PCTEST ENGINEERING LABORATORY, INC.
7185 Oakland Mills Road, Columbia, MD 21046 USA
Tel. +1.410.290.6652 / Fax +1.410.290.6654
http://www.pctestlab.com

SAR EVALUATION REPORT

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

Date of Testing:
02/17/15 - 02/23/15
Test Site/Location:
PCTEST Lab, Columbia, MD, USA
Document Serial No.:
0Y1502160477.A3L

FCC ID: **A3LSC04G**

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

DUT Type: Portable Handset
Application Type: Certification
FCC Rule Part(s): CFR §2.1093
Model(s): SC-04G

Equipment Class	Band & Mode	Tx Frequency	SAR		
			1 gm Head (W/kg)	1 gm Body-Worn (W/kg)	1 gm Hotspot (W/kg)
PCE	GSM/GPRS/EDGE 850	824.20 - 848.80 MHz	0.18	0.35	0.55
PCE	UMTS 850	826.40 - 846.60 MHz	0.22	0.30	0.45
PCE	GSM/GPRS/EDGE 1900	1850.20 - 1909.80 MHz	0.16	0.72	1.09
PCE	LTE Band 17	706.5 - 713.5 MHz	< 0.1	0.21	0.21
PCE	LTE Band 13	779.5 - 784.5 MHz	0.25	0.47	0.47
PCE	LTE Band 41	2498.5 - 2687.5 MHz	< 0.1	0.17	0.27
DTS	2.4 GHz WLAN	2412 - 2462 MHz	0.49	< 0.1	< 0.1
NII	U-NII-1	5180 - 5240 MHz	N/A		
NII	U-NII-2A	5260 - 5320 MHz	0.55	< 0.1	
NII	U-NII-2C < 5.65 GHz	5500 - 5580 MHz	0.66	0.14	
NII	U-NII-2C > 5.65 GHz + U-NII-3	5660 - 5825 MHz	0.86	0.27	
DSS/DTS	Bluetooth	2402 - 2480 MHz	N/A		
Simultaneous SAR per KDB 690783 D01v01r03:			1.21	1.04	1.25

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

The SAR Tick is an initiative of the Mobile Manufacturers Forum (MMF). While a product may be considered eligible, use of the SAR Tick logo requires an agreement with the MMF. Further details can be obtained by emailing: sartick@mmfai.info.

© 2015 PCTEST Engineering Laboratory, Inc.

TABLE OF CONTENTS

1 DEVICE UNDER TEST 3

2 LTE INFORMATION 9

3 INTRODUCTION 10

4 DOSIMETRIC ASSESSMENT 11

5 DEFINITION OF REFERENCE POINTS 12

6 TEST CONFIGURATION POSITIONS FOR HANDSETS 13

7 RF EXPOSURE LIMITS 16

8 FCC MEASUREMENT PROCEDURES 17

9 RF CONDUCTED POWERS 23

10 SYSTEM VERIFICATION 34

11 SAR DATA SUMMARY 36

12 FCC MULTI-TX AND ANTENNA SAR CONSIDERATIONS 44

13 SAR MEASUREMENT VARIABILITY 48

14 EQUIPMENT LIST 48

15 MEASUREMENT UNCERTAINTIES 50

16 CONCLUSION 52

17 REFERENCES 53

APPENDIX A: SAR TEST PLOTS

APPENDIX B: SAR DIPOLE VERIFICATION PLOTS

APPENDIX C: PROBE AND DIPOLE CALIBRATION CERTIFICATES

APPENDIX D: SAR TISSUE SPECIFICATIONS

APPENDIX E: SAR SYSTEM VALIDATION

APPENDIX F: DUT ANTENNA DIAGRAM & SAR TEST SETUP PHOTOGRAPHS

© 2015 PCTEST Engineering Laboratory, Inc.

1 DEVICE UNDER TEST

1.1 Device Overview

Band & Mode	Operating Modes	Tx Frequency
GSM/GPRS/EDGE 850	Voice/Data	824.20 - 848.80 MHz
UMTS 850	Voice/Data	826.40 - 846.60 MHz
GSM/GPRS/EDGE 1900	Voice/Data	1850.20 - 1909.80 MHz
LTE Band 17	Data	706.5 - 713.5 MHz
LTE Band 13	Data	779.5 - 784.5 MHz
LTE Band 41	Data	2498.5 - 2687.5 MHz
2.4 GHz WLAN	Data	2412 - 2462 MHz
U-NII-1	Data	5180 - 5240 MHz
U-NII-2A	Data	5260 - 5320 MHz
U-NII-2C < 5.65 GHz	Data	5500 - 5580 MHz
U-NII-2C > 5.65 GHz + U-NII-3	Data	5660 - 5825 MHz
Bluetooth	Data	2402 - 2480 MHz
NFC	Data	13.56 MHz
ANT+	Data	2402 - 2480 MHz

© 2015 PCTEST Engineering Laboratory, Inc.

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	**33.0**	**33.0**	**31.0**	**29.0**	**28.0**	**26.5**	**24.5**	**23.5**	**22.5**
	Nominal	**32.5**	**32.5**	**30.5**	**28.5**	**27.5**	**26.0**	**24.0**	**23.0**	**22.0**
GSM/GPRS/EDGE 1900	Maximum	**30.0**	**30.0**	**28.5**	**26.5**	**24.5**	**25.0**	**23.5**	**22.5**	**21.5**
	Nominal	**29.5**	**29.5**	**28.0**	**26.0**	**24.0**	**24.5**	**23.0**	**22.0**	**21.0**

Mode / Band		Modulated Average (dBm)		
		3GPP WCDMA Rel 99	*3GPP HSDPA Rel 5*	*3GPP HSUPA Rel 6*
UMTS Band 5 (850 MHz)	Maximum	**23.5**	**22.5**	**22.5**
	Nominal	**23.0**	**22.0**	**22.0**

Mode / Band		Modulated Average (dBm)
LTE Band 17	Maximum	**24.0**
	Nominal	**23.5**
LTE Band 13	Maximum	**24.0**
	Nominal	**23.5**
LTE Band 41	Maximum	**23.5**
	Nominal	**23.0**

Mode / Band		Modulated Average - Single Chain Transmission (dBm)
IEEE 802.11b (2.4 GHz)	Maximum	**15.5**
	Nominal	**15.0**
IEEE 802.11g (2.4 GHz)	Maximum	**13.5**
	Nominal	**13.0**
IEEE 802.11n (2.4 GHz)	Maximum	**12.5**
	Nominal	**12.0**
Bluetooth	Maximum	**11.5**
	Nominal	**11.0**
Bluetooth LE	Maximum	**9.5**
	Nominal	**9.0**

Mode / Band		Modulated Average - Single Chain Transmission (dBm)		
		20 MHz Bandwidth	40 MHz Bandwidth	80 MHz Bandwidth
IEEE 802.11a (5 GHz)	Maximum	**11.5**		
	Nominal	**11.0**		
IEEE 802.11n (5 GHz)	Maximum	**11.5**	**11.5**	
	Nominal	**11.0**	**11.0**	
IEEE 802.11ac (5 GHz)	Maximum	**10.5**	**10.5**	**10.5**
	Nominal	**10.0**	**10.0**	**10.0**

Mode / Band		Modulated Average - MIMO (dBm)		
		20 MHz Bandwidth	40 MHz Bandwidth	80 MHz Bandwidth
IEEE 802.11n (2.4 GHz)	Maximum	**15.5**		
	Nominal	**15.0**		
IEEE 802.11n (5 GHz)	Maximum	**14.5**	**14.5**	
	Nominal	**14.0**	**14.0**	
IEEE 802.11ac (5 GHz)	Maximum	**13.5**	**13.5**	**13.5**
	Nominal	**13.0**	**13.0**	**13.0**

© 2015 PCTEST Engineering Laboratory, Inc.

1.3 DUT Antenna Locations

The overall dimensions of this device are > 9 x 5 cm. The overall diagonal dimension of the device is <160 mm and the diagonal display is <150 mm. A diagram showing the location of the device antennas can be found in Appendix F.

Table 1-1
Sides for SAR Testing

Sides for SAR Testing						
Mode	Back	Front	Top	Bottom	Right	Left
GPRS 850	Yes	Yes	No	Yes	Yes	Yes
UMTS 850	Yes	Yes	No	Yes	Yes	Yes
GPRS 1900	Yes	Yes	No	Yes	Yes	Yes
LTE Band 17	Yes	Yes	No	Yes	Yes	Yes
LTE Band 13	Yes	Yes	No	Yes	Yes	Yes
LTE Band 41	Yes	Yes	No	Yes	Yes	Yes
2.4 GHz WLAN Antenna 1	Yes	Yes	Yes	No	No	Yes
2.4 GHz WLAN Antenna 2	Yes	Yes	Yes	No	No	Yes

Note: Particular DUT edges were not required to be evaluated for Wireless Router SAR if the edges were greater than 2.5 cm from the transmitting antenna according to FCC KDB Publication 941225 D06v02 guidance, page 2. The distances between the transmit antennas and the edges of the device are included in the filing. When wireless router mode is enabled, all 5 GHz bands are disabled. Therefore 5 GHz WIFI is not considered in this section.

1.4 Near Field Communications (NFC) Antenna

This DUT has NFC Operations. The NFC antenna is integrated into the device for this model. Therefore, all SAR tests were performed with the device which already incorporates the NFC antenna. A diagram showing the location of the NFC antenna can be found in Appendix F.

© 2015 PCTEST Engineering Laboratory, Inc.

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.

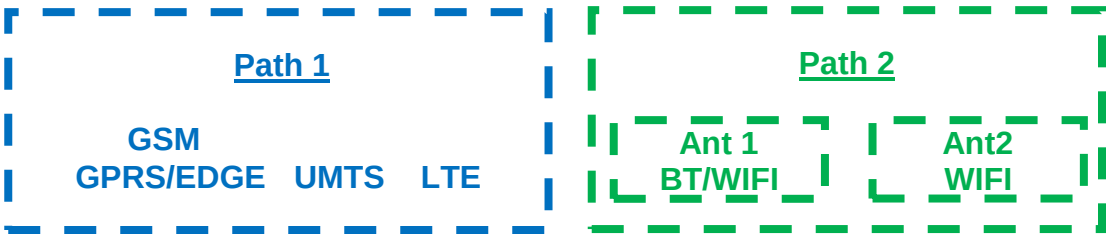


Figure 1-1
Simultaneous Transmission Paths

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	Notes
1	GSM voice + 2.4 GHz WI-FI	Yes	Yes	N/A	
2	GSM voice + 5 GHz WI-FI	Yes	Yes	N/A	
3	GSM voice + 2.4 GHz Bluetooth	N/A	Yes	N/A	
4	UMTS + 2.4 GHz WI-FI	Yes	Yes	Yes	
5	UMTS + 5 GHz WI-FI	Yes	Yes	N/A	
6	UMTS + 2.4 GHz Bluetooth	N/A	Yes	N/A	
7	LTE + 2.4 GHz WI-FI	Yes*	Yes*	Yes	*-Pre-installed VOIP applications are considered.
8	LTE + 2.4 GHz Bluetooth	N/A	Yes*	N/A	*-Pre-installed VOIP applications are considered.
9	GPRS/EDGE + 2.4 GHz WI-FI	N/A	N/A	Yes	
10	LTE + 5 GHz WI-FI	N/A	N/A	N/A	Not supported by SW
11	GPRS/EDGE + 5 GHz WI-FI	N/A	N/A	N/A	Not supported by SW

1. 2.4 GHz WLAN, 5 GHz WLAN, and 2.4 GHz Bluetooth share the same antenna path and cannot transmit simultaneously.
2. All licensed modes share the same antenna path and cannot transmit simultaneously.
3. 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.
4. Per the manufacturer, WIFI Direct is not expected to be used in conjunction with a held-to-ear or body-worn accessory voice call. Therefore, there are no simultaneous transmission scenarios involving WIFI direct beyond that listed in the above table.
5. When wireless router mode is enabled, all 5GHz bands are disabled.
6. This device supports 2x2 MIMO Tx for WLAN 802.11n/ac. Each WLAN antenna can transmit independently or together when operating with MIMO.

© 2015 PCTEST Engineering Laboratory, Inc.

1.6 Miscellaneous SAR Test Considerations

(A) WIFI/BT

Since Wireless Router operations are not allowed by the chipset firmware using 5 GHz WIFI, only 2.4 GHz WIFI Hotspot SAR tests and combinations are considered for SAR with respect to Wireless Router configurations according to FCC KDB 941225 D06v02.

Since U-NII-1 and U-NII-2A bands have the same maximum output power and the highest reported SAR for U-NII-2A is less than 1.2 W/kg, SAR is not required for U-NII-1 band according to FCC KDB 248227 D01 DR02-41929.

Since this device supports the band gap channels, the channels in the U-NII-2C band above 5.65 GHz were grouped with the channels in the U-NII-3 as a single aggregate band. The channels in U-NII-2C below 5.65 GHz were considered separately for SAR evaluation.

This device supports IEEE 802.11ac with the following features:

a) Up to 80 MHz Bandwidth only
b) No aggregate channel configurations
c) 2 Tx antenna output
d) 256 QAM is supported
e) Band gap channels are supported

Per FCC KDB 447498 D01v05, the 1g SAR exclusion threshold for distances <50mm is defined by the following equation:

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

Based on the maximum conducted power of Bluetooth (rounded to the nearest mW) and the antenna to user separation distance, body-worn Bluetooth SAR was not required; [(14/10)* √2.480] = 2.2 < 3.0. Per KDB Publication 447498 D01v05, the maximum power of the channel was rounded to the nearest mW before calculation.

(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 D01v03.

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 D05v02r03.

1.7 Power Reduction for SAR

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

© 2015 PCTEST Engineering Laboratory, Inc.

1.8 Guidance Applied

- IEEE 1528-2003
- FCC KDB Publication 941225 D01v03, D05v02r03, D06v02 (2G/3G/4G and Hotspot)
- FCC KDB Publication 248227 D01 DR02-41929 (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)
- October 2013 TCB Workshop Notes (GPRS Testing Considerations)

1.9 Device Serial Numbers

Several samples were used with identical hardware to support SAR testing. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.

	Head Serial Number	Body-Worn Serial Number	Hotspot Serial Number
GSM/GPRS/EDGE 850	1C0C4	1C0C4	1C0C4
UMTS 850	1C0C4	1C0C4	1C0C4
GSM/GPRS/EDGE 1900	1C0C4	1C0C4	1C0C4
LTE Band 17	1C0A8	1C0A8	1C0A8
LTE Band 13	1C0A8	1C0A8	1C0A8
LTE Band 41	1C0A8	1C0A8	1C0A8
2.4 GHz WLAN	1C0C3	1C0A8	1C0A8
5 GHz WLAN	1C4E6	1C0A8	-

© 2015 PCTEST Engineering Laboratory, Inc.

2 LTE INFORMATION

LTE Information					
FCC ID	**A3LSC04G**				
Form Factor	Portable Handset				
Frequency Range of each LTE transmission band	LTE Band 17 (706.5 - 713.5 MHz)				
	LTE Band 13 (779.5 - 784.5 MHz)				
	LTE Band 41 (2498.5 - 2687.5 MHz)				
Channel Bandwidths	LTE Band 17: 5 MHz, 10 MHz				
	LTE Band 13: 5 MHz, 10 MHz				
	LTE Band 41: 5 MHz, 10 MHz, 15 MHz, 20 MHz				
Channel Numbers and Frequencies (MHz)	Low	Low-Mid	Mid	High-Mid	High
LTE Band 17: 5 MHz	706.5 (23755)	N/A	710 (23790)	N/A	713.5 (23825)
LTE Band 17: 10 MHz	709 (23780)	N/A	710 (23790)	N/A	711 (23800)
LTE Band 13: 5 MHz	779.5 (23205)	N/A	782 (23230)	N/A	784.5 (23255)
LTE Band 13: 10 MHz	782 (23230)	N/A	782 (23230)	N/A	782 (23230)
LTE Band 41: 5 MHz	2498.5 (39675)	2545.8 (40148)	2593 (40620)	2640.3 (41093)	2687.5 (41565)
LTE Band 41: 10 MHz	2501 (39700)	2547 (40160)	2593 (40620)	2639 (41080)	2685 (41540)
LTE Band 41: 15 MHz	2503.5 (39725)	2548.3 (40173)	2593 (40620)	2637.8 (41068)	2682.5 (41515)
LTE Band 41: 20 MHz	2506 (39750)	2549.5 (40185)	2593 (40620)	2636.5 (41055)	2680 (41490)
UE Category	6				
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				
LTE Carrier Aggregation Additional Information	This device does not support full LTE CA Release 10 features in the US. The following LTE Release 10 Features are not supported: Relay, HetNet, Enhanced MIMO, eICI, WIFI Offloading, MDH, eMBMA, Cross-Carrier Scheduling, Enhanced SC-FDMA, Carrier Aggregation.				

© 2015 PCTEST Engineering Laboratory, Inc.

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/m^3)
E = Total RMS electric field strength (V/m)

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

© 2015 PCTEST Engineering Laboratory, Inc.

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:

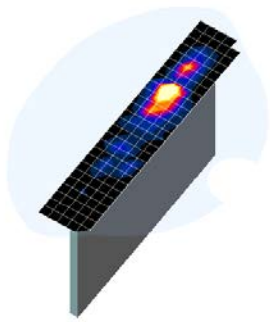


Figure 4-1
Sample SAR Area Scan

1. The SAR distribution at the exposed side of the head or body was measured at a distance no greater than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the device-head and body interface and the horizontal grid resolution was determined per FCC KDB Publication 865664 D01v01 (See Table 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.

Table 4-1
Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01*

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

*Also compliant to IEEE 1528-2013 Table 6

© 2015 PCTEST Engineering Laboratory, Inc.

5 DEFINITION OF REFERENCE POINTS

5.1 EAR REFERENCE POINT

Figure 5-2 shows the front, back and side views of the SAM Twin Phantom. The point "M" is the reference point for the center of the mouth, "LE" is the left ear reference point (ERP), and "RE" is the right ERP. The ERP is 15mm posterior to the entrance to the ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 5-1. The plane passing through the two ear canals and M is defined as the Reference Plane. The line N-F (Neck-Front), 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].

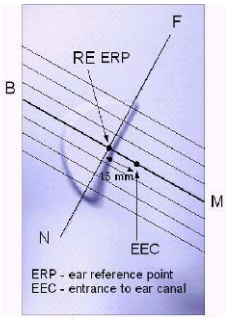


Figure 5-1
Close-Up Side view of ERP

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 than 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

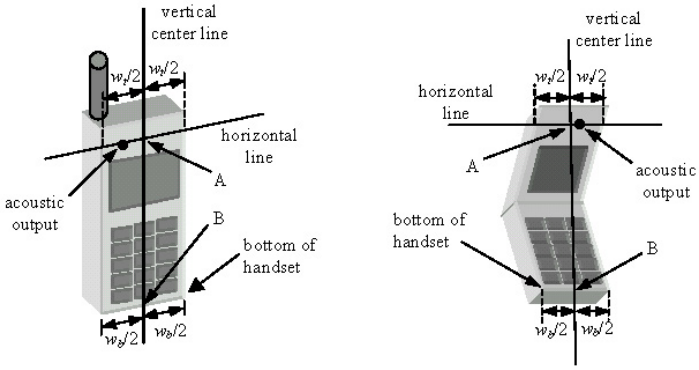


Figure 5-3
Handset Vertical Center & Horizontal Line Reference Points

© 2015 PCTEST Engineering Laboratory, Inc.

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 ε = 3 and loss tangent δ = 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 was 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 / 15º 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 15degrees.
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).

© 2015 PCTEST Engineering Laboratory, Inc.

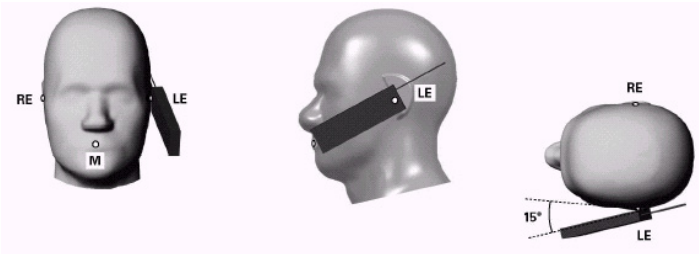


Figure 6-2 Front, Side and Top View of Ear/15º Tilt Position

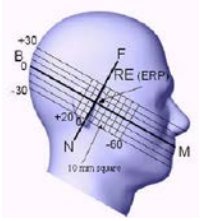


Figure 6-3
Side view w/ relevant markings

6.4 Body-Worn Accessory Configurations

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration (see Figure 6-4). 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.

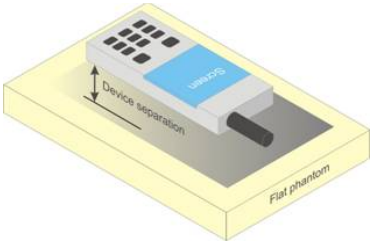


Figure 6-4
Sample Body-Worn Diagram

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 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.

© 2015 PCTEST Engineering Laboratory, Inc.

6.5 Extremity Exposure Configurations

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

Per KDB Publication 447498 D01v05, Cell phones (handsets) are not normally designed to be used on extremities or operated in extremity only exposure conditions. The maximum output power levels of handsets generally do not require extremity SAR testing to show compliance. Therefore, extremity SAR was not evaluated for this device.

6.6 Wireless Router Configurations

Some battery-operated handsets have the capability to transmit and receive user data through simultaneous transmission of WIFI simultaneously with a separate licensed transmitter. The FCC has provided guidance in FCC KDB Publication 941225 D06v02 where SAR test considerations for handsets (L x W ≥ 9 cm x 5 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.

© 2015 PCTEST Engineering Laboratory, Inc.

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 *General Population* (W/kg) or (mW/g)	CONTROLLED ENVIRONMENT *Occupational* (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.

© 2015 PCTEST Engineering Laboratory, Inc.

8 FCC MEASUREMENT PROCEDURES

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 3G SAR Test Reduction Procedure

In FCC KDB Publication 941225 D01v03, certain transmission modes within a frequency band and wireless mode evaluated for SAR are defined as primary modes. The equivalent modes considered for SAR test reduction are denoted as secondary modes. When the maximum output power including tune-up tolerance specified for production units in a secondary mode is ≤ 0.25 dB higher than the primary mode or when the highest reported SAR of the primary mode, scaled by the ratio of specified maximum output power and tune-up tolerance of secondary to primary mode, is ≤ 1.2 W/kg, SAR measurements are not required for the secondary mode. These criteria are referred to as the 3G SAR test reduction procedure. When the 3G SAR test reduction procedure is not satisfied, SAR measurements are additionally required for the secondary mode.

8.3 Procedures Used to Establish RF Signal for SAR

The following procedures are according to FCC KDB Publication 941225 D01v03 “3G SAR Measurement Procedures.”

The device is 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 are 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 is 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 deviates by more than 5%, the SAR test and drift measurements are repeated.

© 2015 PCTEST Engineering Laboratory, Inc.

8.4 SAR Measurement Conditions for UMTS

8.4.1 Output Power Verification

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, 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.

8.4.2 Head SAR Measurements

SAR for next to the ear head exposure is measured using a 12.2 kbps RMC with TPC bits configured to all “1’s”. The 3G SAR test reduction procedure is applied to AMR configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for 12.2 kbps AMR in 3.4 kbps SRB (signaling radio bearer) using the highest reported SAR configuration in 12.2 kbps RMC for head exposure.

8.4.3 Body SAR Measurements

SAR for body exposure configurations is measured using the 12.2 kbps RMC with the TPC bits all “1s”. The 3G SAR test reduction procedure is applied to other spreading codes and multiple $DPDCH_n$ configurations supported by the handset with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured using an applicable RMC configuration with the corresponding spreading code or $DPDCH_n$, for the highest reported SAR configuration in 12.2 kbps RMC.

8.4.4 SAR Measurements with Rel 5 HSDPA

The 3G SAR test reduction procedure is applied to HSDPA body configurations with 12.2 kbps RMC as the primary mode. Otherwise, Body SAR for HSDPA is measured using an FRC with H-Set 1 in Sub-test 1 and a 12.2 kbps RMC configured in Test Loop Mode 1, for the highest reported SAR configuration in 12.2 kbps RMC without HSDPA. Handsets with both HSDPA and HSUPA are tested according to Release 6 HSPA test procedures.

8.4.5 SAR Measurements with Rel 6 HSUPA

The 3G SAR test reduction procedure is applied to HSPA (HSUPA/HSDPA with RMC) body configurations with 12.2 kbps RMC as the primary mode. Otherwise, Body SAR for HSPA is measured with E-DCH Sub-test 5, using H-Set 1 and QPSK for FRC and a 12.2 kbps RMC configured in Test Loop Mode 1 and power control algorithm 2, according to the highest reported body SAR configuration in 12.2 kbps RMC without HSPA.

When VOIP applies to head exposure, the 3G SAR test reduction procedure is applied with 12.2 kbps RMC as the primary mode; otherwise, the same HSPA configuration used for body SAR measurements are applied to head exposure testing.

© 2015 PCTEST Engineering Laboratory, Inc.

8.5 SAR Measurement Conditions for LTE

LTE modes are tested according to FCC KDB 941225 D05v02r03 publication. Establishing connections with base station simulators ensure a consistent means for testing SAR and are recommended for evaluating SAR [4]. The R&S CMW500 or Anritsu MT8820C simulators are 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).

8.5.1 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.

8.5.2 MPR

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

8.5.3 A-MPR

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

8.5.4 Required RB Size and RB Offsets for SAR Testing

According to FCC KDB 941225 D05v02r03:

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 ½ dB higher than the equivalent configuration using QPSK modulation and when the QPSK SAR for those configurations is <1.45 W/kg.

8.5.5 TDD

LTE TDD testing is performed using guidance from FCC KDB 941225 D05v02r03 and the SAR test guidance provided in April 2013 TCB workshop notes. TDD is tested at the highest duty factor using UL-DL configuration 0 with special subframe configuration 6 and applying the FDD LTE procedures in KDB 941225 D05v02r03. SAR testing is performed using the extended cyclic prefix listed in 3GPP TS 36.211 Section 4.

© 2015 PCTEST Engineering Laboratory, Inc.

8.6 SAR Testing with 802.11 Transmitters

The normal network operating configurations of 802.11 transmitters are not suitable for SAR measurements. 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 D01 DR02-41929 for more details.

8.6.1 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.

A periodic duty factor is required for current generation SAR systems to measure SAR. When 802.11 frame gaps are accounted for in the transmission, a maximum transmission duty factor of 92 - 96% is typically achievable in most test mode configurations. A minimum transmission duty factor of 85% is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. The reported SAR is scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

8.6.2 U-NII-1 and U-NII-2A

For devices that operate in both U-NII-1 and U-NII-2A bands, when the same maximum output power is specified for both bands, SAR measurement using OFDM SAR test procedures is not required for U-NII-1 unless the highest reported SAR for U-NII-2A is > 1.2 W/kg. When different maximum output powers are specified for the bands, SAR measurement for the U-NII band with the lower maximum output power is not required unless the highest reported SAR for the U-NII band with the higher maximum output power, adjusted by the ratio of lower to higher specified maximum output power for the two bands, is > 1.2 W/kg.

8.6.3 U-NII-2C and U-NII-3

The frequency range covered by U-NII-2C and U-NII-3 is 380 MHz (5.47 – 5.85 GHz), which requires a minimum of at least two SAR probe calibration frequency points to support SAR measurements. When Terminal Doppler Weather Radar (TDWR) restriction applies, the channels at 5.60 – 5.65 GHz in U-NII-2C band must be disabled with acceptable mechanisms and documented in the equipment certification.

Unless band gap channels are permanently disabled, SAR must be considered for these channels. To maintain SAR measurement accuracy and to facilitate test reduction, the channels in U-NII-2C band above 5.65 GHz are grouped with the 5.8 GHz channels in U-NII-3 band or §15.247 5.8 GHz band to enable two SAR probe calibration frequency points to cover the bands, including the band gap channels. When band gap channels are disabled, each band is tested independently according to the normally required OFDM SAR measurement and probe calibration frequency points requirements.

8.6.4 Initial Test Position Procedure

For exposure conditions with multiple test positions, such as handset operating next to the ear, devices with hotspot mode or UMPC mini-tablet, procedures for initial test position can be applied. Using the transmission mode determined by the DSSS procedure or initial test configuration, area scans are measured for all positions in an exposure condition. The test position with the highest extrapolated (peak) SAR is used as the initial test position. When reported SAR for the initial test position is ≤ 0.4 W/kg, no additional testing for the remaining test positions is required. Otherwise,

© 2015 PCTEST Engineering Laboratory, Inc.

SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR result is ≤ 0.8 W/kg or all test positions are measured.

8.6.5 2.4 GHz SAR Test Requirements

SAR is measured for 2.4 GHz 802.11b DSSS using either the fixed test position or, when applicable, the initial test position procedure. SAR test reduction is determined according to the following:

1) When the reported SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.

2) When the reported SAR is > 0.8 W/kg, SAR is required for that position using the next highest measured output power channel. When any reported SAR is > 1.2 W/kg, SAR is required for the third channel; i.e., all channels require testing.

2.4 GHz 802.11 g/n OFDM are additionally evaluated for SAR if the highest reported SAR for 802.11b, adjusted by the ratio of the OFDM to DSSS specified maximum output power, is › 1.2 W/kg. When SAR is required for OFDM modes in 2.4 GHz band, the Initial Test Configuration Procedures should be followed.

8.6.6 OFDM Transmission Mode and SAR Test Channel Selection

For the 2.4 GHz and 5 GHz bands, when the same maximum output power was specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration with the largest channel bandwidth, lowest order modulation and lowest data rate. When the maximum output power of a channel is the same for equivalent OFDM configurations; for example, 802.11a, 802.11n and 802.11ac or 802.11g and 802.11n with the same channel bandwidth, modulation and data rate etc., the lower order 802.11 mode i.e., 802.11a, then 802.11n and 802.11ac or 802.11g then 802.11n, is used for SAR measurement. When the maximum output power are the same for multiple test channels, either according to the default or additional power measurement requirements, SAR is measured using the channel closest to the middle of the frequency band or aggregated band. When there are multiple channels with the same maximum output power, SAR is measured using the higher number channel.

8.6.7 Initial Test Configuration Procedure

For OFDM, in both 2.4 and 5 GHz bands, an initial test configuration is determined for each frequency band and aggregated band, according to the transmission mode with the highest maximum output power specified for SAR measurements. When the same maximum output power is specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration(s) with the largest channel bandwidth, lowest order modulation, and lowest data rate. If the average RF output powers of the highest identical transmission modes are within 0.25 dB of each other, mid channel of the transmission mode with highest average RF output power is the initial test channel. Otherwise, the channel of the transmission mode with the highest average RF output conducted power will be the initial test configuration.

When the reported SAR is ≤ 0.8 W/kg, no additional measurements on other test channels are required. Otherwise, SAR is evaluated using the subsequent highest average RF output channel until the reported SAR result is ≤ 1.2 W/kg or all channels are measured. When there are multiple untested channels having the same subsequent highest average RF output power, the channel with higher frequency from the lowest 802.11 mode is considered for SAR measurements (See Section 8.6.6).

© 2015 PCTEST Engineering Laboratory, Inc.

8.6.8 Subsequent Test Configuration Procedures

For OFDM configurations in each frequency band and aggregated band, SAR is evaluated for initial test configuration using the fixed test position or the initial test position procedure. When the highest reported SAR (for the initial test configuration), adjusted by the ratio of the specified maximum output power of the subsequent test configuration to initial test configuration, is ≤ 1.2 W/kg, no additional SAR tests for the subsequent test configurations are required.

8.6.9 MIMO SAR considerations

Per KDB 248227 D01 DR02-41929, the simultaneous SAR provisions in KDB Publication 447498 should be applied to determine simultaneous transmission SAR test exclusion for WIFI MIMO. If the sum of 1g single transmission chain SAR measurements is <1.6 W/kg, no additional SAR measurements for MIMO are required. Alternatively, SAR for MIMO can be measured with all antennas transmitting simultaneously at the specified maximum output power of MIMO operation.

© 2015 PCTEST Engineering Laboratory, Inc.

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	31.68	31.72	30.83	28.46	**27.28**	25.72	24.08	22.58	21.44
	190	32.05	32.18	30.73	28.97	**27.70**	25.75	24.22	22.69	21.59
	251	31.53	31.54	30.55	28.07	**26.84**	25.43	23.95	22.29	21.22
GSM 1900	512	28.67	28.69	28.29	**25.32**	22.94	24.20	23.22	21.77	20.43
	661	28.61	28.70	28.02	**25.08**	22.59	23.95	23.08	21.52	20.24
	810	28.49	28.48	27.97	**25.42**	22.92	23.98	22.92	21.42	20.14

		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	22.65	22.69	24.81	24.20	**24.27**	16.69	18.06	18.32	18.43
	190	23.02	23.15	24.71	24.71	**24.69**	16.72	18.20	18.43	18.58
	251	22.50	22.51	24.53	23.81	**23.83**	16.40	17.93	18.03	18.21
GSM 1900	512	19.64	19.66	22.27	**21.06**	19.93	15.17	17.20	17.51	17.42
	661	19.58	19.67	22.00	**20.82**	19.58	14.92	17.06	17.26	17.23
	810	19.46	19.45	21.95	**21.16**	19.91	14.95	16.90	17.16	17.13
GSM 850	**Frame Avg.Targets:**	23.47	23.47	24.48	24.24	**24.49**	16.97	17.98	18.74	18.99
GSM 1900		20.47	20.47	21.98	**21.74**	20.99	15.47	16.98	17.74	17.99

Note:

1. 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.
2. 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.
3. EDGE (8-PSK) output powers were measured with MCS7 on the base station simulator. MCS7 coding scheme was used to measure the output powers for EDGE since investigation has shown that choosing MCS7 coding scheme will ensure 8-PSK modulation. It has been shown that MCS levels that produce 8PSK modulation do not have an impact on output power.

GSM Class: B
GPRS Multislot class: 12 (Max 4 Tx uplink slots)
EDGE Multislot class: 12 (Max 4 Tx uplink slots)
DTM Multislot Class: N/A

Figure 9-1
Power Measurement Setup

© 2015 PCTEST Engineering Laboratory, Inc.

9.2 UMTS Conducted Powers

3GPP Release Version	Mode	3GPP 34.121 Subtest	Cellular Band [dBm]			3GPP MPR [dB]
			4132	4183	4233	
99	WCDMA	12.2 kbps RMC	23.10	23.16	23.08	-
99		12.2 kbps AMR	23.16	23.07	23.14	-
6	HSDPA	Subtest 1	22.17	22.20	22.11	0
6		Subtest 2	22.08	22.20	22.14	0
6		Subtest 3	21.58	21.70	21.66	0.5
6		Subtest 4	21.60	21.67	21.57	0.5
6	HSUPA	Subtest 1	22.11	22.23	22.08	0
6		Subtest 2	20.69	21.08	21.15	2
6		Subtest 3	20.46	20.79	20.70	1
6		Subtest 4	21.52	21.33	21.27	2
6		Subtest 5	22.20	22.15	22.19	0

This device does not support DC-HSDPA.

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

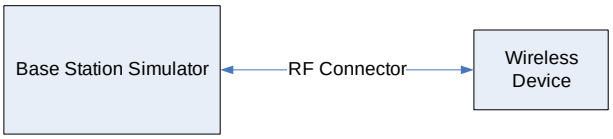


Figure 9-2
Power Measurement Setup

© 2015 PCTEST Engineering Laboratory, Inc.

9.3 LTE Conducted Powers

9.3.1 LTE Band 17

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

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Mid	710.0	23790	10	QPSK	1	0	**23.30**	0	0
	710.0	23790	10	QPSK	1	25	23.16	0	0
	710.0	23790	10	QPSK	1	49	23.10	0	0
	710.0	23790	10	QPSK	25	0	22.22	0-1	1
	710.0	23790	10	QPSK	25	12	**22.25**	0-1	1
	710.0	23790	10	QPSK	25	25	22.18	0-1	1
	710.0	23790	10	QPSK	50	0	22.17	0-1	1
	710.0	23790	10	16QAM	1	0	22.72	0-1	1
	710.0	23790	10	16QAM	1	25	22.68	0-1	1
	710.0	23790	10	16QAM	1	49	22.66	0-1	1
	710.0	23790	10	16QAM	25	0	21.21	0-2	2
	710.0	23790	10	16QAM	25	12	21.26	0-2	2
	710.0	23790	10	16QAM	25	25	21.14	0-2	2
	710.0	23790	10	16QAM	50	0	21.18	0-2	2

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

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

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Mid	710.0	23790	5	QPSK	1	0	23.26	0	0
	710.0	23790	5	QPSK	1	12	23.11	0	0
	710.0	23790	5	QPSK	1	24	23.13	0	0
	710.0	23790	5	QPSK	12	0	22.19	0-1	1
	710.0	23790	5	QPSK	12	6	22.17	0-1	1
	710.0	23790	5	QPSK	12	13	22.12	0-1	1
	710.0	23790	5	QPSK	25	0	22.24	0-1	1
	710.0	23790	5	16-QAM	1	0	22.87	0-1	1
	710.0	23790	5	16-QAM	1	12	22.72	0-1	1
	710.0	23790	5	16-QAM	1	24	22.64	0-1	1
	710.0	23790	5	16-QAM	12	0	21.20	0-2	2
	710.0	23790	5	16-QAM	12	6	21.19	0-2	2
	710.0	23790	5	16-QAM	12	13	21.10	0-2	2
	710.0	23790	5	16-QAM	25	0	21.14	0-2	2

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

© 2015 PCTEST Engineering Laboratory, Inc.

9.3.2 LTE Band 13

Table 9-3
LTE Band 13 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	782.0	23230	10	QPSK	1	0	**23.70**	0	0
	782.0	23230	10	QPSK	1	25	23.60	0	0
	782.0	23230	10	QPSK	1	49	23.44	0	0
	782.0	23230	10	QPSK	25	0	**22.68**	0-1	1
	782.0	23230	10	QPSK	25	12	22.43	0-1	1
	782.0	23230	10	QPSK	25	25	22.29	0-1	1
	782.0	23230	10	QPSK	50	0	22.46	0-1	1
	782.0	23230	10	16QAM	1	0	22.99	0-1	1
	782.0	23230	10	16QAM	1	25	23.00	0-1	1
	782.0	23230	10	16QAM	1	49	22.72	0-1	1
	782.0	23230	10	16QAM	25	0	21.62	0-2	2
	782.0	23230	10	16QAM	25	12	21.60	0-2	2
	782.0	23230	10	16QAM	25	25	21.52	0-2	2
	782.0	23230	10	16QAM	50	0	21.63	0-2	2

Table 9-4
LTE Band 13 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]
Mid	782.0	23230	5	QPSK	1	0	23.80	0	0
	782.0	23230	5	QPSK	1	12	23.52	0	0
	782.0	23230	5	QPSK	1	24	23.16	0	0
	782.0	23230	5	QPSK	12	0	22.58	0-1	1
	782.0	23230	5	QPSK	12	6	22.64	0-1	1
	782.0	23230	5	QPSK	12	13	22.55	0-1	1
	782.0	23230	5	QPSK	25	0	22.59	0-1	1
	782.0	23230	5	16-QAM	1	0	22.98	0-1	1
	782.0	23230	5	16-QAM	1	12	23.00	0-1	1
	782.0	23230	5	16-QAM	1	24	22.66	0-1	1
	782.0	23230	5	16-QAM	12	0	21.55	0-2	2
	782.0	23230	5	16-QAM	12	6	21.63	0-2	2
	782.0	23230	5	16-QAM	12	13	21.56	0-2	2
	782.0	23230	5	16-QAM	25	0	21.59	0-2	2

Note: LTE Band 13 at 5 MHz bandwidth does not support three non-overlapping channels. Per KDB Publication 941225 D05v02, when a device supports overlapping channel assignment in a channel bandwidth configuration, the middle channel of the group of overlapping channels should be selected for testing.

© 2015 PCTEST Engineering Laboratory, Inc.

9.3.3 LTE Band 41

Table 9-5
LTE Band 41 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	2506	39750	20	QPSK	1	0	**23.27**	0	0
	2506	39750	20	QPSK	1	50	23.21	0	0
	2506	39750	20	QPSK	1	99	23.12	0	0
	2506	39750	20	QPSK	50	0	22.09	0-1	1
	2506	39750	20	QPSK	50	25	**22.21**	0-1	1
	2506	39750	20	QPSK	50	50	22.10	0-1	1
	2506	39750	20	QPSK	100	0	22.05	0-1	1
	2506	39750	20	16QAM	1	0	22.31	0-1	1
	2506	39750	20	16QAM	1	50	22.17	0-1	1
	2506	39750	20	16QAM	1	99	22.19	0-1	1
	2506	39750	20	16QAM	50	0	21.19	0-2	2
	2506	39750	20	16QAM	50	25	21.20	0-2	2
	2506	39750	20	16QAM	50	50	20.89	0-2	2
	2506	39750	20	16QAM	100	0	20.92	0-2	2
Low Mid	2549.5	40185	20	QPSK	1	0	22.89	0	0
	2549.5	40185	20	QPSK	1	50	22.84	0	0
	2549.5	40185	20	QPSK	1	99	22.79	0	0
	2549.5	40185	20	QPSK	50	0	22.13	0-1	1
	2549.5	40185	20	QPSK	50	25	22.09	0-1	1
	2549.5	40185	20	QPSK	50	50	21.92	0-1	1
	2549.5	40185	20	QPSK	100	0	21.91	0-1	1
	2549.5	40185	20	16-QAM	1	0	22.18	0-1	1
	2549.5	40185	20	16-QAM	1	50	22.04	0-1	1
	2549.5	40185	20	16-QAM	1	99	21.88	0-1	1
	2549.5	40185	20	16-QAM	50	0	20.79	0-2	2
	2549.5	40185	20	16-QAM	50	25	20.88	0-2	2
	2549.5	40185	20	16-QAM	50	50	21.21	0-2	2
	2549.5	40185	20	16-QAM	100	0	21.28	0-2	2
Mid	2593	40620	20	QPSK	1	0	22.59	0	0
	2593	40620	20	QPSK	1	50	22.47	0	0
	2593	40620	20	QPSK	1	99	22.44	0	0
	2593	40620	20	QPSK	50	0	21.62	0-1	1
	2593	40620	20	QPSK	50	25	21.63	0-1	1
	2593	40620	20	QPSK	50	50	21.62	0-1	1
	2593	40620	20	QPSK	100	0	21.48	0-1	1
	2593	40620	20	16-QAM	1	0	21.88	0-1	1
	2593	40620	20	16-QAM	1	50	21.75	0-1	1
	2593	40620	20	16-QAM	1	99	21.44	0-1	1
	2593	40620	20	16-QAM	50	0	20.71	0-2	2
	2593	40620	20	16-QAM	50	25	20.85	0-2	2
	2593	40620	20	16-QAM	50	50	20.40	0-2	2
	2593	40620	20	16-QAM	100	0	20.38	0-2	2
Mid High	2636.5	41055	20	QPSK	1	0	22.43	0	0
	2636.5	41055	20	QPSK	1	50	22.44	0	0
	2636.5	41055	20	QPSK	1	99	22.07	0	0
	2636.5	41055	20	QPSK	50	0	21.63	0-1	1
	2636.5	41055	20	QPSK	50	25	21.51	0-1	1
	2636.5	41055	20	QPSK	50	50	21.33	0-1	1
	2636.5	41055	20	QPSK	100	0	21.40	0-1	1
	2636.5	41055	20	16-QAM	1	0	21.88	0-1	1
	2636.5	41055	20	16-QAM	1	50	21.78	0-1	1
	2636.5	41055	20	16-QAM	1	99	21.36	0-1	1
	2636.5	41055	20	16-QAM	50	0	20.66	0-2	2
	2636.5	41055	20	16-QAM	50	25	20.58	0-2	2
	2636.5	41055	20	16-QAM	50	50	20.32	0-2	2
	2636.5	41055	20	16-QAM	100	0	20.28	0-2	2
High	2680	41490	20	QPSK	1	0	22.48	0	0
	2680	41490	20	QPSK	1	50	22.28	0	0
	2680	41490	20	QPSK	1	99	22.02	0	0
	2680	41490	20	QPSK	50	0	21.46	0-1	1
	2680	41490	20	QPSK	50	25	21.31	0-1	1
	2680	41490	20	QPSK	50	50	21.21	0-1	1
	2680	41490	20	QPSK	100	0	21.13	0-1	1
	2680	41490	20	16-QAM	1	0	21.90	0-1	1
	2680	41490	20	16-QAM	1	50	21.92	0-1	1
	2680	41490	20	16-QAM	1	99	21.70	0-1	1
	2680	41490	20	16-QAM	50	0	20.43	0-2	2
	2680	41490	20	16-QAM	50	25	20.42	0-2	2
	2680	41490	20	16-QAM	50	50	20.39	0-2	2
	2680	41490	20	16-QAM	100	0	20.33	0-2	2

© 2015 PCTEST Engineering Laboratory, Inc.

Table 9-6
LTE Band 41 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	2503.5	39725	15	QPSK	1	0	23.14	0	0
	2503.5	39725	15	QPSK	1	36	23.18	0	0
	2503.5	39725	15	QPSK	1	74	23.15	0	0
	2503.5	39725	15	QPSK	36	0	22.02	0-1	1
	2503.5	39725	15	QPSK	36	18	22.44	0-1	1
	2503.5	39725	15	QPSK	36	37	21.80	0-1	1
	2503.5	39725	15	QPSK	75	0	21.89	0-1	1
	2503.5	39725	15	16QAM	1	0	22.42	0-1	1
	2503.5	39725	15	16QAM	1	36	22.22	0-1	1
	2503.5	39725	15	16QAM	1	74	22.22	0-1	1
	2503.5	39725	15	16QAM	36	0	21.18	0-2	2
	2503.5	39725	15	16QAM	36	18	21.10	0-2	2
	2503.5	39725	15	16QAM	36	37	21.18	0-2	2
	2503.5	39725	15	16QAM	75	0	21.08	0-2	2
Low Mid	2548.25	40173	15	QPSK	1	0	22.78	0	0
	2548.25	40173	15	QPSK	1	36	22.92	0	0
	2548.25	40173	15	QPSK	1	74	23.00	0	0
	2548.25	40173	15	QPSK	36	0	22.25	0-1	1
	2548.25	40173	15	QPSK	36	18	22.19	0-1	1
	2548.25	40173	15	QPSK	36	37	21.99	0-1	1
	2548.25	40173	15	QPSK	75	0	21.73	0-1	1
	2548.25	40173	15	16-QAM	1	0	22.19	0-1	1
	2548.25	40173	15	16-QAM	1	36	22.33	0-1	1
	2548.25	40173	15	16-QAM	1	74	21.81	0-1	1
	2548.25	40173	15	16-QAM	36	0	20.88	0-2	2
	2548.25	40173	15	16-QAM	36	18	20.66	0-2	2
	2548.25	40173	15	16-QAM	36	37	21.46	0-2	2
	2548.25	40173	15	16-QAM	75	0	21.33	0-2	2
Mid	2593	40620	15	QPSK	1	0	22.55	0	0
	2593	40620	15	QPSK	1	36	22.59	0	0
	2593	40620	15	QPSK	1	74	22.19	0	0
	2593	40620	15	QPSK	36	0	21.76	0-1	1
	2593	40620	15	QPSK	36	18	21.72	0-1	1
	2593	40620	15	QPSK	36	37	21.53	0-1	1
	2593	40620	15	QPSK	75	0	21.42	0-1	1
	2593	40620	15	16-QAM	1	0	21.99	0-1	1
	2593	40620	15	16-QAM	1	36	22.03	0-1	1
	2593	40620	15	16-QAM	1	74	21.40	0-1	1
	2593	40620	15	16-QAM	36	0	20.57	0-2	2
	2593	40620	15	16-QAM	36	18	21.08	0-2	2
	2593	40620	15	16-QAM	36	37	20.32	0-2	2
	2593	40620	15	16-QAM	75	0	20.51	0-2	2
Mid High	2637.75	41068	15	QPSK	1	0	22.21	0	0
	2637.75	41068	15	QPSK	1	36	22.38	0	0
	2637.75	41068	15	QPSK	1	74	22.11	0	0
	2637.75	41068	15	QPSK	36	0	21.77	0-1	1
	2637.75	41068	15	QPSK	36	18	21.52	0-1	1
	2637.75	41068	15	QPSK	36	37	21.57	0-1	1
	2637.75	41068	15	QPSK	75	0	21.56	0-1	1
	2637.75	41068	15	16-QAM	1	0	21.77	0-1	1
	2637.75	41068	15	16-QAM	1	36	21.98	0-1	1
	2637.75	41068	15	16-QAM	1	74	21.07	0-1	1
	2637.75	41068	15	16-QAM	36	0	20.80	0-2	2
	2637.75	41068	15	16-QAM	36	18	20.67	0-2	2
	2637.75	41068	15	16-QAM	36	37	20.57	0-2	2
	2637.75	41068	15	16-QAM	75	0	20.42	0-2	2
High	2682.5	41515	15	QPSK	1	0	22.19	0	0
	2682.5	41515	15	QPSK	1	36	22.43	0	0
	2682.5	41515	15	QPSK	1	74	21.99	0	0
	2682.5	41515	15	QPSK	36	0	21.59	0-1	1
	2682.5	41515	15	QPSK	36	18	21.58	0-1	1
	2682.5	41515	15	QPSK	36	37	21.07	0-1	1
	2682.5	41515	15	QPSK	75	0	21.13	0-1	1
	2682.5	41515	15	16-QAM	1	0	21.94	0-1	1
	2682.5	41515	15	16-QAM	1	36	21.76	0-1	1
	2682.5	41515	15	16-QAM	1	74	21.62	0-1	1
	2682.5	41515	15	16-QAM	36	0	20.41	0-2	2
	2682.5	41515	15	16-QAM	36	18	20.35	0-2	2
	2682.5	41515	15	16-QAM	36	37	20.11	0-2	2
	2682.5	41515	15	16-QAM	75	0	20.40	0-2	2

© 2015 PCTEST Engineering Laboratory, Inc.

Table 9-7
LTE Band 41 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	2501	39700	10	QPSK	1	0	23.00	0	0
	2501	39700	10	QPSK	1	25	23.25	0	0
	2501	39700	10	QPSK	1	49	22.96	0	0
	2501	39700	10	QPSK	25	0	22.00	0-1	1
	2501	39700	10	QPSK	25	12	22.31	0-1	1
	2501	39700	10	QPSK	25	25	21.81	0-1	1
	2501	39700	10	QPSK	50	0	21.97	0-1	1
	2501	39700	10	16QAM	1	0	22.48	0-1	1
	2501	39700	10	16QAM	1	25	22.25	0-1	1
	2501	39700	10	16QAM	1	49	22.23	0-1	1
	2501	39700	10	16QAM	25	0	21.36	0-2	2
	2501	39700	10	16QAM	25	12	21.27	0-2	2
	2501	39700	10	16QAM	25	25	21.05	0-2	2
	2501	39700	10	16QAM	50	0	21.14	0-2	2
Low Mid	2547	40160	10	QPSK	1	0	22.78	0	0
	2547	40160	10	QPSK	1	25	22.99	0	0
	2547	40160	10	QPSK	1	49	22.94	0	0
	2547	40160	10	QPSK	25	0	22.16	0-1	1
	2547	40160	10	QPSK	25	12	22.20	0-1	1
	2547	40160	10	QPSK	25	25	21.99	0-1	1
	2547	40160	10	QPSK	50	0	21.60	0-1	1
	2547	40160	10	16-QAM	1	0	22.11	0-1	1
	2547	40160	10	16-QAM	1	25	22.26	0-1	1
	2547	40160	10	16-QAM	1	49	21.69	0-1	1
	2547	40160	10	16-QAM	25	0	20.96	0-2	2
	2547	40160	10	16-QAM	25	12	20.58	0-2	2
	2547	40160	10	16-QAM	25	25	21.49	0-2	2
	2547	40160	10	16-QAM	50	0	21.40	0-2	2
Mid	2593	40620	10	QPSK	1	0	22.93	0	0
	2593	40620	10	QPSK	1	25	22.79	0	0
	2593	40620	10	QPSK	1	49	22.67	0	0
	2593	40620	10	QPSK	25	0	21.67	0-1	1
	2593	40620	10	QPSK	25	12	21.63	0-1	1
	2593	40620	10	QPSK	25	25	21.55	0-1	1
	2593	40620	10	QPSK	50	0	21.72	0-1	1
	2593	40620	10	16-QAM	1	0	22.11	0-1	1
	2593	40620	10	16-QAM	1	25	21.92	0-1	1
	2593	40620	10	16-QAM	1	49	21.73	0-1	1
	2593	40620	10	16-QAM	25	0	20.64	0-2	2
	2593	40620	10	16-QAM	25	12	21.01	0-2	2
	2593	40620	10	16-QAM	25	25	20.53	0-2	2
	2593	40620	10	16-QAM	50	0	20.64	0-2	2
Mid High	2639	41080	10	QPSK	1	0	22.54	0	0
	2639	41080	10	QPSK	1	25	22.50	0	0
	2639	41080	10	QPSK	1	49	22.27	0	0
	2639	41080	10	QPSK	25	0	21.49	0-1	1
	2639	41080	10	QPSK	25	12	21.44	0-1	1
	2639	41080	10	QPSK	25	25	21.55	0-1	1
	2639	41080	10	QPSK	50	0	21.59	0-1	1
	2639	41080	10	16-QAM	1	0	21.81	0-1	1
	2639	41080	10	16-QAM	1	25	21.77	0-1	1
	2639	41080	10	16-QAM	1	49	21.80	0-1	1
	2639	41080	10	16-QAM	25	0	20.78	0-2	2
	2639	41080	10	16-QAM	25	12	20.55	0-2	2
	2639	41080	10	16-QAM	25	25	20.66	0-2	2
	2639	41080	10	16-QAM	50	0	20.62	0-2	2
High	2685	41540	10	QPSK	1	0	22.60	0	0
	2685	41540	10	QPSK	1	25	22.54	0	0
	2685	41540	10	QPSK	1	49	22.31	0	0
	2685	41540	10	QPSK	25	0	21.54	0-1	1
	2685	41540	10	QPSK	25	12	21.47	0-1	1
	2685	41540	10	QPSK	25	25	21.37	0-1	1
	2685	41540	10	QPSK	50	0	21.39	0-1	1
	2685	41540	10	16-QAM	1	0	22.17	0-1	1
	2685	41540	10	16-QAM	1	25	22.00	0-1	1
	2685	41540	10	16-QAM	1	49	21.90	0-1	1
	2685	41540	10	16-QAM	25	0	20.46	0-2	2
	2685	41540	10	16-QAM	25	12	20.47	0-2	2
	2685	41540	10	16-QAM	25	25	20.44	0-2	2
	2685	41540	10	16-QAM	50	0	20.42	0-2	2

© 2015 PCTEST Engineering Laboratory, Inc.

Table 9-8
LTE Band 41 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	2498.5	39675	5	QPSK	1	0	22.89	0	0
	2498.5	39675	5	QPSK	1	12	23.44	0	0
	2498.5	39675	5	QPSK	1	24	22.99	0	0
	2498.5	39675	5	QPSK	12	0	21.87	0-1	1
	2498.5	39675	5	QPSK	12	6	22.12	0-1	1
	2498.5	39675	5	QPSK	12	13	21.55	0-1	1
	2498.5	39675	5	QPSK	25	0	21.86	0-1	1
	2498.5	39675	5	16-QAM	1	0	22.48	0-1	1
	2498.5	39675	5	16-QAM	1	12	22.14	0-1	1
	2498.5	39675	5	16-QAM	1	24	22.36	0-1	1
	2498.5	39675	5	16-QAM	12	0	21.15	0-2	2
	2498.5	39675	5	16-QAM	12	6	21.46	0-2	2
	2498.5	39675	5	16-QAM	12	13	21.06	0-2	2
	2498.5	39675	5	16-QAM	25	0	21.10	0-2	2
Low Mid	2545.75	40148	5	QPSK	1	0	23.06	0	0
	2545.75	40148	5	QPSK	1	12	22.98	0	0
	2545.75	40148	5	QPSK	1	24	22.67	0	0
	2545.75	40148	5	QPSK	12	0	21.92	0-1	1
	2545.75	40148	5	QPSK	12	6	22.20	0-1	1
	2545.75	40148	5	QPSK	12	13	21.98	0-1	1
	2545.75	40148	5	QPSK	25	0	21.70	0-1	1
	2545.75	40148	5	16-QAM	1	0	22.13	0-1	1
	2545.75	40148	5	16-QAM	1	12	22.47	0-1	1
	2545.75	40148	5	16-QAM	1	24	21.99	0-1	1
	2545.75	40148	5	16-QAM	12	0	21.09	0-2	2
	2545.75	40148	5	16-QAM	12	6	20.86	0-2	2
	2545.75	40148	5	16-QAM	12	13	21.35	0-2	2
	2545.75	40148	5	16-QAM	25	0	21.36	0-2	2
Mid	2593	40620	5	QPSK	1	0	23.13	0	0
	2593	40620	5	QPSK	1	12	23.02	0	0
	2593	40620	5	QPSK	1	24	22.40	0	0
	2593	40620	5	QPSK	12	0	21.86	0-1	1
	2593	40620	5	QPSK	12	6	21.35	0-1	1
	2593	40620	5	QPSK	12	13	21.85	0-1	1
	2593	40620	5	QPSK	25	0	21.43	0-1	1
	2593	40620	5	16-QAM	1	0	21.90	0-1	1
	2593	40620	5	16-QAM	1	12	21.65	0-1	1
	2593	40620	5	16-QAM	1	24	21.44	0-1	1
	2593	40620	5	16-QAM	12	0	20.44	0-2	2
	2593	40620	5	16-QAM	12	6	21.23	0-2	2
	2593	40620	5	16-QAM	12	13	20.28	0-2	2
	2593	40620	5	16-QAM	25	0	20.37	0-2	2
Mid High	2640.25	41093	5	QPSK	1	0	22.60	0	0
	2640.25	41093	5	QPSK	1	12	22.44	0	0
	2640.25	41093	5	QPSK	1	24	22.24	0	0
	2640.25	41093	5	QPSK	12	0	21.36	0-1	1
	2640.25	41093	5	QPSK	12	6	21.48	0-1	1
	2640.25	41093	5	QPSK	12	13	21.38	0-1	1
	2640.25	41093	5	QPSK	25	0	21.82	0-1	1
	2640.25	41093	5	16-QAM	1	0	21.92	0-1	1
	2640.25	41093	5	16-QAM	1	12	21.57	0-1	1
	2640.25	41093	5	16-QAM	1	24	21.62	0-1	1
	2640.25	41093	5	16-QAM	12	0	20.56	0-2	2
	2640.25	41093	5	16-QAM	12	6	20.55	0-2	2
	2640.25	41093	5	16-QAM	12	13	20.46	0-2	2
	2640.25	41093	5	16-QAM	25	0	20.79	0-2	2
High	2687.5	41565	5	QPSK	1	0	22.60	0	0
	2687.5	41565	5	QPSK	1	12	22.61	1	0
	2687.5	41565	5	QPSK	1	24	22.27	0	0
	2687.5	41565	5	QPSK	12	0	21.79	0-1	1
	2687.5	41565	5	QPSK	12	6	21.29	0-1	1
	2687.5	41565	5	QPSK	12	13	21.42	0-1	1
	2687.5	41565	5	QPSK	25	0	21.69	0-1	1
	2687.5	41565	5	16-QAM	1	0	22.13	0-1	1
	2687.5	41565	5	16-QAM	1	12	22.10	0-1	1
	2687.5	41565	5	16-QAM	1	24	21.75	0-1	1
	2687.5	41565	5	16-QAM	12	0	20.64	0-2	2
	2687.5	41565	5	16-QAM	12	6	20.46	0-2	2
	2687.5	41565	5	16-QAM	12	13	20.71	0-2	2
	2687.5	41565	5	16-QAM	25	0	20.15	0-2	2

© 2015 PCTEST Engineering Laboratory, Inc.

9.4 WLAN Conducted Powers

Table 9-9
2.4 GHz Average RF Power – Antenna 1

Freq [MHz]	Channel	2.4GHz Conducted Power [dBm]
		IEEE Transmission Mode
		802.11b
2412	1	**14.78**
2437	6	14.62
2462	11	14.52

Table 9-10
2.4 GHz Average RF Power – Antenna 2

Freq [MHz]	Channel	2.4GHz Conducted Power [dBm]
		IEEE Transmission Mode
		802.11b
2412	1	14.51
2437	6	**14.82**
2462	11	14.46

© 2015 PCTEST Engineering Laboratory, Inc.

Table 9-11
5 GHz (40 MHz Bandwidth) Average RF Power – Antenna 1

Freq [MHz]	Channel	5GHz (40MHz) Conducted Power [dBm]
		IEEE Transmission Mode
		802.11n
5190	38	10.52
5230	46	10.58
5270	54	**11.23**
5310	62	11.07
5510	102	**10.98**
5550	110	10.81
5670	134	11.31
5710	142	11.10
5755	151	**11.22**
5795	159	11.26

Table 9-12
5 GHz (40 MHz Bandwidth) Average RF Power – Antenna 2

Freq [MHz]	Channel	5GHz (40MHz) Conducted Power [dBm]
		IEEE Transmission Mode
		802.11n
5190	38	10.41
5230	46	10.37
5270	54	**11.05**
5310	62	11.01
5510	102	**10.67**
5550	110	10.62
5670	134	11.32
5710	142	11.28
5755	151	**11.38**
5795	159	11.15

© 2015 PCTEST Engineering Laboratory, Inc.

Table 9-13
5 GHz (40 MHz Bandwidth) Average RF Power – MIMO

Freq [MHz]	Channel	5GHz (40MHz) Conducted Power [dBm]
		IEEE Transmission Mode
		802.11n
5190	38	13.48
5230	46	13.49
5270	54	**14.15**
5310	62	14.05
5510	102	**13.84**
5550	110	13.73
5670	134	14.33
5710	142	14.20
5755	151	**14.31**
5795	159	14.22

Justification for test configurations for WLAN per KDB Publication 248227 D01DR02-41929:

- Power measurements were performed for the transmission mode configuration with the highest maximum output power specified for production units.
- For transmission modes with the same maximum output power specification, powers were measured for the largest channel bandwidth, lowest order modulation and lowest data rate.
- For transmission modes with identical maximum specified output power, channel bandwidth, modulation and data rates, power measurements were required for all identical configurations.
- For each transmission mode configuration, powers were measured for the highest and lowest channels; and at the mid-band channel(s) when there were at least 3 channels supported. For configurations with multiple mid-band channels, due to an even number of channels, both channels were measured.
- The bolded data rate and channel above were tested for SAR.

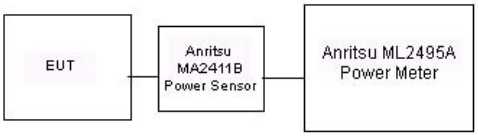


Figure 9-3
Power Measurement Setup

© 2015 PCTEST Engineering Laboratory, Inc.

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
2/19/2015	750H	23.7	695	0.847	41.372	0.889	42.227	-4.72%	-2.02%
			710	0.861	41.144	0.890	42.149	-3.26%	-2.38%
			725	0.875	40.958	0.891	42.071	-1.80%	-2.65%
			740	0.888	40.738	0.893	41.994	-0.56%	-2.99%
			755	0.901	40.537	0.894	41.916	0.78%	-3.29%
			770	0.915	40.346	0.895	41.838	2.23%	-3.57%
			785	0.930	40.118	0.896	41.760	3.79%	-3.93%
2/17/2015	835H	22.1	820	0.887	41.704	0.899	41.578	-1.33%	0.30%
			835	0.902	41.516	0.900	41.500	0.22%	0.04%
			850	0.916	41.340	0.916	41.500	0.00%	-0.39%
2/17/2015	1900H	22.0	1850	1.361	38.514	1.400	40.000	-2.79%	-3.71%
			1880	1.390	38.386	1.400	40.000	-0.71%	-4.03%
			1910	1.424	38.266	1.400	40.000	1.71%	-4.34%
2/19/2015	2450H	23.2	2401	1.703	40.794	1.756	39.287	-3.02%	3.84%
			2450	1.754	40.636	1.800	39.200	-2.56%	3.66%
			2499	1.803	40.425	1.853	39.138	-2.70%	3.29%
			2500	1.803	40.415	1.855	39.136	-2.80%	3.27%
			2550	1.861	40.256	1.909	39.073	-2.51%	3.03%
02/18/2015	5200H-5800H	19.8	5260	4.632	36.201	4.717	35.917	-1.80%	0.79%
			5280	4.647	36.168	4.737	35.894	-1.90%	0.76%
			5300	4.662	36.141	4.758	35.871	-2.02%	0.75%
			5500	4.878	35.853	4.963	35.643	-1.71%	0.59%
			5520	4.890	35.823	4.983	35.620	-1.87%	0.57%
			5700	5.082	35.532	5.168	35.414	-1.66%	0.33%
			5745	5.138	35.479	5.214	35.363	-1.46%	0.33%
			5765	5.153	35.455	5.234	35.340	-1.55%	0.33%
			5800	5.188	35.416	5.270	35.300	-1.56%	0.33%
02/23/2015	5800H	19.1	5745	5.381	36.492	5.214	35.363	3.20%	3.19%
			5765	5.407	36.458	5.234	35.340	3.31%	3.16%
			5800	5.446	36.405	5.270	35.300	3.34%	3.13%
2/23/2015	750B	22.6	695	0.913	56.992	0.959	55.745	-4.80%	2.24%
			710	0.927	56.866	0.960	55.687	-3.44%	2.12%
			725	0.940	56.715	0.961	55.629	-2.19%	1.95%
			740	0.952	56.561	0.963	55.570	-1.14%	1.78%
			755	0.966	56.439	0.964	55.512	0.21%	1.67%
			770	0.982	56.280	0.965	55.453	1.76%	1.49%
			785	0.996	56.113	0.966	55.395	3.11%	1.30%
2/17/2015	835B	22.3	820	0.992	54.427	0.969	55.258	2.37%	-1.50%
			835	1.005	54.281	0.970	55.200	3.61%	-1.66%
			850	1.019	54.152	0.988	55.154	3.14%	-1.82%
2/18/2015	1900B	22.1	1850	1.525	51.393	1.520	53.300	0.33%	-3.58%
			1880	1.555	51.251	1.520	53.300	2.30%	-3.84%
			1910	1.592	51.164	1.520	53.300	4.74%	-4.01%
2/23/2015	2450B	23.5	2401	1.903	52.660	1.903	52.765	0.00%	-0.20%
			2450	1.967	52.481	1.950	52.700	0.87%	-0.42%
			2499	2.030	52.304	2.019	52.638	0.54%	-0.63%
			2500	2.029	52.292	2.021	52.636	0.40%	-0.65%
			2550	2.095	52.101	2.092	52.573	0.14%	-0.90%
02/23/2015	5200B-5800B	21.5	5260	5.456	51.135	5.369	48.933	1.62%	4.50%
			5280	5.458	51.084	5.393	48.906	1.21%	4.45%
			5300	5.505	51.124	5.416	48.879	1.64%	4.59%
			5500	5.855	50.845	5.650	48.607	3.63%	4.60%
			5520	5.851	50.625	5.673	48.580	3.14%	4.21%
			5700	6.122	50.339	5.883	48.336	4.06%	4.14%
			5745	6.228	50.395	5.936	48.275	4.92%	4.39%
			5765	6.214	50.276	5.959	48.248	4.28%	4.20%
			5800	6.244	50.082	6.000	48.200	4.07%	3.90%

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.

© 2015 PCTEST Engineering Laboratory, Inc.

10.2 Test System Verification

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

Table 10-2
System Verification Results

System Verification TARGET & MEASURED												
SAR System #	Tissue Frequency (MHz)	Tissue Type	Date:	Amb. Temp (°C)	Liquid Temp (°C)	Input Power (W)	Dipole SN	Probe SN	Measured SAR_{1g} (W/kg)	1 W Target SAR_{1g} (W/kg)	1 W Normalized SAR_{1g} (W/kg)	$Deviation_{1g}$ (%)
D	750	HEAD	02/19/2015	23.1	23.5	0.100	1054	3263	0.840	8.330	8.400	0.84%
G	835	HEAD	02/17/2015	23.2	22.1	0.100	4d133	3213	0.950	9.200	9.500	3.26%
D	1900	HEAD	02/17/2015	23.3	22.0	0.100	5d149	3263	4.020	40.200	40.200	0.00%
G	2450	HEAD	02/19/2015	24.3	23.2	0.100	719	3213	4.810	52.100	48.100	-7.68%
E	5300	HEAD	02/18/2015	20.9	19.8	0.050	1057	7308	3.910	84.700	78.200	-7.67%
E	5500	HEAD	02/18/2015	20.8	19.8	0.050	1057	7308	3.980	84.300	79.600	-5.58%
E	5800	HEAD	02/18/2015	21.0	19.9	0.050	1057	7308	3.780	81.100	75.600	-6.78%
E	5800	HEAD	02/23/2015	20.6	20.4	0.050	1057	7308	3.670	81.100	73.400	-9.49%
K	750	BODY	02/23/2015	24.4	22.6	0.100	1054	3288	0.869	8.640	8.690	0.58%
K	835	BODY	02/17/2015	23.4	22.3	0.100	4d133	3288	1.010	9.350	10.100	8.02%
D	1900	BODY	02/18/2015	22.9	22.1	0.100	5d149	3263	4.270	40.400	42.700	5.69%
D	2450	BODY	02/23/2015	22.0	23.5	0.100	719	3263	5.140	51.800	51.400	-0.77%
H	5300	BODY	02/23/2015	21.6	20.8	0.050	1057	3920	3.810	74.200	76.200	2.70%
H	5500	BODY	02/23/2015	21.5	20.8	0.050	1057	3920	4.260	79.200	85.200	7.58%
H	5800	BODY	02/23/2015	21.7	20.8	0.050	1057	3920	3.830	75.100	76.600	2.00%

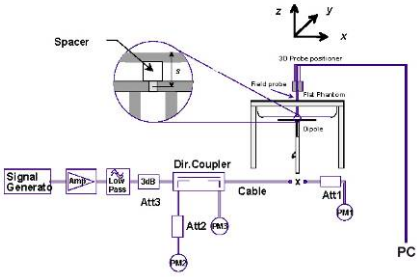


Figure 10-1
System Verification Setup Diagram

Figure 10-2
System Verification Setup Photo

© 2015 PCTEST Engineering Laboratory, Inc.

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	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.										(W/kg)		(W/kg)	
836.60	190	GSM 850	GSM	33.0	32.05	0.13	Right	Cheek	1C0C4	1:8.3	0.148	1.245	0.184	A1
836.60	190	GSM 850	GSM	33.0	32.05	-0.05	Right	Tilt	1C0C4	1:8.3	0.102	1.245	0.127	
836.60	190	GSM 850	GSM	33.0	32.05	0.06	Left	Cheek	1C0C4	1:8.3	0.123	1.245	0.153	
836.60	190	GSM 850	GSM	33.0	32.05	0.01	Left	Tilt	1C0C4	1:8.3	0.082	1.245	0.102	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Head 1.6 W/kg (mW/g) averaged over 1 gram							

Table 11-2
UMTS 850 Head SAR

MEASUREMENT RESULTS														
FREQUENCY		Mode/Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Side	Test Position	Device Serial Number	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.										(W/kg)		(W/kg)	
836.60	4183	UMTS 850	RMC	23.5	23.16	0.14	Right	Cheek	1C0C4	1:1	0.192	1.081	0.208	
836.60	4183	UMTS 850	RMC	23.5	23.16	0.16	Right	Tilt	1C0C4	1:1	0.173	1.081	0.187	
836.60	4183	UMTS 850	RMC	23.5	23.16	-0.01	Left	Cheek	1C0C4	1:1	0.204	1.081	0.221	A2
836.60	4183	UMTS 850	RMC	23.5	23.16	0.07	Left	Tilt	1C0C4	1:1	0.174	1.081	0.188	
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
GSM 1900 Head SAR

MEASUREMENT RESULTS														
FREQUENCY		Mode/Band	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Side	Test Position	Device Serial Number	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.										(W/kg)		(W/kg)	
1880.00	661	GSM 1900	GSM	30.0	28.61	-0.05	Right	Cheek	1C0C4	1:8.3	0.073	1.377	0.101	
1880.00	661	GSM 1900	GSM	30.0	28.61	0.12	Right	Tilt	1C0C4	1:8.3	0.069	1.377	0.095	
1880.00	661	GSM 1900	GSM	30.0	28.61	-0.20	Left	Cheek	1C0C4	1:8.3	0.117	1.377	0.161	A3
1880.00	661	GSM 1900	GSM	30.0	28.61	0.03	Left	Tilt	1C0C4	1:8.3	0.043	1.377	0.059	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Head 1.6 W/kg (mW/g) averaged over 1 gram							

© 2015 PCTEST Engineering Laboratory, Inc.

Table 11-4
LTE Band 17 Head SAR

MEASUREMENT RESULTS																				
FREQUENCY			Mode	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Side	Test Position	Modulation	RB Size	RB Offset	Device Serial Number	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.															(W/kg)		(W/kg)	
710.00	23790	Mid	LTE Band 17	10	24.0	23.30	0.05	0	Right	Cheek	QPSK	1	0	1C0A8	1:1	0.066	1.175	0.078	
710.00	23790	Mid	LTE Band 17	10	23.0	22.25	0.20	1	Right	Cheek	QPSK	25	12	1C0A8	1:1	0.054	1.189	0.064	
710.00	23790	Mid	LTE Band 17	10	24.0	23.30	0.05	0	Right	Tilt	QPSK	1	0	1C0A8	1:1	0.037	1.175	0.043	
710.00	23790	Mid	LTE Band 17	10	23.0	22.25	0.09	1	Right	Tilt	QPSK	25	12	1C0A8	1:1	0.033	1.189	0.039	
710.00	23790	Mid	LTE Band 17	10	24.0	23.30	0.04	0	Left	Cheek	QPSK	1	0	1C0A8	1:1	0.079	1.175	0.093	A4
710.00	23790	Mid	LTE Band 17	10	23.0	22.25	0.04	1	Left	Cheek	QPSK	25	12	1C0A8	1:1	0.071	1.189	0.084	
710.00	23790	Mid	LTE Band 17	10	24.0	23.30	0.03	0	Left	Tilt	QPSK	1	0	1C0A8	1:1	0.039	1.175	0.046	
710.00	23790	Mid	LTE Band 17	10	23.0	22.25	0.09	1	Left	Tilt	QPSK	25	12	1C0A8	1:1	0.036	1.189	0.043	
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
LTE Band 13 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)	
782.00	23230	Mid	LTE Band 13	10	24.0	23.70	0.00	0	Right	Cheek	QPSK	1	0	1C0A8	1:1	0.198	1.072	0.212	
782.00	23230	Mid	LTE Band 13	10	23.0	22.68	0.03	1	Right	Cheek	QPSK	25	0	1C0A8	1:1	0.159	1.076	0.171	
782.00	23230	Mid	LTE Band 13	10	24.0	23.70	-0.03	0	Right	Tilt	QPSK	1	0	1C0A8	1:1	0.136	1.072	0.146	
782.00	23230	Mid	LTE Band 13	10	23.0	22.68	0.00	1	Right	Tilt	QPSK	25	0	1C0A8	1:1	0.117	1.076	0.126	
782.00	23230	Mid	LTE Band 13	10	24.0	23.70	0.01	0	Left	Cheek	QPSK	1	0	1C0A8	1:1	0.231	1.072	0.248	A5
782.00	23230	Mid	LTE Band 13	10	23.0	22.68	0.08	1	Left	Cheek	QPSK	25	0	1C0A8	1:1	0.191	1.076	0.206	
782.00	23230	Mid	LTE Band 13	10	24.0	23.70	0.04	0	Left	Tilt	QPSK	1	0	1C0A8	1:1	0.137	1.072	0.147	
782.00	23230	Mid	LTE Band 13	10	23.0	22.68	0.07	1	Left	Tilt	QPSK	25	0	1C0A8	1:1	0.125	1.076	0.135	
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 41 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)	
2506.00	39750	Low	LTE Band 41	20	23.5	23.27	0.15	0	Right	Cheek	QPSK	1	0	1C0A8	1:1.58	0.034	1.054	0.036	A6
2506.00	39750	Low	LTE Band 41	20	22.5	22.21	0.03	1	Right	Cheek	QPSK	50	25	1C0A8	1:1.58	0.018	1.069	0.019	
2506.00	39750	Low	LTE Band 41	20	23.5	23.27	0.02	0	Right	Tilt	QPSK	1	0	1C0A8	1:1.58	0.002	1.054	0.002	
2506.00	39750	Low	LTE Band 41	20	22.5	22.21	0.02	1	Right	Tilt	QPSK	50	25	1C0A8	1:1.58	0.002	1.069	0.002	
2506.00	39750	Low	LTE Band 41	20	23.5	23.27	0.14	0	Left	Cheek	QPSK	1	0	1C0A8	1:1.58	0.013	1.054	0.014	
2506.00	39750	Low	LTE Band 41	20	22.5	22.21	0.07	1	Left	Cheek	QPSK	50	25	1C0A8	1:1.58	0.006	1.069	0.006	
2506.00	39750	Low	LTE Band 41	20	23.5	23.27	0.05	0	Left	Tilt	QPSK	1	0	1C0A8	1:1.58	0.004	1.054	0.004	
2506.00	39750	Low	LTE Band 41	20	22.5	22.21	0.04	1	Left	Tilt	QPSK	50	25	1C0A8	1:1.58	0.003	1.069	0.003	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population									Head 1.6 W/kg (mW/g) averaged over 1 gram										

© 2015 PCTEST Engineering Laboratory, Inc.

Table 11-7
DTS Head SAR

MEASUREMENT RESULTS																			
FREQUENCY		Mode	Service	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Side	Test Position	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Duty Cycle (%)	Peak SAR of Area Scan	SAR (1g)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Scaled SAR (1g)	Plot #
MHz	Ch.													W/kg	(W/kg)			(W/kg)	
2412	1	802.11b	DSSS	22	15.5	14.78	-0.01	Right	Cheek	1	1C0C3	1	99.8	0.479	0.412	1.180	1.002	0.487	A7
2412	1	802.11b	DSSS	22	15.5	14.78	0.01	Right	Tilt	1	1C0C3	1	99.8	0.288	0.233	1.180	1.002	0.276	
2412	1	802.11b	DSSS	22	15.5	14.78	-	Left	Cheek	1	1C0C3	1	99.8	0.232	-	1.180	1.002	-	
2412	1	802.11b	DSSS	22	15.5	14.78	-	Left	Tilt	1	1C0C3	1	99.8	0.160	-	1.180	1.002	-	
2437	6	802.11b	DSSS	22	15.5	14.82	-	Right	Cheek	2	1C0C3	1	99.8	0.234	-	1.169	1.002	-	
2437	6	802.11b	DSSS	22	15.5	14.82	0.02	Right	Tilt	2	1C0C3	1	99.8	0.283	0.251	1.169	1.002	0.294	
2437	6	802.11b	DSSS	22	15.5	14.82	-	Left	Cheek	2	1C0C3	1	99.8	0.170	-	1.169	1.002	-	
2437	6	802.11b	DSSS	22	15.5	14.82	-	Left	Tilt	2	1C0C3	1	99.8	0.160	-	1.169	1.002	-	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population								Head 1.6 W/kg (mW/g) averaged over 1 gram											

Table 11-8
NII Head SAR

MEASUREMENT RESULTS																			
FREQUENCY		Mode	Service	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Side	Test Position	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Duty Cycle (%)	Peak SAR of Area Scan	SAR (1g)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Scaled SAR (1g)	Plot #
MHz	Ch.													W/kg	(W/kg)			(W/kg)	
5270	54	802.11n	OFDM	40	11.5	11.23	0.01	Right	Cheek	1	1C4E6	13.5	98.0	1.132	0.506	1.064	1.020	0.549	
5270	54	802.11n	OFDM	40	11.5	11.23	0.09	Right	Tilt	1	1C4E6	13.5	98.0	0.536	0.270	1.064	1.020	0.293	
5270	54	802.11n	OFDM	40	11.5	11.23	-	Left	Cheek	1	1C4E6	13.5	98.0	0.531	-	1.064	1.020	-	
5270	54	802.11n	OFDM	40	11.5	11.23	-	Left	Tilt	1	1C4E6	13.5	98.0	0.260	-	1.064	1.020	-	
5270	54	802.11n	OFDM	40	11.5	11.05	0.00	Right	Cheek	2	1C4E6	13.5	98.0	0.049	0.035	1.109	1.020	0.040	
5270	54	802.11n	OFDM	40	11.5	11.05	-	Right	Tilt	2	1C4E6	13.5	98.0	0.020	-	1.109	1.020	-	
5270	54	802.11n	OFDM	40	11.5	11.05	-	Left	Cheek	2	1C4E6	13.5	98.0	0.035	-	1.109	1.020	-	
5270	54	802.11n	OFDM	40	11.5	11.05	-	Left	Tilt	2	1C4E6	13.5	98.0	0.020	-	1.109	1.020	-	
5270	54	802.11n	OFDM	40	14.5	14.15	0.01	Right	Cheek	MIMO	1C4E6	27	95.0	1.050	0.466	1.084	1.053	0.532	
5270	54	802.11n	OFDM	40	14.5	14.15	0.04	Right	Tilt	MIMO	1C4E6	27	95.0	0.506	0.281	1.084	1.053	0.321	
5270	54	802.11n	OFDM	40	14.5	14.15	-	Left	Cheek	MIMO	1C4E6	27	95.0	0.468	-	1.084	1.053	-	
5270	54	802.11n	OFDM	40	14.5	14.15	-	Left	Tilt	MIMO	1C4E6	27	95.0	0.249	-	1.084	1.053	-	
5510	102	802.11n	OFDM	40	11.5	10.98	0.08	Right	Cheek	1	1C4E6	13.5	98.0	0.996	0.570	1.127	1.020	0.655	
5510	102	802.11n	OFDM	40	11.5	10.98	0.19	Right	Tilt	1	1C4E6	13.5	98.0	0.693	0.360	1.127	1.020	0.414	
5510	102	802.11n	OFDM	40	11.5	10.98	-	Left	Cheek	1	1C4E6	13.5	98.0	0.352	-	1.127	1.020	-	
5510	102	802.11n	OFDM	40	11.5	10.98	-	Left	Tilt	1	1C4E6	13.5	98.0	0.252	-	1.127	1.020	-	
5510	102	802.11n	OFDM	40	11.5	10.67	-	Right	Cheek	2	1C4E6	13.5	98.0	0.403	-	1.211	1.020	-	
5510	102	802.11n	OFDM	40	11.5	10.67	-	Right	Tilt	2	1C4E6	13.5	98.0	0.134	-	1.211	1.020	-	
5510	102	802.11n	OFDM	40	11.5	10.67	0.06	Left	Cheek	2	1C4E6	13.5	98.0	0.434	0.167	1.211	1.020	0.206	
5510	102	802.11n	OFDM	40	11.5	10.67	-	Left	Tilt	2	1C4E6	13.5	98.0	0.154	-	1.211	1.020	-	
5510	102	802.11n	OFDM	40	14.5	13.84	0.04	Right	Cheek	MIMO	1C4E6	27	95.0	0.865	0.520	1.164	1.053	0.637	
5510	102	802.11n	OFDM	40	14.5	13.84	0.07	Right	Tilt	MIMO	1C4E6	27	95.0	0.678	0.327	1.164	1.053	0.401	
5510	102	802.11n	OFDM	40	14.5	13.84	-	Left	Cheek	MIMO	1C4E6	27	95.0	0.634	-	1.164	1.053	-	
5510	102	802.11n	OFDM	40	14.5	13.84	-	Left	Tilt	MIMO	1C4E6	27	95.0	0.368	-	1.164	1.053	-	
5710	142	802.11n	OFDM	40	11.5	11.10	-0.13	Right	Cheek	1	1C4E6	13.5	98.0	1.535	0.711	1.096	1.020	0.795	
5755	151	802.11n	OFDM	40	11.5	11.22	0.01	Right	Cheek	1	1C4E6	13.5	98.0	1.531	0.788	1.067	1.020	0.858	
5755	151	802.11n	OFDM	40	11.5	11.22	0.05	Right	Tilt	1	1C4E6	13.5	98.0	1.006	0.474	1.067	1.020	0.516	
5755	151	802.11n	OFDM	40	11.5	11.22	-	Left	Cheek	1	1C4E6	13.5	98.0	0.631	-	1.067	1.020	-	
5755	151	802.11n	OFDM	40	11.5	11.22	-	Left	Tilt	1	1C4E6	13.5	98.0	0.533	-	1.067	1.020	-	
5755	151	802.11n	OFDM	40	11.5	11.38	0.06	Right	Cheek	2	1C4E6	13.5	98.0	2.368	0.716	1.028	1.020	0.751	
5755	151	802.11n	OFDM	40	11.5	11.38	-	Right	Tilt	2	1C4E6	13.5	98.0	0.838	-	1.028	1.020	-	
5755	151	802.11n	OFDM	40	11.5	11.38	0.09	Left	Cheek	2	1C4E6	13.5	98.0	2.560	0.754	1.028	1.020	0.791	
5755	151	802.11n	OFDM	40	11.5	11.38	-	Left	Tilt	2	1C4E6	13.5	98.0	0.830	-	1.028	1.020	-	
5710	142	802.11n	OFDM	40	14.5	14.20	0.02	Right	Cheek	MIMO	1C4E6	27	95.0	2.116	0.695	1.072	1.053	0.784	
5755	151	802.11n	OFDM	40	14.5	14.31	0.09	Right	Cheek	MIMO	1C4E6	27	95.0	1.449	0.896	1.045	1.053	0.986	A8
5755	151	802.11n	OFDM	40	14.5	14.31	0.08	Right	Tilt	MIMO	1C4E6	27	95.0	0.913	0.453	1.045	1.053	0.498	
5755	151	802.11n	OFDM	40	14.5	14.31	-	Left	Cheek	MIMO	1C4E6	27	95.0	0.684	-	1.045	1.053	-	
5755	151	802.11n	OFDM	40	14.5	14.31	-	Left	Tilt	MIMO	1C4E6	27	95.0	0.773	-	1.045	1.053	-	
5755	151	802.11n	OFDM	40	14.5	14.31	0.04	Right	Cheek	MIMO	1C4E6	27	95.0	1.942	0.827	1.045	1.053	0.910	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population								Head 1.6 W/kg (mW/g) averaged over 1 gram											

Note: Variability measurement is highlighted in Blue.

© 2015 PCTEST Engineering Laboratory, Inc.

11.2 Standalone Body-Worn SAR Data

Table 11-9
GSM/UMTS Body-Worn SAR Data

MEASUREMENT RESULTS															
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Device Serial Number	# of Time Slots	Duty Cycle	Side	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
836.60	190	GSM 850	GSM	33.0	32.05	-0.14	10 mm	1C0C4	1	1:8.3	back	0.279	1.245	0.347	A9
836.60	4183	UMTS 850	RMC	23.5	23.16	-0.02	10 mm	1C0C4	N/A	1:1	back	0.281	1.081	0.304	A11
1880.00	661	GSM 1900	GSM	30.0	28.61	-0.01	10 mm	1C0C4	1	1:8.3	back	0.520	1.377	**0.716**	A13
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 11-10
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)	Plot #
MHz	Ch.															(W/kg)		(W/kg)	
710.00	23790	Mid	LTE Band 17	10	24.0	23.30	-0.02	0	1C0A8	QPSK	1	0	10 mm	back	1:1	0.181	1.175	0.213	A15
710.00	23790	Mid	LTE Band 17	10	23.0	22.25	-0.02	1	1C0A8	QPSK	25	12	10 mm	back	1:1	0.160	1.189	0.190	
782.00	23230	Mid	LTE Band 13	10	24.0	23.70	0.05	0	1C0A8	QPSK	1	0	10 mm	back	1:1	0.438	1.072	0.470	A16
782.00	23230	Mid	LTE Band 13	10	23.0	22.68	-0.04	1	1C0A8	QPSK	25	0	10 mm	back	1:1	0.350	1.076	0.377	
2506.00	39750	Low	LTE Band 41	20	23.5	23.27	-0.09	0	1C0A8	QPSK	1	0	10 mm	back	1:1.58	0.158	1.054	0.167	A17
2506.00	39750	Low	LTE Band 41	20	22.5	22.21	-0.06	1	1C0A8	QPSK	50	25	10 mm	back	1:1.58	0.111	1.069	0.119	
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 11-11
DTS Body-Worn SAR

MEASUREMENT RESULTS																			
FREQUENCY		Mode	Service	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle (%)	Peak SAR of Area Scan	SAR (1g)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Scaled SAR (1g)	Plot #
MHz	Ch.													W/kg	(W/kg)			(W/kg)	
2412	1	802.11b	DSSS	22	15.5	14.78	0.04	10 mm	1	1C0A8	1	back	99.8	0.081	0.065	1.180	1.002	**0.077**	A19
2437	6	802.11b	DSSS	22	15.5	14.82	0.02	10 mm	2	1C0A8	1	back	99.8	0.066	0.054	1.169	1.002	0.063	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population								Body 1.6 W/kg (mW/g) averaged over 1 gram											

Table 11-12
NII Body-Worn SAR

MEASUREMENT RESULTS																			
FREQUENCY		Mode	Service	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle (%)	Peak SAR of Area Scan	SAR (1g)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Scaled SAR (1g)	Plot #
MHz	Ch.													W/kg	(W/kg)			(W/kg)	
5270	54	802.11n	OFDM	40	11.5	11.23	-0.08	10 mm	1	1C0A8	13.5	back	98.0	0.081	0.036	1.064	1.020	0.039	
5270	54	802.11n	OFDM	40	11.5	11.05	0.03	10 mm	2	1C0A8	13.5	back	98.0	0.108	0.045	1.109	1.020	0.051	
5510	102	802.11n	OFDM	40	11.5	10.98	-0.06	10 mm	1	1C0A8	13.5	back	98.0	0.083	0.032	1.127	1.020	0.037	
5510	102	802.11n	OFDM	40	11.5	10.67	0.18	10 mm	2	1C0A8	13.5	back	98.0	0.294	0.112	1.211	1.020	0.139	
5755	151	802.11n	OFDM	40	11.5	11.22	0.09	10 mm	1	1C0A8	13.5	back	98.0	0.122	0.057	1.067	1.020	0.062	
5755	151	802.11n	OFDM	40	11.5	11.38	0.20	10 mm	2	1C0A8	13.5	back	98.0	0.610	0.253	1.028	1.020	**0.265**	A21
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population								Body 1.6 W/kg (mW/g) averaged over 1 gram											

© 2015 PCTEST Engineering Laboratory, Inc.

11.3 Standalone Wireless Router SAR Data

Table 11-13
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	28.0	27.70	-0.03	10 mm	1C0C4	4	1:2.076	back	0.384	1.072	0.412	
836.60	190	GSM 850	GPRS	28.0	27.70	-0.02	10 mm	1C0C4	4	1:2.076	front	0.382	1.072	0.410	
836.60	190	GSM 850	GPRS	28.0	27.70	0.04	10 mm	1C0C4	4	1:2.076	bottom	0.173	1.072	0.185	
836.60	190	GSM 850	GPRS	28.0	27.70	-0.03	10 mm	1C0C4	4	1:2.076	right	0.516	1.072	0.553	A10
836.60	190	GSM 850	GPRS	28.0	27.70	-0.19	10 mm	1C0C4	4	1:2.076	left	0.411	1.072	0.441	
836.60	4183	UMTS 850	RMC	23.5	23.16	-0.02	10 mm	1C0C4	N/A	1:1	back	0.281	1.081	0.304	
836.60	4183	UMTS 850	RMC	23.5	23.16	0.00	10 mm	1C0C4	N/A	1:1	front	0.268	1.081	0.290	
836.60	4183	UMTS 850	RMC	23.5	23.16	-0.03	10 mm	1C0C4	N/A	1:1	bottom	0.110	1.081	0.119	
836.60	4183	UMTS 850	RMC	23.5	23.16	-0.02	10 mm	1C0C4	N/A	1:1	right	0.412	1.081	0.445	A12
836.60	4183	UMTS 850	RMC	23.5	23.16	-0.01	10 mm	1C0C4	N/A	1:1	left	0.281	1.081	0.304	
1850.20	512	GSM 1900	GPRS	26.5	25.32	-0.10	10 mm	1C0C4	3	1:2.76	back	0.674	1.312	0.884	
1880.00	661	GSM 1900	GPRS	26.5	25.08	-0.04	10 mm	1C0C4	3	1:2.76	back	0.693	1.387	0.961	
1909.80	810	GSM 1900	GPRS	26.5	25.42	0.02	10 mm	1C0C4	3	1:2.76	back	0.850	1.282	**1.090**	A14
1850.20	512	GSM 1900	GPRS	26.5	25.32	-0.01	10 mm	1C0C4	3	1:2.76	front	0.619	1.312	0.812	
1880.00	661	GSM 1900	GPRS	26.5	25.08	-0.07	10 mm	1C0C4	3	1:2.76	front	0.687	1.387	0.953	
1909.80	810	GSM 1900	GPRS	26.5	25.42	-0.05	10 mm	1C0C4	3	1:2.76	front	0.823	1.282	1.055	
1850.20	512	GSM 1900	GPRS	26.5	25.32	0.10	10 mm	1C0C4	3	1:2.76	bottom	0.699	1.312	0.917	
1880.00	661	GSM 1900	GPRS	26.5	25.08	0.00	10 mm	1C0C4	3	1:2.76	bottom	0.736	1.387	1.021	
1909.80	810	GSM 1900	GPRS	26.5	25.42	0.03	10 mm	1C0C4	3	1:2.76	bottom	0.846	1.282	1.085	
1880.00	661	GSM 1900	GPRS	26.5	25.08	0.04	10 mm	1C0C4	3	1:2.76	right	0.048	1.387	0.067	
1880.00	661	GSM 1900	GPRS	26.5	25.08	0.06	10 mm	1C0C4	3	1:2.76	left	0.195	1.387	0.270	
1909.80	810	GSM 1900	GPRS	26.5	25.42	-0.12	10 mm	1C0C4	3	1:2.76	back	0.790	1.282	1.013	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Body 1.6 W/kg (mW/g) averaged over 1 gram								

Note: Variability measurement is highlighted in Blue.

Table 11-14
LTE Band 17 Hotspot SAR

MEASUREMENT RESULTS																			
FREQUENCY			Mode	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Device Serial Number	Modulation	RB Size	RB Offset	Spacing	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.															(W/kg)		(W/kg)	
710.00	23790	Mid	LTE Band 17	10	24.0	23.30	-0.02	0	1C0A8	QPSK	1	0	10 mm	back	1:1	0.181	1.175	0.213	A15
710.00	23790	Mid	LTE Band 17	10	23.0	22.25	-0.02	1	1C0A8	QPSK	25	12	10 mm	back	1:1	0.160	1.189	0.190	
710.00	23790	Mid	LTE Band 17	10	24.0	23.30	0.07	0	1C0A8	QPSK	1	0	10 mm	front	1:1	0.173	1.175	0.203	
710.00	23790	Mid	LTE Band 17	10	23.0	22.25	0.02	1	1C0A8	QPSK	25	12	10 mm	front	1:1	0.151	1.189	0.180	
710.00	23790	Mid	LTE Band 17	10	24.0	23.30	-0.09	0	1C0A8	QPSK	1	0	10 mm	bottom	1:1	0.030	1.175	0.035	
710.00	23790	Mid	LTE Band 17	10	23.0	22.25	0.07	1	1C0A8	QPSK	25	12	10 mm	bottom	1:1	0.026	1.189	0.031	
710.00	23790	Mid	LTE Band 17	10	24.0	23.30	0.07	0	1C0A8	QPSK	1	0	10 mm	right	1:1	0.076	1.175	0.089	
710.00	23790	Mid	LTE Band 17	10	23.0	22.25	0.17	1	1C0A8	QPSK	25	12	10 mm	right	1:1	0.065	1.189	0.077	
710.00	23790	Mid	LTE Band 17	10	24.0	23.30	-0.14	0	1C0A8	QPSK	1	0	10 mm	left	1:1	0.097	1.175	0.114	
710.00	23790	Mid	LTE Band 17	10	23.0	22.25	0.00	1	1C0A8	QPSK	25	12	10 mm	left	1:1	0.080	1.189	0.095	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population								Body 1.6 W/kg (mW/g) averaged over 1 gram											

© 2015 PCTEST Engineering Laboratory, Inc.

Table 11-15
LTE Band 13 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)	
782.00	23230	Mid	LTE Band 13	10	24.0	23.70	0.05	0	1C0A8	QPSK	1	0	10 mm	back	1:1	0.438	1.072	0.470	A16
782.00	23230	Mid	LTE Band 13	10	23.0	22.68	-0.04	1	1C0A8	QPSK	25	0	10 mm	back	1:1	0.350	1.076	0.377	
782.00	23230	Mid	LTE Band 13	10	24.0	23.70	0.01	0	1C0A8	QPSK	1	0	10 mm	front	1:1	0.377	1.072	0.404	
782.00	23230	Mid	LTE Band 13	10	23.0	22.68	-0.01	1	1C0A8	QPSK	25	0	10 mm	front	1:1	0.303	1.076	0.326	
782.00	23230	Mid	LTE Band 13	10	24.0	23.70	0.06	0	1C0A8	QPSK	1	0	10 mm	bottom	1:1	0.070	1.072	0.075	
782.00	23230	Mid	LTE Band 13	10	23.0	22.68	-0.01	1	1C0A8	QPSK	25	0	10 mm	bottom	1:1	0.054	1.076	0.058	
782.00	23230	Mid	LTE Band 13	10	24.0	23.70	-0.02	0	1C0A8	QPSK	1	0	10 mm	right	1:1	0.301	1.072	0.323	
782.00	23230	Mid	LTE Band 13	10	23.0	22.68	0.04	1	1C0A8	QPSK	25	0	10 mm	right	1:1	0.256	1.076	0.275	
782.00	23230	Mid	LTE Band 13	10	24.0	23.70	-0.05	0	1C0A8	QPSK	1	0	10 mm	left	1:1	0.375	1.072	0.402	
782.00	23230	Mid	LTE Band 13	10	23.0	22.68	0.04	1	1C0A8	QPSK	25	0	10 mm	left	1:1	0.300	1.076	0.323	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population								Body 1.6 W/kg (mW/g) averaged over 1 gram											

Table 11-16
LTE Band 41 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)	
2506.00	39750	Low	LTE Band 41	20	23.5	23.27	-0.09	0	1C0A8	QPSK	1	0	10 mm	back	1:1.58	0.158	1.054	0.167	
2506.00	39750	Low	LTE Band 41	20	22.5	22.21	-0.06	1	1C0A8	QPSK	50	25	10 mm	back	1:1.58	0.111	1.069	0.119	
2506.00	39750	Low	LTE Band 41	20	23.5	23.27	-0.17	0	1C0A8	QPSK	1	0	10 mm	front	1:1.58	0.123	1.054	0.130	
2506.00	39750	Low	LTE Band 41	20	22.5	22.21	-0.16	1	1C0A8	QPSK	50	25	10 mm	front	1:1.58	0.088	1.069	0.094	
2506.00	39750	Low	LTE Band 41	20	23.5	23.27	-0.06	0	1C0A8	QPSK	1	0	10 mm	bottom	1:1.58	0.252	1.054	0.266	A18
2506.00	39750	Low	LTE Band 41	20	22.5	22.21	0.04	1	1C0A8	QPSK	50	25	10 mm	bottom	1:1.58	0.187	1.069	0.200	
2506.00	39750	Low	LTE Band 41	20	23.5	23.27	0.07	0	1C0A8	QPSK	1	0	10 mm	right	1:1.58	0.052	1.054	0.055	
2506.00	39750	Low	LTE Band 41	20	22.5	22.21	0.06	1	1C0A8	QPSK	50	25	10 mm	right	1:1.58	0.040	1.069	0.043	
2506.00	39750	Low	LTE Band 41	20	23.5	23.27	0.11	0	1C0A8	QPSK	1	0	10 mm	left	1:1.58	0.012	1.054	0.013	
2506.00	39750	Low	LTE Band 41	20	22.5	22.21	0.04	1	1C0A8	QPSK	50	25	10 mm	left	1:1.58	0.009	1.069	0.010	
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
WLAN Hotspot SAR

MEASUREMENT RESULTS																			
FREQUENCY		Mode	Service	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle (%)	Peak SAR of Area Scan	SAR (1g)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Scaled SAR (1g)	Plot #
MHz	Ch.													W/kg	(W/kg)			(W/kg)	
2412	1	802.11b	DSSS	22	15.5	14.78	0.04	10 mm	1	1C0A8	1	back	99.8	0.081	0.065	1.180	1.002	0.077	
2412	1	802.11b	DSSS	22	15.5	14.78	-	10 mm	1	1C0A8	1	front	99.8	0.068	-	1.180	1.002	-	
2412	1	802.11b	DSSS	22	15.5	14.78	-	10 mm	1	1C0A8	1	top	99.8	0.055	-	1.180	1.002	-	
2412	1	802.11b	DSSS	22	15.5	14.78	-	10 mm	1	1C0A8	1	left	99.8	0.047	-	1.180	1.002	-	
2437	6	802.11b	DSSS	22	15.5	14.82	-	10 mm	2	1C0A8	1	back	99.8	0.066	-	1.169	1.002	-	
2437	6	802.11b	DSSS	22	15.5	14.82	-	10 mm	2	1C0A8	1	front	99.8	0.053	-	1.169	1.002	-	
2437	6	802.11b	DSSS	22	15.5	14.82	-0.11	10 mm	2	1C0A8	1	top	99.8	0.089	0.070	1.169	1.002	**0.082**	A20
2437	6	802.11b	DSSS	22	15.5	14.82	-	10 mm	2	1C0A8	1	left	99.8	0.006	-	1.169	1.002	-	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population								Body 1.6 W/kg (mW/g) averaged over 1 gram											

© 2015 PCTEST Engineering Laboratory, Inc.

11.4 SAR Test Notes

General Notes:

1. The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2003, 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 performed when the measured SAR results for a frequency band were greater than 0.8 W/kg. Repeated SAR measurements are highlighted in the tables above for clarity. Please see Section 13 for variability analysis.
9. During SAR Testing for the Wireless Router conditions per FCC KDB Publication 941225 D06v02, the actual Portable Hotspot operation (with actual simultaneous transmission of a transmitter with WIFI) was not activated (See Section 6.6 for more details).

GSM Test Notes:

1. Body-Worn accessory testing is typically associated with voice operations. Therefore, GSM voice was evaluated for body-worn SAR.
2. Justification for reduced test configurations per KDB Publication 941225 D01v01 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 > ½ 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 D01v03. HSPA and AMR SAR were 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 > ½ dB, instead of the middle channel, the highest output power channel was used.

© 2015 PCTEST Engineering Laboratory, Inc.

LTE Notes:

1. LTE Considerations: LTE test configurations are determined according to SAR Evaluation Considerations for LTE Devices in FCC KDB Publication 941225 D05v02r03. The general test procedures used for testing can be found in Section 8.5.4.
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).
4. Per FCC KDB Publication 447498 D01v05r01, when the reported (scaled) for LTE Band 41 SAR measured at the highest output power channel in a given a test configuration was < 0.6 W/kg, testing at the other channels was not required for such test configurations.
5. TDD LTE was tested per FCC KDB 941225 D05v02r03 and using the guidance provided in April 2013 TCB workshop notes. Testing was performed using UL-DL configuration 0 with 6 UL subframes and 2 S subframes using extended cyclic prefix only and special subframe configuration 6. SAR tests were performed at maximum output power and worst-case transmission duty factor in extended cyclic prefix. Per 3GPP 36.211 Section 4, the duty factor for special subframe configuration 6 using extended cyclic prefix is 0.633.

WLAN Notes:

1. For held-to-ear and hotspot operations, the initial test position procedures were applied. The test position with the highest extrapolated peak SAR will be used as the initial test position. When reported SAR for the initial test position is ≤ 0.4 W/kg, no additional testing for the remaining test positions was required. Otherwise, SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR result is ≤ 0.8 W/kg or all test positions are measured.
2. Justification for test configurations for WLAN per KDB Publication 248227 D01DR02-41929 for 2.4 GHz WIFI single transmission chain operations, the highest measured maximum output power channel for DSSS was selected for SAR measurement. SAR for OFDM modes (2.4 GHz 802.11g/n) was not required due to the maximum allowed powers and the highest reported DSSS SAR. See Section 8.6.5 for more information.
3. Justification for test configurations for WLAN per KDB Publication 248227 D01DR02-41929 for 5 GHz WIFI single transmission chain operations, the initial test configuration was selected according to the transmission mode with the highest maximum allowed powers. Other transmission modes were not investigated since the highest reported SAR for initial test configuration adjusted by the ratio of maximum output powers is less than 1.2 W/kg. See Section 8.6.6 for more information.
4. Per KDB Publication 248227 D01DR02-41929, MIMO SAR was measured with both antennas transmitting simultaneously at the specified maximum output power in MIMO mode following the initial test configuration procedures for 5 GHz head SAR. Per KDB Publication 248227 D01DR02- 41929,SAR for MIMO for all other bands and exposure conditions was evaluated by following the simultaneous SAR provisions from KDB Publication 447498. Please see Section 12 for complete analysis.
5. When the maximum reported 1g averaged SAR is ≤0.8 W/kg, SAR testing on additional channels was not required. Otherwise, SAR for the next highest output power channel was required until the reported SAR result was ≤ 1.20 W/kg or all test channels were measured.
6. Wireless Router operations are not allowed by the chipset firmware using 5 GHz WIFI. Therefore, 5 GHz WIFI was not tested for Hotspot SAR.
7. The device was configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools. The reported SAR was scaled to the 100% transmission duty factor to determine compliance. Procedures used to measure the duty factor are identical to that in the associated EMC test reports.

© 2015 PCTEST Engineering Laboratory, Inc.

12 FCC MULTI-TX AND ANTENNA SAR CONSIDERATIONS

12.1 Introduction

The following procedures adopted from FCC KDB Publication 447498 D01v05r02 are applicable to devices with built-in unlicensed transmitters such as 802.11 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 a physical test configuration is ≤1.6 W/kg. The different test positions in an exposure condition may be considered collectively to determine SAR test exclusion according to the sum of 1-g or 10-g SAR.

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.

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

Table 12-1
Estimated SAR

Mode	Frequency	Maximum Allowed Power	Separation Distance (Body)	Estimated SAR (Body)
	[MHz]	[dBm]	[mm]	[W/kg]
Bluetooth	2480	11.50	10	0.294

Note:
1. 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.
2. Head SAR for 5 GHz MIMO was measured with both antennas transmitting simultaneously at the specified maximum output power in MIMO mode following the initial test configuration procedures.
3. MIMO SAR for 2.4 GHz Head and for 2.4/5GHz Body-worn and Hotspot exposure conditions were determined by the sum of 1g single transmission chain SAR values because the summation represents higher output power and yields more conservative result per KDB 248227 D01 DR02-41929.
4. The highest reported SAR for each exposure condition is used for SAR summation purpose.

© 2015 PCTEST Engineering Laboratory, Inc.

12.3 Head SAR Simultaneous Transmission Analysis

Table 12-2
Simultaneous Transmission Scenario with 2.4 GHz WLAN (Held to Ear)

Exposure Condition	Mode	2G/3G/4G SAR (W/kg)	2.4 GHz WLAN Ant 1 SAR (W/kg)	2.4 GHz WLAN Ant 2 SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2	1+3	1+2+3
Head SAR	GSM 850	0.184	0.487	0.294	0.671	0.478	0.965
	UMTS 850	0.221	0.487	0.294	0.708	0.515	1.002
	GSM 1900	0.161	0.487	0.294	0.648	0.455	0.942
	LTE Band 17	0.093	0.487	0.294	0.580	0.387	0.874
	LTE Band 13	0.248	0.487	0.294	0.735	0.542	1.029
	LTE Band 41	0.036	0.487	0.294	0.523	0.330	0.817

Table 12-3
Simultaneous Transmission Scenario with 5 GHz WLAN Ant 1 (Held to Ear)

Exposure Condition	Mode	2G/3G SAR (W/kg)	5 GHz WLAN Ant 1 SAR (W/kg)	Σ SAR (W/kg)
		1	2	1+2
Head SAR	GSM 850	0.184	0.858	1.042
	UMTS 850	0.221	0.858	1.079
	GSM 1900	0.161	0.858	1.019

Table 12-4
Simultaneous Transmission Scenario with 5 GHz WLAN Ant 2 (Held to Ear)

Exposure Condition	Mode	2G/3G SAR (W/kg)	5 GHz WLAN Ant 2 SAR (W/kg)	Σ SAR (W/kg)
		1	2	1+2
Head SAR	GSM 850	0.184	0.791	0.975
	UMTS 850	0.221	0.791	1.012
	GSM 1900	0.161	0.791	0.952

Table 12-5
Simultaneous Transmission Scenario with 5 GHz WLAN MIMO (Held to Ear)

Exposure Condition	Mode	2G/3G SAR (W/kg)	5 GHz WLAN MIMO SAR (W/kg)	Σ SAR (W/kg)
		1	2	1+2
Head SAR	GSM 850	0.184	0.986	1.170
	UMTS 850	0.221	0.986	1.207
	GSM 1900	0.161	0.986	1.147

© 2015 PCTEST Engineering Laboratory, Inc.

12.4 Body-Worn Simultaneous Transmission Analysis

Table 12-6
Simultaneous Transmission Scenario with 2.4 GHz WLAN (Body-Worn at 1.0 cm)

Exposure Condition	Mode	2G/3G/4G SAR (W/kg)	2.4 GHz WLAN Ant 1 SAR (W/kg)	2.4 GHz WLAN Ant 2 SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2	1+3	1+2+3
Body-Worn	GSM 850	0.347	0.077	0.063	0.424	0.410	0.487
	UMTS 850	0.304	0.077	0.063	0.381	0.367	0.444
	GSM 1900	0.716	0.077	0.063	0.793	0.779	0.856
	LTE Band 17	0.213	0.077	0.063	0.290	0.276	0.353
	LTE Band 13	0.470	0.077	0.063	0.547	0.533	0.610
	LTE Band 41	0.167	0.077	0.063	0.244	0.230	0.307

Table 12-7
Simultaneous Transmission Scenario with 5 GHz WLAN (Body-Worn at 1.0 cm)

Exposure Condition	Mode	2G/3G SAR (W/kg)	5 GHz WLAN Ant 1 SAR (W/kg)	5 GHz WLAN Ant 2 SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2	1+3	1+2+3
Body-Worn	GSM 850	0.347	0.062	0.265	0.409	0.612	0.674
	UMTS 850	0.304	0.062	0.265	0.366	0.569	0.631
	GSM 1900	0.716	0.062	0.265	0.778	0.981	1.043

Table 12-8
Simultaneous Transmission Scenario with Bluetooth (Body-Worn at 1.0 cm)

Exposure Condition	Mode	2G/3G/4G SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)
		1	2	1+2
Body-Worn	GSM 850	0.347	0.294	0.641
	UMTS 850	0.304	0.294	0.598
	GSM 1900	0.716	0.294	1.010
	LTE Band 17	0.213	0.294	0.507
	LTE Band 13	0.470	0.294	0.764
	LTE Band 41	0.167	0.294	0.461

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.

© 2015 PCTEST Engineering Laboratory, Inc.

12.5 Hotspot SAR Simultaneous Transmission Analysis

Table 12-9
Simultaneous Transmission Scenario with 2.4 GHz (Hotspot at 1.0 cm)

Exposure Condition	Mode	2G/3G/4G SAR (W/kg)	2.4 GHz WLAN Ant 1 SAR (W/kg)	2.4 GHz WLAN Ant 2 SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2	1+3	1+2+3
Hotspot SAR	GPRS 850	0.553	0.077	0.082	0.630	0.635	0.712
	UMTS 850	0.445	0.077	0.082	0.522	0.527	0.604
	GPRS 1900	1.090	0.077	0.082	1.167	1.172	**1.249**
	LTE Band 17	0.213	0.077	0.082	0.290	0.295	0.372
	LTE Band 13	0.470	0.077	0.082	0.547	0.552	0.629
	LTE Band 41	0.266	0.077	0.082	0.343	0.348	0.425

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.

© 2015 PCTEST Engineering Laboratory, Inc.

13 SAR MEASUREMENT VARIABILITY

13.1 Measurement Variability

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

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

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

Table 13-1
Head SAR Measurement Variability Results

HEAD VARIABILITY RESULTS															
Band	FREQUENCY		Mode/Band	Service, Antenna	Side	Test Position	Data Rate (Mbps)	Measured SAR (1g)	1st Repeated SAR (1g)	Ratio	2nd Repeated SAR (1g)	Ratio	3rd Repeated SAR (1g)	Ratio
	MHz	Ch.						(W/kg)	(W/kg)		(W/kg)		(W/kg)	
5750	5755.00	151	802.11n 40 MHz Bandwidth	OFDM, MIMO	Right	Cheek	27	0.896	0.827	1.08	N/A	N/A	N/A	N/A
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 13-2
Body SAR Measurement Variability Results

BODY VARIABILITY RESULTS														
Band	FREQUENCY		Mode	Service	# of GPRS Slots	Side	Spacing	Measured SAR (1g)	1st Repeated SAR (1g)	Ratio	2nd Repeated SAR (1g)	Ratio	3rd Repeated SAR (1g)	Ratio
	MHz	Ch.						(W/kg)	(W/kg)		(W/kg)		(W/kg)	
1900	1909.80	810	GSM 1900	GPRS	3	back	10 mm	0.850	0.790	1.08	N/A	N/A	N/A	N/A
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Body 1.6 W/kg (mW/g) averaged over 1 gram							

13.2 Measurement Uncertainty

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

© 2015 PCTEST Engineering Laboratory, Inc.

14 EQUIPMENT LIST

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Gigatronics	80701A	(0.05-18GHz) Power Sensor	10/30/2014	Annual	10/30/2015	1833460
Agilent	E8257D	(250kHz-20GHz) Signal Generator	4/15/2014	Annual	4/15/2015	MY45470194
Agilent	8753E	(30kHz-6GHz) Network Analyzer	12/30/2014	Annual	12/30/2015	JP38020182
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
SPEAG	D1900V2	1900 MHz SAR Dipole	7/23/2014	Annual	7/23/2015	5d149
SPEAG	D2450V2	2450 MHz SAR Dipole	8/11/2014	Annual	8/11/2015	719
Narda	4014C-6	4 - 8 GHz SMA 6 dB Directional Coupler	CBT	N/A	CBT	N/A
SPEAG	D5GHzV2	5 GHz SAR Dipole	1/21/2015	Annual	1/21/2016	1057
MCL	BW-N6W5+	6dB Attenuator	CBT	N/A	CBT	1139
SPEAG	D750V3	750 MHz Dipole	3/17/2014	Annual	3/17/2015	1054
SPEAG	D835V2	835 MHz SAR Dipole	7/24/2014	Annual	7/24/2015	4d133
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	433971
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	433972
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Narda	BW-S3W2	Attenuator (3dB)	CBT	N/A	CBT	120
Rohde & Schwarz	CMU200	Base Station Simulator	4/24/2014	Annual	4/24/2015	836371/0079
Rohde & Schwarz	CMU200	Base Station Simulator	6/6/2014	Annual	6/6/2015	109892
Rohde & Schwarz	CMU200	Base Station Simulator	12/4/2014	Annual	12/4/2015	833855/0010
Pasternack	PE2208-6	Bidirectional Coupler	CBT	N/A	CBT	N/A
Pasternack	PE2209-10	Bidirectional Coupler	CBT	N/A	CBT	N/A
SPEAG	DAE4	Dasy Data Acquisition Electronics	4/11/2014	Annual	4/11/2015	1368
SPEAG	DAE4	Dasy Data Acquisition Electronics	5/14/2014	Annual	5/14/2015	859
SPEAG	DAE4	Dasy Data Acquisition Electronics	9/17/2014	Annual	9/17/2015	1323
SPEAG	DAE4	Dasy Data Acquisition Electronics	9/18/2014	Annual	9/18/2015	1364
SPEAG	DAE4	Dasy Data Acquisition Electronics	1/19/2015	Annual	1/19/2016	1407
Mini-Circuits	BW-N20W5+	DC to 18 GHz Precision Fixed 20 dB Attenuator	CBT	N/A	CBT	N/A
SPEAG	DAK-3.5	Dielectric Assessment Kit	5/6/2014	Annual	5/6/2015	1070
Mitutoyo	CD-6"CSX	Digital Caliper	5/8/2014	Biennial	5/8/2016	13264162
Fisher Scientific	15-077-960	Digital Thermometer	12/4/2013	Biennial	12/4/2015	130764551
Agilent	E4438C	ESG Vector Signal Generator	3/31/2014	Annual	3/31/2015	MY42082659
Control Company	4052	Long Stem Thermometer	9/27/2013	Biennial	9/27/2015	130567447
Fisher Scientific	S407993	Long Stem Thermometer	11/4/2013	Biennial	11/4/2015	130671826
MiniCircuits	VLF-6000+	Low Pass Filter	CBT	N/A	CBT	N/A
MiniCircuits	SLP-2400+	Low Pass Filter	CBT	N/A	CBT	R8979500903
Mini-Circuits	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
Agilent	N9020A	MXA Signal Analyzer	10/27/2014	Annual	10/27/2015	US46470561
Agilent	N5182A	MXG Vector Signal Generator	4/15/2014	Annual	4/15/2015	MY47420800
Agilent	N5182A	MXG Vector Signal Generator	4/15/2014	Annual	4/15/2015	MY47420651
Mini-Circuits	BW-N20W5	Power Attenuator	CBT	N/A	CBT	1226
Anritsu	ML2495A	Power Meter	10/31/2013	Biennial	10/31/2015	1039008
Anritsu	MA2411B	Pulse Power Sensor	3/25/2014	Annual	3/25/2015	1207470
Anritsu	MA2411B	Pulse Power Sensor	11/13/2014	Annual	11/13/2015	1339018
Anritsu	MT8820C	Radio Communication Analyzer	5/6/2014	Annual	5/6/2015	6201144419
Anritsu	MT8820C	Radio Communication Analyzer	8/28/2014	Annual	8/28/2015	6201240328
Rohde & Schwarz	CMW500	Radio Communication Tester	4/17/2014	Annual	4/17/2015	101699
Rohde & Schwarz	CMW500	Radio Communication Tester	4/17/2014	Annual	4/17/2015	102060
Tektronix	RSA6114A	Real Time Spectrum Analyzer	4/16/2014	Annual	4/16/2015	B010177
SPEAG	ES3DV3	SAR Probe	5/15/2014	Annual	5/15/2015	3263
SPEAG	EX3DV4	SAR Probe	7/16/2014	Annual	7/16/2015	7308
SPEAG	ES3DV3	SAR Probe	9/24/2014	Annual	9/24/2015	3288
SPEAG	EX3DV4	SAR Probe	12/12/2014	Annual	12/12/2015	3920
SPEAG	ES3DV3	SAR Probe	1/20/2015	Annual	1/20/2016	3213
COMTECH	AR85729-5/5759B	Solid State Amplifier	CBT	N/A	CBT	M3W1A00-1002
COMTech	AR85729-5	Solid State Amplifier	CBT	N/A	CBT	M1S5A00-009
Agilent	8753ES	S-Parameter Network Analyzer	5/22/2014	Annual	5/22/2015	US39170118
Fisher Scientific	S97611	Thermometer	4/12/2013	Biennial	4/12/2015	130219303
Seekonk	NC-100	Torque Wrench	3/18/2014	Biennial	3/18/2016	N/A
Seekonk	NC-100	Torque Wrench 5/16", 8" lbs	3/18/2014	Biennial	3/18/2016	N/A
Gigatronics	8651A	Universal Power Meter	10/30/2014	Annual	10/30/2015	8650319
Anritsu	MA24106A	USB Power Sensor	5/14/2014	Annual	5/14/2015	1231538
Anritsu	MA24106A	USB Power Sensor	5/14/2014	Annual	5/14/2015	1231535
VWR	36934-158	Wall-Mounted Thermometer	8/8/2013	Biennial	8/8/2015	130477877
Control Company	36934-158	Wall-Mounted Thermometer	4/29/2014	Biennial	4/29/2016	122014488
Agilent	E5515C	Wireless Communications Test Set	11/4/2014	Biennial	11/4/2016	GB43193563
Agilent	E5515C	Wireless Communications Test Set	11/20/2014	Biennial	11/20/2016	GB43163447

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.

© 2015 PCTEST Engineering Laboratory, Inc.

15 MEASUREMENT UNCERTAINTIES

Applicable for frequencies less than 3000 MHz:

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

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

© 2015 PCTEST Engineering Laboratory, Inc.

Applicable for frequencies up to 6 GHz:

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

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

© 2015 PCTEST Engineering Laboratory, Inc.

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]

© 2015 PCTEST Engineering Laboratory, Inc.

17 REFERENCES

[1] Federal Communications Commission, ET Docket 93-62, Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation, Aug. 1996.

[2] ANSI/IEEE C95.1-2005, American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 3kHz to 300GHz, New York: IEEE, 2006.

[3] ANSI/IEEE C95.1-1992, American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 3kHz to 300GHz, New York: IEEE, Sept. 1992.

[4] ANSI/IEEE C95.3-2002, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave, New York: IEEE, December 2002.

[5] IEEE Standards Coordinating Committee 39 –Standards Coordinating Committee 34 – IEEE Std. 1528-2003, Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head Due to Wireless Communications Devices: Measurement Techniques.

[6] NCRP, National Council on Radiation Protection and Measurements, Biological Effects and Exposure Criteria for RadioFrequency Electromagnetic Fields, NCRP Report No. 86, 1986. Reprinted Feb. 1995.

[7] T. Schmid, O. Egger, N. Kuster, Automated E-field scanning system for dosimetric assessments, IEEE Transaction on Microwave Theory and Techniques, vol. 44, Jan. 1996, pp. 105-113.

[8] K. Pokovic, T. Schmid, N. Kuster, Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies, ICECOM97, Oct. 1997, pp. 1-124.

[9] K. Pokovic, T. Schmid, and N. Kuster, E-field Probe with improved isotropy in brain simulating liquids, Proceedings of the ELMAR, Zadar, Croatia, June 23-25, 1996, pp. 172-175.

[10] Schmid & Partner Engineering AG, Application Note: Data Storage and Evaluation, June 1998, p2.

[11] V. Hombach, K. Meier, M. Burkhardt, E. Kuhn, N. Kuster, The Dependence of EM Energy Absorption upon Human Modeling at 900 MHz, IEEE Transaction on Microwave Theory and Techniques, vol. 44 no. 10, Oct. 1996, pp. 1865-1873.

[12] N. Kuster and Q. Balzano, Energy absorption mechanism by biological bodies in the near field of dipole antennas above 300MHz, IEEE Transaction on Vehicular Technology, vol. 41, no. 1, Feb. 1992, pp. 17-23.

[13] G. Hartsgrove, A. Kraszewski, A. Surowiec, Simulated Biological Materials for Electromagnetic Radiation Absorption Studies, University of Ottawa, Bioelectromagnetics, Canada: 1987, pp. 29-36.

[14] Q. Balzano, O. Garay, T. Manning Jr., Electromagnetic Energy Exposure of Simulated Users of Portable Cellular Telephones, IEEE Transactions on Vehicular Technology, vol. 44, no.3, Aug. 1995.

[15] W. Gander, Computermathematick, Birkhaeuser, Basel, 1992.

[16] W.H. Press, S.A. Teukolsky, W.T. Vetterling, and B.P. Flannery, Numerical Recipes in C, The Art of Scientific Computing, Second edition, Cambridge University Press, 1992.

[17] N. Kuster, R. Kastle, T. Schmid, Dosimetric evaluation of mobile communications equipment with known precision, IEEE Transaction on Communications, vol. E80-B, no. 5, May 1997, pp. 645-652.

© 2015 PCTEST Engineering Laboratory, Inc.

[18] CENELEC CLC/SC111B, European Prestandard (prENV 50166-2), Human Exposure to Electromagnetic Fields High-frequency: 10kHz-300GHz, Jan. 1995.

[19] Prof. Dr. Niels Kuster, ETH, Eidgenössische Technische Hoschschule Zürich, Dosimetric Evaluation of the Cellular Phone.

[20] IEC 62209-1, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 1: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz), Feb. 2005.

[21] Industry Canada RSS-102 Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands) Issue 4, March 2010.

[22] Health Canada Safety Code 6 Limits of Human Exposure to Radio Frequency Electromagnetic Fields in the Frequency Range from 3 kHz – 300 GHz, 2009

[23] FCC SAR Test Procedures for 2G-3G Devices, Mobile Hotspot and UMPC Devices KDB Publications 941225, D01-D07

[24] SAR Measurement Guidance for IEEE 802.11 Transmitters, KDB Publication 248227 D01 DR02-41929

[25] FCC SAR Considerations for Handsets with Multiple Transmitters and Antennas, KDB Publications 648474 D03-D04

[26] FCC SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers, FCC KDB Publication 616217 D04

[27] FCC SAR Measurement and Reporting Requirements for 100MHz – 6 GHz, KDB Publications 865664 D01-D02

[28] FCC General RF Exposure Guidance and SAR Procedures for Dongles, KDB Publication 447498, D01-D02

[29] Anexo à Resolução No. 533, de 10 de Septembro de 2009.

[30] IEC 62209-2, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz), Mar. 2010.

© 2015 PCTEST Engineering Laboratory, Inc.

APPENDIX A: SAR TEST DATA

© 2014 PCTEST Engineering Laboratory, Inc.

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0C4

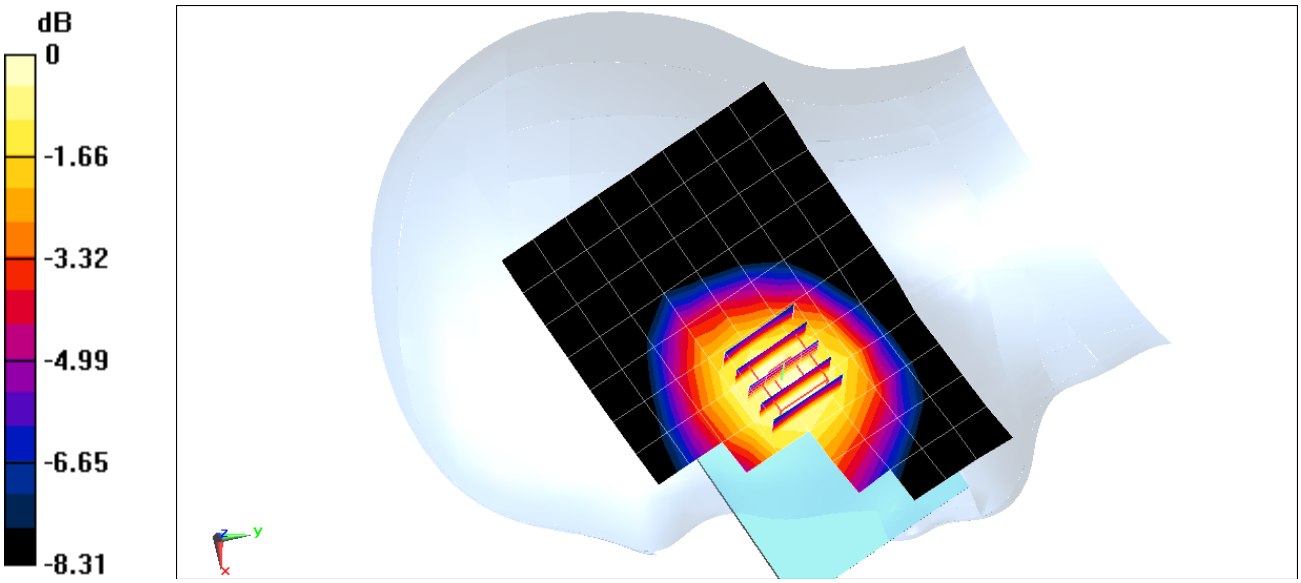
Communication System: UID 0, GSM; Frequency: 836.6 MHz; Duty Cycle: 1:8.3
Medium: 835 Head, Medium parameters used (interpolated):
f = 836.6 MHz; σ = 0.903 S/m; ε_r = 41.497; ρ = 1000 kg/m^3
Phantom section: Right Section

Test Date: 02-17-2015; Ambient Temp: 23.2°C; Tissue Temp: 22.1°C

Probe: ES3DV3 - SN3213; ConvF(6.26, 6.26, 6.26); Calibrated: 1/20/2015;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1407; Calibrated: 1/19/2015
Phantom: SAM Front; Type: SAM; Serial: 1686
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=15mm, dy=15mm
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 12.79 V/m; Power Drift = 0.13 dB
Peak SAR (extrapolated) = 0.180 W/kg
SAR(1 g) = 0.148 W/kg



0 dB = 0.161 W/kg = -7.93 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0C4

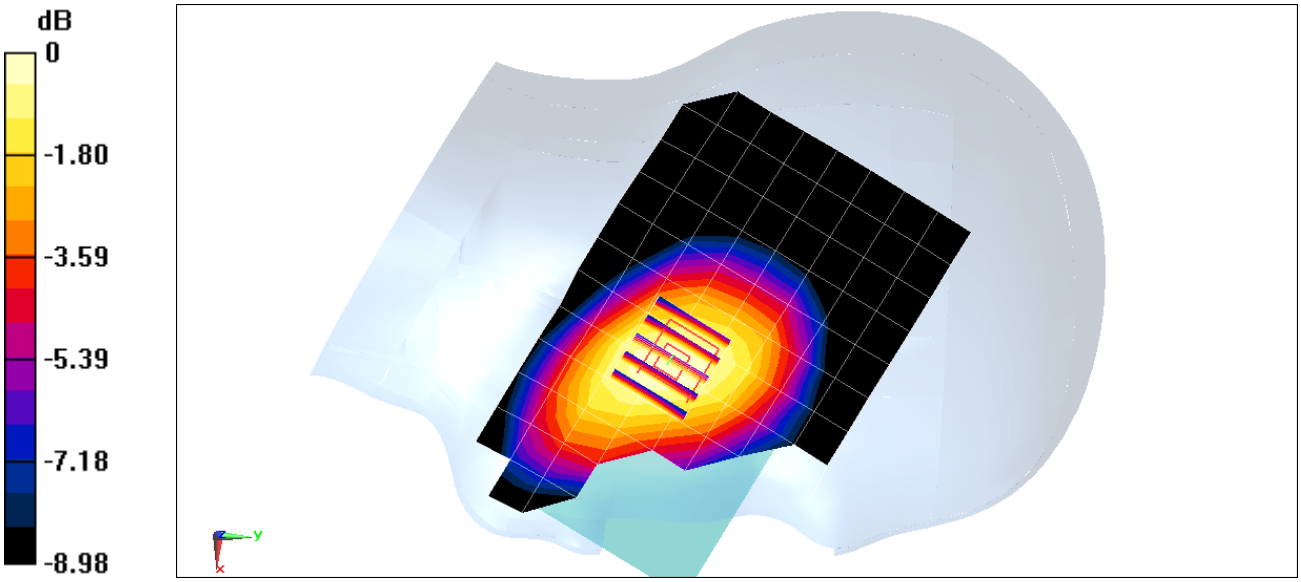
Communication System: UID 0, UMTS; Frequency: 836.6 MHz; Duty Cycle: 1:1
Medium: 835 Head, Medium parameters used (interpolated):
f = 836.6 MHz; σ = 0.903 S/m; ε_r = 41.497; ρ = 1000 kg/m^3
Phantom section: Left Section

Test Date: 02-17-2015; Ambient Temp: 23.2°C; Tissue Temp: 22.1°C

Probe: ES3DV3 - SN3213; ConvF(6.26, 6.26, 6.26); Calibrated: 1/20/2015;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1407; Calibrated: 1/19/2015
Phantom: SAM Front; Type: SAM; Serial: 1686
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

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

Area Scan (9x15x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 15.79 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 0.255 W/kg
SAR(1 g) = 0.204 W/kg



0 dB = 0.224 W/kg = -6.50 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0C4

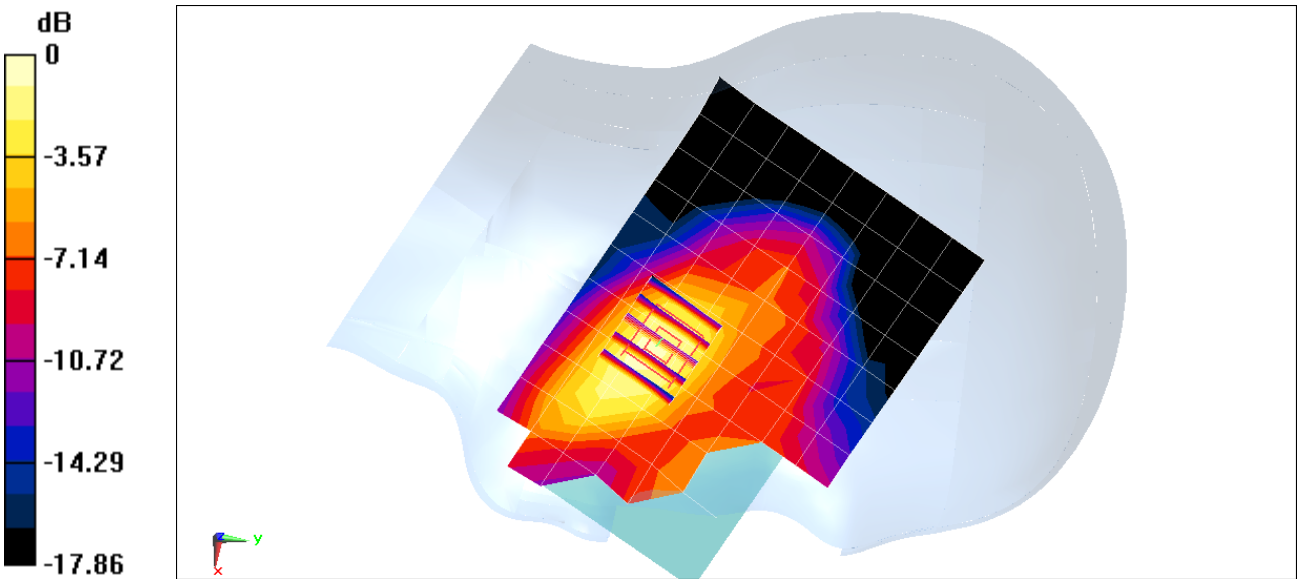
Communication System: UID 0, GSM1900; Frequency: 1880 MHz; Duty Cycle: 1:8.3
Medium: 1900 Head, Medium parameters used:
f = 1880 MHz; σ = 1.39 S/m; ε_r = 38.386; ρ = 1000 kg/m^3
Phantom section: Left Section

Test Date: 02-17-2015; Ambient Temp: 23.3°C; Tissue Temp: 22.0°C

Probe: ES3DV3 - SN3263; ConvF(5.08, 5.08, 5.08); Calibrated: 5/15/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn859; Calibrated: 5/14/2014
Phantom: SAM v5.0 front; Type: QD000P40CD; Serial: TP-1646
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

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

Area Scan (9x15x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 8.880 V/m; Power Drift = -0.20 dB
Peak SAR (extrapolated) = 0.189 W/kg
SAR(1 g) = 0.117 W/kg



0 dB = 0.142 W/kg = -8.48 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0A8

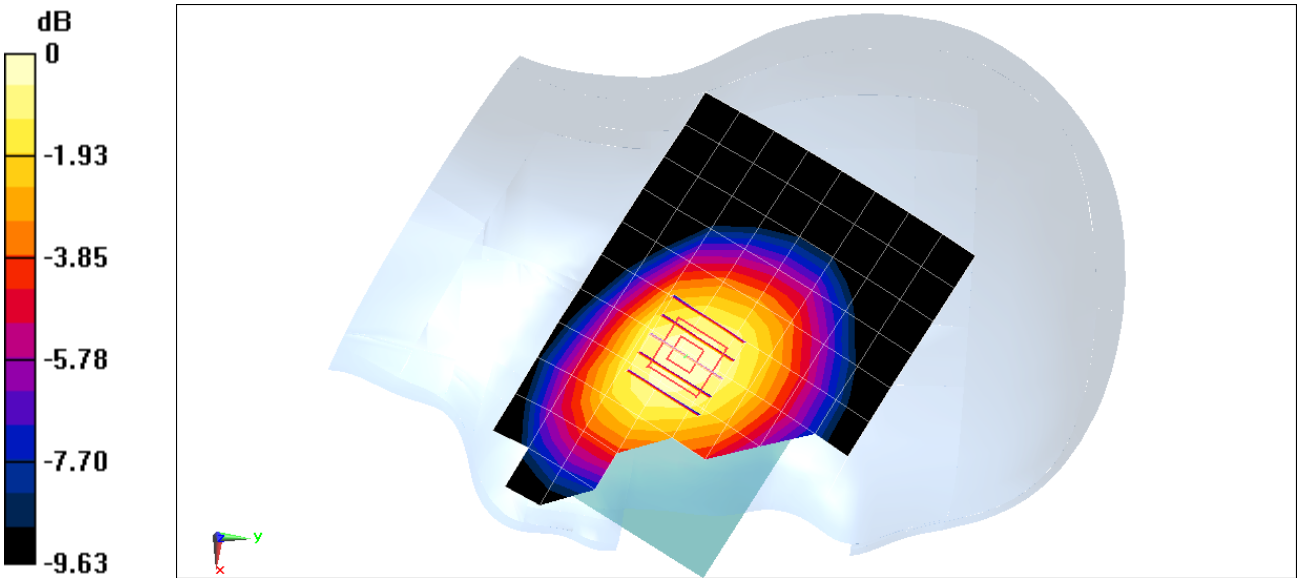
Communication System: UID 0, LTE Band 17; Frequency: 710 MHz; Duty Cycle: 1:1
Medium: 750 Head, Medium parameters used:
f = 710 MHz; σ = 0.861 S/m; ε_r = 41.144; ρ = 1000 kg/m^3
Phantom section: Left Section

Test Date: 02-19-2015; Ambient Temp: 23.1°C; Tissue Temp: 23.5°C

Probe: ES3DV3 - SN3263; ConvF(6.42, 6.42, 6.42); Calibrated: 5/15/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn859; Calibrated: 5/14/2014
Phantom: SAM v5.0 front; Type: QD000P40CD; Serial: TP-1646
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: LTE Band 17, Left Head, Cheek, Mid.ch, QPSK,
10 MHz Bandwidth, 1 RB, 0 RB Offset

Area Scan (9x13x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 10.22 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 0.100 W/kg
SAR(1 g) = 0.079 W/kg



0 dB = 0.0869 W/kg = -10.61 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0A8

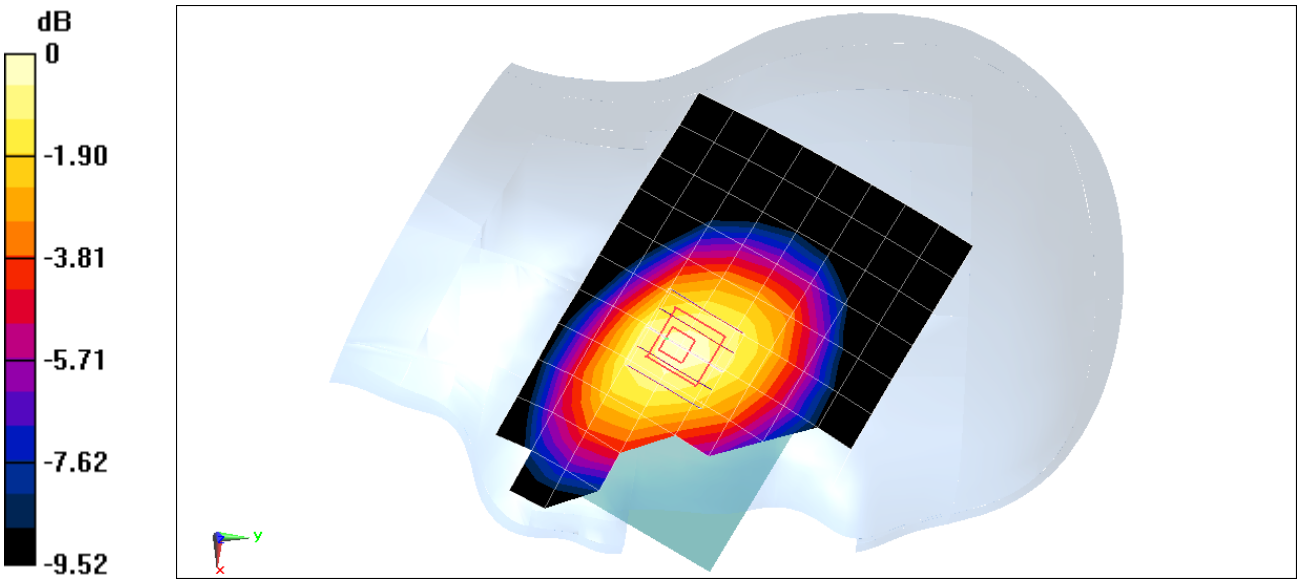
Communication System: UID 0, LTE Band 13; Frequency: 782 MHz; Duty Cycle: 1:1
Medium: 750 Head, Medium parameters used (interpolated):
f = 782 MHz; σ = 0.927 S/m; ε_r = 40.164; ρ = 1000 kg/m^3
Phantom section: Left Section

Test Date: 02-19-2015; Ambient Temp: 23.1°C; Tissue Temp: 23.5°C

Probe: ES3DV3 - SN3263; ConvF(6.42, 6.42, 6.42); Calibrated: 5/15/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn859; Calibrated: 5/14/2014
Phantom: SAM v5.0 front; Type: QD000P40CD; Serial: TP-1646
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: LTE Band 13, Left Head, Cheek, Mid.ch, QPSK,
10 MHz Bandwidth, 1 RB, 0 RB Offset

Area Scan (9x13x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 16.95 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 0.303 W/kg
SAR(1 g) = 0.231 W/kg



0 dB = 0.254 W/kg = -5.95 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0A8

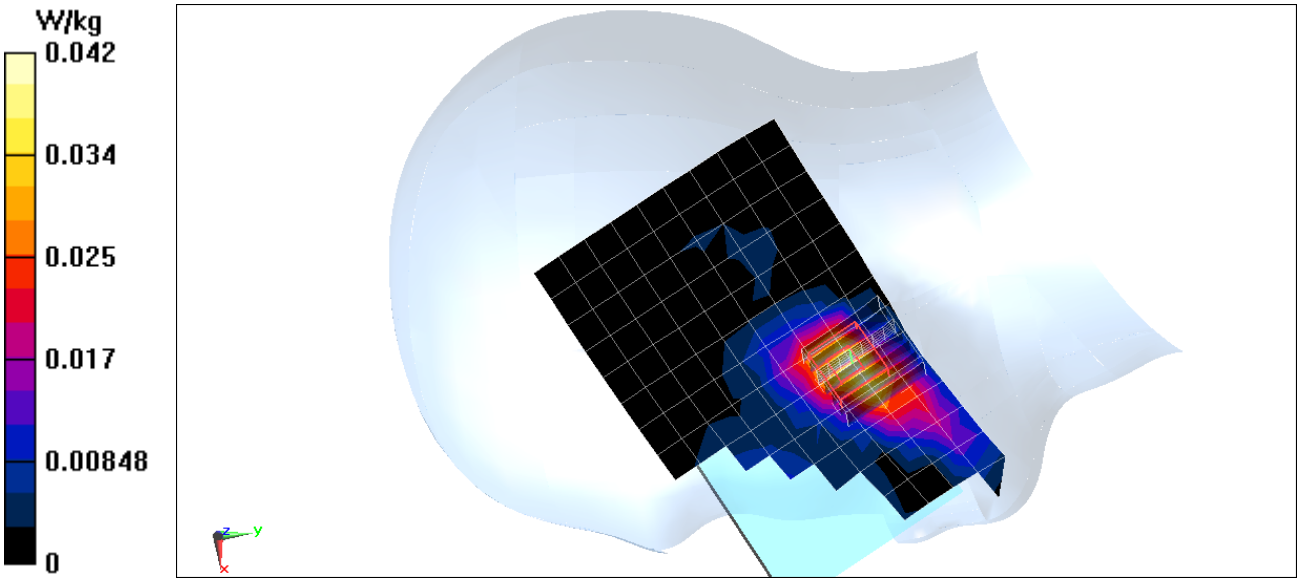
Communication System: UID 0, LTE Band 41; Frequency: 2506 MHz; Duty Cycle: 1:1.58
Medium: 2450 Head, Medium parameters used (interpolated):
f = 2506 MHz; σ = 1.81 S/m; ε_r = 40.396; ρ = 1000 kg/m^3
Phantom section: Right Section

Test Date: 02-19-2015; Ambient Temp: 24.3°C; Tissue Temp: 23.2°C

Probe: ES3DV3 - SN3213; ConvF(4.54, 4.54, 4.54); Calibrated: 1/20/2015;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1407; Calibrated: 1/19/2015
Phantom: SAM Front; Type: SAM; Serial: 1686
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: LTE Band 41, Right Head, Cheek, Low.ch,
20 MHz Bandwidth, QPSK, 1 RB, 0 RB Offset

Area Scan (10x17x1): Measurement grid: dx=12mm, dy=12mm
Zoom Scan (8x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 5.231 V/m; Power Drift = 0.15 dB
Peak SAR (extrapolated) = 0.0650 W/kg
SAR(1 g) = 0.034 W/kg



PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0C3

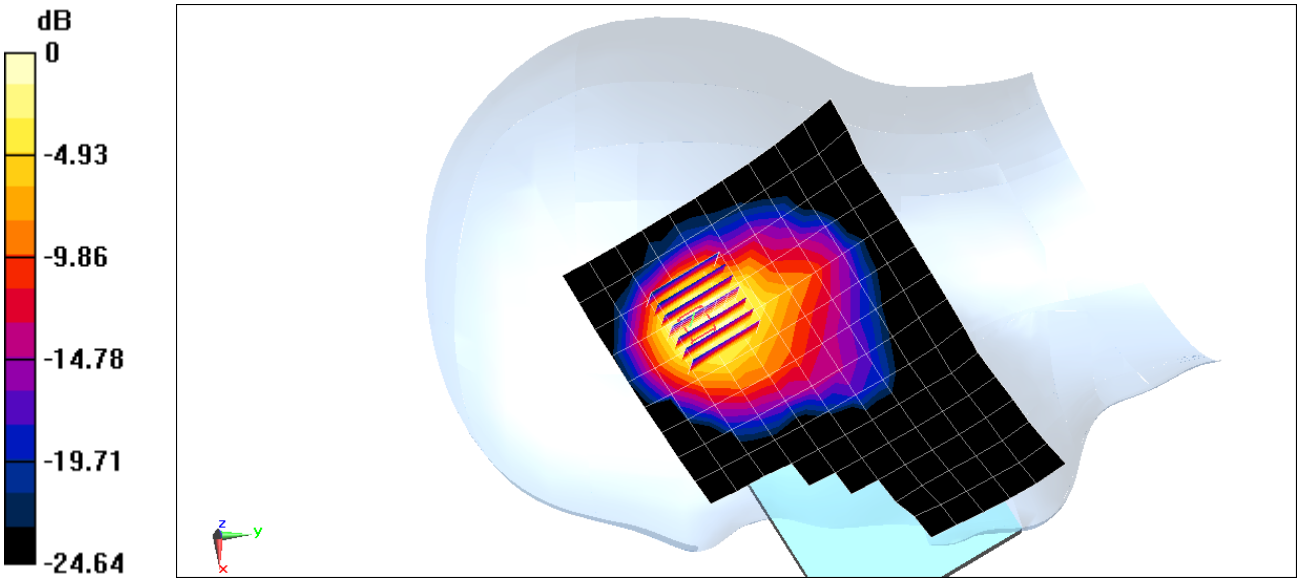
Communication System: UID 0, IEEE 802.11b; Frequency: 2412 MHz; Duty Cycle: 1:1
Medium: 2450 Head, Medium parameters used (interpolated):
f = 2412 MHz; σ = 1.714 S/m; ε_r = 40.759; ρ = 1000 kg/m^3
Phantom section: Right Section

Test Date: 02-19-2015; Ambient Temp: 24.3°C; Tissue Temp: 23.2°C

Probe: ES3DV3 - SN3213; ConvF(4.54, 4.54, 4.54); Calibrated: 1/20/2015;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1407; Calibrated: 1/19/2015
Phantom: SAM Front; Type: SAM; Serial: 1686
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: IEEE 802.11b, 22 MHz Bandwidth, Right Head, Cheek, Ch 01, 1 Mbps, Antenna 1

Area Scan (11x18x1): Measurement grid: dx=12mm, dy=12mm
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 16.07 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 0.940 W/kg
SAR(1 g) = 0.412 W/kg



0 dB = 0.525 W/kg = -2.80 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C4E6

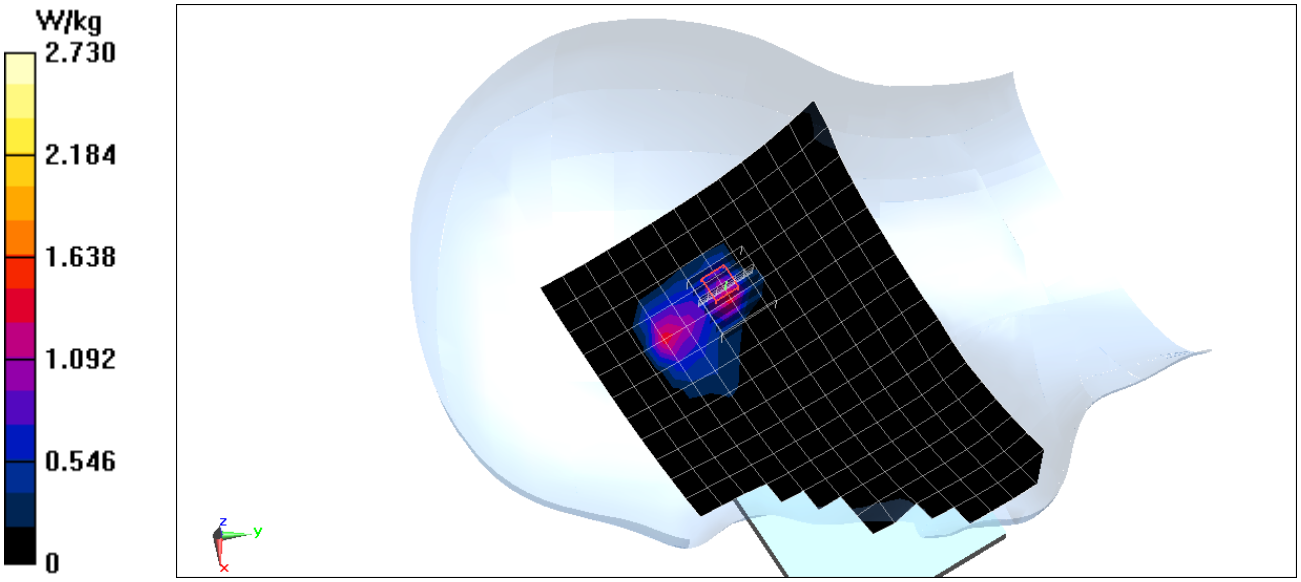
Communication System: UID 0, IEEE 802.11n 5.2-5.8 GHz Band; Frequency: 5755 MHz; Duty Cycle: 1:1
Medium: 5 GHz Head, Medium parameters used (interpolated):
f = 5755 MHz; σ = 5.146 S/m; ε_r = 35.467; ρ = 1000 kg/m^3
Phantom section: Right Section

Test Date: 02-18-2015; Ambient Temp: 21.0°C; Tissue Temp: 19.9°C

Probe: EX3DV4 - SN7308; ConvF(4.81, 4.81, 4.81); Calibrated: 7/16/2014;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1323; Calibrated: 9/17/2014
Phantom: SAM V5.0 Right; Type: QD000P40CD; Serial: 1647
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: IEEE 802.11n, U-NII-3, 40 MHz Bandwidth, Right Head, Cheek, Ch 151, 27 Mbps, MIMO

Area Scan (13x18x1): 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 = 8.314 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 5.32 W/kg
SAR(1 g) = 0.896 W/kg



PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0C4

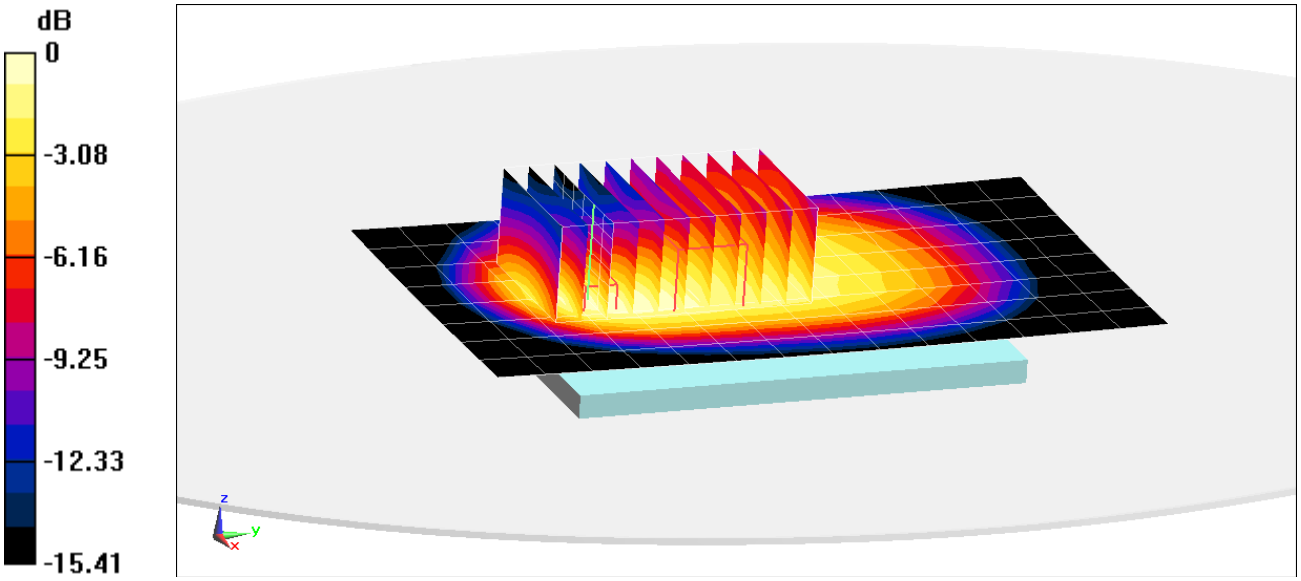
Communication System: UID 0, GSM850; Frequency: 836.6 MHz; Duty Cycle: 1:8.3
Medium: 835 Body, Medium parameters used (interpolated):
f = 836.6 MHz; σ = 1.006 S/m; ε_r = 54.267; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-17-2015; Ambient Temp: 23.4°C; Tissue Temp: 22.3°C

Probe: ES3DV3 - SN3288; ConvF(6.32, 6.32, 6.32); Calibrated: 9/24/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1364; Calibrated: 9/18/2014
Phantom: ELI v5.0; Type: QDOVA001BB; Serial: 1229
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

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

Area Scan (9x15x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (7x11x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 16.85 V/m; Power Drift = -0.14 dB
Peak SAR (extrapolated) = 0.500 W/kg
SAR(1 g) = 0.279 W/kg



0 dB = 0.343 W/kg = -4.65 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0C4

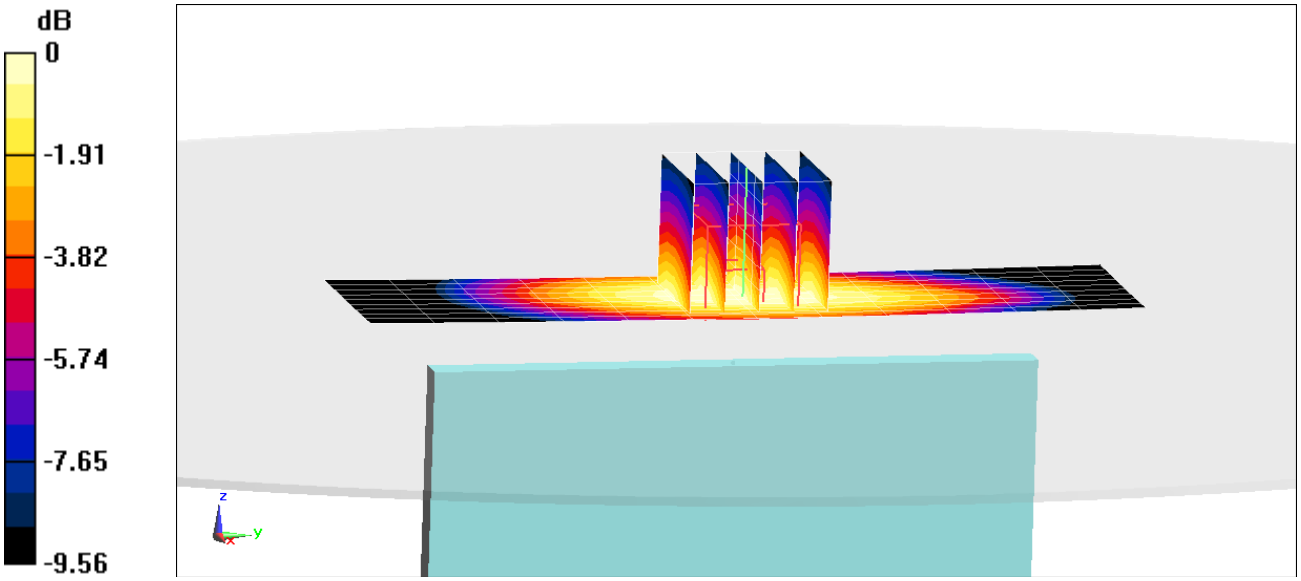
Communication System: UID 0, GSM850 GPRS; 4 Tx slots; Frequency: 836.6 MHz; Duty Cycle: 1:2.076
Medium: 835 Body, Medium parameters used (interpolated):
f = 836.6 MHz; σ = 1.006 S/m; ε_r = 54.267; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-17-2015; Ambient Temp: 23.4°C; Tissue Temp: 22.3°C

Probe: ES3DV3 - SN3288; ConvF(6.32, 6.32, 6.32); Calibrated: 9/24/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1364; Calibrated: 9/18/2014
Phantom: ELI v5.0; Type: QDOVA001BB; Serial: 1229
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: GPRS 850, Body SAR, Right Edge, Mid.ch, 4 Tx Slots

Area Scan (10x13x1): Measurement grid: dx=5mm, dy=15mm
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 23.43 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 0.731 W/kg
SAR(1 g) = 0.516 W/kg



0 dB = 0.585 W/kg = -2.33 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0C4

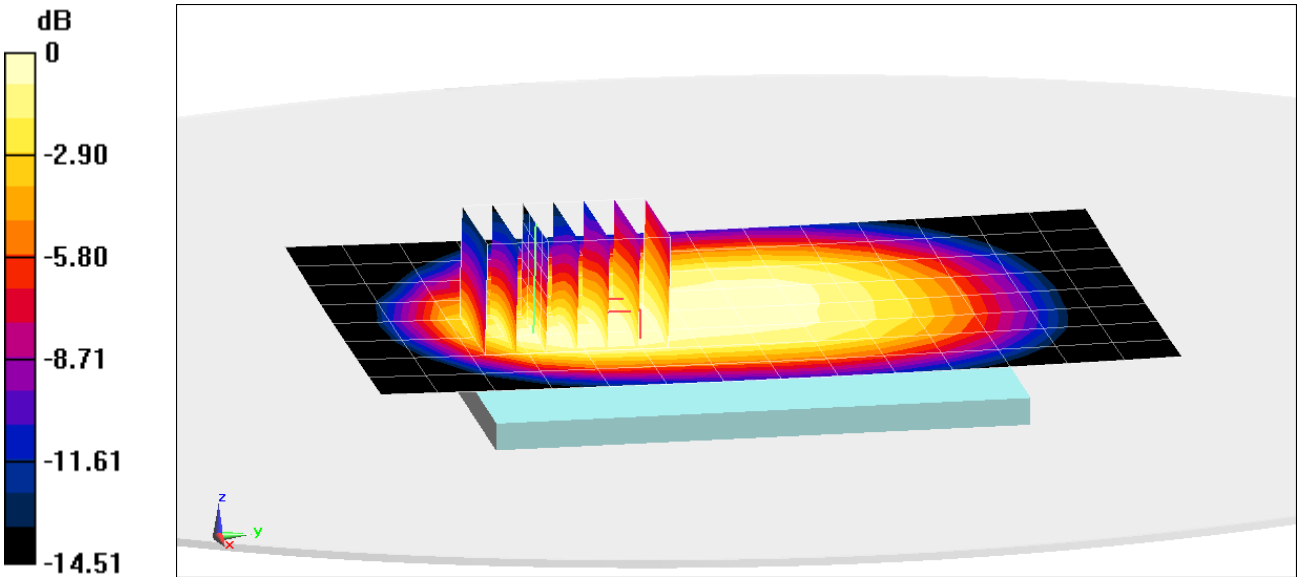
Communication System: UID 0, UMTS; Frequency: 836.6 MHz; Duty Cycle: 1:1
Medium: 835 Body, Medium parameters used (interpolated):
f = 836.6 MHz; σ = 1.006 S/m; ε_r = 54.267; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-17-2015; Ambient Temp: 23.4°C; Tissue Temp: 22.3°C

Probe: ES3DV3 - SN3288; ConvF(6.32, 6.32, 6.32); Calibrated: 9/24/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1364; Calibrated: 9/18/2014
Phantom: ELI v5.0; Type: QDOVA001BB; Serial: 1229
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 (9x15x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (5x7x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 17.23 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 0.476 W/kg
SAR(1 g) = 0.281 W/kg



0 dB = 0.330 W/kg = -4.81 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0C4

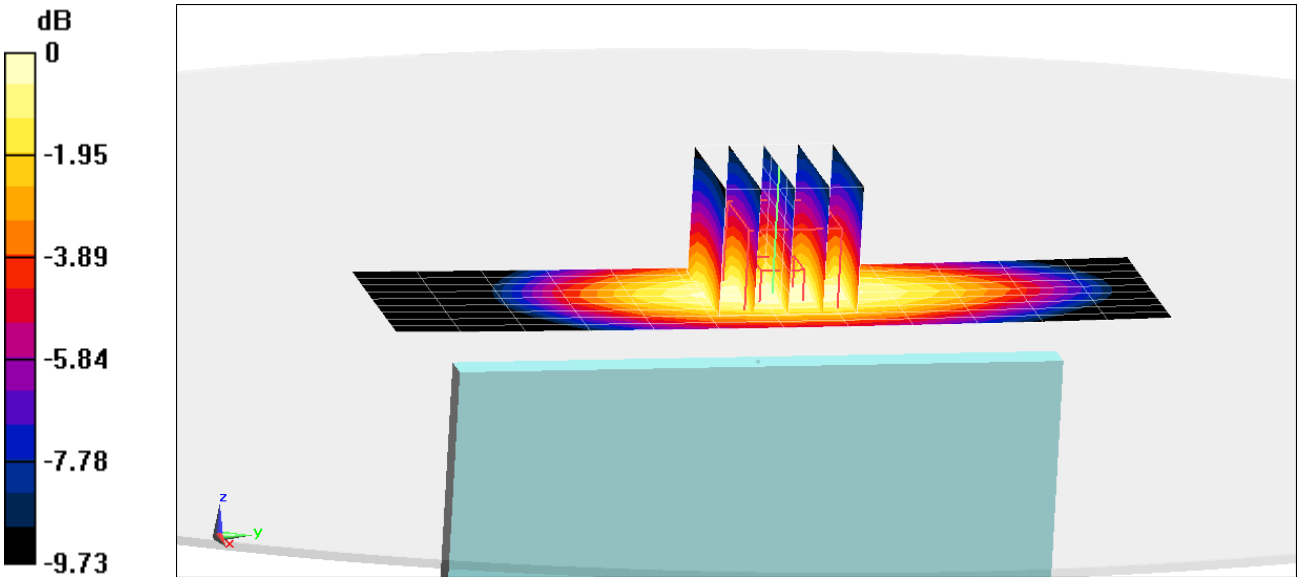
Communication System: UID 0, UMTS; Frequency: 836.6 MHz; Duty Cycle: 1:1
Medium: 835 Body, Medium parameters used (interpolated):
f = 836.6 MHz; σ = 1.006 S/m; ε_r = 54.267; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-17-2015; Ambient Temp: 23.4°C; Tissue Temp: 22.3°C

Probe: ES3DV3 - SN3288; ConvF(6.32, 6.32, 6.32); Calibrated: 9/24/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1364; Calibrated: 9/18/2014
Phantom: ELI v5.0; Type: QDOVA001BB; Serial: 1229
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 (10x13x1): Measurement grid: dx=5mm, dy=15mm
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 21.19 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 0.596 W/kg
SAR(1 g) = 0.412 W/kg



0 dB = 0.476 W/kg = -3.22 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0C4

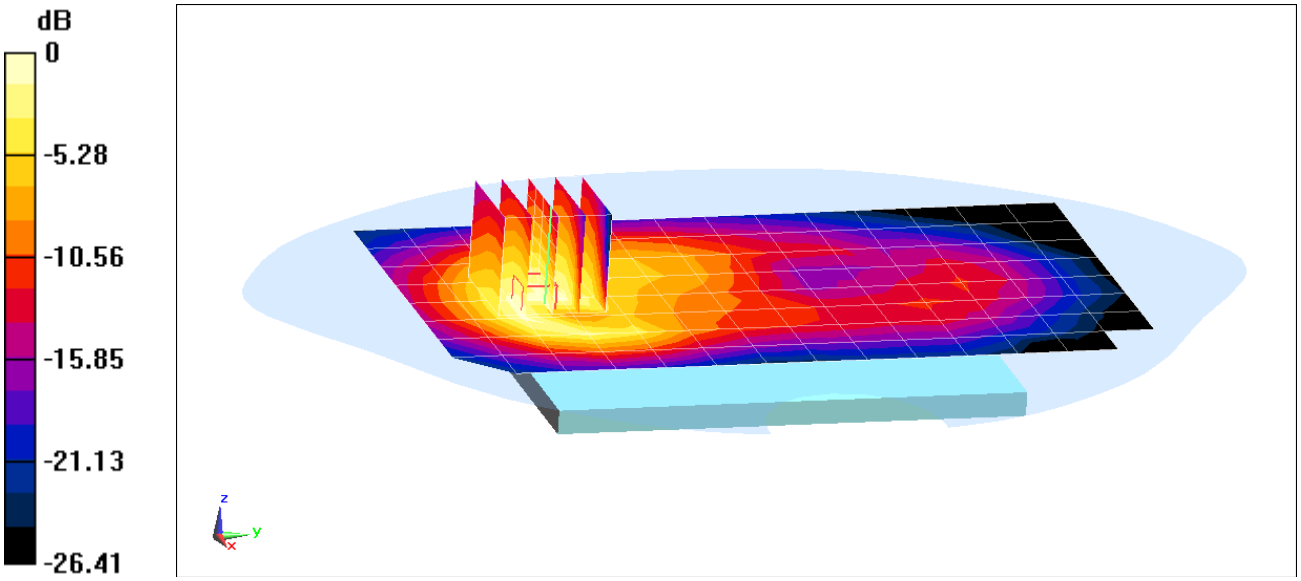
Communication System: UID 0, GSM; Frequency: 1880 MHz; Duty Cycle: 1:8.3
Medium: 1900 Body, Medium parameters used:
f = 1880 MHz; σ = 1.555 S/m; ε_r = 51.251; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-18-2015; Ambient Temp: 22.9°C; Tissue Temp: 22.1°C

Probe: ES3DV3 - SN3263; ConvF(4.78, 4.78, 4.78); Calibrated: 5/15/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn859; Calibrated: 5/14/2014
Phantom: SAM v5.0 Left; Type: QD000P40CD; Serial: TP: 1687
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

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

Area Scan (9x15x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 17.67 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 0.923 W/kg
SAR(1 g) = 0.520 W/kg



0 dB = 0.621 W/kg = -2.07 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0C4

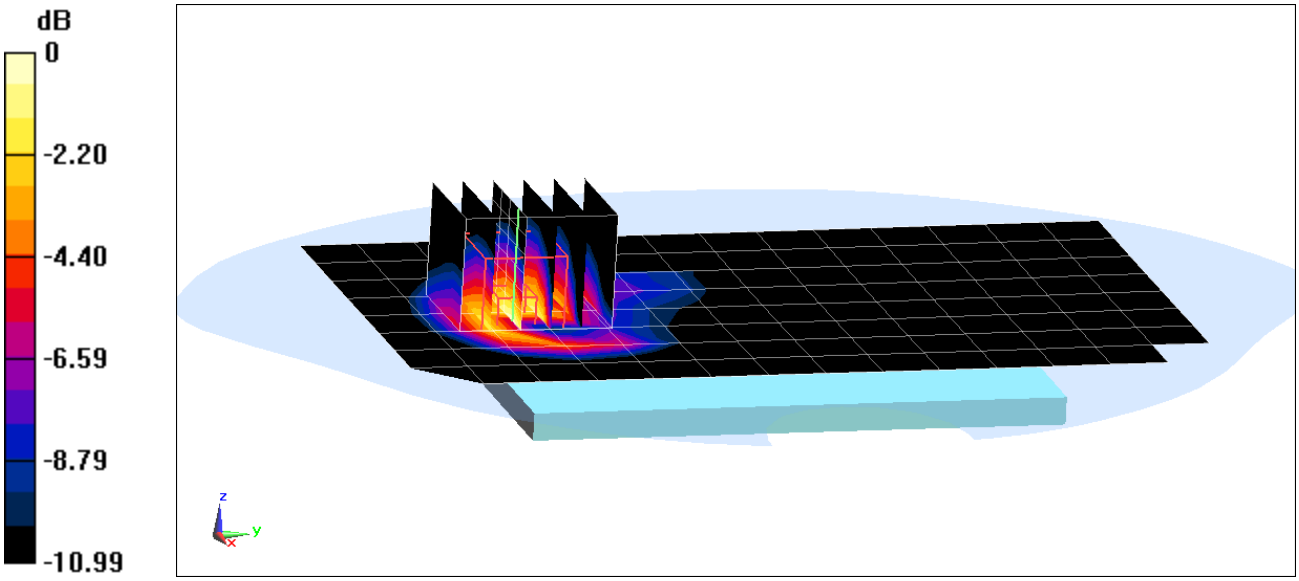
Communication System: UID 0, GSM GPRS; 3 Tx slots, Frequency: 1909.8 MHz; Duty Cycle: 1:2.76
Medium: 1900 Body, Medium parameters used:
f = 1910 MHz; σ = 1.592 S/m; ε_r = 51.164; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-18-2015; Ambient Temp: 22.9°C; Tissue Temp: 22.1°C

Probe: ES3DV3 - SN3263; ConvF(4.78, 4.78, 4.78); Calibrated: 5/15/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn859; Calibrated: 5/14/2014
Phantom: SAM v5.0 Left; Type: QD000P40CD; Serial: TP: 1687
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

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

Area Scan (9x15x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (5x6x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 22.71 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 1.53 W/kg
SAR(1 g) = 0.850 W/kg



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

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0A8

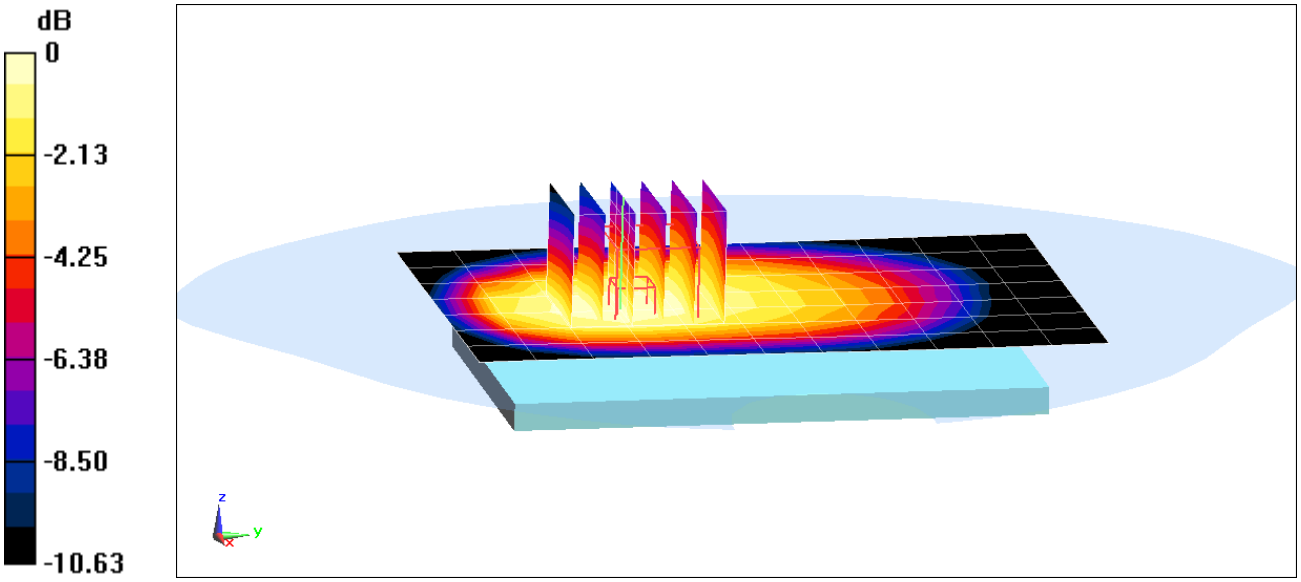
Communication System: UID 0, LTE Band 17; Frequency: 710 MHz; Duty Cycle: 1:1
Medium: 750 Body, Medium parameters used:
f = 710 MHz; σ = 0.927 S/m; ε_r = 56.866; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-23-2015; Ambient Temp: 24.4°C; Tissue Temp: 22.6°C

Probe: ES3DV3 - SN3288; ConvF(6.38, 6.38, 6.38); 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 17, Body SAR, Back Side, Mid.ch,
10 MHz Bandwidth, QPSK, 1 RB, 0 RB Offset

Area Scan (8x12x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (5x6x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 14.55 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 0.245 W/kg
SAR(1 g) = 0.181 W/kg



0 dB = 0.204 W/kg = -6.90 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0A8

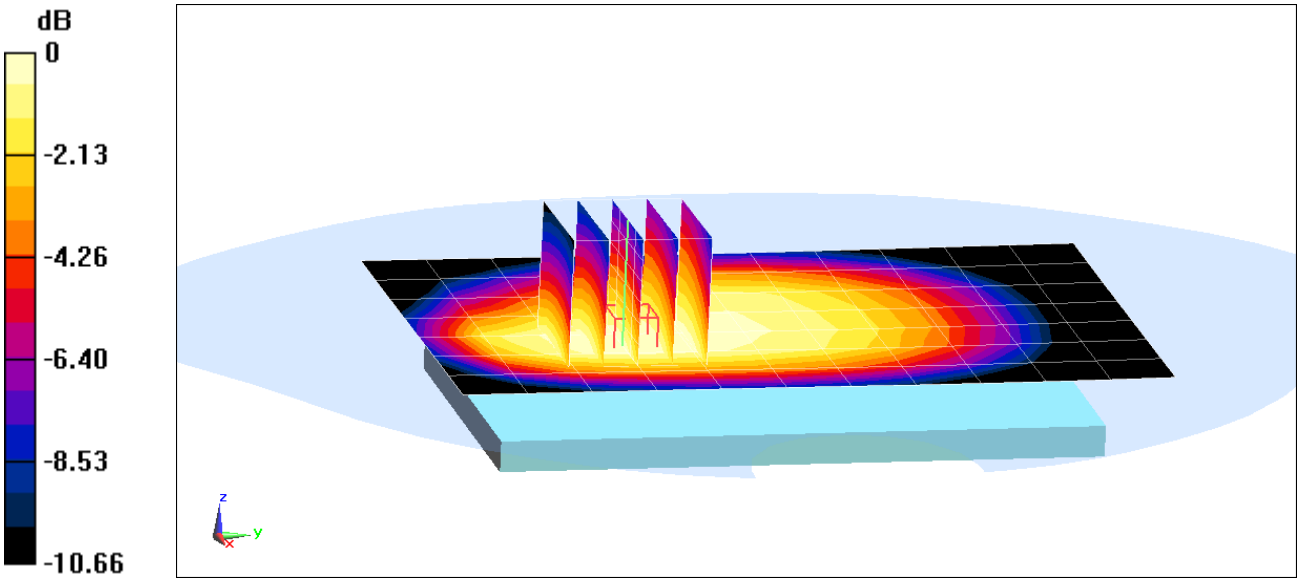
Communication System: UID 0, LTE Band 13; Frequency: 782 MHz; Duty Cycle: 1:1
Medium: 750 Body, Medium parameters used (interpolated):
f = 782 MHz; σ = 0.993 S/m; ε_r = 56.146; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-23-2015; Ambient Temp: 24.4°C; Tissue Temp: 22.6°C

Probe: ES3DV3 - SN3288; ConvF(6.38, 6.38, 6.38); 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 13, Body SAR, Back Side, Mid.ch,
10 MHz Bandwidth, QPSK, 1 RB, 0 RB Offset

Area Scan (8x12x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 21.30 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 0.582 W/kg
SAR(1 g) = 0.438 W/kg



0 dB = 0.487 W/kg = -3.12 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0A8

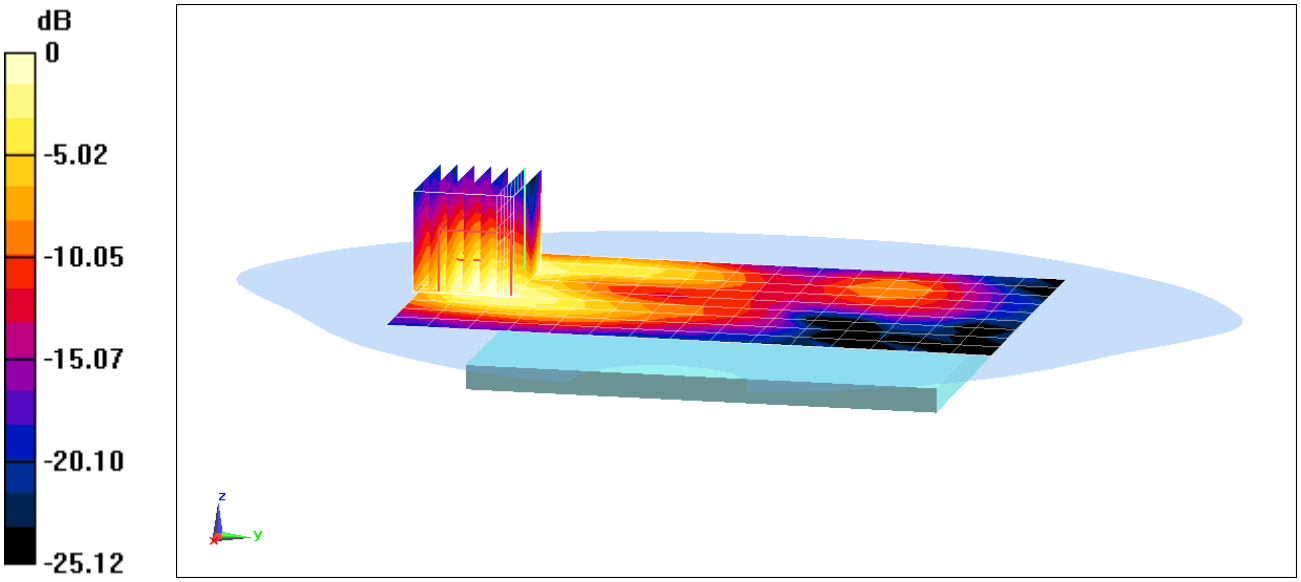
Communication System: UID 0, LTE Band 41; Frequency: 2506 MHz; Duty Cycle: 1:1.58
Medium: 2450 Body, Medium parameters used (interpolated):
f = 2506 MHz; σ = 2.037 S/m; ε_r = 52.269; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-23-2015; Ambient Temp: 22.0°C; Tissue Temp: 23.5°C

Probe: ES3DV3 - SN3263; ConvF(4.27, 4.27, 4.27); Calibrated: 5/15/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn859; Calibrated: 5/14/2014
Phantom: SAM v5.0 front; Type: QD000P40CD; Serial: TP-1646
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: LTE Band 41, Body SAR, Back side, Low.ch,
20 MHz Bandwidth, QPSK, 1 RB, 0 RB Offset

Area Scan (10x16x1): Measurement grid: dx=12mm, dy=12mm
Zoom Scan (9x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 9.353 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 0.366 W/kg
SAR(1 g) = 0.158 W/kg



0 dB = 0.211 W/kg = -6.76 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0A8

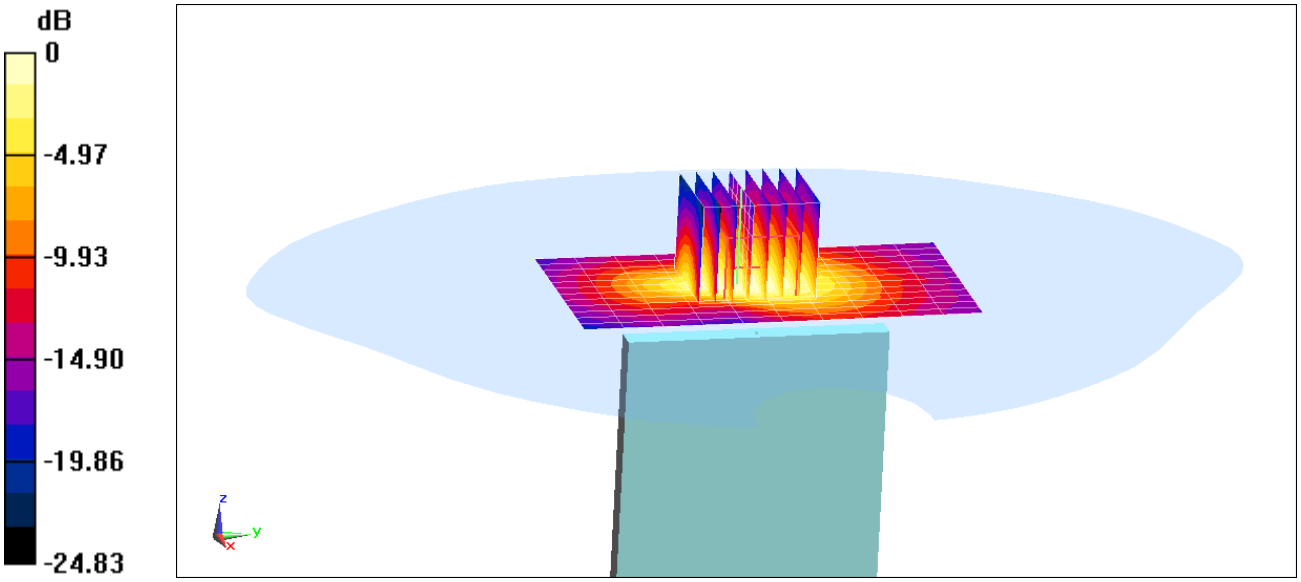
Communication System: UID 0, LTE Band 41; Frequency: 2506 MHz; Duty Cycle: 1:1.58
Medium: 2450 Body, Medium parameters used (interpolated):
f = 2506 MHz; σ = 2.037 S/m; ε_r = 52.269; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-23-2015; Ambient Temp: 22.0°C; Tissue Temp: 23.5°C

Probe: ES3DV3 - SN3263; ConvF(4.27, 4.27, 4.27); Calibrated: 5/15/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn859; Calibrated: 5/14/2014
Phantom: SAM v5.0 front; Type: QD000P40CD; Serial: TP-1646
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: LTE Band 41, Body SAR, Bottom Edge, Low.ch,
20 MHz Bandwidth, QPSK, 1 RB, 0 RB Offset

Area Scan (13x11x1): Measurement grid: dx=5mm, dy=12mm
Zoom Scan (7x8x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 12.03 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 0.511 W/kg
SAR(1 g) = 0.252 W/kg



0 dB = 0.324 W/kg = -4.89 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0A8

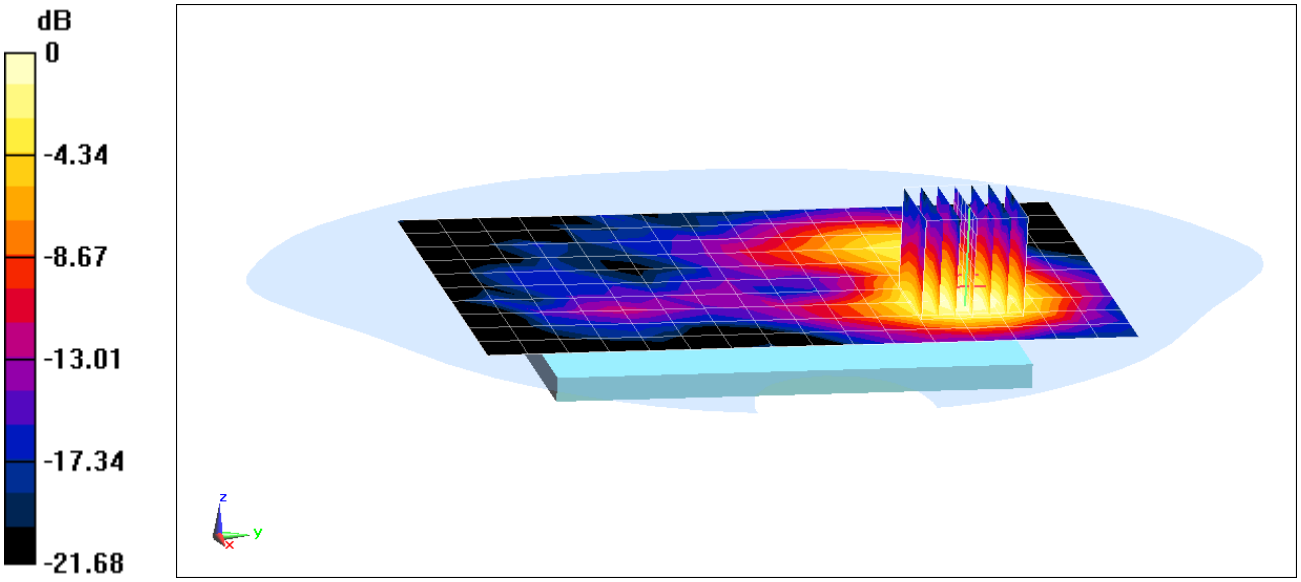
Communication System: UID 0, IEEE 802.11b; Frequency: 2412 MHz; Duty Cycle: 1:1
Medium: 2450 Body, Medium parameters used (interpolated):
f = 2412 MHz; σ = 1.917 S/m; ε_r = 52.62; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-23-2015; Ambient Temp: 22.0°C; Tissue Temp: 23.5°C

Probe: ES3DV3 - SN3263; ConvF(4.27, 4.27, 4.27); Calibrated: 5/15/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn859; Calibrated: 5/14/2014
Phantom: SAM v5.0 front; Type: QD000P40CD; Serial: TP-1646
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: IEEE 802.11b, 22 MHz Bandwidth, Body SAR,
Ch 1, 1 Mbps, Back Side, Antenna 1

Area Scan (11x17x1): Measurement grid: dx=12mm, dy=12mm
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 6.045 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 0.135 W/kg
SAR(1 g) = 0.065 W/kg



0 dB = 0.0817 W/kg = -10.88 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0A8

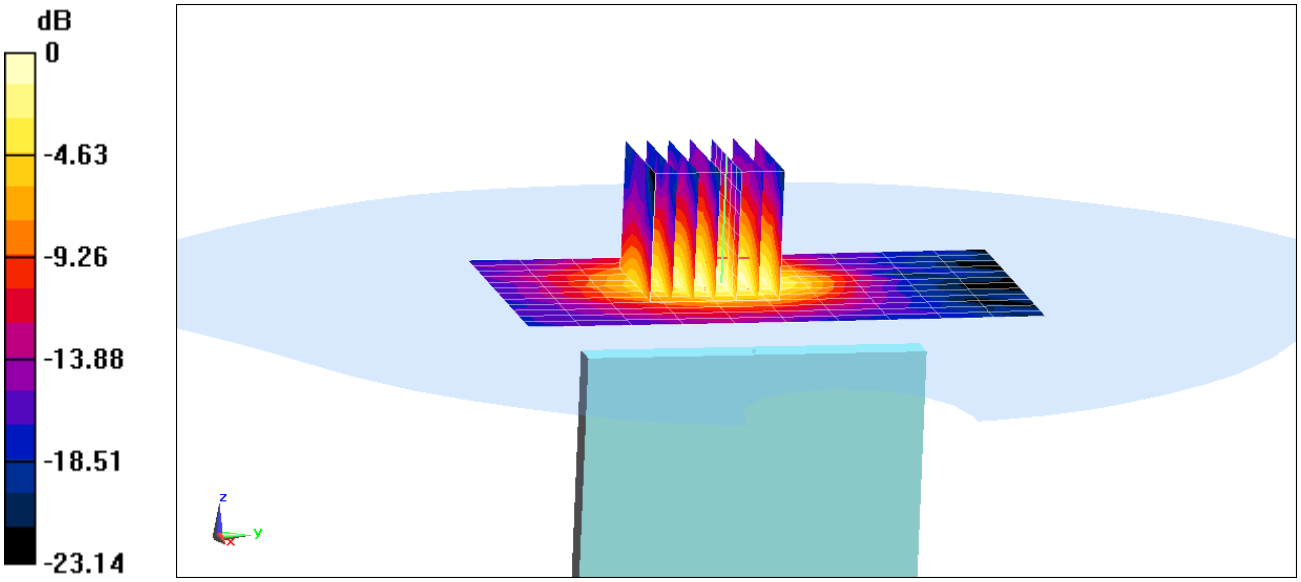
Communication System: UID 0, IEEE 802.11b; Frequency: 2437 MHz; Duty Cycle: 1:1
Medium: 2450 Body, Medium parameters used (interpolated):
f = 2437 MHz; σ = 1.95 S/m; ε_r = 52.528; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-23-2015; Ambient Temp: 22.0°C; Tissue Temp: 23.5°C

Probe: ES3DV3 - SN3263; ConvF(4.27, 4.27, 4.27); Calibrated: 5/15/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn859; Calibrated: 5/14/2014
Phantom: SAM v5.0 front; Type: QD000P40CD; Serial: TP-1646
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: IEEE 802.11b, 22 MHz Bandwidth Body SAR,
Ch 6, 1 Mbps, Top Edge, Antenna 2

Area Scan (13x11x1): Measurement grid: dx=5mm, dy=12mm
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 6.226 V/m; Power Drift = -0.11 dB
Peak SAR (extrapolated) = 0.143 W/kg
SAR(1 g) = 0.070 W/kg



0 dB = 0.0889 W/kg = -10.51 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSC04G; Type: Portable Handset; Serial: 1C0A8

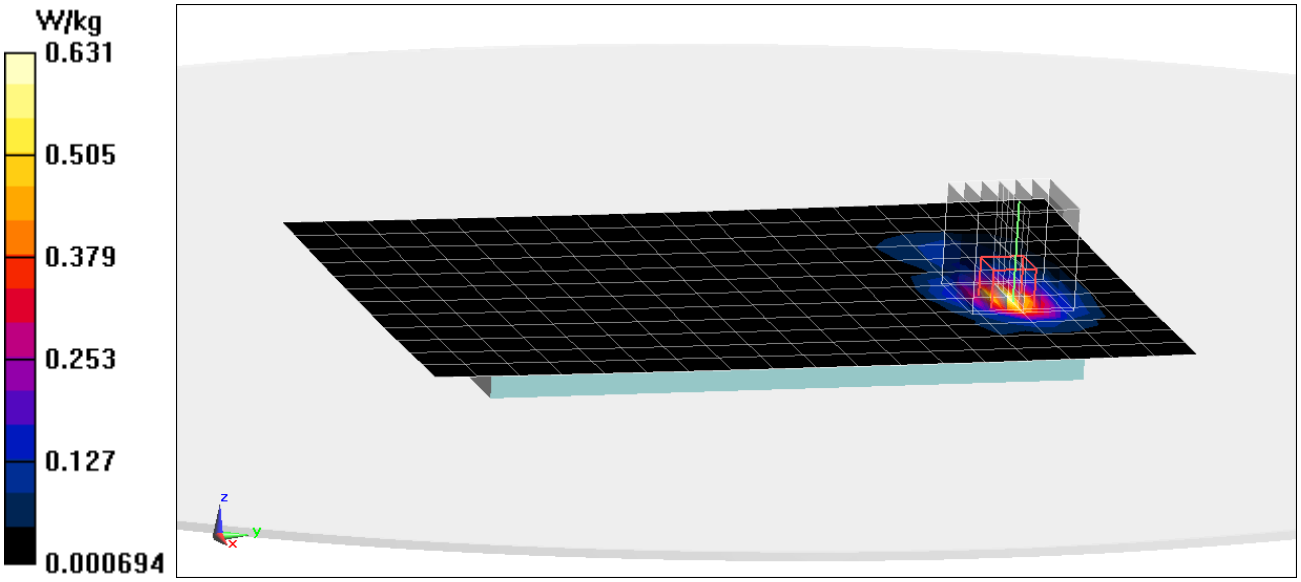
Communication System: UID 0, 802.11n 5.2-5.8 GHz Band; Frequency: 5755 MHz; Duty Cycle: 1:1
Medium: 5GHz Body, Medium parameters used (interpolated):
f = 5755 MHz; σ = 6.221 S/m; ε_r = 50.336; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-23-2015; Ambient Temp: 21.7°C; Tissue Temp: 20.8°C

Probe: EX3DV4 - SN3920; ConvF(3.93, 3.93, 3.93); Calibrated: 12/12/2014;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1368; Calibrated: 4/11/2014
Phantom: ELI Front; Type: QDOVA002AA; Serial: TP:1202
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Mode: IEEE 802.11n, U-NII-3, 40 MHz Bandwidth,
Body SAR, Ch 151, 13.5 Mbps, Back Side, Antenna 2

Area Scan (13x19x1): Measurement grid: dx=10mm, dy=10mm
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Reference Value = 6.576 V/m; Power Drift = 0.20 dB
Peak SAR (extrapolated) = 1.09 W/kg
SAR(1 g) = 0.253 W/kg



APPENDIX B: SYSTEM VERIFICATION

© 2014 PCTEST Engineering Laboratory, Inc.

PCTEST ENGINEERING LABORATORY, INC.

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

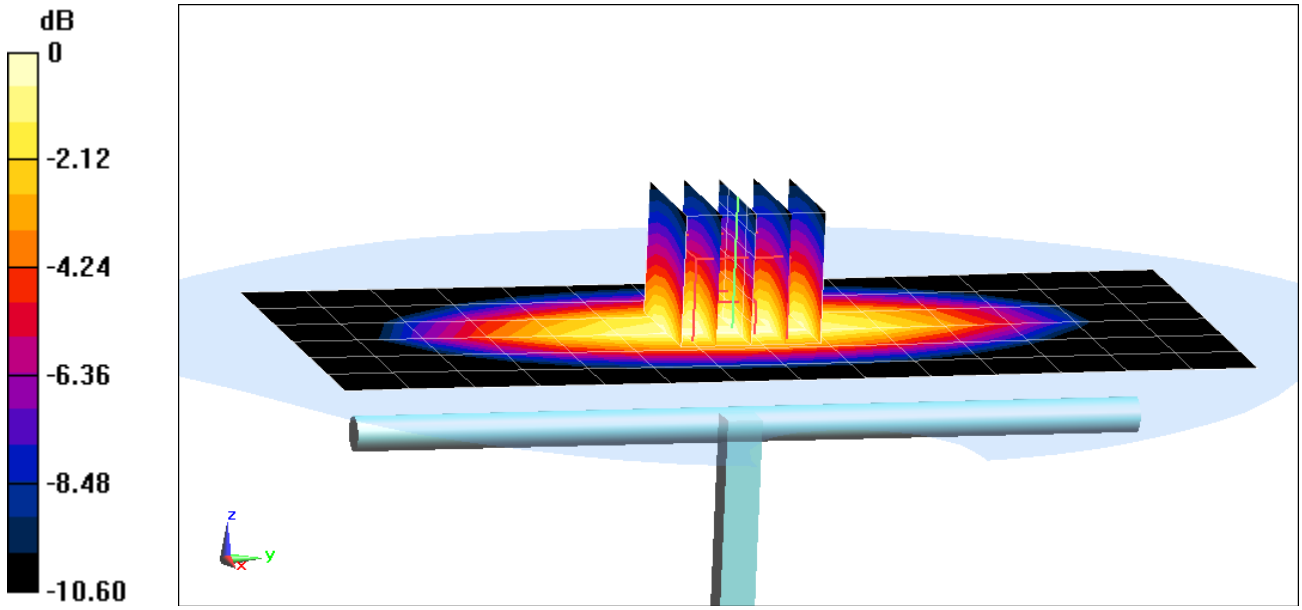
Communication System: UID 0, CW; Frequency: 750 MHz; Duty Cycle: 1:1
Medium: 750 Head Medium parameters used (interpolated):
f = 750 MHz; σ = 0.897 S/m; ε_r = 40.604; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 02-19-2015; Ambient Temp: 23.1°C; Tissue Temp: 23.5°C

Probe: ES3DV3 - SN3263; ConvF(6.42, 6.42, 6.42); Calibrated: 5/15/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn859; Calibrated: 5/14/2014
Phantom: SAM v5.0 front; Type: QD000P40CD; Serial: TP-1646
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) = 1.26 W/kg
SAR(1 g) = 0.840 W/kg
Deviation = 0.84%



0 dB = 0.983 W/kg = -0.07 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

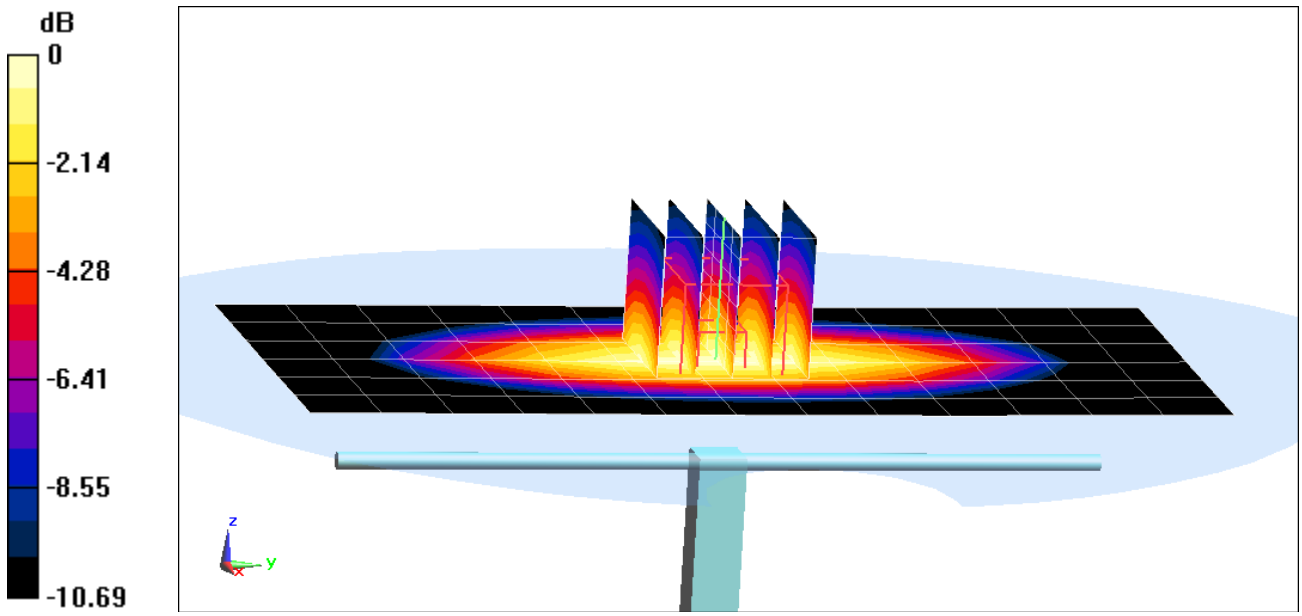
Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1
Medium: 835 Head Medium parameters used:
f = 835 MHz; σ = 0.902 S/m; ε_r = 41.516; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 02-17-2015; Ambient Temp: 23.2°C; Tissue Temp: 22.1°C

Probe: ES3DV3 - SN3213; ConvF(6.26, 6.26, 6.26); Calibrated: 1/20/2015;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1407; Calibrated: 1/19/2015
Phantom: SAM Front; Type: SAM; Serial: 1686
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

835 MHz System Verification

Area Scan (7x14x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Input Power = 20 dBm (100 mW)
Peak SAR (extrapolated) = 1.40 W/kg
SAR(1 g) = 0.950 W/kg
Deviation = 3.26%



0 dB = 1.11 W/kg = 0.45 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: 5d149

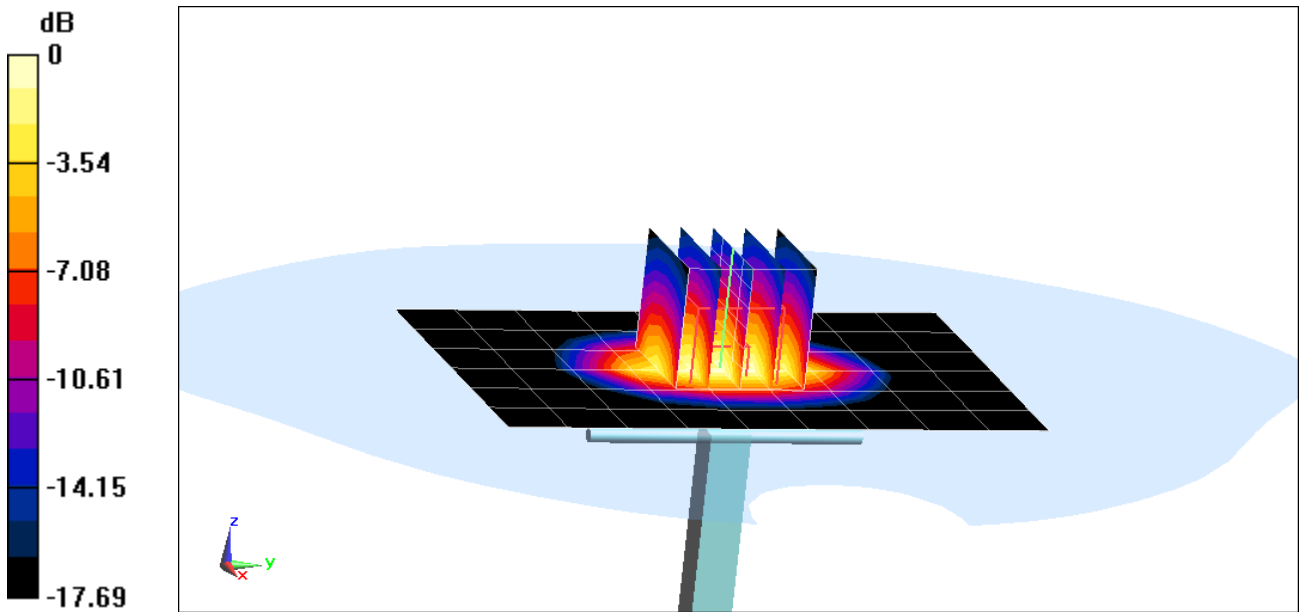
Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium: 1900 Head Medium parameters used (interpolated):
f = 1900 MHz; σ = 1.413 S/m; ε_r = 38.306; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-17-2015; Ambient Temp: 23.3°C; Tissue Temp: 22.0°C

Probe: ES3DV3 - SN3263; ConvF(5.08, 5.08, 5.08); Calibrated: 5/15/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn859; Calibrated: 5/14/2014
Phantom: SAM v5.0 front; Type: QD000P40CD; Serial: TP-1646
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) = 7.41 W/kg
SAR(1 g) = 4.02 W/kg
Deviation = 0.00%



0 dB = 5.13 W/kg = 7.10 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

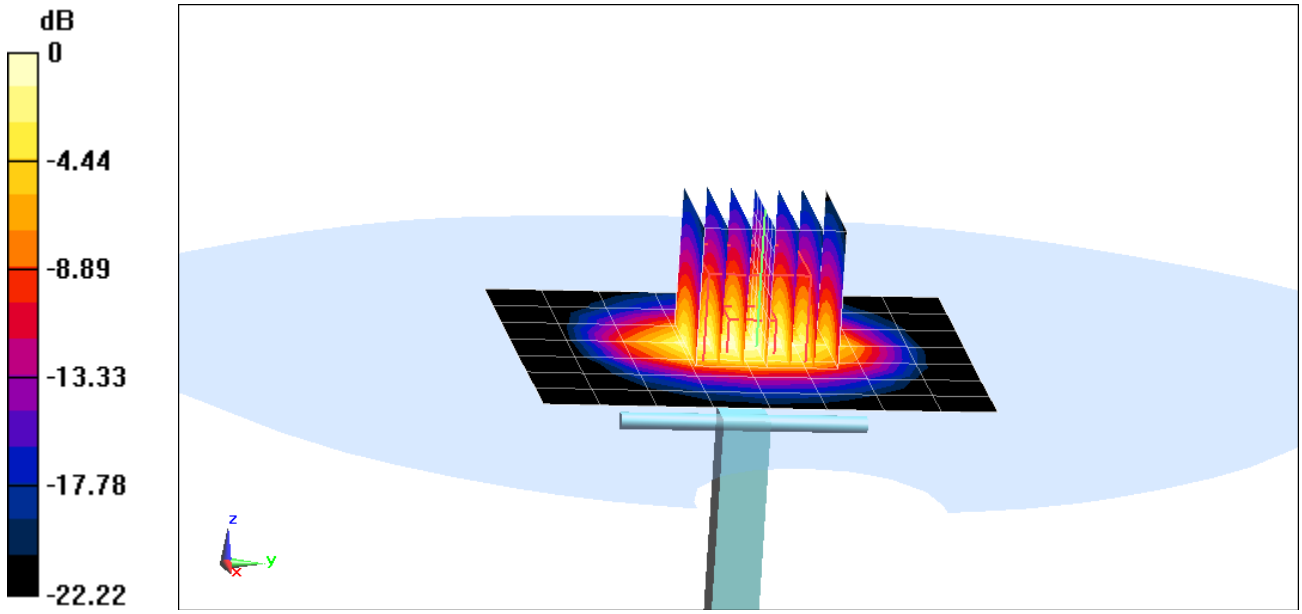
Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: 2450 Head Medium parameters used:
f = 2450 MHz; σ = 1.754 S/m; ε_r = 40.636; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-19-2015; Ambient Temp: 24.3°C; Tissue Temp: 23.2°C

Probe: ES3DV3 - SN3213; ConvF(4.54, 4.54, 4.54); Calibrated: 1/20/2015;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1407; Calibrated: 1/19/2015
Phantom: SAM Front; Type: SAM; Serial: 1686
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

2450 MHz System Verification

Area Scan (8x9x1): Measurement grid: dx=12mm, dy=12mm
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Input Power = 20 dBm (100 mW)
Peak SAR (extrapolated) = 9.83 W/kg
SAR(1 g) = 4.81 W/kg
Deviation = -7.68%



0 dB = 6.24 W/kg = 7.95 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

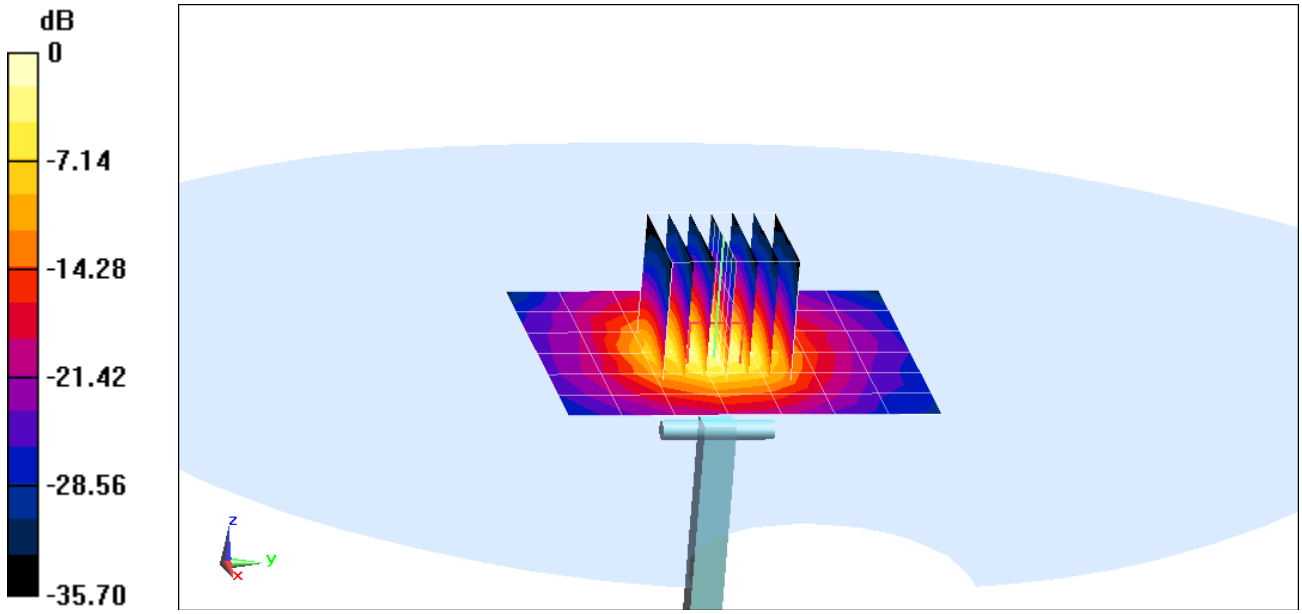
Communication System: UID 0, CW; Frequency: 5300 MHz; Duty Cycle: 1:1
Medium: 5 GHz Head Medium parameters used:
f = 5300 MHz; σ = 4.662 S/m; ε_r = 36.141; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-18-2015; Ambient Temp: 20.9°C; Tissue Temp: 19.8°C

Probe: EX3DV4 - SN7308; ConvF(5.37, 5.37, 5.37); Calibrated: 7/16/2014;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1323; Calibrated: 9/17/2014
Phantom: SAM V5.0 Right; Type: QD000P40CD; Serial: 1647
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

5300 MHz System Verification

Area Scan (7x8x1): Measurement grid: dx=10mm, dy=10mm
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Input Power = 17 dBm (50 mW)
Peak SAR (extrapolated) = 16.9 W/kg
SAR(1 g) = 3.91 W/kg
Deviation = -7.67%



0 dB = 10.0 W/kg = 10.00 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

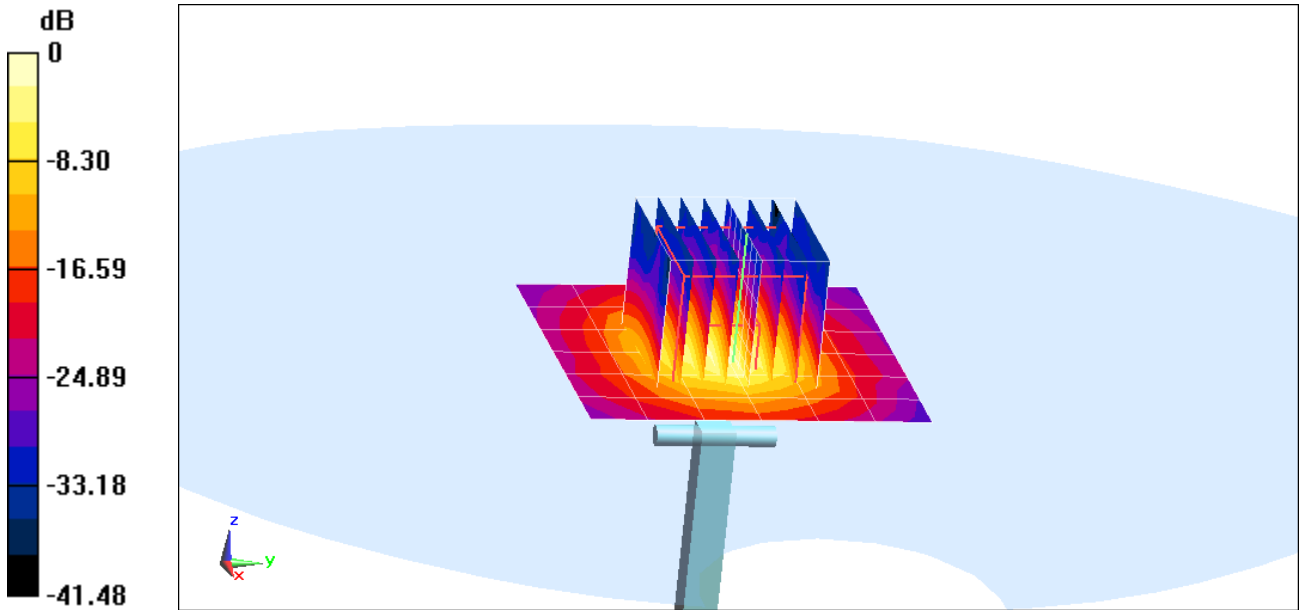
Communication System: UID 0, CW; Frequency: 5500 MHz; Duty Cycle: 1:1
Medium: 5 GHz Head Medium parameters used:
f = 5500 MHz; σ = 4.878 S/m; ε_r = 35.853; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-18-2015; Ambient Temp: 20.8°C; Tissue Temp: 19.8°C

Probe: EX3DV4 - SN7308; ConvF(4.64, 4.64, 4.64); Calibrated: 7/16/2014;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1323; Calibrated: 9/17/2014
Phantom: SAM V5.0 Right; Type: QD000P40CD; Serial: 1647
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

5500 MHz System Verification

Area Scan (7x7x1): Measurement grid: dx=10mm, dy=10mm
Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Input Power = 17 dBm (50 mW)
Peak SAR (extrapolated) = 17.6 W/kg
SAR(1 g) = 3.98 W/kg
Deviation = -5.58%



0 dB = 9.68 W/kg = 9.86 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

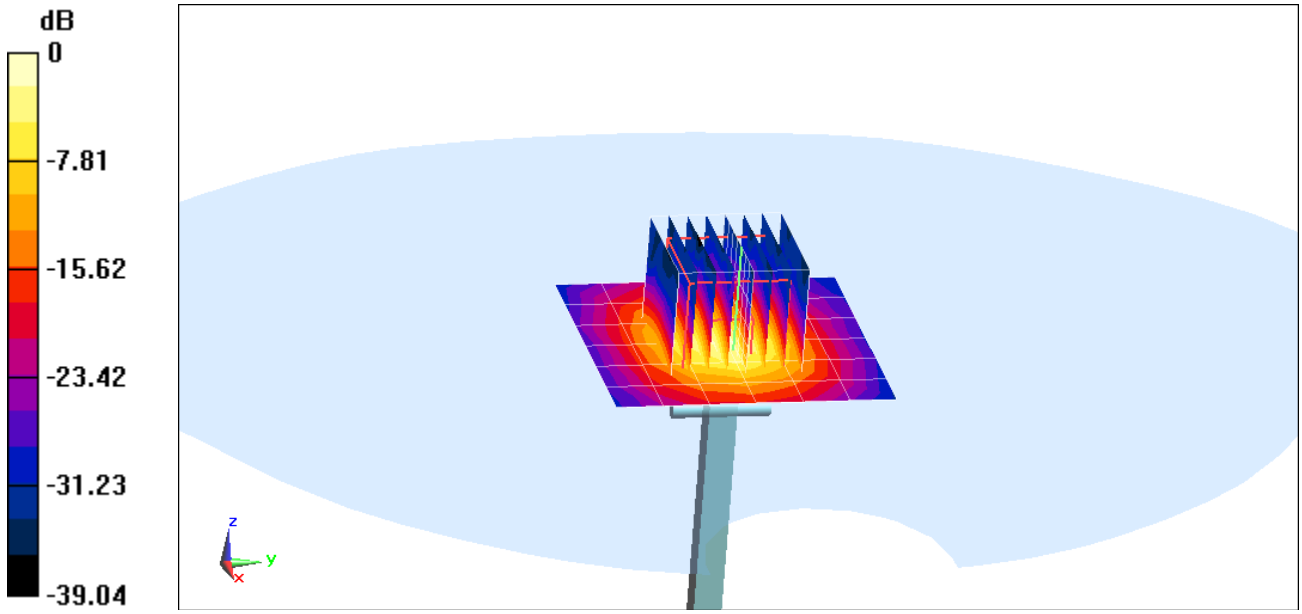
Communication System: UID 0, CW; Frequency: 5800 MHz; Duty Cycle: 1:1
Medium: 5 GHz Head Medium parameters used:
f = 5800 MHz; σ = 5.446 S/m; ε_r = 36.405; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-23-2015; Ambient Temp: 20.6°C; Tissue Temp: 20.4°C

Probe: EX3DV4 - SN7308; ConvF(4.81, 4.81, 4.81); Calibrated: 7/16/2014;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1323; Calibrated: 9/17/2014
Phantom: SAM V5.0 Right; Type: QD000P40CD; Serial: 1647
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

5800 MHz System Verification

Area Scan (7x7x1): Measurement grid: dx=10mm, dy=10mm
Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Input Power = 17 dBm (50 mW)
Peak SAR (extrapolated) = 17.0 W/kg
SAR(1 g) = 3.67 W/kg
Deviation = -9.49%



0 dB = 9.15 W/kg = 9.61 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

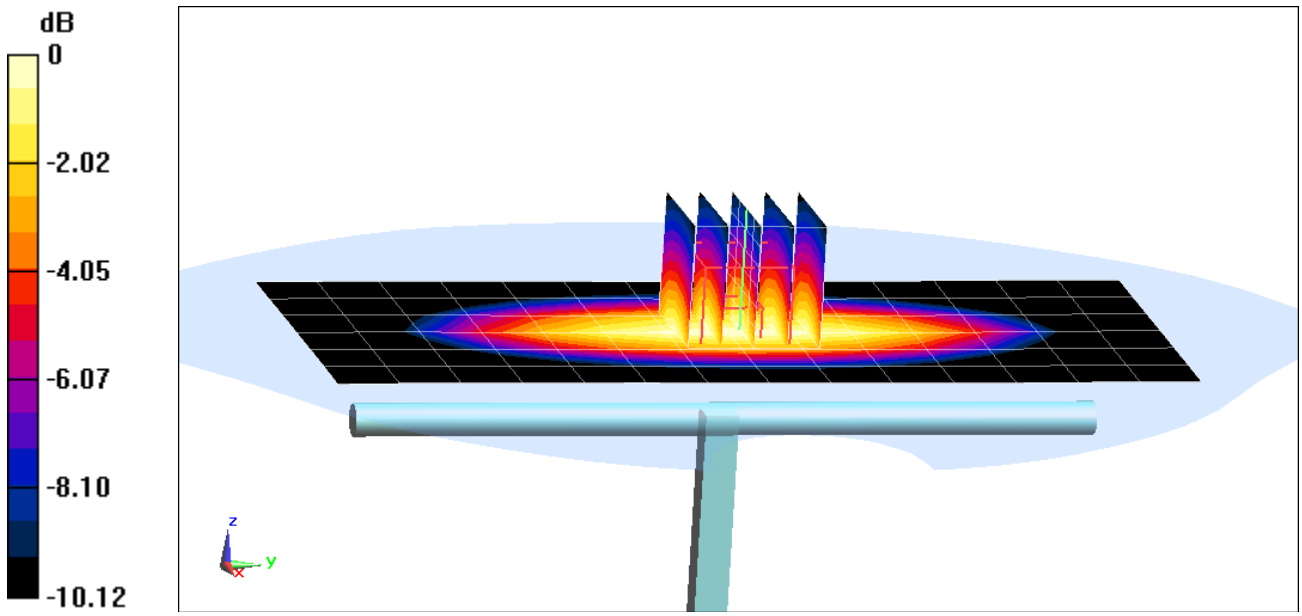
Communication System: UID 0, CW; Frequency: 750 MHz; Duty Cycle: 1:1
Medium: 750 Body Medium parameters used (interpolated):
f = 750 MHz; σ = 0.961 S/m; ε_r = 56.48; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 02-23-2015; Ambient Temp: 24.4°C; Tissue Temp: 22.6°C

Probe: ES3DV3 - SN3288; ConvF(6.38, 6.38, 6.38); 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) = 1.29 W/kg
SAR(1 g) = 0.869 W/kg
Deviation = 0.58%



0 dB = 1.01 W/kg = 0.04 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

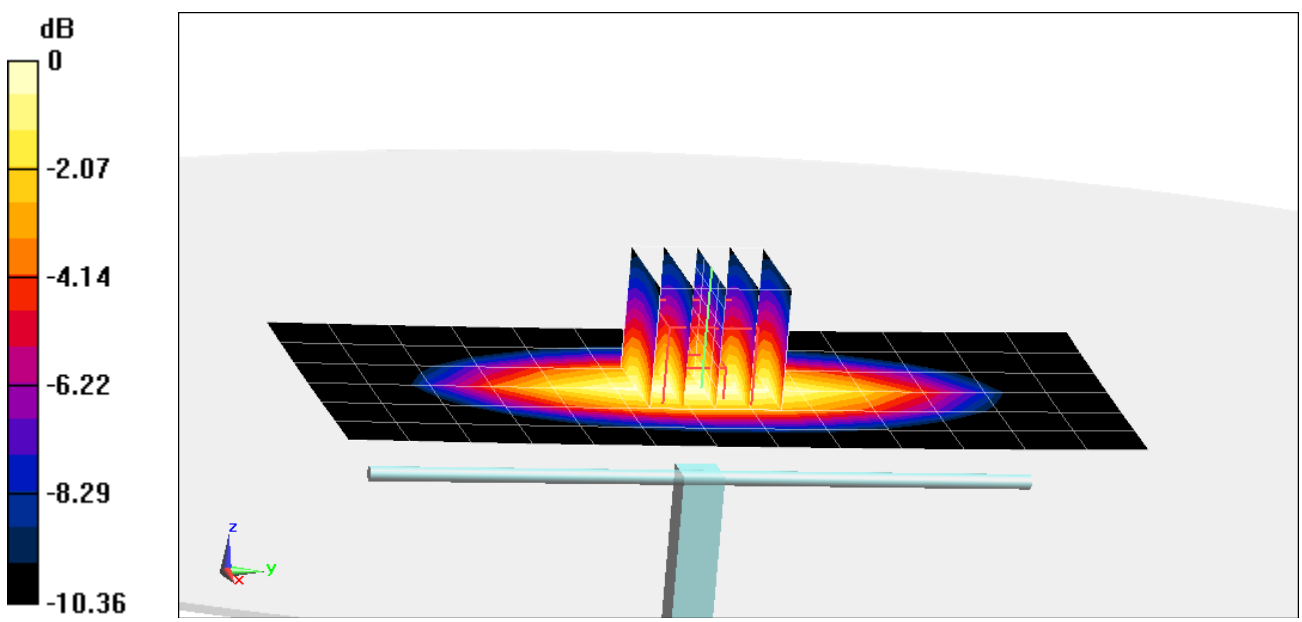
Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1
Medium: 835 Body Medium parameters used:
f = 835 MHz; σ = 1.005 S/m; ε_r = 54.281; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 02-17-2015; Ambient Temp: 23.4°C; Tissue Temp: 22.3°C

Probe: ES3DV3 - SN3288; ConvF(6.32, 6.32, 6.32); Calibrated: 9/24/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1364; Calibrated: 9/18/2014
Phantom: ELI v5.0; Type: QDOVA001BB; Serial: 1229
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

835 MHz System Verification

Area Scan (7x14x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Input Power = 20 dBm (100 mW)
Peak SAR (extrapolated) = 1.48 W/kg
SAR(1 g) = 1.01 W/kg
Deviation = 8.02%



0 dB = 1.18 W/kg = 0.72 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: 5d149

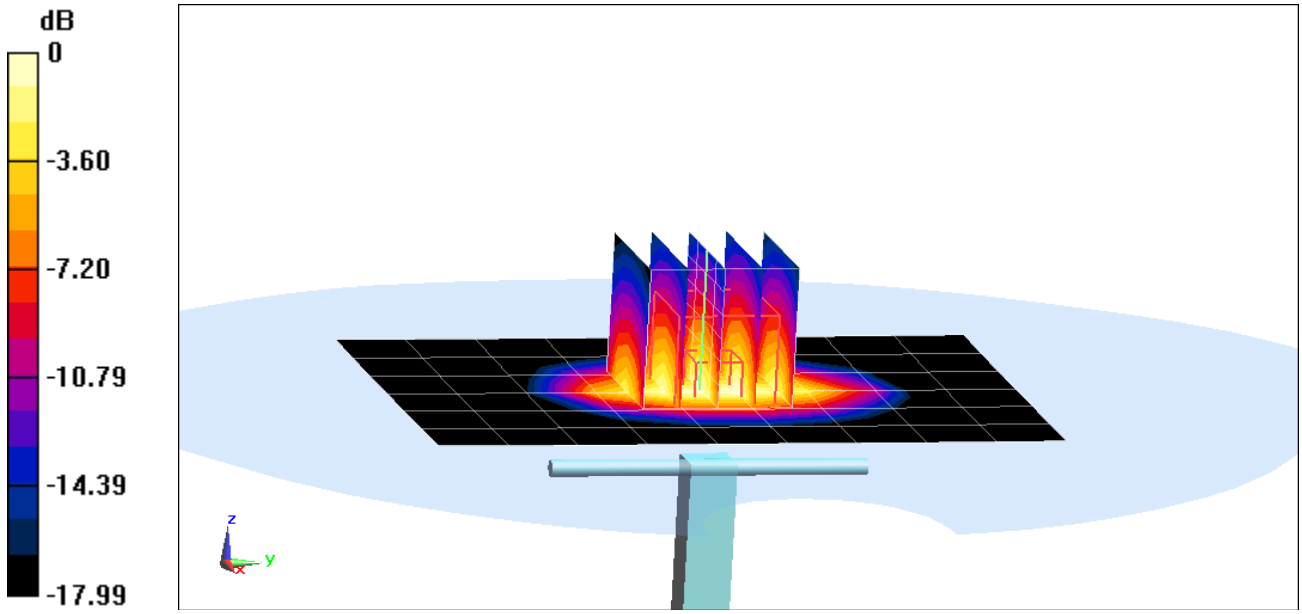
Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium: 1900 Body Medium parameters used (interpolated):
f = 1900 MHz; σ = 1.580 S/m; ε_r = 51.193; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-18-2015; Ambient Temp: 22.9°C; Tissue Temp: 22.1°C

Probe: ES3DV3 - SN3263; ConvF(4.78, 4.78, 4.78); Calibrated: 5/15/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn859; Calibrated: 5/14/2014
Phantom: SAM v5.0 Left; Type: QD000P40CD; Serial: TP: 1687
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) = 7.67 W/kg
SAR(1 g) = 4.27 W/kg
Deviation = 5.69%



0 dB = 5.37 W/kg = 7.30 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

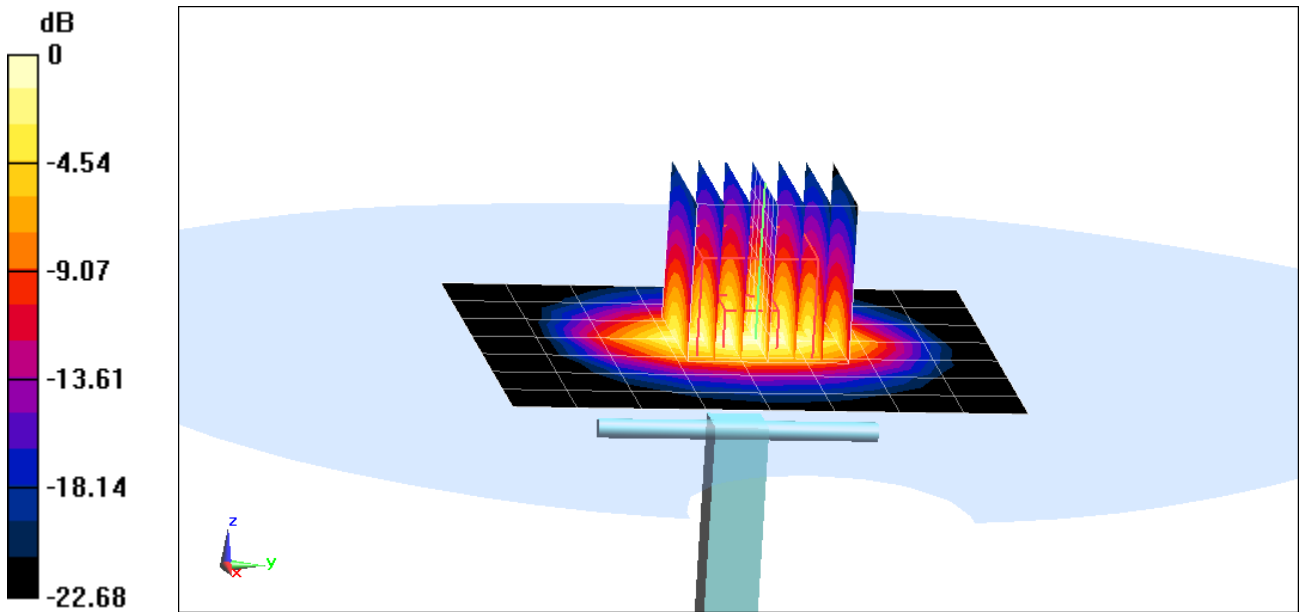
Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: 2450 Body Medium parameters used:
f = 2450 MHz; σ = 1.967 S/m; ε_r = 52.481; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-23-2015; Ambient Temp: 22.0°C; Tissue Temp: 23.5°C

Probe: ES3DV3 - SN3263; ConvF(4.27, 4.27, 4.27); Calibrated: 5/15/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn859; Calibrated: 5/14/2014
Phantom: SAM v5.0 front; Type: QD000P40CD; Serial: TP-1646
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

2450 MHz System Verification

Area Scan (8x9x1): Measurement grid: dx=12mm, dy=12mm
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Input Power = 20 dBm (100 mW)
Peak SAR (extrapolated) = 11.2 W/kg
SAR(1 g) = 5.14 W/kg
Deviation = -0.77%



0 dB = 6.75 W/kg = 8.29 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

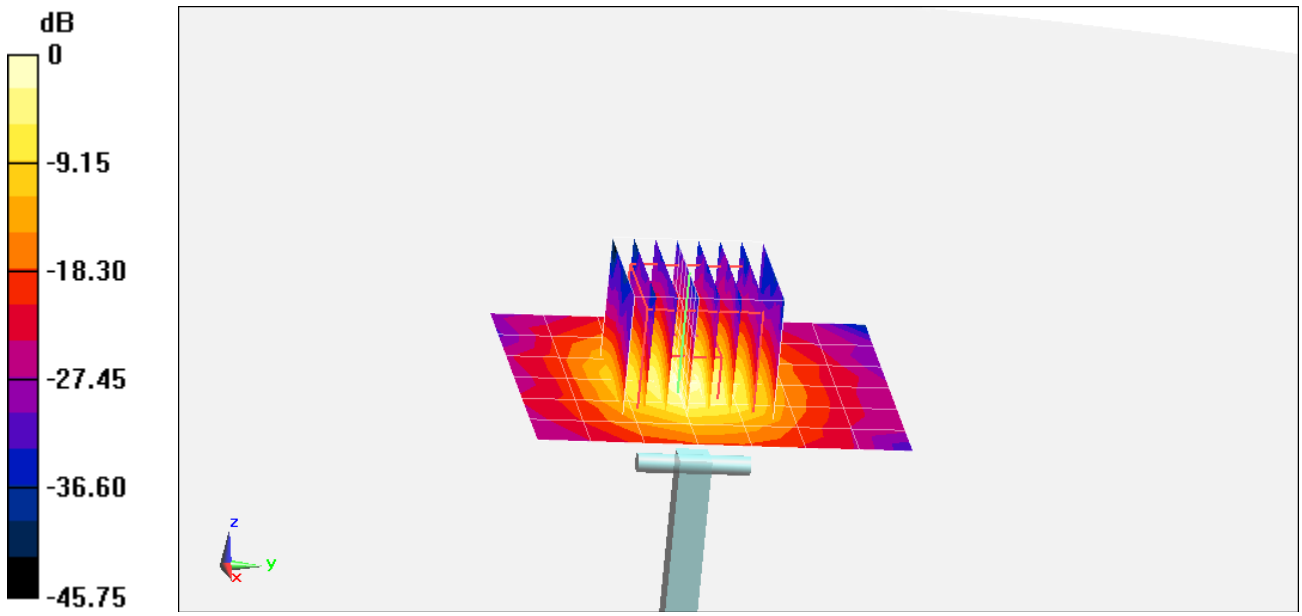
Communication System: UID 0, CW; Frequency: 5300 MHz; Duty Cycle: 1:1
Medium: 5GHz Body Medium parameters used:
f = 5300 MHz; σ = 5.505 S/m; ε_r = 51.124; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-23-2015; Ambient Temp: 21.6°C; Tissue Temp: 20.8°C

Probe: EX3DV4 - SN3920; ConvF(4.16, 4.16, 4.16); Calibrated: 12/12/2014;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1368; Calibrated: 4/11/2014
Phantom: ELI Front; Type: QDOVA002AA; Serial: TP:1202
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

5300 MHz System Verification

Area Scan (7x8x1): Measurement grid: dx=10mm, dy=10mm
Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Input Power = 17 dBm (50 mW)
Peak SAR (extrapolated) = 15.7 W/kg
SAR(1 g) = 3.81 W/kg
Deviation = 2.70%



0 dB = 9.02 W/kg = 9.55 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

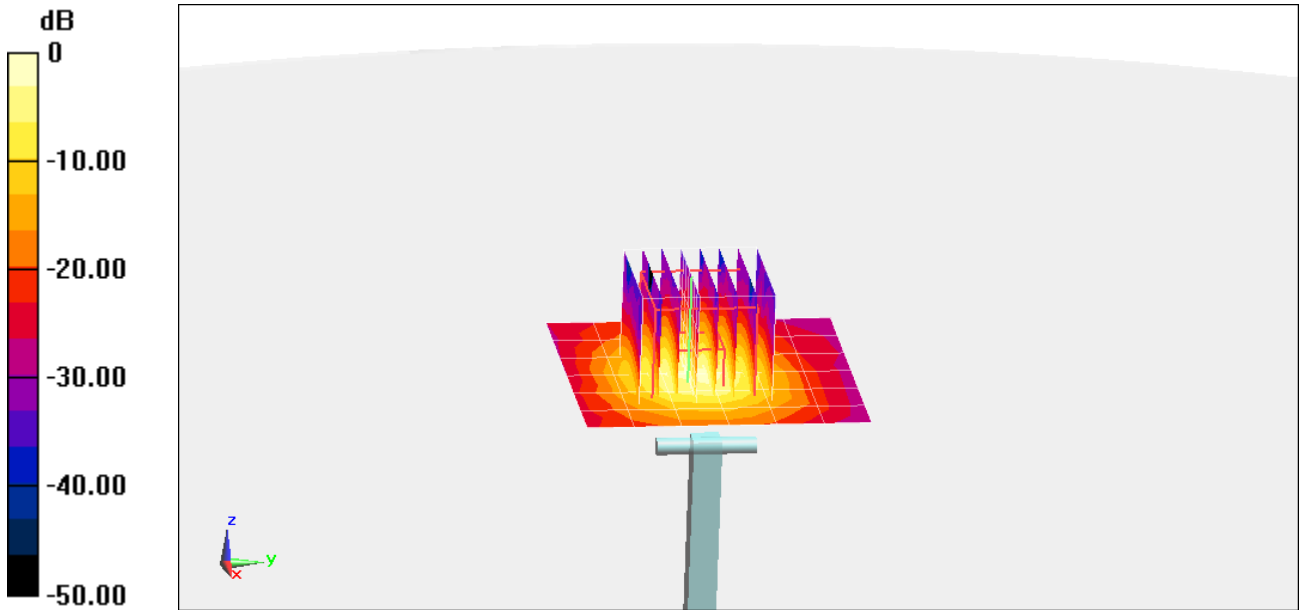
Communication System: UID 0, CW; Frequency: 5500 MHz; Duty Cycle: 1:1
Medium: 5GHz Body Medium parameters used:
f = 5500 MHz; σ = 5.855 S/m; ε_r = 50.845; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-23-2015; Ambient Temp: 21.5°C; Tissue Temp: 20.8°C

Probe: EX3DV4 - SN3920; ConvF(3.79, 3.79, 3.79); Calibrated: 12/12/2014;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1368; Calibrated: 4/11/2014
Phantom: ELI Front; Type: QDOVA002AA; Serial: TP:1202
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

5500 MHz System Verification

Area Scan (7x7x1): Measurement grid: dx=10mm, dy=10mm
Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Input Power = 17 dBm (50 mW)
Peak SAR (extrapolated) = 17.9 W/kg
SAR(1 g) = 4.26 W/kg
Deviation = 7.58%



0 dB = 10.1 W/kg = 10.04 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

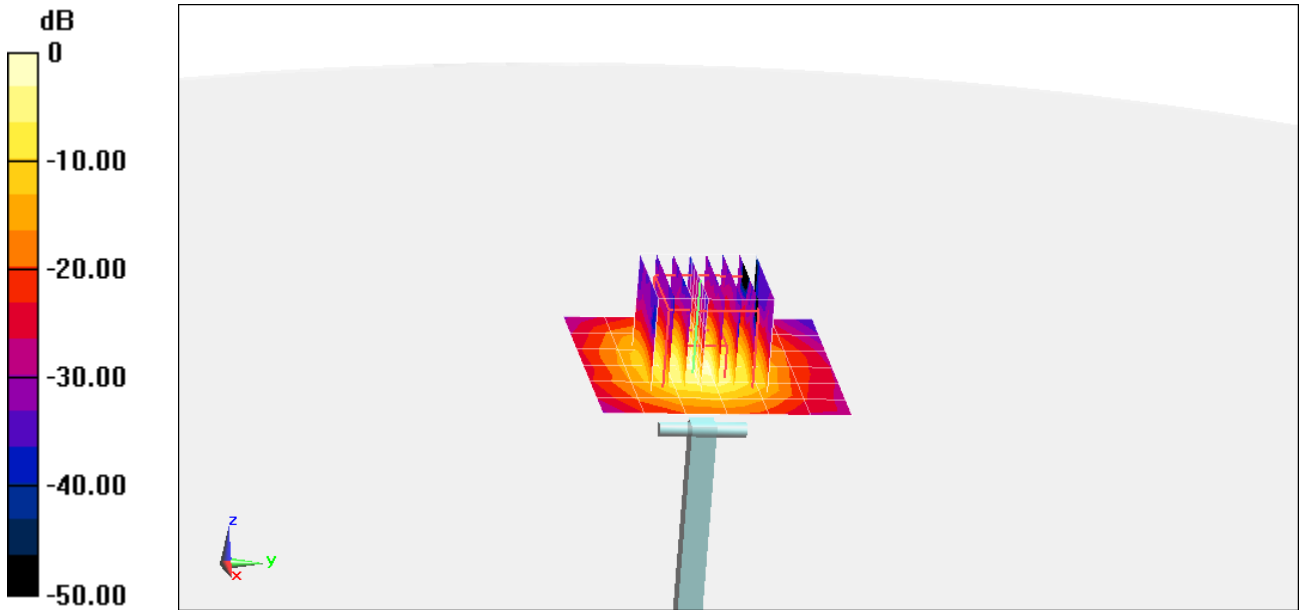
Communication System: UID 0, CW; Frequency: 5800 MHz; Duty Cycle: 1:1
Medium: 5GHz Body Medium parameters used:
f = 5800 MHz; σ = 6.244 S/m; ε_r = 50.082; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-23-2015; Ambient Temp: 21.7°C; Tissue Temp: 20.8°C

Probe: EX3DV4 - SN3920; ConvF(3.93, 3.93, 3.93); Calibrated: 12/12/2014;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1368; Calibrated: 4/11/2014
Phantom: ELI Front; Type: QDOVA002AA; Serial: TP:1202
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

5800 MHz System Verification

Area Scan (7x7x1): Measurement grid: dx=10mm, dy=10mm
Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Input Power = 17 dBm (50 mW)
Peak SAR (extrapolated) = 17.6 W/kg
SAR(1 g) = 3.83 W/kg
Deviation = 2.00%



0 dB = 9.87 W/kg = 9.94 dBW/kg

APPENDIX C: PROBE CALIBRATION

© 2014 PCTEST Engineering Laboratory, Inc.

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

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

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

Accreditation No.: SCS 108

Client **PC Test**

Certificate No: 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

CCJ 3/28/14

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 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

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

Issued: March 17, 2014

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

PCTH 80880

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	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	750 MHz ± 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 ± 0.2) °C	40.6 ± 6 %	0.92 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.15 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**8.33 W/kg ± 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 ± 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 ± 0.2) °C	55.2 ± 6 %	1.00 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.23 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**8.64 W/kg ± 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 ± 16.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	55.1 Ω + 0.7 jΩ
Return Loss	- 26.2 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.5 Ω - 2.8 jΩ
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

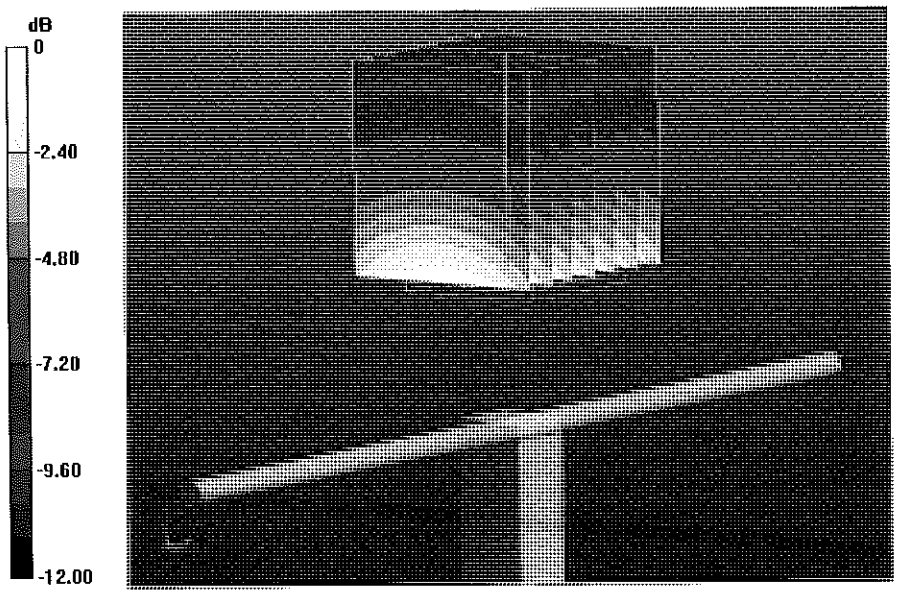
Communication System: UID 0 - CW; Frequency: 750 MHz
Medium parameters used: f = 750 MHz; σ = 0.92 S/m; ε_r = 40.6; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

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)

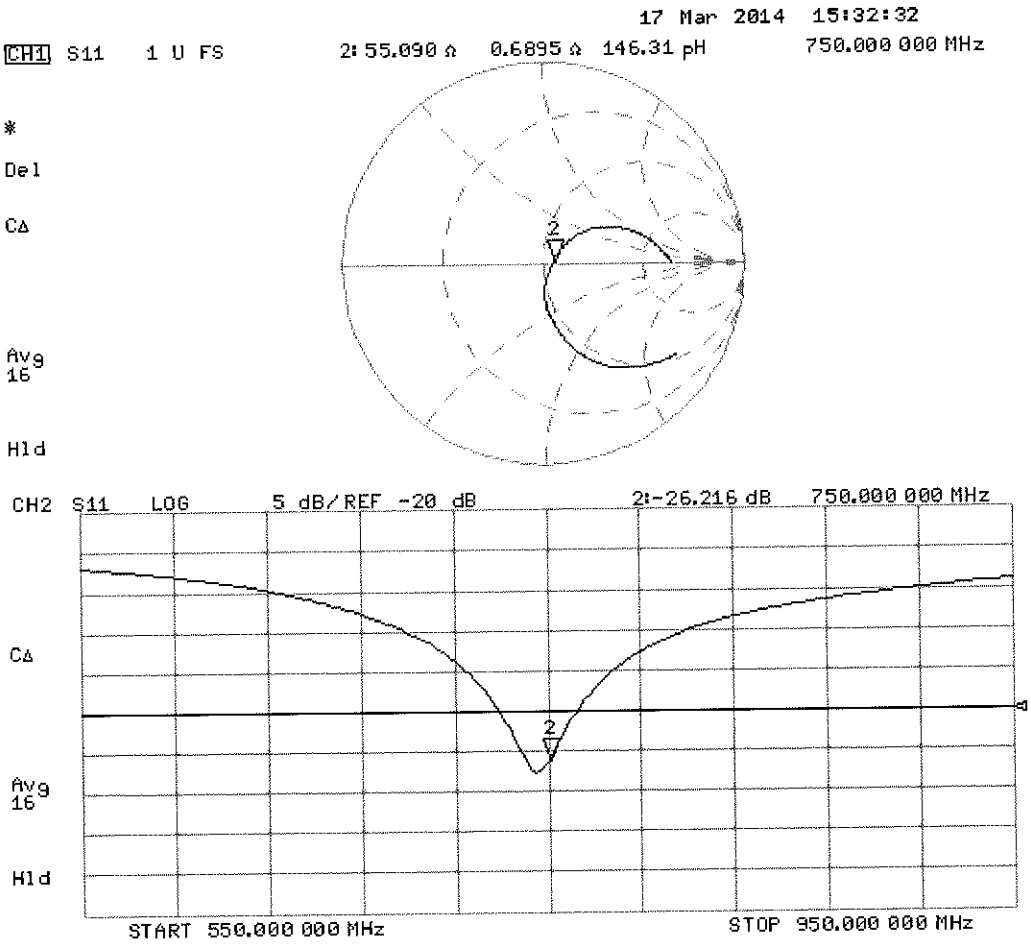
Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

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



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

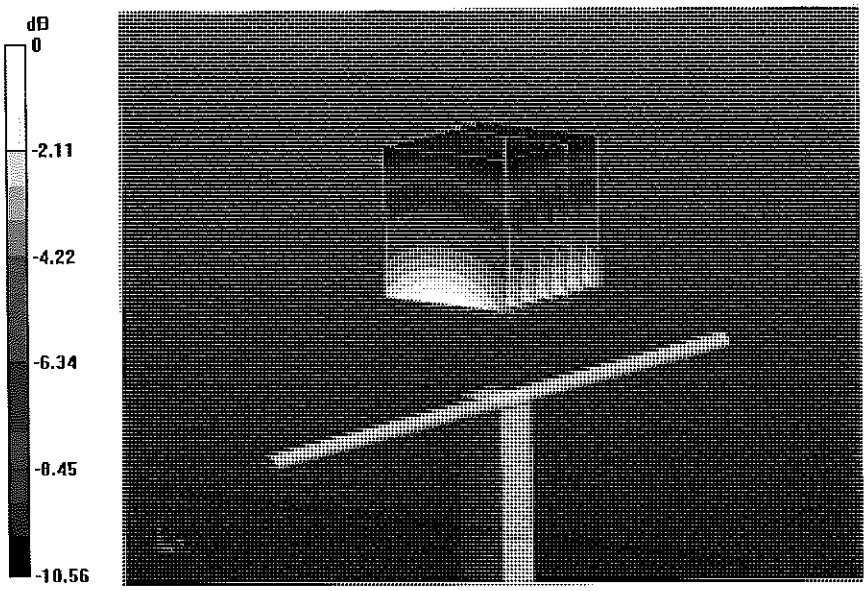
Communication System: UID 0 - CW; Frequency: 750 MHz
Medium parameters used: f = 750 MHz; σ = 1 S/m; ε_r = 55.2; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

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)

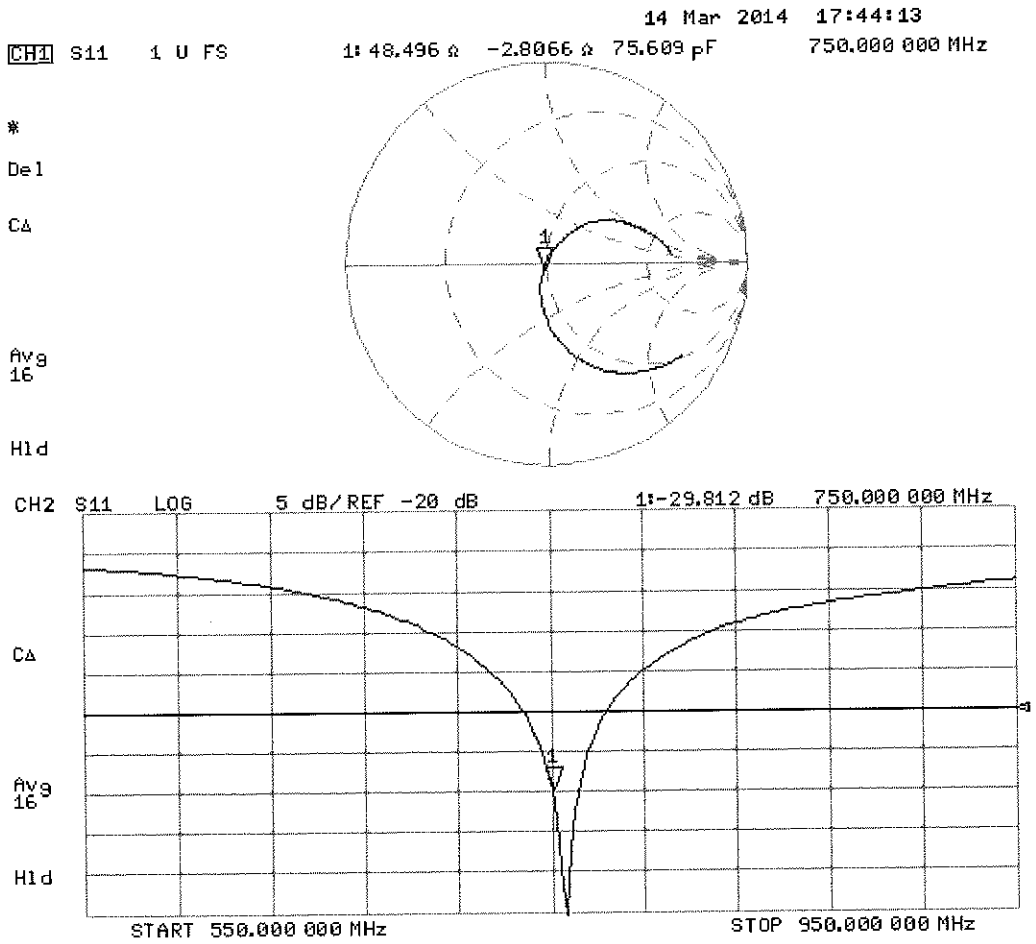
Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

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



0 dB = 2.59 W/kg = 4.13 dBW/kg

Impedance Measurement Plot for Body TSL



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

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

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D835V2-4d133_Jul14**

CALIBRATION CERTIFICATE

Object	D835V2 - SN: 4d133
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	July 24, 2014

CC 8/6/14

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

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

Issued: July 24, 2014

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

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "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	V52.8.8
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 ± 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 ± 0.2) °C	41.1 ± 6 %	0.94 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.38 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**9.20 W/kg ± 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 ± 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 ± 0.2) °C	53.8 ± 6 %	1.02 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.44 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**9.35 W/kg ± 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 ± 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 jΩ
Return Loss	- 34.7 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.8 Ω - 3.3 jΩ
Return Loss	- 27.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.395 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	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

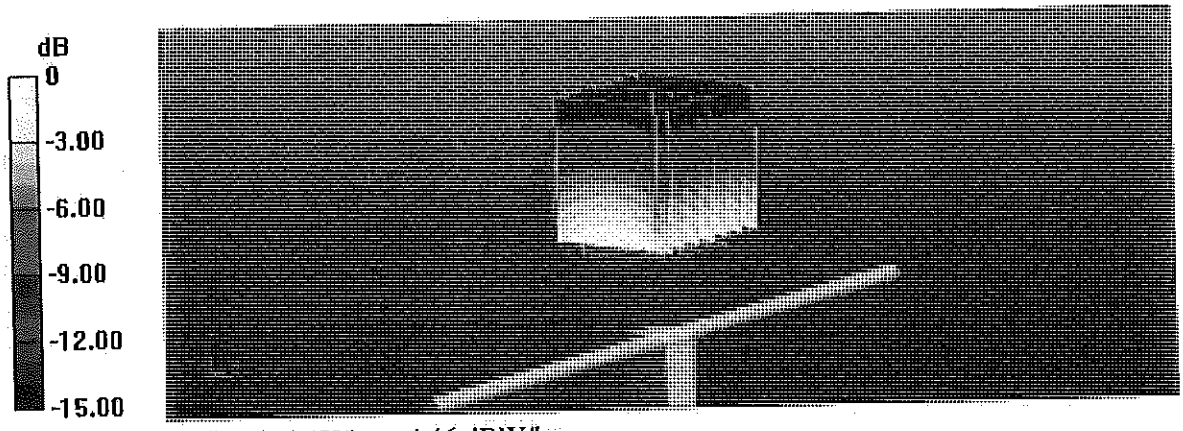
Communication System: UID 0 - CW; Frequency: 835 MHz
Medium parameters used: f = 835 MHz; σ = 0.94 S/m; ε_r = 41.1; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

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)

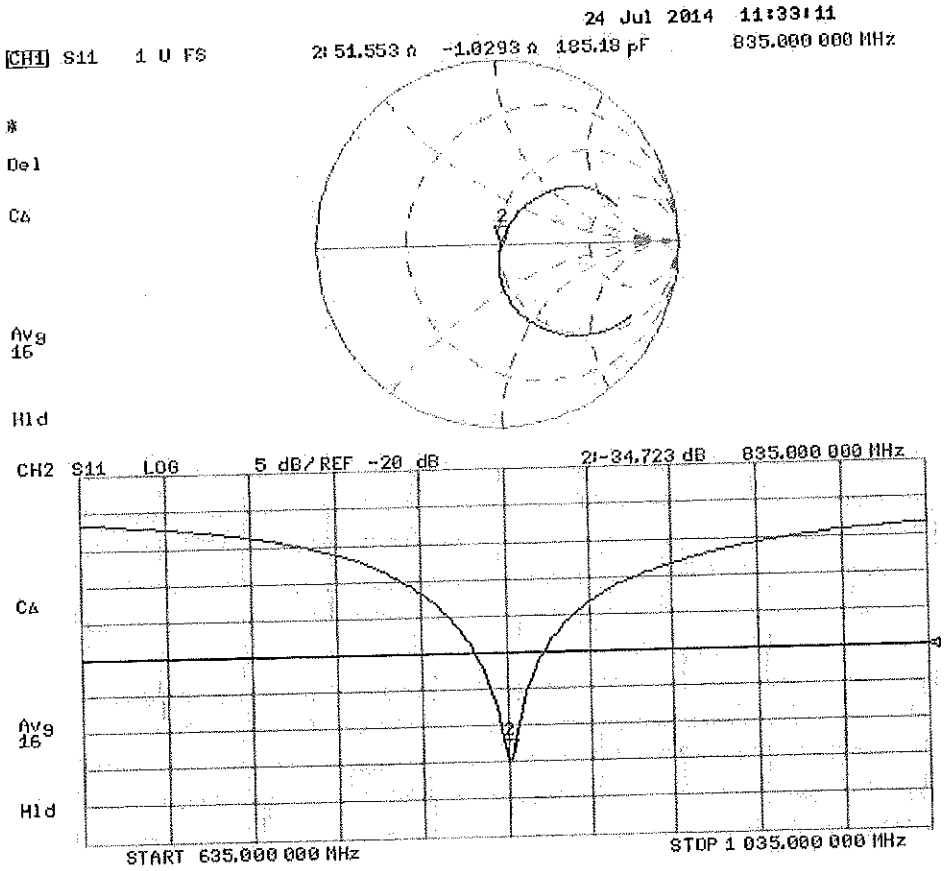
Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

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



0 dB = 2.79 W/kg = 4.46 dBW/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

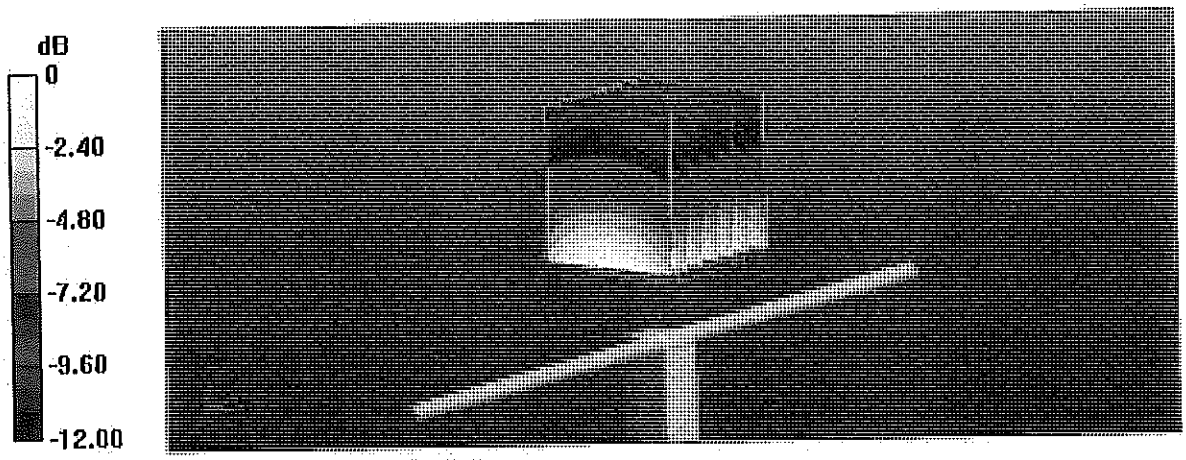
Communication System: UID 0 - CW; Frequency: 835 MHz
Medium parameters used: f = 835 MHz; σ = 1.02 S/m; ε_r = 53.8; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

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)

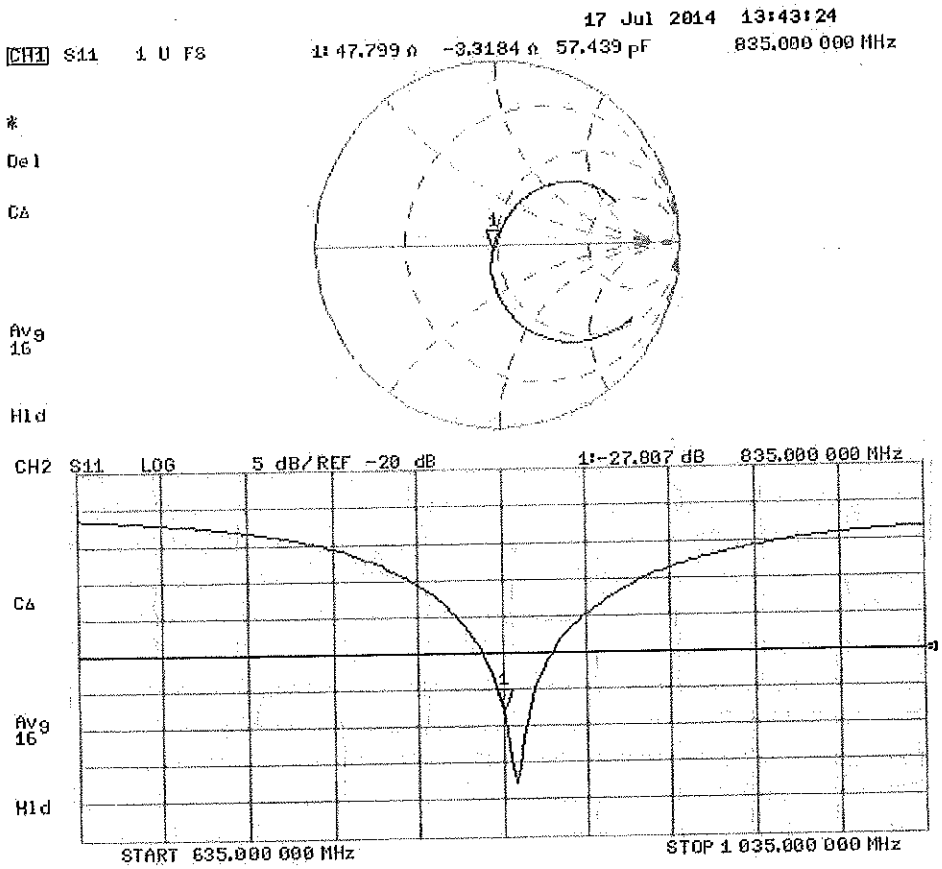
Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

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



0 dB = 2.84 W/kg = 4.53 dBW/kg

Impedance Measurement Plot for Body TSL



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: **D1900V2-5d149_Jul14**

CALIBRATION CERTIFICATE

Object	D1900V2 - SN: 5d149
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	July 23, 2014

CC 11/5/14

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

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

Issued: July 23, 2014

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

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "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	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz ± 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 ± 0.2) °C	39.5 ± 6 %	1.38 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	10.0 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**40.2 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**21.0 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.5 ± 6 %	1.51 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.1 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**40.4 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.33 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.3 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.6 Ω + 5.5 jΩ
Return Loss	- 24.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.8 Ω + 6.1 jΩ
Return Loss	- 24.0 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: 23.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d149

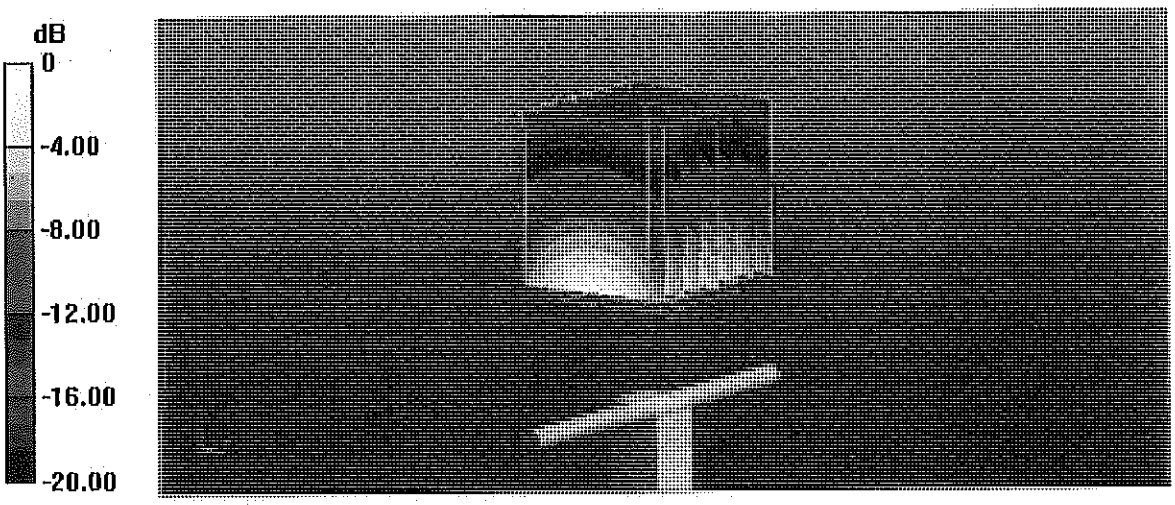
Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; σ = 1.38 S/m; ε_r = 39.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

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: 30.04.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

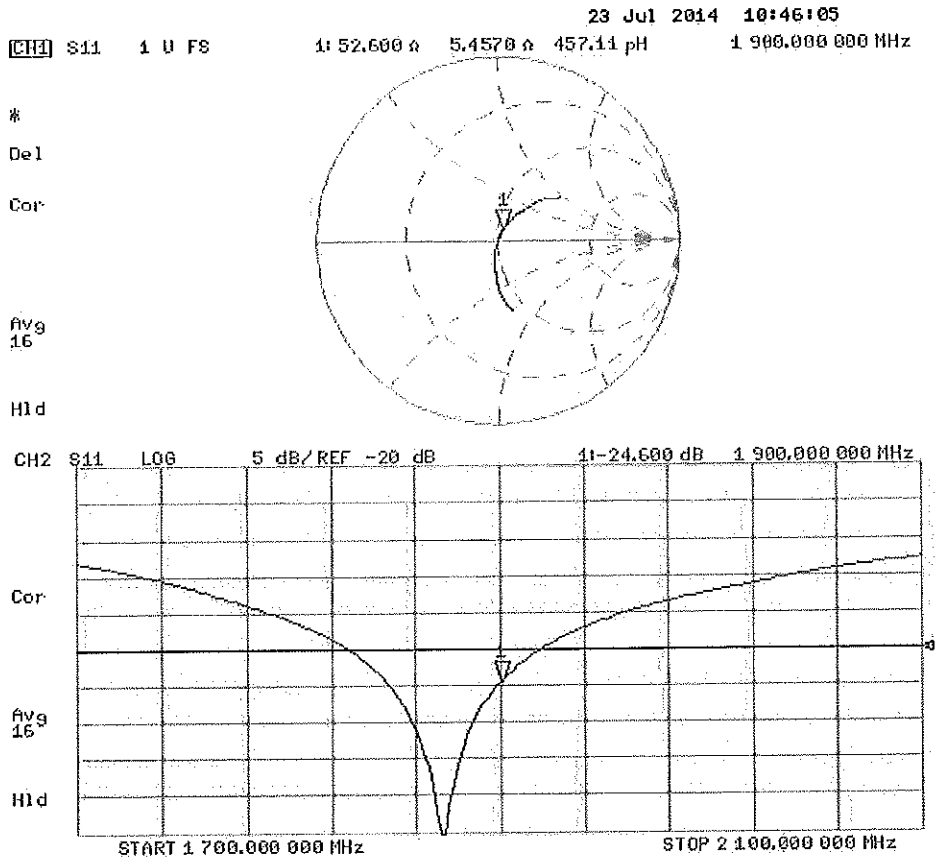
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 98.92 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 18.4 W/kg
SAR(1 g) = 10 W/kg; SAR(10 g) = 5.24 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



DASY5 Validation Report for Body TSL

Date: 23.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d149

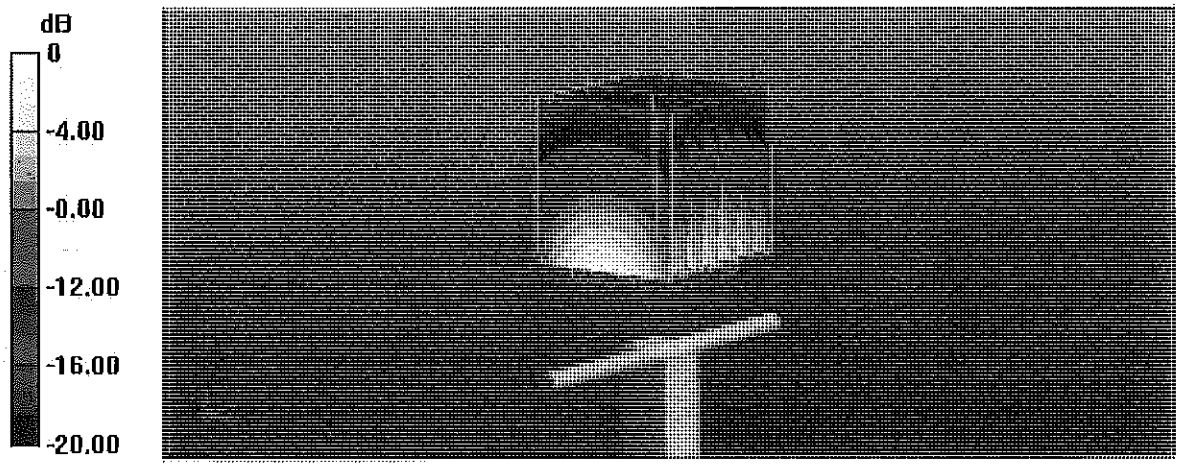
Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; σ = 1.51 S/m; ε_r = 52.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

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: 30.04.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

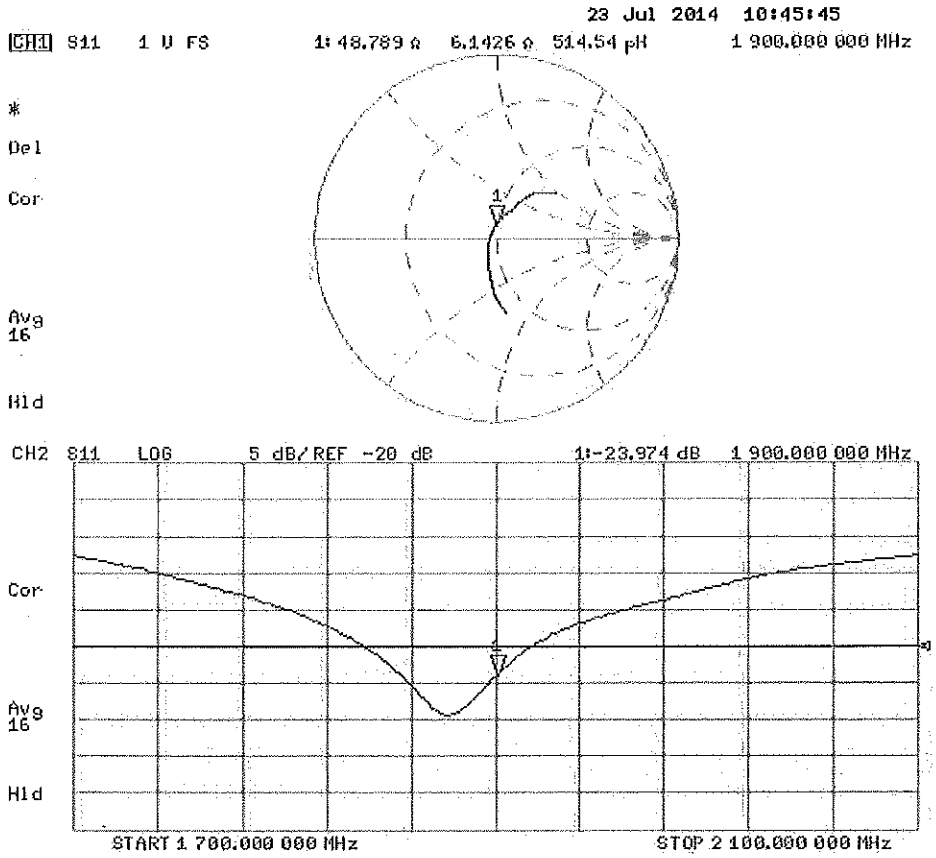
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 95.83 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 17.6 W/kg
SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.33 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 Body TSL



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

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

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

Accreditation No.: SCS 108

Client **PC Test**

Certificate No: 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

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	M. Weber
Approved by:	Katja Pokovic	Technical Manager	

Issued: August 12, 2014

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

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "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	V52.8.8
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 ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	38.0 ± 6 %	1.82 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**52.1 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.09 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.2 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	50.5 ± 6 %	2.02 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.3 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**51.8 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (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 ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.9 Ω + 3.0 jΩ
Return Loss	- 25.2 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.9 Ω + 5.8 jΩ
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

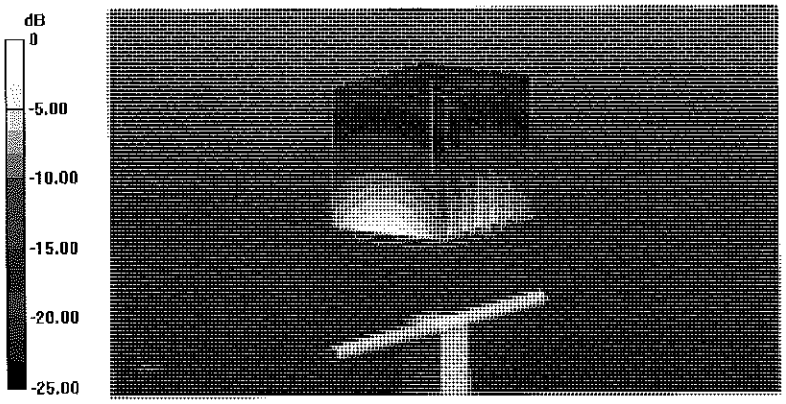
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.82 S/m; ε_r = 38; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

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)

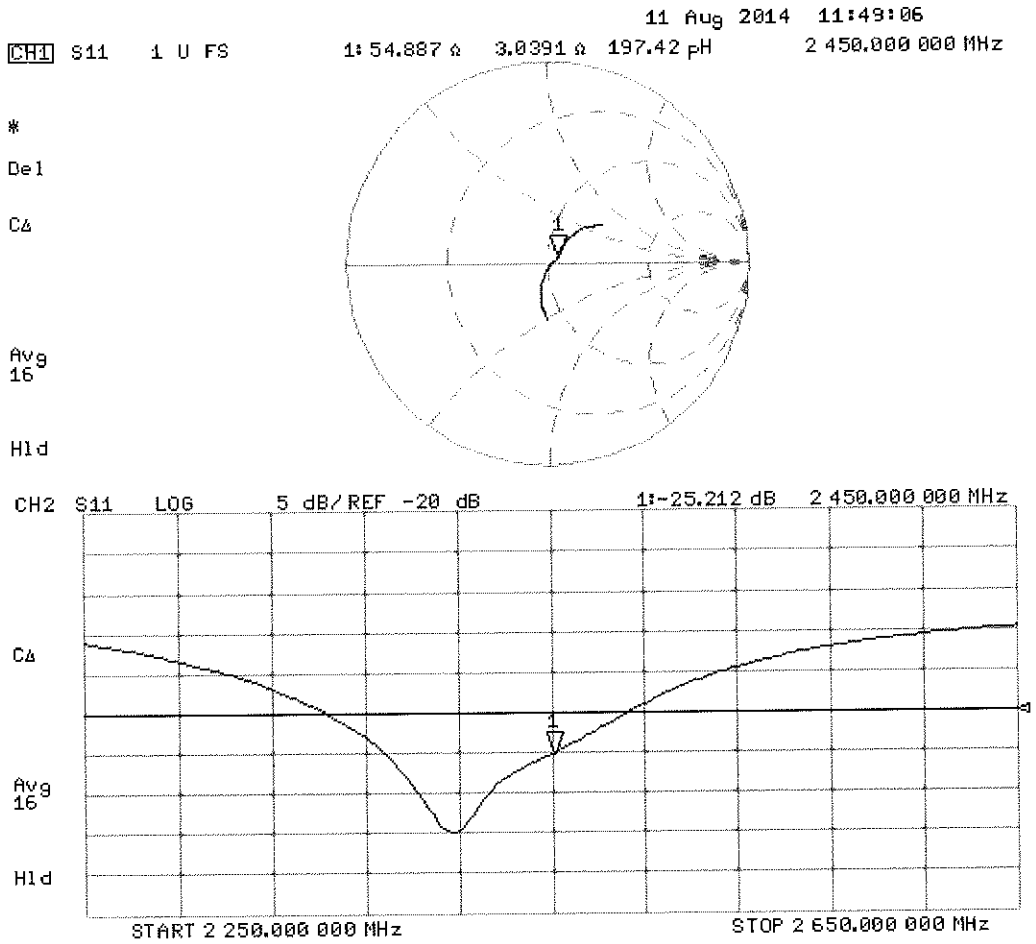
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

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



0 dB = 17.4 W/kg = 12.41 dBW/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

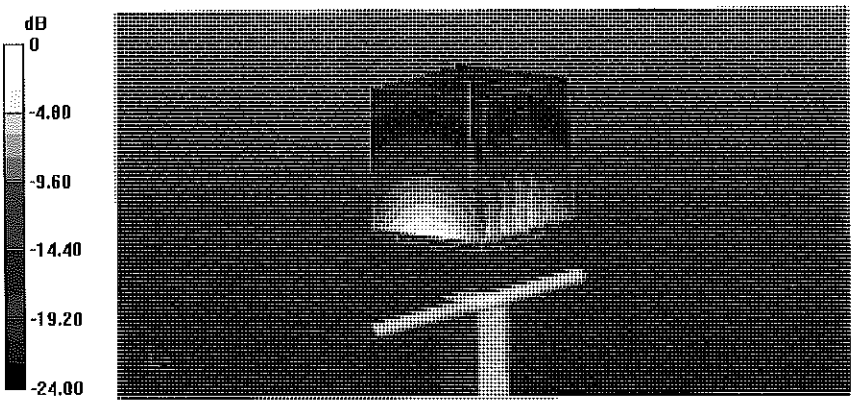
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.02 S/m; ε_r = 50.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

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)

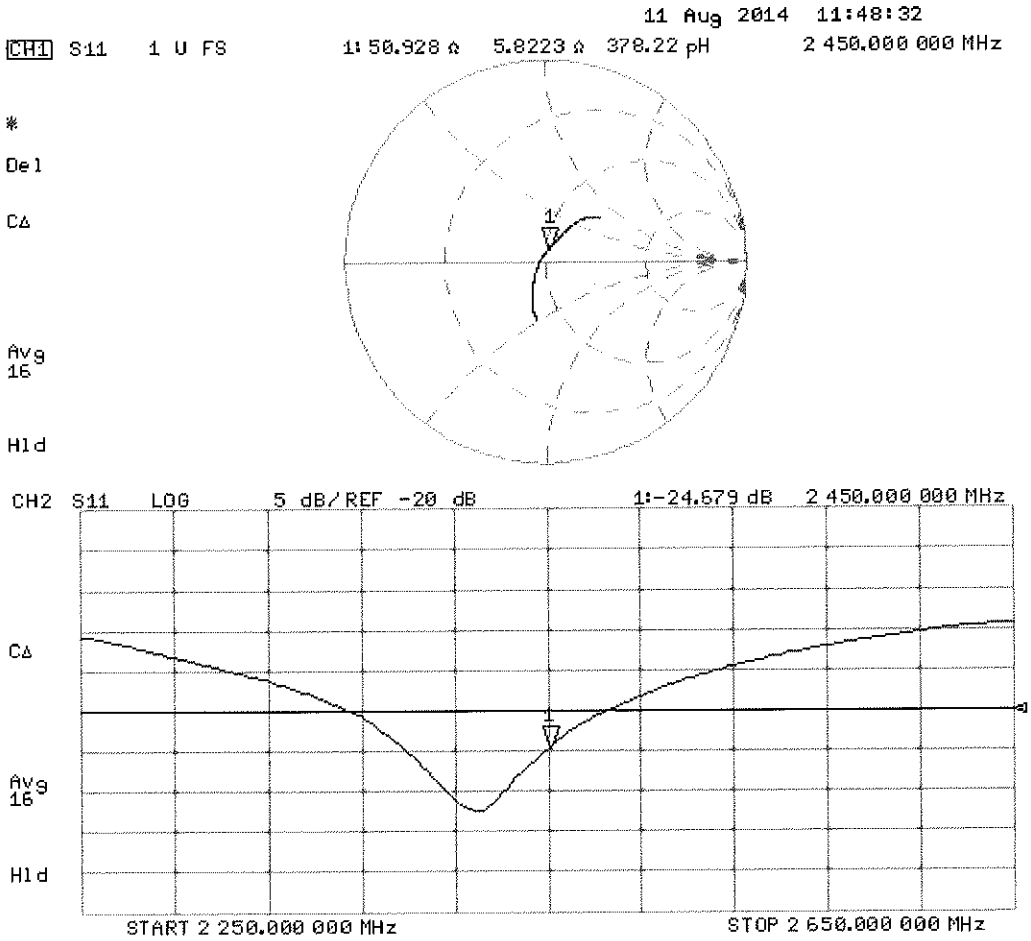
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

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



0 dB = 17.6 W/kg = 12.46 dBW/kg

Impedance Measurement Plot for Body TSL



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

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

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

Accreditation No.: SCS 0108

Client **PC Test**

Certificate No: D5GHzV2-1057_Jan15

CALIBRATION CERTIFICATE

Object	D5GHzV2 - SN:1057
Calibration procedure(s)	QA CAL-22.v2 Calibration procedure for dipole validation kits between 3-6 GHz
Calibration date:	January 21, 2015

CC
2/3/15

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	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
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 EX3DV4	SN: 3503	30-Dec-14 (No. EX3-3503_Dec14)	Dec-15
DAE4	SN: 601	18-Aug-14 (No. DAE4-601_Aug14)	Aug-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-14)	In house check: Oct-15

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	M. Weber
Approved by:	Katja Pokovic	Technical Manager	

Issued: January 22, 2015

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

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEC 62209-2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation, and Procedures"; Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", March 2010
b) 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	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz ± 1 MHz 5300 MHz ± 1 MHz 5500 MHz ± 1 MHz 5600 MHz ± 1 MHz 5800 MHz ± 1 MHz	

Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.3 ± 6 %	4.56 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.14 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**81.5 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.1 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.1 ± 6 %	4.66 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.47 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**84.7 W / kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.41 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.1 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	35.9 ± 6 %	4.86 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.43 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**84.3 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.38 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.8 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.6 ± 6 %	4.97 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	8.38 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**83.8 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.7 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.4 ± 6 %	5.18 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	8.11 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**81.1 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.9 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	49.4 ± 6 %	5.42 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.37 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**73.9 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.05 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.6 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	49.2 ± 6 %	5.55 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5300 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.41 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**74.2 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.08 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.9 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	48.9 ± 6 %	5.82 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	7.90 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	2.19 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	48.7 ± 6 %	5.96 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	7.75 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**77.7 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.14 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.5 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.4 ± 6 %	6.25 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	7.49 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**75.1 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.06 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.6 W/kg ± 19.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS0108)

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	49.0 Ω - 9.4 jΩ
Return Loss	- 20.4 dB

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	48.3 Ω - 4.2 jΩ
Return Loss	- 26.8 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	49.2 Ω - 5.0 jΩ
Return Loss	- 25.9 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	54.4 Ω - 4.8 jΩ
Return Loss	- 24.1 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	51.8 Ω - 2.6 jΩ
Return Loss	- 30.1 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	48.2 Ω - 8.4 jΩ
Return Loss	- 21.2 dB

Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	48.6 Ω - 3.6 jΩ
Return Loss	- 28.2 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	49.4 Ω - 4.1 jΩ
Return Loss	- 27.6 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	55.1 Ω - 4.0 jΩ
Return Loss	- 24.2 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	51.6 Ω - 1.6 jΩ
Return Loss	- 33.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.202 ns

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	November 27, 2006

DASY5 Validation Report for Head TSL

Date: 21.01.2015

Test Laboratory: SPEAG, Zurich, Switzerland

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

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; σ = 4.56 S/m; ε_r = 36.3; ρ = 1000 kg/m^3 , Medium parameters used: f = 5300 MHz; σ = 4.66 S/m; ε_r = 36.1; ρ = 1000 kg/m^3 , Medium parameters used: f = 5500 MHz; σ = 4.86 S/m; ε_r = 35.9; ρ = 1000 kg/m^3 , Medium parameters used: f = 5600 MHz; σ = 4.97 S/m; ε_r = 35.6; ρ = 1000 kg/m^3 , Medium parameters used: f = 5800 MHz; σ = 5.18 S/m; ε_r = 35.4; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.51, 5.51, 5.51); Calibrated: 30.12.2014, ConvF(5.21, 5.21, 5.21); Calibrated: 30.12.2014, ConvF(5.12, 5.12, 5.12); Calibrated: 30.12.2014, ConvF(4.92, 4.92, 4.92); Calibrated: 30.12.2014, ConvF(4.9, 4.9, 4.9); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

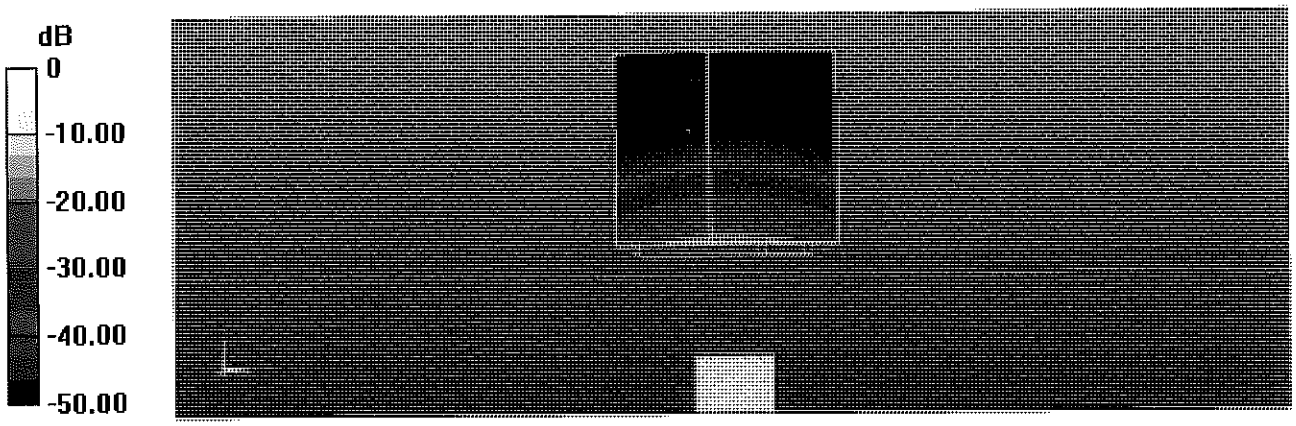
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 65.51 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 29.8 W/kg
SAR(1 g) = 8.14 W/kg; SAR(10 g) = 2.31 W/kg
Maximum value of SAR (measured) = 19.3 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 = 65.30 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 32.1 W/kg
SAR(1 g) = 8.47 W/kg; SAR(10 g) = 2.41 W/kg
Maximum value of SAR (measured) = 20.4 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 = 64.33 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 33.5 W/kg
SAR(1 g) = 8.43 W/kg; SAR(10 g) = 2.38 W/kg
Maximum value of SAR (measured) = 20.6 W/kg

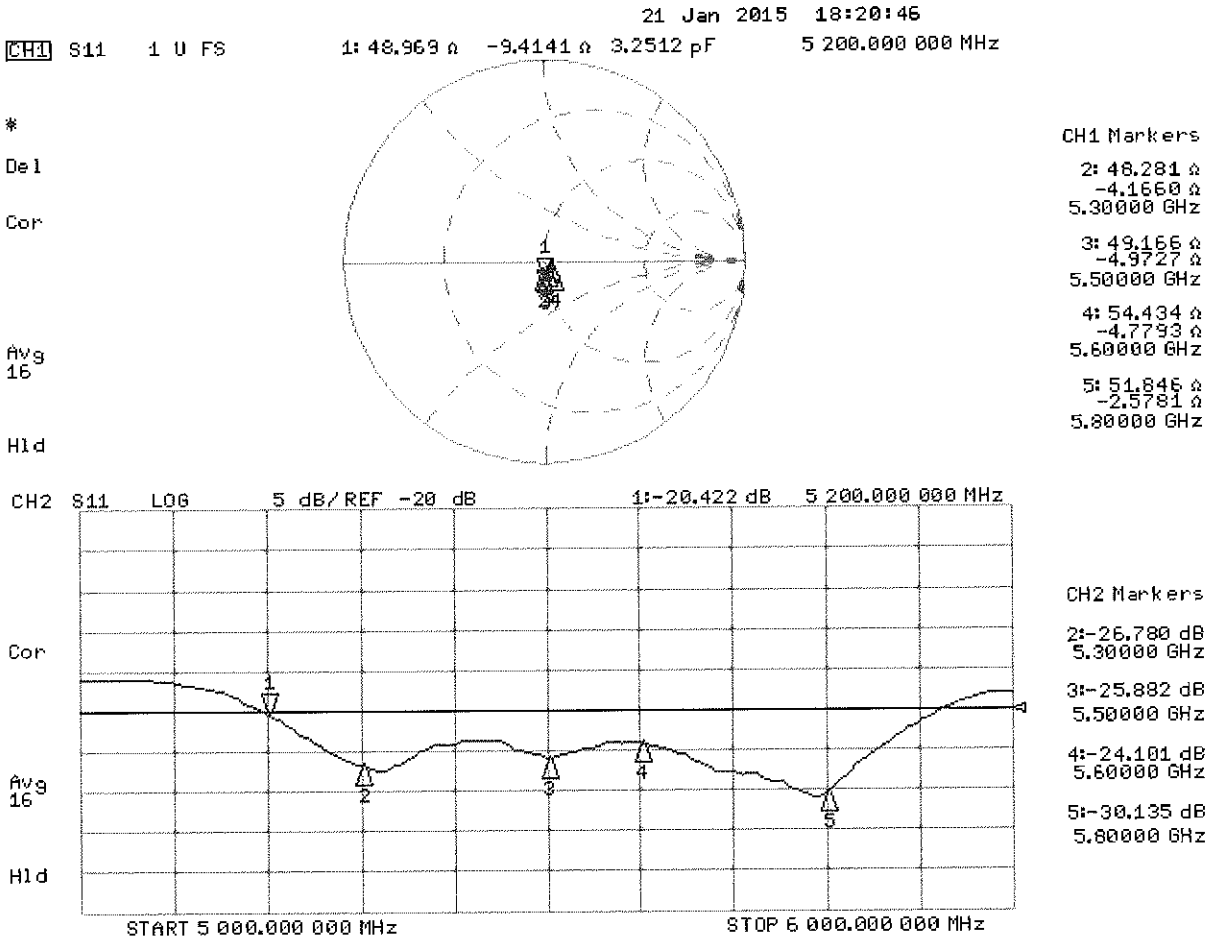
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 64.47 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 33.5 W/kg
SAR(1 g) = 8.38 W/kg; SAR(10 g) = 2.37 W/kg
Maximum value of SAR (measured) = 20.2 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 62.34 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 33.8 W/kg
SAR(1 g) = 8.11 W/kg; SAR(10 g) = 2.29 W/kg
Maximum value of SAR (measured) = 19.8 W/kg



0 dB = 19.3 W/kg = 12.86 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 20.01.2015

Test Laboratory: SPEAG, Zurich, Switzerland

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

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; σ = 5.42 S/m; ε_r = 49.4; ρ = 1000 kg/m^3 , Medium parameters used: f = 5300 MHz; σ = 5.55 S/m; ε_r = 49.2; ρ = 1000 kg/m^3 , Medium parameters used: f = 5500 MHz; σ = 5.82 S/m; ε_r = 48.9; ρ = 1000 kg/m^3 , Medium parameters used: f = 5600 MHz; σ = 5.96 S/m; ε_r = 48.7; ρ = 1000 kg/m^3 , Medium parameters used: f = 5800 MHz; σ = 6.25 S/m; ε_r = 48.4; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.95, 4.95, 4.95); Calibrated: 30.12.2014, ConvF(4.78, 4.78, 4.78); Calibrated: 30.12.2014, ConvF(4.45, 4.45, 4.45); Calibrated: 30.12.2014, ConvF(4.35, 4.35, 4.35); Calibrated: 30.12.2014, ConvF(4.32, 4.32, 4.32); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

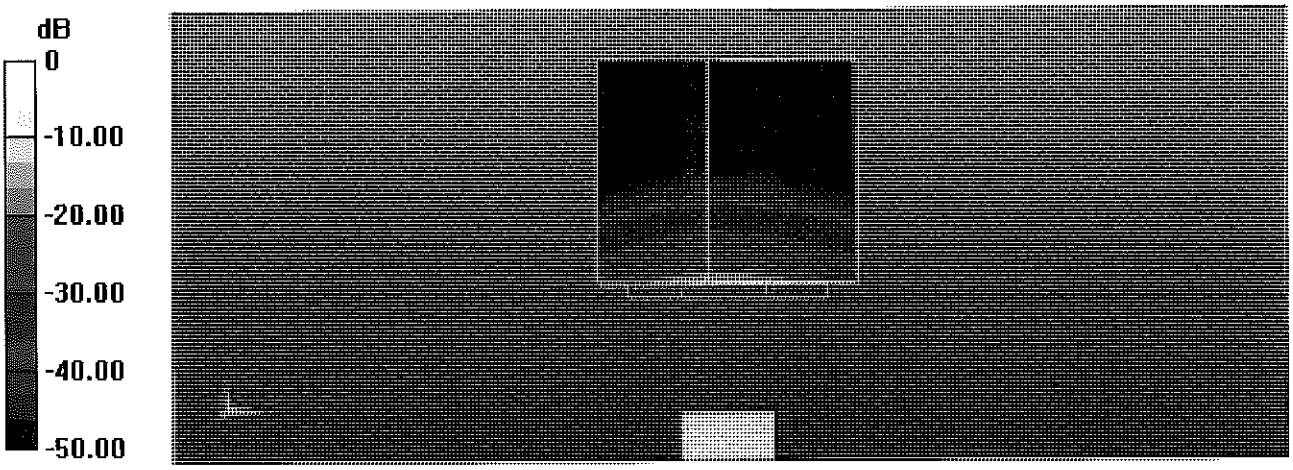
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 58.76 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 28.9 W/kg
SAR(1 g) = 7.37 W/kg; SAR(10 g) = 2.05 W/kg
Maximum value of SAR (measured) = 17.4 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 = 58.35 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 29.8 W/kg
SAR(1 g) = 7.41 W/kg; SAR(10 g) = 2.08 W/kg
Maximum value of SAR (measured) = 17.6 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 = 59.04 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 33.7 W/kg
SAR(1 g) = 7.9 W/kg; SAR(10 g) = 2.19 W/kg
Maximum value of SAR (measured) = 19.2 W/kg

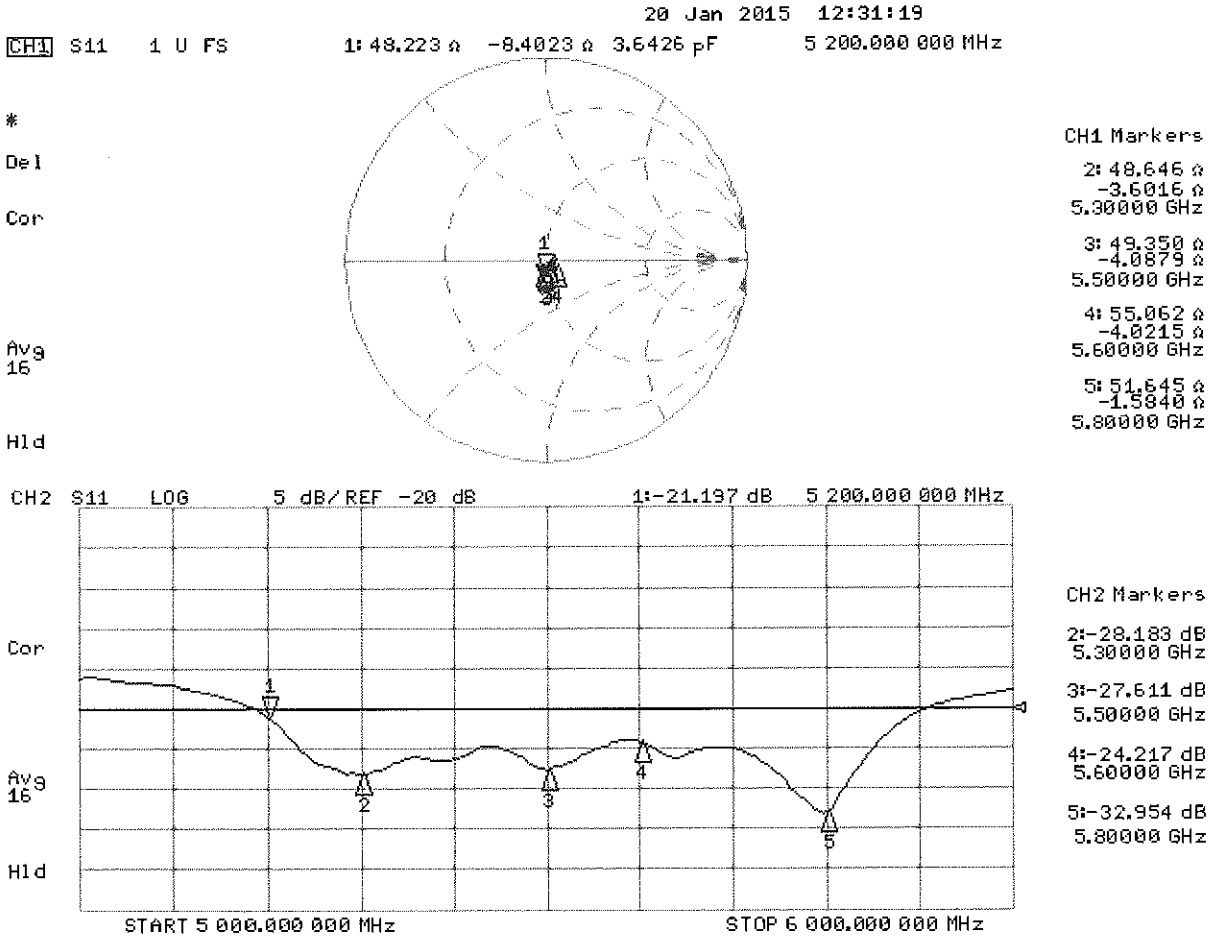
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 57.74 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 34.1 W/kg
SAR(1 g) = 7.75 W/kg; SAR(10 g) = 2.14 W/kg
Maximum value of SAR (measured) = 19.1 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 = 55.86 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 34.7 W/kg
SAR(1 g) = 7.49 W/kg; SAR(10 g) = 2.06 W/kg
Maximum value of SAR (measured) = 18.6 W/kg



0 dB = 17.4 W/kg = 12.41 dBW/kg

Impedance Measurement Plot for Body TSL



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: ES3-3263_May14

CALIBRATION CERTIFICATE

Object	ES3DV3 - SN:3263
Calibration procedure(s)	QA CAL-01.v9, QA CAL-23.v5, QA CAL-25.v6 Calibration procedure for dosimetric E-field probes
Calibration date:	May 15, 2014

CCV 7/17/14

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 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:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: May 15, 2014

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

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

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

Probe ES3DV3

SN:3263

Manufactured: January 25, 2010
Calibrated: May 15, 2014

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

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

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	1.21	1.24	1.13	± 10.1 %
DCP (mV)[B]	103.8	102.3	104.7	

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	156.3	±3.5 %
		Y	0.0	0.0	1.0		203.1	
		Z	0.0	0.0	1.0		197.2	
10010-CAA	SAR Validation (Square, 100ms, 10ms)	X	2.33	59.4	10.8	10.00	46.4	±1.4 %
		Y	4.39	63.4	13.6		50.8	
		Z	1.35	55.5	7.8		39.6	
10011-CAB	UMTS-FDD (WCDMA)	X	3.49	68.2	19.1	2.91	126.7	±0.7 %
		Y	3.28	66.9	18.5		120.7	
		Z	2.74	63.1	15.1		113.5	
10012-CAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	X	3.51	72.0	20.3	1.87	127.9	±0.7 %
		Y	3.21	69.4	18.8		124.1	
		Z	1.93	60.6	12.6		113.3	
10013-CAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps)	X	11.30	70.8	23.3	9.46	125.2	±2.5 %
		Y	12.42	72.7	24.4		129.4	
		Z	10.03	67.8	21.1		105.5	
10021-DAB	GSM-FDD (TDMA, GMSK)	X	24.45	99.1	27.6	9.39	141.4	±1.4 %
		Y	29.93	99.5	29.0		124.5	
		Z	4.53	73.0	18.1		111.6	
10023-DAB	GPRS-FDD (TDMA, GMSK, TN 0)	X	25.10	99.7	27.9	9.57	134.2	±1.9 %
		Y	24.85	96.1	28.0		120.2	
		Z	5.99	76.5	19.1		142.5	
10024-DAB	GPRS-FDD (TDMA, GMSK, TN 0-1)	X	24.34	93.0	23.0	6.56	117.1	±1.4 %
		Y	26.49	92.6	24.2		148.7	
		Z	4.00	69.6	13.8		136.6	
10027-DAB	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	X	51.24	99.9	23.5	4.80	131.1	±1.9 %
		Y	56.83	99.5	24.3		101.8	
		Z	1.70	61.4	9.1		107.7	
10028-DAB	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	X	60.12	99.6	22.2	3.55	138.7	±1.9 %
		Y	64.73	99.9	23.4		105.5	
		Z	1.13	58.4	6.0		116.0	
10032-CAA	IEEE 802.15.1 Bluetooth (GFSK, DH5)	X	77.27	99.6	19.6	1.16	149.5	±2.5 %
		Y	60.44	99.7	21.0		109.4	
		Z	0.34	55.9	2.9		131.4	
10039-CAB	CDMA2000 (1xRTT, RC1)	X	4.79	66.8	19.0	4.57	124.5	±0.9 %
		Y	4.85	66.4	18.8		125.6	
		Z	4.06	63.4	16.1		108.1	

10081-CAB	CDMA2000 (1xRTT, RC3)	X	3.93	66.1	18.5	3.97	119.8	±0.7 %
		Y	3.90	65.5	18.2		120.1	
		Z	3.29	62.4	15.3		108.5	
10098-CAB	UMTS-FDD (HSUPA, Subtest 2)	X	4.68	66.9	18.7	3.98	131.2	±0.7 %
		Y	4.64	66.6	18.6		130.5	
		Z	4.15	64.5	16.5		118.8	
10100-CAB	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	6.61	68.1	20.0	5.67	137.5	±1.7 %
		Y	6.70	68.4	20.2		137.7	
		Z	5.90	65.6	17.9		124.0	
10108-CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	6.44	67.5	19.8	5.80	135.1	±1.7 %
		Y	6.60	68.0	20.1		135.4	
		Z	5.75	64.9	17.6		121.8	
10110-CAB	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK)	X	6.14	67.1	19.7	5.75	131.6	±1.2 %
		Y	6.28	67.4	19.9		132.7	
		Z	5.62	65.5	18.2		118.4	
10114-CAA	IEEE 802.11n (HT Greenfield, 13.5 Mbps, BPSK)	X	10.18	68.8	21.2	8.10	124.3	±1.9 %
		Y	10.60	69.7	21.8		126.2	
		Z	9.38	67.0	19.8		108.4	
10117-CAA	IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK)	X	10.23	68.9	21.3	8.07	125.0	±1.9 %
		Y	10.56	69.6	21.7		127.1	
		Z	9.37	67.1	19.8		109.1	
10151-CAB	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	10.23	75.7	26.0	9.28	125.0	±2.7 %
		Y	14.60	83.3	29.5		147.3	
		Z	8.05	69.7	22.3		106.3	
10154-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	6.12	67.0	19.6	5.75	131.6	±1.4 %
		Y	6.28	67.4	19.9		132.4	
		Z	5.49	64.7	17.4		117.9	
10160-CAB	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK)	X	6.57	67.5	19.8	5.82	136.0	±1.4 %
		Y	6.71	67.9	20.1		137.1	
		Z	5.89	65.2	17.8		122.4	
10169-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	4.82	66.0	19.3	5.73	113.5	±1.4 %
		Y	5.12	66.3	19.4		116.6	
		Z	4.75	65.9	18.3		142.7	
10172-CAB	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	9.53	80.6	28.6	9.21	136.5	±2.2 %
		Y	11.32	81.6	28.8		109.2	
		Z	6.84	72.0	23.8		117.3	
10175-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	4.86	66.2	19.4	5.72	112.9	±1.2 %
		Y	5.10	66.2	19.4		115.9	
		Z	4.55	64.9	17.8		137.7	
10181-CAB	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	X	4.81	66.0	19.2	5.72	111.6	±1.2 %
		Y	5.13	66.4	19.5		116.1	
		Z	4.70	65.7	18.3		137.1	
10193-CAA	IEEE 802.11n (HT Greenfield, 6.5 Mbps, BPSK)	X	9.80	68.3	21.0	8.09	117.2	±2.2 %
		Y	10.23	69.1	21.6		121.5	
		Z	9.85	68.9	20.8		148.4	

10196-CAA	IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK)	X	9.81	68.4	21.1	8.10	117.7	±2.2 %
		Y	10.23	69.2	21.6		121.7	
		Z	9.87	69.0	20.9		149.9	
10219-CAA	IEEE 802.11n (HT Mixed, 7.2 Mbps, BPSK)	X	9.71	68.3	21.0	8.03	117.8	±2.2 %
		Y	10.12	69.1	21.6		121.0	
		Z	8.90	66.6	19.6		104.1	
10222-CAA	IEEE 802.11n (HT Mixed, 15 Mbps, BPSK)	X	10.14	68.7	21.2	8.06	122.3	±1.9 %
		Y	10.52	69.5	21.7		125.4	
		Z	9.28	66.8	19.6		108.5	
10225-CAB	UMTS-FDD (HSPA+)	X	7.25	67.8	19.9	5.97	146.3	±1.7 %
		Y	7.32	67.5	19.8		149.3	
		Z	6.52	65.7	18.0		130.7	
10237-CAB	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	9.55	80.7	28.7	9.21	137.2	±2.5 %
		Y	11.34	81.7	28.9		109.9	
		Z	6.98	72.5	24.0		119.5	
10252-CAB	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	9.26	74.1	25.3	9.24	115.6	±3.3 %
		Y	13.72	82.5	29.3		137.9	
		Z	8.83	73.3	24.4		144.1	
10267-CAB	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	10.06	75.2	25.8	9.30	122.9	±2.7 %
		Y	14.69	83.4	29.6		147.6	
		Z	8.02	69.6	22.3		103.4	
10274-CAB	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.10)	X	6.08	67.2	19.0	4.87	140.2	±1.2 %
		Y	6.23	67.5	19.2		143.5	
		Z	5.52	65.4	17.4		125.1	
10275-CAB	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.4)	X	4.44	66.7	18.7	3.96	122.1	±0.7 %
		Y	4.39	66.3	18.5		124.4	
		Z	3.83	63.7	16.0		114.0	
10291-AAB	CDMA2000, RC3, SO55, Full Rate	X	3.64	66.7	18.6	3.46	115.7	±0.7 %
		Y	3.60	66.0	18.2		118.0	
		Z	3.17	64.2	16.3		108.4	
10292-AAB	CDMA2000, RC3, SO32, Full Rate	X	3.62	67.0	18.8	3.39	116.9	±0.9 %
		Y	3.54	66.1	18.2		119.1	
		Z	3.24	64.2	15.8		145.6	
10297-AAA	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	6.43	67.5	19.8	5.81	132.0	±1.4 %
		Y	6.60	68.0	20.1		134.9	
		Z	5.81	65.4	18.0		115.0	
10311-AAA	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK)	X	7.04	68.1	20.2	6.06	137.5	±1.4 %
		Y	7.19	68.6	20.5		140.3	
		Z	6.26	65.7	18.2		119.6	
10315-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 96pc duty cycle)	X	3.05	70.0	19.4	1.71	121.7	±0.7 %
		Y	2.91	68.7	18.7		123.4	
		Z	1.83	60.2	12.3		108.4	
10316-AAA	IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 96pc duty cycle)	X	10.05	68.7	21.4	8.36	117.3	±1.9 %
		Y	10.57	69.7	22.0		122.8	
		Z	9.11	66.5	19.7		103.1	

10403-AAB	CDMA2000 (1xEV-DO, Rev. 0)	X	4.81	68.3	18.8	3.76	125.8	±0.7 %
		Y	4.65	66.5	18.1		130.8	
		Z	3.98	64.7	16.0		114.7	
10404-AAB	CDMA2000 (1xEV-DO, Rev. A)	X	4.91	69.1	19.2	3.77	123.3	±0.7 %
		Y	4.60	66.6	18.1		128.5	
		Z	3.73	64.0	15.4		112.0	
10415-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle)	X	2.78	69.0	19.0	1.54	121.9	±0.7 %
		Y	2.46	66.8	17.9		122.5	
		Z	1.83	60.9	13.0		112.4	
10416-AAA	IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 99pc duty cycle)	X	9.88	68.4	21.2	8.23	116.6	±1.7 %
		Y	10.29	69.2	21.7		121.5	
		Z	9.25	67.3	20.2		103.4	

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:3263

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
750	41.9	0.89	6.42	6.42	6.42	0.72	1.18	± 12.0 %
835	41.5	0.90	6.23	6.23	6.23	0.27	2.02	± 12.0 %
1750	40.1	1.37	5.41	5.41	5.41	0.74	1.23	± 12.0 %
1900	40.0	1.40	5.08	5.08	5.08	0.80	1.16	± 12.0 %
2450	39.2	1.80	4.47	4.47	4.47	0.80	1.22	± 12.0 %
2600	39.0	1.96	4.33	4.33	4.33	0.66	1.41	± 12.0 %

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[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:3263

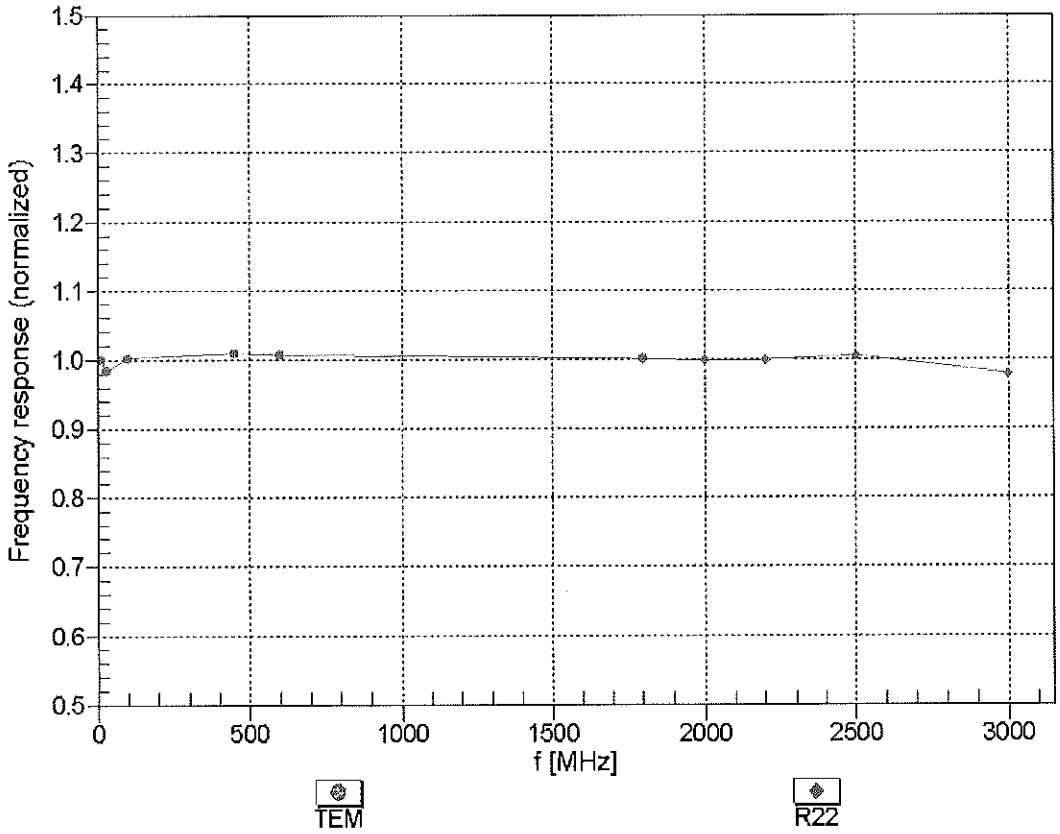
Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
750	55.5	0.96	6.19	6.19	6.19	0.52	1.41	± 12.0 %
835	55.2	0.97	6.16	6.16	6.16	0.68	1.28	± 12.0 %
1750	53.4	1.49	4.98	4.98	4.98	0.38	1.91	± 12.0 %
1900	53.3	1.52	4.78	4.78	4.78	0.66	1.35	± 12.0 %
2450	52.7	1.95	4.27	4.27	4.27	0.72	1.13	± 12.0 %
2600	52.5	2.16	4.11	4.11	4.11	0.74	1.07	± 12.0 %

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

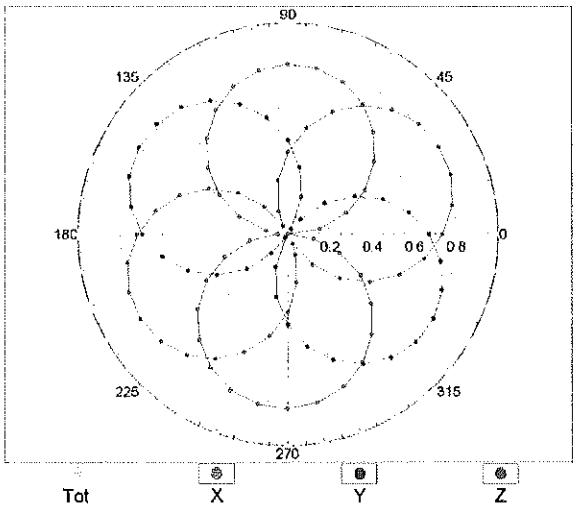
(TEM-Cell:ifi110 EXX, Waveguide: R22)



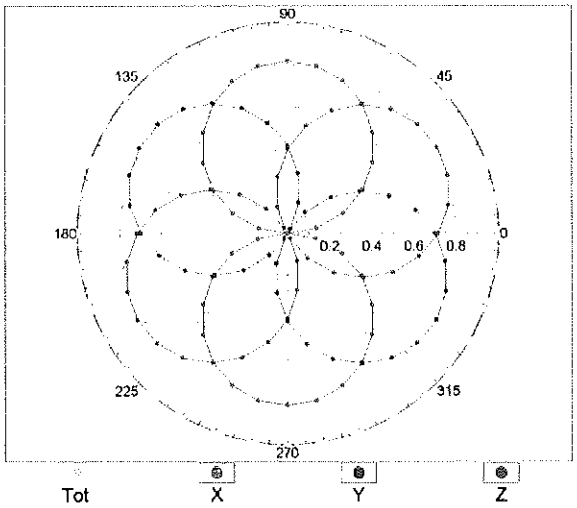
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

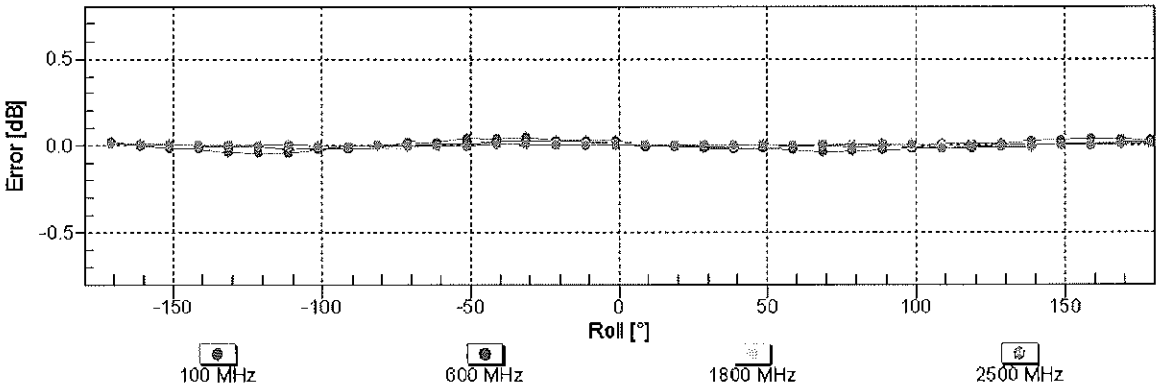
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



f=1800 MHz,R22

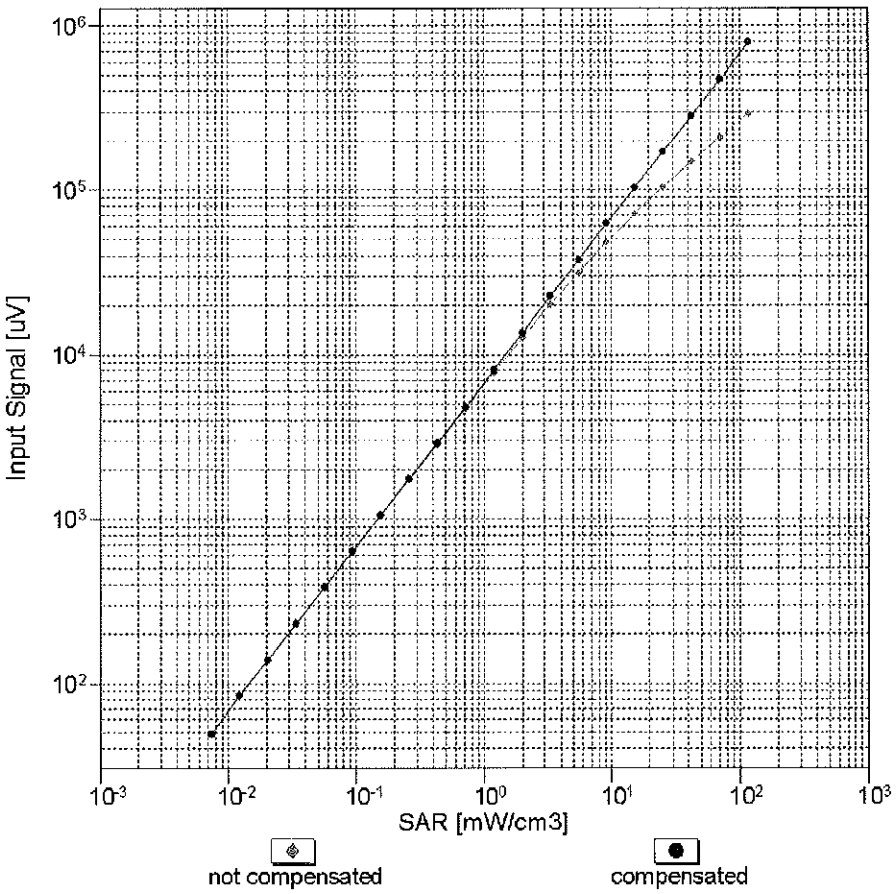


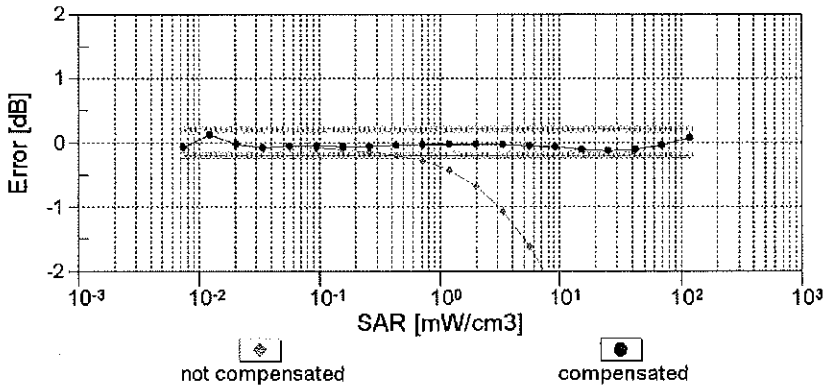


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR_{head})

(TEM cell , f_{eval}= 1900 MHz)

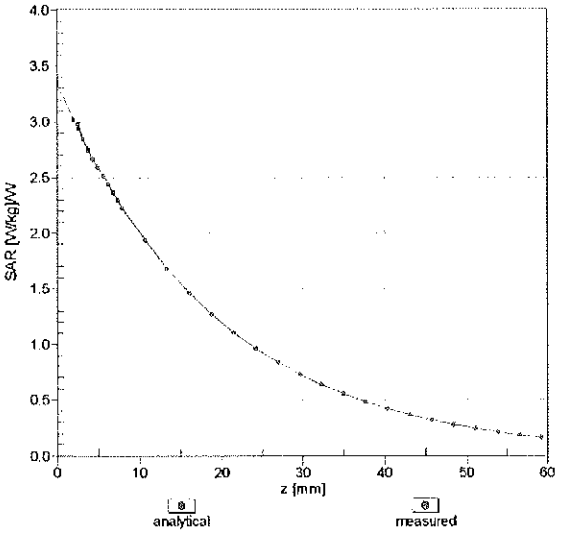




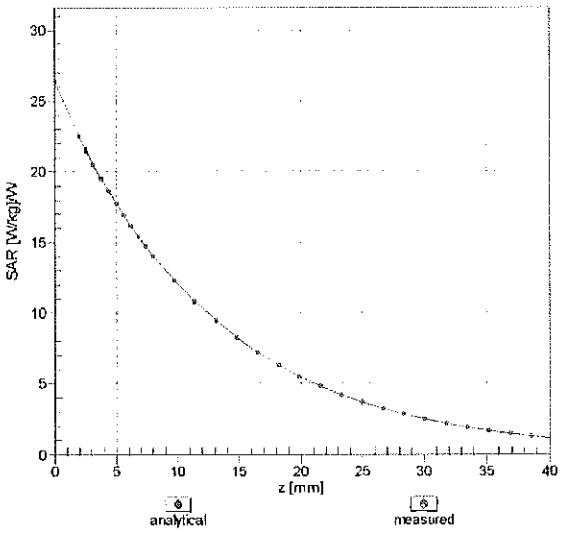
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

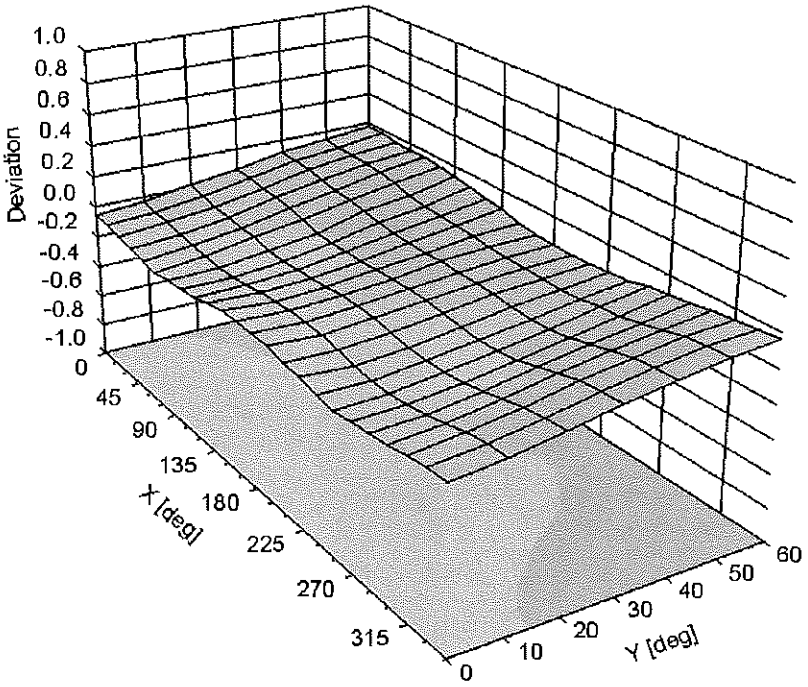


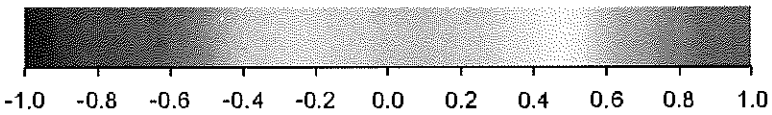
f = 1750 MHz,WGLS R22 (H_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz





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

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

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-111.2
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
Servizio svizzero di taratura
S Swiss Calibration Service

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

Accreditation No.: SCS 0108

Client **PC Test**

Certificate No: ES3-3213_Jan15

CALIBRATION CERTIFICATE

Object	ES3DV3 - SN:3213
Calibration procedure(s)	QA CAL-01.v9, QA CAL-23.v5, QA CAL-25.v6 Calibration procedure for dosimetric E-field probes
Calibration date:	January 20, 2015

CC 1/30/15

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-14 (No. ES3-3013_Dec14)	Dec-15
DAE4	SN: 660	14-Jan-15 (No. DAE4-660_Jan15)	Jan-16
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

	Name	Function	Signature
Calibrated by:	Israe Elnaouq	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: January 22, 2015

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

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

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

Probe ES3DV3

SN:3213

Manufactured: October 14, 2008
Calibrated: January 20, 2015

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3213

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	1.49	1.37	1.34	± 10.1 %
DCP (mV)[B]	99.9	101.8	101.4	

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	169.8	±3.8 %
		Y	0.0	0.0	1.0		215.4	
		Z	0.0	0.0	1.0		214.5	
10010-CAA	SAR Validation (Square, 100ms, 10ms)	X	1.84	57.8	10.2	10.00	47.4	±1.9 %
		Y	1.82	58.6	10.3		44.3	
		Z	1.65	57.3	9.2		44.2	
10011-CAB	UMTS-FDD (WCDMA)	X	3.32	66.8	18.5	2.91	135.8	±0.5 %
		Y	3.18	66.4	18.2		127.9	
		Z	3.21	66.5	18.2		128.1	
10012-CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	X	2.90	68.1	18.4	1.87	137.2	±0.7 %
		Y	2.97	69.2	19.0		130.1	
		Z	2.80	68.0	18.4		129.9	
10013-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps)	X	11.40	71.2	23.7	9.46	135.1	±3.8 %
		Y	11.25	71.3	23.9		124.2	
		Z	10.96	70.3	23.2		124.8	
10021-DAB	GSM-FDD (TDMA, GMSK)	X	18.25	96.6	27.2	9.39	140.4	±1.7 %
		Y	21.48	99.9	28.2		133.3	
		Z	11.76	89.4	24.5		127.3	
10023-DAB	GPRS-FDD (TDMA, GMSK, TN 0)	X	13.12	91.7	26.0	9.57	126.4	±1.9 %
		Y	17.05	95.2	26.6		127.3	
		Z	8.91	85.2	23.3		118.8	
10024-DAB	GPRS-FDD (TDMA, GMSK, TN 0-1)	X	34.78	100.0	25.2	6.56	116.4	±1.7 %
		Y	33.37	99.5	24.8		111.7	
		Z	34.11	99.5	24.6		110.5	
10027-DAB	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	X	37.18	99.7	24.0	4.80	131.2	±1.7 %
		Y	44.91	99.8	23.3		127.4	
		Z	41.51	99.7	23.2		125.0	
10028-DAB	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	X	48.95	99.5	22.4	3.55	140.9	±1.7 %
		Y	67.41	99.8	21.5		137.8	
		Z	56.45	100.0	21.9		135.0	
10032-CAA	IEEE 802.15.1 Bluetooth (GFSK, DH5)	X	20.23	99.3	22.1	1.16	111.3	±1.2 %
		Y	32.72	99.5	20.6		109.6	
		Z	48.57	100.0	20.0		108.8	
10100-CAB	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	6.60	67.9	20.0	5.67	144.6	±1.2 %
		Y	6.55	68.2	20.2		142.7	
		Z	6.50	67.8	19.9		141.5	

10103-CAB	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	10.34	75.7	26.2	9.29	133.2	±2.5 %
		Y	10.31	76.5	26.9		128.2	
		Z	9.74	74.5	25.6		127.1	
10108-CAC	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	6.50	67.6	20.0	5.80	142.8	±1.2 %
		Y	6.41	67.7	20.1		140.3	
		Z	6.41	67.6	19.9		140.2	
10117-CAB	IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK)	X	10.36	69.2	21.6	8.07	132.8	±2.7 %
		Y	10.42	69.7	21.9		131.4	
		Z	10.22	69.1	21.4		130.0	
10151-CAB	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	9.65	74.6	25.8	9.28	127.9	±2.5 %
		Y	9.66	75.6	26.7		123.7	
		Z	9.14	73.6	25.3		122.7	
10154-CAC	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	6.14	66.9	19.6	5.75	139.3	±1.4 %
		Y	6.08	67.2	19.9		138.5	
		Z	6.05	66.9	19.6		137.3	
10160-CAB	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK)	X	6.58	67.5	19.9	5.82	144.3	±1.4 %
		Y	6.54	67.8	20.1		143.7	
		Z	6.50	67.5	19.8		142.1	
10169-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	4.93	66.1	19.3	5.73	120.6	±0.9 %
		Y	4.93	66.7	19.8		120.9	
		Z	4.85	66.3	19.5		118.9	
10172-CAB	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	8.93	79.5	28.6	9.21	140.8	±2.5 %
		Y	9.60	82.9	30.6		139.9	
		Z	8.30	78.2	27.9		136.6	
10175-CAC	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	4.90	66.0	19.3	5.72	118.8	±0.9 %
		Y	4.93	66.8	19.8		120.2	
		Z	4.81	66.1	19.3		116.6	
10181-CAB	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	X	4.92	66.1	19.3	5.72	119.0	±0.9 %
		Y	4.92	66.6	19.8		120.5	
		Z	4.77	65.8	19.2		115.8	
10196-CAB	IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK)	X	9.93	68.7	21.4	8.10	125.0	±2.5 %
		Y	10.06	69.4	21.9		128.3	
		Z	9.78	68.5	21.2		120.5	
10225-CAB	UMTS-FDD (HSPA+)	X	6.66	65.7	18.8	5.97	106.5	±0.9 %
		Y	6.81	66.6	19.3		112.3	
		Z	6.64	66.0	18.9		108.0	
10237-CAB	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	8.91	79.4	28.5	9.21	141.4	±2.2 %
		Y	9.39	82.3	30.4		146.7	
		Z	8.40	78.5	28.2		141.2	
10252-CAB	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	8.84	73.3	25.2	9.24	119.1	±2.7 %
		Y	8.94	74.6	26.3		118.6	
		Z	8.39	72.4	24.7		114.0	
10267-CAB	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	9.62	74.6	25.8	9.30	126.2	±2.7 %
		Y	9.77	76.0	26.9		126.1	
		Z	9.10	73.4	25.2		121.4	

10275-CAB	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.4)	X	4.43	66.4	18.5	3.96	132.5	±0.7 %
		Y	4.37	66.6	18.6		134.1	
		Z	4.40	66.7	18.6		130.5	
10291-AAB	CDMA2000, RC3, SO55, Full Rate	X	3.63	66.4	18.4	3.46	122.5	±0.5 %
		Y	3.54	66.5	18.5		124.9	
		Z	3.55	66.3	18.3		121.4	
10292-AAB	CDMA2000, RC3, SO32, Full Rate	X	3.49	65.9	18.1	3.39	125.1	±0.5 %
		Y	3.52	66.7	18.6		126.1	
		Z	3.51	66.5	18.4		123.8	
10297-AAA	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	6.49	67.6	19.9	5.81	143.1	±1.4 %
		Y	6.49	68.0	20.3		142.3	
		Z	6.42	67.6	19.9		144.3	
10311-AAA	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK)	X	7.06	68.1	20.2	6.06	147.6	±1.7 %
		Y	7.09	68.7	20.7		148.2	
		Z	7.03	68.3	20.4		149.8	
10403-AAB	CDMA2000 (1xEV-DO, Rev. 0)	X	4.66	67.4	18.4	3.76	135.3	±0.5 %
		Y	4.69	68.1	18.7		134.9	
		Z	4.72	68.2	18.7		136.5	
10404-AAB	CDMA2000 (1xEV-DO, Rev. A)	X	4.58	67.4	18.3	3.77	133.4	±0.5 %
		Y	4.68	68.4	18.9		132.8	
		Z	4.58	67.9	18.5		135.4	
10415-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle)	X	2.41	65.7	17.2	1.54	131.4	±0.7 %
		Y	2.42	66.4	17.7		131.3	
		Z	2.59	67.7	18.2		134.1	
10416-AAA	IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 99pc duty cycle)	X	10.06	68.9	21.5	8.23	127.6	±2.7 %
		Y	10.12	69.5	22.0		126.3	
		Z	10.04	69.1	21.7		129.7	

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

[A] The uncertainties of NormX,Y,Z do not affect the 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:3213

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	6.45	6.45	6.45	0.57	1.37	± 12.0 %
835	41.5	0.90	6.26	6.26	6.26	0.65	1.26	± 12.0 %
1750	40.1	1.37	5.22	5.22	5.22	0.47	1.47	± 12.0 %
1900	40.0	1.40	5.06	5.06	5.06	0.80	1.14	± 12.0 %
2450	39.2	1.80	4.54	4.54	4.54	0.78	1.22	± 12.0 %
2600	39.0	1.96	4.33	4.33	4.33	0.80	1.28	± 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:3213

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	6.11	6.11	6.11	0.71	1.24	± 12.0 %
835	55.2	0.97	6.07	6.07	6.07	0.35	1.86	± 12.0 %
1750	53.4	1.49	4.93	4.93	4.93	0.51	1.47	± 12.0 %
1900	53.3	1.52	4.72	4.72	4.72	0.80	1.20	± 12.0 %
2450	52.7	1.95	4.37	4.37	4.37	0.71	1.12	± 12.0 %
2600	52.5	2.16	4.20	4.20	4.20	0.66	0.95	± 12.0 %

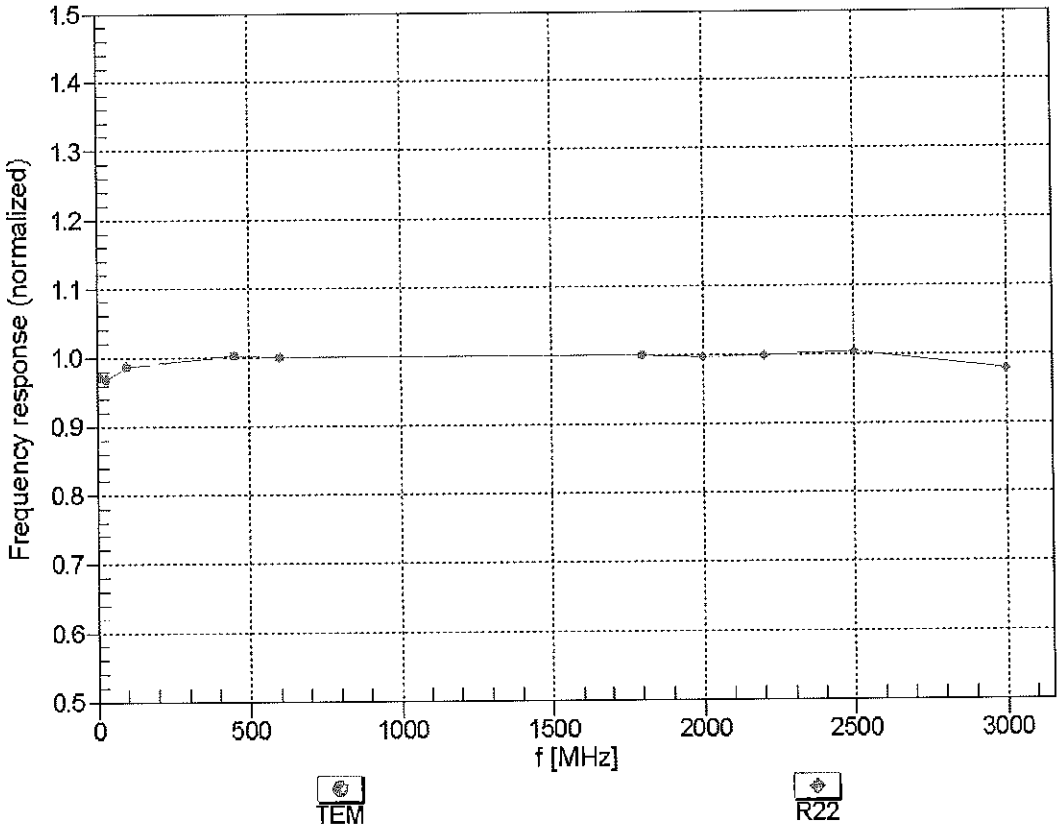
[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz 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

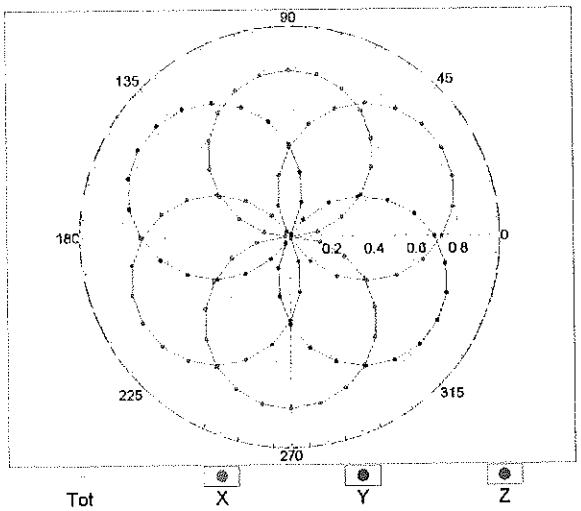
(TEM-Cell:ifi110 EXX, Waveguide: R22)



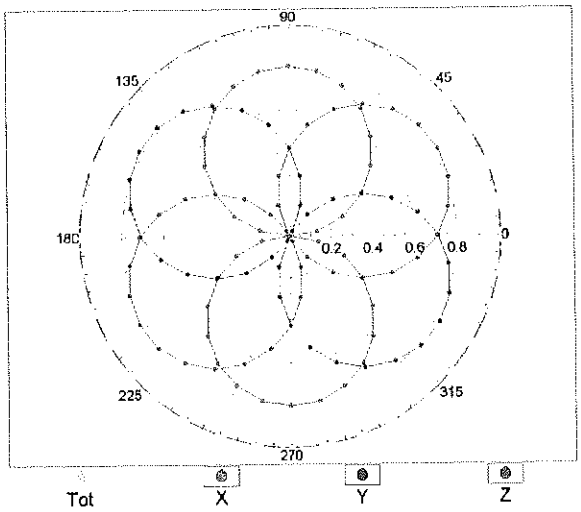
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

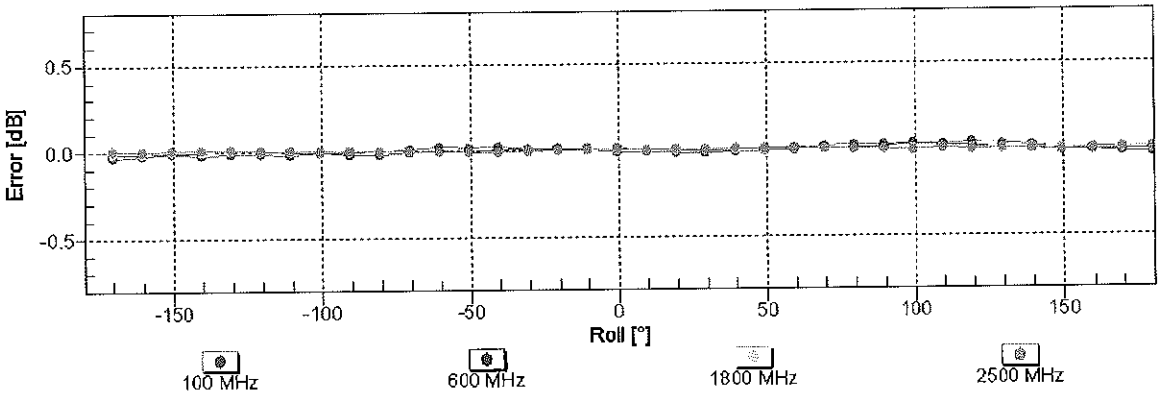
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



f=1800 MHz,R22

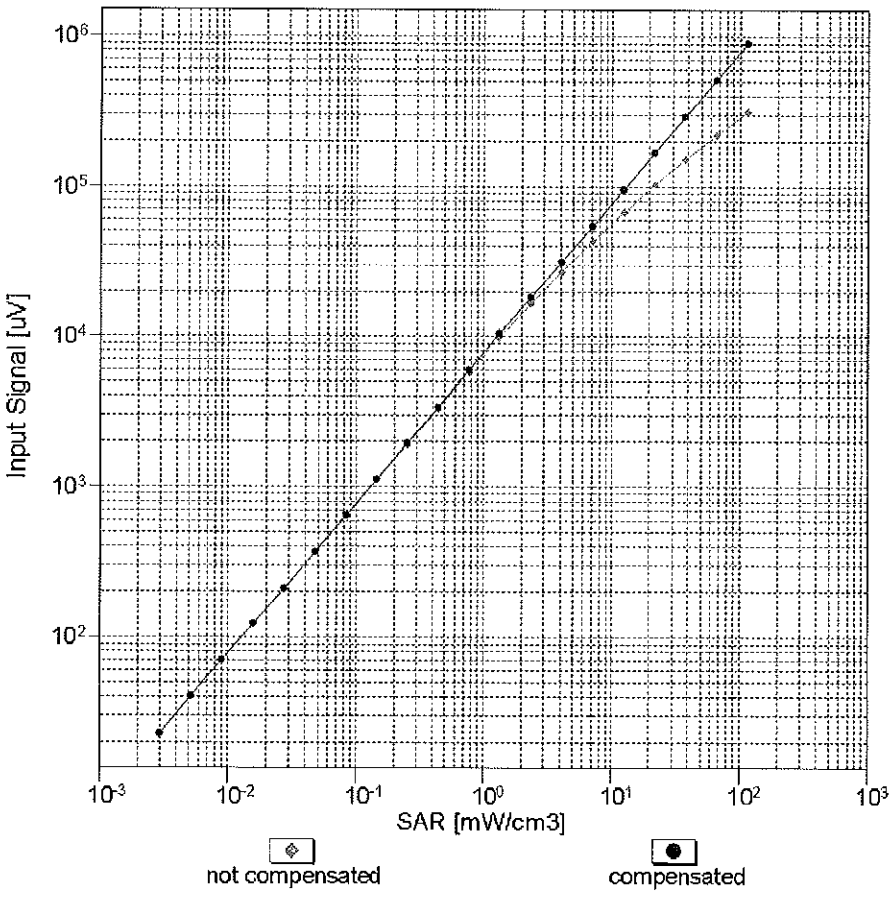


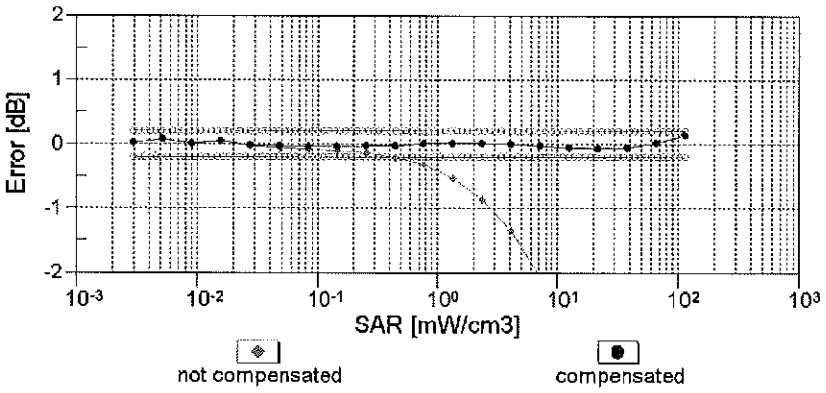


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR_{head})

(TEM cell , f_{eval}= 1900 MHz)

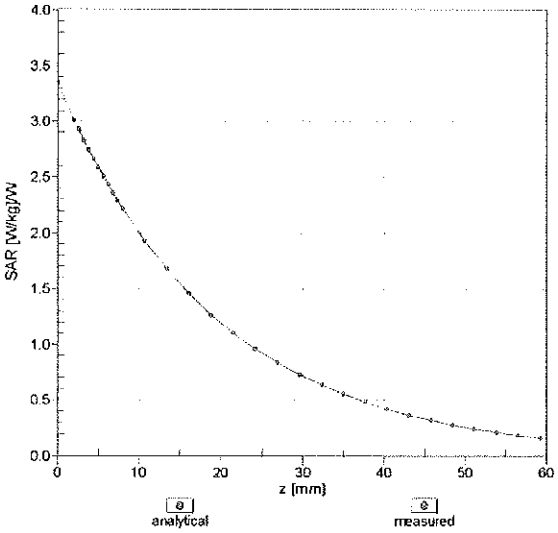




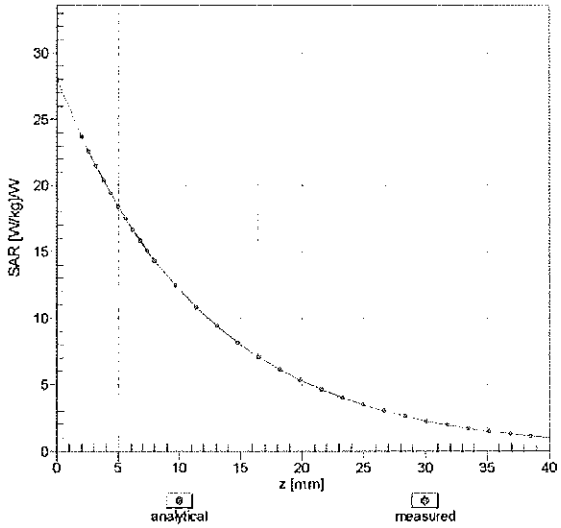
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

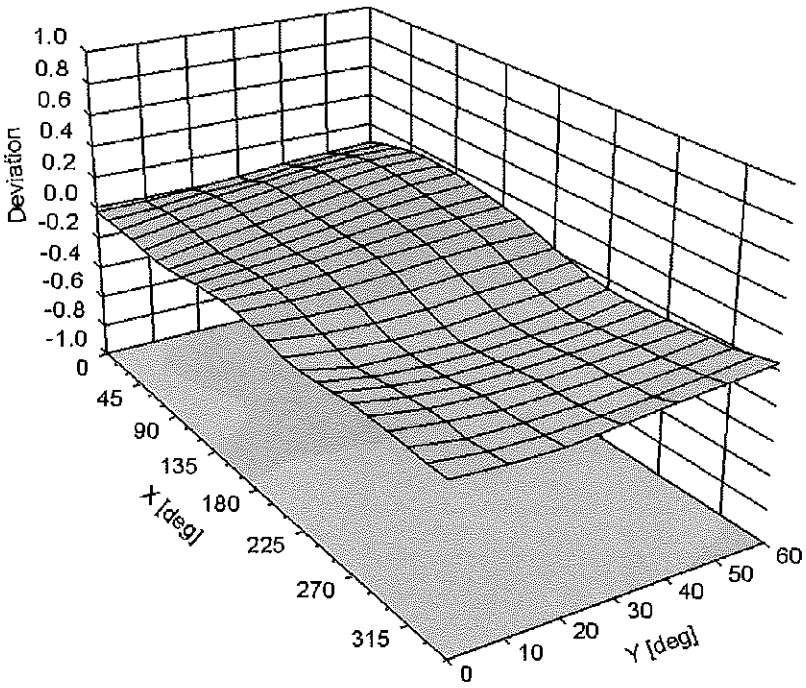


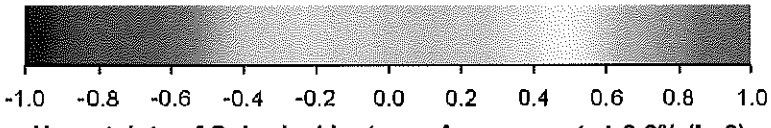
f = 1900 MHz,WGLS R22 (H_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz





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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3213

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-70.6
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

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: **EX3-7308_Jul14**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:7308
Calibration procedure(s)	QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6 Calibration procedure for dosimetric E-field probes
Calibration date:	July 16, 2014

CC 11/4/14

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 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:	Jaton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: July 21, 2014

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

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

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

Probe EX3DV4

SN:7308

Manufactured: March 11, 2014
Calibrated: July 16, 2014

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7308

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.50	0.60	0.45	± 10.1 %
DCP (mV)[B]	100.8	98.6	99.9	

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	160.9	±2.5 %
		Y	0.0	0.0	1.0		132.5	
		Z	0.0	0.0	1.0		154.1	
10012-CAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	X	2.79	68.0	18.3	1.87	125.2	±0.5 %
		Y	2.74	67.3	17.9		142.6	
		Z	2.74	67.2	17.7		119.7	
10062-CAA	IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps)	X	10.26	68.8	21.6	8.68	124.2	±2.5 %
		Y	10.73	69.7	22.0		144.6	
		Z	9.98	68.3	21.3		116.1	
10114-CAA	IEEE 802.11n (HT Greenfield, 13.5 Mbps, BPSK)	X	10.24	68.6	21.0	8.10	125.1	±2.2 %
		Y	9.68	67.1	20.1		99.7	
		Z	10.17	68.5	21.0		122.8	
10117-CAA	IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK)	X	10.27	68.7	21.0	8.07	126.1	±2.2 %
		Y	9.67	67.0	20.1		100.6	
		Z	10.12	68.4	20.9		123.9	
10193-CAA	IEEE 802.11n (HT Greenfield, 6.5 Mbps, BPSK)	X	9.83	68.2	20.9	8.09	120.3	±2.5 %
		Y	10.37	69.4	21.5		147.5	
		Z	9.71	68.2	20.9		116.9	
10196-CAA	IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK)	X	9.80	68.2	20.9	8.10	120.4	±1.9 %
		Y	9.54	67.2	20.3		102.9	
		Z	9.65	68.0	20.8		116.5	
10219-CAA	IEEE 802.11n (HT Mixed, 7.2 Mbps, BPSK)	X	9.67	68.0	20.8	8.03	119.1	±1.9 %
		Y	9.41	67.1	20.2		102.5	
		Z	9.54	68.0	20.8		116.0	
10222-CAA	IEEE 802.11n (HT Mixed, 15 Mbps, BPSK)	X	10.21	68.6	21.0	8.06	125.9	±2.2 %
		Y	9.84	67.5	20.4		106.4	
		Z	10.09	68.4	20.9		122.3	
10315-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 96pc duty cycle)	X	2.92	69.3	18.9	1.71	123.4	±0.5 %
		Y	2.80	68.0	18.2		107.9	
		Z	2.85	68.3	18.3		122.3	
10317-AAA	IEEE 802.11a WiFi 5 GHz (OFDM, 6 Mbps, 96pc duty cycle)	X	9.98	68.4	21.2	8.36	119.4	±1.9 %
		Y	9.66	67.3	20.5		101.7	
		Z	9.79	68.1	21.0		115.6	

10400-AAA	IEEE 802.11ac WiFi (20MHz, 64-QAM, 99pc duty cycle)	X	10.10	68.5	21.2	8.37	121.3	±2.2 %
		Y	9.82	67.5	20.6		103.5	
		Z	9.90	68.2	21.1		116.6	
10402-AAA	IEEE 802.11ac WiFi (80MHz, 64-QAM, 99pc duty cycle)	X	11.17	69.7	21.7	8.53	131.0	±2.2 %
		Y	10.57	68.2	20.8		110.9	
		Z	11.01	69.4	21.5		128.1	

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 6 and 7).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7308

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)
5250	35.9	4.71	5.37	5.37	5.37	0.30	1.80	± 13.1 %
5600	35.5	5.07	4.64	4.64	4.64	0.35	1.80	± 13.1 %
5750	35.4	5.22	4.81	4.81	4.81	0.40	1.80	± 13.1 %

[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: EX3DV4 - SN:7308

Calibration Parameter Determined in Body Tissue Simulating Media

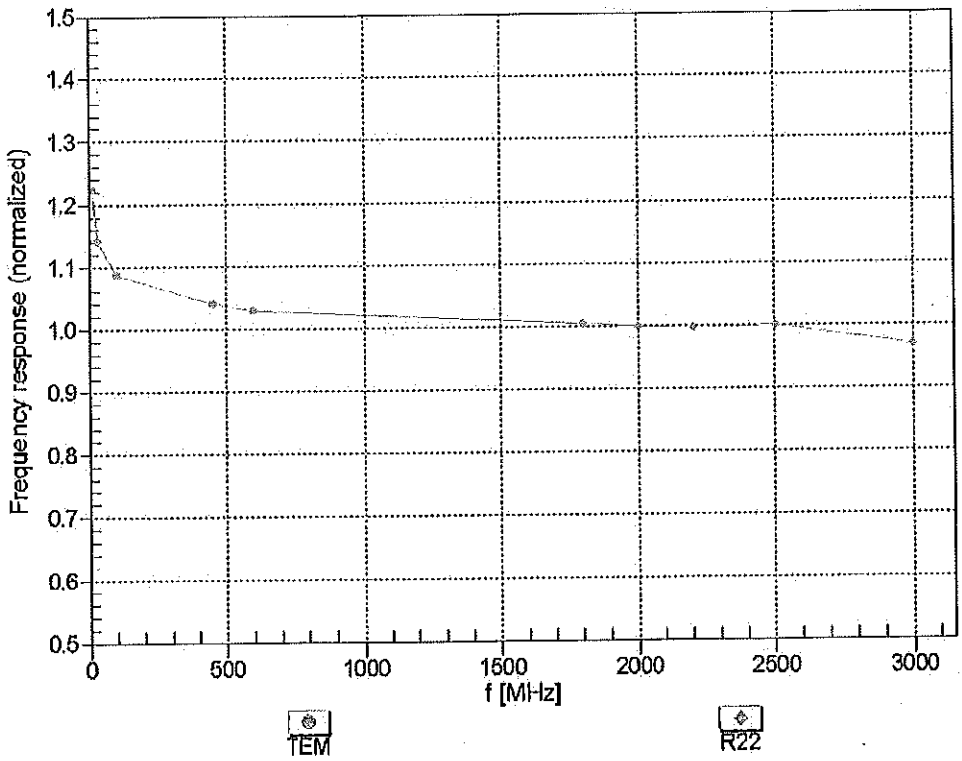
f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
5250	48.9	5.36	4.60	4.60	4.60	0.35	1.90	± 13.1 %
5600	48.5	5.77	4.09	4.09	4.09	0.40	1.90	± 13.1 %
5750	48.3	5.94	4.22	4.22	4.22	0.50	1.90	± 13.1 %

[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.

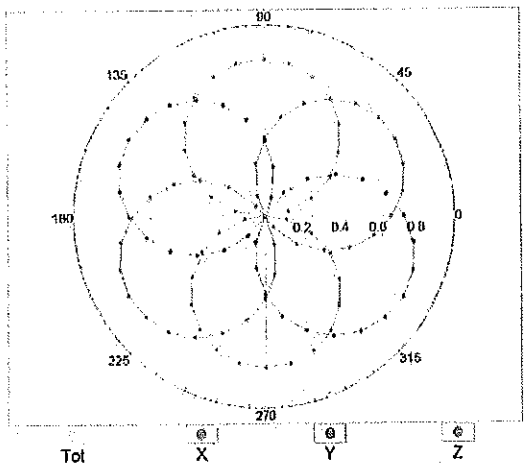
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



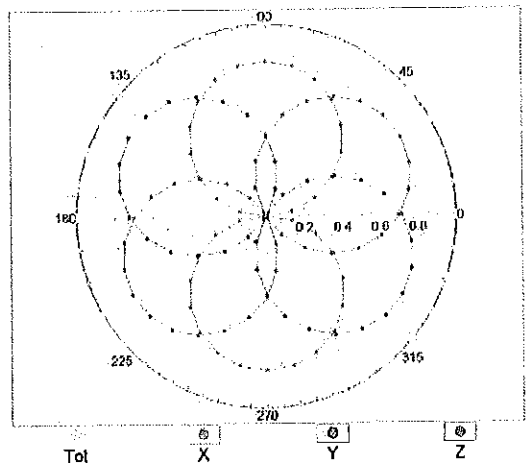
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

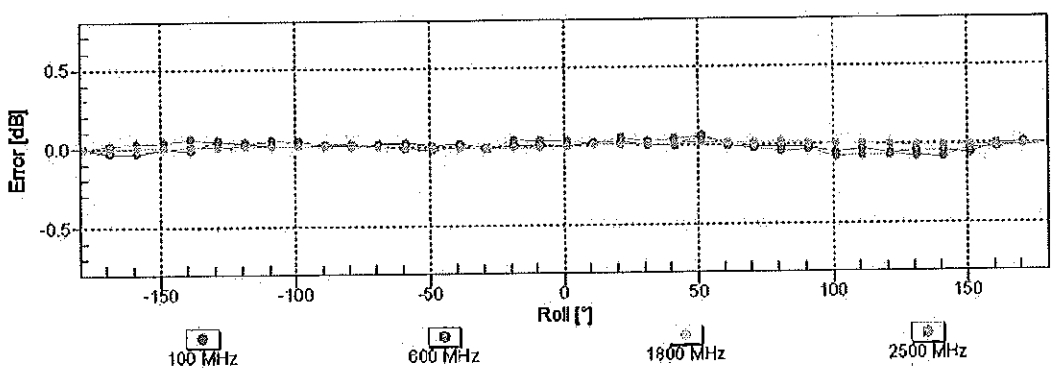
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



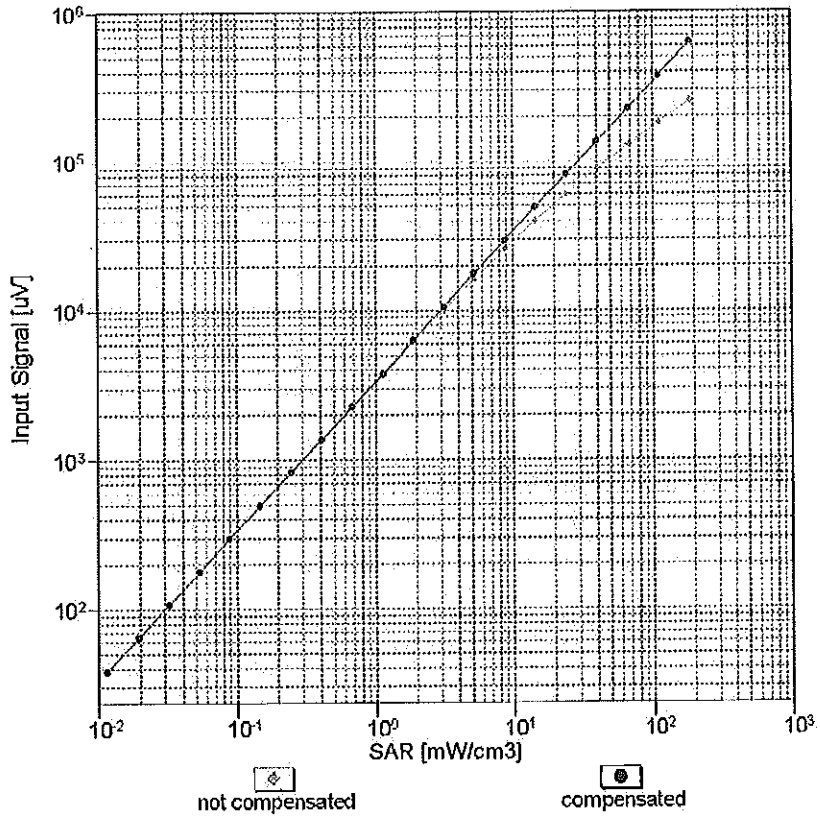
f=1800 MHz,R22

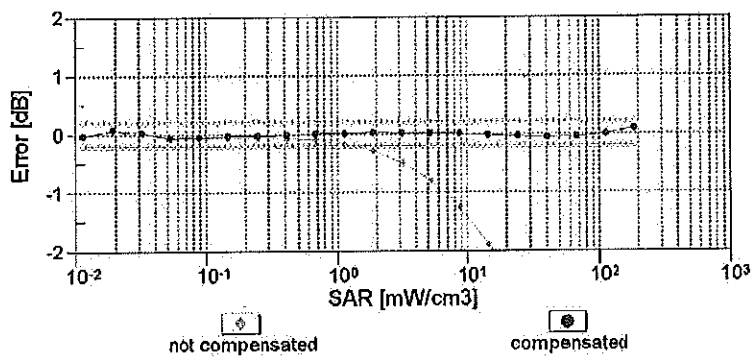




Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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

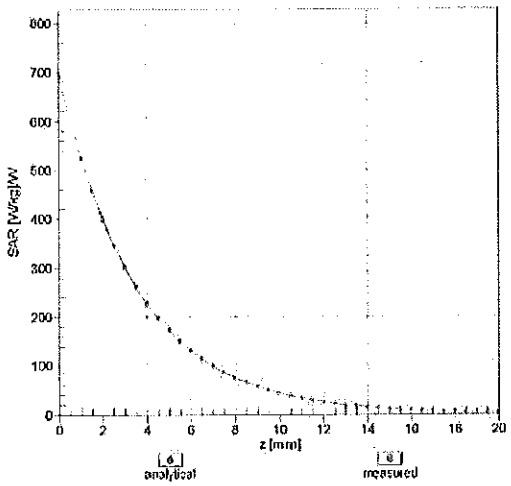




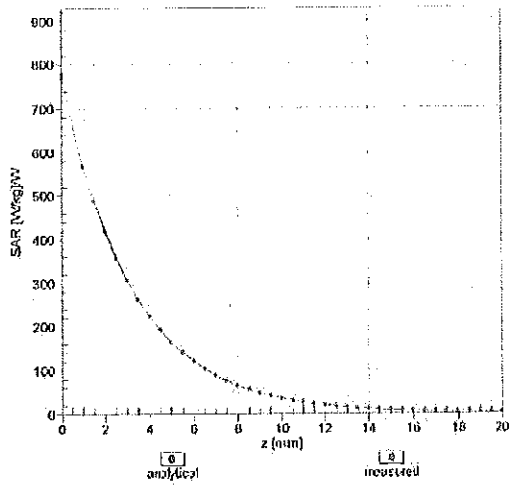
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment

f = 5250 MHz,WGLS R58 (H_convF)-SCS

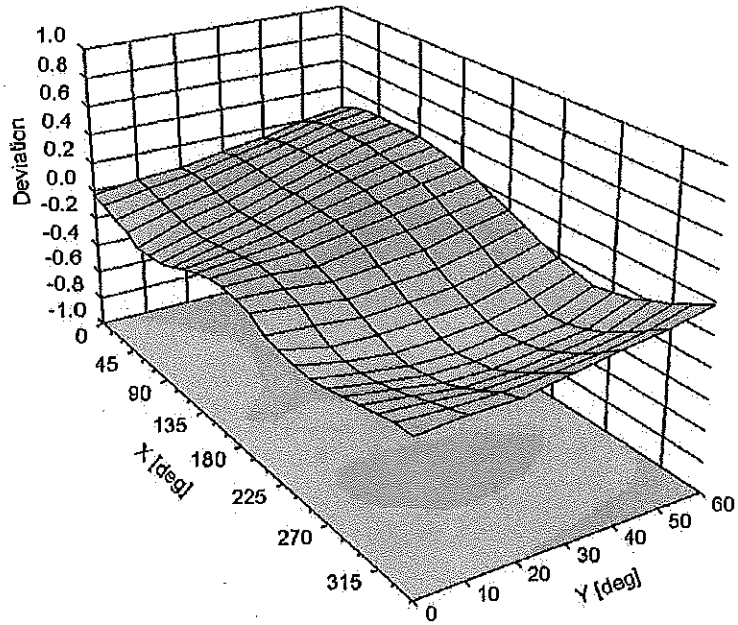


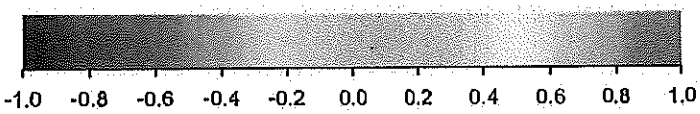
f = 5750 MHz,WGLS R58 (H_convF)-SCS



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz





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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7308

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-68.9
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

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

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

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

Accreditation No.: SCS 108

Client PC Test

Certificate No: ES3-3288_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
Calibration date:	September 24, 2014

CC 12/12/14

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 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.

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E^2-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (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 ($\mu V/(V/m)^2$)[A]	1.05	1.16	0.92	± 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	±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	±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	±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	±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	±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	±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	±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	±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	±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	±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	±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	±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 %

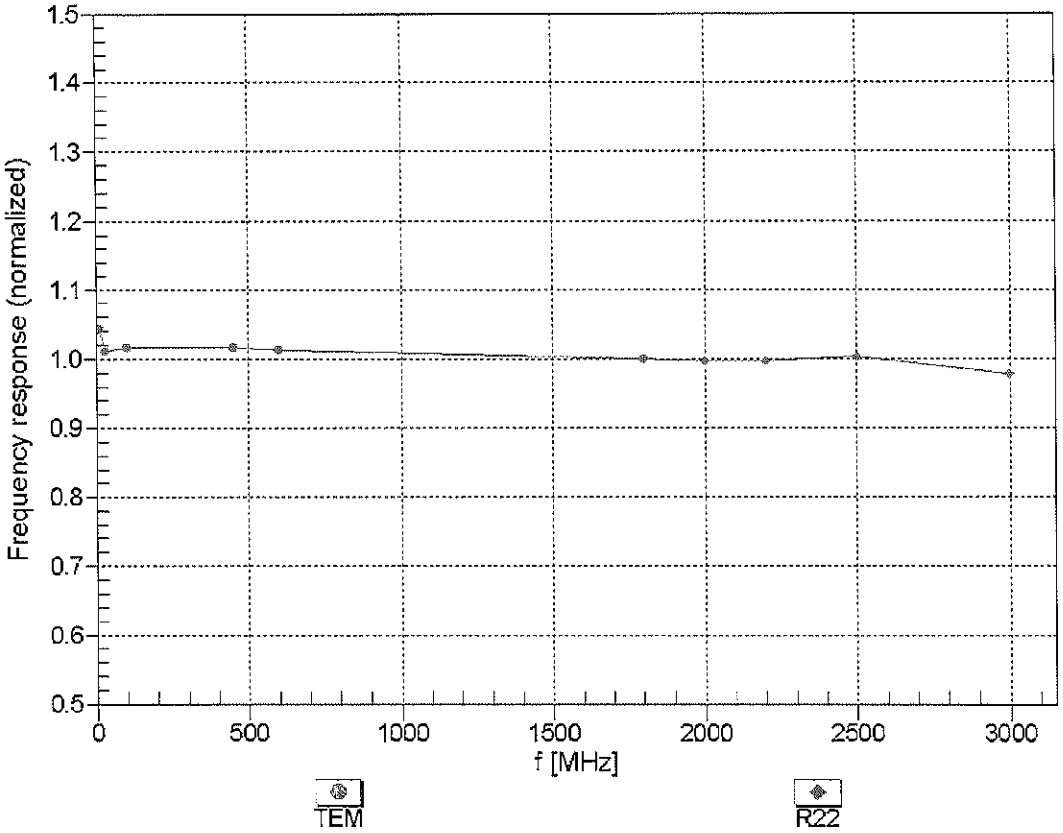
[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz 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

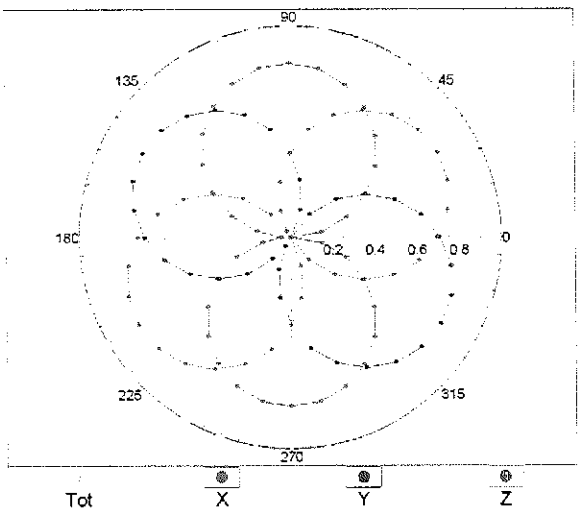
(TEM-Cell:ifi110 EXX, Waveguide: R22)



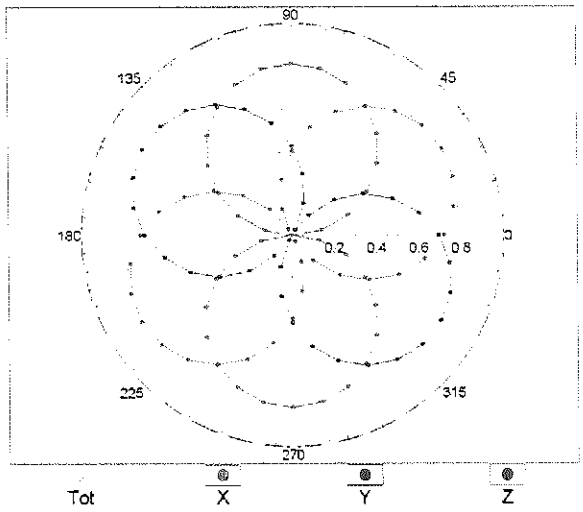
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

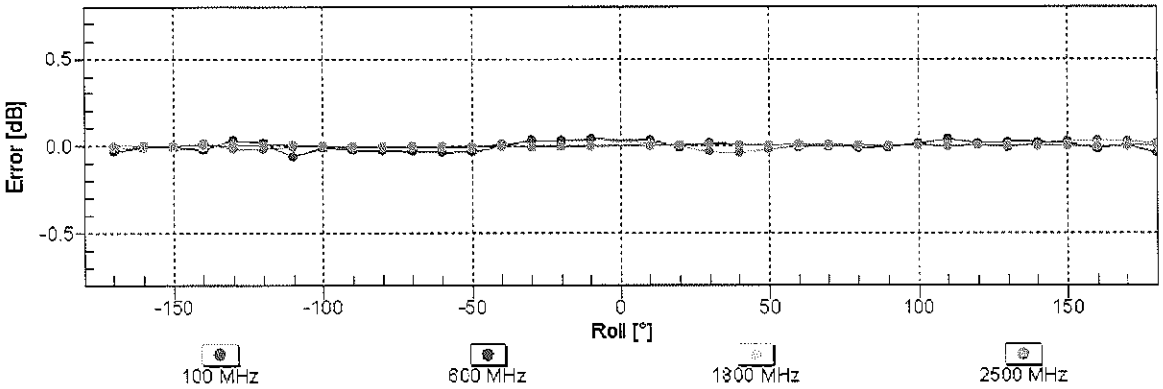
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



f=1800 MHz,R22

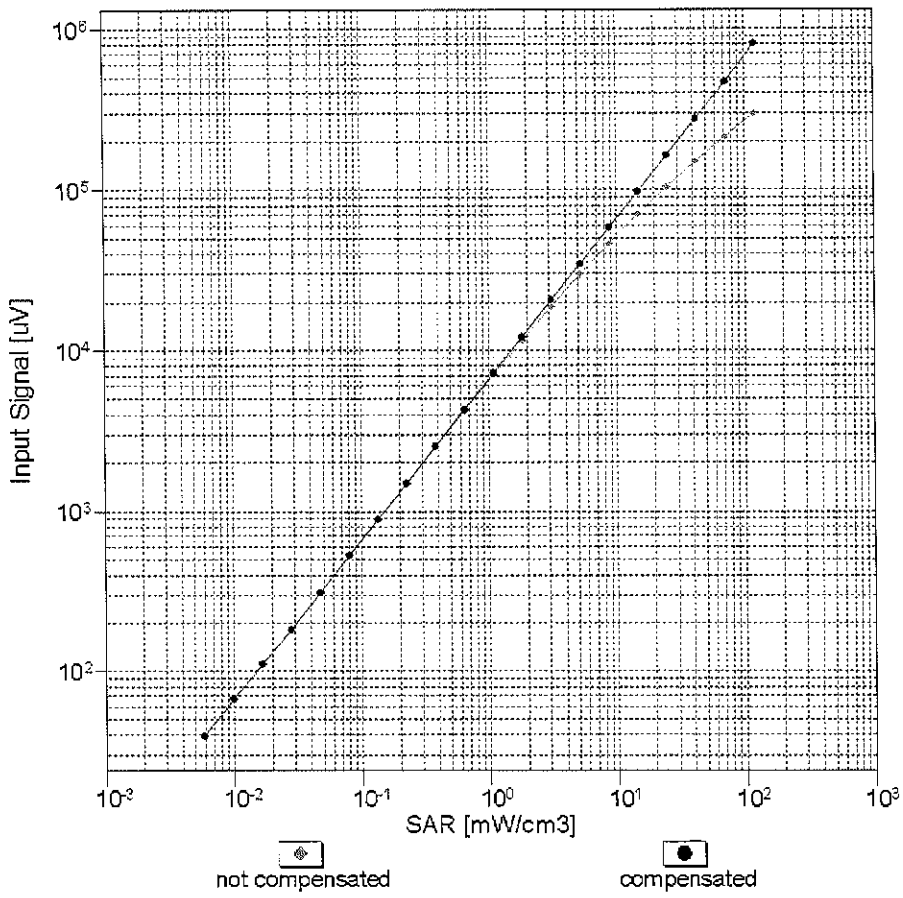


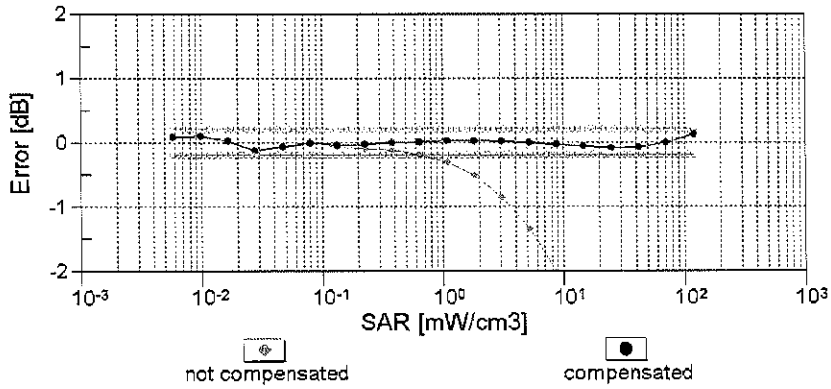


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR_{head})

(TEM cell , f_{eval}= 1900 MHz)

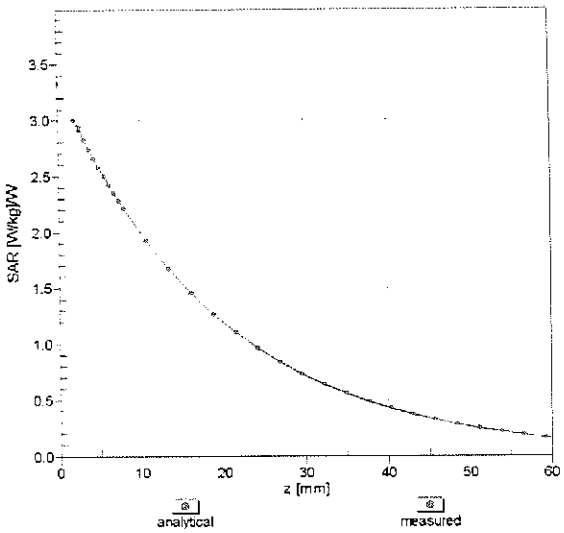




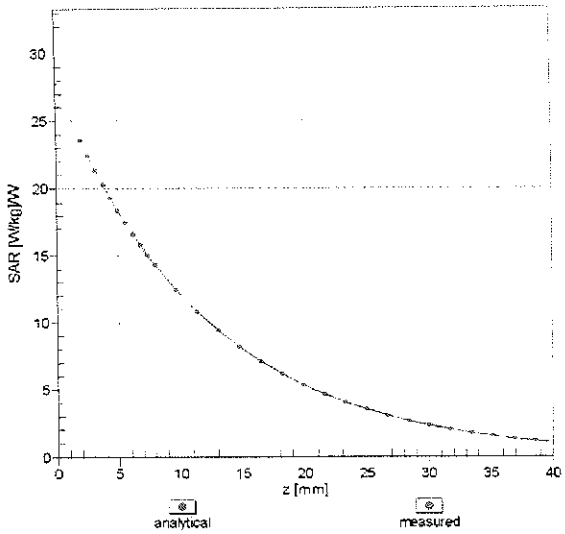
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

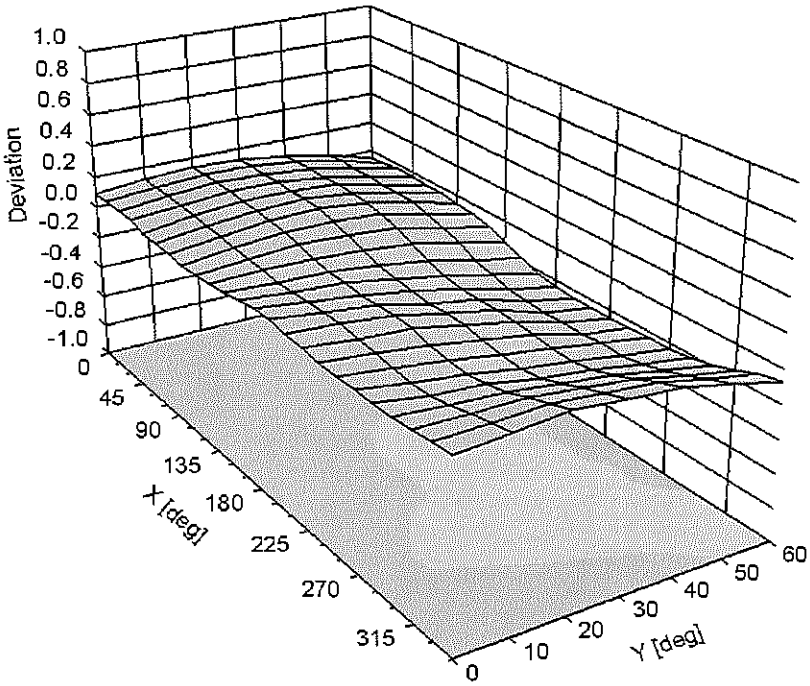


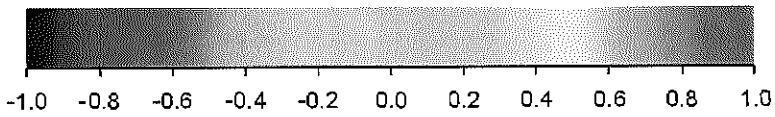
f = 1900 MHz,WGLS R22 (H_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz





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

DASY/EASY - Parameters of Probe: ES3DV3 - SN: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
Servizio svizzero di taratura
S Swiss Calibration Service

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

Accreditation No.: SCS 108

Client PC Test

Certificate No: EX3-3920_Dec14

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3920
Calibration procedure(s)	QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6 Calibration procedure for dosimetric E-field probes
Calibration date:	December 12, 2014

CC 12/12/14

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 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-14)	In house check: Oct-15

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

Issued: December 13, 2014

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

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

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

Probe EX3DV4

SN:3920

Manufactured: December 18, 2012
Calibrated: December 12, 2014

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3920

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (μV/(V/m)^2)[A]	0.35	0.50	0.50	± 10.1 %
DCP (mV)[B]	104.2	98.5	97.7	

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	131.7	±3.5 %
		Y	0.0	0.0	1.0		140.3	
		Z	0.0	0.0	1.0		136.8	
10010-CAA	SAR Validation (Square, 100ms, 10ms)	X	0.94	56.5	8.3	10.00	38.1	±0.7 %
		Y	2.14	63.7	12.2		41.6	
		Z	3.89	70.9	15.1		40.9	
10012-CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	X	2.91	68.2	18.0	1.87	142.7	±0.7 %
		Y	2.48	64.3	15.8		132.6	
		Z	2.61	65.8	16.8		129.2	
10013-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps)	X	10.41	69.4	22.2	9.46	149.3	±3.5 %
		Y	10.78	69.4	22.2		146.4	
		Z	10.76	69.7	22.6		141.9	
10032-CAA	IEEE 802.15.1 Bluetooth (GFSK, DH5)	X	0.29	58.3	5.2	1.16	136.2	±0.7 %
		Y	0.52	61.5	7.4		149.5	
		Z	0.99	66.7	9.6		146.5	
10062-CAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps)	X	9.78	68.2	21.1	8.68	126.2	±3.3 %
		Y	10.40	68.9	21.4		145.8	
		Z	10.43	69.3	21.9		146.6	
10103-CAB	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	7.49	68.0	21.7	9.29	145.0	±2.2 %
		Y	7.76	68.0	21.7		137.3	
		Z	8.12	69.7	22.9		139.5	
10117-CAB	IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK)	X	10.08	68.6	20.8	8.07	140.7	±3.0 %
		Y	10.01	67.8	20.3		129.1	
		Z	10.13	68.3	20.8		130.9	
10151-CAB	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	7.12	67.7	21.7	9.28	140.0	±2.2 %
		Y	7.42	67.6	21.5		133.0	
		Z	7.70	69.2	22.8		135.2	
10172-CAB	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	5.55	68.8	22.5	9.21	129.9	±2.7 %
		Y	6.01	69.1	22.6		144.5	
		Z	6.16	70.6	23.9		146.7	
10196-CAB	IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK)	X	9.56	68.2	20.7	8.10	132.3	±3.0 %
		Y	10.09	68.7	20.9		149.9	
		Z	10.08	69.0	21.3		147.9	
10237-CAB	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	5.60	69.2	22.8	9.21	133.6	±2.7 %
		Y	6.05	69.3	22.7		145.6	
		Z	6.15	70.5	23.9		147.8	

10252-CAB	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	6.68	67.3	21.6	9.24	133.4	±2.7 %
		Y	7.19	68.0	21.9		147.8	
		Z	7.38	69.3	23.0		147.7	
10267-CAB	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	7.14	67.7	21.8	9.30	139.9	±2.2 %
		Y	7.44	67.6	21.5		133.0	
		Z	7.68	69.1	22.7		131.5	
10317-AAB	IEEE 802.11a WiFi 5 GHz (OFDM, 6 Mbps, 96pc duty cycle)	X	9.72	68.3	21.0	8.36	132.1	±3.3 %
		Y	10.25	68.8	21.2		148.1	
		Z	10.27	69.2	21.6		148.7	
10400-AAB	IEEE 802.11ac WiFi (20MHz, 64-QAM, 99pc duty cycle)	X	9.78	68.3	20.9	8.37	131.9	±3.3 %
		Y	9.97	67.9	20.7		125.1	
		Z	10.36	69.3	21.7		148.4	
10401-AAB	IEEE 802.11ac WiFi (40MHz, 64-QAM, 99pc duty cycle)	X	10.63	68.9	21.2	8.60	142.5	±3.0 %
		Y	10.72	68.6	21.0		133.5	
		Z	10.74	68.8	21.4		133.0	
10402-AAB	IEEE 802.11ac WiFi (80MHz, 64-QAM, 99pc duty cycle)	X	10.89	69.3	21.2	8.53	145.0	±3.3 %
		Y	10.70	68.4	20.8		133.2	
		Z	10.95	69.2	21.4		134.0	
10415-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle)	X	2.84	68.2	17.9	1.54	141.1	±0.5 %
		Y	2.39	64.2	15.6		130.2	
		Z	2.63	66.6	17.2		128.6	
10416-AAA	IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 99pc duty cycle)	X	9.67	68.3	20.9	8.23	131.6	±3.3 %
		Y	10.14	68.6	21.0		147.9	
		Z	10.17	69.1	21.5		148.5	
10417-AAA	IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps, 99pc duty cycle)	X	9.67	68.3	20.9	8.23	133.0	±3.3 %
		Y	9.78	67.7	20.5		124.4	
		Z	10.21	69.1	21.5		149.4	

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 6 and 7).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3920

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)
2450	39.2	1.80	7.12	7.12	7.12	0.62	0.65	± 12.0 %
2600	39.0	1.96	6.85	6.85	6.85	0.36	0.86	± 12.0 %
5200	36.0	4.66	4.87	4.87	4.87	0.35	1.80	± 13.1 %
5300	35.9	4.76	4.69	4.69	4.69	0.35	1.80	± 13.1 %
5500	35.6	4.96	4.44	4.44	4.44	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.35	4.35	4.35	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.27	4.27	4.27	0.40	1.80	± 13.1 %

[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: EX3DV4 - SN:3920

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)
2450	52.7	1.95	7.02	7.02	7.02	0.80	0.50	± 12.0 %
2600	52.5	2.16	6.78	6.78	6.78	0.80	0.50	± 12.0 %
5200	49.0	5.30	4.33	4.33	4.33	0.45	1.90	± 13.1 %
5300	48.9	5.42	4.16	4.16	4.16	0.45	1.90	± 13.1 %
5500	48.6	5.65	3.79	3.79	3.79	0.50	1.90	± 13.1 %
5600	48.5	5.77	3.66	3.66	3.66	0.50	1.90	± 13.1 %
5800	48.2	6.00	3.93	3.93	3.93	0.50	1.90	± 13.1 %

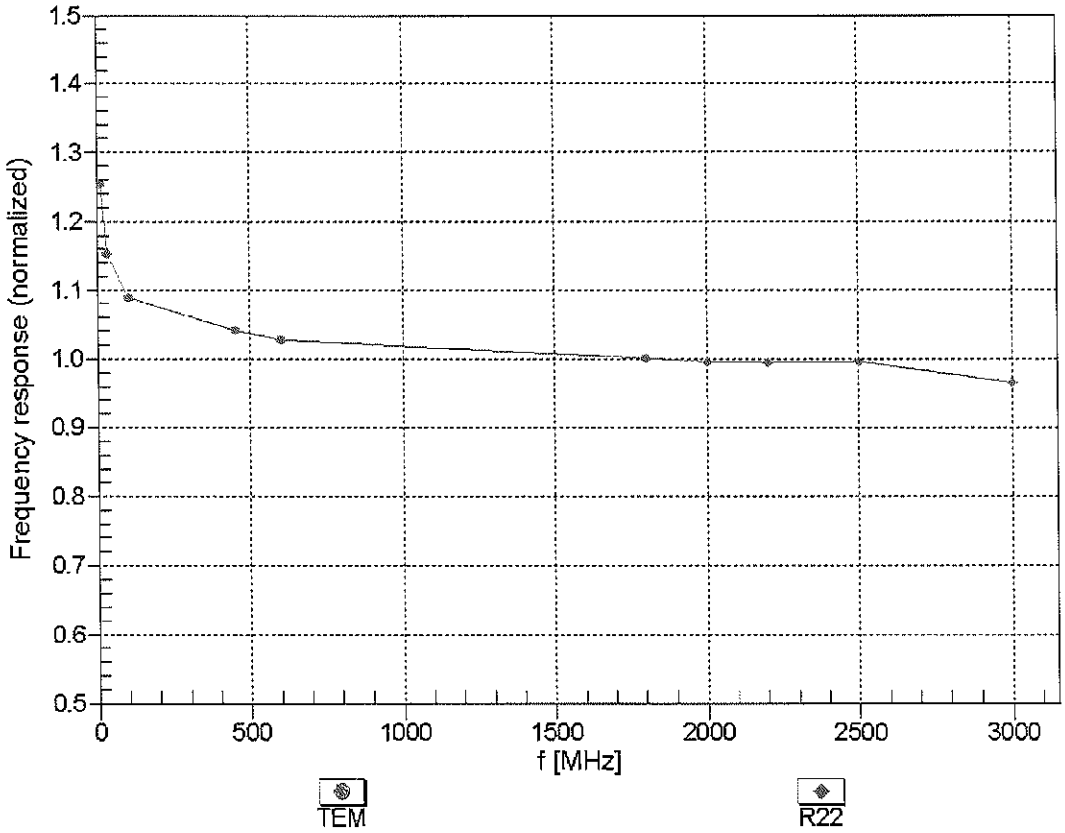
[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz 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

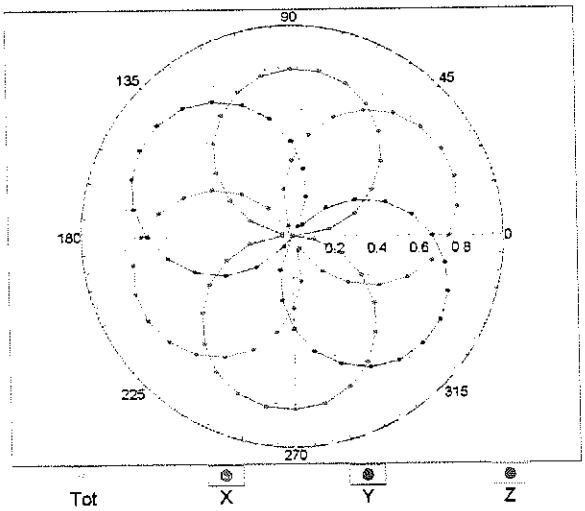
(TEM-Cell:ifi110 EXX, Waveguide: R22)



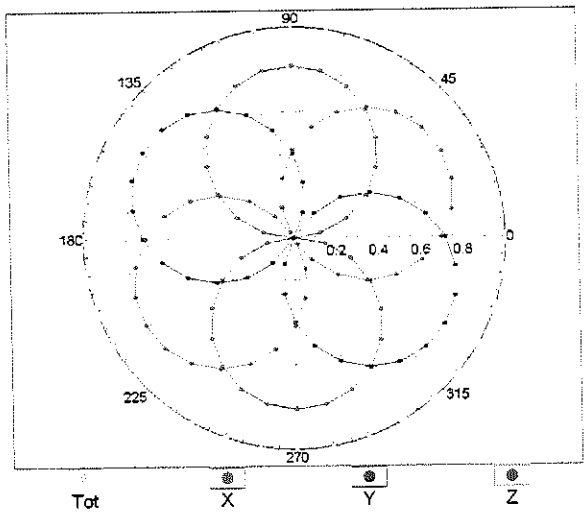
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

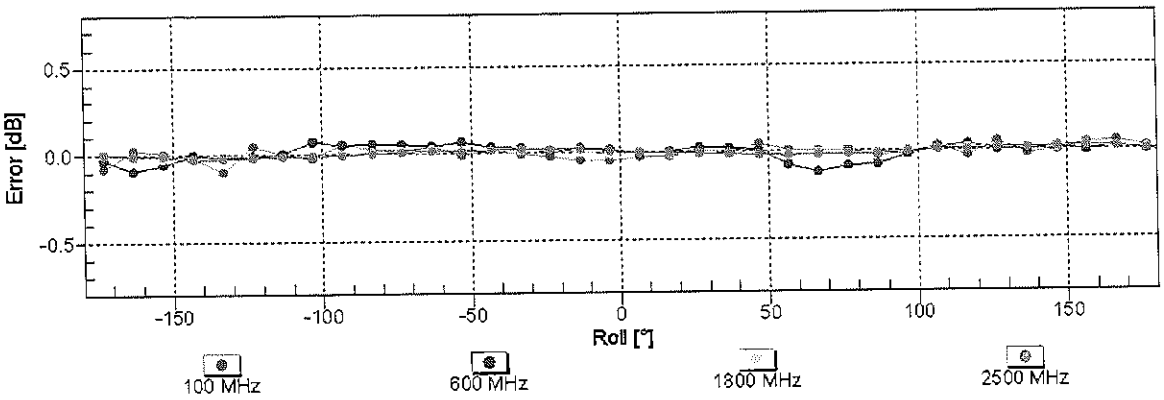
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



f=1800 MHz,R22

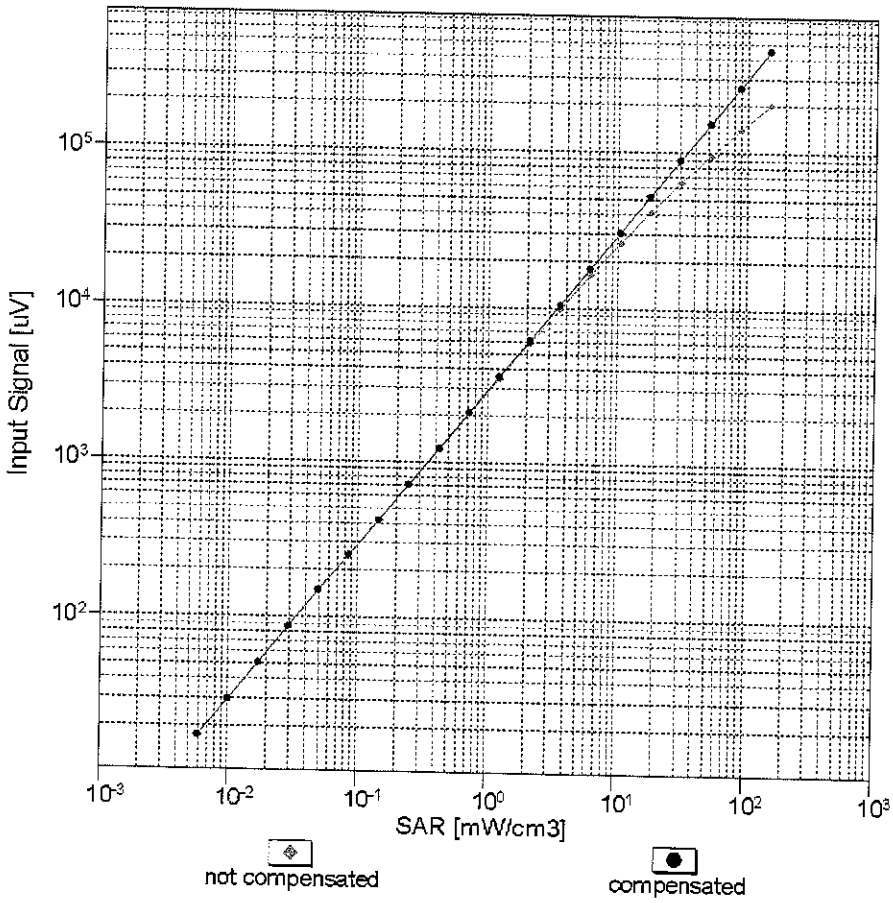


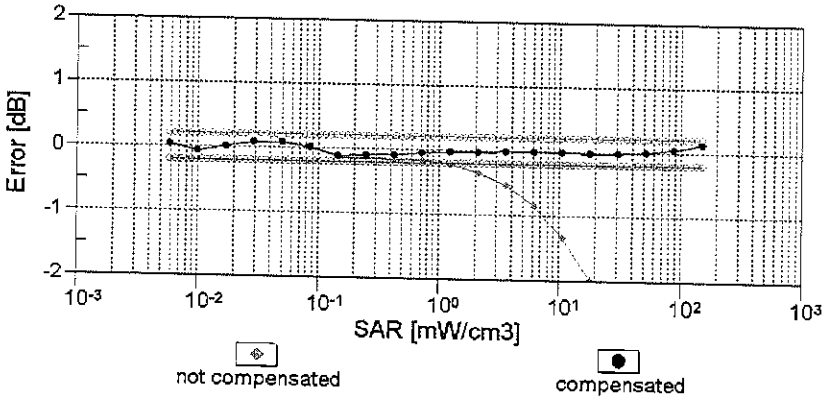


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR_{head})

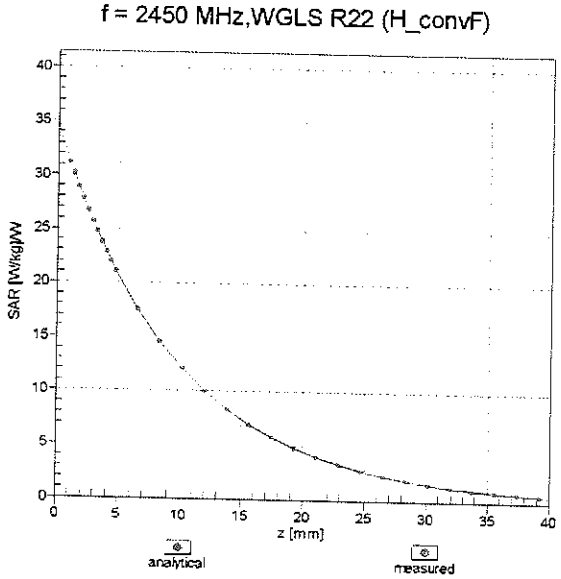
(TEM cell , f_{eval}= 1900 MHz)

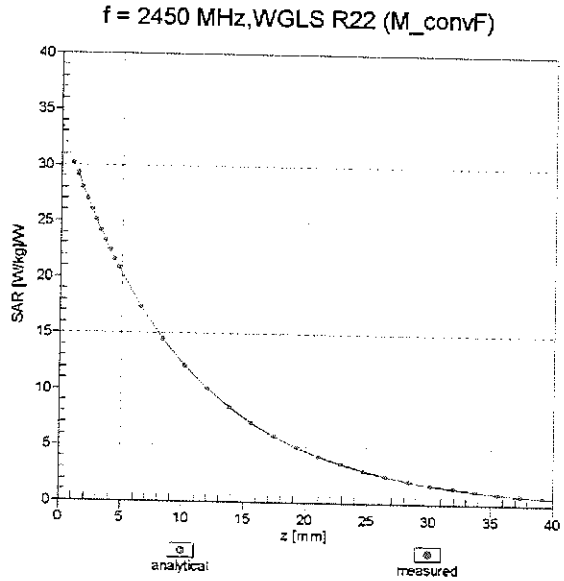




Uncertainty of Linearity Assessment: ± 0.6% (k=2)

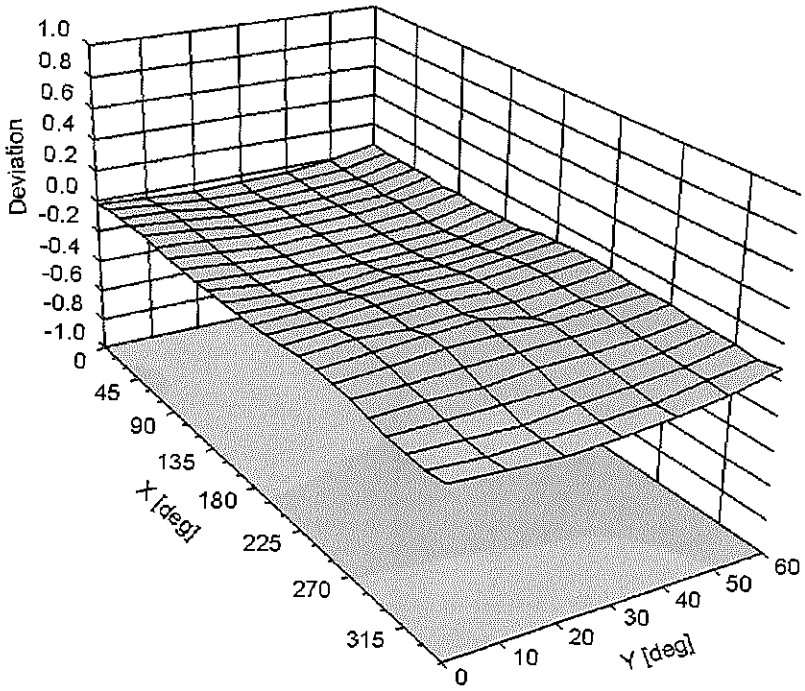
Conversion Factor Assessment

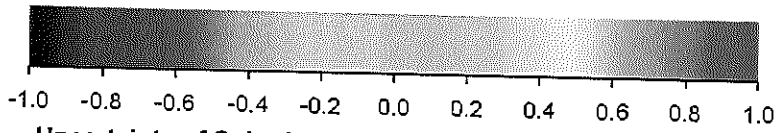




Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz





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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3920

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-23.3
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

APPENDIX D: SAR TISSUE SPECIFICATIONS

Measurement Procedure for Tissue Verification:

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

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

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

Table D-I
Composition of the Tissue Equivalent Matter

Frequency (MHz)	750	750	835	835	1900	1900	2450	2450	5200-5800	5200-5800
Tissue	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Ingredients (% by weight)										
Bactericide	See page 2-3	See page 2	0.1	0.1			See page 4		See page 5	
DGBE					44.92	29.44		26.7		
HEC			1	1						
NaCl			1.45	0.94	0.18	0.39		0.1		
Sucrose			57	44.9						
Polysorbate (Tween) 80										20
Water			40.45	53.06	54.9	70.17		73.2		80

© 2015 PCTEST Engineering Laboratory, Inc.

2 Composition / Information on ingredients

The Item is composed of the following ingredients:

H_2O	Water, 35 – 58%
Sucrose	Sugar, white, refined, 40 – 60%
NaCl	Sodium Chloride, 0 – 6%
Hydroxyethyl-cellulose	Medium Viscosity (CAS# 9004-62-0), <0.3%
Preventol-D7	Preservative: aqueous preparation, (CAS# 55965-84-9), containing 5-chloro-2-methyl-3(2H)-isothiazolone and 2-methyyl-3(2H)-isothiazolone, 0.1 – 0.7% Relevant for safety; Refer to the respective Safety Data Sheet*.

Figure D-1
Composition of 750 MHz Head and Body Tissue Equivalent Matter

Note: 750MHz liquid recipes are proprietary SPEAG. Since the composition is approximate to the actual liquids utilized, the manufacturer tissue-equivalent liquid data sheets are provided below.

Measurement Certificate / Material Test

Item Name	**Body Tissue Simulating Liquid (MSL750V2)**
Product No.	SL AAM 075 AA (Charge: 130828-1)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

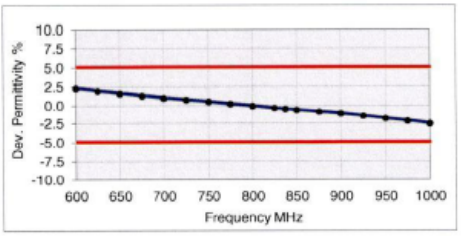
Test Condition

Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	28-Aug-13
Operator	IEN

Additional Information

TSL Density	1.212 g/cm³
TSL Heat-capacity	3.006 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
600	57.4	24.76	0.83	56.1	0.95	2.3	-13.2
625	57.1	24.42	0.85	56.0	0.95	2.0	-11.0
650	56.8	24.09	0.87	55.9	0.96	1.6	-8.9
675	56.6	23.80	0.89	55.8	0.96	1.3	-6.7
700	56.3	23.52	0.92	55.7	0.96	1.0	-4.5
725	56.1	23.27	0.94	55.6	0.96	0.8	-2.4
750	**55.8**	**23.03**	**0.96**	**55.5**	**0.96**	**0.5**	**-0.3**
775	55.6	22.87	0.99	55.4	0.97	0.2	2.1
800	55.3	22.71	1.01	55.3	0.97	-0.1	4.5
825	55.1	22.54	1.03	55.2	0.98	-0.3	5.8
838	54.9	22.45	1.05	55.2	0.98	-0.5	6.4
850	54.8	22.37	1.06	55.2	0.99	-0.6	7.0
875	54.6	22.25	1.08	55.1	1.02	-0.9	6.2
900	54.4	22.13	1.11	55.0	1.05	-1.1	5.5
925	54.2	22.02	1.13	55.0	1.06	-1.5	6.6
950	53.9	21.91	1.16	54.9	1.08	-1.8	7.7
975	53.7	21.84	1.18	54.9	1.09	-2.2	9.0
1000	53.5	21.77	1.21	54.8	1.10	-2.5	10.3



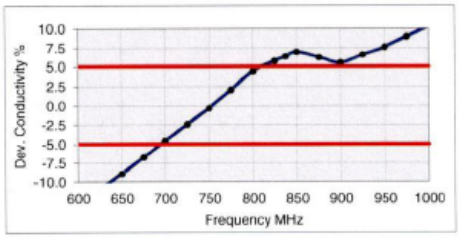


Figure D-2
750MHz Body Tissue Equivalent Matter

© 2015 PCTEST Engineering Laboratory, Inc.

Measurement Certificate / Material Test

Item Name	**Head Tissue Simulating Liquid (HSL750V2)**
Product No.	SL AAH 075 AA (Charge: 130826-2)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

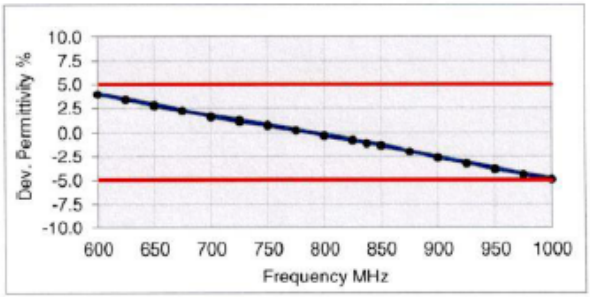
Test Condition

Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	28-Aug-13
Operator	IEN

Additional Information

TSL Density	1.284 g/cm^3
TSL Heat-capacity	2.701 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
600	44.4	23.32	0.78	42.7	0.88	3.9	-11.7
625	44.0	23.05	0.80	42.6	0.88	3.4	-9.3
650	43.6	22.78	0.82	42.5	0.89	2.8	-7.0
675	43.3	22.54	0.85	42.3	0.89	2.2	-4.7
700	42.9	22.30	0.87	42.2	0.89	1.6	-2.4
725	42.6	22.10	0.89	42.1	0.89	1.2	0.0
750	**42.3**	**21.90**	**0.91**	**41.9**	**0.89**	**0.8**	**2.3**
775	41.9	21.74	0.94	41.8	0.90	0.2	4.6
800	41.6	21.57	0.96	41.7	0.90	-0.3	7.0
825	41.3	21.42	0.98	41.6	0.91	-0.8	8.4
838	41.1	21.35	0.99	41.5	0.91	-1.0	9.1
850	41.0	21.27	1.01	41.5	0.92	-1.3	9.8
875	40.7	21.14	1.03	41.5	0.94	-2.0	9.1
900	40.4	21.00	1.05	41.5	0.97	-2.6	8.4
925	40.1	20.89	1.07	41.5	0.98	-3.2	9.4
950	39.9	20.78	1.10	41.4	0.99	-3.8	10.4
975	39.6	20.69	1.12	41.4	1.00	-4.4	11.7
1000	39.3	20.60	1.15	41.3	1.01	-4.9	12.9



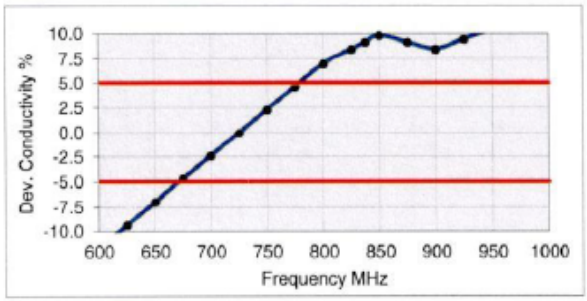


Figure D-3
750MHz Head Tissue Equivalent Matter

© 2015 PCTEST Engineering Laboratory, Inc.

2 Composition / Information on ingredients

The Item is composed of the following ingredients:

H2O	Water, 52 – 75%
C8H18O3	Diethylene glycol monobutyl ether (DGBE), 25 – 48% (CAS-No. 112-34-5, EC-No. 203-961-6, EC-index-No. 603-096-00-8) Relevant for safety; Refer to the respective Safety Data Sheet*.
NaCl	Sodium Chloride, <1.0%

Figure D-4
Composition of 2.4 – 2.6 GHz Head Tissue Equivalent Matter

Note: 2.4 GHz head liquid recipes are proprietary SPEAG. Since the composition is approximate to the actual liquids utilized, the manufacturer tissue-equivalent liquid data sheets are provided below.

Measurement Certificate / Material Test

Item Name	**Head Tissue Simulating Liquid (HSL2450V2)**
Product No.	SL AAH 245 BA (Charge: 130926-1)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

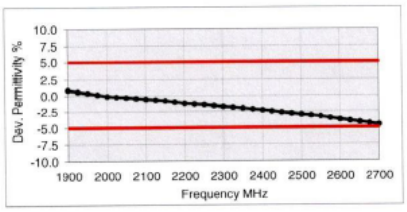
Test Condition

Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	23°C
Test Date	2-Oct-13
Operator	CL

Additional Information

TSL Density	0.988 g/cm^3
TSL Heat-capacity	3.680 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
1900	40.3	11.88	1.26	40.0	1.40	0.9	-10.3
1925	40.3	11.98	1.28	40.0	1.40	0.6	-8.3
1950	40.2	12.08	1.31	40.0	1.40	0.4	-6.4
1975	40.1	12.15	1.34	40.0	1.40	0.2	-4.6
2000	40.0	12.23	1.36	40.0	1.40	-0.1	-2.8
2025	39.9	12.34	1.39	40.0	1.42	-0.2	-2.3
2050	39.8	12.45	1.42	39.9	1.44	-0.3	-1.7
2075	39.7	12.54	1.45	39.9	1.47	-0.4	-1.3
2100	39.6	12.64	1.48	39.8	1.49	-0.5	-0.8
2125	39.5	12.69	1.50	39.8	1.51	-0.7	-0.7
2150	39.4	12.75	1.52	39.7	1.53	-0.8	-0.6
2175	39.3	12.84	1.55	39.7	1.56	-1.0	-0.1
2200	39.2	12.94	1.58	39.6	1.58	-1.2	0.4
2225	39.1	13.00	1.61	39.6	1.60	-1.3	0.6
2250	39.0	13.07	1.64	39.6	1.62	-1.4	0.8
2275	38.9	13.15	1.66	39.5	1.64	-1.5	1.2
2300	**38.8**	**13.22**	**1.69**	**39.5**	**1.67**	**-1.7**	**1.5**
2325	38.7	13.32	1.72	39.4	1.69	-1.9	2.0
2350	38.6	13.42	1.75	39.4	1.71	-2.0	2.5
2375	38.5	13.49	1.78	39.3	1.73	-2.1	2.8
2400	38.4	13.56	1.81	39.3	1.76	-2.3	3.1
2425	38.3	13.63	1.84	39.2	1.78	-2.5	3.5
2450	**38.2**	**13.71**	**1.87**	**39.2**	**1.80**	**-2.6**	**3.8**
2475	38.1	13.79	1.90	39.2	1.83	-2.8	3.9
2500	38.0	13.87	1.93	39.1	1.85	-3.0	4.0
2525	37.9	13.96	1.96	39.1	1.88	-3.1	4.2
2550	37.8	14.05	1.99	39.1	1.91	-3.3	4.4
2575	37.7	14.11	2.02	39.0	1.94	-3.5	4.4
2600	**37.5**	**14.17**	**2.05**	**39.0**	**1.96**	**-3.8**	**4.4**
2625	37.4	14.23	2.08	39.0	1.99	-4.0	4.4
2650	37.3	14.30	2.11	38.9	2.02	-4.2	4.5
2675	37.2	14.37	2.14	38.9	2.05	-4.4	4.6
2700	37.1	14.45	2.17	38.9	2.07	-4.6	4.7



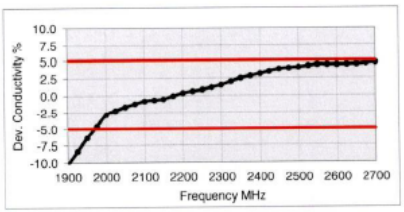


Figure D-5
2.4 – 2.6 GHz Head Tissue Equivalent Matter

© 2015 PCTEST Engineering Laboratory, Inc.

2 Composition / Information on ingredients

The Item is composed of the following ingredients:

Water	50 – 65%
Mineral oil	10 – 30%
Emulsifiers	8 – 25%
Sodium salt	0 – 1.5%

Figure D-6
Composition of 5 GHz Head Tissue Equivalent Matter

Note: 5GHz head liquid recipes are proprietary SPEAG. Since the composition is approximate to the actual liquids utilized, the manufacturer tissue-equivalent liquid data sheets are provided below.

Measurement Certificate / Material Test

Item Name	**Head Tissue Simulating Liquid (HBBL3500-5800V5)**
Product No.	SL AAH 502 AC (Charge: 130903-1)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

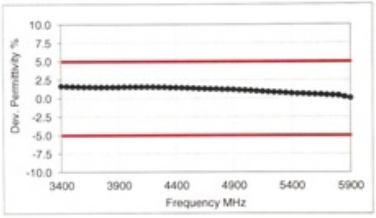
Test Condition

Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	4-Sep-13
Operator	IEN

Additional Information

TSL Density	0.985 g/cm³
TSL Heat-capacity	3.383 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
3400	38.7	15.01	2.84	38.0	2.81	1.7	1.1
3500	**38.5**	**14.98**	**2.92**	**37.9**	**2.91**	**1.5**	**0.3**
3600	38.4	14.98	3.00	37.8	3.02	1.5	-0.5
3700	**38.3**	**14.97**	**3.08**	**37.7**	**3.12**	**1.6**	**-1.2**
3800	38.2	14.95	3.16	37.6	3.22	1.6	-1.9
3900	38.1	14.96	3.25	37.5	3.32	1.7	-2.2
4000	37.9	14.98	3.33	37.4	3.43	1.5	-2.8
4100	37.8	15.00	3.42	37.2	3.53	1.5	-3.0
4200	37.7	15.04	3.51	37.1	3.63	1.5	-3.3
4300	37.6	15.10	3.61	37.0	3.73	1.6	-3.3
4400	37.4	15.16	3.71	36.9	3.84	1.4	-3.3
4500	37.3	15.22	3.81	36.8	3.94	1.4	-3.2
4600	37.2	15.29	3.91	36.7	4.04	1.4	-3.2
4700	37.0	15.34	4.01	36.6	4.14	1.2	-3.2
4800	36.9	15.41	4.11	36.4	4.25	1.3	-3.2
4850	36.8	15.43	4.16	36.4	4.30	1.1	-3.2
4900	36.8	15.47	4.22	36.3	4.35	1.3	-2.9
4950	36.7	15.49	4.26	36.3	4.40	1.2	-3.2
5000	36.6	15.52	4.32	36.2	4.45	1.1	-2.9
5050	36.5	15.55	4.37	36.2	4.50	0.9	-2.9
5100	36.5	15.59	4.42	36.1	4.55	1.1	-2.9
5150	36.4	15.62	4.47	36.0	4.60	1.0	-2.9
5200	**36.3**	**15.65**	**4.53**	**36.0**	**4.66**	**0.9**	**-2.7**
5250	36.2	15.67	4.58	35.9	4.71	0.8	-2.7
5300	36.2	15.71	4.63	35.9	4.76	0.9	-2.7
5350	36.1	15.73	4.68	35.8	4.81	0.8	-2.7
5400	36.0	15.75	4.73	35.8	4.86	0.7	-2.7
5450	35.9	15.78	4.78	35.7	4.91	0.6	-2.7
5500	**35.9**	**15.79**	**4.83**	**35.6**	**4.96**	**0.7**	**-2.7**
5550	35.8	15.83	4.89	35.6	5.01	0.6	-2.5
5600	35.7	15.86	4.94	35.5	5.07	0.5	-2.5
5650	35.7	15.89	5.00	35.5	5.12	0.6	-2.3
5700	35.6	15.92	5.05	35.4	5.17	0.5	-2.3
5750	35.5	15.96	5.11	35.4	5.22	0.4	-2.1
5800	**35.5**	**15.97**	**5.15**	**35.3**	**5.27**	**0.6**	**-2.3**
5850	35.4	16.02	5.21	35.3	5.34	0.3	-2.3
5900	35.3	16.03	5.26	35.3	5.40	0.0	-2.6



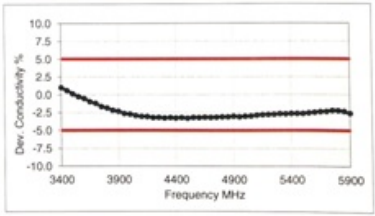


Figure D-7
5GHz Head Tissue Equivalent Matter

© 2015 PCTEST Engineering Laboratory, Inc.

APPENDIX E: SAR SYSTEM VALIDATION

Per FCC KDB 865664 D02v01, SAR system validation status should be documented to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the required tissue- equivalent media for system validation, according to the procedures outlined in FCC KDB 865664 D01 v01 and IEEE 1528-2013. Since SAR probe calibrations are frequency dependent, each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media.

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

Table E-I
SAR System Validation Summary

SAR SYSTEM #	FREQ. [MHz]	DATE	PROBE SN	PROBE TYPE	PROBE CAL. POINT		COND.	PERM.	CW VALIDATION			MOD. VALIDATION		
							(σ)	(ε_r)	SENSI-TIVITY	PROBE LINEARITY	PROBE ISOTROPY	MOD. TYPE	DUTY FACTOR	PAR
D	750	8/28/2014	3263	ES3DV3	750	Head	0.911	40.71	PASS	PASS	PASS	N/A	N/A	N/A
G	835	2/17/2015	3213	ES3DV3	835	Head	0.902	41.52	PASS	PASS	PASS	GMSK	PASS	N/A
D	1900	9/30/2014	3263	ES3DV3	1900	Head	1.421	39.44	PASS	PASS	PASS	GMSK	PASS	N/A
G	2450	2/6/2015	3213	ES3DV3	2450	Head	1.803	40.93	PASS	PASS	PASS	OFDM/TDD	PASS	PASS
E	5300	10/28/2014	7308	EX3DV4	5250	Head	4.617	36.20	PASS	PASS	PASS	OFDM	N/A	PASS
E	5500	10/28/2014	7308	EX3DV4	5600	Head	4.828	35.97	PASS	PASS	PASS	OFDM	N/A	PASS
E	5800	10/28/2014	7308	EX3DV4	5750	Head	5.113	35.53	PASS	PASS	PASS	OFDM	N/A	PASS
K	750	10/15/2014	3288	ES3DV3	750	Body	0.998	55.59	PASS	PASS	PASS	N/A	N/A	N/A
K	835	10/13/2014	3288	ES3DV3	835	Body	0.998	52.95	PASS	PASS	PASS	GMSK	PASS	N/A
D	1900	10/9/2014	3263	ES3DV3	1900	Body	1.569	52.31	PASS	PASS	PASS	GMSK	PASS	N/A
D	2450	10/3/2014	3263	ES3DV3	2450	Body	1.977	50.94	PASS	PASS	PASS	OFDM/TDD	PASS	PASS
H	5300	12/30/2014	3920	EX3DV4	5300	Body	5.523	47.80	PASS	PASS	PASS	OFDM	N/A	PASS
H	5500	12/30/2014	3920	EX3DV4	5500	Body	5.800	47.43	PASS	PASS	PASS	OFDM	N/A	PASS
H	5800	12/30/2014	3920	EX3DV4	5800	Body	6.191	46.98	PASS	PASS	PASS	OFDM	N/A	PASS

NOTE: While the probes have been calibrated for both CW and modulated signals, all measurements were performed using communication systems calibrated for CW signals only. Modulations in the table above represent test configurations for which the measurement system has been validated per FCC KDB Publication 865664 D01v01 for scenarios when CW probe calibrations are used with other signal types. SAR systems were validated for modulated signals with a periodic duty cycle, such as GMSK, or with a high peak to average ratio (>5 dB), such as OFDM according to KDB 865664.

© 2015 PCTEST Engineering Laboratory, Inc.