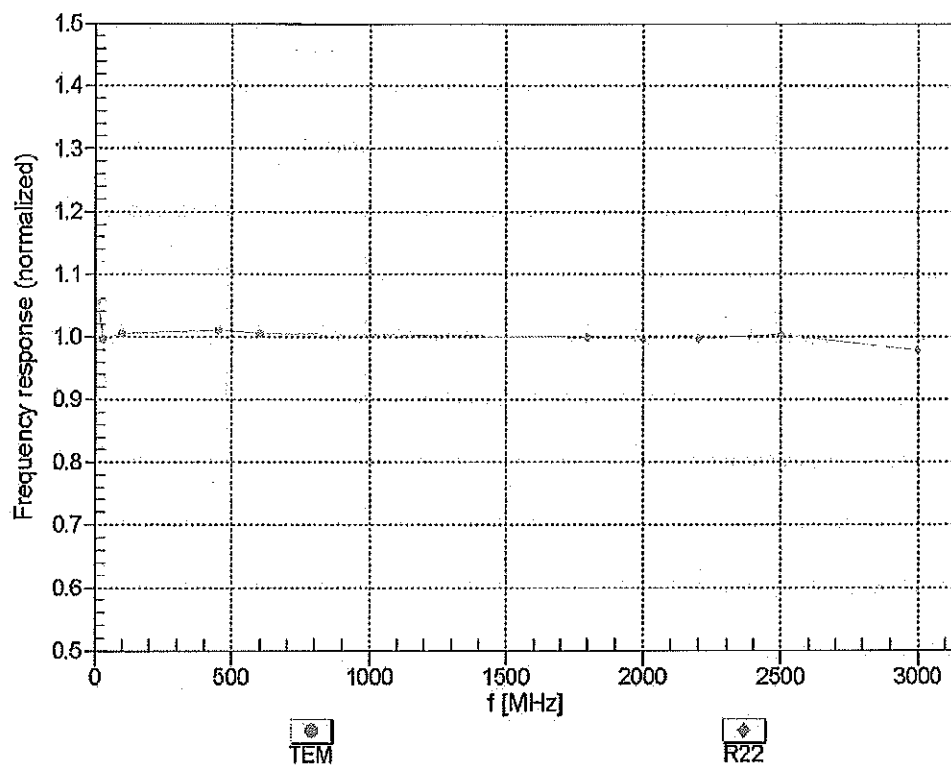
^c Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

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

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

Frequency Response of E-Field

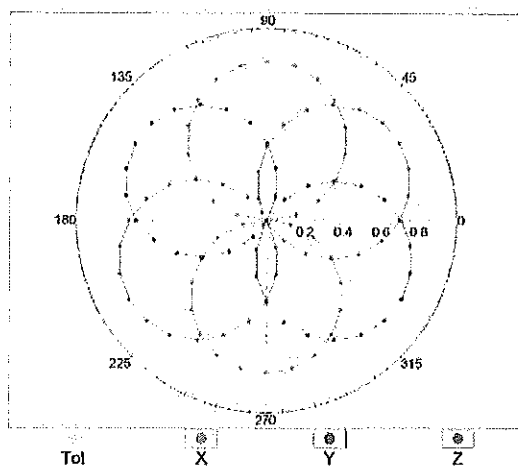
(TEM-Cell: Ifi110 EXX, Waveguide: R22)



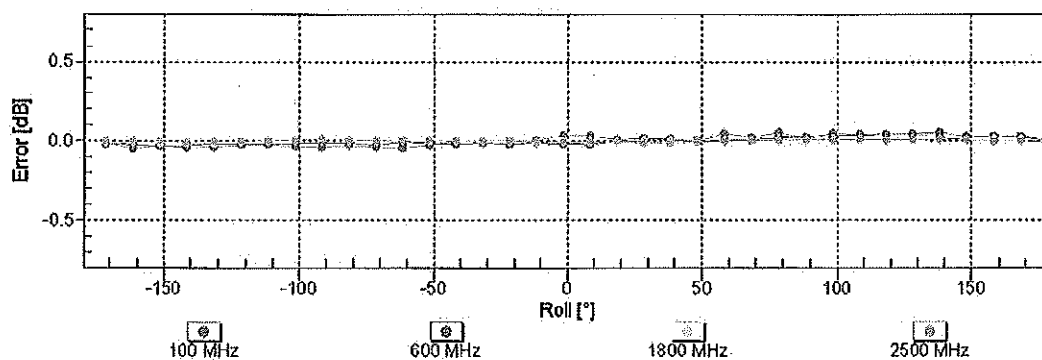
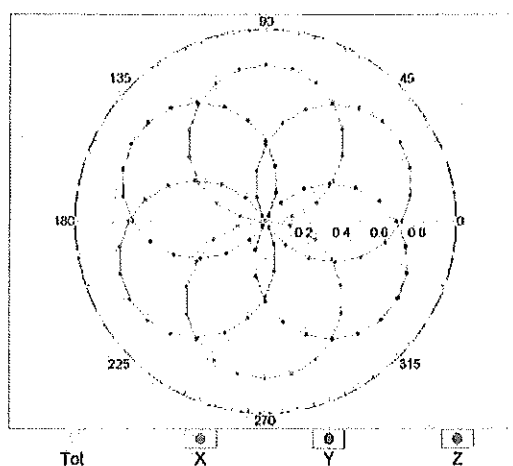
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

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

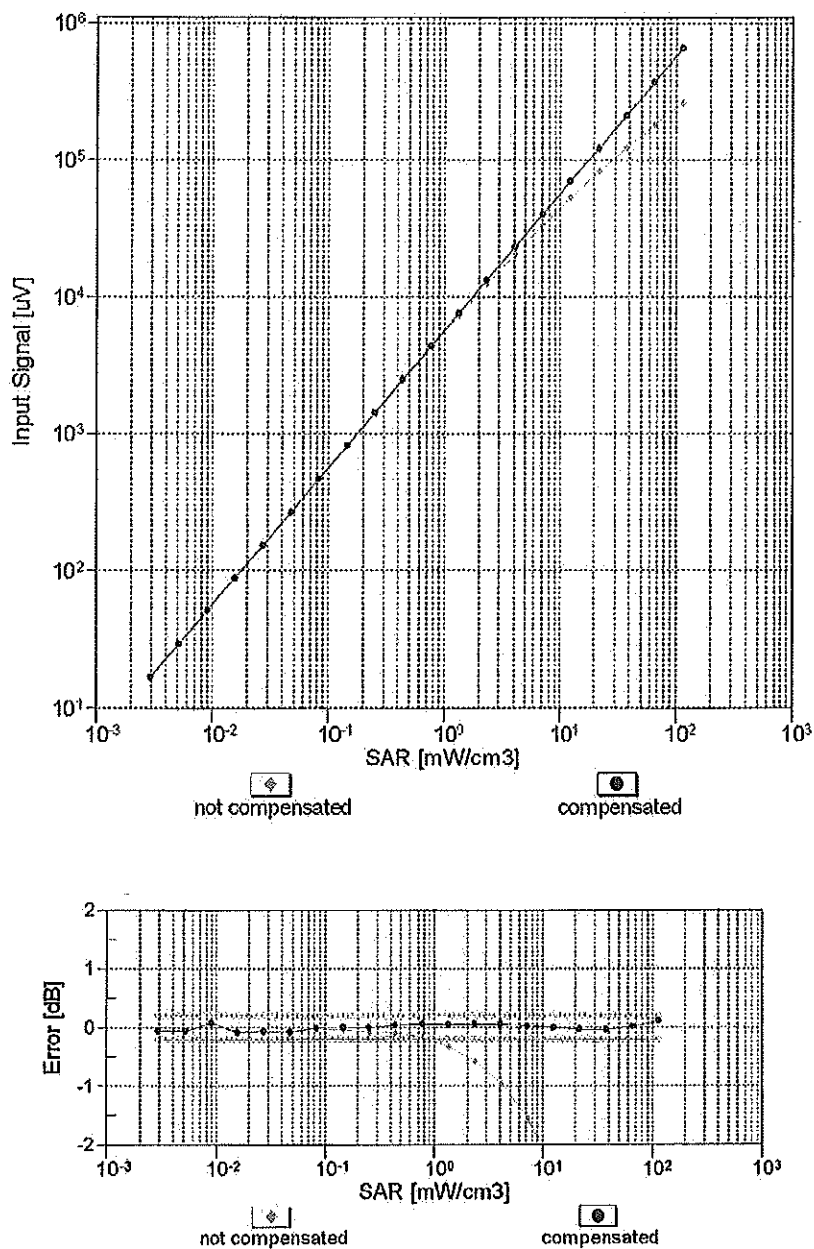
f=600 MHz,TEM



f=1800 MHz,R22

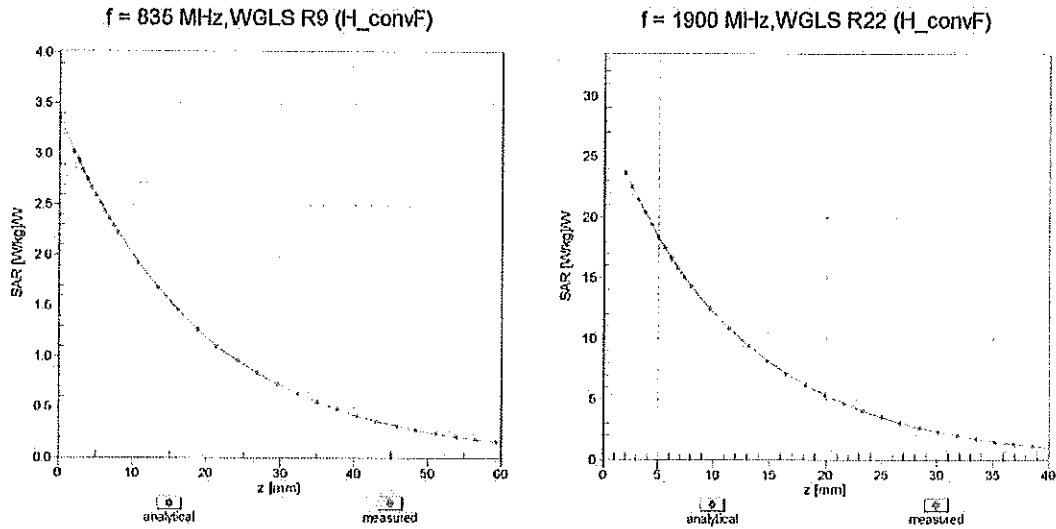
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell, $f_{\text{eval}} = 1900 \text{ MHz}$)

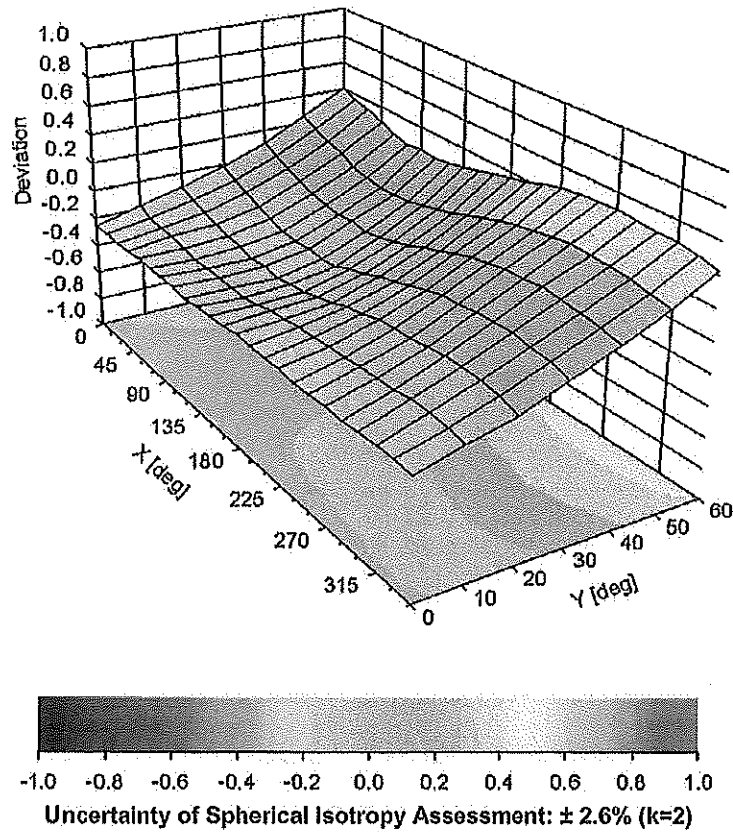


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



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



DASY/EASY - Parameters of Probe: ES3DV3 - SN:3334**Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	18.5
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



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

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **ES3-3288_Sep14/2**

CALIBRATION CERTIFICATE (Replacement of No:ES3-3288_Sep14)

Object **ES3DV3 - SN:3288**

Calibration procedure(s)

QA CAL-01.v9, QA CAL-23.v5, QA CAL-25.v6
Calibration procedure for dosimetric E-field probes

CC
W12/14

Calibration date:

September 24, 2014

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

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

Calibration Equipment used (M&TE critical for calibration)

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

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
Issued: November 3, 2014			
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

Glossary:

TSL	tissue simulating liquid
NORM _{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
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

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

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.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).

Probe ES3DV3

SN:3288

Manufactured:	July 6, 2010
Repaired:	September 18, 2014
Calibrated:	September 24, 2014

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3288

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	1.05	1.16	0.92	$\pm 10.1 \%$
DCP (mV) ^B	105.1	104.6	106.7	

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	195.8	$\pm 3.5 \%$
		Y	0.0	0.0	1.0		175.9	
		Z	0.0	0.0	1.0		177.1	
10010- CAA	SAR Validation (Square, 100ms, 10ms)	X	2.71	61.9	11.4	10.00	40.3	$\pm 2.2 \%$
		Y	2.37	60.2	11.2		42.6	
		Z	1.54	56.6	8.9		41.2	
10011- CAB	UMTS-FDD (WCDMA)	X	3.29	67.1	18.4	2.91	133.8	$\pm 0.5 \%$
		Y	3.43	67.9	18.9		139.5	
		Z	3.45	68.1	18.9		141.3	
10012- CAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	X	2.99	68.9	18.6	1.87	135.1	$\pm 0.7 \%$
		Y	3.59	72.4	20.4		140.7	
		Z	3.54	72.4	20.3		143.0	
10013- CAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps)	X	11.15	70.8	23.3	9.46	132.3	$\pm 3.5 \%$
		Y	11.29	70.8	23.2		141.1	
		Z	11.07	70.7	23.2		139.2	
10021- DAB	GSM-FDD (TDMA, GMSK)	X	14.71	90.5	24.5	9.39	149.0	$\pm 1.9 \%$
		Y	16.40	92.8	26.0		131.3	
		Z	11.34	87.2	23.6		126.1	
10023- DAB	GPRS-FDD (TDMA, GMSK, TN 0)	X	15.91	92.2	25.3	9.57	138.9	$\pm 2.5 \%$
		Y	21.25	96.9	27.2		142.0	
		Z	11.68	87.2	23.5		145.9	
10024- DAB	GPRS-FDD (TDMA, GMSK, TN 0-1)	X	38.62	99.8	24.7	6.56	123.8	$\pm 2.2 \%$
		Y	36.71	99.7	25.2		128.1	
		Z	36.56	99.4	24.5		129.5	
10027- DAB	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	X	56.60	99.6	22.6	4.80	138.8	$\pm 1.9 \%$
		Y	46.94	99.9	23.7		149.9	
		Z	51.17	99.8	22.9		144.9	
10028- DAB	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	X	70.88	100.0	21.6	3.55	147.5	$\pm 1.9 \%$
		Y	52.58	99.8	22.6		129.4	
		Z	76.98	99.8	21.2		128.7	
10032- CAA	IEEE 802.15.1 Bluetooth (GFSK, DH5)	X	98.89	99.5	18.9	1.16	135.8	$\pm 1.4 \%$
		Y	78.39	99.6	19.5		141.7	
		Z	95.21	95.5	17.1		143.4	
10039- CAB	CDMA2000 (1xRTT, RC1)	X	4.72	66.7	18.9	4.57	133.7	$\pm 0.9 \%$
		Y	4.85	67.1	19.1		137.7	
		Z	4.81	67.4	19.2		141.9	

10081-CAB	CDMA2000 (1xRTT, RC3)	X	3.91	66.3	18.6	3.97	129.5	±0.7 %
		Y	4.00	66.6	18.7		133.7	
		Z	3.99	66.8	18.8		137.5	
10098-CAB	UMTS-FDD (HSUPA, Subtest 2)	X	4.63	66.9	18.7	3.98	141.4	±0.7 %
		Y	4.78	67.5	19.0		147.7	
		Z	4.57	66.8	18.6		127.8	
10100-CAB	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	6.59	68.2	20.1	5.67	149.2	±1.4 %
		Y	6.36	67.3	19.6		130.7	
		Z	6.36	67.5	19.6		133.6	
10108-CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	6.44	67.8	20.0	5.80	146.6	±1.4 %
		Y	6.23	66.8	19.4		128.8	
		Z	6.24	67.1	19.6		131.4	
10110-CAB	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK)	X	6.08	67.1	19.6	5.75	143.2	±1.4 %
		Y	6.20	67.4	19.8		148.0	
		Z	5.92	66.6	19.3		128.5	
10114-CAA	IEEE 802.11n (HT Greenfield, 13.5 Mbps, BPSK)	X	10.32	69.3	21.5	8.10	137.0	±2.2 %
		Y	10.31	69.1	21.4		143.5	
		Z	10.37	69.5	21.6		146.1	
10117-CAA	IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK)	X	10.35	69.4	21.6	8.07	138.3	±2.2 %
		Y	10.36	69.3	21.4		146.4	
		Z	10.42	69.6	21.6		149.0	
10151-CAB	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	9.95	75.7	26.2	9.28	134.9	±3.3 %
		Y	10.37	76.0	26.1		146.6	
		Z	9.77	75.4	26.0		142.5	
10154-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	6.12	67.2	19.7	5.75	144.9	±1.4 %
		Y	6.21	67.4	19.8		148.8	
		Z	5.91	66.5	19.3		128.7	
10160-CAB	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK)	X	6.28	66.7	19.4	5.82	125.5	±1.2 %
		Y	6.37	66.8	19.4		129.7	
		Z	6.36	67.1	19.6		132.9	
10169-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	5.08	67.6	20.2	5.73	147.0	±1.2 %
		Y	4.95	66.6	19.6		128.6	
		Z	4.91	66.9	19.8		131.2	
10172-CAB	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	8.18	77.2	27.2	9.21	123.4	±2.7 %
		Y	8.37	76.6	26.6		129.5	
		Z	7.97	76.7	26.9		128.7	
10175-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	5.05	67.4	20.1	5.72	146.2	±1.4 %
		Y	5.10	67.3	20.0		142.8	
		Z	4.87	66.7	19.6		129.6	
10181-CAB	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	X	5.04	67.4	20.0	5.72	145.5	±1.2 %
		Y	5.12	67.4	20.0		143.4	
		Z	4.87	66.7	19.6		129.9	
10193-CAA	IEEE 802.11n (HT Greenfield, 6.5 Mbps, BPSK)	X	9.92	68.9	21.4	8.09	131.0	±2.2 %
		Y	9.84	68.5	21.1		130.0	
		Z	9.94	69.0	21.4		138.6	

10196-CAA	IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK)	X	9.90	68.9	21.4	8.10	130.8	±2.2 %
		Y	9.81	68.4	21.0		131.4	
		Z	9.95	69.1	21.5		140.5	
10219-CAA	IEEE 802.11n (HT Mixed, 7.2 Mbps, BPSK)	X	9.81	68.8	21.3	8.03	130.0	±2.2 %
		Y	9.89	68.9	21.3		138.1	
		Z	9.89	69.1	21.5		140.5	
10222-CAA	IEEE 802.11n (HT Mixed, 15 Mbps, BPSK)	X	10.25	69.2	21.4	8.06	137.1	±2.2 %
		Y	10.30	69.2	21.4		144.4	
		Z	10.38	69.6	21.6		148.4	
10225-CAB	UMTS-FDD (HSPA+)	X	6.90	66.8	19.3	5.97	132.8	±1.4 %
		Y	7.09	67.3	19.6		142.0	
		Z	7.04	67.4	19.6		143.5	
10237-CAB	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	9.61	81.9	29.6	9.21	149.3	±2.7 %
		Y	8.66	77.6	27.1		133.7	
		Z	8.20	77.5	27.3		132.2	
10252-CAB	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	9.16	74.5	25.8	9.24	126.3	±3.0 %
		Y	9.62	75.0	25.8		137.4	
		Z	9.16	74.8	25.9		135.2	
10267-CAB	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	9.97	75.7	26.3	9.30	133.7	±3.3 %
		Y	10.38	75.9	26.1		146.1	
		Z	9.91	75.7	26.3		143.8	
10274-CAB	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.10)	X	5.86	66.6	18.7	4.87	129.9	±0.9 %
		Y	6.01	67.1	19.0		135.7	
		Z	5.95	67.1	19.0		139.4	
10275-CAB	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.4)	X	4.40	66.7	18.6	3.96	136.4	±0.7 %
		Y	4.55	67.3	19.0		138.3	
		Z	4.56	67.6	19.1		144.3	
10291-AAB	CDMA2000, RC3, SO55, Full Rate	X	3.64	66.9	18.7	3.46	127.4	±0.5 %
		Y	3.77	67.6	19.1		130.2	
		Z	3.72	67.5	19.0		134.4	
10292-AAB	CDMA2000, RC3, SO32, Full Rate	X	3.58	67.0	18.7	3.39	128.4	±0.5 %
		Y	3.73	67.7	19.1		132.7	
		Z	3.69	67.8	19.1		136.1	
10297-AAA	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	6.43	67.7	19.9	5.81	145.5	±1.4 %
		Y	6.49	67.7	19.9		149.5	
		Z	6.23	67.0	19.6		129.5	
10311-AAA	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK)	X	6.74	67.3	19.8	6.06	126.7	±1.4 %
		Y	6.83	67.5	19.8		132.9	
		Z	6.81	67.6	19.9		135.8	
10315-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 96pc duty cycle)	X	3.00	69.9	19.4	1.71	133.9	±0.5 %
		Y	3.30	71.5	20.1		141.0	
		Z	3.22	71.4	20.0		142.9	
10316-AAA	IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 96pc duty cycle)	X	10.17	69.2	21.8	8.36	130.5	±2.5 %
		Y	10.20	69.1	21.6		138.4	
		Z	10.20	69.4	21.8		140.7	

10403-AAB	CDMA2000 (1xEV-DO, Rev. 0)	X	4.75	68.3	18.8	3.76	138.5	±0.7 %
		Y	5.00	69.1	19.2		146.7	
		Z	4.92	69.2	19.1		148.5	
10404-AAB	CDMA2000 (1xEV-DO, Rev. A)	X	4.73	68.6	18.9	3.77	136.3	±0.7 %
		Y	4.97	69.4	19.4		143.7	
		Z	4.91	69.6	19.3		146.0	
10415-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle)	X	2.65	68.1	18.5	1.54	135.2	±0.5 %
		Y	3.05	70.8	19.9		140.7	
		Z	2.87	69.8	19.3		144.8	
10416-AAA	IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 99pc duty cycle)	X	10.00	69.0	21.5	8.23	130.8	±2.2 %
		Y	10.06	68.9	21.4		138.6	
		Z	10.08	69.3	21.7		141.6	

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 8 and 9).

^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:3288

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unct. (k=2)
750	41.9	0.89	6.81	6.81	6.81	0.37	1.70	± 12.0 %
835	41.5	0.90	6.51	6.51	6.51	0.45	1.52	± 12.0 %
1750	40.1	1.37	5.38	5.38	5.38	0.44	1.58	± 12.0 %
1900	40.0	1.40	5.17	5.17	5.17	0.80	1.18	± 12.0 %
2450	39.2	1.80	4.56	4.56	4.56	0.80	1.21	± 12.0 %
2600	39.0	1.96	4.44	4.44	4.44	0.80	1.22	± 12.0 %

^C Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

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

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3288

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unct. (k=2)
750	55.5	0.96	6.38	6.38	6.38	0.31	1.89	± 12.0 %
835	55.2	0.97	6.32	6.32	6.32	0.55	1.39	± 12.0 %
1750	53.4	1.49	5.03	5.03	5.03	0.57	1.44	± 12.0 %
1900	53.3	1.52	4.82	4.82	4.82	0.51	1.54	± 12.0 %
2450	52.7	1.95	4.36	4.36	4.36	0.71	1.07	± 12.0 %
2600	52.5	2.16	4.22	4.22	4.22	0.80	1.07	± 12.0 %

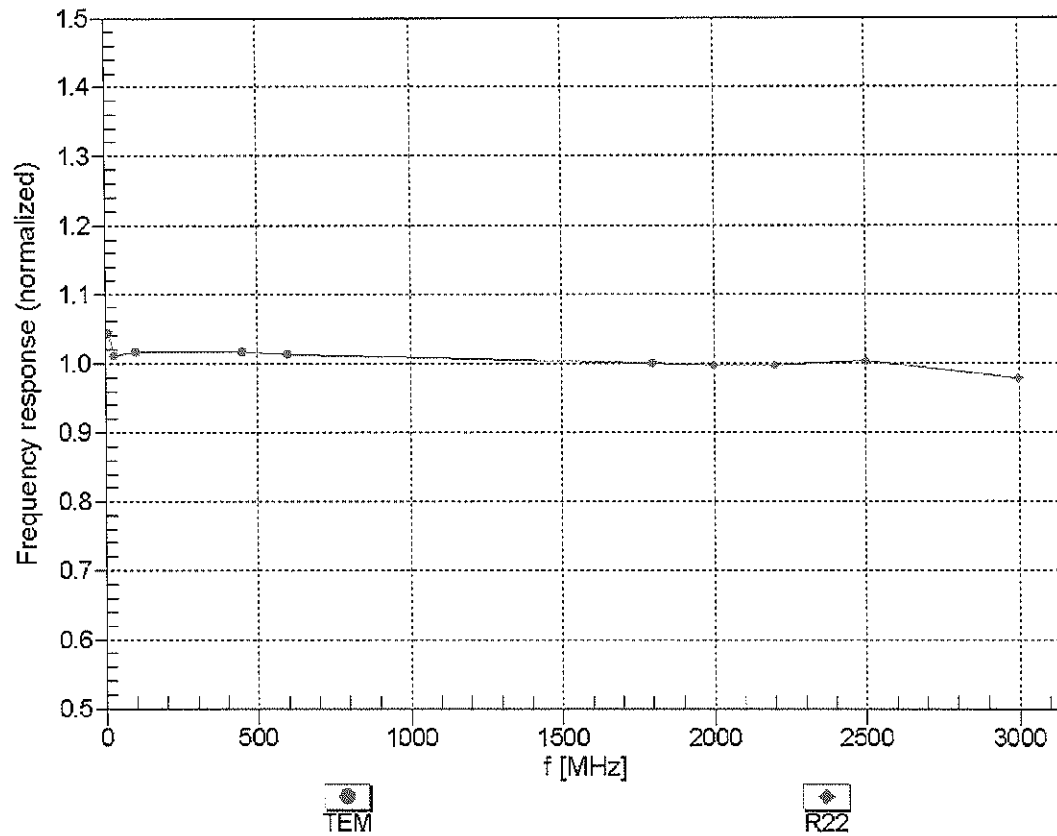
^C Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

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

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

Frequency Response of E-Field

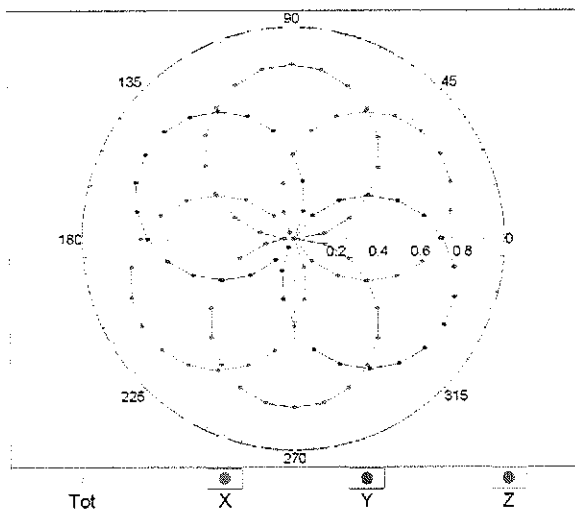
(TEM-Cell:ifi110 EXX, Waveguide: R22)



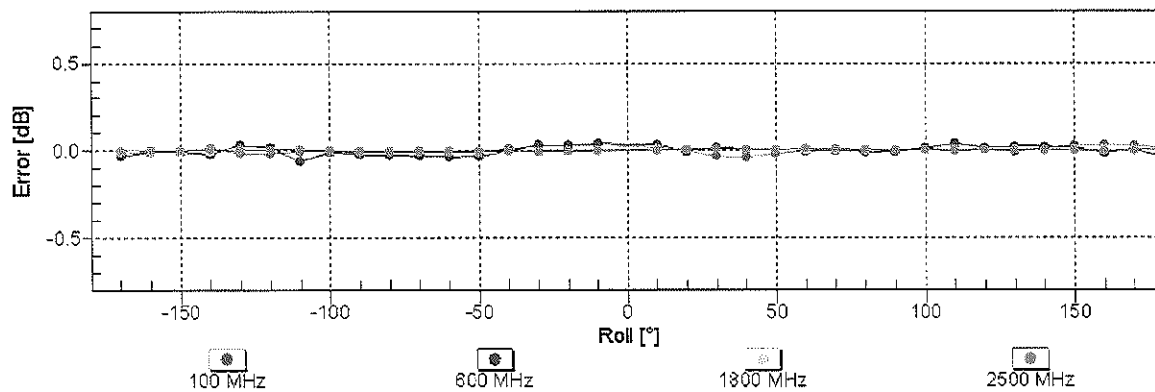
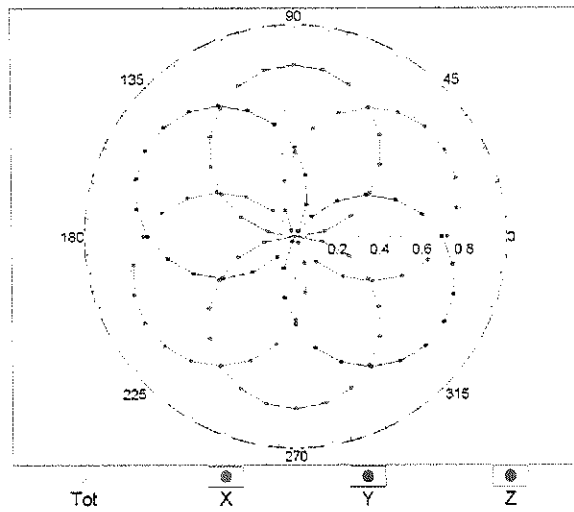
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz,TEM

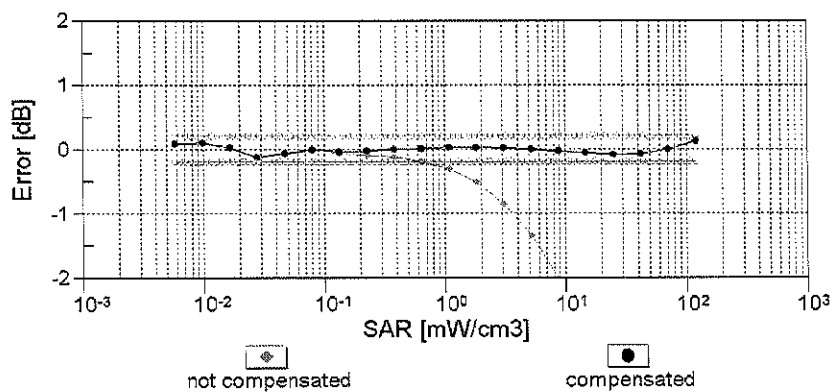
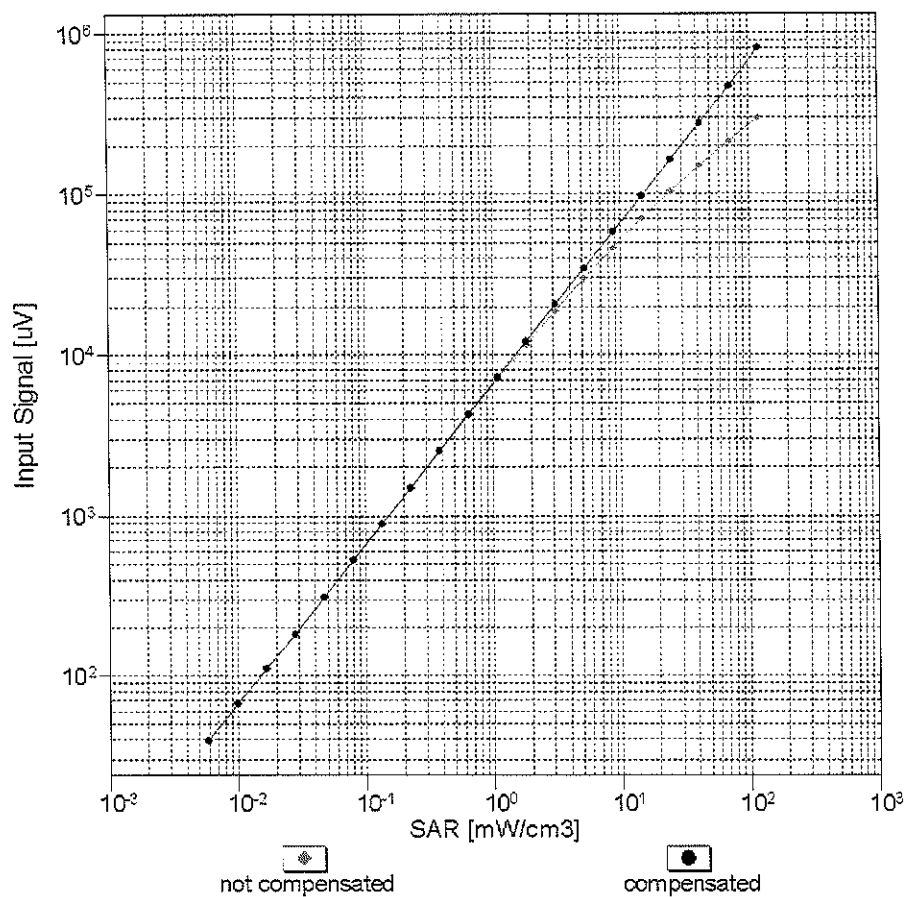


f=1800 MHz,R22



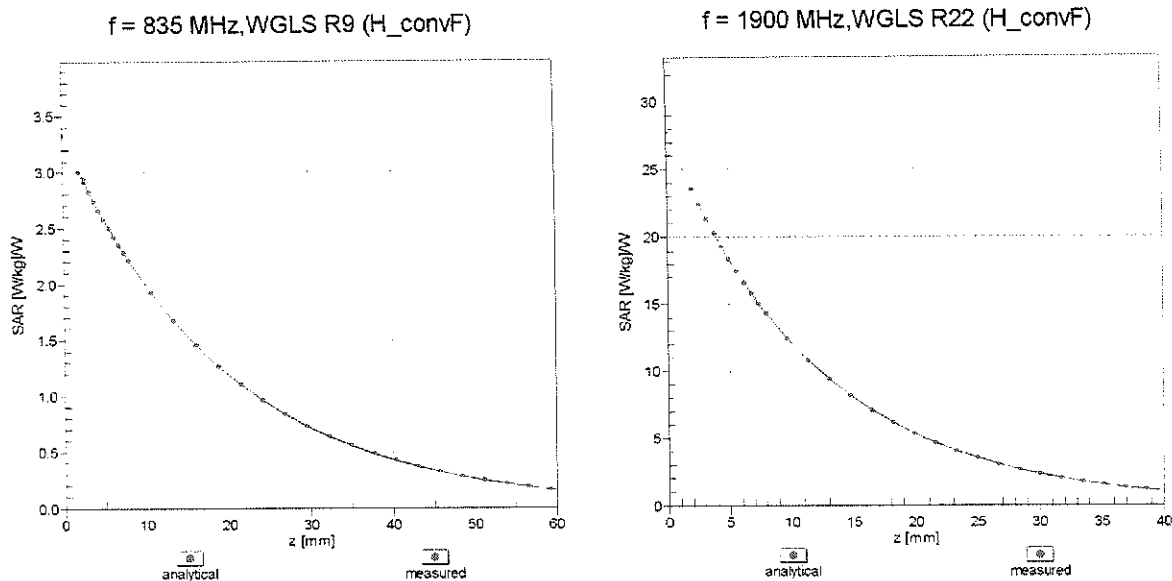
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell , $f_{\text{eval}} = 1900 \text{ MHz}$)



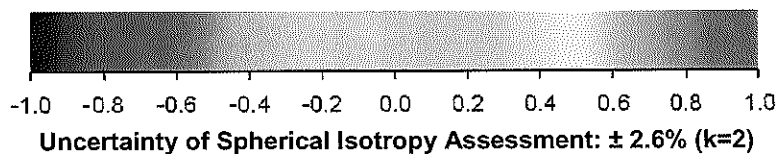
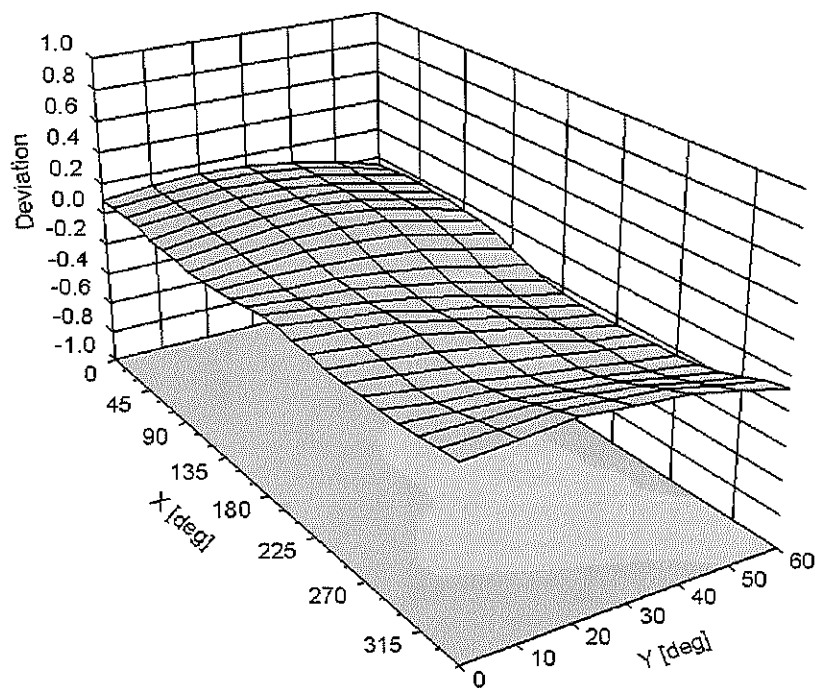
Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ , θ), $f = 900 \text{ MHz}$



DASY/EASY - Parameters of Probe: ES3DV3 - SN:3288

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-110
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

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



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

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D1750V2-1051_Apr14**

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 10, 2014**

✓
KOK
5/7/14

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

Issued: April 10, 2014

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



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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	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 %	1.35 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	9.02 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	36.2 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	4.79 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	19.2 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	52.0 $\pm$ 6 %	1.48 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	9.37 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	37.4 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	5.04 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.1 W/kg $\pm$ 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$50.7 \Omega + 0.4 j\Omega$
Return Loss	- 41.5 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$46.8 \Omega + 0.8 j\Omega$
Return Loss	- 29,3 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: 10.04.2014

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; $\sigma = 1.35$ 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(5.23, 5.23, 5.23); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: I001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

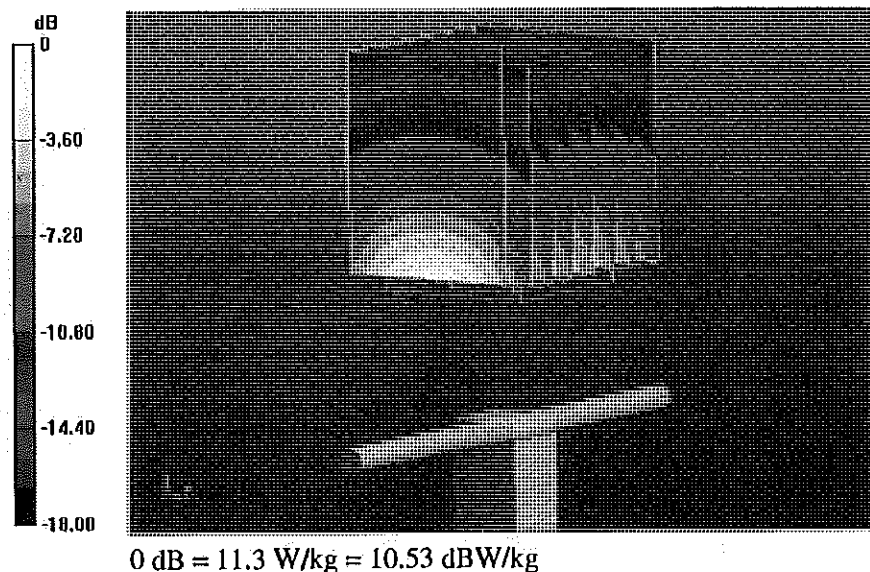
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.631 V/m; Power Drift = 0.00 dB

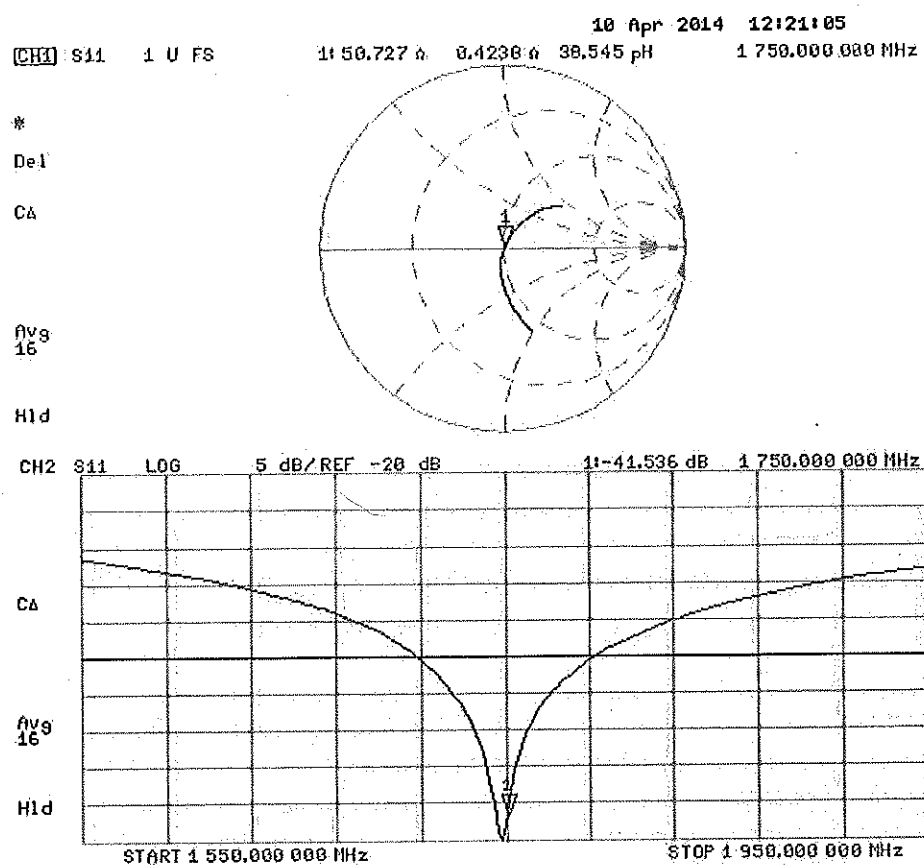
Peak SAR (extrapolated) = 16.2 W/kg

SAR(1 g) = 9.02 W/kg; SAR(10 g) = 4.79 W/kg

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



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 10.04.2014

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; $\sigma = 1.48$ S/m; $\epsilon_r = 52$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.89, 4.89, 4.89); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

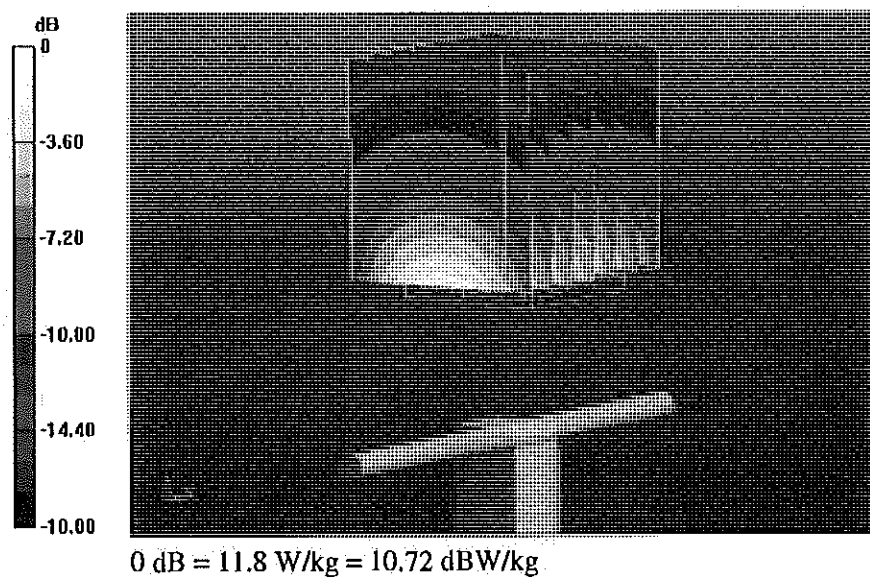
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.321 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 16.1 W/kg

SAR(1 g) = 9.37 W/kg; SAR(10 g) = 5.04 W/kg

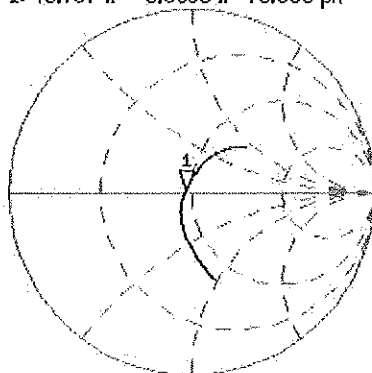
Maximum value of SAR (measured) = 11.8 W/kg



Impedance Measurement Plot for Body TSL

10 Apr 2014 12:20:40
 [CH1] S11 1 U FS 1: 46.787 Ω 0.8086 Ω 73.538 pH 1 750.000 000 MHz

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 Del
 CA



AV9
 16

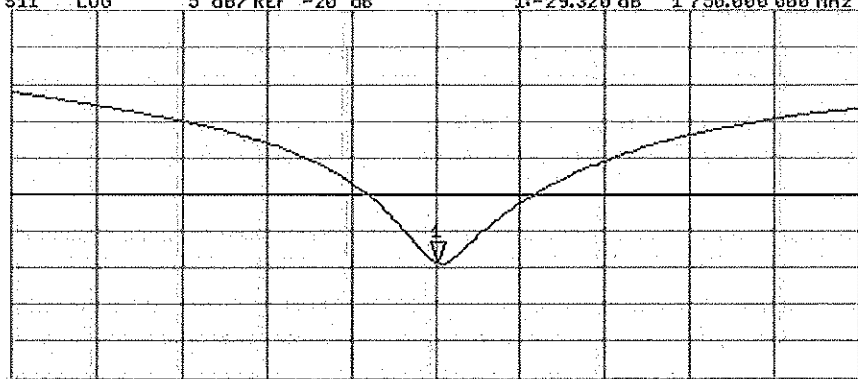
H1d

CH2 S11 LOG 5 dB/REF -20 dB 1: -29.320 dB 1 750.000 000 MHz

CA

AV9
 16

H1d





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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D1900V2-5d141_Apr14**

CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d141**

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

Calibration date: **April 09, 2014**

✓
Kok
5/7/14

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292763	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 801	25-Apr-13 (No. DAE4-801_Apr13)	Apr-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

Approved by: **Katja Pokovic** Technical Manager

Signature

Issued: April 9, 2014

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



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Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

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	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	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	39.1 $\pm$ 6 %	1.36 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	9.91 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	40.1 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	5.17 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	20.8 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	52.4 $\pm$ 6 %	1.52 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	10.2 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	40.6 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	5.41 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.6 W/kg $\pm$ 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$52.8 \Omega + 5.5 j\Omega$
Return Loss	- 24.5 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$48.8 \Omega + 6.3 j\Omega$
Return Loss	- 23.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.199 ns
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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: 09.04.2014

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; $\sigma = 1.36$ 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(5.06, 5.06, 5.06); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

Dipole Calibration for Head Tissue/ $P_{in}=250$ mW, $d=10$ mm/Zoom Scan (7x7x7)/Cube 0:

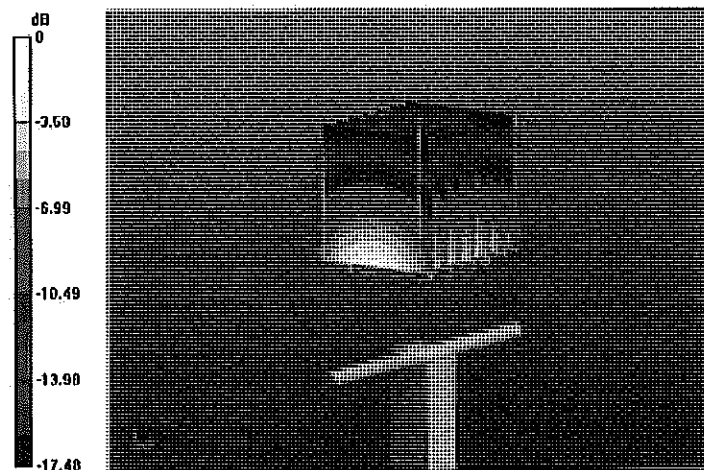
Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 99.080 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 18.2 W/kg

SAR(1 g) = 9.91 W/kg; SAR(10 g) = 5.17 W/kg

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

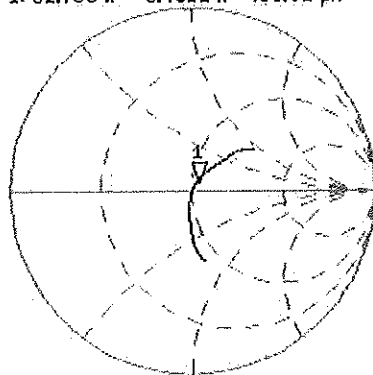


0 dB = 12.5 W/kg = 10.97 dBW/kg

Impedance Measurement Plot for Head TSL

9 Apr 2014 11:03:32
 CH1 S11 1 U FS 1 52.760 n 5.4512 n 456.62 pF 1 900.000 000 MHz

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 Del
 CA



AVG
 16

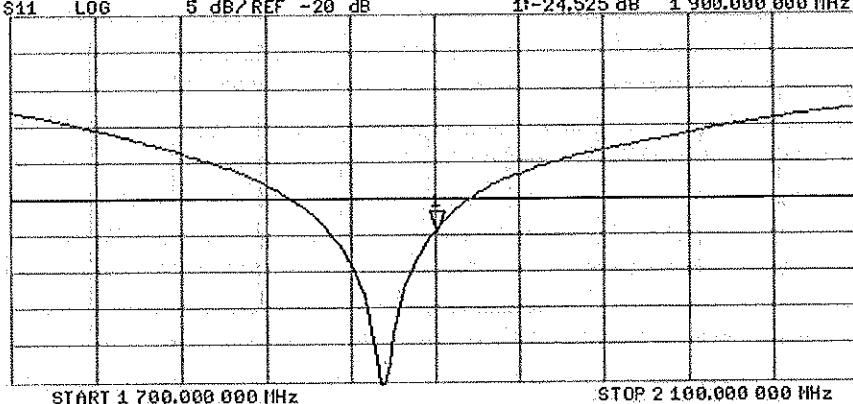
H1d

CH2 S11 LOG 5 dB/REF -20 dB 1 24.525 dB 1 900.000 000 MHz

CA

AVG
 16

H1d



DASY5 Validation Report for Body TSL

Date: 09.04.2014

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; $\sigma = 1.52$ S/m; $\epsilon_r = 52.4$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.76, 4.76, 4.76); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

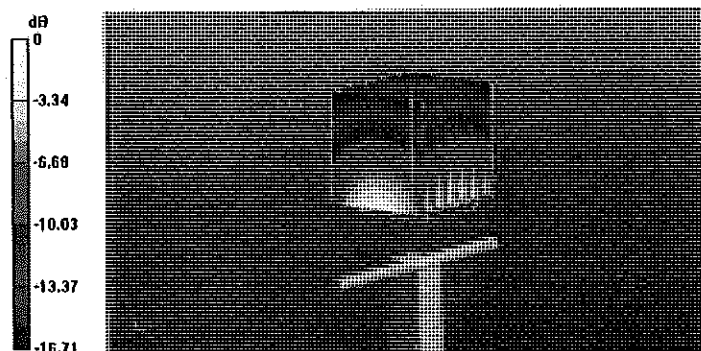
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.820 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 17.9 W/kg

SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.41 W/kg

Maximum value of SAR (measured) = 12.9 W/kg



0 dB = 12.9 W/kg = 11.11 dBW/kg

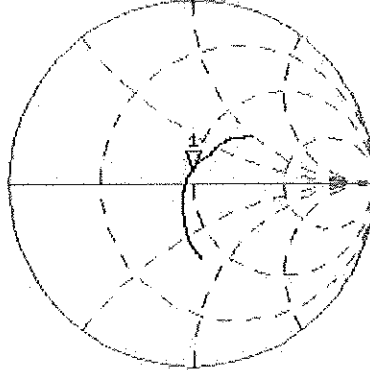
Impedance Measurement Plot for Body TSL

9 Apr 2014 11:02:32
 CH1 S11 1 U FS 1: 48.752 Ω 6.3320 Ω 530.41 μ H 1 900.000 000 MHz

*
 Del
 CA

Avg
 16

↑

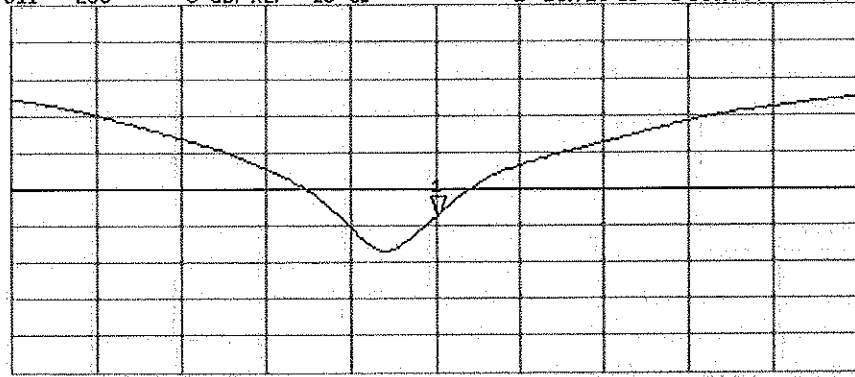


CH2 S11 LOG 5 dB/REF -20 dB 1: -23.715 dB 1 900.000 000 MHz

CA

Avg
 16

↑



START 1 700.000 000 MHz

STOP 2 100.000 000 MHz



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Client **PC Test**

Certificate No: **D1900V2-5d148_Feb14**

CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d148**

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

Calibration date: **February 27, 2014**

CCV
3/4/2014

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

Calibrated by: **Jeton Kastrati** Name **Laboratory Technician** Function **Signature**

Approved by: **Katja Pokovic** Technical Manager

Issued: February 27, 2014

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**

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Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	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	38.9 $\pm$ 6 %	1.39 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	10.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	40.7 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	5.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.2 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	52.8 $\pm$ 6 %	1.49 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	9.73 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	39.3 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	5.15 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.7 W/kg $\pm$ 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$52.5 \Omega + 5.5 j\Omega$
Return Loss	- 24.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$48.0 \Omega + 6.7 j\Omega$
Return Loss	- 23.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.197 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: 27.02.2014

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.39$ S/m; $\epsilon_r = 38.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.06, 5.06, 5.06); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

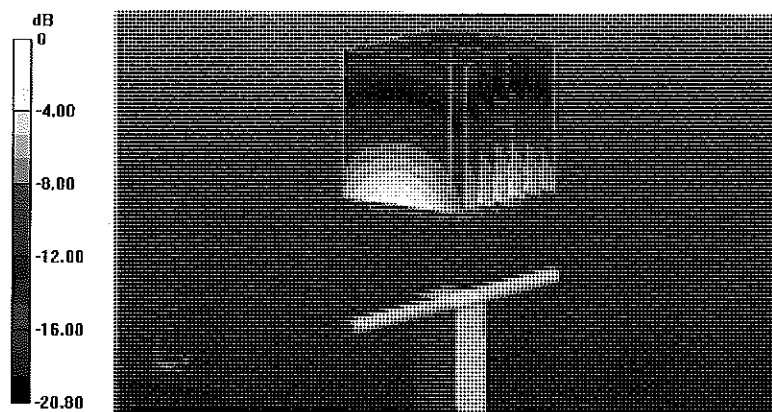
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.796 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 18.9 W/kg

SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.31 W/kg

Maximum value of SAR (measured) = 12.8 W/kg

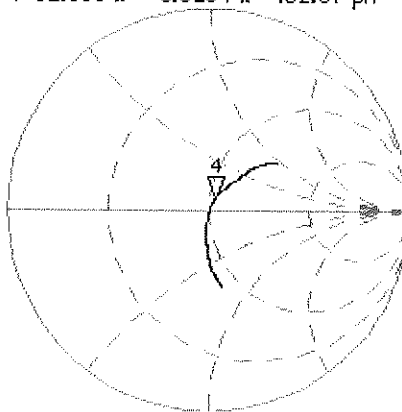


0 dB = 12.8 W/kg = 11.07 dBW/kg

Impedance Measurement Plot for Head TSL

27 Feb 2014 09:42:31
 [CH1] S11 1 U FS 4: 52.533 Δ 5.5234 Δ 462.67 pH 1 900.000 000 MHz

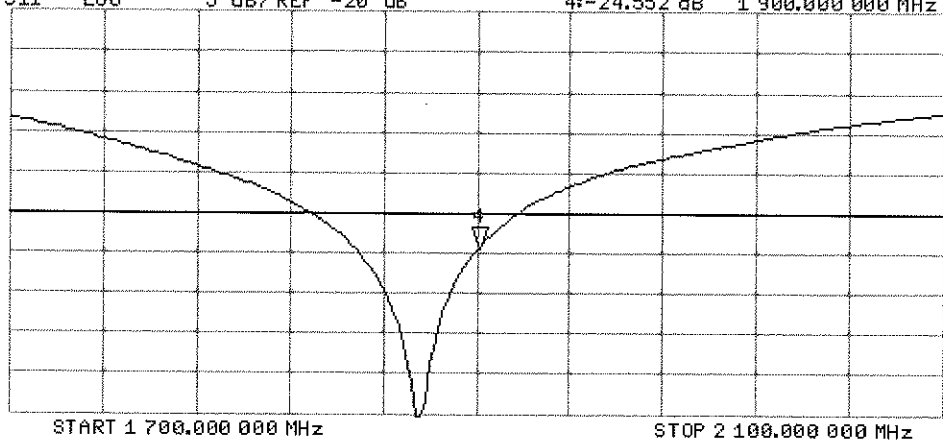
*
 De1
 CA



AVG
 16
 H1d

CH2 S11 LOG 5 dB/REF -20 dB 4:-24.552 dB 1 900.000 000 MHz

CA
 AVG
 16
 H1d



DASY5 Validation Report for Body TSL

Date: 27.02.2014

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.49$ S/m; $\epsilon_r = 52.8$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.76, 4.76, 4.76); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

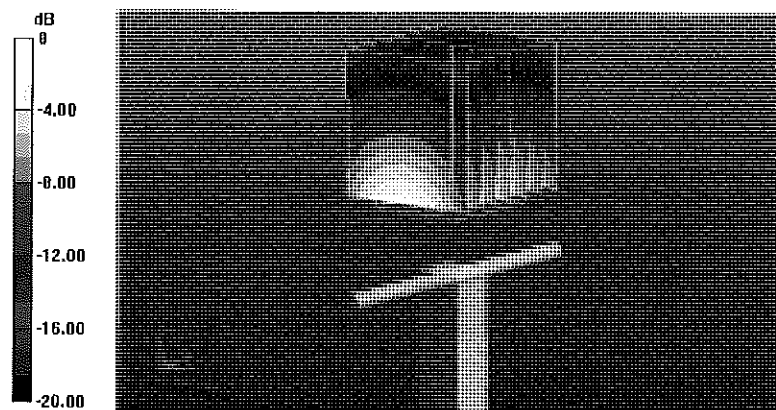
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.520 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 17.0 W/kg

SAR(1 g) = 9.73 W/kg; SAR(10 g) = 5.15 W/kg

Maximum value of SAR (measured) = 12.2 W/kg

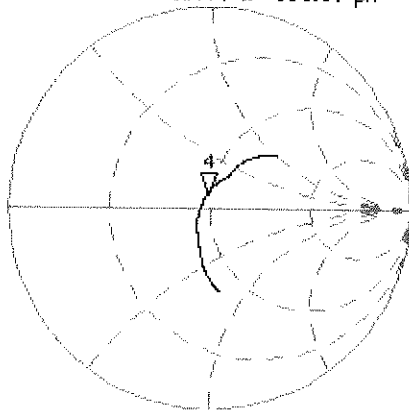


0 dB = 12.2 W/kg = 10.86 dBW/kg

Impedance Measurement Plot for Body TSL

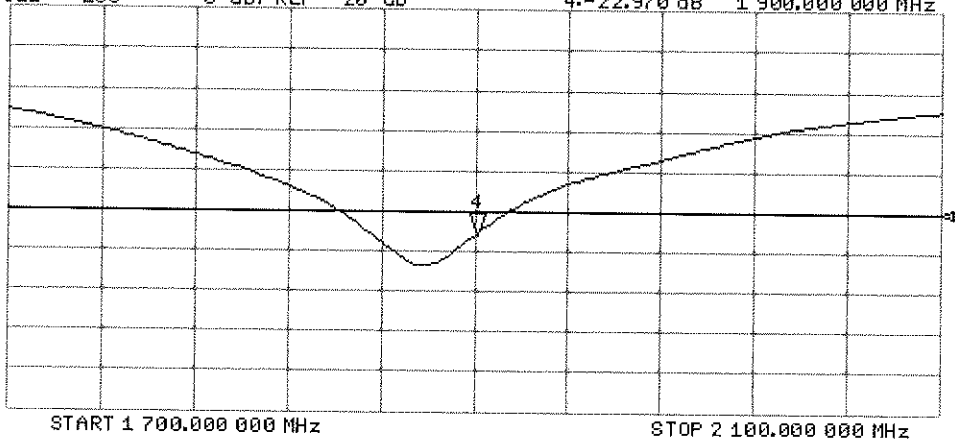
CH1 S11 1 U FS 4: 47.971 Ω 6.6777 Ω 559.37 pF 1 900.000 000 MHz 27 Feb 2014 09:42:04

*
De1
CA
Avg
16
H1d



CH2 S11 LOG 5 dB/REF -20 dB 4:-22.970 dB 1 900.000 000 MHz

CA
Avg
16
H1d





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Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D2450V2-719_Aug14**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 719**

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

Calibration date: **August 11, 2014**

✓ KOK
9/8/14

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	30-Apr-14 (No. DAE4-601_Apr14)	Apr-15
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

Calibrated by: **Michael Weber** Function: **Laboratory Technician**

Signature

M. Weber

Approved by: **Katja Pokovic** Technical Manager

Katja Pokovic

Issued: August 12, 2014

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	38.0 $\pm$ 6 %	1.82 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	52.1 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.09 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.2 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	50.5 $\pm$ 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	13.3 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	51.8 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.10 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.0 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$54.9 \Omega + 3.0 j\Omega$
Return Loss	- 25.2 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$50.9 \Omega + 5.8 j\Omega$
Return Loss	- 24.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.149 ns
----------------------------------	----------

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

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	September 10, 2002

DASY5 Validation Report for Head TSL

Date: 11.08.2014

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.82$ S/m; $\epsilon_r = 38$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.53, 4.53, 4.53); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

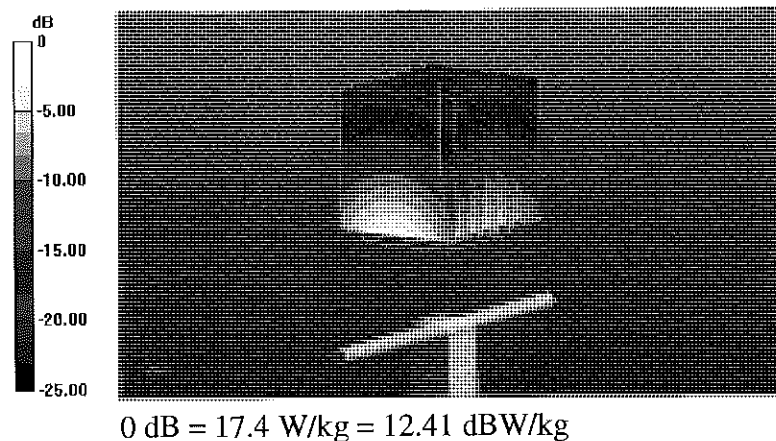
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 101.6 V/m; Power Drift = 0.03 dB

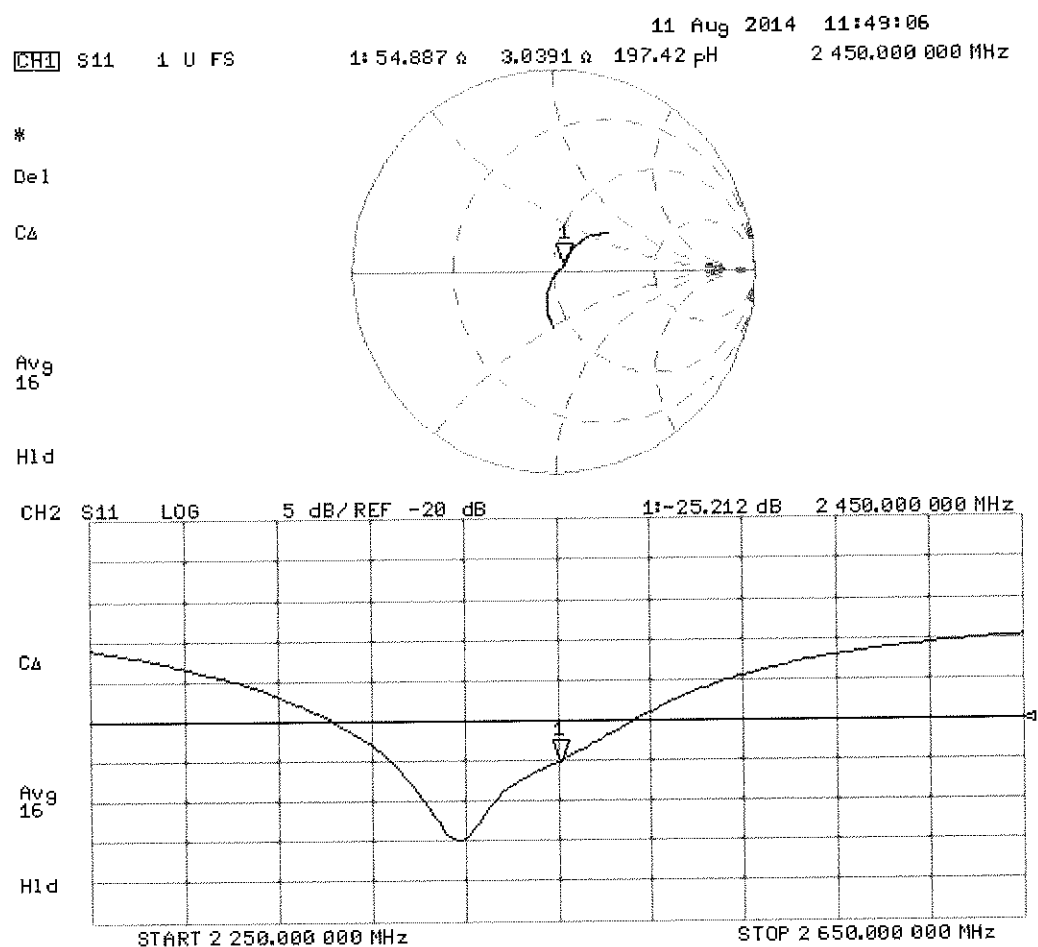
Peak SAR (extrapolated) = 27.5 W/kg

SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.09 W/kg

Maximum value of SAR (measured) = 17.4 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 11.08.2014

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.02$ S/m; $\epsilon_r = 50.5$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.35, 4.35, 4.35); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

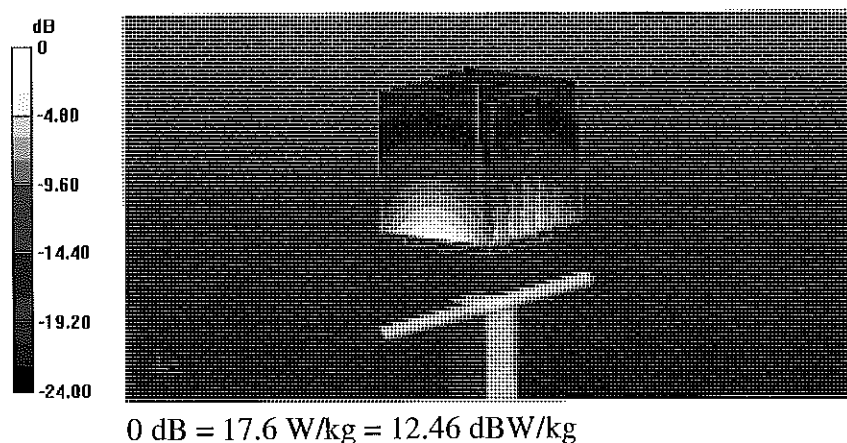
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.08 V/m; Power Drift = -0.01 dB

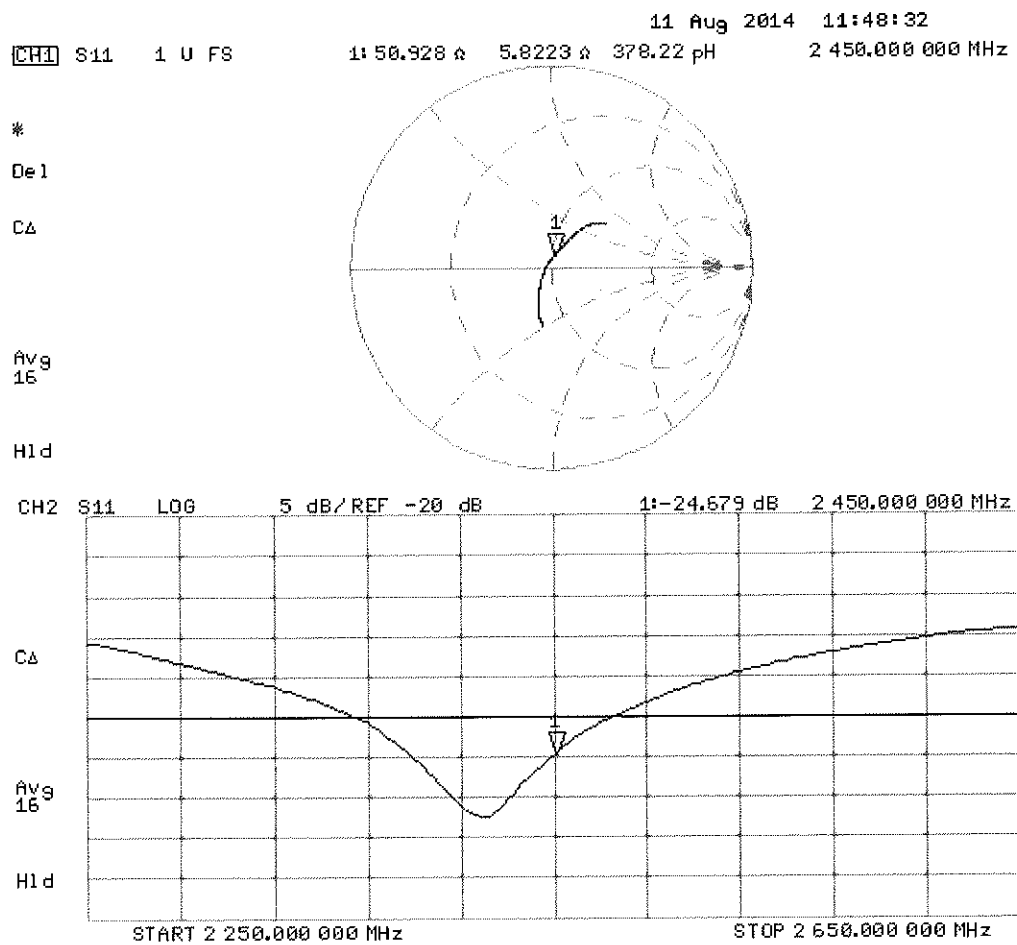
Peak SAR (extrapolated) = 27.9 W/kg

SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.1 W/kg

Maximum value of SAR (measured) = 17.6 W/kg



Impedance Measurement Plot for Body TSL





Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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Client **PC Test**

Certificate No: **D5GHzV2-1120_Feb14**

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 26, 2014**

CC✓
3/16/14

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe EX3DV4	SN: 3503	30-Dec-13 (No. EX3-3503_Dec13)	Dec-14
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

Signature

Approved by: **Katja Pokovic** Technical Manager

Signature

Issued: February 27, 2014

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



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Glossary:

TSL	tissue simulating liquid
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) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"
- c) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013

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	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz $\pm$ 1 MHz 5300 MHz $\pm$ 1 MHz 5500 MHz $\pm$ 1 MHz 5600 MHz $\pm$ 1 MHz 5800 MHz $\pm$ 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 $\pm$ 0.2) °C	37.1 $\pm$ 6 %	4.52 mho/m $\pm$ 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	7.87 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.1 W/kg $\pm$ 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.5 W/kg $\pm$ 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	36.9 ± 6 %	4.63 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	83.4 W / kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.8 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	36.7 ± 6 %	4.84 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.45 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	84.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.1 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	36.6 ± 6 %	4.95 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	8.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	82.2 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.5 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	36.3 ± 6 %	5.16 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	7.87 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.1 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.23 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.4 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.8 ± 6 %	5.40 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.43 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	74.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.08 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.7 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	47.6 ± 6 %	5.53 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5300 MHz

SAR averaged over 1 cm³ (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	75.8 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.14 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.3 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	47.3 ± 6 %	5.80 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	7.96 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	79.2 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.21 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	22.0 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.1 ± 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	7.98 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	79.4 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.21 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	22.0 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	46.8 ± 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	7.47 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	74.4 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.07 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.6 W/kg ± 19.5 % (k=2)

Appendix

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	$54.0\ \Omega - 5.6\ j\Omega$
Return Loss	- 23.6 dB

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	$51.1\ \Omega + 1.6\ j\Omega$
Return Loss	- 34.6 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	$51.1\ \Omega - 2.3\ j\Omega$
Return Loss	- 31.9 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	$58.4\ \Omega - 0.2\ j\Omega$
Return Loss	- 22.2 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	$52.9\ \Omega + 2.8\ j\Omega$
Return Loss	- 28.2 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	$52.3\ \Omega - 5.9\ j\Omega$
Return Loss	- 24.2 dB

Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	$51.1\ \Omega + 1.2\ j\Omega$
Return Loss	- 35.8 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	$50.5\ \Omega - 2.6\ j\Omega$
Return Loss	- 31.6 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	59.5 Ω - 2.9 j Ω
Return Loss	- 20.9 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	54.2 Ω + 1.1 j Ω
Return Loss	- 27.7 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: 26.02.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1120

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz

Medium parameters used: $f = 5200$ MHz; $\sigma = 4.52$ S/m; $\epsilon_r = 37.1$; $\rho = 1000$ kg/m³,

Medium parameters used: $f = 5300$ MHz; $\sigma = 4.63$ S/m; $\epsilon_r = 36.9$; $\rho = 1000$ kg/m³,

Medium parameters used: $f = 5500$ MHz; $\sigma = 4.84$ S/m; $\epsilon_r = 36.7$; $\rho = 1000$ kg/m³,

Medium parameters used: $f = 5600$ MHz; $\sigma = 4.95$ S/m; $\epsilon_r = 36.6$; $\rho = 1000$ kg/m³,

Medium parameters used: $f = 5800$ MHz; $\sigma = 5.16$ S/m; $\epsilon_r = 36.3$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.52, 5.52, 5.52); Calibrated: 30.12.2013, ConvF(5.2, 5.2, 5.2); Calibrated: 30.12.2013, ConvF(5.01, 5.01, 5.01); Calibrated: 30.12.2013, ConvF(4.86, 4.86, 4.86); Calibrated: 30.12.2013, ConvF(4.91, 4.91, 4.91); Calibrated: 30.12.2013;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

Reference Value = 62.794 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 28.6 W/kg

SAR(1 g) = 7.87 W/kg; SAR(10 g) = 2.24 W/kg

Maximum value of SAR (measured) = 18.0 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 = 63.390 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 31.5 W/kg

SAR(1 g) = 8.3 W/kg; SAR(10 g) = 2.37 W/kg

Maximum value of SAR (measured) = 19.2 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 = 63.321 V/m; Power Drift = 0.08 dB

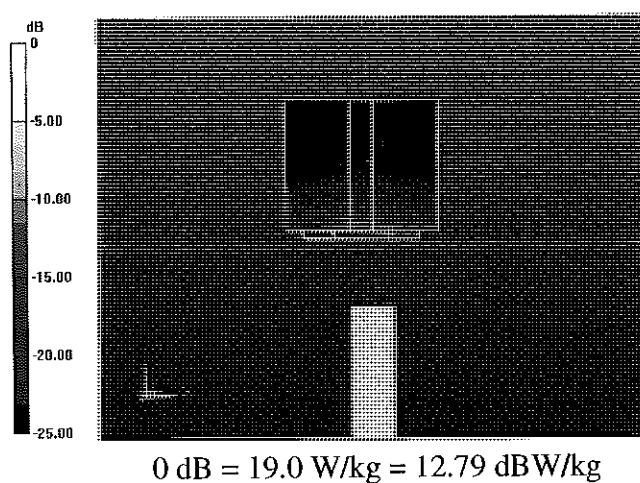
Peak SAR (extrapolated) = 33.6 W/kg

SAR(1 g) = 8.45 W/kg; SAR(10 g) = 2.4 W/kg

Maximum value of SAR (measured) = 20.0 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 62.007 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 32.7 W/kg
SAR(1 g) = 8.18 W/kg; SAR(10 g) = 2.33 W/kg
Maximum value of SAR (measured) = 19.4 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 = 59.638 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 33.0 W/kg
SAR(1 g) = 7.87 W/kg; SAR(10 g) = 2.23 W/kg
Maximum value of SAR (measured) = 19.0 W/kg



Impedance Measurement Plot for Head TSL

26 Feb 2014 10:12:36

[CH1] S11 1 U FS 1: 53.980 Ω -5.5879 Ω 5.4773 pF 5 200.000 000 MHz

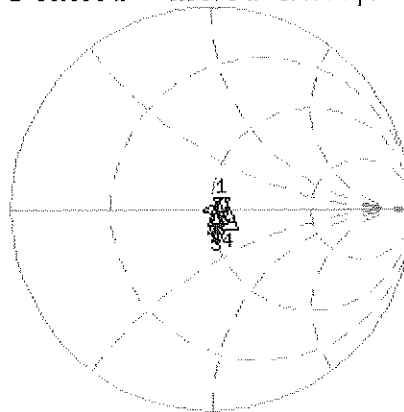
*

Del

Cor

Avg
16

H1d



CH1 Markers

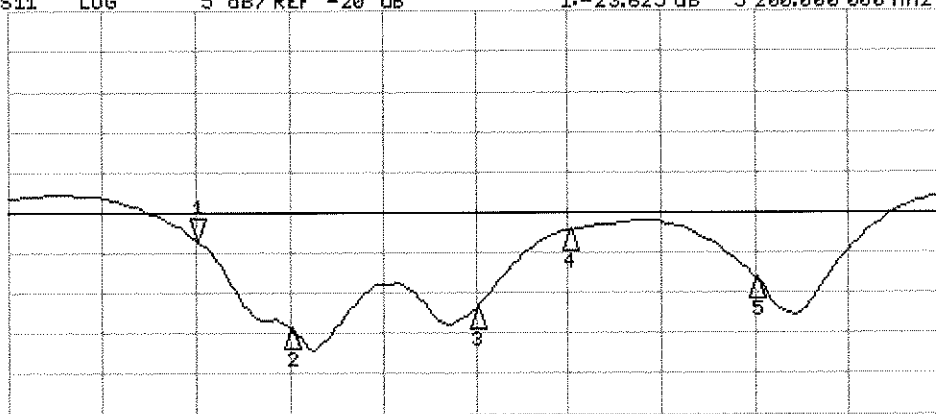
2: 51.086 Ω
1.5508 Ω
5.30000 GHz
3: 51.148 Ω
-2.3066 Ω
5.50000 GHz
4: 50.436 Ω
-158.20 m Ω
5.60000 GHz
5: 52.877 Ω
2.8086 Ω
5.80000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 1: -23.625 dB 5 200.000 000 MHz

Cor

Avg
16

H1d



CH2 Markers

2: -34.550 dB
5.30000 GHz
3: -31.869 dB
5.50000 GHz
4: -22.182 dB
5.60000 GHz
5: -28.164 dB
5.80000 GHz

START 5 000.000 000 MHz

STOP 6 000.000 000 MHz

DASY5 Validation Report for Body TSL

Date: 25.02.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1120

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz

Medium parameters used: $f = 5200$ MHz; $\sigma = 5.4$ S/m; $\epsilon_r = 47.8$; $\rho = 1000$ kg/m³,

Medium parameters used: $f = 5300$ MHz; $\sigma = 5.53$ S/m; $\epsilon_r = 47.6$; $\rho = 1000$ kg/m³,

Medium parameters used: $f = 5500$ MHz; $\sigma = 5.8$ S/m; $\epsilon_r = 47.3$; $\rho = 1000$ kg/m³,

Medium parameters used: $f = 5600$ MHz; $\sigma = 5.94$ S/m; $\epsilon_r = 47.1$; $\rho = 1000$ kg/m³,

Medium parameters used: $f = 5800$ MHz; $\sigma = 6.21$ S/m; $\epsilon_r = 46.8$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.01, 5.01, 5.01); Calibrated: 30.12.2013, ConvF(4.76, 4.76, 4.76); Calibrated: 30.12.2013, ConvF(4.52, 4.52, 4.52); Calibrated: 30.12.2013, ConvF(4.3, 4.3, 4.3); Calibrated: 30.12.2013, ConvF(4.47, 4.47, 4.47); Calibrated: 30.12.2013;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

Reference Value = 59.562 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 29.5 W/kg

SAR(1 g) = 7.43 W/kg; SAR(10 g) = 2.08 W/kg

Maximum value of SAR (measured) = 17.7 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 = 58.903 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 31.1 W/kg

SAR(1 g) = 7.62 W/kg; SAR(10 g) = 2.14 W/kg

Maximum value of SAR (measured) = 18.4 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 = 59.015 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 34.5 W/kg

SAR(1 g) = 7.96 W/kg; SAR(10 g) = 2.21 W/kg

Maximum value of SAR (measured) = 19.5 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 = 58.626 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 35.6 W/kg

SAR(1 g) = 7.98 W/kg; SAR(10 g) = 2.21 W/kg

Maximum value of SAR (measured) = 19.8 W/kg

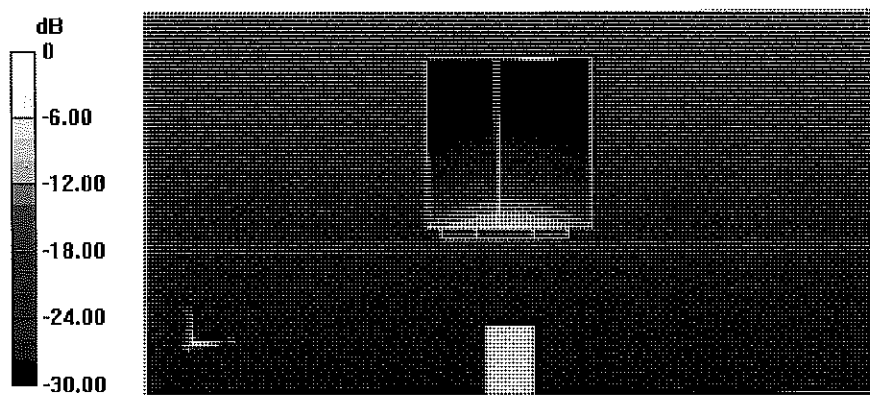
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 55.428 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 34.9 W/kg

SAR(1 g) = 7.47 W/kg; SAR(10 g) = 2.07 W/kg

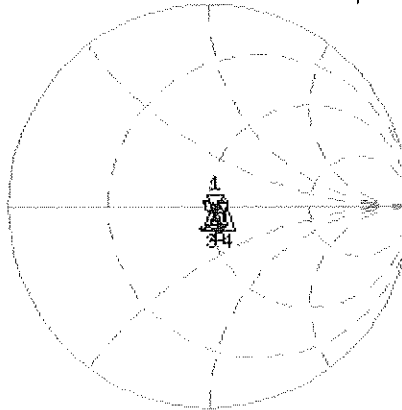
Maximum value of SAR (measured) = 18.8 W/kg



Impedance Measurement Plot for Body TSL

25 Feb 2014 15:49:48
 [CH1] S11 1 U FS 1: 52.344 Ω -5.8965 Ω 5.1907 pF 5 200.000 000 MHz

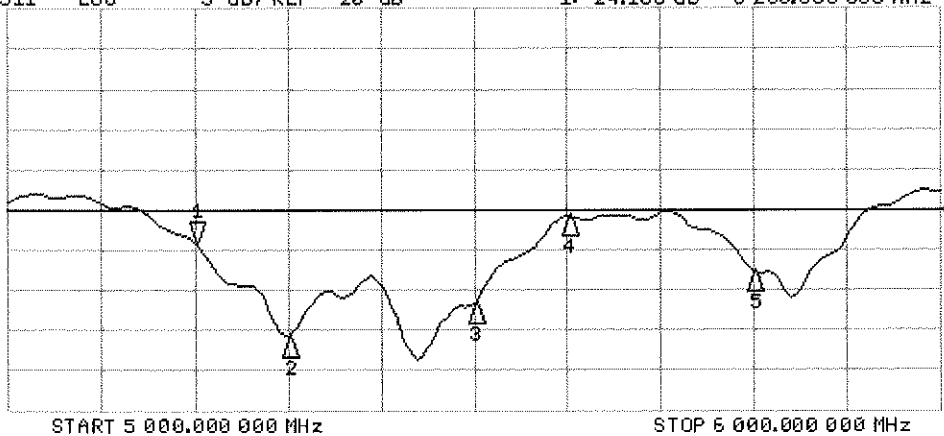
*
 Del
 Cor
 Avg
 16
 H1d



CH1 Markers
 2: 51.105 Ω
 1.1973 Ω
 5.30000 GHz
 3: 50.543 Ω
 -2.5781 Ω
 5.50000 GHz
 4: 59.457 Ω
 -2.9082 Ω
 5.60000 GHz
 5: 54.162 Ω
 1.1016 Ω
 5.80000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 1: -24.165 dB 5 200.000 000 MHz

Cor
 Avg
 16
 H1d



CH2 Markers
 2: -35.830 dB
 5.30000 GHz
 3: -31.626 dB
 5.50000 GHz
 4: -20.878 dB
 5.60000 GHz
 5: -27.672 dB
 5.80000 GHz



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

Client **PC Test**

Certificate No: **D750V3-1054_Mar14**

CALIBRATION CERTIFICATE

Object **D750V3 - SN: 1054**

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

Calibration date: **March 17, 2014**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

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

Signature

Israe El-Naouq
Katja Pokovic

Issued: March 17, 2014

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



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	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	40.6 $\pm$ 6 %	0.92 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	2.15 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	8.33 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	1.39 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	5.42 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	55.2 $\pm$ 6 %	1.00 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	2.23 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	8.64 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	1.46 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	5.69 W/kg $\pm$ 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$55.1 \Omega + 0.7 j\Omega$
Return Loss	- 26.2 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$48.5 \Omega - 2.8 j\Omega$
Return Loss	- 29.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.035 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 08, 2011

DASY5 Validation Report for Head TSL

Date: 17.03.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1054

Communication System: UID 0 - CW; Frequency: 750 MHz

Medium parameters used: $f = 750 \text{ MHz}$; $\sigma = 0.92 \text{ S/m}$; $\epsilon_r = 40.6$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.37, 6.37, 6.37); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

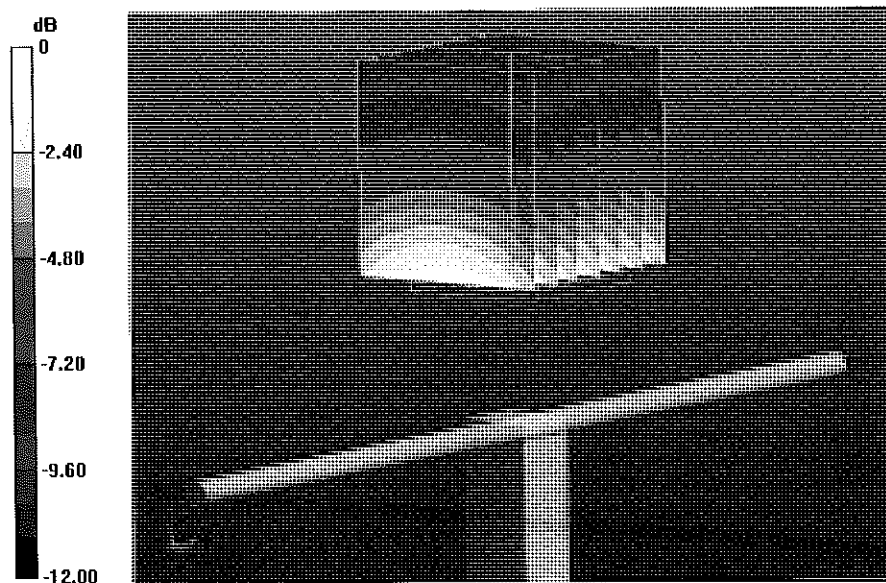
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 53.851 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 3.25 W/kg

SAR(1 g) = 2.15 W/kg; SAR(10 g) = 1.39 W/kg

Maximum value of SAR (measured) = 2.51 W/kg

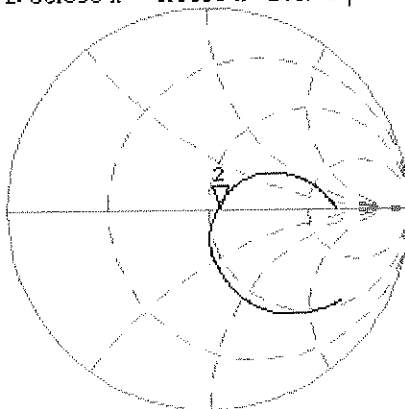


0 dB = 2.51 W/kg = 4.00 dBW/kg

Impedance Measurement Plot for Head TSL

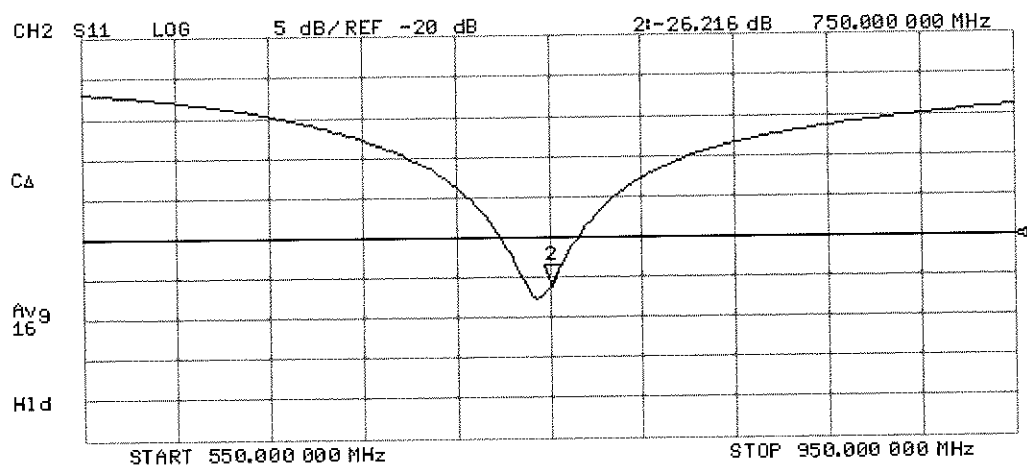
17 Mar 2014 15:32:32
[CH1] S11 1 U FS 2: 55.090 Ω 0.6895 Ω 146.31 pF 750.000 000 MHz

*
De1
CA



Avg
16

H1d



DASY5 Validation Report for Body TSL

Date: 14.03.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1054

Communication System: UID 0 - CW; Frequency: 750 MHz

Medium parameters used: $f = 750$ MHz; $\sigma = 1$ S/m; $\epsilon_r = 55.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.13, 6.13, 6.13); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

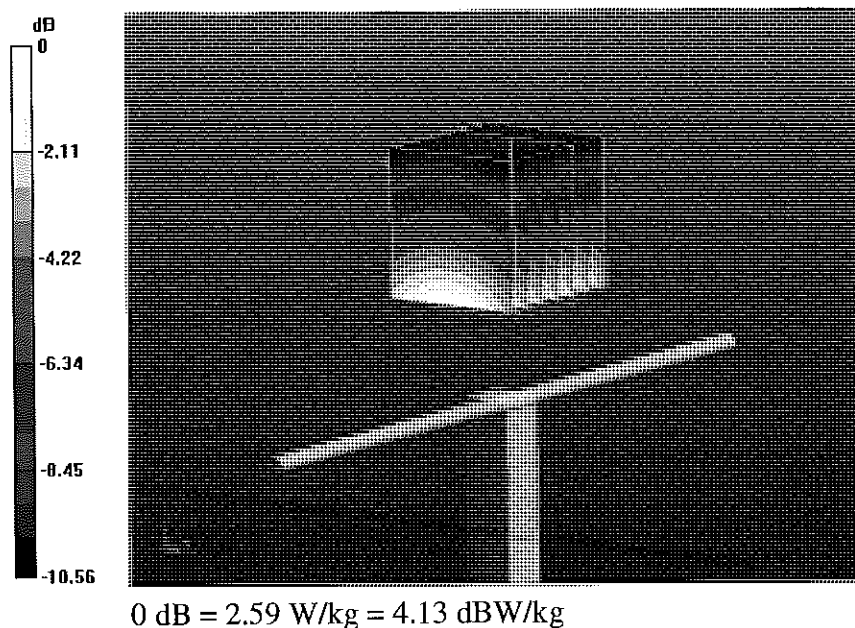
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 52.788 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 3.27 W/kg

SAR(1 g) = 2.23 W/kg; SAR(10 g) = 1.46 W/kg

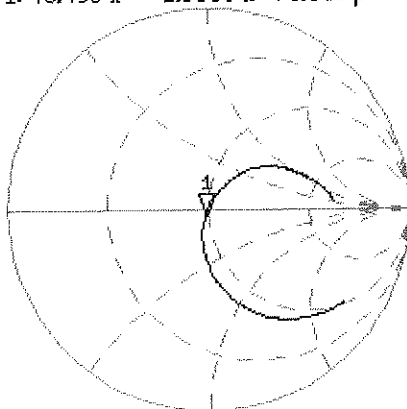
Maximum value of SAR (measured) = 2.59 W/kg



Impedance Measurement Plot for Body TSL

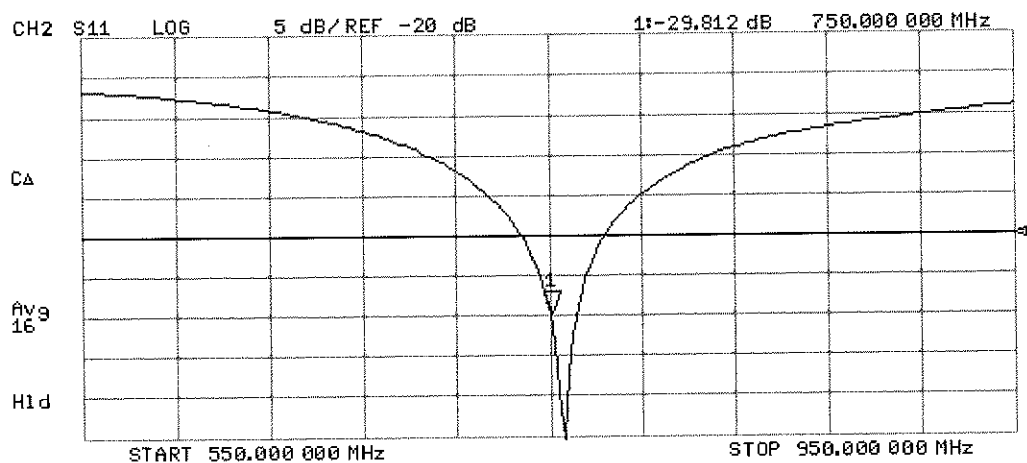
14 Mar 2014 17:44:13
[CH1] S11 1 U FS 1: 48.496 Ω -2.8066 Ω 75.609 pF 750.000 000 MHz

*
De1
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: **D835V2-4d119_Apr14**

CALIBRATION CERTIFICATE

Object **D835V2 - SN: 4d119**

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

OCV
4/25/14

Calibration date: **April 07, 2014**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

Signature

Leif Klysner

Approved by: **Katja Pokovic** Technical Manager

Katja Pokovic

Issued: April 9, 2014

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	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	41.6 $\pm$ 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	2.38 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.22 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	1.53 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	5.97 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	53.6 $\pm$ 6 %	1.02 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	2.44 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.34 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	1.59 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	6.15 W/kg $\pm$ 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.2 Ω - 1.6 j Ω
Return Loss	- 34.0 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.3 Ω - 4.5 j Ω
Return Loss	- 24.4 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.386 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: 07.04.2014

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; $\epsilon_r = 41.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.22, 6.22, 6.22); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

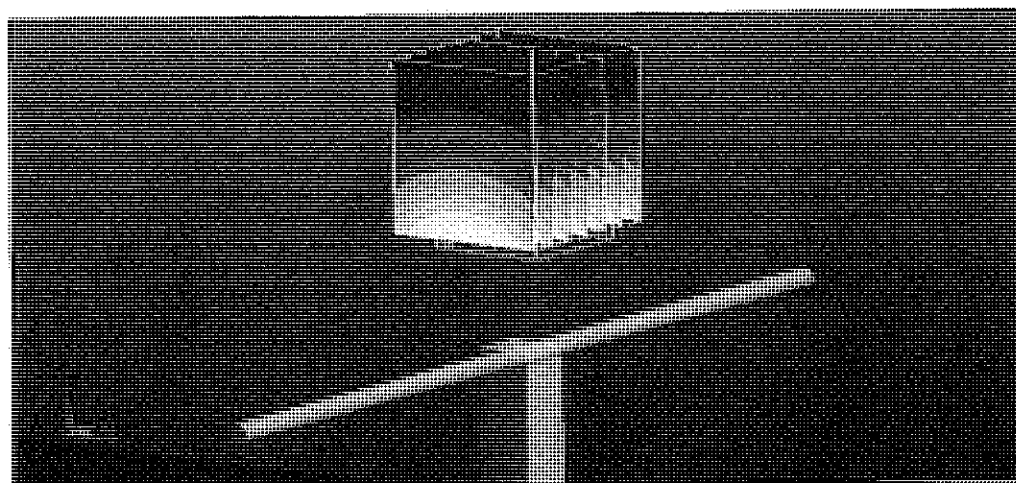
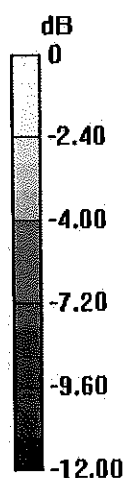
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 56.289 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 3.59 W/kg

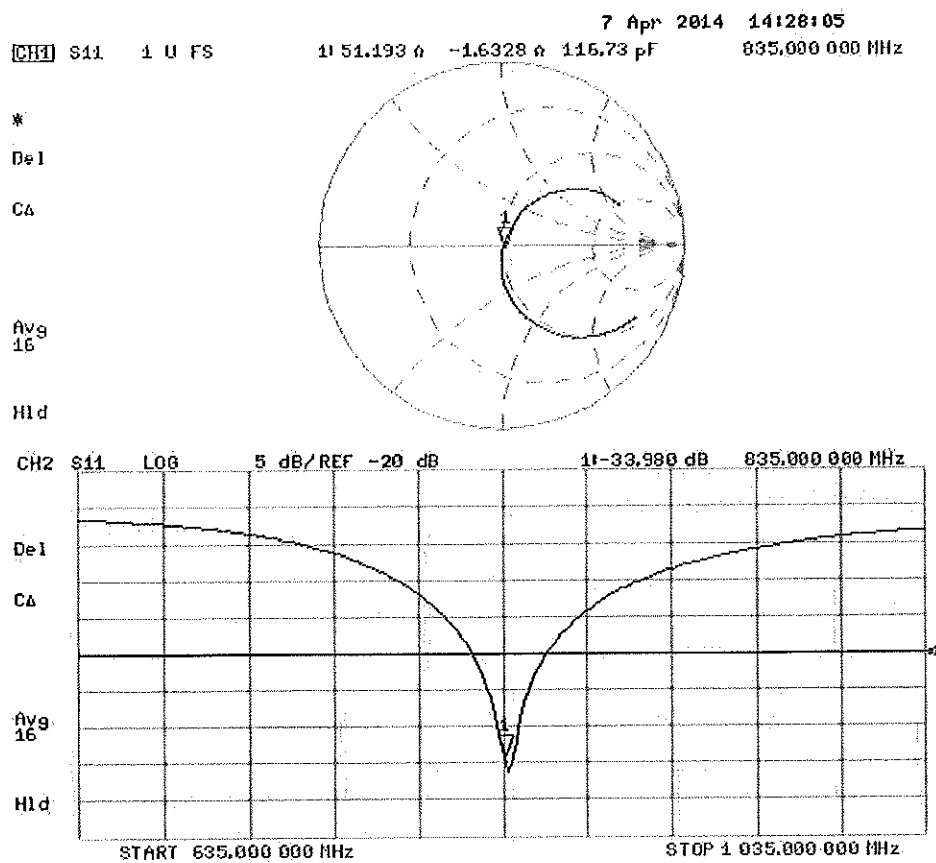
SAR(1 g) = 2.38 W/kg; SAR(10 g) = 1.53 W/kg

Maximum value of SAR (measured) = 2.80 W/kg



0 dB = 2.80 W/kg = 4.47 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 07.04.2014

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; $\sigma = 1.02$ S/m; $\epsilon_r = 53.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.09, 6.09, 6.09); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

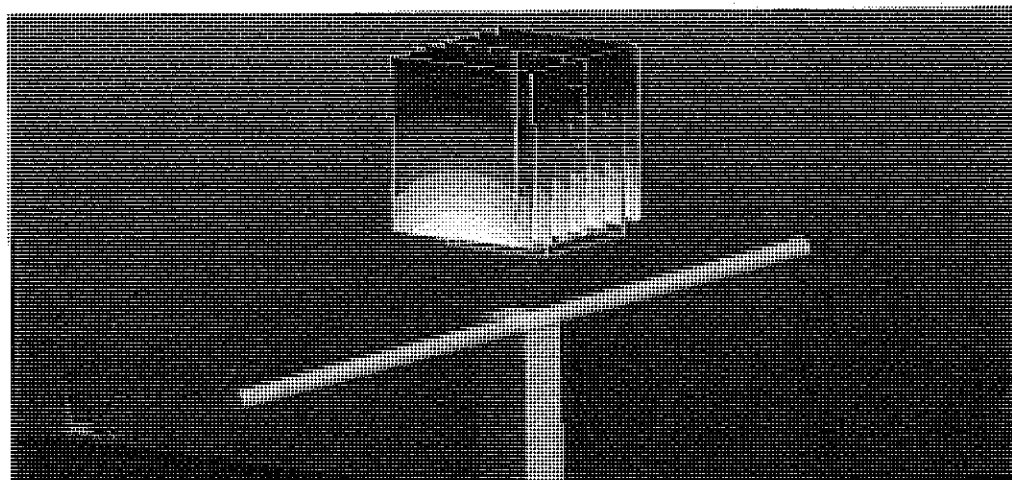
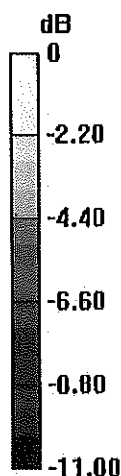
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 54.594 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 3.61 W/kg

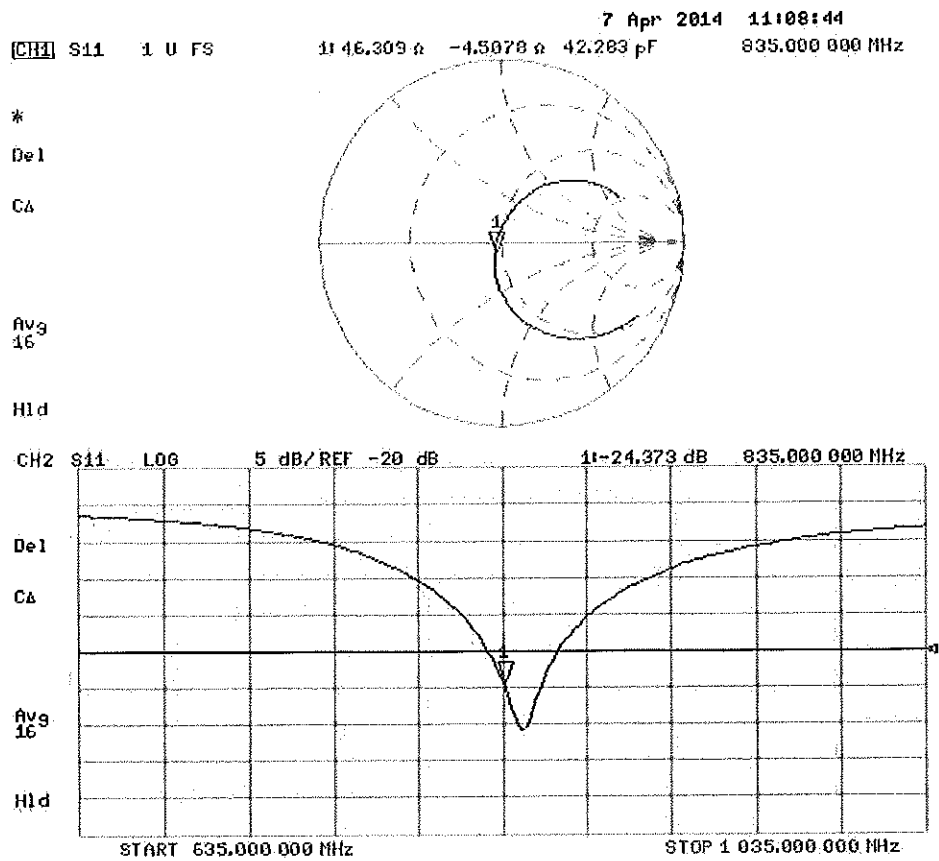
SAR(1 g) = 2.44 W/kg; SAR(10 g) = 1.59 W/kg

Maximum value of SAR (measured) = 2.85 W/kg



0 dB = 2.85 W/kg = 4.55 dBW/kg

Impedance Measurement Plot for Body TSL





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Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D835V2-4d133_Jul14**

CALIBRATION CERTIFICATE

Object **D835V2 - SN: 4d133**

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

CC
W/CM

Calibration date: **July 24, 2014**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	30-Apr-14 (No. DAE4-601_Apr14)	Apr-15

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8763E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

Calibrated by: **Name** **Function**
Jeton Kastrali **Laboratory Technician**

Signature

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

Issued: July 24, 2014

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
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	41.1 $\pm$ 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	2.38 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.20 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	1.53 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	5.96 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	53.8 $\pm$ 6 %	1.02 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	2.44 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.35 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	1.59 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	6.15 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.6 Ω - 1.0 j Ω
Return Loss	- 34.7 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.8 Ω - 3.3 j Ω
Return Loss	- 27.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.395 ns
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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	July 22, 2011

DASY5 Validation Report for Head TSL

Date: 24.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d133

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

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.94 \text{ S/m}$; $\epsilon_r = 41.1$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.22, 6.22, 6.22); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Head Tissue/Pin=250 mW, $d=15\text{mm}$ /Zoom Scan (7x7x7)/Cube 0:

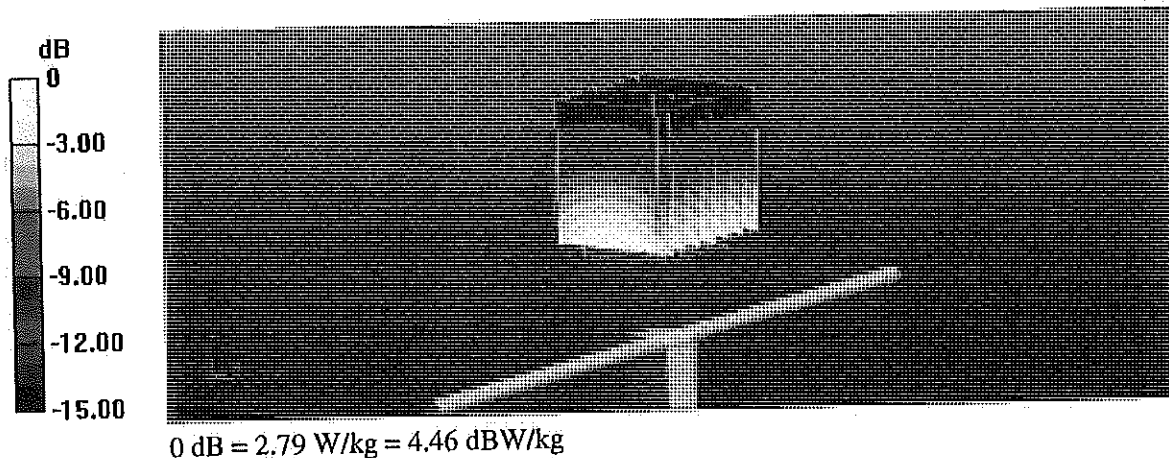
Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 56.07 V/m; Power Drift = 0.03 dB

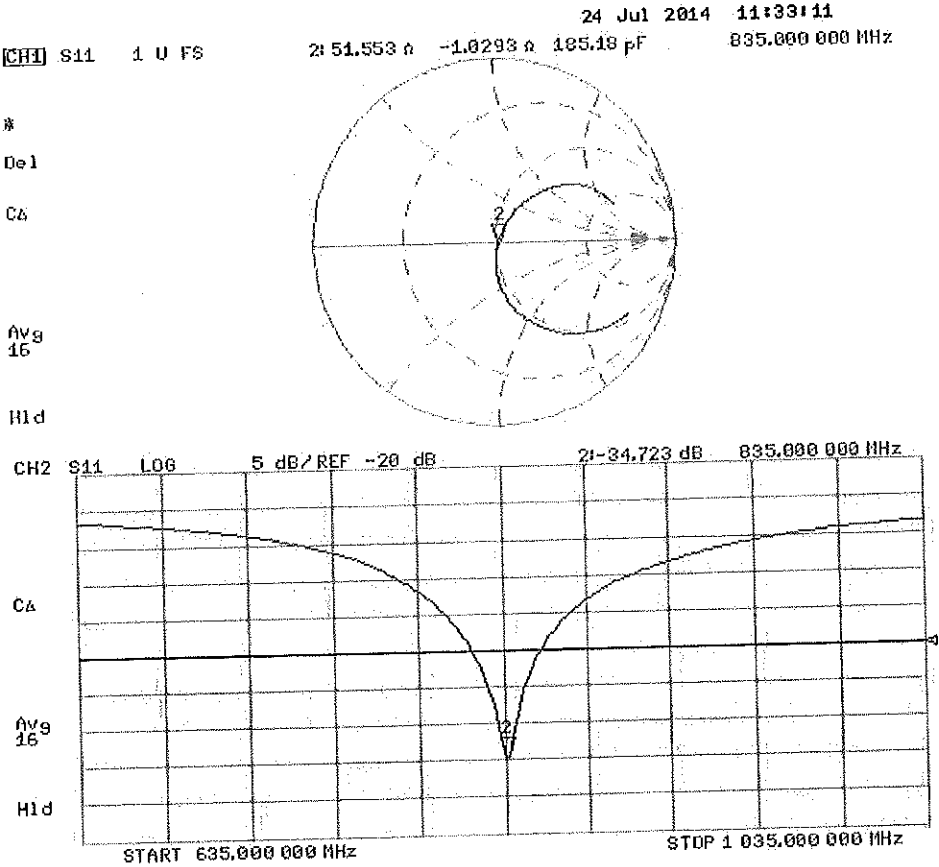
Peak SAR (extrapolated) = 3.58 W/kg

SAR(1 g) = 2.38 W/kg; SAR(10 g) = 1.53 W/kg

Maximum value of SAR (measured) = 2.79 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 17.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d133

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

Medium parameters used: $f = 835$ MHz; $\sigma = 1.02$ S/m; $\epsilon_r = 53.8$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.09, 6.09, 6.09); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

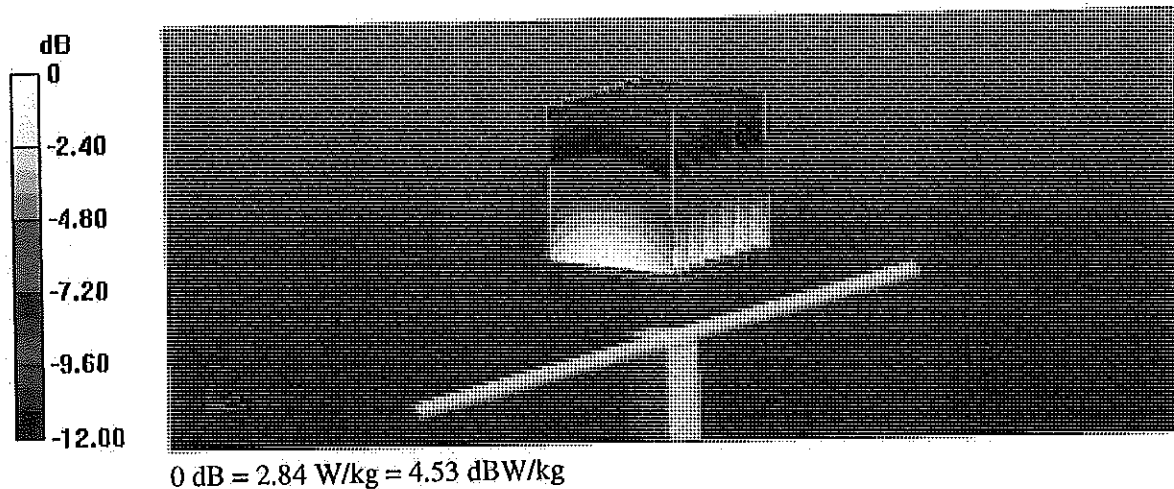
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 54.61 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 3.59 W/kg

SAR(1 g) = 2.44 W/kg; SAR(10 g) = 1.59 W/kg

Maximum value of SAR (measured) = 2.84 W/kg



Impedance Measurement Plot for Body TSL

