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SAR EVALUATION REPORT

Applicant Name:
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Gyeonggi-do 443-742, Korea

Date of Testing:
10/14/14 - 10/29/14
Test Site/Location:
PCTEST Lab, Columbia, MD, USA
Document Serial No.:
0Y1410152012.A3L

FCC ID:	**A3LSC03G**
APPLICANT:	**SAMSUNG ELECTRONICS, CO. LTD.**

DUT Type:	Portable Tablet
Application Type:	Certification
FCC Rule Part(s):	CFR §2.1093
Model(s):	SC-03G

Equipment Class	Band & Mode	Tx Frequency	SAR 1 gm Body (W/kg)
PCB	GPRS/EDGE 850	824.20 - 848.80 MHz	0.80
PCB	UMTS 850	826.40 - 846.60 MHz	0.48
PCB	GPRS/EDGE 1900	1850.20 - 1909.80 MHz	1.05
DTS	2.4 GHz WLAN	2412 - 2462 MHz	1.10
DTS	5.8 GHz WLAN	5745 - 5825 MHz	0.80
NII	5.2 GHz WLAN	5180 - 5240 MHz	1.10
NII	5.3 GHz WLAN	5260 - 5320 MHz	1.10
NII	5.5 GHz WLAN	5500 - 5700 MHz	1.05
DSS/DTS	Bluetooth	2402 - 2480 MHz	N/A
Simultaneous SAR per KDB 690783 D01v01r03:			1.57

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

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

Randy Ortanez
President

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.

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1 DEVICE UNDER TEST

1.1 Device Overview

Band & Mode	Operating Modes	Tx Frequency
GPRS/EDGE 850	Data	824.20 - 848.80 MHz
UMTS 850	Data	826.40 - 846.60 MHz
GPRS/EDGE 1900	Data	1850.20 - 1909.80 MHz
2.4 GHz WLAN	Data	2412 - 2462 MHz
5.8 GHz WLAN	Data	5745 - 5825 MHz
5.2 GHz WLAN	Data	5180 - 5240 MHz
5.3 GHz WLAN	Data	5260 - 5320 MHz
5.5 GHz WLAN	Data	5500 - 5700 MHz
Bluetooth	Data	2402 - 2480 MHz
ANT+	Data	2402 - 2480 MHz

1.2 Power Reduction for SAR

This device uses a sensor for SAR compliance. The sensor is activated when used in close proximity to the user's body. The sensor triggers power reduction for data modes for main antenna and is only applicable for tablet operations. There is no power reduction mechanism for WIFI/BT modes for SAR purposes.

Since the device is a full size tablet, the Body SAR was evaluated per FCC KDB Publication 616217 D04 for full sized tablets.

1.3 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.

1.3.1 Maximum Power

Mode / Band		Burst Average GMSK (dBm)				Burst Average 8-PSK (dBm)			
		1 TX Slots	*2 TX Slots*	*3 TX Slots*	*4 TX Slots*	*1 TX Slots*	*2 TX Slots*	*3 TX Slots*	*4 TX Slots*
GPRS/EDGE 850	Maximum	**33.0**	**29.0**	**28.0**	**27.0**	**27.0**	**26.5**	**22.5**	**21.5**
	Nominal	**32.5**	**28.5**	**27.5**	**26.5**	**26.5**	**26.0**	**22.0**	**21.0**
GPRS/EDGE 1900	Maximum	**29.5**	**29.0**	**27.5**	**26.0**	**26.0**	**25.5**	**20.5**	**19.5**
	Nominal	**29.0**	**28.5**	**27.0**	**25.5**	**25.5**	**25.0**	**20.0**	**19.0**

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**	**23.5**	**23.5**
	Nominal	**23.0**	**23.0**	**23.0**

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Mode / Band		Modulated Average (dBm)
SISO IEEE 802.11b (2.4 GHz)	Maximum	**12.0**
	Nominal	**11.5**
SISO IEEE 802.11g (2.4 GHz)	Maximum	**11.5**
	Nominal	**11.0**
SISO IEEE 802.11n (2.4 GHz)	Maximum	**10.5**
	Nominal	**10.0**
MIMO IEEE 802.11n (2.4 GHz)	Maximum	**13.0**
	Nominal	**12.5**
SISO IEEE 802.11a (5 GHz)	Maximum	**9.0**
	Nominal	**8.5**
SISO IEEE 802.11n (5 GHz)	Maximum	**9.0**
	Nominal	**8.5**
MIMO IEEE 802.11n (5 GHz) 20 MHz Bandwidth	Maximum	**11.5**
	Nominal	**11.0**
MIMO IEEE 802.11n (5 GHz) 40 MHz Bandwidth	Maximum	**10.5**
	Nominal	**10.0**
SISO IEEE 802.11ac (5 GHz)	Maximum	**9.0**
	Nominal	**8.5**
MIMO IEEE 802.11ac (5 GHz) 20 MHz BAndwidth	Maximum	**11.5**
	Nominal	**11.0**
MIMO IEEE 802.11ac (5 GHz) 40 MHz Bandwidth	Maximum	**10.5**
	Nominal	**10.0**
MIMO IEEE 802.11ac (5 GHz) 80 MHz BAndwidth	Maximum	**10.5**
	Nominal	**10.0**
Bluetooth	Maximum	**9.5**
	Nominal	**9.0**
Bluetooth LE	Maximum	**7.0**
	Nominal	**6.5**

1.3.2 Reduced Power – Body at 0.0 cm

Mode / Band		Burst Average GMSK (dBm)				Burst Average 8-PSK (dBm)			
		1 TX Slots	*2 TX Slots*	*3 TX Slots*	*4 TX Slots*	*1 TX Slots*	*2 TX Slots*	*3 TX Slots*	*4 TX Slots*
GPRS/EDGE 850	Maximum	**25.0**	**23.5**	**22.0**	**20.5**	**21.5**	**20.0**	**16.0**	**15.0**
	Nominal	**24.5**	**23.0**	**21.5**	**20.0**	**21.0**	**19.5**	**15.5**	**14.5**
GPRS/EDGE 1900	Maximum	**19.5**	**18.5**	**17.5**	**16.0**	**18.5**	**16.0**	**11.0**	**10.5**
	Nominal	**19.0**	**18.0**	**17.0**	**15.5**	**18.0**	**15.5**	**10.5**	**10.0**

Mode / Band		Modulated Average (dBm)		
		3GPP WCDMA Rel 99	*3GPP HSDPA Rel 5*	*3GPP HSUPA Rel 6*
UMTS Band 5 (850 MHz)	Maximum	**15.5**	**15.5**	**15.5**
	Nominal	**15.0**	**15.0**	**15.0**

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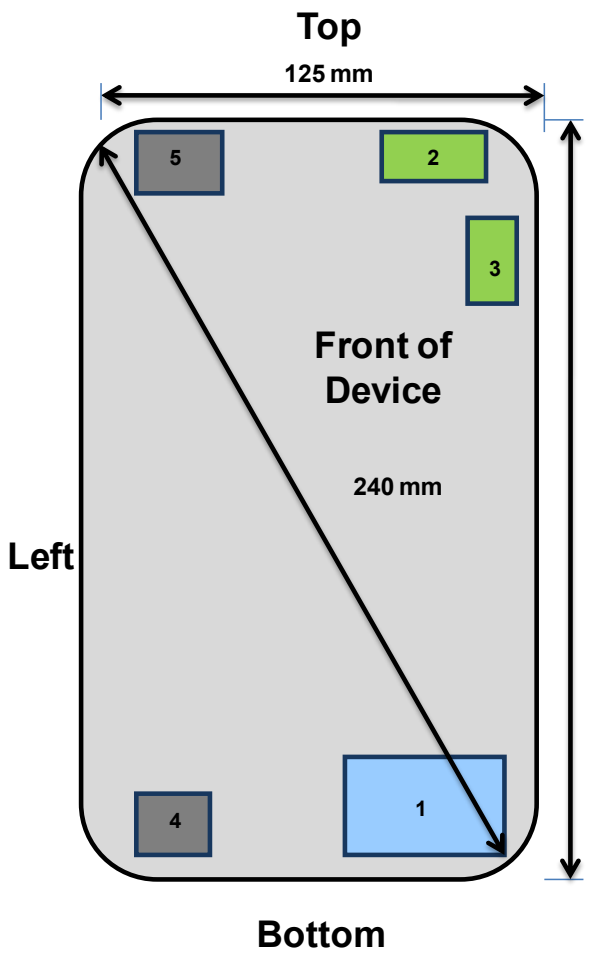
1.4 DUT Antenna Locations



1. GPRS/EDGE 850/1900 MHz (Tx/Rx)
   UMTS 850 (Tx/Rx)
2. 2.4/5GHz WIFI Antenna 1 (Tx/Rx)
   2.4 GHz BT (Tx/Rx)
   GPS (Rx Only)
3. 2.4/5GHz WIFI Antenna 2 (Tx/Rx)
4. UMTS 850 (Rx Only)
5. Diversity Antenna, Non-US bands

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

Figure 1-1
DUT Antenna Locations

Table 1-1
Sides for SAR Testing

Mode	Back	Top	Bottom	Right	Left
GPRS 850	Yes	No	Yes	Yes	No
UMTS 850	Yes	No	Yes	Yes	No
GPRS 1900	Yes	No	Yes	Yes	No
2.4 GHz WLAN	Yes	Yes	No	Yes	No
5 GHz WLAN	Yes	Yes	No	Yes	No

Note: Per FCC KDB 616217 D04v01r01, Particular DUT edges were not required to be evaluated for SAR based on the SAR exclusion threshold in KDB 447498 D01v05r01.

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1.5 Simultaneous Transmission Capabilities

According to FCC KDB Publication 447498 D05v01, transmitters are considered to be transmitting simultaneously when there is overlapping transmission, with the exception of transmissions during network hand-offs with maximum hand-off duration less than 30 seconds.
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.

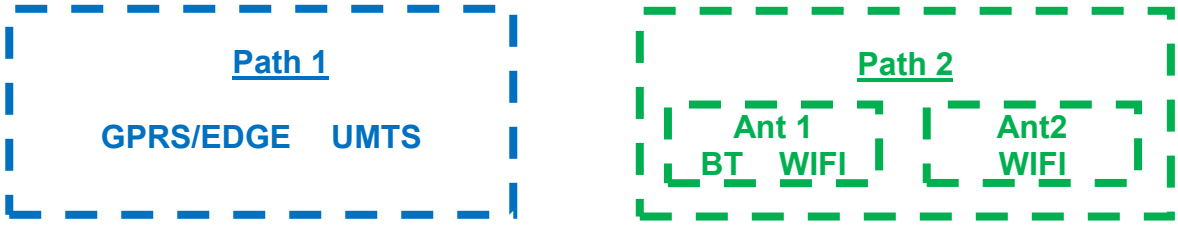

Figure 1-2
Simultaneous Transmission Paths

Table 1-2
Simultaneous Transmission Scenarios

No.	Capable Transmit Configuration	Body
1	UMTS + 2.4 GHz WI-FI	Yes
2	UMTS + 2.4 GHz Bluetooth	Yes
3	GPRS/EDGE + 2.4 GHz WI-FI	Yes
4	GPRS/EDGE + 2.4 GHz Bluetooth	Yes
5	UMTS + 5 GHz WI-FI	N/A
6	GPRS/EDGE + 5 GHz WI-FI	N/A

1. All licensed modes share the same antenna path and cannot transmit simultaneously.
2. When wireless router mode is enabled, all 5 GHz bands are disabled.
3. This device supports 2x2 MIMO Tx for WLAN 802.11n/ac. Each WLAN antenna can transmit independently or together when operating with MIMO.

1.6 SAR Test Exclusions Applied

(A) WIFI/BT

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; [(9/5)* √2.480] = 2.8< 3.0.
Per KDB Publication 447498 D01v05, the maximum power of the channel was rounded to the nearest mW before calculation.

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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) No new 5 GHz channels

(B) Licensed Transmitter(s)

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

1.7 Guidance Applied

- FCC KDB Publication 616217 D04v01 (Tablet SAR Considerations)
- FCC KDB Publication 941225 D01v02, D03v01, D06v01r01 (2G/3G)
- FCC KDB Publication 248227 D01v01r02 (SAR Considerations for 802.11 Devices)
- FCC KDB Publication 447498 D01v05r02 (General SAR Guidance)
- FCC KDB Publication 865664 D01v01r03, D02v01r01 (SAR Measurements up to 6 GHz)
- April 2013 TCB Workshop Notes (IEEE 802.11ac)
- October 2013 TCB Workshop Notes (GPRS Testing Considerations)

1.8 Device Serial Numbers

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

	Serial Number Maximum Power	Serial Number Reduced Power
GPRS/EDGE 850	1010-1	1010-2
UMTS 850	1010-1	1010-2
GPRS/EDGE 1900	1010-1	1010-2
2.4 GHz WLAN	1310-1	-
5 GHz WLAN	1310-3	-

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2 INTRODUCTION

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

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [3] and Health Canada RF Exposure Guidelines Safety Code 6 [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.

2.1 SAR Definition

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

Equation 2-1
SAR Mathematical Equation

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

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

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

where:

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

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

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3 DOSIMETRIC ASSESSMENT

3.1 Measurement Procedure

The evaluation was performed using the following procedure compliant to FCC KDB Publication 865664 D01v01 and IEEE 1528-2013:

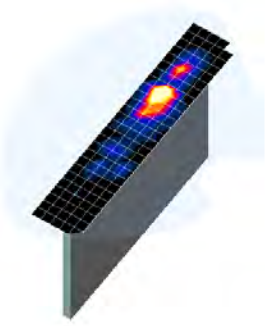

Figure 3-1
Sample SAR Area Scan

1. The SAR distribution at the exposed side of the head or body was measured at a distance no greater than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the device-head and body interface and the horizontal grid resolution was determined per FCC KDB Publication 865664 D01v01 (See Table 3-1) 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 3-1) 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 3-1. 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 3-1
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

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4 SAR TESTING PROCEDURES

4.1 SAR Testing for Tablet per KDB Publication 616217 D04

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

4.2 Additional Test Positions due to Proximity Sensor Considerations

This device uses a proximity sensor to reduce data powers in tablet-device use conditions.

While the device's antenna is within a certain distance of the user, the sensor activates and reduces the maximum output power allowed. However, the sensor is not active when the device is moved beyond the sensor triggering distance and the maximum output power is no longer limited. Therefore, an additional exposure condition is needed in the vicinity of the triggering distance to ensure SAR is compliant when the device is allowed to operate at a non-reduced output power level.

FCC KDB 616217 D04 Section 6 was used as a guideline for selecting SAR test distances for this device at these additional exposure conditions. Since the proximity sensor activation distance for the back side of the device is 17 mm, a conservative distance of 16 mm was tested for SAR on the back side at maximum power. Since the proximity sensor activation distance for the bottom edge of the device is 12 mm, a conservative distance of 11 mm was tested for SAR on the bottom edge at maximum power. Since the proximity sensor activation distance for the right edge of the device is 6 mm, a conservative distance of 5 mm was tested for SAR on the right edge at maximum power. Sensor triggering distance summary data is included in Appendix G.

The sensor is designed to support sufficient detection range and sensitivity to cover regions of the sensors in all applicable directions since the sensor entirely covers the antenna.

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5 RF EXPOSURE LIMITS

5.1 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.

5.2 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 5-1
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.

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6 FCC MEASUREMENT PROCEDURES

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

6.1 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.

6.2 Procedures Used to Establish RF Signal for SAR

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

The device was placed into a simulated call using a base station simulator in a RF shielded chamber. Establishing connections in this manner ensure a consistent means for testing SAR and are recommended for evaluating SAR [4]. Devices under test were evaluated prior to testing, with a fully charged battery and were configured to operate at maximum output power. In order to verify that the device was tested throughout the SAR test at maximum output power, the SAR measurement system measures a "point SAR" at an arbitrary reference point at the start and end of the 1 gram SAR evaluation, to assess for any power drifts during the evaluation. If the power drift deviated by more than 5%, the SAR test and drift measurements were repeated.

6.3 SAR Measurement Conditions for UMTS

6.3.1 Output Power Verification

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

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

6.3.2 Body SAR Measurements

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

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6.3.3 Procedures Used to Establish RF Signal for SAR HSDPA Data Devices

The following procedures are applicable to HSDPA data devices operating under 3GPP Release 5. Body exposure conditions are typically applicable to these devices, including handsets and data modems operating in various electronic devices. HSDPA operates in conjunction with UMTS and requires an active DPCCH. The default test configuration is to measure SAR in UMTS without HSDPA, with an established radio link between the DUT and a communication test set with 12.2 kbps RMC mode configured in Test Loop Mode 1; and tested with HSDPA with FRC and a 12.2 kbps RMC using the highest SAR configuration in UMTS. SAR is selectively confirmed for other physical channel configurations according to output power, exposure conditions and device operating capabilities. Maximum output power is verified according to 3GPP TS 23.121 (Release 5) and SAR must be measured according to these maximum output conditions.

Sub-Test	β_c	β_d	β_d *(SF)*	β_c/β_d	β_{HS} *(Note1, Note 2)*	CM (dB) *(Note 3)*	MPR (dB) *(Note 3)*
1	2/15	15/15	64	2/15	4/15	0.0	0.0
2	12/15 *(Note 4)*	15/15 *(Note 4)*	64	12/15 *(Note 4)*	24/15	1.0	0.0
3	15/15	8/15	64	15/8	30/15	1.5	0.5
4	15/15	4/15	64	15/4	30/15	1.5	0.5

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

Note 2: For the HS-DPCCH power mask requirement test in clause 5.2C, 5.7A, and the Error Vector Magnitude (EVM) with HS-DPCCH test in clause 5.13.1A, and HSDPA EVM with phase discontinuity in clause 5.13.1AA, Δ_{ACK} and $\Delta_{NACK} = 8$ ($A_{hs} = 30/15$) with $\beta_{hs} = 30/15 * \beta_c$, and $\Delta_{CQI} = 7$ ($A_{hs} = 24/15$) with $\beta_{hs} = 24/15 * \beta_c$.

Note 3: CM = 1 for β_c/β_d =12/15, β_{hs}/β_c=24/15. For all other combinations of DPDCH, DPCCH and HS-DPCCH the MPR is based on the relative CM difference. This is applicable for only UEs that support HSDPA in release 6 and later releases.

Figure 6-1
Table C.10.1.4 of TS 234.121-1

6.3.4 SAR Measurement Conditions for HSUPA Data Devices

SAR for body exposure configurations are measured according to the 'Body SAR Measurements' procedures in the 'WCDMA Handsets' section of the KDB 941225 D01 FCC 3G document. In addition, Body SAR is also measured for HSPA when the maximum average output of each RF channel with HSPA active is at least ¼ dB higher of that measured without HSPA in 12.2 kbps RMC mode or the maximum SAR for 12.2 kbps RMC is above 75% of the SAR limit. 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 with power control algorithm 2, according to the highest body SAR configuration in 12.2 kbps RMC without HSPA. When VOIP is applicable for head exposure, SAR is not required when the maximum output of each RF channel with HSPA is less than ¼ dB higher than that measured using 12.2 kbps RMC; otherwise, the same HSPA configuration used for body measurements should be used to test for head exposure.

Due to inner loop power control requirements in HSPA, a commercial communication test set should be used for the output power and SAR tests. The 12.2 kbps RMC, FRC H-set 1 and EDCH configurations for HSPA should be configured according to the β values indicated below as well as other applicable procedures described in the 'WCDMA Handset' and 'Release 5 HSDPA Data Devices' sections of the FCC 3G document.

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Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	β_{hs}[1]	β_{ec}	β_{ed}	β_{ed} (SF)	β_{ed} (codes)	CM[2] (dB)	MPR (dB)	AG[4] Index	E-TFCI
1	11/15[3]	15/15[3]	64	11/15[3]	22/15	209/225	1039/225	4	1	1.0	0.0	20	75
2	6/15	15/15	64	6/15	12/15	12/15	94/75	4	1	3.0	2.0	12	67
3	15/15	9/15	64	15/9	30/15	30/15	β_{ed1}: 47/15 β_{ed2}: 47/15	4	2	2.0	1.0	15	92
4	2/15	15/15	64	2/15	4/15	2/15	56/75	4	1	3.0	2.0	17	71
5	15/15[4]	15/15[4]	64	15/15[4]	30/15	24/15	134/15	4	1	1.0	0.0	21	81

Note 1: Δ_{ACK}, Δ_{NACK} and $\Delta_{CQI} = 8 \Leftrightarrow A_{hs} = \beta_{hs}/\beta_c = 30/15 \Leftrightarrow \beta_{hs} = 30/15 * \beta_c$.
Note 2: CM = 1 for β_c/β_d =12/15, β_{hs}/β_c=24/15. For all other combinations of DPDCH, DPCCH, HS- DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference.
Note 3: For subtest 1 the β_c/β_d ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 10/15$ and $\beta_d = 15/15$.
Note 4: For subtest 5 the β_c/β_d ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 14/15$ and $\beta_d = 15/15$.
Note 5: Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Table 5.1g.
Note 6: β_{ed} can not be set directly; it is set by Absolute Grant Value.

6.4 SAR Testing with 802.11 Transmitters

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

6.4.1 General Device Setup

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

6.4.2 Frequency Channel Configurations [24]

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

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

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

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6.4.3 MIMO SAR considerations

Per KDB 248227, SAR for MIMO was measured with both transmitting simultaneously and was evaluated independently of SISO operation. For 2.4 and 5 GHz MIMO, IEEE 802.11n 20 MHz bandwidth was evaluated. Other IEEE 802.11 modes and bandwidths were not investigated for MIMO operations since the maximum allowed output power (including tolerance) was not higher for these modes.

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7 RF CONDUCTED POWERS

7.1 GPRS/EDGE Conducted Powers

Table 7-1
Maximum GPRS/EDGE Conducted Powers

		Maximum Burst-Averaged Output Power							
		GPRS/EDGE Data (GMSK)				*EDGE Data (8-PSK)*			
Band	**Channel**	**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	31.32	28.66	27.92	**26.58**	26.30	26.24	22.37	21.17
	190	31.51	28.67	27.60	**26.28**	26.17	26.14	22.36	21.13
	251	31.18	28.35	27.49	**26.15**	25.81	25.78	21.98	20.88
GSM 1900	512	28.90	27.39	**26.09**	25.04	25.31	24.82	19.78	18.97
	661	29.01	27.43	**26.27**	25.14	25.29	24.80	19.93	19.06
	810	29.19	27.76	**26.56**	25.22	25.52	25.04	20.26	19.42
		Calculated Maximum Frame-Averaged Output Power							
		GPRS/EDGE Data (GMSK)				*EDGE Data (8-PSK)*			
Band	**Channel**	**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	22.29	22.64	23.66	**23.57**	17.27	20.22	18.11	18.16
	190	22.48	22.65	23.34	**23.27**	17.14	20.12	18.10	18.12
	251	22.15	22.33	23.23	**23.14**	16.78	19.76	17.72	17.87
GSM 1900	512	19.87	21.37	**21.83**	22.03	16.28	18.80	15.52	15.96
	661	19.98	21.41	**22.01**	22.13	16.26	18.78	15.67	16.05
	810	20.16	21.74	**22.30**	22.21	16.49	19.02	16.00	16.41
GSM 850	**Frame Avg.Targets:**	23.47	22.48	23.24	**23.49**	17.47	19.98	17.74	17.99
GSM 1900		19.97	22.48	**22.74**	22.49	16.47	18.98	15.74	15.99

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Table 7-2
Reduced GPRS/EDGE Conducted Powers

		Maximum Burst-Averaged Output Power							
		GPRS/EDGE Data (GMSK)				*EDGE Data (8-PSK)*			
Band	**Channel**	**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	24.62	23.26	**21.64**	20.10	21.50	19.40	15.35	14.31
	190	24.80	23.25	**21.71**	20.28	21.31	19.56	15.29	14.29
	251	24.48	23.02	**21.56**	20.13	21.19	19.45	15.11	14.16
GSM 1900	512	19.07	18.22	**17.18**	15.53	17.94	15.35	10.42	9.89
	661	19.11	18.13	**17.15**	15.80	17.95	15.25	10.45	10.01
	810	19.29	18.45	**17.50**	15.90	18.38	15.77	10.80	10.38
		Calculated Maximum Frame-Averaged Output Power							
		GPRS/EDGE Data (GMSK)				*EDGE Data (8-PSK)*			
Band	**Channel**	**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	15.59	17.24	**17.38**	17.09	12.47	13.38	11.09	11.30
	190	15.77	17.23	**17.45**	17.27	12.28	13.54	11.03	11.28
	251	15.45	17.00	**17.30**	17.12	12.16	13.43	10.85	11.15
GSM 1900	512	10.04	12.20	**12.92**	12.52	8.91	9.33	6.16	6.88
	661	10.08	12.11	**12.89**	12.79	8.92	9.23	6.19	7.00
	810	10.26	12.43	**13.24**	12.89	9.35	9.75	6.54	7.37
GSM 850	**Frame Avg.Targets:**	15.47	16.98	**17.24**	16.99	11.97	13.48	11.24	11.49
GSM 1900		9.97	11.98	**12.74**	12.49	8.97	9.48	6.24	6.99

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. The source-based frame-averaged output power was evaluated for all GPRS/EDGE slot configurations. Per October 2013 TCB Workshop Notes, the configuration with the highest target frame averaged output power was evaluated for hotspot SAR. When the maximum frame-averaged powers are equivalent across two or more slots (within 0.25 dB), the configuration with the most number of time slots was tested.
3. 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.
4. 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: C
GPRS Multislot class: 12 (Max 4 Tx uplink slots)
EDGE Multislot class: 12 (Max 4 Tx uplink slots)
DTM Multislot Class: N/A

Figure 7-1
Power Measurement Setup

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7.2 UMTS Conducted Powers

Table 7-3
Maximum 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	23.47	23.50	23.49	-
6	HSDPA	Subtest 1	22.33	22.39	22.38	0
6		Subtest 2	22.36	22.42	22.43	0
6		Subtest 3	21.84	21.93	21.92	0.5
6		Subtest 4	21.84	21.91	21.90	0.5
6	HSUPA	Subtest 1	21.71	21.84	21.81	0
6		Subtest 2	21.25	21.22	21.23	2
6		Subtest 3	21.25	21.71	21.38	1
6		Subtest 4	21.36	21.41	21.48	2
6		Subtest 5	22.33	22.38	22.39	0

Table 7-4
Reduced 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	15.17	15.16	15.21	-
6	HSDPA	Subtest 1	14.01	13.89	14.22	0
6		Subtest 2	13.93	13.86	14.21	0
6		Subtest 3	13.36	13.27	13.64	0.5
6		Subtest 4	13.34	13.24	13.63	0.5
6	HSUPA	Subtest 1	13.67	13.54	13.55	0
6		Subtest 2	12.38	12.83	13.11	2
6		Subtest 3	12.75	12.56	12.96	1
6		Subtest 4	13.37	13.26	13.22	2
6		Subtest 5	13.96	13.78	14.16	0

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

This device does not support DC-HSDPA.

It is expected by the manufacturer that MPR for some HSPA subtests may be up to 2 dB more than specified by 3GPP, but also as low as 0 dB according to the chipset implementation in this model.

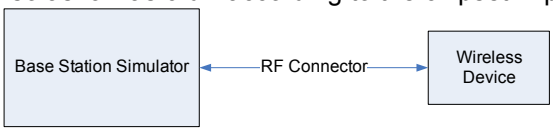

Figure 7-2
Power Measurement Setup

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7.3 WLAN Conducted Powers

Table 7-5
SISO IEEE 802.11b Average RF Power – Antenna 1

Mode	Freq [MHz]	Channel	802.11b (2.4 GHz) Conducted Power [dBm]			
			Data Rate [Mbps]			
			1	2	5.5	11
802.11b	2412	1*	10.88	10.89	10.97	11.03
802.11b	2437	6*	**11.82**	11.53	11.58	11.67
802.11b	2462	11*	11.73	11.69	11.88	11.81

Table 7-6
SISO IEEE 802.11b Average RF Power – Antenna 2

Mode	Freq [MHz]	Channel	802.11b (2.4 GHz) Conducted Power [dBm]			
			Data Rate [Mbps]			
			1	2	5.5	11
802.11b	2412	1*	11.38	11.43	11.45	11.49
802.11b	2437	6*	**11.69**	11.78	11.75	11.78
802.11b	2462	11*	11.12	11.12	11.22	11.27

Table 7-7
SISO IEEE 802.11g Average RF Power – Antenna 1

Mode	Freq [MHz]	Channel	802.11g (2.4 GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			6	9	12	18	24	36	48	54
802.11g	2412	1	10.27	10.27	10.30	10.34	10.51	10.68	10.77	10.54
802.11g	2437	6	11.17	11.16	11.14	11.26	11.37	11.49	11.48	11.49
802.11g	2462	11	11.27	11.29	11.34	11.38	11.45	11.49	11.47	11.48

Table 7-8
SISO IEEE 802.11g Average RF Power – Antenna 2

Mode	Freq [MHz]	Channel	802.11g (2.4 GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			6	9	12	18	24	36	48	54
802.11g	2412	1	10.55	10.33	10.36	9.92	10.10	10.76	11.24	10.17
802.11g	2437	6	11.02	11.25	10.90	10.81	11.42	11.25	11.35	11.24
802.11g	2462	11	10.32	10.23	10.22	10.20	10.54	10.54	10.70	10.10

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Table 7-9
SISO IEEE 802.11n Average RF Power – Antenna 1

Mode	Freq [MHz]	Channel	802.11n (2.4 GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			6.5	13	19.5	26	39	52	58.5	65
802.11n	2412	1	8.86	8.81	8.73	9.04	9.05	9.07	9.12	8.98
802.11n	2437	6	9.35	9.24	9.20	9.58	9.52	9.64	9.58	9.54
802.11n	2462	11	9.74	9.73	9.61	9.89	9.95	10.00	10.07	9.93

Table 7-10
SISO IEEE 802.11n Average RF Power – Antenna 2

Mode	Freq [MHz]	Channel	802.11n (2.4GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			6.5	13	19.5	26	39	52	58.5	65
802.11n	2412	1	9.16	9.12	9.44	9.89	9.51	9.61	9.34	9.41
802.11n	2437	6	9.61	9.96	9.84	10.49	9.93	10.47	10.16	10.17
802.11n	2462	11	9.21	9.34	9.76	9.78	9.60	10.02	9.89	9.93

Table 7-11
MIMO IEEE 802.11n Average RF Power

802.11n (2.4 GHz) Conducted Power [dBm]			
Mode	Freq [MHz]	Channel	Data Rate [Mbps]
			13
802.11n	2412	1	12.02
802.11n	2437	6	12.49
802.11n	2462	11	**12.49**

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Table 7-12
SISO IEEE 802.11a Average RF Power – Antenna 1

Mode	Freq [MHz]	Channel	802.11a (5 GHz) 20 MHz Bandwidth Conducted Power [dBm]							
			Data Rate [Mbps]							
			6	9	12	18	24	36	48	54
802.11a	5180	36*	**8.70**	8.56	8.47	8.67	8.74	8.62	8.89	8.68
802.11a	5200	40	8.64	8.51	8.37	8.61	8.63	8.54	8.91	8.63
802.11a	5220	44	8.43	8.32	8.16	8.46	8.44	8.37	8.63	8.40
802.11a	5240	48*	8.38	8.28	8.22	8.42	8.34	8.29	8.56	8.32
802.11a	5260	52*	8.46	8.51	8.39	8.49	8.48	8.32	8.63	8.51
802.11a	5280	56	8.27	8.25	8.18	8.28	8.24	8.19	8.41	8.35
802.11a	5300	60	8.26	8.32	8.24	8.36	8.34	8.07	8.37	8.26
802.11a	5320	64*	**8.46**	8.59	8.39	8.42	8.53	8.30	8.65	8.46
802.11a	5500	100	8.43	8.50	8.32	8.55	8.67	8.64	8.67	8.48
802.11a	5520	104*	8.47	8.58	8.36	8.63	8.71	8.70	8.78	8.46
802.11a	5540	108	8.49	8.55	8.34	8.63	8.72	8.62	8.69	8.47
802.11a	5560	112	**8.58**	8.64	8.53	8.70	8.81	8.80	8.81	8.61
802.11a	5580	116*	8.51	8.61	8.39	8.63	8.71	8.76	8.80	8.59
802.11a	5600	120	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11a	5620	124	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11a	5640	128	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11a	5660	132	8.36	8.49	8.27	8.48	8.61	8.60	8.61	8.39
802.11a	5680	136*	8.28	8.40	8.17	8.43	8.56	8.55	8.53	8.26
802.11a	5700	140	8.48	8.48	8.39	8.59	8.74	8.75	8.78	8.54
802.11a	5745	149*	**8.51**	8.34	8.27	8.50	8.63	8.58	8.70	8.49
802.11a	5765	153	8.34	8.10	8.15	8.35	8.44	8.41	8.58	8.29
802.11a	5785	157*	8.22	8.05	7.94	8.16	8.40	8.33	8.42	8.20
802.11a	5805	161	8.22	8.06	7.98	8.22	8.29	8.27	8.40	8.14
802.11a	5825	165*	7.96	7.82	7.71	7.97	8.08	7.94	8.18	7.95

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

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

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Table 7-13
SISO IEEE 802.11a Average RF Power – Antenna 2

Mode	Freq [MHz]	Channel	802.11a (5 GHz) 20 MHz Bandwidth Conducted Power [dBm]							
			Data Rate [Mbps]							
			6	9	12	18	24	36	48	54
802.11a	5180	36*	8.51	8.68	8.71	8.53	8.72	8.71	8.70	8.50
802.11a	5200	40	8.48	8.60	8.63	8.30	8.65	8.71	8.68	8.67
802.11a	5220	44	8.55	8.69	8.34	8.42	8.71	8.72	8.72	8.71
802.11a	5240	48*	**8.64**	8.28	8.16	8.06	8.16	8.72	8.61	8.12
802.11a	5260	52*	8.53	8.44	8.71	8.68	8.72	8.50	8.71	8.71
802.11a	5280	56	**8.89**	8.47	8.72	8.64	8.67	8.65	8.68	8.70
802.11a	5300	60	8.69	8.36	8.62	8.67	8.66	8.72	8.71	8.70
802.11a	5320	64*	8.68	8.39	8.51	8.48	8.51	8.72	8.69	8.67
802.11a	5500	100	**8.58**	8.28	8.56	8.40	8.71	8.43	8.55	8.45
802.11a	5520	104*	8.41	8.45	8.70	8.40	8.50	8.68	8.61	8.30
802.11a	5540	108	8.43	8.46	8.33	8.70	8.72	8.62	8.72	8.44
802.11a	5560	112	8.49	8.36	8.58	8.20	8.71	8.69	8.63	8.51
802.11a	5580	116*	8.29	8.06	7.81	8.32	8.56	8.68	8.48	8.44
802.11a	5600	120	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11a	5620	124	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11a	5640	128	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11a	5660	132	7.68	7.95	7.64	7.69	7.97	7.77	8.15	7.70
802.11a	5680	136*	7.56	7.51	7.55	7.71	7.75	7.66	8.09	7.99
802.11a	5700	140	7.61	7.64	7.73	7.79	7.87	7.84	7.65	7.55
802.11a	5745	149*	8.01	8.37	8.13	8.06	8.51	8.53	8.45	8.12
802.11a	5765	153	8.32	8.05	8.58	8.05	8.38	8.51	8.42	8.24
802.11a	5785	157*	**8.39**	8.17	8.35	8.52	8.56	8.49	8.15	8.27
802.11a	5805	161	8.26	8.28	8.28	8.01	8.10	8.26	8.63	8.46
802.11a	5825	165*	8.21	8.11	8.06	8.27	8.44	8.28	8.59	8.41

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

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

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Table 7-14
SISO IEEE 802.11n Average RF Power – 20 MHz Bandwidth – Antenna 1

Mode	Freq [MHz]	Channel	802.11n (5 GHz) 20 MHz Bandwidth Conducted Power [dBm]							
			Data Rate [Mbps]							
			6.5	13	19.5	26	39	52	58.5	65
802.11n	5180	36	8.33	8.37	8.42	8.75	8.78	8.66	8.80	8.67
802.11n	5200	40	8.37	8.39	8.43	8.79	8.86	8.76	8.78	8.66
802.11n	5220	44	8.24	8.19	8.30	8.63	8.76	8.55	8.69	8.54
802.11n	5240	48	8.21	8.21	8.35	8.65	8.61	8.55	8.68	8.62
802.11n	5260	52	8.29	8.18	8.35	8.55	8.64	8.53	8.68	8.52
802.11n	5280	56	8.31	8.27	8.39	8.52	8.60	8.57	8.67	8.57
802.11n	5300	60	8.30	8.18	8.41	8.51	8.64	8.52	8.68	8.48
802.11n	5320	64	8.31	8.20	8.42	8.53	8.66	8.54	8.65	8.51
802.11n	5500	100	8.30	8.34	8.38	8.62	8.59	8.48	8.60	8.61
802.11n	5520	104	8.27	8.34	8.32	8.59	8.52	8.47	8.57	8.57
802.11n	5540	108	8.34	8.41	8.38	8.61	8.71	8.50	8.67	8.64
802.11n	5560	112	8.28	8.29	8.42	8.53	8.59	8.49	8.54	8.60
802.11n	5580	116	8.27	8.30	8.40	8.67	8.56	8.46	8.54	8.65
802.11n	5600	120	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11n	5620	124	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11n	5640	128	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11n	5660	132	8.18	8.25	8.24	8.48	8.53	8.35	8.51	8.44
802.11n	5680	136	8.37	8.40	8.38	8.64	8.72	8.55	8.65	8.69
802.11n	5700	140	8.29	8.32	8.37	8.57	8.55	8.49	8.61	8.58
802.11n	5745	149	8.45	8.24	8.51	8.73	8.71	8.69	8.66	8.62
802.11n	5765	153	8.29	8.09	8.38	8.54	8.57	8.53	8.46	8.50
802.11n	5785	157	8.16	7.94	8.28	8.41	8.47	8.36	8.39	8.31
802.11n	5805	161	8.11	7.93	8.23	8.34	8.37	8.32	8.24	8.25
802.11n	5825	165	7.87	7.68	7.89	8.17	8.09	8.11	8.00	8.02

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Table 7-15
SISO IEEE 802.11n Average RF Power – 20 MHz Bandwidth – Antenna 2

Mode	Freq [MHz]	Channel	802.11n (5 GHz) 20 MHz Bandwidth Conducted Power [dBm]							
			Data Rate [Mbps]							
			6.5	13	19.5	26	39	52	58.5	65
802.11n	5180	36	8.38	8.41	8.28	8.60	8.62	8.64	8.57	8.60
802.11n	5200	40	8.16	8.15	8.09	8.32	8.36	8.41	8.39	8.38
802.11n	5220	44	8.21	8.29	8.08	8.41	8.46	8.47	8.39	8.43
802.11n	5240	48	8.09	8.06	7.98	8.36	8.30	8.41	8.27	8.30
802.11n	5260	52	8.30	8.31	8.39	8.62	8.65	8.64	8.52	8.62
802.11n	5280	56	8.29	8.30	8.44	8.62	8.63	8.56	8.49	8.56
802.11n	5300	60	8.46	8.47	8.52	8.56	8.64	8.59	8.63	8.59
802.11n	5320	64	8.38	8.39	8.49	8.65	8.58	8.64	8.61	8.60
802.11n	5500	100	8.07	8.11	8.04	8.38	8.37	8.22	8.26	8.36
802.11n	5520	104	8.06	8.08	8.01	8.37	8.36	8.22	8.31	8.32
802.11n	5540	108	7.94	8.00	7.92	8.24	8.24	8.18	8.16	8.21
802.11n	5560	112	7.97	7.97	7.98	8.28	8.36	8.20	8.14	8.22
802.11n	5580	116	7.93	7.96	7.87	8.21	8.24	8.08	8.14	8.17
802.11n	5600	120	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11n	5620	124	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11n	5640	128	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11n	5660	132	7.98	8.00	7.94	8.24	8.37	8.16	8.19	8.21
802.11n	5680	136	7.90	7.87	7.89	8.18	8.20	8.07	8.03	8.20
802.11n	5700	140	7.67	7.63	7.62	7.98	7.93	7.86	7.93	7.89
802.11n	5745	149	8.20	8.16	8.19	8.52	8.45	8.53	8.42	8.47
802.11n	5765	153	7.95	7.86	7.95	8.22	8.20	8.27	8.16	8.23
802.11n	5785	157	7.83	7.82	7.88	8.20	8.07	8.15	8.04	8.12
802.11n	5805	161	7.95	7.87	7.95	8.21	8.23	8.33	8.10	8.16
802.11n	5825	165	7.82	7.83	7.79	8.14	8.00	8.13	8.02	8.09

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Table 7-16
MIMO IEEE 802.11n Average RF Power – 20 MHz Bandwidth

802.11n (5 GHz) 20 MHz Bandwidth Conducted Power [dBm]			
Mode	Freq [MHz]	Channel	Data Rate [Mbps]
			13
802.11n	5180	36	**11.37**
802.11n	5200	40	11.28
802.11n	5220	44	11.24
802.11n	5240	48	11.16
802.11n	5260	52	11.31
802.11n	5280	56	11.31
802.11n	5300	60	**11.39**
802.11n	5320	64	11.36
802.11n	5500	100	**11.20**
802.11n	5520	104	11.18
802.11n	5540	108	11.15
802.11n	5560	112	11.14
802.11n	5580	116	11.11
802.11n	5600	120	N/A
802.11n	5620	124	N/A
802.11n	5640	128	N/A
802.11n	5660	132	11.09
802.11n	5680	136	11.15
802.11n	5700	140	11.00
802.11n	5745	149	**11.34**
802.11n	5765	153	11.13
802.11n	5785	157	11.01
802.11n	5805	161	11.04
802.11n	5825	165	10.86

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Table 7-17
SISO IEEE 802.11n Average RF Power – 40 MHz Bandwidth – Antenna 1

Mode	Freq [MHz]	Channel	802.11n (5 GHz) 40 MHz Bandwidth Conducted Power [dBm]							
			Data Rate [Mbps]							
			13.5	27	40.5	54	81	108	121.5	135
802.11n	5190	38	8.28	8.56	8.47	8.90	8.94	8.91	8.94	8.86
802.11n	5230	46	8.18	8.54	8.36	8.80	8.94	8.78	8.89	8.66
802.11n	5270	54	8.28	8.40	8.48	8.70	8.68	8.66	8.70	8.67
802.11n	5310	62	8.33	8.49	8.51	8.62	8.69	8.70	8.70	8.66
802.11n	5510	102	8.22	8.38	8.46	8.61	8.67	8.65	8.63	8.68
802.11n	5550	110	8.28	8.42	8.50	8.66	8.59	8.69	8.58	8.69
802.11n	5590	118	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11n	5630	126	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11n	5670	134	8.14	8.25	8.37	8.82	8.57	8.58	8.70	8.69
802.11n	5755	151	8.34	8.48	8.48	8.74	8.75	8.68	8.74	8.75
802.11n	5795	159	8.14	8.28	8.23	8.46	8.68	8.54	8.71	8.55

Table 7-18
SISO IEEE 802.11n Average RF Power – 40 MHz Bandwidth – Antenna 2

Mode	Freq [MHz]	Channel	802.11n (5 GHz) 40 MHz Bandwidth Conducted Power [dBm]							
			Data Rate [Mbps]							
			13.5	27	40.5	54	81	108	121.5	135
802.11n	5190	38	8.59	8.51	8.60	8.72	8.65	8.52	8.58	8.62
802.11n	5230	46	8.52	8.50	8.44	8.69	8.56	8.50	8.51	8.59
802.11n	5270	54	8.72	8.73	8.74	8.78	8.75	8.82	8.79	8.81
802.11n	5310	62	8.78	8.80	8.81	8.77	8.79	8.90	8.83	8.88
802.11n	5510	102	8.32	8.25	8.24	8.39	8.34	8.40	8.40	8.30
802.11n	5550	110	8.14	8.11	8.12	8.19	8.12	8.24	8.28	8.05
802.11n	5590	118	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11n	5630	126	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11n	5670	134	8.10	8.09	8.04	8.12	8.13	8.25	8.26	8.12
802.11n	5755	151	8.21	8.13	8.20	8.16	8.26	8.22	8.28	8.20
802.11n	5795	159	7.95	7.81	7.98	7.98	8.07	8.03	8.03	7.90

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Table 7-19
MIMO IEEE 802.11n Average RF Power – 40 MHz Bandwidth

802.11n (5 GHz) 40 MHz Bandwidth Conducted Power [dBm]			
Mode	Freq [MHz]	Channel	Data Rate [Mbps]
			27
802.11n	5190	38	10.37
802.11n	5230	46	10.28
802.11n	5270	54	10.43
802.11n	5310	62	10.49
802.11n	5510	102	10.20
802.11n	5550	110	10.14
802.11n	5590	118	N/A
802.11n	5630	126	N/A
802.11n	5670	134	10.05
802.11n	5755	151	10.21
802.11n	5795	159	9.98

Table 7-20
SISO IEEE 802.11ac Average RF Power – 80 MHz Bandwidth – Antenna 1

Mode	Freq [MHz]	Channel	802.11ac (5 GHz) 80 MHz Bandwidth Conducted Power [dBm]									
			Data Rate [Mbps]									
			29.3	58.5	87.8	117	175.5	234	263.3	292.5	351	390
802.11ac	5210	42	**8.63**	8.56	8.33	8.87	8.86	8.78	8.77	8.87	8.87	8.85
802.11ac	5290	58	**8.43**	8.43	8.19	8.65	8.59	8.64	8.62	8.61	8.67	8.66
802.11ac	5530	106	**8.46**	8.43	8.32	8.69	8.67	8.63	8.48	8.69	8.70	8.61
802.11ac	5775	155	**8.44**	8.47	8.28	8.68	8.67	8.63	8.65	8.54	8.65	8.68

Table 7-21
SISO IEEE 802.11ac Average RF Power – 80 MHz Bandwidth – Antenna 2

Mode	Freq [MHz]	Channel	802.11ac (5 GHz) 80 MHz Bandwidth Conducted Power [dBm]									
			Data Rate [Mbps]									
			29.3	58.5	87.8	117	175.5	234	263.3	292.5	351	390
802.11ac	5210	42	**8.27**	8.24	8.23	8.51	8.46	8.41	8.42	8.45	8.51	8.44
802.11ac	5290	58	**8.44**	8.58	8.27	8.68	8.67	8.68	8.66	8.68	8.65	8.68
802.11ac	5530	106	**8.08**	8.12	7.99	8.25	8.18	8.28	8.17	8.31	8.27	8.30
802.11ac	5775	155	**7.81**	7.83	7.76	8.05	8.04	8.03	7.94	8.05	8.04	8.02

Table 7-22
MIMO IEEE 802.11ac Average RF Power – 80 MHz Bandwidth

802.11ac (5 GHz) 80 MHz Bandwidth Conducted Power [dBm]			
Mode	Freq [MHz]	Channel	Data Rate [Mbps]
			58.5
802.11ac	5210	42	10.39
802.11ac	5290	58	10.37
802.11ac	5530	106	10.21
802.11ac	5775	155	10.07

Justification for reduced test configurations for WIFI channels per KDB Publication 248227 D01v01r02 and October 2012/April 2013 FCC/TCB Meeting Notes:

- For 2.4 GHz SISO operations, highest average RF output power channel for the lowest data rate for IEEE 802.11b were selected for SAR evaluation. Other IEEE 802.11 SISO modes (including

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802.11g/n) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11b mode.

- For 5 GHz SISO operations, highest average RF output power channel for the lowest data rate for IEEE 802.11a were selected for SAR evaluation. Other IEEE 802.11 SISO modes (including 802.11n) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11a mode.
- Full SAR tests for all SISO IEEE 802.11ac configurations were not required because the average output power was not more than 0.25 dB higher than IEEE 802.11a mode. IEEE 802.11ac in SISO mode was evaluated for the highest IEEE 802.11a position in each 5 GHz band and exposure condition.
- For MIMO 2.4 GHz and 5 GHz operations, the highest average RF output power channel for the lowest data rate for IEEE 802.11n (20 MHz bandwidth) was selected for SAR evaluation. Other IEEE 802.11 modes and bandwidths were not investigated for MIMO operations since the maximum allowed output power (including tolerance) was not higher for these modes.
- The individual spectra for each 2x2 MIMO WIFI Antenna were summed mathematically in linear power units for the MIMO output power measurements.
- When the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is <1.6 W/kg and the reported 1g averaged SAR is <0.8 W/kg, SAR testing on other channels is not required. Otherwise, the other default (or corresponding required) test channels were additionally tested using the lowest data rate.
- The bolded data rate and channel above were tested for SAR.

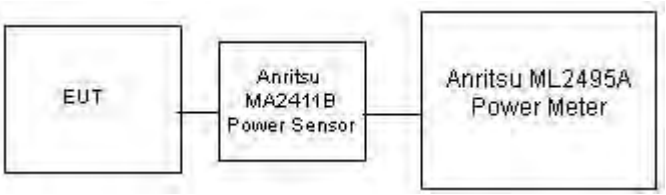

Figure 7-3
Power Measurement Setup for Bandwidths < 50 MHz

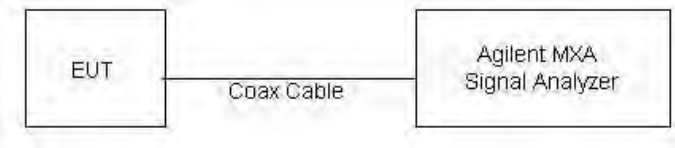

Figure 7-4
Power Measurement Setup for Bandwidths > 50 MHz

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8 SYSTEM VERIFICATION

8.1 Tissue Verification

Table 8-1
Measured Tissue Properties

Calibrated for Tests Performed on:	Tissue Type	Tissue Temp During Calibration (C°)	Measured Frequency (MHz)	Measured Conductivity, σ (S/m)	Measured Dielectric Constant, ε	TARGET Conductivity, σ (S/m)	TARGET Dielectric Constant, ε	% dev σ	% dev ε
10/15/2014	835B	20.6	820	0.938	54.163	0.969	55.258	-3.20%	-1.98%
			835	0.952	54.062	0.970	55.200	-1.86%	-2.06%
			850	0.969	53.907	0.988	55.154	-1.92%	-2.26%
10/29/2014	835B	20.9	820	0.946	52.945	0.969	55.258	-2.37%	-4.19%
			835	0.960	52.799	0.970	55.200	-1.03%	-4.35%
			850	0.976	52.646	0.988	55.154	-1.21%	-4.55%
10/14/2014	1900B	22.7	1850	1.526	52.622	1.520	53.300	0.39%	-1.27%
			1880	1.560	52.528	1.520	53.300	2.63%	-1.45%
			1910	1.594	52.415	1.520	53.300	4.87%	-1.66%
10/20/2014	2450B	22.6	2401	1.977	50.914	1.903	52.765	3.89%	-3.51%
			2450	2.039	50.743	1.950	52.700	4.56%	-3.71%
			2499	2.106	50.548	2.019	52.638	4.31%	-3.97%
10/20/2014	5200B-5800B	22.3	5180	5.276	48.733	5.276	49.041	0.00%	-0.63%
			5200	5.286	48.674	5.299	49.014	-0.25%	-0.69%
			5220	5.307	48.656	5.323	48.987	-0.30%	-0.68%
			5240	5.348	48.652	5.346	48.960	0.04%	-0.63%
			5260	5.369	48.614	5.369	48.933	0.00%	-0.65%
			5280	5.404	48.535	5.393	48.906	0.20%	-0.76%
			5300	5.417	48.492	5.416	48.879	0.02%	-0.79%
			5320	5.437	48.463	5.439	48.851	-0.04%	-0.79%
			5500	5.677	48.028	5.650	48.607	0.48%	-1.19%
			5520	5.703	48.004	5.673	48.580	0.53%	-1.19%
			5540	5.731	47.993	5.696	48.553	0.61%	-1.15%
			5560	5.756	47.956	5.720	48.526	0.63%	-1.17%
			5600	5.824	47.875	5.766	48.471	1.01%	-1.23%
			5660	5.900	47.823	5.837	48.390	1.08%	-1.17%
			5680	5.932	47.800	5.860	48.363	1.23%	-1.16%
			5700	5.960	47.769	5.883	48.336	1.31%	-1.17%
			5745	6.029	47.707	5.936	48.275	1.57%	-1.18%
			5765	6.068	47.734	5.959	48.248	1.83%	-1.07%
			5785	6.088	47.673	5.982	48.220	1.77%	-1.13%
			5800	6.121	47.717	6.000	48.200	2.02%	-1.00%
			5805	6.136	47.636	6.006	48.193	2.16%	-1.16%

The above measured tissue parameters were used in the DASY software. The DASY software was used to perform interpolation to determine the dielectric parameters at the SAR test device frequencies (per KDB Publication 865664 and IEEE 1528-2013 6.6.1.2). The tissue parameters listed in the SAR test plots may slightly differ from the table above due to significant digit rounding in the software.

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8.2 Test System Verification

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

Table 8-2
System Verification Results

System Verification TARGET & MEASURED												
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)	$Deviation_{1g}$ (%)
C	835	BODY	10/15/2014	21.7	20.6	0.100	4d132	3213	0.929	9.580	9.290	-3.03%
C	835	BODY	10/29/2014	21.7	20.7	0.100	4d132	3213	0.959	9.580	9.590	0.10%
D	1900	BODY	10/14/2014	24.9	23.1	0.100	5d141	3263	4.250	40.600	42.500	4.68%
B	2450	BODY	10/20/2014	22.6	21.9	0.100	882	3318	5.330	49.500	53.300	7.68%
A	5200	BODY	10/20/2014	21.7	20.6	0.100	1120	3920	7.510	74.000	75.100	1.49%
A	5300	BODY	10/20/2014	21.7	20.6	0.100	1120	3920	7.700	75.800	77.000	1.58%
A	5500	BODY	10/20/2014	21.7	20.6	0.100	1120	3920	7.900	79.200	79.000	-0.25%
A	5600	BODY	10/20/2014	21.7	20.6	0.100	1120	3920	8.140	79.400	81.400	2.52%
A	5800	BODY	10/20/2014	21.7	20.6	0.100	1120	3920	7.520	74.400	75.200	1.08%

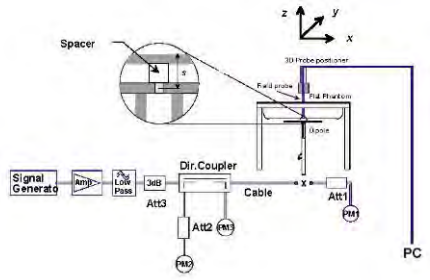

Figure 8-1
System Verification Setup Diagram

Figure 8-2
System Verification Setup Photo

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9 SAR DATA SUMMARY

9.1 Standalone Body SAR Data

Table 9-1
GPRS/UMTS Body 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	GPRS 850	GPRS	27.0	26.28	0.03	16 mm	1010-1	4	1:2.076	back	0.486	1.180	0.573	
836.60	190	GPRS 850	GPRS	27.0	26.28	-0.04	11 mm	1010-1	4	1:2.076	bottom	0.410	1.180	0.484	
836.60	190	GPRS 850	GPRS	27.0	26.28	-0.03	5 mm	1010-1	4	1:2.076	right	0.307	1.180	0.362	
836.60	190	GPRS 850	GPRS	22.0	21.71	-0.08	0 mm	1010-2	3	1:2.76	back	0.745	1.069	0.796	A1
836.60	190	GPRS 850	GPRS	22.0	21.71	-0.07	0 mm	1010-2	3	1:2.76	bottom	0.272	1.069	0.291	
836.60	190	GPRS 850	GPRS	22.0	21.71	-0.03	0 mm	1010-2	3	1:2.76	right	0.181	1.069	0.193	
836.60	4183	UMTS 850	RMC	23.5	23.50	0.00	16 mm	1010-1	N/A	1:1	back	0.478	1.000	0.478	A2
836.60	4183	UMTS 850	RMC	23.5	23.50	-0.03	11 mm	1010-1	N/A	1:1	bottom	0.413	1.000	0.413	
836.60	4183	UMTS 850	RMC	23.5	23.50	-0.18	5 mm	1010-1	N/A	1:1	right	0.315	1.000	0.315	
836.60	4183	UMTS 850	RMC	15.5	15.16	-0.03	0 mm	1010-2	N/A	1:1	back	0.416	1.081	0.450	
836.60	4183	UMTS 850	RMC	15.5	15.16	0.03	0 mm	1010-2	N/A	1:1	bottom	0.174	1.081	0.188	
836.60	4183	UMTS 850	RMC	15.5	15.16	-0.18	0 mm	1010-2	N/A	1:1	right	0.109	1.081	0.118	
1880.00	661	GPRS 1900	GPRS	27.5	26.27	-0.02	16 mm	1010-1	3	1:2.76	back	0.414	1.327	0.549	
1880.00	661	GPRS 1900	GPRS	27.5	26.27	0.10	11 mm	1010-1	3	1:2.76	bottom	0.378	1.327	0.502	
1850.20	512	GPRS 1900	GPRS	27.5	26.09	0.10	5 mm	1010-1	3	1:2.76	right	0.678	1.384	0.938	
1880.00	661	GPRS 1900	GPRS	27.5	26.27	0.00	5 mm	1010-1	3	1:2.76	right	0.674	1.327	0.894	
1909.80	810	GPRS 1900	GPRS	27.5	26.56	0.02	5 mm	1010-1	3	1:2.76	right	0.719	1.242	0.893	
1850.20	512	GPRS 1900	GPRS	17.5	17.18	-0.03	0 mm	1010-2	3	1:2.76	back	0.980	1.076	**1.054**	
1880.00	661	GPRS 1900	GPRS	17.5	17.15	0.03	0 mm	1010-2	3	1:2.76	back	0.942	1.084	1.021	
1909.80	810	GPRS 1900	GPRS	17.5	17.50	-0.04	0 mm	1010-2	3	1:2.76	back	0.988	1.000	0.988	
1880.00	661	GPRS 1900	GPRS	17.5	17.15	0.10	0 mm	1010-2	3	1:2.76	bottom	0.340	1.084	0.369	
1880.00	661	GPRS 1900	GPRS	17.5	17.15	0.01	0 mm	1010-2	3	1:2.76	right	0.222	1.084	0.241	
1909.80	810	GPRS 1900	GPRS	17.5	17.50	0.09	0 mm	1010-2	3	1:2.76	back	1.010	1.000	1.010	A3
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 data is highlighted blue in the table above.

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Table 9-2
2.4 WLAN Body SAR

MEASUREMENT RESULTS																
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.												(W/kg)		(W/kg)	
2412	1	IEEE 802.11b	DSSS	12.0	10.88	0.07	0 mm	1	1310-1	1	back	1:1	0.758	1.294	0.981	
2437	6	IEEE 802.11b	DSSS	12.0	11.82	-0.04	0 mm	1	1310-1	1	back	1:1	1.050	1.042	1.094	A4
2462	11	IEEE 802.11b	DSSS	12.0	11.73	0.06	0 mm	1	1310-1	1	back	1:1	1.030	1.064	**1.096**	
2437	6	IEEE 802.11b	DSSS	12.0	11.82	-0.13	0 mm	1	1310-1	1	top	1:1	0.446	1.042	0.465	
2437	6	IEEE 802.11b	DSSS	12.0	11.82	-0.08	0 mm	1	1310-1	1	right	1:1	0.021	1.042	0.022	
2412	1	IEEE 802.11b	DSSS	12.0	11.38	-0.02	0 mm	2	1310-1	1	back	1:1	0.796	1.153	0.918	
2437	6	IEEE 802.11b	DSSS	12.0	11.69	0.00	0 mm	2	1310-1	1	back	1:1	0.683	1.074	0.734	
2462	11	IEEE 802.11b	DSSS	12.0	11.12	0.03	0 mm	2	1310-1	1	back	1:1	0.673	1.225	0.824	
2437	6	IEEE 802.11b	DSSS	12.0	11.69	-0.01	0 mm	2	1310-1	1	top	1:1	0.084	1.074	0.090	
2437	6	IEEE 802.11b	DSSS	12.0	11.69	0.05	0 mm	2	1310-1	1	right	1:1	0.288	1.074	0.309	
2412	1	IEEE 802.11n	OFDM	13.0	12.02	0.07	0 mm	MIMO	1310-1	13	back	1:1	0.552	1.253	0.692	
2437	6	IEEE 802.11n	OFDM	13.0	12.49	0.04	0 mm	MIMO	1310-1	13	back	1:1	0.635	1.125	0.714	
2462	11	IEEE 802.11n	OFDM	13.0	12.49	0.04	0 mm	MIMO	1310-1	13	back	1:1	0.653	1.125	0.735	
2462	11	IEEE 802.11n	OFDM	13.0	12.49	-0.10	0 mm	MIMO	1310-1	13	top	1:1	0.408	1.125	0.459	
2462	11	IEEE 802.11n	OFDM	13.0	12.49	0.04	0 mm	MIMO	1310-1	13	right	1:1	0.088	1.125	0.099	
2437	6	IEEE 802.11b	DSSS	12.0	11.82	-0.15	0 mm	1	1310-1	1	back	1:1	1.000	1.042	1.042	
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 data is highlighted blue in the table above.

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Table 9-3
5.8 WLAN Body SAR

MEASUREMENT RESULTS																
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.												(W/kg)		(W/kg)	
5745	149	IEEE 802.11a	OFDM	9.0	8.51	0.04	0 mm	1	1310-3	6	back	1:1	0.588	1.119	0.658	
5765	153	IEEE 802.11a	OFDM	9.0	8.34	-0.03	0 mm	1	1310-3	6	back	1:1	0.607	1.164	0.707	
5805	161	IEEE 802.11a	OFDM	9.0	8.22	0.03	0 mm	1	1310-3	6	back	1:1	0.656	1.197	0.785	
5745	149	IEEE 802.11a	OFDM	9.0	8.51	0.10	0 mm	1	1310-3	6	top	1:1	0.674	1.119	0.754	
5765	153	IEEE 802.11a	OFDM	9.0	8.34	0.04	0 mm	1	1310-3	6	top	1:1	0.686	1.164	0.799	A5
5805	161	IEEE 802.11a	OFDM	9.0	8.22	0.04	0 mm	1	1310-3	6	top	1:1	0.658	1.197	0.788	
5775	155	IEEE 802.11ac	OFDM	9.0	8.44	0.06	0 mm	1	1310-3	29.3	top	1:1	0.648	1.138	0.737	
5745	149	IEEE 802.11a	OFDM	9.0	8.51	0.11	0 mm	1	1310-3	6	right	1:1	0.040	1.119	0.045	
5785	157	IEEE 802.11a	OFDM	9.0	8.39	0.08	0 mm	2	1310-3	6	back	1:1	0.185	1.151	0.213	
5785	157	IEEE 802.11a	OFDM	9.0	8.39	0.18	0 mm	2	1310-3	6	top	1:1	0.016	1.151	0.018	
5765	153	IEEE 802.11a	OFDM	9.0	8.32	0.04	0 mm	2	1310-3	6	right	1:1	0.319	1.169	0.373	
5785	157	IEEE 802.11a	OFDM	9.0	8.39	0.17	0 mm	2	1310-3	6	right	1:1	0.301	1.151	0.346	
5805	161	IEEE 802.11a	OFDM	9.0	8.26	0.17	0 mm	2	1310-3	6	right	1:1	0.293	1.186	0.347	
5775	155	IEEE 802.11ac	OFDM	9.0	7.81	0.15	0 mm	2	1310-3	29.3	right	1:1	0.239	1.315	0.314	
5745	149	IEEE 802.11n	OFDM	11.5	11.34	0.13	0 mm	MIMO	1310-3	13	back	1:1	0.519	1.038	0.539	
5765	153	IEEE 802.11n	OFDM	11.5	11.13	0.15	0 mm	MIMO	1310-3	13	back	1:1	0.538	1.089	0.586	
5805	161	IEEE 802.11n	OFDM	11.5	11.04	0.02	0 mm	MIMO	1310-3	13	back	1:1	0.552	1.112	0.614	
5745	149	IEEE 802.11n	OFDM	11.5	11.34	0.10	0 mm	MIMO	1310-3	13	top	1:1	0.622	1.038	0.646	
5765	153	IEEE 802.11n	OFDM	11.5	11.13	0.08	0 mm	MIMO	1310-3	13	top	1:1	0.592	1.089	0.645	
5805	161	IEEE 802.11n	OFDM	11.5	11.04	0.08	0 mm	MIMO	1310-3	13	top	1:1	0.585	1.112	0.651	
5745	149	IEEE 802.11n	OFDM	11.5	11.34	0.06	0 mm	MIMO	1310-3	13	right	1:1	0.304	1.038	0.316	
5765	153	IEEE 802.11n	OFDM	11.5	11.13	0.18	0 mm	MIMO	1310-3	13	right	1:1	0.273	1.089	0.297	
5805	161	IEEE 802.11n	OFDM	11.5	11.04	0.13	0 mm	MIMO	1310-3	13	right	1:1	0.241	1.112	0.268	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Body 1.6 W/kg (mW/g) averaged over 1 gram									

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Table 9-4
5.2 WLAN Body SAR

MEASUREMENT RESULTS																
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.												(W/kg)		(W/kg)	
5180	36	IEEE 802.11a	OFDM	9.0	8.70	0.00	0 mm	1	1310-3	6	back	1:1	0.562	1.072	0.602	
5220	44	IEEE 802.11a	OFDM	9.0	8.43	0.09	0 mm	1	1310-3	6	back	1:1	0.599	1.140	0.683	
5180	36	IEEE 802.11a	OFDM	9.0	8.70	0.04	0 mm	1	1310-3	6	top	1:1	0.602	1.072	0.645	
5220	44	IEEE 802.11a	OFDM	9.0	8.43	0.05	0 mm	1	1310-3	6	top	1:1	0.667	1.140	0.760	
5210	42	IEEE 802.11ac	OFDM	9.0	8.63	0.14	0 mm	1	1310-3	29.3	top	1:1	0.595	1.089	0.648	
5180	36	IEEE 802.11a	OFDM	9.0	8.70	-0.15	0 mm	1	1310-3	6	right	1:1	0.030	1.072	0.032	
5180	36	IEEE 802.11a	OFDM	9.0	8.51	0.15	0 mm	2	1310-3	6	back	1:1	0.876	1.119	0.980	
5240	48	IEEE 802.11a	OFDM	9.0	8.64	0.15	0 mm	2	1310-3	6	back	1:1	0.825	1.086	0.896	
5240	48	IEEE 802.11a	OFDM	9.0	8.64	0.19	0 mm	2	1310-3	6	top	1:1	0.031	1.086	0.034	
5180	36	IEEE 802.11a	OFDM	9.0	8.51	0.04	0 mm	2	1310-3	6	right	1:1	0.917	1.119	1.026	
5240	48	IEEE 802.11a	OFDM	9.0	8.64	0.00	0 mm	2	1310-3	6	right	1:1	1.010	1.086	1.097	
5210	42	IEEE 802.11ac	OFDM	9.0	8.27	0.15	0 mm	2	1310-3	29.3	right	1:1	0.739	1.183	0.874	
5180	36	IEEE 802.11n	OFDM	11.5	11.37	0.13	0 mm	MIMO	1310-3	13	back	1:1	0.735	1.030	0.757	
5220	44	IEEE 802.11n	OFDM	11.5	11.24	0.12	0 mm	MIMO	1310-3	13	back	1:1	0.700	1.062	0.743	
5180	36	IEEE 802.11n	OFDM	11.5	11.37	0.05	0 mm	MIMO	1310-3	13	top	1:1	0.507	1.030	0.522	
5220	44	IEEE 802.11n	OFDM	11.5	11.24	0.12	0 mm	MIMO	1310-3	13	top	1:1	0.523	1.062	0.555	
5180	36	IEEE 802.11n	OFDM	11.5	11.37	0.08	0 mm	MIMO	1310-3	13	right	1:1	0.878	1.030	0.904	
5220	44	IEEE 802.11n	OFDM	11.5	11.24	0.09	0 mm	MIMO	1310-3	13	right	1:1	0.910	1.062	0.966	
5240	48	IEEE 802.11a	OFDM	9.0	8.64	0.09	0 mm	2	1310-3	6	right	1:1	0.913	1.086	0.992	
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 data is highlighted blue in the table above.

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Table 9-5
5.3 WLAN Body SAR

MEASUREMENT RESULTS																
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.												(W/kg)		(W/kg)	
5260	52	IEEE 802.11a	OFDM	9.0	8.46	0.06	0 mm	1	1310-3	6	back	1:1	0.599	1.132	0.678	
5320	64	IEEE 802.11a	OFDM	9.0	8.46	0.11	0 mm	1	1310-3	6	back	1:1	0.624	1.132	0.706	
5260	52	IEEE 802.11a	OFDM	9.0	8.46	0.20	0 mm	1	1310-3	6	top	1:1	0.689	1.132	0.780	
5320	64	IEEE 802.11a	OFDM	9.0	8.46	0.12	0 mm	1	1310-3	6	top	1:1	0.736	1.132	0.833	
5290	58	IEEE 802.11ac	OFDM	9.0	8.43	0.21	0 mm	1	1310-3	29.3	top	1:1	0.649	1.140	0.740	
5320	64	IEEE 802.11a	OFDM	9.0	8.46	0.20	0 mm	1	1310-3	6	right	1:1	0.040	1.132	0.045	
5280	56	IEEE 802.11a	OFDM	9.0	8.89	0.19	0 mm	2	1310-3	6	back	1:1	0.828	1.026	0.850	
5300	60	IEEE 802.11a	OFDM	9.0	8.69	0.13	0 mm	2	1310-3	6	back	1:1	0.795	1.074	0.854	
5280	56	IEEE 802.11a	OFDM	9.0	8.89	0.03	0 mm	2	1310-3	6	top	1:1	0.029	1.026	0.030	
5280	56	IEEE 802.11a	OFDM	9.0	8.89	-0.18	0 mm	2	1310-3	6	right	1:1	1.070	1.026	1.098	A6
5300	60	IEEE 802.11a	OFDM	9.0	8.69	-0.07	0 mm	2	1310-3	6	right	1:1	0.972	1.074	1.044	
5290	58	IEEE 802.11ac	OFDM	9.0	8.44	0.13	0 mm	2	1310-3	29.3	right	1:1	0.845	1.138	0.962	
5260	52	IEEE 802.11n	OFDM	11.5	11.31	0.10	0 mm	MIMO	1310-3	13	back	1:1	0.659	1.045	0.689	
5300	60	IEEE 802.11n	OFDM	11.5	11.39	0.10	0 mm	MIMO	1310-3	13	back	1:1	0.627	1.026	0.643	
5260	52	IEEE 802.11n	OFDM	11.5	11.31	0.01	0 mm	MIMO	1310-3	13	top	1:1	0.548	1.045	0.573	
5300	60	IEEE 802.11n	OFDM	11.5	11.39	0.02	0 mm	MIMO	1310-3	13	top	1:1	0.588	1.026	0.603	
5260	52	IEEE 802.11n	OFDM	11.5	11.31	0.04	0 mm	MIMO	1310-3	13	right	1:1	1.020	1.045	1.066	
5300	60	IEEE 802.11n	OFDM	11.5	11.39	0.13	0 mm	MIMO	1310-3	13	right	1:1	0.965	1.026	0.990	
5280	56	IEEE 802.11a	OFDM	9.0	8.89	-0.16	0 mm	2	1310-3	6	right	1:1	1.010	1.026	1.036	
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 data is highlighted blue in the table above.

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Table 9-6
5.5 WLAN Body SAR

MEASUREMENT RESULTS																
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.												(W/kg)		(W/kg)	
5540	108	IEEE 802.11a	OFDM	9.0	8.49	0.08	0 mm	1	1310-3	6	back	1:1	0.568	1.125	0.639	
5560	112	IEEE 802.11a	OFDM	9.0	8.58	0.06	0 mm	1	1310-3	6	back	1:1	0.570	1.102	0.628	
5700	140	IEEE 802.11a	OFDM	9.0	8.48	0.02	0 mm	1	1310-3	6	back	1:1	0.595	1.127	0.671	
5540	108	IEEE 802.11a	OFDM	9.0	8.49	0.11	0 mm	1	1310-3	6	top	1:1	0.763	1.125	0.858	
5560	112	IEEE 802.11a	OFDM	9.0	8.58	0.07	0 mm	1	1310-3	6	top	1:1	0.746	1.102	0.822	
5700	140	IEEE 802.11a	OFDM	9.0	8.48	0.09	0 mm	1	1310-3	6	top	1:1	0.764	1.127	0.861	
5530	106	IEEE 802.11ac	OFDM	9.0	8.46	0.08	0 mm	1	1310-3	29.3	top	1:1	0.707	1.132	0.800	
5560	112	IEEE 802.11a	OFDM	9.0	8.58	0.18	0 mm	1	1310-3	6	right	1:1	0.039	1.102	0.043	
5500	100	IEEE 802.11a	OFDM	9.0	8.58	0.21	0 mm	2	1310-3	6	back	1:1	0.458	1.102	0.505	
5560	112	IEEE 802.11a	OFDM	9.0	8.49	0.10	0 mm	2	1310-3	6	back	1:1	0.392	1.125	0.441	
5660	132	IEEE 802.11a	OFDM	9.0	7.68	0.06	0 mm	2	1310-3	6	back	1:1	0.282	1.355	0.382	
5500	100	IEEE 802.11a	OFDM	9.0	8.58	0.14	0 mm	2	1310-3	6	top	1:1	0.021	1.102	0.023	
5500	100	IEEE 802.11a	OFDM	9.0	8.58	0.01	0 mm	2	1310-3	6	right	1:1	0.953	1.102	1.050	
5560	112	IEEE 802.11a	OFDM	9.0	8.49	0.05	0 mm	2	1310-3	6	right	1:1	0.765	1.125	0.861	
5660	132	IEEE 802.11a	OFDM	9.0	7.68	0.09	0 mm	2	1310-3	6	right	1:1	0.482	1.355	0.653	
5530	106	IEEE 802.11ac	OFDM	9.0	8.08	0.14	0 mm	2	1310-3	29.3	right	1:1	0.628	1.236	0.776	
5500	100	IEEE 802.11n	OFDM	11.5	11.20	0.14	0 mm	MIMO	1310-3	13	back	1:1	0.520	1.072	0.557	
5560	112	IEEE 802.11n	OFDM	11.5	11.14	0.07	0 mm	MIMO	1310-3	13	back	1:1	0.516	1.086	0.560	
5680	136	IEEE 802.11n	OFDM	11.5	11.15	-0.01	0 mm	MIMO	1310-3	13	back	1:1	0.541	1.084	0.586	
5500	100	IEEE 802.11n	OFDM	11.5	11.20	0.12	0 mm	MIMO	1310-3	13	top	1:1	0.628	1.072	0.673	
5560	112	IEEE 802.11n	OFDM	11.5	11.14	0.03	0 mm	MIMO	1310-3	13	top	1:1	0.619	1.086	0.672	
5680	136	IEEE 802.11n	OFDM	11.5	11.15	0.06	0 mm	MIMO	1310-3	13	top	1:1	0.650	1.084	0.705	
5500	100	IEEE 802.11n	OFDM	11.5	11.20	0.07	0 mm	MIMO	1310-3	13	right	1:1	0.824	1.072	0.883	
5560	112	IEEE 802.11n	OFDM	11.5	11.14	0.09	0 mm	MIMO	1310-3	13	right	1:1	0.662	1.086	0.719	
5680	136	IEEE 802.11n	OFDM	11.5	11.15	0.18	0 mm	MIMO	1310-3	13	right	1:1	0.397	1.084	0.430	
5500	100	IEEE 802.11a	OFDM	9.0	8.58	0.10	0 mm	2	1310-3	6	right	1:1	0.873	1.102	0.962	
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 data is highlighted blue in the table above.

9.2 SAR Test Notes

General Notes:

1. The test data reported are the worst-case SAR values according to test procedures specified in FCC KDB Publication 616217 D04v01, 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.

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6. Per FCC KDB 865664 D01 v01, variability SAR tests were performed when the measured SAR results for a frequency band were greater than 0.8 W/kg. Repeated SAR measurements are highlighted in the tables above for clarity. Please see Section 11 for variability analysis.
7. Per FCC KDB Publication 616217 D04 Section 4.3, SAR tests are required for the back surface and edges of the tablet with the tablet touching the phantom. The SAR Exclusion Threshold in FCC KDB 447498 D01v05 was applied to determine SAR test exclusion for adjacent edge configurations. Bottom and Right Edge SAR tests were required for the main antenna. Top and Right Edge was required for the WLAN/BT antennas.

GPRS Test Notes:

1. Justification for reduced test configurations per KDB Publication 941225 D03v01 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.
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.

UMTS Notes:

1. UMTS mode was tested under RMC 12.2 kbps with HSPA Inactive per KDB Publication 941225 D01v02. HSPA SAR was not required since the average output power of the HSPA subtests was not more than 0.25 dB higher than the RMC level and SAR was less than 1.2 W/kg.
2. Per FCC KDB Publication 447498 D01v05, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is ≤ 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.

WLAN Notes:

1. Justification for reduced test configurations for WIFI channels per KDB Publication 248227 D01v01r02 and October 2012 FCC/TCB Meeting Notes for 2.4 GHz WIFI SISO operations: Highest average RF output power channel for the lowest data rate was selected for SAR evaluation in 802.11b. Other SISO IEEE 802.11 modes (including 802.11g/n) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11b mode.
2. Justification for reduced test configurations for WIFI channels per KDB Publication 248227 D01v01r02 and October 2012 FCC/TCB Meeting Notes for SISO 5 GHz WIFI operations: Highest average RF output power channel for the lowest data rate was selected for SAR evaluation in 802.11a. Other IEEE SISO 802.11 modes (including 802.11n) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11a mode.
3. Per April 2013 TCB Workshop notes, full SISO SAR tests for all IEEE 802.11ac configurations were not required because the average output power was not more than 0.25 dB higher than IEEE 802.11a mode. IEEE 802.11ac SISO was evaluated for the highest IEEE 802.11a position in each 5 GHz band and exposure condition.
4. When Hotspot is enabled, all 5 GHz bands are disabled. Therefore no 5 GHz WIFI Wireless Router SAR Data was required.
5. Per KDB 248227, SAR for MIMO was measured with both antennas transmitting simultaneously and was evaluated in dependently of SISO operation. For 2.4 GHz MIMO, IEEE 802.11n was evaluated. For 5 GHz MIMO, IEEE 802.11n 20 MHz bandwidth was evaluated.
6. WIFI transmission was verified using an uncalibrated spectrum analyzer.
7. When the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is <1.6 W/kg and the reported 1g averaged SAR is <0.8 W/kg, SAR testing on other default channels was not required.
8. There is no sensor power reduction mechanism applied for WIFI/BT modes.

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10 FCC MULTI-TX AND ANTENNA SAR CONSIDERATIONS

10.1 Introduction

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

10.2 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. 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 10-1
Estimated SAR

Mode	Configuration	Frequency	Maximum Allowed Power	Separation Distance (Body)	Estimated SAR (Body)
		[MHz]	[dBm]	[mm]	[W/kg]
Bluetooth	Back Side, Top Edge, Right Edge Touching*	2480	9.50	5	0.378
Bluetooth	Back Side	2480	9.50	16	0.118
Bluetooth	Right Edge	2480	9.50	5	0.378

Note:

1. Per KDB Publication 447498 D01v05, the maximum power of the channel was rounded to the nearest mW before calculation.
2. (*) – Per FCC KDB Publication 447498, when the test separation distance is < 5 mm, a distance of 5 mm is applied to determine estimated SAR.
3. For configurations excluded per 447498 D01v05, an estimated SAR of 0.4 W/kg was used to determine simultaneous transmission SAR exclusion when the test separation distance was > 50 mm.

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10.3 Body Simultaneous Transmission Analysis

Table 10-2
Simultaneous Transmission Scenario with 2.4 GHz WLAN Antenna 1 (Body at 0.0 cm)

Simult Tx	Configuration	GPRS 850 SAR (W/kg)	2.4 GHz WLAN Ant 1 SAR (W/kg)	Σ SAR (W/kg)	SPLSR	Simult Tx	Configuration	UMTS 850 SAR (W/kg)	2.4 GHz WLAN Ant 1 SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.796	1.096	See Note	0.01	Body SAR	Back	0.450	1.096	**1.546**
	Top	0.400	0.465	**0.865**	N/A		Top	0.400	0.465	0.865
	Bottom	0.291	0.400	0.691	N/A		Bottom	0.188	0.400	0.588
	Right	0.193	0.022	0.215	N/A		Right	0.118	0.022	0.140
	Left	0.400	0.400	0.800	N/A		Left	0.400	0.400	0.800

Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN Ant 1 SAR (W/kg)	Σ SAR (W/kg)	SPLSR
Body SAR	Back	1.054	1.096	See Note	0.02
	Top	0.400	0.465	**0.865**	N/A
	Bottom	0.369	0.400	0.769	N/A
	Right	0.241	0.022	0.263	N/A
	Left	0.400	0.400	0.800	N/A

Table 10-3
Simultaneous Transmission Scenario with 2.4 GHz WLAN Antenna 2 (Body at 0.0 cm)

Simult Tx	Configuration	GPRS 850 SAR (W/kg)	2.4 GHz WLAN Ant 2 SAR (W/kg)	Σ SAR (W/kg)	SPLSR	Simult Tx	Configuration	UMTS 850 SAR (W/kg)	2.4 GHz WLAN Ant 2 SAR (W/kg)	Σ SAR (W/kg)	SPLSR
Body SAR	Back	0.796	0.918	See Note	0.01	Body SAR	Back	0.450	0.918	**1.368**	N/A
	Top	0.400	0.090	0.490	N/A		Top	0.400	0.090	0.490	N/A
	Bottom	0.291	0.400	0.691	N/A		Bottom	0.188	0.400	0.588	N/A
	Right	0.193	0.309	0.502	N/A		Right	0.118	0.309	0.427	N/A
	Left	0.400	0.400	**0.800**	N/A		Left	0.400	0.400	0.800	N/A

Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN Ant 2 SAR (W/kg)	Σ SAR (W/kg)	SPLSR
Body SAR	Back	1.054	0.918	See Note	0.02
	Top	0.400	0.090	0.490	N/A
	Bottom	0.369	0.400	0.769	N/A
	Right	0.241	0.309	0.550	N/A
	Left	0.400	0.400	**0.800**	N/A

Table 10-4
Simultaneous Transmission Scenario with 2.4 GHz WLAN MIMO (Body at 0.0 cm)

Simult Tx	Configuration	GPRS 850 SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	Σ SAR (W/kg)	SPLSR	Simult Tx	Configuration	UMTS 850 SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	Σ SAR (W/kg)	SPLSR
Body SAR	Back	0.796	0.735	**1.531**	N/A	Body SAR	Back	0.450	0.735	**1.185**	N/A
	Top	0.400	0.459	0.859	N/A		Top	0.400	0.459	0.859	N/A
	Bottom	0.291	0.400	0.691	N/A		Bottom	0.188	0.400	0.588	N/A
	Right	0.193	0.099	0.292	N/A		Right	0.118	0.099	0.217	N/A
	Left	0.400	0.400	0.800	N/A		Left	0.400	0.400	0.800	N/A

Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	Σ SAR (W/kg)	SPLSR
Body SAR	Back	1.054	0.735	See Note	0.01
	Top	0.400	0.459	**0.859**	N/A
	Bottom	0.369	0.400	0.769	N/A
	Right	0.241	0.099	0.340	N/A
	Left	0.400	0.400	0.800	N/A

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Table 10-5
Simultaneous Transmission Scenario with Bluetooth (Body at 0.0 cm)

Simult Tx	Configuration	GPRS 850 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	SPLSR	Simult Tx	Configuration	UMTS 850 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	SPLSR
Body SAR	Back	0.796	0.378	**1.174**	N/A	Body SAR	Back	0.450	0.378	**0.828**	N/A
	Top	0.400	0.378	0.778	N/A		Top	0.400	0.378	0.778	N/A
	Bottom	0.291	0.400	0.691	N/A		Bottom	0.188	0.400	0.588	N/A
	Right	0.193	0.378	0.571	N/A		Right	0.118	0.378	0.496	N/A
	Left	0.400	0.400	0.800	N/A		Left	0.400	0.400	0.800	N/A

Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	SPLSR
Body SAR	Back	1.054	0.378	**1.432**	N/A
	Top	0.400	0.378	0.778	N/A
	Bottom	0.369	0.400	0.769	N/A
	Right	0.241	0.378	0.619	N/A
	Left	0.400	0.400	0.800	N/A

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.

Table 10-6
Simultaneous Transmission Scenario with 2.4 GHz WLAN Antenna 1 (Back Side at 1.6 cm)

Configuration	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN Ant 1 SAR (W/kg)	Σ SAR (W/kg)	SPLSR
Back Side	GSM 850	0.573	<1.096	See Note 1	<0.01
Back Side	UMTS 850	0.478	<1.096	**<1.574**	N/A
Back Side	GSM 1900	0.549	<1.096	See Note 1	<0.01

Table 10-7
Simultaneous Transmission Scenario with 2.4 GHz WLAN Antenna 2 (Back Side at 1.6 cm)

Configuration	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN Ant 2 SAR (W/kg)	Σ SAR (W/kg)
Back Side	GSM 850	0.573	<0.918	<1.491
Back Side	UMTS 850	0.478	<0.918	<1.396
Back Side	GSM 1900	0.549	<0.918	<1.467

Table 10-8
Simultaneous Transmission Scenario with 2.4 GHz WLAN MIMO (Back Side at 1.6 cm)

Configuration	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	Σ SAR (W/kg)
Back Side	GSM 850	0.573	<0.735	<1.308
Back Side	UMTS 850	0.478	<0.735	<1.213
Back Side	GSM 1900	0.549	<0.735	<1.284

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Table 10-9
Simultaneous Transmission Scenario with Bluetooth (Back Side at 1.6 cm)

Configuration	Mode	2G/3G SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)
Back Side	GSM 850	0.573	0.118	0.691
Back Side	UMTS 850	0.478	0.118	0.596
Back Side	GSM 1900	0.549	0.118	0.667

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.

Table 10-10
Simultaneous Transmission Scenario with 2.4 GHz WLAN Antenna 1 (Bottom Edge at 1.1 cm)

Configuration	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN Ant 1 SAR (W/kg)	Σ SAR (W/kg)
Bottom Edge	GSM 850	0.484	0.400	0.884
Bottom Edge	UMTS 850	0.413	0.400	0.813
Bottom Edge	GSM 1900	0.502	0.400	0.902

Table 10-11
Simultaneous Transmission Scenario with 2.4 GHz WLAN Antenna 2 (Bottom Edge at 1.1 cm)

Configuration	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN Ant 2 SAR (W/kg)	Σ SAR (W/kg)
Bottom Edge	GSM 850	0.484	0.400	0.884
Bottom Edge	UMTS 850	0.413	0.400	0.813
Bottom Edge	GSM 1900	0.502	0.400	0.902

Table 10-12
Simultaneous Transmission Scenario with 2.4 GHz WLAN MIMO (Bottom Edge at 1.1 cm)

Configuration	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	Σ SAR (W/kg)
Bottom Edge	GSM 850	0.484	0.400	0.884
Bottom Edge	UMTS 850	0.413	0.400	0.813
Bottom Edge	GSM 1900	0.502	0.400	0.902

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Table 10-13
Simultaneous Transmission Scenario with Bluetooth (Bottom Edge at 1.1 cm)

Configuration	Mode	2G/3G SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)
Bottom Edge	GSM 850	0.484	0.400	0.884
Bottom Edge	UMTS 850	0.413	0.400	0.813
Bottom Edge	GSM 1900	0.502	0.400	0.902

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.

Table 10-14
Simultaneous Transmission Scenario with 2.4 GHz WLAN Antenna 1 (Right Edge at 0.5 cm)

Configuration	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN Ant 1 SAR (W/kg)	Σ SAR (W/kg)
Right Edge	GSM 850	0.362	<0.022	<0.384
Right Edge	UMTS 850	0.315	<0.022	<0.337
Right Edge	GSM 1900	0.938	<0.022	<0.960

Table 10-15
Simultaneous Transmission Scenario with 2.4 GHz WLAN Antenna 2 (Right Edge at 0.5 cm)

Configuration	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN Ant 2 SAR (W/kg)	Σ SAR (W/kg)
Right Edge	GSM 850	0.362	<0.309	<0.671
Right Edge	UMTS 850	0.315	<0.309	<0.624
Right Edge	GSM 1900	0.938	<0.309	<1.247

Table 10-16
Simultaneous Transmission Scenario with 2.4 GHz WLAN MIMO (Right Edge at 0.5 cm)

Configuration	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	Σ SAR (W/kg)
Right Edge	GSM 850	0.362	<0.099	<0.461
Right Edge	UMTS 850	0.315	<0.099	<0.414
Right Edge	GSM 1900	0.938	<0.099	<1.037

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Table 10-17
Simultaneous Transmission Scenario with Bluetooth (Right Edge at 0.5 cm)

Configuration	Mode	2G/3G SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)
Right Edge	GSM 850	0.362	0.378	0.740
Right Edge	UMTS 850	0.315	0.378	0.693
Right Edge	GSM 1900	0.938	0.378	1.316

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.

Notes:

1. No evaluation was performed to determine the aggregate 1g SAR for these configurations as the SPLS ratio between the antenna pairs was not higher than 0.04 per FCC KDB 447498 D01v05. See Section 11.4 for detailed SPLS ratio analysis.
2. For SAR summations for body back at 1.6 cm, WLAN SAR values for 0.0 cm were used since the 0.0 cm test distance for WLAN was more conservative. "<" denotes that the 0.0 cm WLAN SAR values were used for summation purposes.
3. For SAR summations for body right edge at 0.5 cm, WLAN SAR values for 0.0 cm were used since the 0.0 cm test distance for WLAN was more conservative. "<" denotes that the 0.0 cm WLAN SAR values were used for summation purposes.
4. For configurations excluded per 447498 D01v05, an estimated SAR of 0.4 W/kg was used to determine simultaneous transmission SAR exclusion when the test separation distance was > 50 mm.

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10.4 SPLSR Evaluation and Analysis

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

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

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

The sums of the standalone SAR values were above 1.6 W/kg for the Body Back Side configuration at a separation distance of 0.0 cm for 2.4 GHz WLAN Antenna 1, 2 and MIMO operating with GPRS 850 and GPRS 1900 operating at limited power.

Table 10-18
Peak SAR Locations for Body Back Side at 0.0 cm

Mode/Band	x (mm)	y (mm)	Reported SAR (W/kg)
2.4 GHz WLAN Ant 1	-41.00	-96.00	1.096
2.4 GHz WLAN Ant 2	-29.01	-72.00	0.918
2.4 GHz WLAN MIMO	-40.99	-96.00	0.735
GPRS 850	-27.02	95.00	0.796
GPRS 1900	-27.00	90.00	1.054

Table 10-19
SAR Sum to Peak Location Separation Ratio Calculations

Antenna Pair		Standalone 1g SAR (W/kg)		Standalone SAR Sum (W/kg)	Peak SAR Separation Distance (mm)	SPLS Ratio
Ant "a"	Ant "b"	a	b	a+b	D_{a-b}	$(a+b)^{1.5}/D_{a-b}$
GPRS 850	2.4 GHz WLAN Ant 1	0.796	1.096	1.892	191.51	0.01
GPRS 850	2.4 GHz WLAN Ant 2	0.796	0.918	1.714	167.01	0.01
GPRS 1900	2.4 GHz WLAN Ant 1	1.054	1.096	2.15	186.53	0.02
GPRS 1900	2.4 GHz WLAN Ant 2	1.054	0.918	1.972	162.02	0.02
GPRS 1900	2.4 GHz WLAN MIMO	1.054	0.735	1.789	186.53	0.01

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Figure 10-1
Peak SAR Locations for Body Back Side at 0.0 cm GPRS 850 and 2.4 GHz WLAN Antenna 1

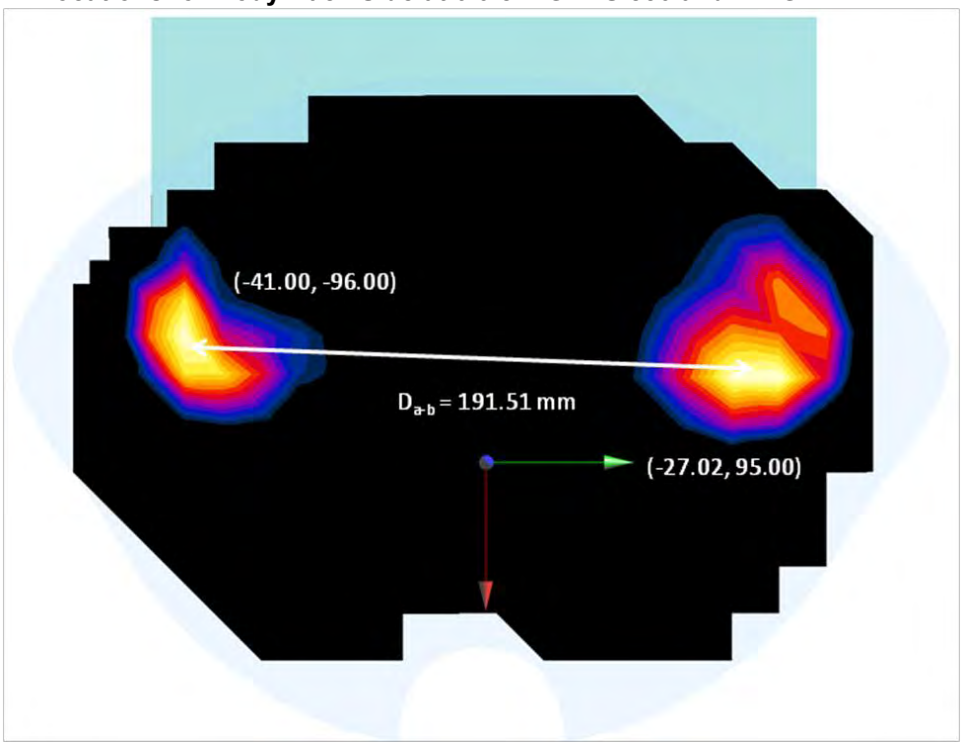

Figure 10-2
Peak SAR Locations for Body Back Side at 0.0 cm GPRS 850 and 2.4 GHz WLAN Antenna 2

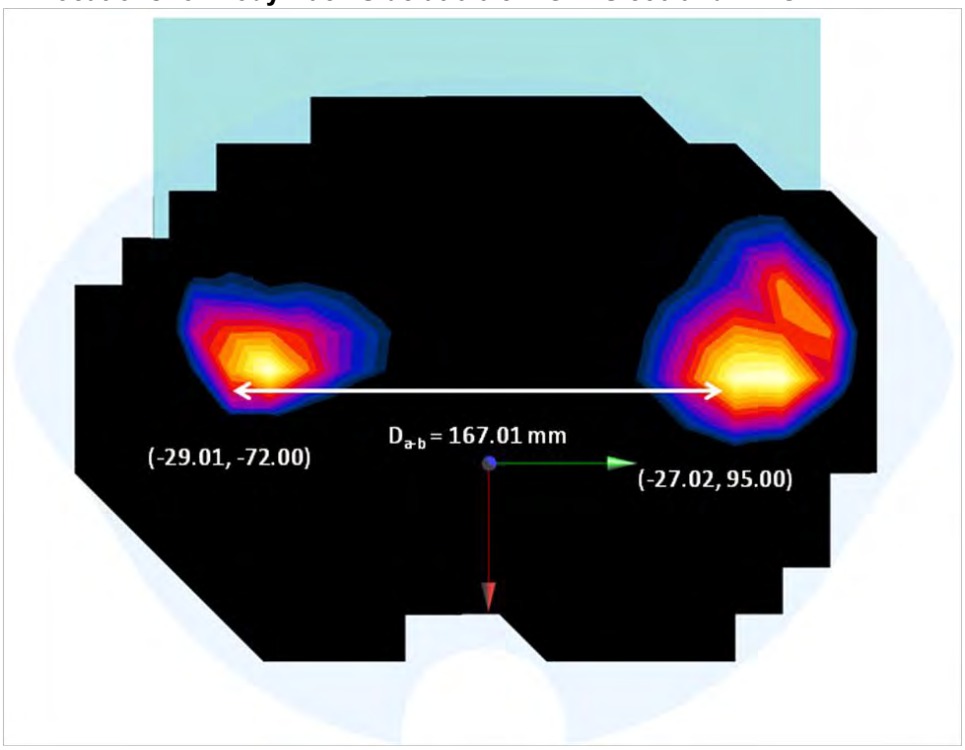

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Figure 10-3
Peak SAR Locations for Body Back Side at 0.0 cm GPRS 1900 and 2.4 GHz WLAN Antenna 1

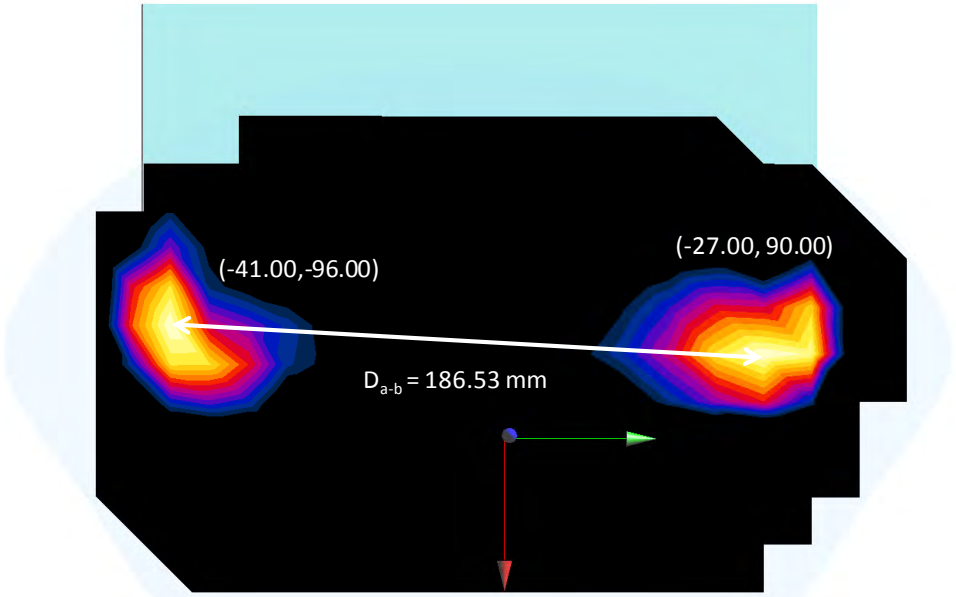

Figure 10-4
Peak SAR Locations for Body Back Side at 0.0 cm GPRS 1900 and 2.4 GHz WLAN Antenna 2

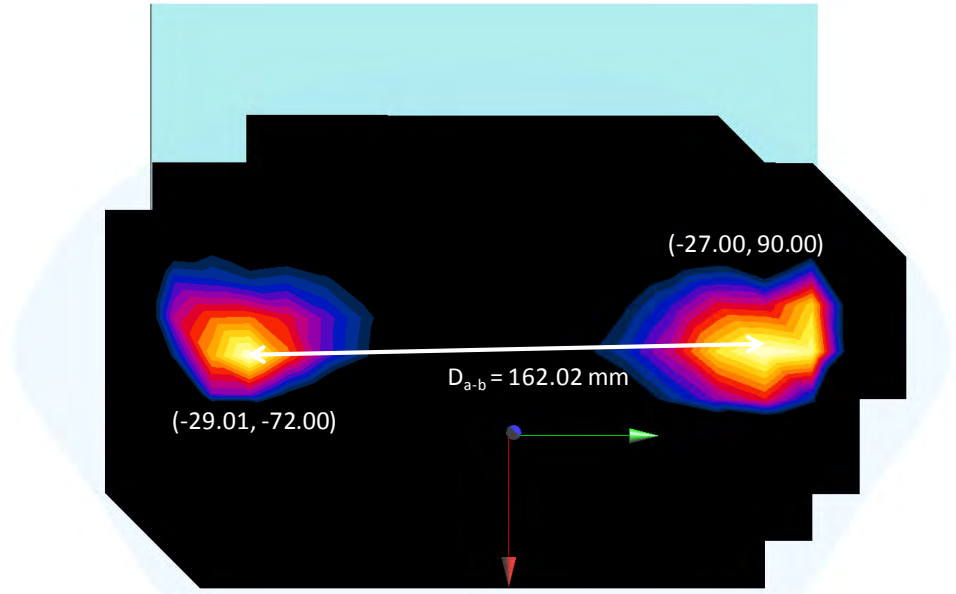

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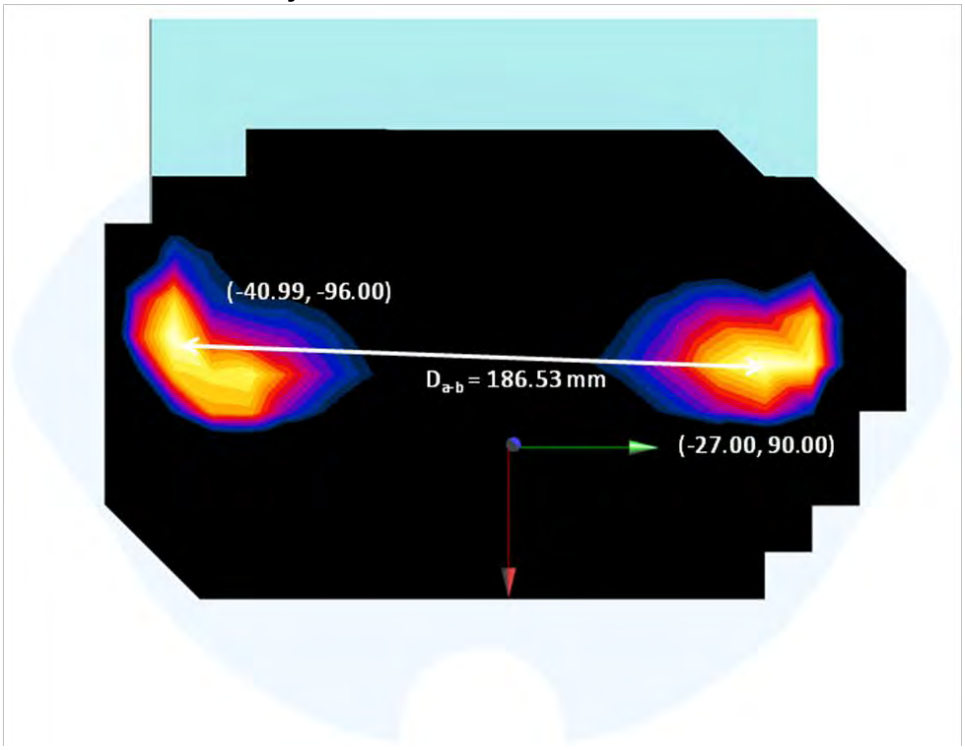
Figure 10-5
Peak SAR Locations for Body Back Side at 0.0 cm GPRS 1900 and 2.4 GHz WLAN MIMO



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The sums of the standalone SAR values were above 1.6 W/kg for the Body Back Side configuration at a separation distance of 1.6 cm for 2.4 GHz WLAN Antenna 1 operating with GPRS 850 and GPRS 1900 operating at maximum power.

Table 10-20
Peak SAR Locations for Body Back Side at 1.6 cm

Mode/Band	x (mm)	y (mm)	Reported SAR (W/kg)
2.4 GHz WLAN Ant 1	-41.00	-96.00	<1.096
GPRS 850	-27.02	80.00	0.573
GPRS 1900	-37.00	105.00	0.549

Table 10-21
SAR Sum to Peak Location Separation Ratio Calculations

Antenna Pair		Standalone 1g SAR (W/kg)		Standalone SAR Sum (W/kg)	Peak SAR Separation Distance (mm)	SPLS Ratio
Ant "a"	Ant "b"	a	b	a+b	D_{a-b}	$(a+b)^{1.5}/D_{a-b}$
GPRS 850	2.4 GHz WLAN Ant 1	0.573	<1.096	<1.669	176.55	<0.01
GPRS 1900	2.4 GHz WLAN Ant 1	0.549	<1.096	<1.645	201.04	<0.01

Figure 10-6
Peak SAR Locations for Body Back Side at 1.6 cm GPRS 850 and 2.4 GHz WLAN Antenna 1

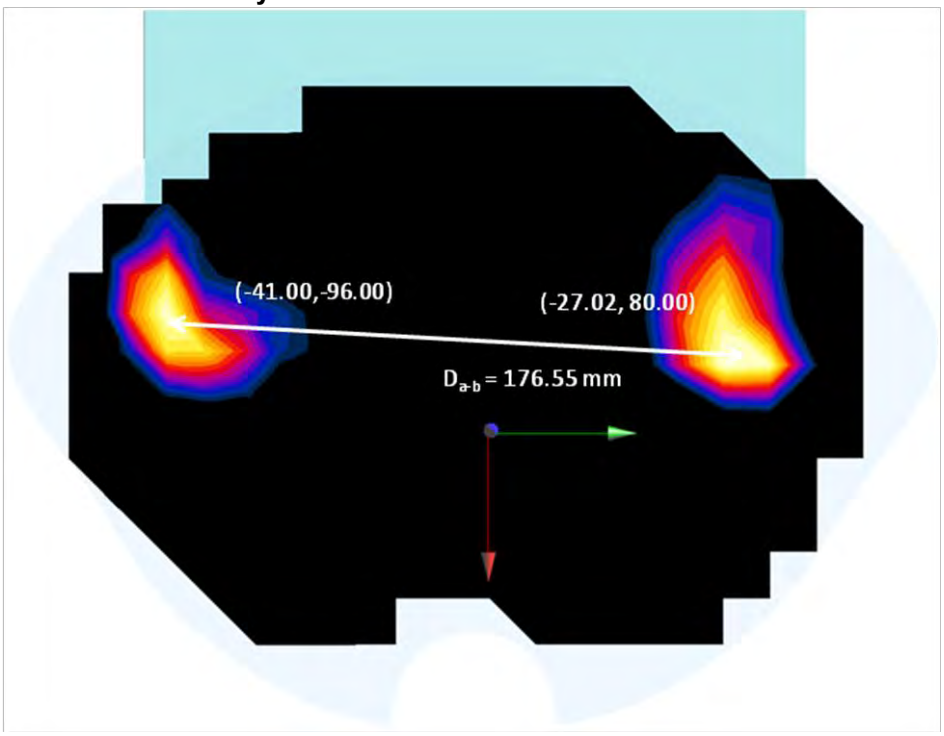

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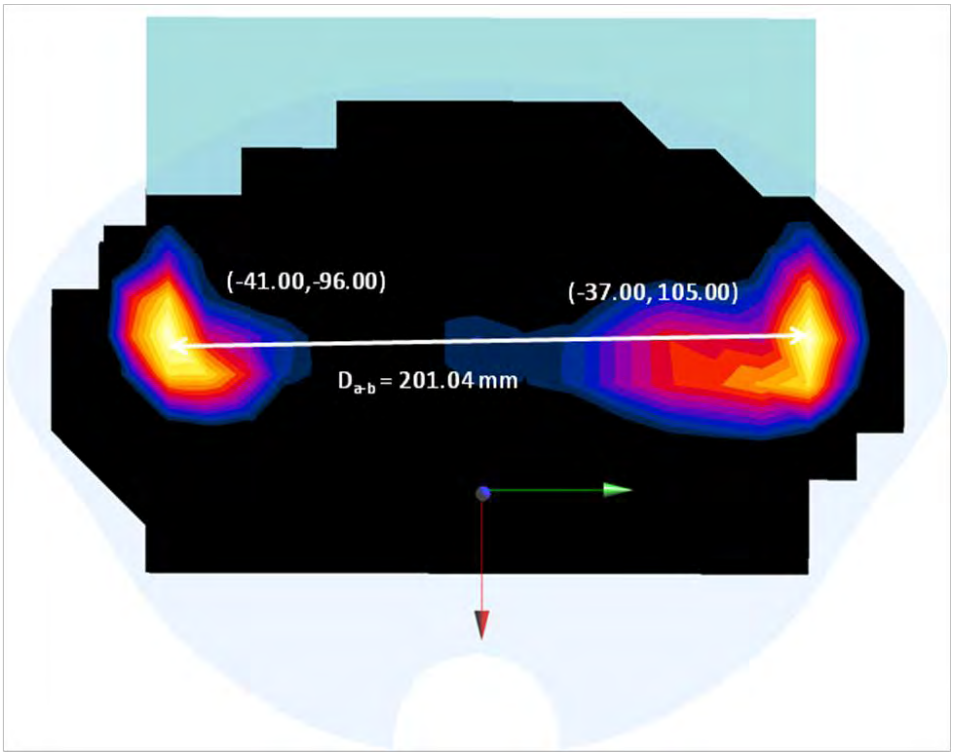
Figure 10-7
Peak SAR Locations for Body Back Side at 1.6 cm GPRS 1900 and 2.4 GHz WLAN Antenna 1



10.5 Simultaneous Transmission Conclusion

The above numerical summed SAR and SPLSR analysis results for all the worst-case simultaneous transmission conditions were below the SAR limit. Therefore, the above analysis is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit and therefore no measured volumetric simultaneous SAR summation is required per FCC KDB Publication 447498 D01v05 and IEEE 1528-2013 Section 6.3.4.1.2.

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11 SAR MEASUREMENT VARIABILITY

11.1 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 11-1
Body SAR Measurement Variability Results

BODY VARIABILITY RESULTS															
Band	FREQUENCY		Mode	Service	# of Time Slots	Data Rate (Mbps)	Side	Spacing	Measured SAR (1g)	1st Repeated SAR (1g)	Ratio	2nd Repeated SAR (1g)	Ratio	3rd Repeated SAR (1g)	Ratio
	MHz	Ch.							(W/kg)	(W/kg)		(W/kg)		(W/kg)	
1900	1909.80	810	GSM 1900	GPRS	3	N/A	back	0 mm	0.988	1.010	1.02	N/A	N/A	N/A	N/A
2450	2437.00	6	IEEE 802.11b	DSSS, ANT 1	N/A	1	back	0 mm	1.050	1.000	1.05	N/A	N/A	N/A	N/A
5200	5240.00	48	IEEE 802.11a	OFDM, ANT 2	N/A	6	right	0 mm	1.010	0.913	1.11	N/A	N/A	N/A	N/A
5300	5280.00	56	IEEE 802.11a	OFDM, ANT 2	N/A	6	right	0 mm	1.070	1.010	1.06	N/A	N/A	N/A	N/A
5500	5500.00	100	IEEE 802.11a	OFDM, ANT 2	N/A	6	right	0 mm	0.953	0.873	1.09	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						

11.2 Measurement Uncertainty

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

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12 EQUIPMENT LIST

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	E8257D	(250kHz-20GHz) Signal Generator	4/15/2014	Annual	4/15/2015	MY45470194
Agilent	8594A	(9kHz-2.9GHz) Spectrum Analyzer	N/A	N/A	N/A	3051A00187
Agilent	8648D	(9kHz-4GHz) Signal Generator	4/15/2014	Annual	4/15/2015	3629U00687
Agilent	E4438C	ESG Vector Signal Generator	4/25/2014	Annual	4/25/2015	MY42082385
Agilent	N9020A	MXA Signal Analyzer	10/29/2013	Annual	10/29/2014	US46470561
Agilent	N5182A	MXG Vector Signal Generator	4/15/2014	Annual	4/15/2015	MY47420651
Agilent	8753ES	S-Parameter Network Analyzer	10/29/2013	Annual	10/29/2014	US39170122
Agilent	E5515C	Wireless Communications Test Set	6/26/2013	Biennial	6/26/2015	GB41450275
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	433971
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	433972
Anritsu	ML2469A	Power Meter	3/14/2014	Annual	3/14/2015	1306009
Anritsu	MA2481A	Power Sensor	10/30/2013	Annual	10/30/2014	5605
Anritsu	MA2411B	Pulse Power Sensor	11/14/2013	Annual	11/14/2014	1126066
Anritsu	MT8820C	Radio Communication Analyzer	12/12/2013	Annual	12/12/2014	6201300731
Anritsu	MA24106A	USB Power Sensor	1/3/2014	Annual	1/3/2015	1349509
Anritsu	MA24106A	USB Power Sensor	1/3/2014	Annual	1/3/2015	1349514
COMTech	AR85729-5	Solid State Amplifier	CBT	N/A	CBT	M1S5A00-009
COMTECH	AR85729-5/5759B	Solid State Amplifier	CBT	N/A	CBT	M3W1A00-1002
Fisher Scientific	S407993	Long Stem Thermometer	11/4/2013	Biennial	11/4/2015	130671821
Fisher Scientific	S407993	Long Stem Thermometer	11/4/2013	Biennial	11/4/2015	130671826
Gigatronics	80701A	(0.05-18GHz) Power Sensor	10/30/2013	Annual	10/30/2014	1833460
Gigatronics	8651A	Universal Power Meter	10/30/2013	Annual	10/30/2014	8650319
MCL	BW-N6W5+	6dB Attenuator	CBT	N/A	CBT	1139
MiniCircuits	VLF-6000+	Low Pass Filter	CBT	N/A	CBT	N/A
MiniCircuits	SLP-2400+	Low Pass Filter	CBT	N/A	CBT	R8979500903
Mini-Circuits	BW-N20W5+	DC to 18 GHz Precision Fixed 20 dB Attenuator	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-1200+	Low Pass Filter DC to 1000 MHz	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-2950+	Low Pass Filter DC to 2700 MHz	CBT	N/A	CBT	N/A
Mini-Circuits	BW-N20W5	Power Attenuator	CBT	N/A	CBT	1226
Mitutoyo	CD-6"CSX	Digital Caliper	5/8/2014	Biennial	5/8/2016	13264162
Narda	4014C-6	4 - 8 GHz SMA 6 dB Directional Coupler	CBT	N/A	CBT	N/A
Narda	BW-S3W2	Attenuator (3dB)	CBT	N/A	CBT	120
Pasternack	PE2208-6	Bidirectional Coupler	CBT	N/A	CBT	N/A
Pasternack	PE2209-10	Bidirectional Coupler	CBT	N/A	CBT	N/A
Rohde & Schwarz	CMU200	Base Station Simulator	6/6/2014	Annual	6/6/2015	109892
Rohde & Schwarz	CMU200	Base Station Simulator	4/24/2014	Annual	4/24/2015	836371/0079
Rohde & Schwarz	CMW500	Radio Communication Tester	4/18/2014	Annual	4/18/2015	101699
Seekonk	NC-100	Torque Wrench 5/16", 8" lbs	3/18/2014	Biennial	3/18/2016	N/A
SPEAG	D1900V2	1900 MHz SAR Dipole	4/9/2014	Annual	4/9/2015	5d141
SPEAG	D2450V2	2450 MHz SAR Dipole	2/24/2014	Annual	2/24/2015	882
SPEAG	D5GHzV2	5 GHz SAR Dipole	2/26/2014	Annual	2/26/2015	1120
SPEAG	D835V2	835 MHz SAR Dipole	7/10/2014	Annual	7/10/2015	4d132
SPEAG	DAE4	Dasy Data Acquisition Electronics	12/12/2013	Annual	12/12/2014	649
SPEAG	DAE4	Dasy Data Acquisition Electronics	5/14/2014	Annual	5/14/2015	859
SPEAG	DAE4	Dasy Data Acquisition Electronics	1/22/2014	Annual	1/22/2015	1272
SPEAG	DAE4	Dasy Data Acquisition Electronics	11/18/2013	Annual	11/18/2014	1407
SPEAG	DAK-3.5	Dielectric Assessment Kit	5/6/2014	Annual	5/6/2015	1070
SPEAG	DAK-3.5	Dielectric Assessment Kit	11/13/2013	Annual	11/13/2014	1091
SPEAG	ES3DV3	SAR Probe	4/11/2014	Annual	4/11/2015	3213
SPEAG	ES3DV3	SAR Probe	5/15/2014	Annual	5/15/2015	3263
SPEAG	ES3DV3	SAR Probe	3/19/2014	Annual	3/19/2015	3318
SPEAG	EX3DV4	SAR Probe	12/18/2013	Annual	12/18/2014	3920
Tektronix	RSA6114A	Real Time Spectrum Analyzer	4/16/2014	Annual	4/16/2015	B010177
VWR	36934-158	Wall-Mounted Thermometer	8/8/2013	Biennial	8/8/2015	130477866
VWR	36934-158	Wall-Mounted Thermometer	8/8/2013	Biennial	8/8/2015	130477877

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

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13 MEASUREMENT UNCERTAINTIES

Applicable for frequencies less than 3000 MHz.

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

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

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Applicable for frequencies up to 6 GHz.

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

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

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14 CONCLUSION

14.1 Measurement Conclusion

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

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

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15 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. -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.

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[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 procedures for IEEE 802.11a/b/g KDB Publication 248227 D01v01r02

[25] FCC SAR Considerations for Handsets with Multiple Transmitters and Antennas, KDB Publications 648474 D02-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.

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APPENDIX A: SAR TEST DATA

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DUT: A3LSC03G; Type: Portable Tablet; Serial: 1010-2

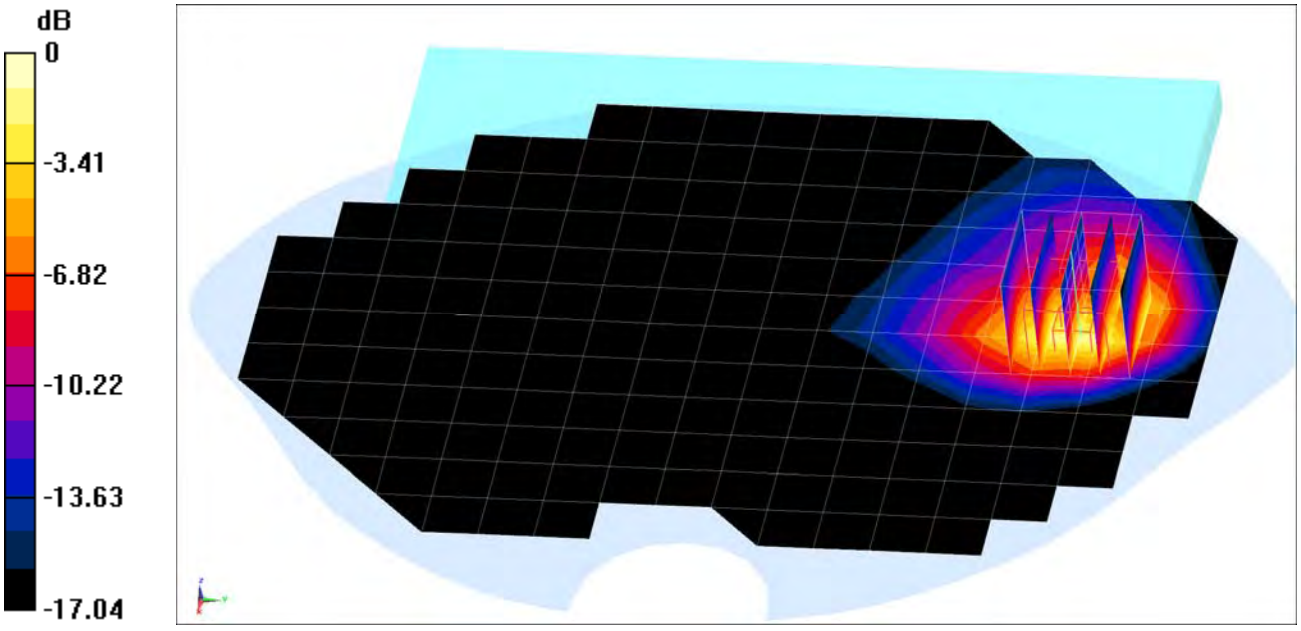
Communication System: UID 0, GSM850 GPRS; 3 Tx slots; Frequency: 836.6 MHz; Duty Cycle: 1:2.76
Medium: 835 Body Medium parameters used (interpolated):
f = 836.6 MHz; σ = 0.954 S/m; ε_r = 54.045; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 10-15-2014; Ambient Temp: 21.7°C; Tissue Temp: 20.6°C

Probe: ES3DV3 - SN3213; ConvF(6.18, 6.18, 6.18); Calibrated: 4/11/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1407; Calibrated: 11/18/2013
Phantom: Sub TWIN SAM; Type: QD000P40CC; Serial: TP-1357
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7164)

Mode: GPRS 850, Body SAR, Back side, Mid.ch, 3 Tx Slots

Area Scan (13x18x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 25.646 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 1.55 W/kg
SAR(1 g) = 0.745 W/kg



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

DUT: A3LSC03G; Type: Portable Tablet; Serial: 1010-1

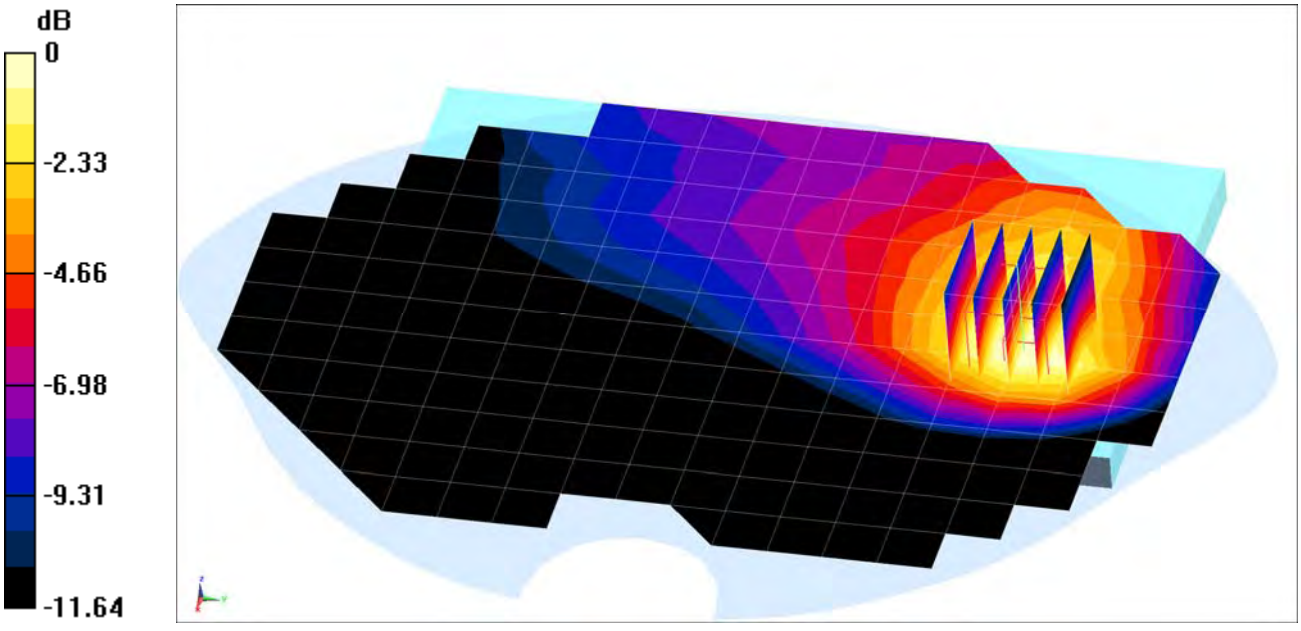
Communication System: UID 0, UMTS; Frequency: 836.6 MHz; Duty Cycle: 1:1
Medium: 835 Body Medium parameters used (interpolated):
f = 836.6 MHz; σ = 0.962 S/m; εr = 52.783; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.6 cm

Test Date: 10-29-2014; Ambient Temp: 21.7°C; Tissue Temp: 20.7°C

Probe: ES3DV3 - SN3213; ConvF(6.18, 6.18, 6.18); Calibrated: 4/11/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1407; Calibrated: 11/18/2013
Phantom: Sub TWIN SAM; Type: QD000P40CC; Serial: TP-1357
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7164)

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

Area Scan (13x18x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 23.226 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 0.721 W/kg
SAR(1 g) = 0.478 W/kg



0 dB = 0.554 W/kg = -2.56 dBW/kg

DUT: A3LSC03G; Type: Portable Tablet; Serial: 1010-2

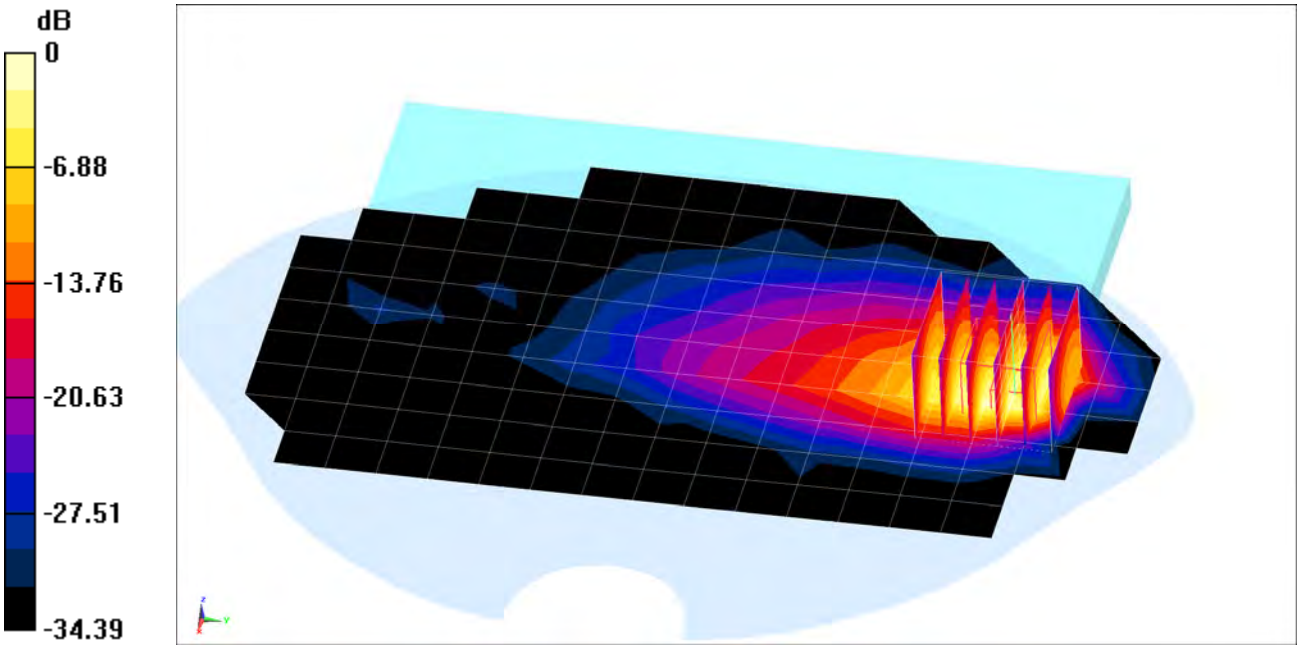
Communication System: UID 0, GSM1900 GPRS; 3 Tx slots; Frequency: 1909.8 MHz; Duty Cycle: 1:2.76
Medium: 1900 Body Medium parameters used:
f = 1910 MHz; σ = 1.594 S/m; ε_r = 52.415; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 10-14-2014; Ambient Temp: 24.9°C; Tissue Temp: 23.1°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 front; Type: QD000P40CD; Serial: TP-1646
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7164)

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

Area Scan (11x18x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (6x6x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 23.646 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 2.37 W/kg
SAR(1 g) = 1.01 W/kg



0 dB = 1.38 W/kg = 1.40 dBW/kg

DUT: A3LSC03G; Type: Portable Tablet; Serial: 1310-1

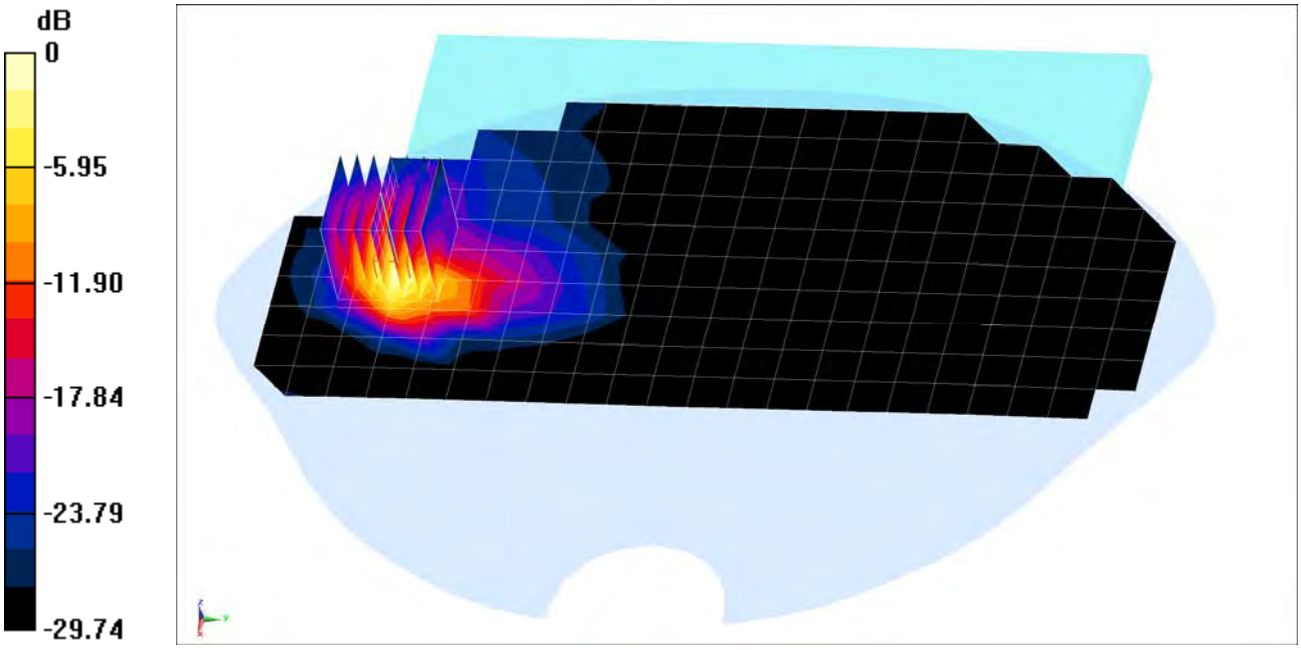
Communication System: UID 0, IEEE 802.11b; Frequency: 2437 MHz; Duty Cycle: 1:1
Medium: 2450 Body Medium parameters used (interpolated):
f = 2437 MHz; σ = 2.023 S/m; ε_r = 50.788; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 10-20-2014; Ambient Temp: 22.6°C; Tissue Temp: 21.9°C

Probe: ES3DV3 - SN3318; ConvF(4.15, 4.15, 4.15); Calibrated: 3/19/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 6/19/2014
Phantom: Main Twin Sam; Type: QD000P40CC; Serial: TP: 1375
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7164)

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

Area Scan (11x23x1): Measurement grid: dx=12mm, dy=12mm
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 21.776 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 3.40 W/kg
SAR(1 g) = 1.05 W/kg



0 dB = 1.65 W/kg = 2.17 dBW/kg

DUT: A3LSC03G; Type: Portable Tablet; Serial: 1310-3

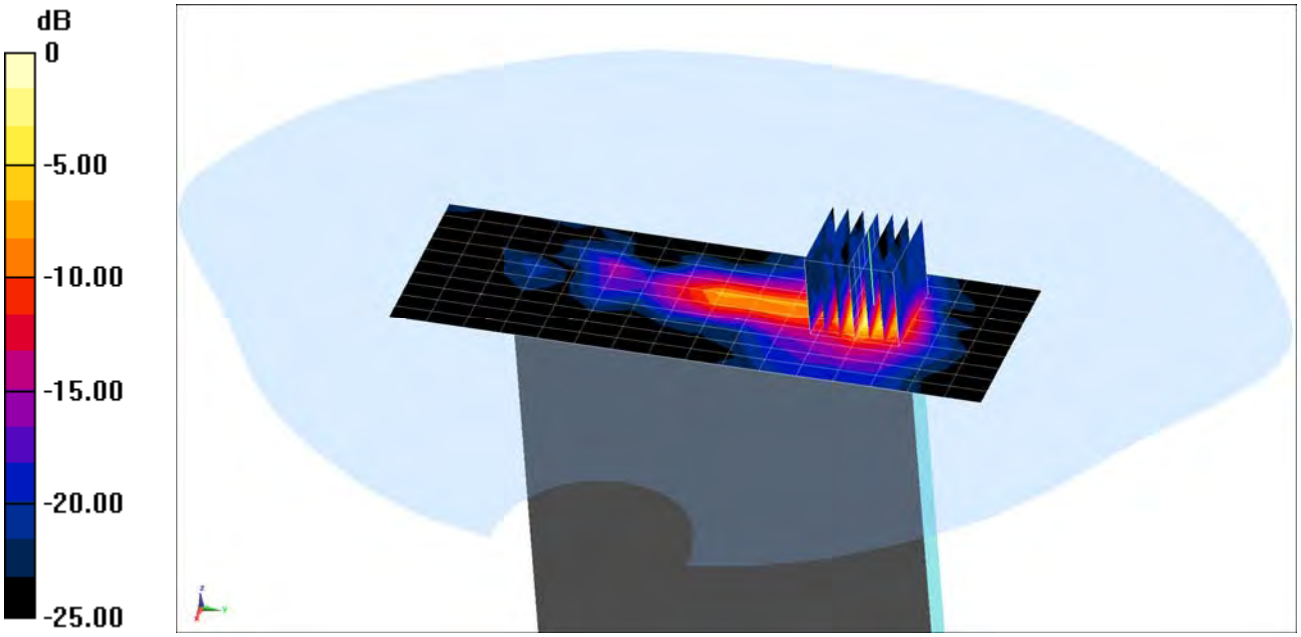
Communication System: UID 0, 802.11a 5.2-5.8 GHz Band; Frequency: 5765 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body Medium parameters used:
f = 5765 MHz; σ = 6.068 S/m; ε_r = 47.734; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 10-20-2014; Ambient Temp: 21.7°C; Tissue Temp: 20.6°C

Probe: EX3DV4 - SN3920; ConvF(4, 4, 4); Calibrated: 12/18/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn649; Calibrated: 12/12/2013
Phantom: SAM Sub with CRP v4.0; Type: QD000P40CC; Serial: TP:1357
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7164)

Mode: IEEE 802.11a, 5.8 GHz, Body SAR, Ch 153, 6 Mbps, Top Edge, Antenna 1

Area Scan (11x17x1): Measurement grid: dx=5mm, dy=10mm
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio = 1.4
Reference Value = 11.583 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 3.89 W/kg
SAR(1 g) = 0.686 W/kg



0 dB = 1.88 W/kg = 2.74 dBW/kg

DUT: A3LSC03G; Type: Portable Tablet; Serial: 1310-3

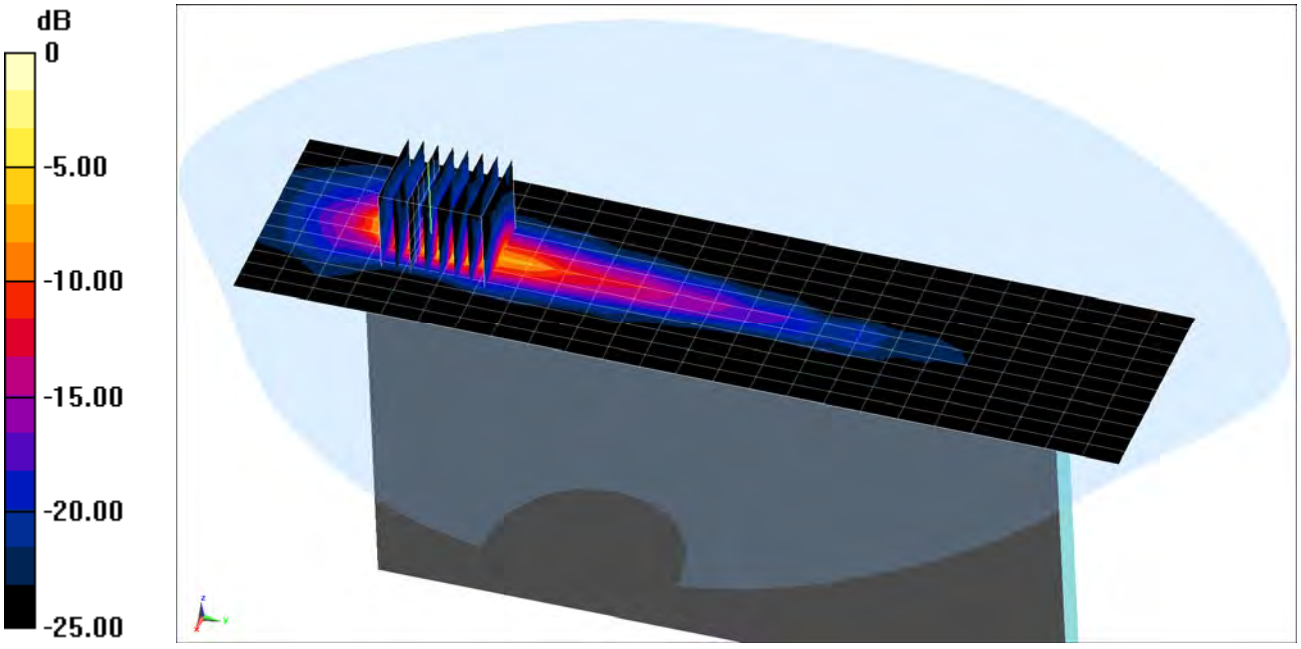
Communication System: UID 0, 802.11a 5.2-5.8 GHz Band; Frequency: 5280 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body Medium parameters used:
f = 5280 MHz; σ = 5.404 S/m; ε_r = 48.535; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 10-20-2014; Ambient Temp: 21.7°C; Tissue Temp: 20.6°C

Probe: EX3DV4 - SN3920; ConvF(4.11, 4.11, 4.11); Calibrated: 12/18/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn649; Calibrated: 12/12/2013
Phantom: SAM Sub with CRP v4.0; Type: QD000P40CC; Serial: TP:1357
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7164)

Mode: IEEE 802.11a, 5.3 GHz, Body SAR, Ch 56, 6 Mbps, Right Edge, Antenna 2

Area Scan (13x25x1): Measurement grid: dx=5mm, dy=10mm
Zoom Scan (7x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio = 1.4
Reference Value = 15.192 V/m; Power Drift = -0.18 dB
Peak SAR (extrapolated) = 6.26 W/kg
SAR(1 g) = 1.07 W/kg



0 dB = 3.31 W/kg = 5.20 dBW/kg

APPENDIX B: SYSTEM VERIFICATION

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DUT: SAR Dipole 835 MHz; Type: D835V2; Serial: 4d132

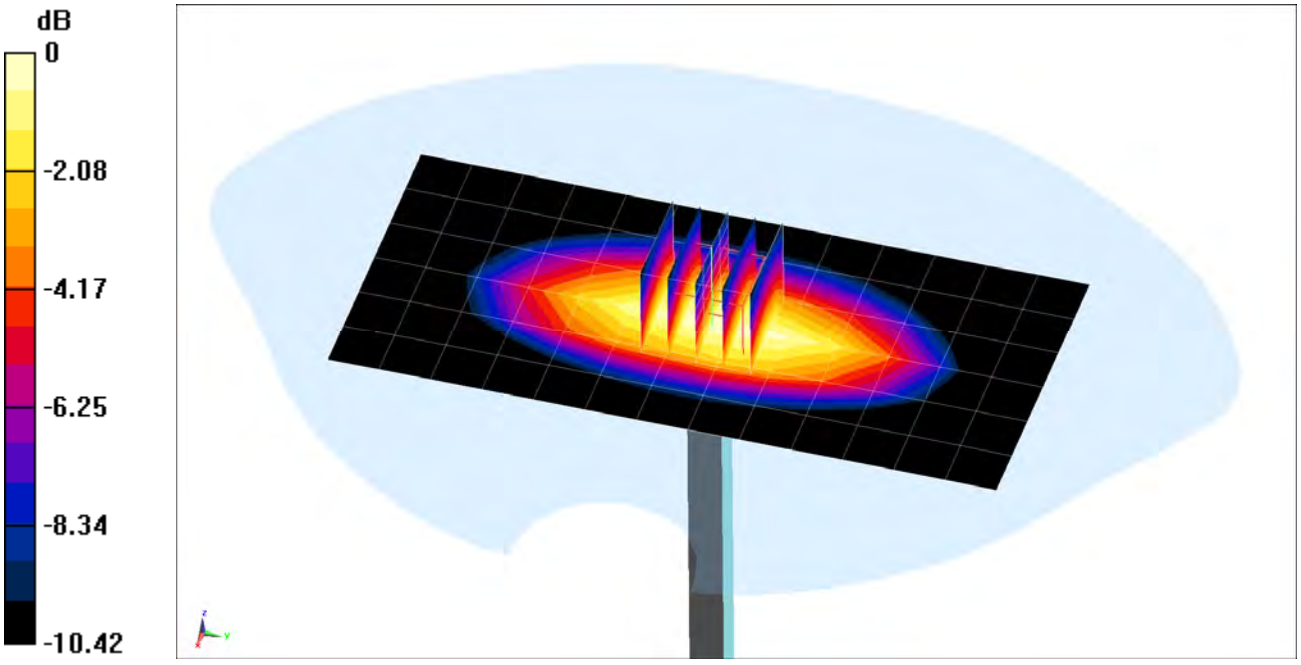
Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1
Medium: 835 Body Medium parameters used:
f = 835 MHz; σ = 0.952 S/m; ε_r = 54.062; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.5 cm

Test Date: 10-15-2014; Ambient Temp: 21.7°C; Tissue Temp: 20.6°C

Probe: ES3DV3 - SN3213; ConvF(6.18, 6.18, 6.18); Calibrated: 4/11/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1407; Calibrated: 11/18/2013
Phantom: Sub TWIN SAM; Type: QD000P40CC; Serial: TP-1357
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7164)

835 MHz System Verification

Area Scan (7x14x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 1.36 W/kg
SAR(1 g) = 0.929 W/kg
Deviation = -3.03%



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

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

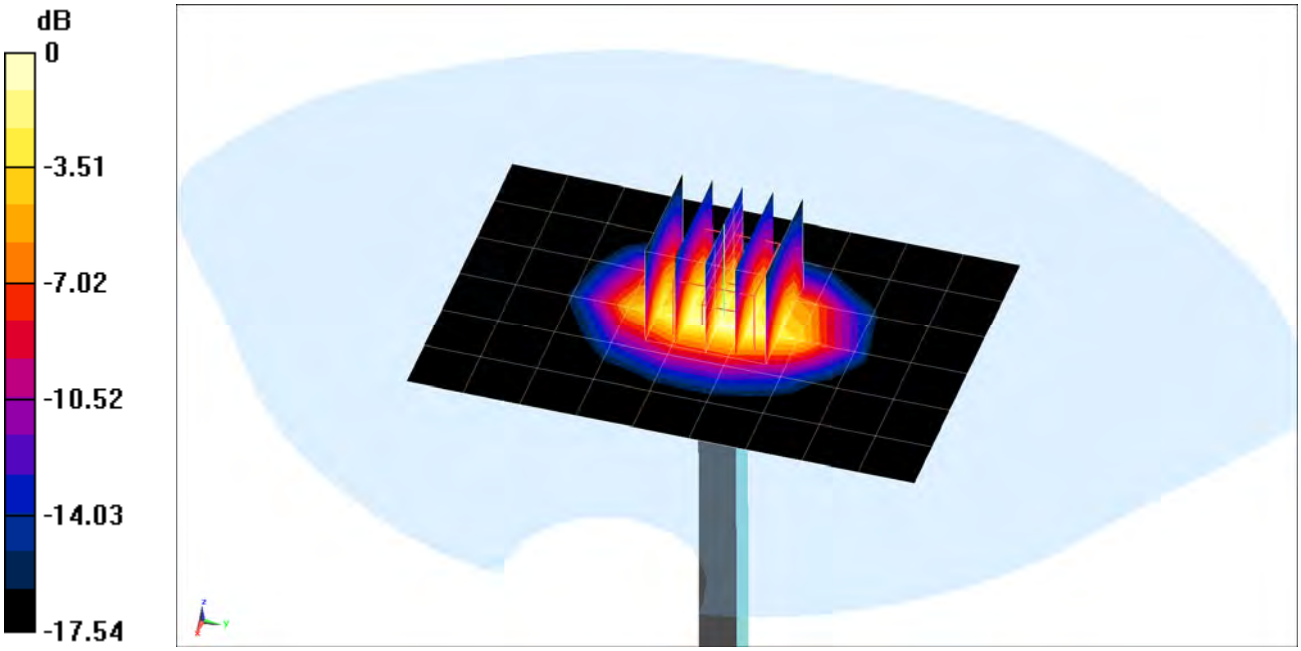
Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium: 1900 Body Medium parameters used (interpolated):
$f = 1900$ MHz; $\sigma = 1.583$ S/m; $\varepsilon_r = 52.453$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-14-2014; Ambient Temp: 24.9°C; Tissue Temp: 23.1°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 front; Type: QD000P40CD; Serial: TP-1646
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7164)

1900 MHz System Verification

Area Scan (7x10x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 7.58 W/kg
SAR(1 g) = 4.25 W/kg
Deviation = 4.68%



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

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

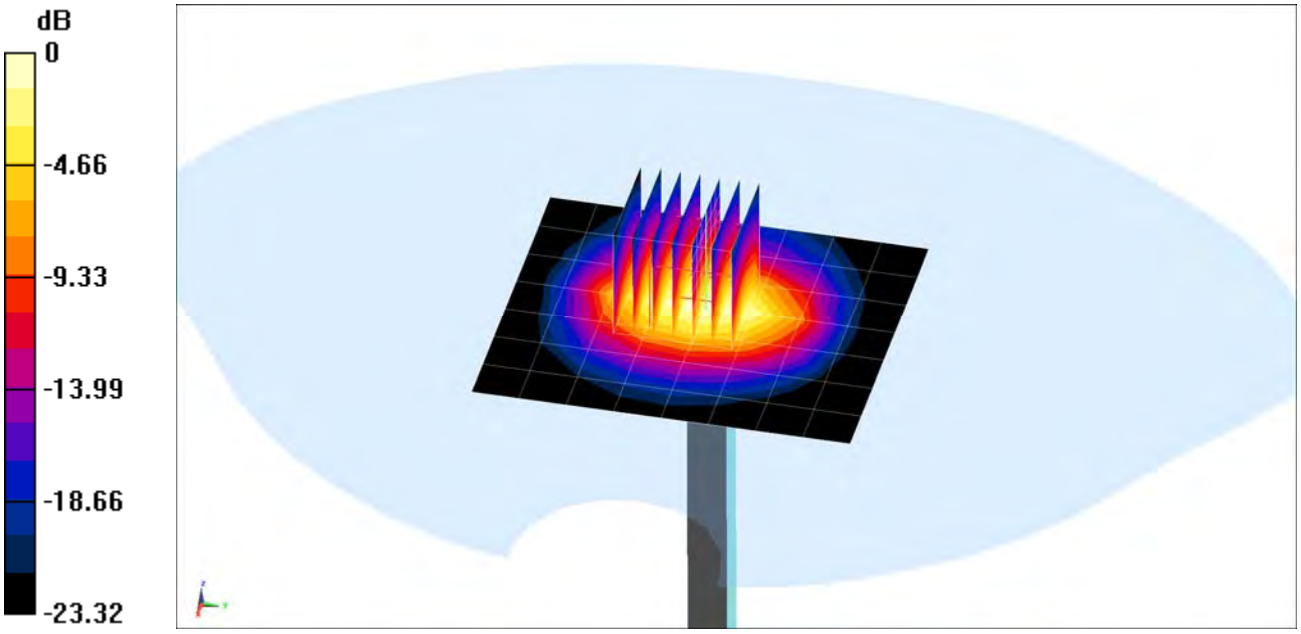
Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: 2450 Body Medium parameters used:
f = 2450 MHz; σ = 2.039 S/m; ε_r = 50.743; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-20-2014; Ambient Temp: 22.6°C; Tissue Temp: 21.9°C

Probe: ES3DV3 - SN3318; ConvF(4.15, 4.15, 4.15); Calibrated: 3/19/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 6/19/2014
Phantom: Main Twin Sam; Type: QD000P40CC; Serial: TP: 1375
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7164)

2450 MHz System Verification

Area Scan (8x9x1): Measurement grid: dx=12mm, dy=12mm
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 11.9 W/kg
SAR(1 g) = 5.33 W/kg
Deviation = 7.68%



0 dB = 7.03 W/kg = 8.47 dBW/kg

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

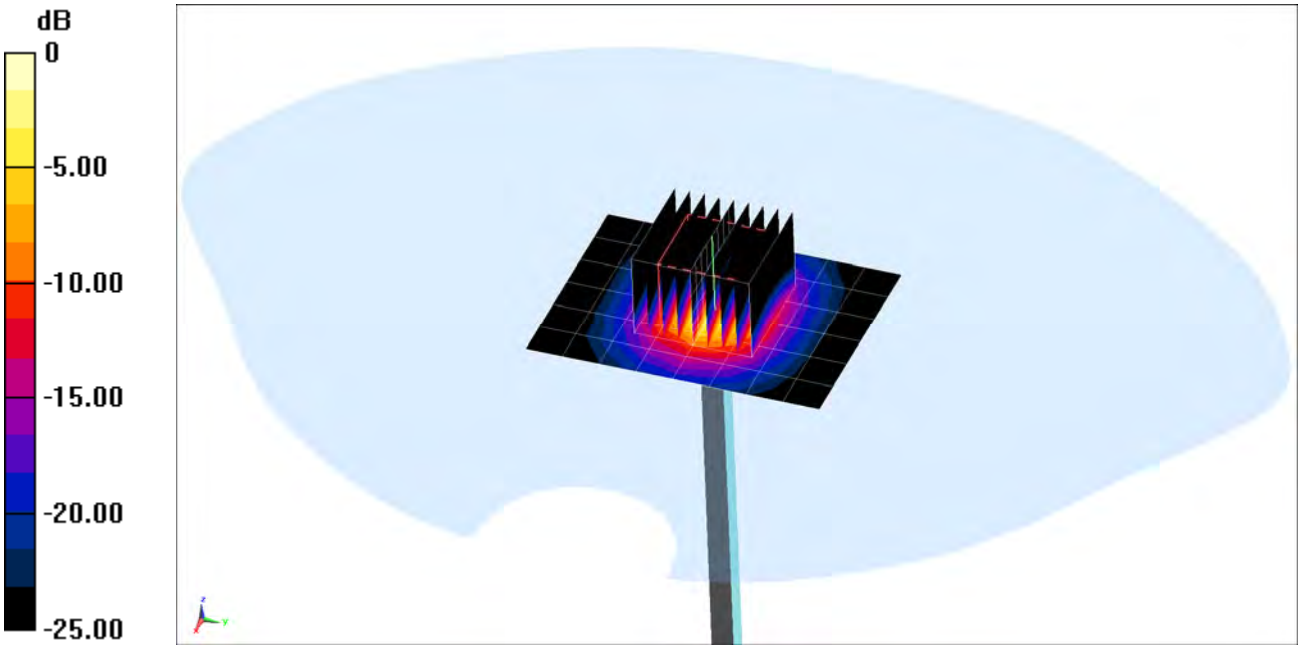
Communication System: UID 0, CW; Frequency: 5200 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body Medium parameters used:
f = 5200 MHz; σ = 5.286 S/m; ε_r = 48.674; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-20-2014; Ambient Temp: 21.7°C; Tissue Temp: 20.6°C

Probe: EX3DV4 - SN3920; ConvF(4.23, 4.23, 4.23); Calibrated: 12/18/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn649; Calibrated: 12/12/2013
Phantom: SAM Sub with CRP v4.0; Type: QD000P40CC; Serial: TP:1357
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7164)

5200MHz System Verification

Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm
Zoom Scan (9x9x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio = 1.4
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 30.2 W/kg
SAR(1 g) = 7.51 W/kg
Deviation = 1.49%



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

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

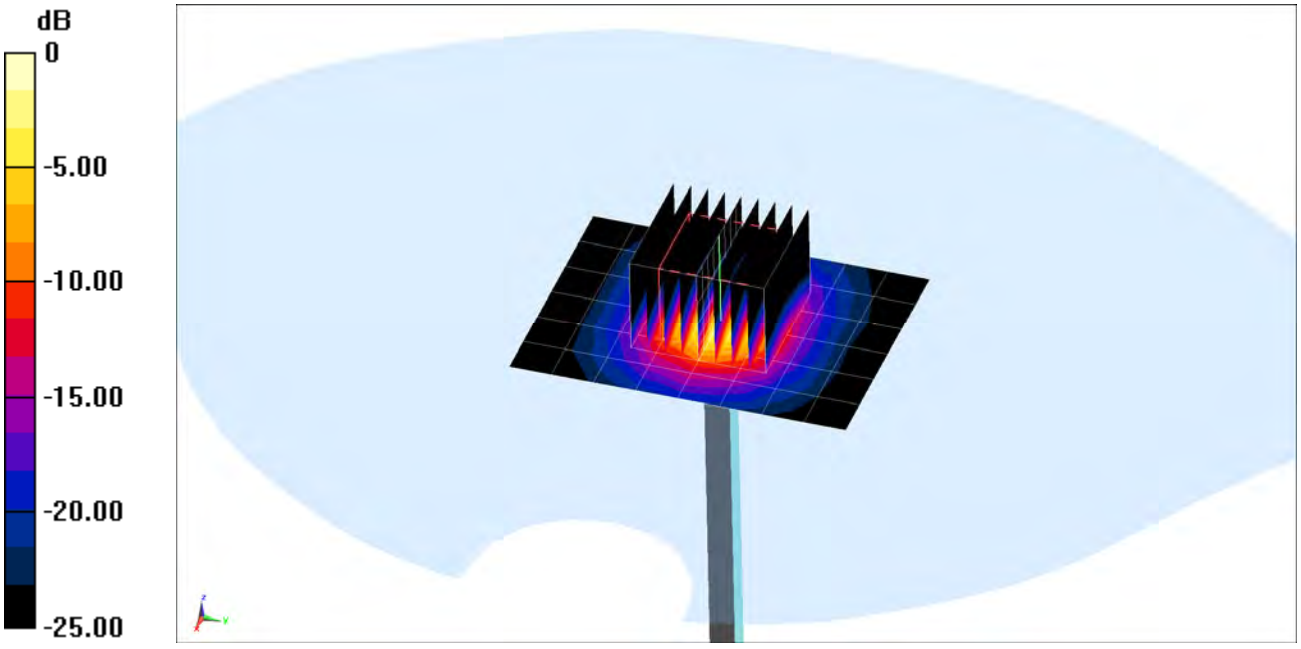
Communication System: UID 0, CW; Frequency: 5300 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body Medium parameters used:
f = 5300 MHz; σ = 5.417 S/m; ε_r = 48.492; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-20-2014; Ambient Temp: 21.7°C; Tissue Temp: 20.6°C

Probe: EX3DV4 - SN3920; ConvF(4.11, 4.11, 4.11); Calibrated: 12/18/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn649; Calibrated: 12/12/2013
Phantom: SAM Sub with CRP v4.0; Type: QD000P40CC; Serial: TP:1357
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7164)

5300 MHz System Verification

Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm
Zoom Scan (9x9x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio = 1.4
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 31.9 W/kg
SAR(1 g) = 7.7 W/kg
Deviation = 1.58%



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

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

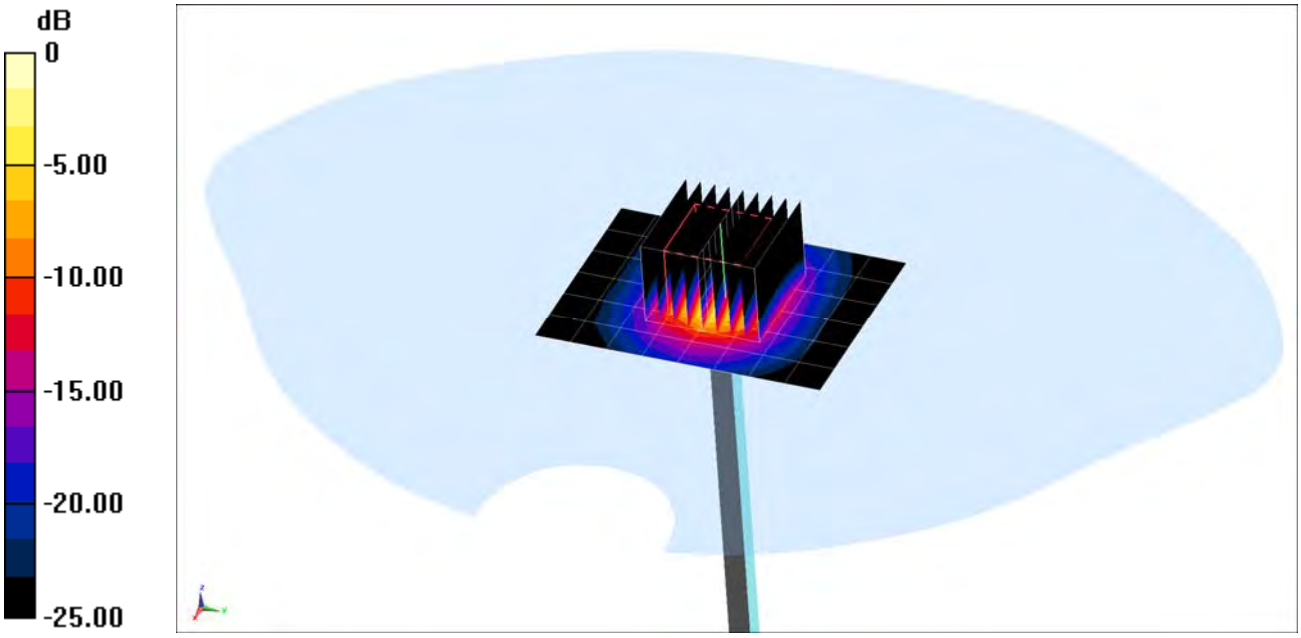
Communication System: UID 0, CW; Frequency: 5500 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body Medium parameters used:
f = 5500 MHz; σ = 5.677 S/m; ε_r = 48.028; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-20-2014; Ambient Temp: 21.7°C; Tissue Temp: 20.6°C

Probe: EX3DV4 - SN3920; ConvF(3.8, 3.8, 3.8); Calibrated: 12/18/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn649; Calibrated: 12/12/2013
Phantom: SAM Sub with CRP v4.0; Type: QD000P40CC; Serial: TP:1357
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7164)

5500MHz System Verification

Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm
Zoom Scan (9x9x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio = 1.4
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 34.7 W/kg
SAR(1 g) = 7.9 W/kg
Deviation = -0.25%



0 dB = 20.7 W/kg = 13.16 dBW/kg

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

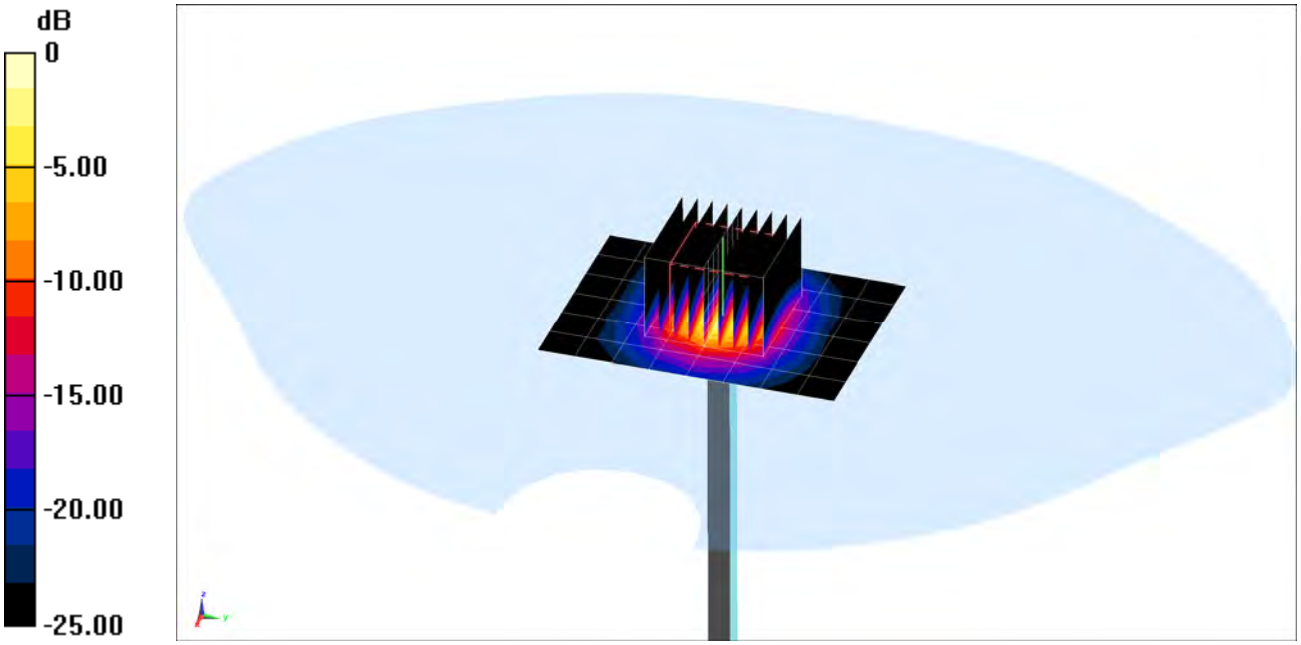
Communication System: UID 0, CW; Frequency: 5600 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body Medium parameters used:
f = 5600 MHz; σ = 5.824 S/m; ε_r = 47.875; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-20-2014; Ambient Temp: 21.7°C; Tissue Temp: 20.6°C

Probe: EX3DV4 - SN3920; ConvF(3.62, 3.62, 3.62); Calibrated: 12/18/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn649; Calibrated: 12/12/2013
Phantom: SAM Sub with CRP v4.0; Type: QD000P40CC; Serial: TP:1357
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7164)

5600MHz System Verification

Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm
Zoom Scan (9x9x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio = 1.4
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 36.7 W/kg
SAR(1 g) = 8.14 W/kg
Deviation = 2.52%



0 dB = 21.5 W/kg = 13.32 dBW/kg

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

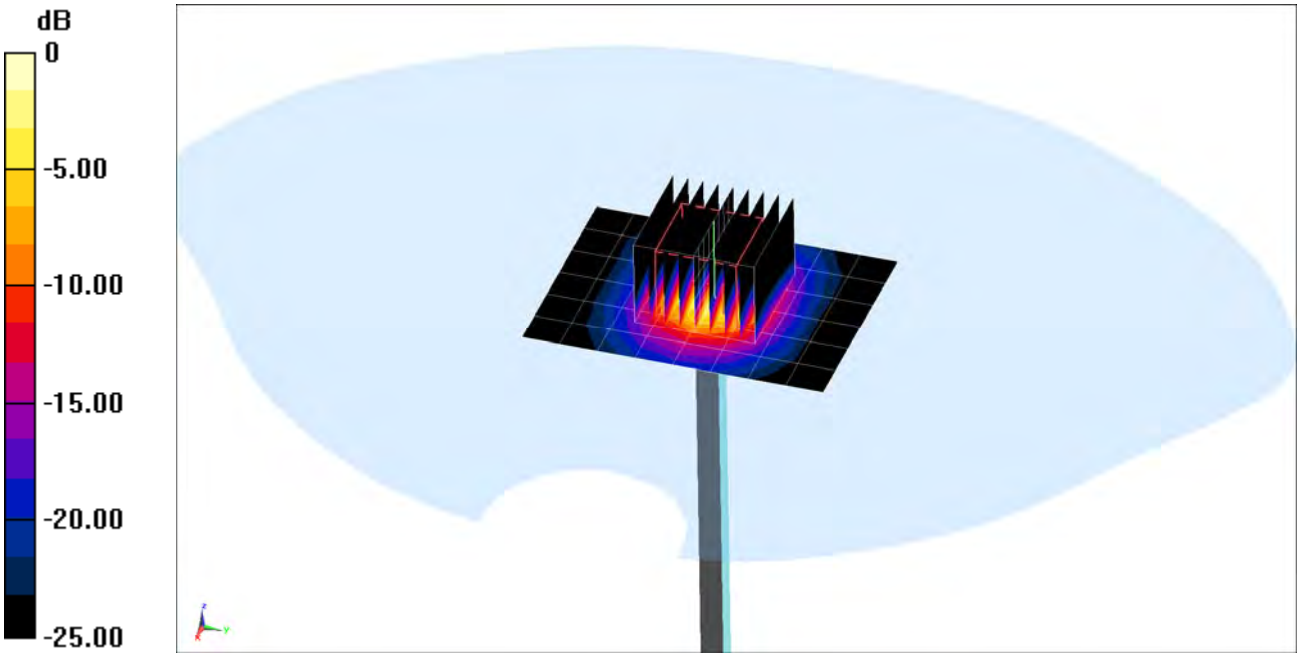
Communication System: UID 0, CW; Frequency: 5800 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body Medium parameters used:
f = 5800 MHz; σ = 6.121 S/m; ε_r = 47.717; ρ = 1000 kg/m^3
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-20-2014; Ambient Temp: 21.7°C; Tissue Temp: 20.6°C

Probe: EX3DV4 - SN3920; ConvF(4, 4, 4); Calibrated: 12/18/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn649; Calibrated: 12/12/2013
Phantom: SAM Sub with CRP v4.0; Type: QD000P40CC; Serial: TP:1357
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7164)

5800 MHz System Verification

Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm
Zoom Scan (9x9x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio = 1.4
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 35.4 W/kg
SAR(1 g) = 7.52 W/kg
Deviation = 1.08%



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

APPENDIX C: PROBE CALIBRATION

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
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: ES3-3213_Apr14

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

CCV 5/7/14

Calibration date: April 11, 2014

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

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

Calibration Equipment used (M&TE critical for calibration)

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

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: April 14, 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:3213

Manufactured: October 14, 2008
Calibrated: April 11, 2014

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]	1.47	1.36	1.32	± 10.1 %
DCP (mV)[B]	102.9	101.6	102.7	

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	197.4	±3.8 %
		Y	0.0	0.0	1.0		219.1	
		Z	0.0	0.0	1.0		195.3	
10010-CAA	SAR Validation (Square, 100ms, 10ms)	X	5.05	68.5	14.4	10.00	41.4	±0.9 %
		Y	9.83	75.4	16.6		39.8	
		Z	10.63	76.7	17.0		40.3	
10011-CAB	UMTS-FDD (WCDMA)	X	3.25	67.1	18.8	2.91	135.4	±0.5 %
		Y	3.21	66.6	18.4		131.4	
		Z	3.43	68.3	19.4		133.5	
10012-CAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	X	3.39	71.8	20.4	1.87	137.8	±0.7 %
		Y	2.98	69.1	19.1		133.1	
		Z	3.26	71.3	20.3		133.8	
10021-DAB	GSM-FDD (TDMA, GMSK)	X	22.08	99.1	27.6	9.39	143.1	±2.2 %
		Y	21.57	99.6	28.2		141.4	
		Z	13.61	90.9	24.9		137.1	
10023-DAB	GPRS-FDD (TDMA, GMSK, TN 0)	X	16.13	94.0	26.2	9.57	133.8	±1.9 %
		Y	22.39	99.7	28.1		137.8	
		Z	18.99	97.5	27.4		129.2	
10024-DAB	GPRS-FDD (TDMA, GMSK, TN 0-1)	X	21.23	93.4	23.4	6.56	148.9	±1.9 %
		Y	33.62	99.9	25.4		148.5	
		Z	32.72	99.7	25.1		141.6	
10027-DAB	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	X	49.20	99.7	23.0	4.80	138.6	±2.5 %
		Y	40.22	99.8	23.9		134.7	
		Z	43.82	99.8	23.4		131.9	
10028-DAB	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	X	50.05	99.8	22.4	3.55	146.5	±2.2 %
		Y	51.41	99.6	22.3		144.4	
		Z	46.36	99.5	22.4		140.0	
10032-CAA	IEEE 802.15.1 Bluetooth (GFSK, DH5)	X	40.43	99.5	20.4	1.16	135.1	±1.7 %
		Y	24.55	99.5	21.7		133.5	
		Z	32.87	99.9	21.0		131.0	
10039-CAB	CDMA2000 (1xRTT, RC1)	X	4.69	66.6	19.0	4.57	133.4	±0.9 %
		Y	4.76	66.9	19.3		133.2	
		Z	4.71	66.8	19.2		130.1	

10081-CAB	CDMA2000 (1xRTT, RC3)	X	3.87	66.1	18.6	3.97	129.0	±0.7 %
		Y	3.89	66.1	18.7		129.6	
		Z	3.97	66.6	19.0		146.7	
10098-CAB	UMTS-FDD (HSUPA, Subtest 2)	X	4.59	66.8	18.8	3.98	141.1	±0.7 %
		Y	4.64	67.0	19.0		140.0	
		Z	4.67	67.2	19.1		138.5	
10100-CAB	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	6.52	68.0	20.1	5.67	147.5	±1.4 %
		Y	6.61	68.3	20.4		148.5	
		Z	6.51	68.0	20.1		145.4	
10108-CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	6.39	67.5	19.9	5.80	145.2	±1.4 %
		Y	6.44	67.8	20.2		145.8	
		Z	6.41	67.7	20.1		145.5	
10110-CAB	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK)	X	6.02	66.7	19.5	5.75	141.3	±1.4 %
		Y	6.10	67.2	20.0		141.0	
		Z	6.05	67.0	19.8		141.2	
10114-CAA	IEEE 802.11n (HT Greenfield, 13.5 Mbps, BPSK)	X	10.19	68.9	21.4	8.10	135.6	±2.2 %
		Y	10.43	69.6	21.9		135.7	
		Z	10.21	69.0	21.5		134.5	
10117-CAA	IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK)	X	10.17	68.9	21.3	8.07	137.7	±2.5 %
		Y	10.45	69.6	21.9		137.2	
		Z	10.22	69.1	21.5		136.9	
10151-CAB	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	9.70	74.8	25.8	9.28	133.6	±3.0 %
		Y	9.81	75.7	26.7		130.1	
		Z	9.49	74.4	25.7		131.6	
10154-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	6.07	67.0	19.7	5.75	142.9	±1.4 %
		Y	6.19	67.6	20.2		145.4	
		Z	6.06	67.0	19.8		141.7	
10160-CAB	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK)	X	6.50	67.5	19.9	5.82	148.5	±1.4 %
		Y	6.35	67.0	19.7		127.0	
		Z	6.52	67.6	20.0		147.9	
10169-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	5.00	66.8	19.8	5.73	145.4	±1.4 %
		Y	5.13	67.5	20.4		148.9	
		Z	5.06	67.3	20.2		144.8	
10172-CAB	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	9.02	79.7	28.5	9.21	148.9	±3.0 %
		Y	8.14	77.1	27.6		125.0	
		Z	8.82	79.5	28.6		147.1	
10175-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	5.05	67.2	20.0	5.72	146.2	±1.4 %
		Y	5.14	67.6	20.4		145.9	
		Z	5.00	67.1	20.1		140.8	
10181-CAB	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	X	5.07	67.2	20.0	5.72	149.7	±1.4 %
		Y	5.15	67.6	20.4		146.0	
		Z	5.00	67.0	20.0		141.0	

10193-CAA	IEEE 802.11n (HT Greenfield, 6.5 Mbps, BPSK)	X	9.92	68.8	21.4	8.09	135.2	±2.2 %
		Y	10.06	69.3	21.8		130.6	
		Z	9.78	68.4	21.2		126.9	
10196-CAA	IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK)	X	9.93	68.9	21.4	8.10	136.4	±2.2 %
		Y	10.06	69.3	21.9		131.1	
		Z	9.84	68.7	21.4		128.8	
10219-CAA	IEEE 802.11n (HT Mixed, 7.2 Mbps, BPSK)	X	9.81	68.8	21.4	8.03	135.3	±2.2 %
		Y	9.95	69.3	21.8		130.1	
		Z	9.71	68.5	21.2		127.4	
10222-CAA	IEEE 802.11n (HT Mixed, 15 Mbps, BPSK)	X	10.24	69.1	21.5	8.06	141.2	±2.2 %
		Y	10.45	69.7	22.0		136.8	
		Z	10.13	68.9	21.4		133.6	
10225-CAB	UMTS-FDD (HSPA+)	X	6.95	66.9	19.5	5.97	137.9	±1.4 %
		Y	7.03	67.2	19.8		133.2	
		Z	6.92	66.9	19.5		130.6	
10237-CAB	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	8.08	76.6	27.0	9.21	127.8	±3.0 %
		Y	10.15	84.0	31.2		149.6	
		Z	8.67	79.0	28.3		145.4	
10252-CAB	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	8.92	73.6	25.3	9.24	126.0	±3.5 %
		Y	9.19	75.1	26.5		124.0	
		Z	9.66	76.2	26.8		149.1	
10267-CAB	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	9.59	74.5	25.7	9.30	131.9	±3.0 %
		Y	9.87	75.8	26.8		130.6	
		Z	9.36	73.9	25.5		127.8	
10274-CAB	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.10)	X	5.84	66.6	18.8	4.87	128.6	±0.9 %
		Y	5.87	66.7	19.0		128.8	
		Z	6.08	67.6	19.4		149.9	
10275-CAB	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.4)	X	4.35	66.6	18.8	3.96	134.0	±0.9 %
		Y	4.46	67.0	19.1		138.5	
		Z	4.39	66.8	19.0		129.4	
10291-AAB	CDMA2000, RC3, SO55, Full Rate	X	3.72	67.5	19.2	3.46	149.2	±0.7 %
		Y	3.66	67.1	19.1		129.6	
		Z	3.72	67.6	19.3		143.2	
10292-AAB	CDMA2000, RC3, SO32, Full Rate	X	3.54	66.9	18.8	3.39	128.3	±0.5 %
		Y	3.61	67.2	19.1		130.4	
		Z	3.69	67.8	19.4		146.2	
10297-AAA	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	6.38	67.4	19.9	5.81	145.8	±1.4 %
		Y	6.50	68.0	20.4		148.6	
		Z	6.35	67.4	19.9		140.8	
10311-AAA	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK)	X	6.70	67.2	19.7	6.06	127.8	±1.4 %
		Y	6.85	67.7	20.3		130.2	
		Z	6.98	68.2	20.4		147.9	

10315-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 96pc duty cycle)	X	2.82	69.1	19.2	1.71	135.1	±0.7 %
		Y	2.92	69.5	19.6		136.9	
		Z	3.22	71.8	20.6		130.9	
10403-AAB	CDMA2000 (1xEV-DO, Rev. 0)	X	4.77	68.3	18.9	3.76	140.0	±0.5 %
		Y	4.80	68.4	19.1		141.4	
		Z	4.86	68.9	19.3		134.8	
10404-AAB	CDMA2000 (1xEV-DO, Rev. A)	X	4.61	68.0	18.8	3.77	138.2	±0.7 %
		Y	4.67	68.2	19.0		139.3	
		Z	4.69	68.5	19.1		133.9	

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

[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: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	6.58	6.58	6.58	0.34	1.79	± 12.0 %
835	41.5	0.90	6.37	6.37	6.37	0.29	1.94	± 12.0 %
1750	40.1	1.37	5.18	5.18	5.18	0.79	1.17	± 12.0 %
1900	40.0	1.40	4.99	4.99	4.99	0.57	1.36	± 12.0 %
2450	39.2	1.80	4.40	4.40	4.40	0.78	1.28	± 12.0 %
2600	39.0	1.96	4.25	4.25	4.25	0.77	1.23	± 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.

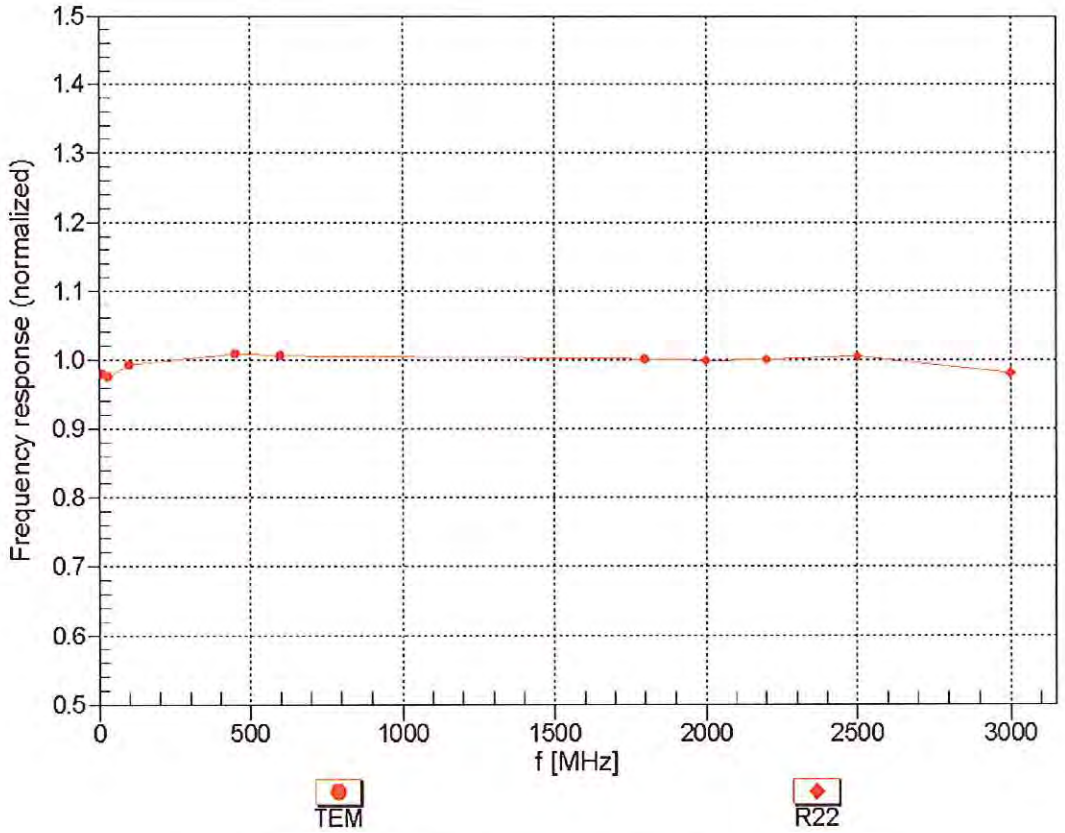
DASY/EASY - Parameters of Probe: ES3DV3 - SN:3213

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	6.21	6.21	6.21	0.77	1.19	± 12.0 %
835	55.2	0.97	6.18	6.18	6.18	0.54	1.37	± 12.0 %
1750	53.4	1.49	4.89	4.89	4.89	0.73	1.27	± 12.0 %
1900	53.3	1.52	4.68	4.68	4.68	0.47	1.70	± 12.0 %
2450	52.7	1.95	4.26	4.26	4.26	0.70	1.16	± 12.0 %
2600	52.5	2.16	4.05	4.05	4.05	0.67	1.00	± 12.0 %

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

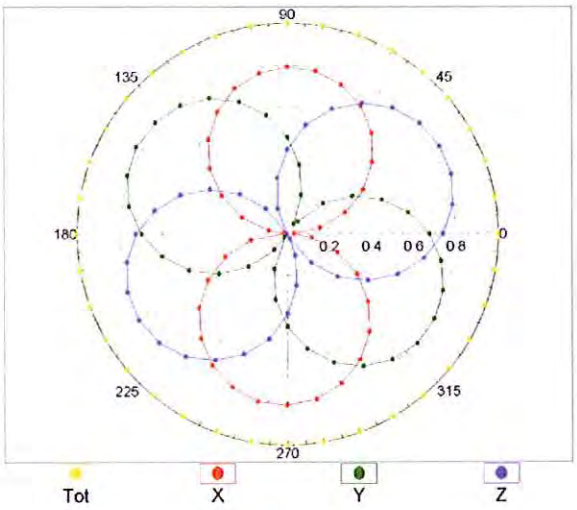
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



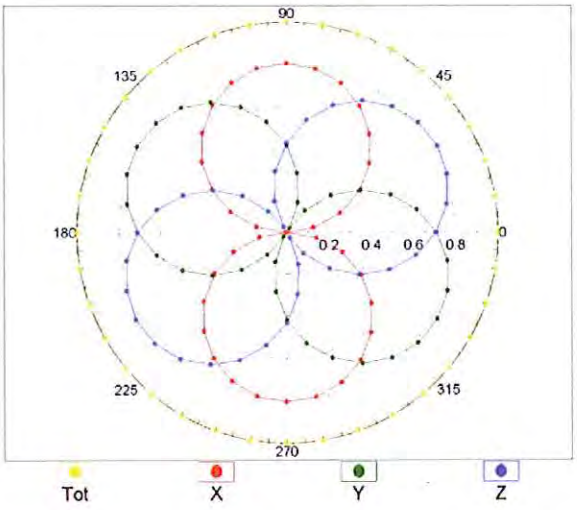
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

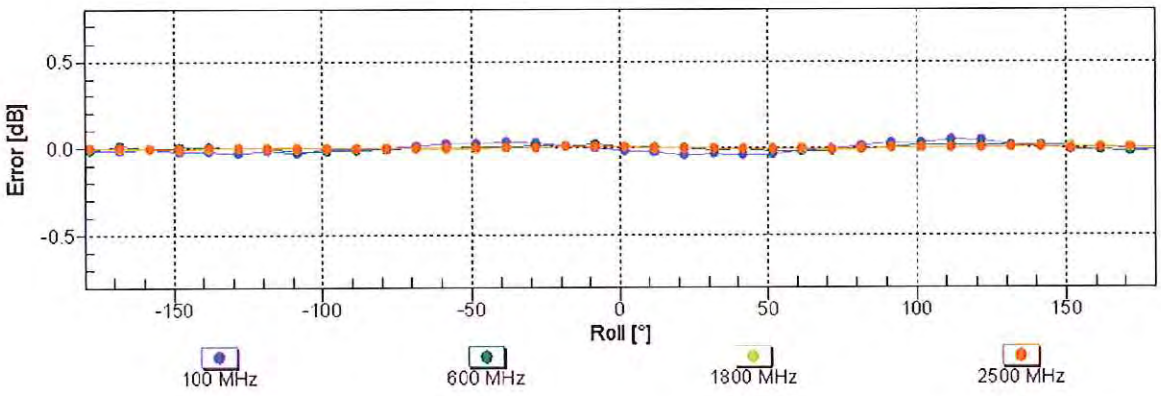
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



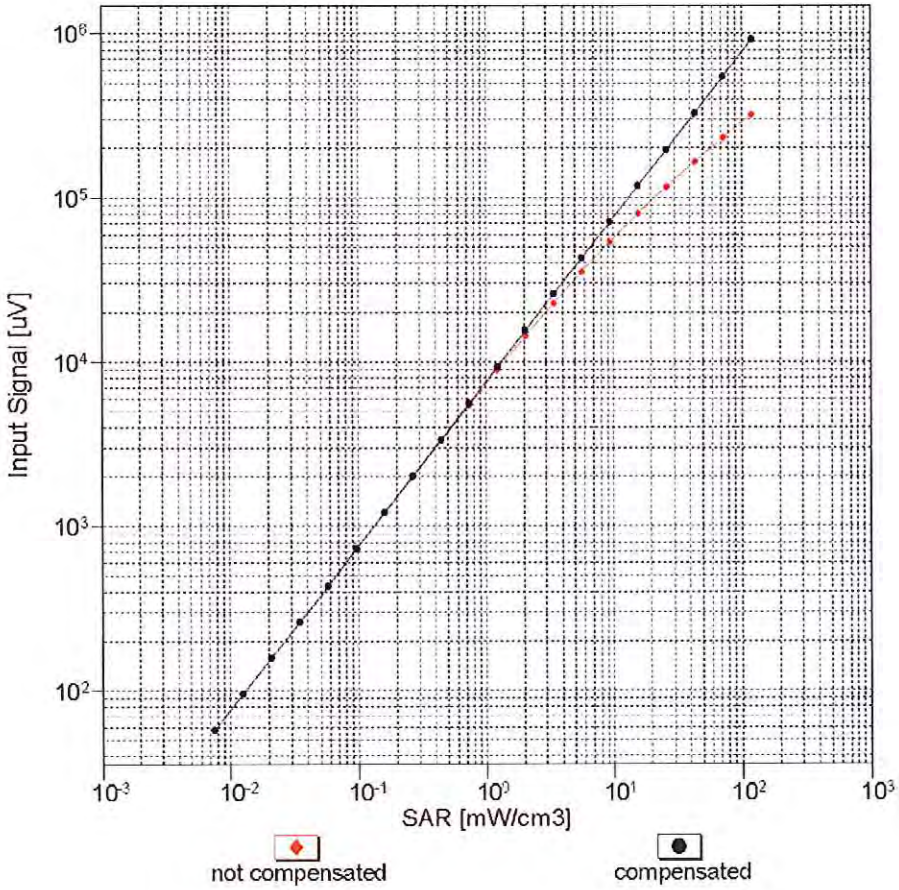
f=1800 MHz,R22

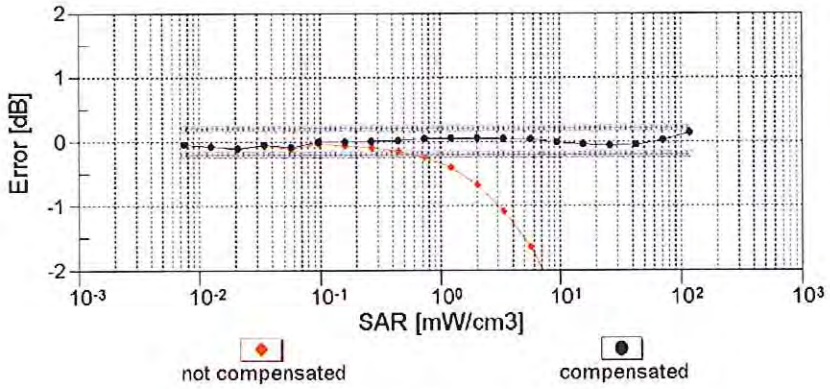




Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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

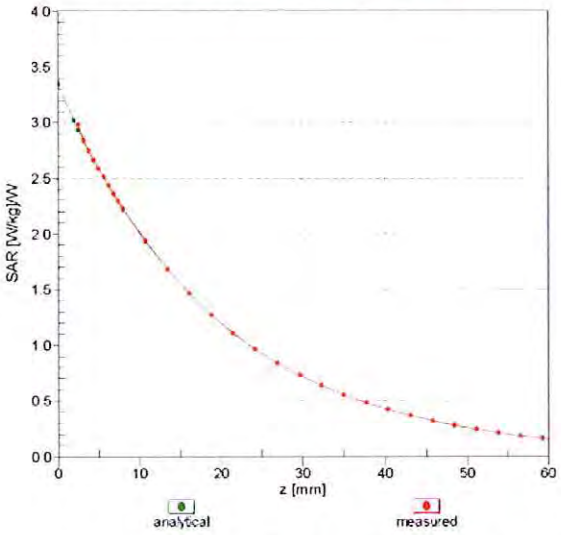




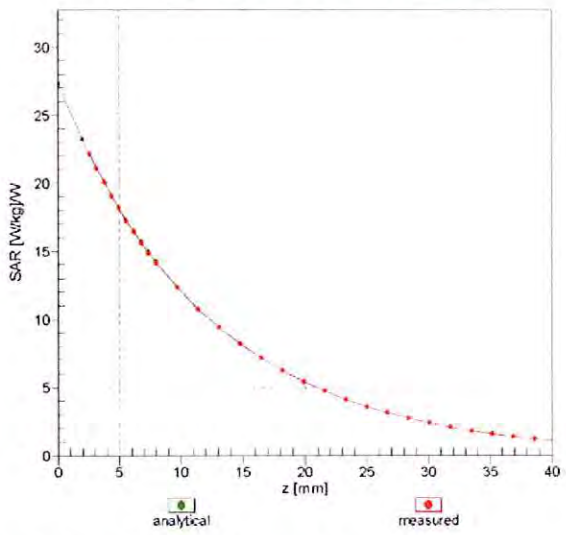
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

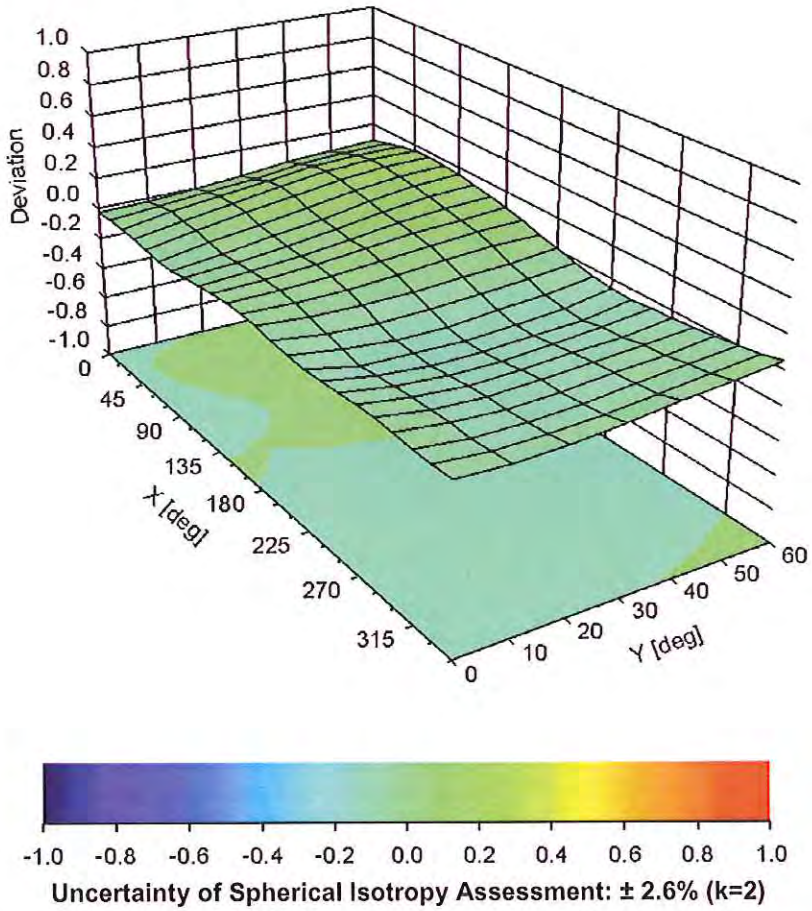


f = 1900 MHz,WGLS R22 (H_convF)



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 (°)	-68.3
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
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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

CC✓ 7/17/14

Calibration date: May 15, 2014

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

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

Calibration Equipment used (M&TE critical for calibration)

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

	Name	Function	Signature
Calibrated by:	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.

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

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

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.

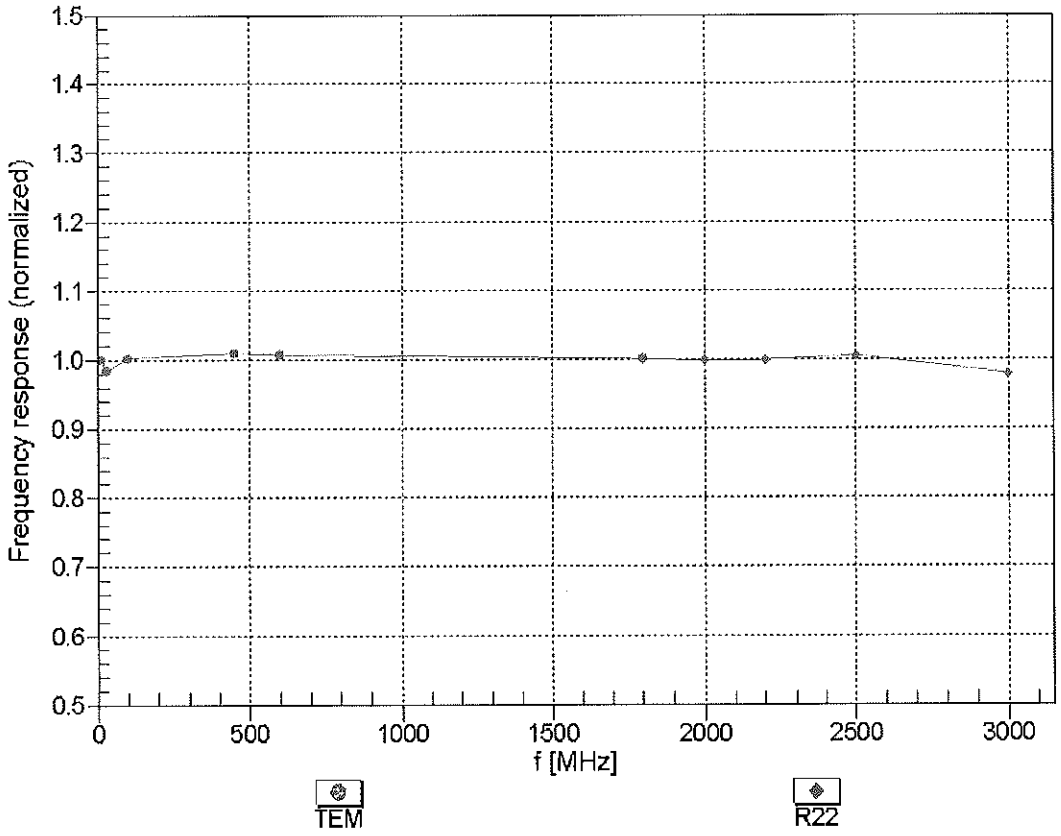
DASY/EASY - Parameters of Probe: ES3DV3 - SN:3263

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.

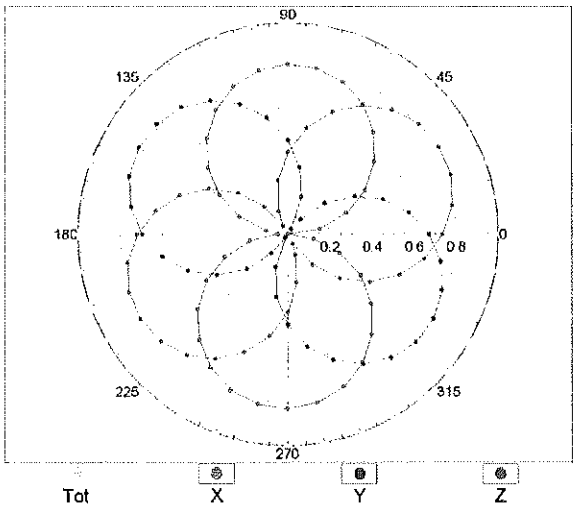
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



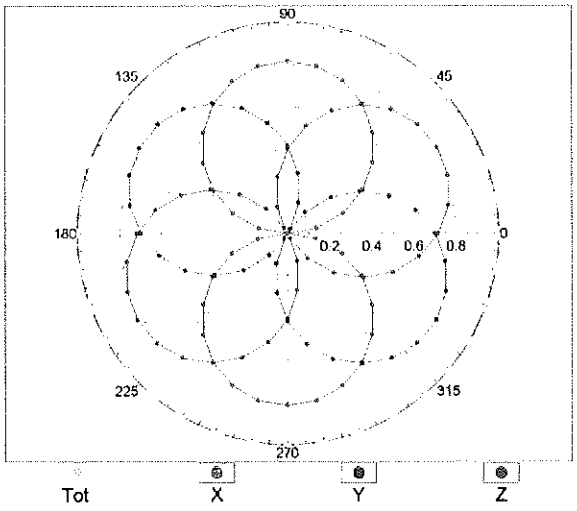
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

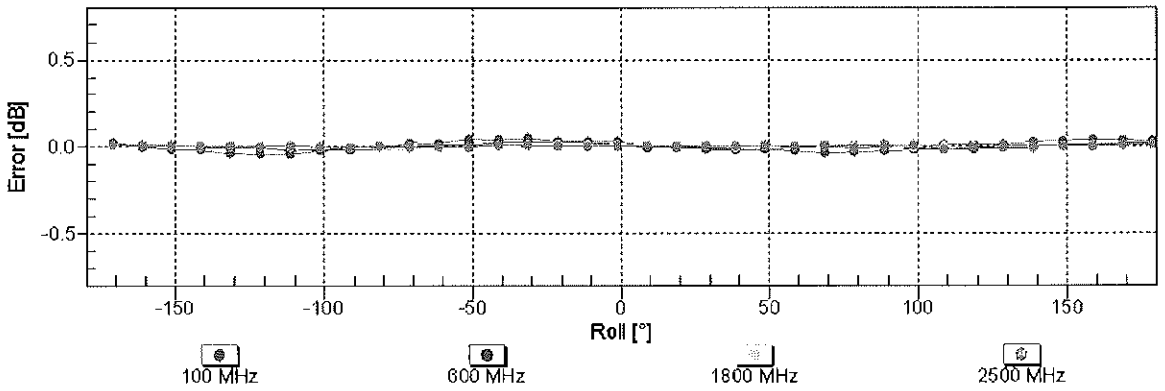
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



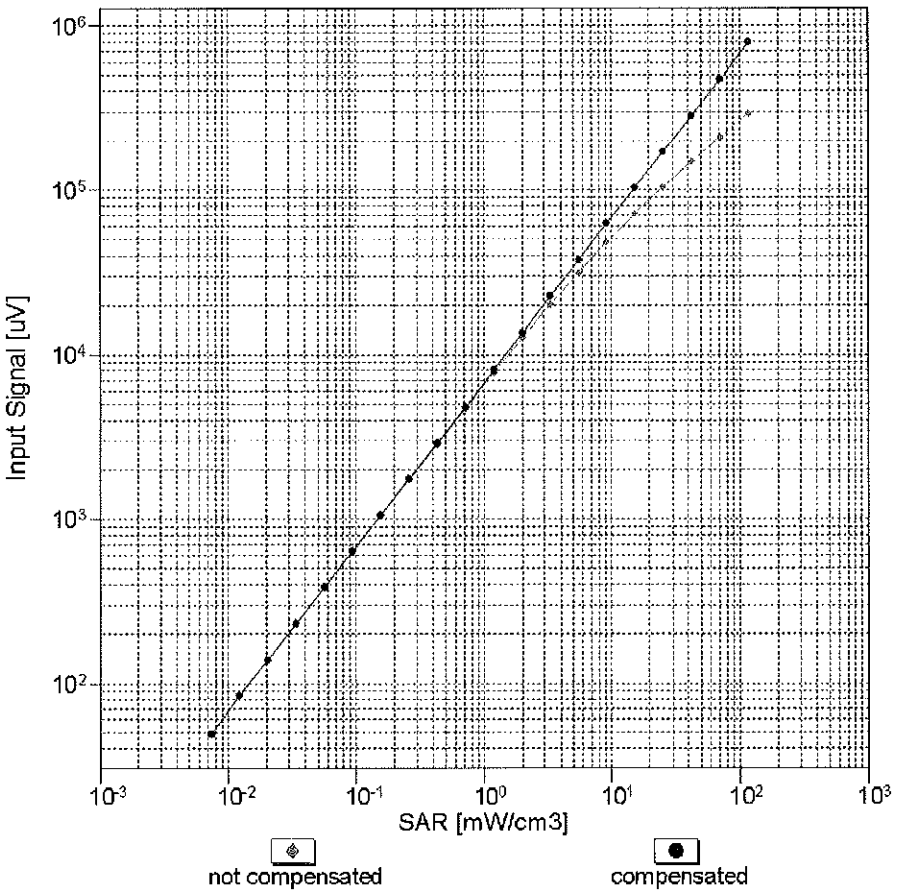
f=1800 MHz,R22

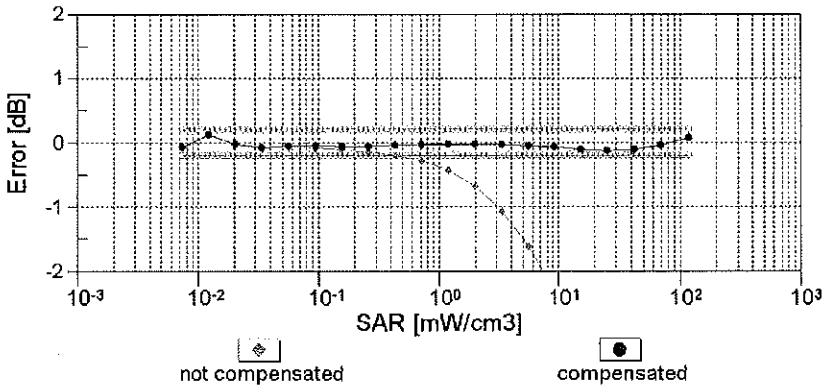




Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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

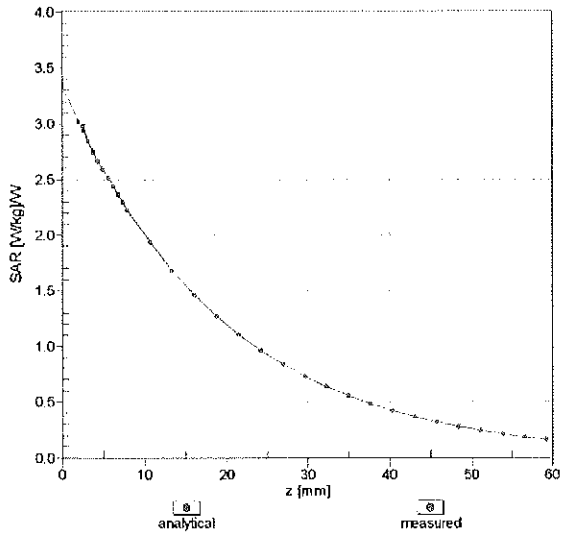




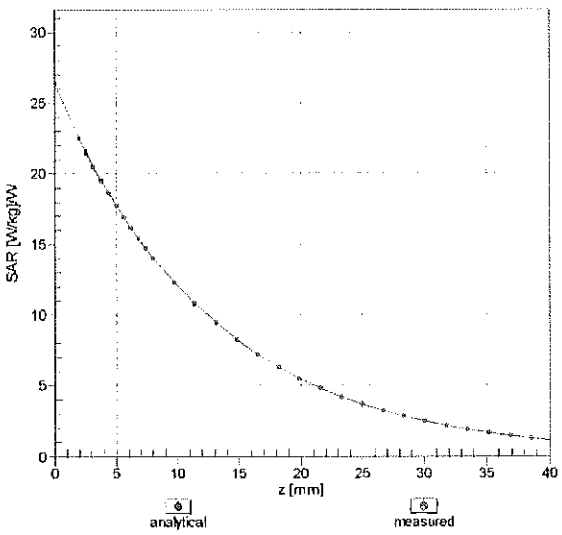
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

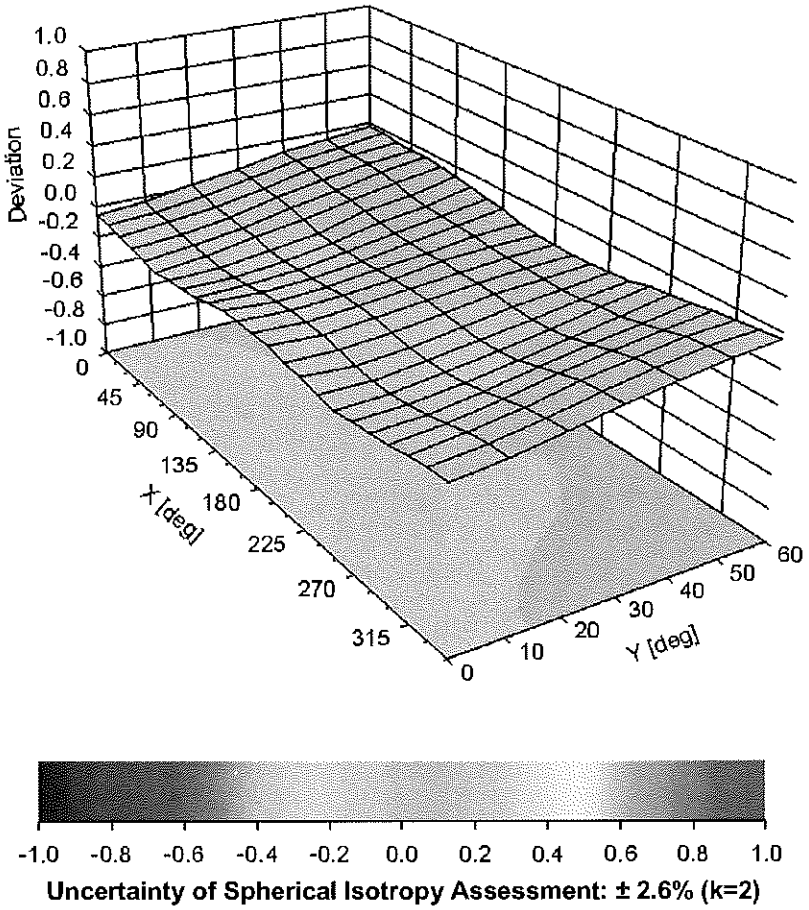


f = 1750 MHz,WGLS R22 (H_convF)



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
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: ES3-3318_Mar14

CALIBRATION CERTIFICATE

Object: ES3DV3 - SN:3318

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

Calibration date: March 19, 2014

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	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:	Claudio Leubler	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 20, 2014

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

PCT# 81086

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) **Accreditation No.: SCS 108**
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Glossary:

TSL	tissue simulating liquid
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:3318

Manufactured: January 10, 2012
Calibrated: March 19, 2014

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3318

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	1.15	0.92	1.28	± 10.1 %
DCP (mV)[B]	103.7	106.6	103.0	

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	206.6	±3.5 %
		Y	0.0	0.0	1.0		191.6	
		Z	0.0	0.0	1.0		210.8	
10010-CAA	SAR Validation (Square, 100ms, 10ms)	X	2.42	60.3	10.9	10.00	43.0	±2.2 %
		Y	3.36	65.8	13.1		37.7	
		Z	2.28	59.0	10.5		45.1	
10011-CAB	UMTS-FDD (WCDMA)	X	3.31	67.2	18.5	2.91	142.6	±0.7 %
		Y	3.62	68.9	19.4		129.4	
		Z	3.29	67.1	18.4		147.8	
10012-CAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	X	2.93	68.4	18.4	1.87	144.8	±0.7 %
		Y	3.77	73.3	20.6		128.5	
		Z	2.80	67.7	18.1		127.7	
10021-DAB	GSM-FDD (TDMA, GMSK)	X	14.08	90.6	24.9	9.39	130.3	±1.7 %
		Y	8.50	83.1	22.0		142.1	
		Z	25.27	99.8	28.1		149.0	
10023-DAB	GPRS-FDD (TDMA, GMSK, TN 0)	X	13.46	89.8	24.8	9.57	128.1	±2.2 %
		Y	6.59	78.2	19.9		131.8	
		Z	19.91	95.7	26.9		144.4	
10024-DAB	GPRS-FDD (TDMA, GMSK, TN 0-1)	X	39.25	100.0	24.8	6.56	135.6	±2.2 %
		Y	9.13	82.4	19.5		126.4	
		Z	38.59	99.7	25.2		123.5	
10027-DAB	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	X	35.79	94.6	21.5	4.80	123.0	±1.7 %
		Y	20.24	91.0	20.8		144.4	
		Z	55.60	99.7	23.2		137.0	
10028-DAB	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	X	71.64	99.9	21.6	3.55	137.3	±1.9 %
		Y	47.72	99.6	22.0		129.8	
		Z	66.56	100.0	22.2		145.2	
10032-CAA	IEEE 802.15.1 Bluetooth (GFSK, DH5)	X	97.45	96.9	17.8	1.16	127.3	±1.7 %
		Y	77.67	99.9	19.2		143.7	
		Z	96.05	98.9	18.8		130.7	
10039-CAB	CDMA2000 (1xRTT, RC1)	X	4.76	66.8	18.9	4.57	149.0	±0.9 %
		Y	4.86	67.6	19.3		143.4	
		Z	4.61	66.1	18.6		128.4	

10081-CAB	CDMA2000 (1xRTT, RC3)	X	3.95	66.4	18.6	3.97	142.6	±0.9 %
		Y	4.07	67.2	19.0		138.1	
		Z	3.96	66.4	18.6		145.8	
10098-CAB	UMTS-FDD (HSUPA, Subtest 2)	X	4.50	66.2	18.3	3.98	132.6	±0.7 %
		Y	4.69	67.2	18.7		129.6	
		Z	4.50	66.2	18.3		135.6	
10100-CAB	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	6.40	67.5	19.7	5.67	139.1	±1.4 %
		Y	6.44	67.6	19.6		135.6	
		Z	6.49	67.9	20.0		141.7	
10108-CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	6.28	67.0	19.5	5.80	136.5	±1.4 %
		Y	6.26	67.0	19.4		132.7	
		Z	6.34	67.4	19.8		139.7	
10110-CAB	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK)	X	5.94	66.5	19.3	5.75	133.1	±1.2 %
		Y	5.91	66.4	19.2		129.4	
		Z	6.02	66.8	19.5		136.8	
10114-CAA	IEEE 802.11n (HT Greenfield, 13.5 Mbps, BPSK)	X	10.12	68.7	21.1	8.10	125.9	±2.2 %
		Y	9.86	68.1	20.7		122.4	
		Z	10.28	69.2	21.5		129.8	
10117-CAA	IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK)	X	10.14	68.7	21.2	8.07	128.1	±1.9 %
		Y	9.88	68.2	20.8		124.7	
		Z	10.31	69.2	21.5		131.1	
10151-CAB	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	9.41	73.8	25.2	9.28	124.1	±3.3 %
		Y	8.81	72.4	24.3		141.2	
		Z	10.35	76.3	26.6		130.6	
10154-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	5.94	66.4	19.3	5.75	134.0	±1.2 %
		Y	5.93	66.5	19.2		129.9	
		Z	6.03	66.9	19.6		137.4	
10160-CAB	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK)	X	6.39	67.0	19.5	5.82	139.6	±1.2 %
		Y	6.38	67.1	19.5		134.5	
		Z	6.47	67.4	19.8		142.4	
10169-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	4.92	66.7	19.6	5.73	137.2	±1.2 %
		Y	4.87	66.9	19.7		131.9	
		Z	5.02	67.0	19.8		141.0	
10172-CAB	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	8.97	79.6	28.4	9.21	139.6	±3.0 %
		Y	6.93	73.1	24.9		126.3	
		Z	10.63	83.9	30.5		148.1	
10175-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	4.91	66.6	19.6	5.72	133.1	±1.2 %
		Y	4.88	66.9	19.7		130.2	
		Z	5.01	66.9	19.8		140.4	
10181-CAB	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	X	4.90	66.5	19.5	5.72	132.8	±1.2 %
		Y	4.83	66.7	19.6		129.2	
		Z	5.01	66.9	19.8		139.9	

10193-CAA	IEEE 802.11n (HT Greenfield, 6.5 Mbps, BPSK)	X	10.12	69.4	21.7	8.09	143.0	±2.5 %
		Y	9.89	68.8	21.2		141.3	
		Z	9.92	68.8	21.4		125.1	
10196-CAA	IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK)	X	10.14	69.5	21.8	8.10	143.8	±2.5 %
		Y	9.91	68.9	21.3		143.5	
		Z	9.90	68.8	21.4		124.8	
10219-CAA	IEEE 802.11n (HT Mixed, 7.2 Mbps, BPSK)	X	10.02	69.3	21.7	8.03	143.0	±2.5 %
		Y	9.84	68.9	21.2		143.7	
		Z	9.79	68.7	21.3		124.3	
10222-CAA	IEEE 802.11n (HT Mixed, 15 Mbps, BPSK)	X	10.11	68.8	21.3	8.06	122.9	±2.2 %
		Y	9.82	68.1	20.7		122.7	
		Z	10.28	69.2	21.5		130.2	
10225-CAB	UMTS-FDD (HSPA+)	X	7.03	67.2	19.6	5.97	145.1	±1.4 %
		Y	7.11	67.6	19.7		146.9	
		Z	6.93	66.8	19.4		127.8	
10237-CAB	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	9.05	80.0	28.7	9.21	135.3	±3.0 %
		Y	7.02	73.5	25.1		128.4	
		Z	10.78	84.4	30.8		148.7	
10252-CAB	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	9.88	76.7	27.0	9.24	139.4	±3.3 %
		Y	8.18	71.6	24.0		131.0	
		Z	9.61	75.3	26.2		123.9	
10267-CAB	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	10.72	77.7	27.4	9.30	147.9	±3.3 %
		Y	8.78	72.3	24.3		139.0	
		Z	10.44	76.5	26.7		130.7	
10274-CAB	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.10)	X	5.90	66.7	18.7	4.87	140.3	±0.9 %
		Y	6.06	67.5	19.1		139.5	
		Z	6.00	67.1	19.0		148.5	
10275-CAB	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.4)	X	4.48	67.1	18.8	3.96	147.2	±0.9 %
		Y	4.64	67.8	19.1		144.4	
		Z	4.30	66.2	18.4		129.4	
10291-AAB	CDMA2000, RC3, SO55, Full Rate	X	3.62	66.7	18.5	3.46	137.6	±0.7 %
		Y	3.87	68.3	19.3		135.0	
		Z	3.57	66.4	18.3		143.6	
10292-AAB	CDMA2000, RC3, SO32, Full Rate	X	3.57	66.8	18.6	3.39	142.1	±0.7 %
		Y	3.83	68.5	19.4		139.1	
		Z	3.58	66.9	18.6		144.4	
10297-AAA	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	6.28	67.0	19.6	5.81	136.3	±1.2 %
		Y	6.26	67.0	19.4		131.7	
		Z	6.34	67.3	19.8		138.8	
10311-AAA	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK)	X	6.88	67.8	20.0	6.06	142.1	±1.4 %
		Y	6.84	67.6	19.8		137.6	
		Z	6.94	68.0	20.2		144.8	

10315-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 96pc duty cycle)	X	2.81	68.5	18.6	1.71	147.2	±0.5 %
		Y	3.61	73.2	20.8		147.8	
		Z	2.71	67.8	18.3		127.6	
10403-AAB	CDMA2000 (1xEV-DO, Rev. 0)	X	4.63	67.7	18.4	3.76	128.2	±0.7 %
		Y	5.21	70.6	19.8		149.8	
		Z	4.58	67.2	18.3		131.6	
10404-AAB	CDMA2000 (1xEV-DO, Rev. A)	X	4.63	68.1	18.7	3.77	126.5	±0.7 %
		Y	5.18	70.9	19.9		147.1	
		Z	4.52	67.4	18.4		130.9	

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

[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:3318

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	0.80	1.15	± 12.0 %
835	41.5	0.90	6.18	6.18	6.18	0.42	1.51	± 12.0 %
1750	40.1	1.37	5.41	5.41	5.41	0.74	1.19	± 12.0 %
1900	40.0	1.40	5.33	5.33	5.33	0.80	1.20	± 12.0 %
2450	39.2	1.80	4.69	4.69	4.69	0.77	1.37	± 12.0 %
2600	39.0	1.96	4.43	4.43	4.43	0.80	1.31	± 12.0 %

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

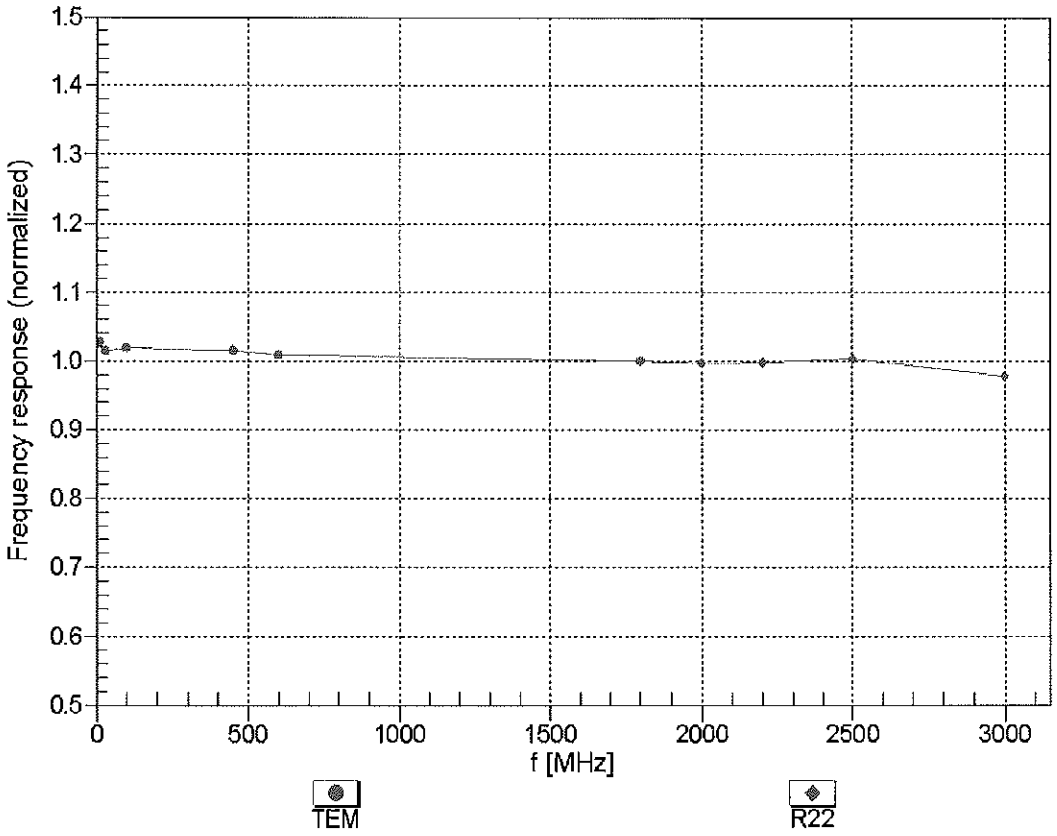
DASY/EASY - Parameters of Probe: ES3DV3 - SN:3318

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	6.16	6.16	6.16	0.39	1.68	± 12.0 %
835	55.2	0.97	6.12	6.12	6.12	0.39	1.74	± 12.0 %
1750	53.4	1.49	4.80	4.80	4.80	0.50	1.57	± 12.0 %
1900	53.3	1.52	4.60	4.60	4.60	0.55	1.56	± 12.0 %
2450	52.7	1.95	4.15	4.15	4.15	0.74	1.08	± 12.0 %
2600	52.5	2.16	3.98	3.98	3.98	0.66	0.96	± 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.

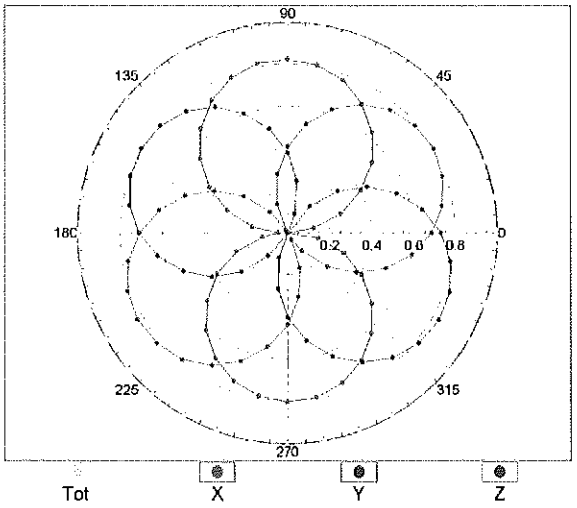
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



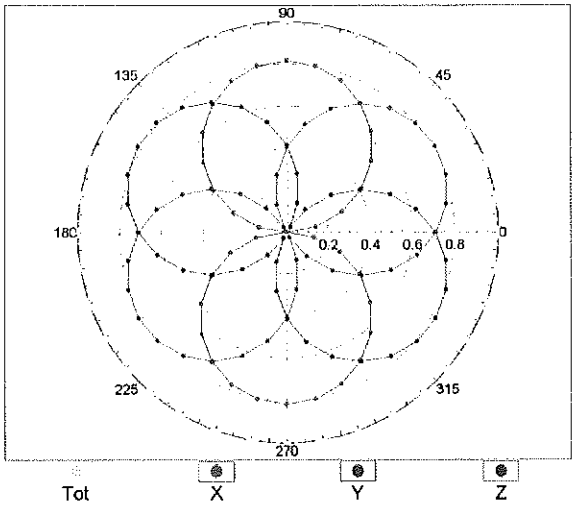
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

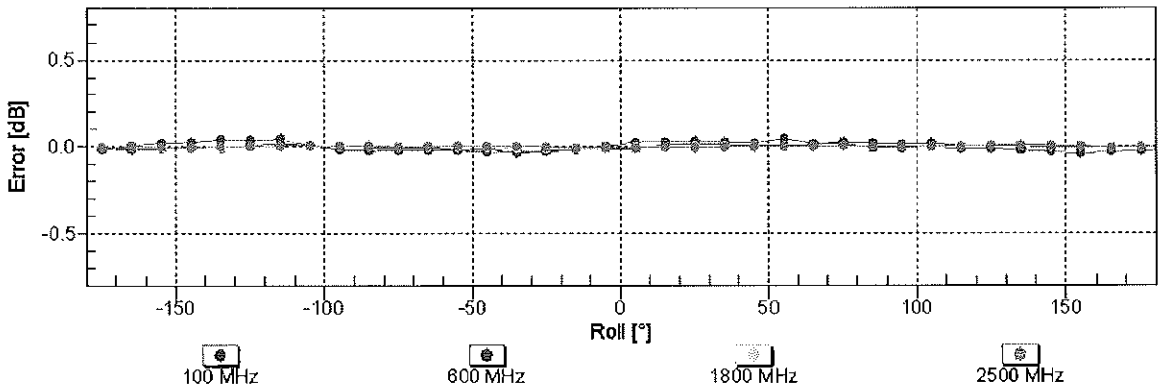
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



f=1800 MHz,R22

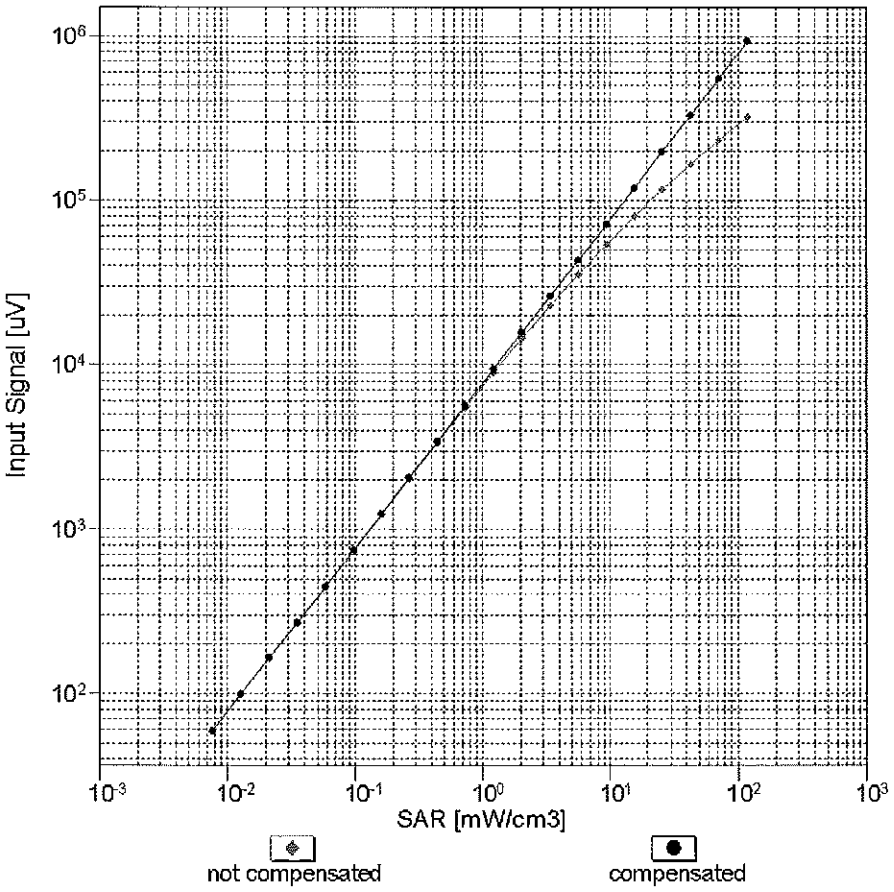


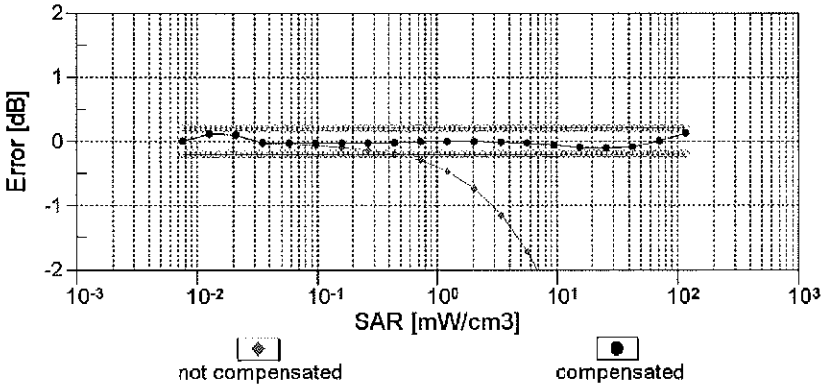


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR_{head})

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

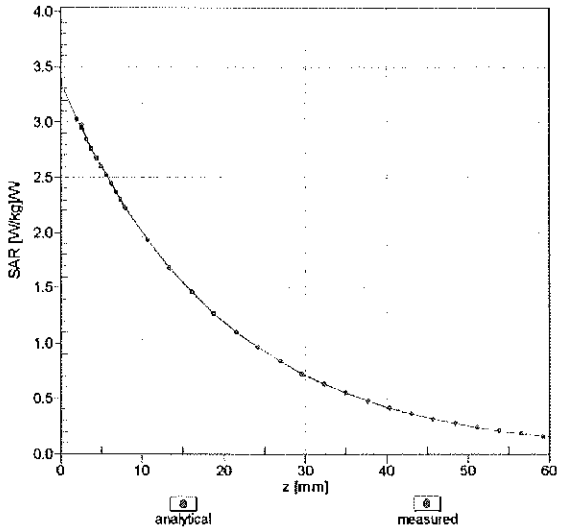




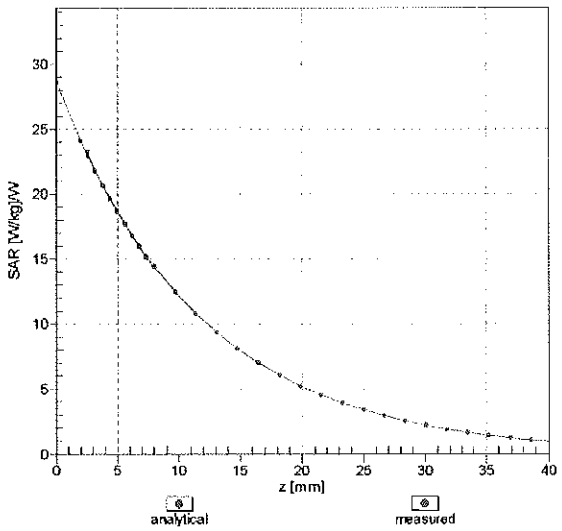
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

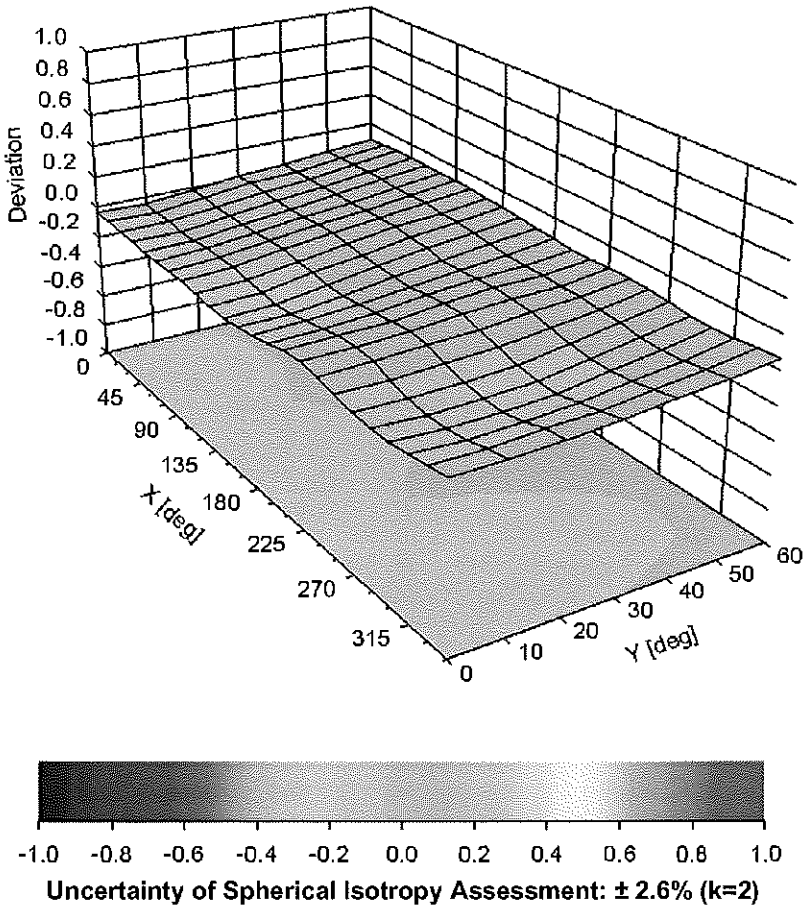


f = 1900 MHz,WGLS R22 (H_convF)



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:3318

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-104.8
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

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: EX3-3920_Dec13

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 18, 2013

JCC
1/12/14

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	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	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-15
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: December 19, 2013

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

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) **Accreditation No.: SCS 108**

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

Glossary:

TSL	tissue simulating liquid
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., $\vartheta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

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 $\vartheta = 0$ ($f \le 900$ 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 $f \le 800$ 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 18, 2013

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 ($\mu V/(V/m)^2$)[A]	0.34	0.50	0.49	± 10.1 %
DCP (mV)[B]	102.9	99.5	98.3	

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	182.5	±2.7 %
		Y	0.0	0.0	1.0		164.9	
		Z	0.0	0.0	1.0		153.0	
10010-CAA	SAR Validation (Square, 100ms, 10ms)	X	0.76	53.8	6.5	10.00	44.1	±2.2 %
		Y	2.33	62.8	11.4		43.7	
		Z	1.15	55.6	7.5		53.0	
10011-CAA	UMTS-FDD (WCDMA)	X	3.36	66.5	17.5	2.91	142.4	±0.5 %
		Y	3.15	65.0	16.7		131.4	
		Z	3.26	66.0	17.7		121.6	
10012-CAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	X	2.69	66.4	16.9	1.87	138.1	±0.5 %
		Y	2.56	65.1	16.2		130.7	
		Z	2.72	66.6	17.2		121.4	
10021-DAA	GSM-FDD (TDMA, GMSK)	X	2.06	63.4	11.7	9.39	99.7	±1.9 %
		Y	2.43	66.1	14.1		94.7	
		Z	2.90	69.9	16.1		121.8	
10023-DAA	GPRS-FDD (TDMA, GMSK, TN 0)	X	1.94	62.4	11.3	9.57	95.1	±1.9 %
		Y	2.31	64.8	13.1		90.1	
		Z	2.98	70.4	16.4		117.0	
10024-DAA	GPRS-FDD (TDMA, GMSK, TN 0-1)	X	2.19	67.1	12.2	6.56	140.1	±1.4 %
		Y	2.35	67.0	12.9		134.0	
		Z	3.45	73.5	16.1		131.4	
10027-DAA	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	X	1.18	61.7	8.5	4.80	121.6	±1.2 %
		Y	1.57	63.4	10.0		116.0	
		Z	1.57	65.5	11.9		109.2	
10028-DAA	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	X	3.80	74.5	13.3	3.55	130.3	±0.9 %
		Y	1.00	60.5	8.0		123.9	
		Z	1.58	66.1	11.1		119.0	
10032-CAA	IEEE 802.15.1 Bluetooth (GFSK, DH5)	X	0.18	55.2	3.4	1.16	111.6	±0.7 %
		Y	0.34	57.4	4.4		143.6	
		Z	0.40	59.2	5.7		136.6	
10039-CAA	CDMA2000 (1xRTT, RC1)	X	4.49	65.9	18.1	4.57	131.8	±0.9 %
		Y	4.57	65.1	17.5		123.0	
		Z	4.66	65.9	18.3		118.6	
10062-CAA	IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps)	X	10.09	68.6	21.3	8.68	126.5	±2.5 %
		Y	10.31	68.5	21.1		121.9	
		Z	10.12	68.3	21.3		115.8	

10098-CAA	UMTS-FDD (HSUPA, Subtest 2)	X	4.64	66.6	18.1	3.98	144.6	±0.7 %
		Y	4.54	65.4	17.4		133.9	
		Z	4.60	66.1	18.0		128.0	
10100-CAB	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	6.00	65.5	18.3	5.67	104.2	±1.4 %
		Y	6.44	66.7	18.8		138.2	
		Z	6.54	67.4	19.4		134.7	
10108-CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	6.37	67.0	19.2	5.80	149.0	±1.4 %
		Y	6.40	66.6	18.9		141.2	
		Z	6.40	66.9	19.4		132.1	
10110-CAB	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK)	X	5.96	66.3	18.9	5.75	142.3	±1.4 %
		Y	6.05	66.1	18.7		136.6	
		Z	6.03	66.3	19.1		128.2	
10114-CAA	IEEE 802.11n (HT Greenfield, 13.5 Mbps, BPSK)	X	10.28	68.7	20.9	8.10	137.3	±2.5 %
		Y	10.32	68.5	20.7		131.3	
		Z	10.24	68.5	20.9		124.5	
10117-CAA	IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK)	X	10.29	68.8	20.9	8.07	138.5	±2.5 %
		Y	10.34	68.6	20.8		131.9	
		Z	10.26	68.5	20.9		125.5	
10151-CAB	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	7.20	67.5	21.6	9.28	118.6	±2.2 %
		Y	7.59	67.9	21.6		116.7	
		Z	7.78	69.2	22.7		110.7	
10154-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	5.98	66.4	18.9	5.75	142.7	±1.2 %
		Y	5.97	65.7	18.4		132.7	
		Z	6.06	66.4	19.1		128.6	
10160-CAB	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK)	X	6.41	66.8	19.1	5.82	147.7	±1.4 %
		Y	6.48	66.5	18.8		137.3	
		Z	6.53	67.0	19.4		134.9	
10169-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	4.59	65.5	18.6	5.73	120.3	±1.2 %
		Y	4.76	65.0	18.2		113.9	
		Z	4.82	65.6	18.9		112.0	
10172-CAB	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	5.77	69.3	22.7	9.21	128.1	±1.9 %
		Y	6.15	69.3	22.6		123.8	
		Z	6.22	70.3	23.6		120.8	
10175-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	4.62	65.6	18.7	5.72	120.2	±0.9 %
		Y	4.75	65.0	18.2		113.5	
		Z	4.80	65.6	18.8		110.7	
10181-CAB	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	X	4.57	65.4	18.6	5.72	118.9	±0.9 %
		Y	4.72	64.8	18.1		113.1	
		Z	4.81	65.6	18.8		110.4	
10193-CAA	IEEE 802.11n (HT Greenfield, 6.5 Mbps, BPSK)	X	9.77	68.3	20.8	8.09	128.1	±2.5 %
		Y	9.84	67.9	20.5		117.1	
		Z	9.80	68.1	20.8		116.6	
10196-CAA	IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK)	X	9.78	68.4	20.8	8.10	128.4	±2.5 %
		Y	9.86	68.0	20.5		120.3	
		Z	9.82	68.1	20.9		119.1	

10219-CAA	IEEE 802.11n (HT Mixed, 7.2 Mbps, BPSK)	X	9.70	68.4	20.8	8.03	128.0	±2.5 %
		Y	9.79	68.0	20.5		119.6	
		Z	9.72	68.1	20.8		118.7	
10222-CAA	IEEE 802.11n (HT Mixed, 15 Mbps, BPSK)	X	10.27	68.8	20.9	8.06	137.0	±2.5 %
		Y	10.18	68.3	20.6		125.2	
		Z	10.20	68.5	20.9		124.8	
10225-CAA	UMTS-FDD (HSPA+)	X	6.64	66.1	18.7	5.97	108.8	±1.4 %
		Y	7.23	67.1	19.1		148.9	
		Z	7.31	67.7	19.7		146.5	
10237-CAB	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	5.82	69.6	23.0	9.21	130.2	±1.9 %
		Y	6.14	69.2	22.6		123.9	
		Z	6.25	70.4	23.7		122.2	
10252-CAB	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	6.85	67.5	21.7	9.24	112.9	±2.2 %
		Y	7.54	69.0	22.4		149.2	
		Z	7.80	70.6	23.7		147.3	
10267-CAB	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	7.23	67.6	21.6	9.30	118.3	±2.2 %
		Y	7.55	67.7	21.5		111.5	
		Z	7.79	69.2	22.7		109.6	
10274-CAA	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.10)	X	5.64	65.9	18.1	4.87	105.5	±1.2 %
		Y	6.04	66.4	18.2		142.6	
		Z	6.09	66.9	18.7		138.4	
10275-CAA	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.4)	X	4.42	66.3	18.1	3.96	135.8	±0.7 %
		Y	4.26	65.0	17.3		119.3	
		Z	4.40	65.9	18.0		120.4	
10291-AAA	CDMA2000, RC3, SO55, Full Rate	X	3.62	66.7	18.1	3.46	123.6	±0.7 %
		Y	3.38	64.3	16.7		112.5	
		Z	3.59	66.0	17.9		114.3	
10292-AAA	CDMA2000, RC3, SO32, Full Rate	X	3.46	66.0	17.7	3.39	127.3	±0.5 %
		Y	3.35	64.5	16.8		113.7	
		Z	3.50	65.7	17.7		115.4	
10297-AAA	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	6.35	66.9	19.2	5.81	145.7	±1.2 %
		Y	6.26	66.1	18.7		129.2	
		Z	6.42	67.0	19.4		131.3	
10311-AAA	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK)	X	6.45	65.9	18.7	6.06	103.7	±1.7 %
		Y	6.90	66.9	19.1		137.2	
		Z	7.04	67.7	19.8		137.5	
10315-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 96pc duty cycle)	X	2.85	67.8	17.7	1.71	135.6	±0.5 %
		Y	2.45	64.7	16.0		121.4	
		Z	2.75	67.3	17.6		122.1	
10317-AAA	IEEE 802.11a WiFi 5 GHz (OFDM, 6 Mbps, 96pc duty cycle)	X	9.93	68.5	21.0	8.36	128.1	±2.7 %
		Y	10.02	68.1	20.7		117.9	
		Z	10.01	68.3	21.1		119.4	
10400-AAA	IEEE 802.11ac WiFi (20MHz, 64-QAM, 99pc duty cycle)	X	10.09	68.8	21.2	8.37	134.9	±2.5 %
		Y	10.16	68.3	20.8		119.8	
		Z	10.14	68.5	21.2		121.0	

10402-AAA	IEEE 802.11ac WiFi (80MHz, 64-QAM, 99pc duty cycle)	X	11.18	69.8	21.5	8.53	147.1	±2.7 %
		Y	10.79	68.6	20.8		126.5	
		Z	11.17	69.6	21.6		131.4	
10403-AAA	CDMA2000 (1xEV-DO, Rev. 0)	X	4.83	69.6	18.9	3.76	139.6	±0.5 %
		Y	4.70	67.1	17.6		128.1	
		Z	4.90	68.4	18.6		127.8	
10404-AAA	CDMA2000 (1xEV-DO, Rev. A)	X	4.73	69.5	18.9	3.77	134.8	±0.5 %
		Y	4.62	67.1	17.7		124.9	
		Z	4.67	67.7	18.1		125.9	

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

[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: 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)
750	41.9	0.89	10.05	10.05	10.05	0.27	1.13	± 12.0 %
835	41.5	0.90	9.69	9.69	9.69	0.50	0.76	± 12.0 %
1750	40.1	1.37	7.91	7.91	7.91	0.72	0.62	± 12.0 %
1900	40.0	1.40	7.70	7.70	7.70	0.77	0.61	± 12.0 %
2450	39.2	1.80	6.98	6.98	6.98	0.37	0.86	± 12.0 %
2600	39.0	1.96	6.74	6.74	6.74	0.34	0.97	± 12.0 %
5200	36.0	4.66	4.87	4.87	4.87	0.40	1.80	± 13.1 %
5300	35.9	4.76	4.66	4.66	4.66	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.54	4.54	4.54	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.37	4.37	4.37	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.11	4.11	4.11	0.50	1.80	± 13.1 %

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

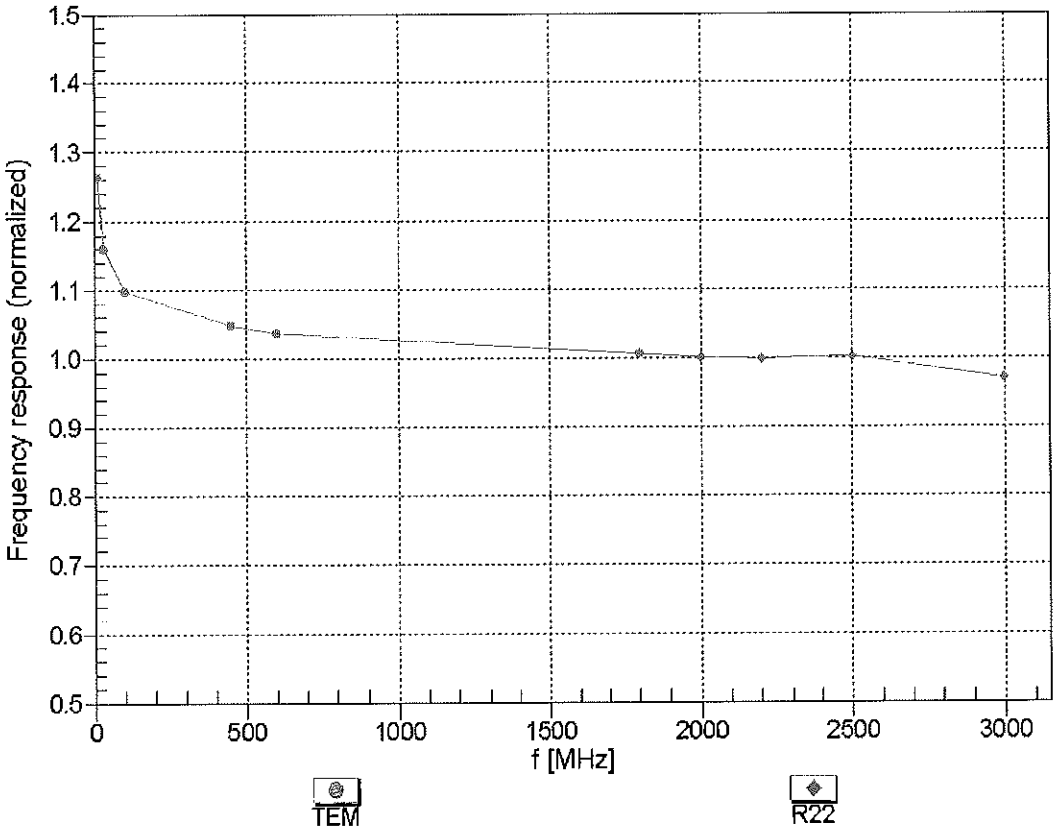
Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
750	55.5	0.96	9.54	9.54	9.54	0.32	1.07	± 12.0 %
835	55.2	0.97	9.47	9.47	9.47	0.45	0.85	± 12.0 %
1750	53.4	1.49	7.77	7.77	7.77	0.59	0.74	± 12.0 %
1900	53.3	1.52	7.50	7.50	7.50	0.37	0.91	± 12.0 %
2450	52.7	1.95	7.18	7.18	7.18	0.80	0.56	± 12.0 %
2600	52.5	2.16	6.91	6.91	6.91	0.80	0.57	± 12.0 %
5200	49.0	5.30	4.23	4.23	4.23	0.50	1.90	± 13.1 %
5300	48.9	5.42	4.11	4.11	4.11	0.50	1.90	± 13.1 %
5500	48.6	5.65	3.80	3.80	3.80	0.50	1.90	± 13.1 %
5600	48.5	5.77	3.62	3.62	3.62	0.50	1.90	± 13.1 %
5800	48.2	6.00	4.00	4.00	4.00	0.50	1.90	± 13.1 %

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

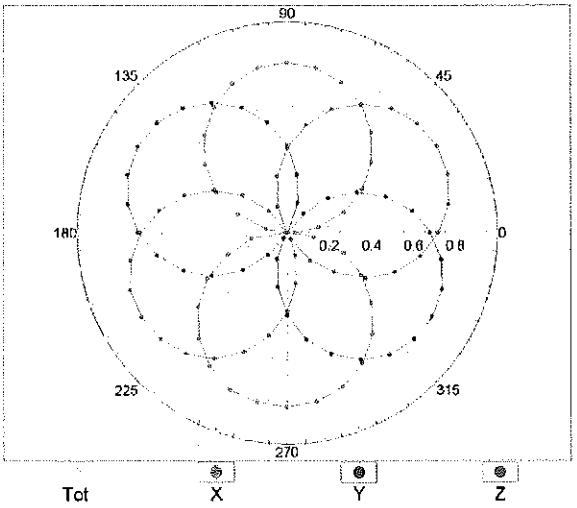
(TEM-Cell:ifi110 EXX, Waveguide: R22)



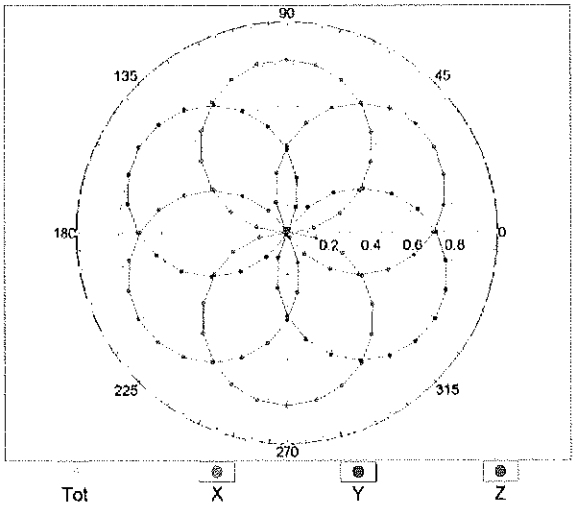
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

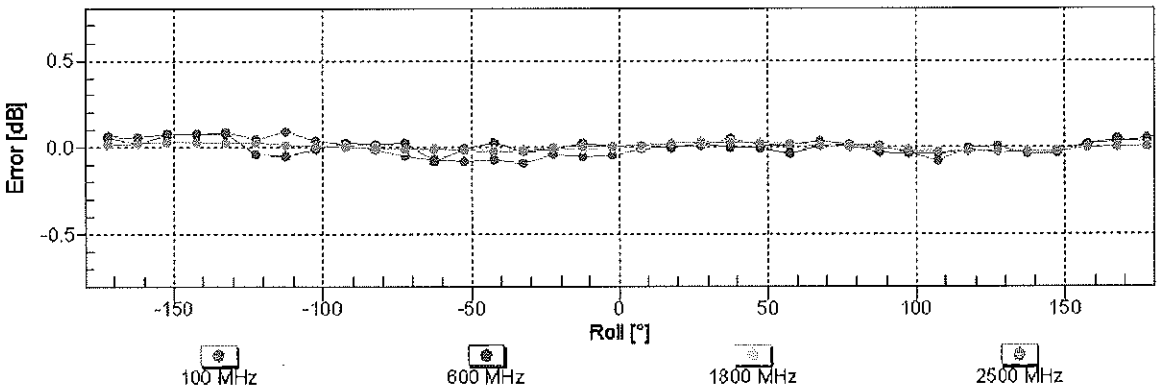
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



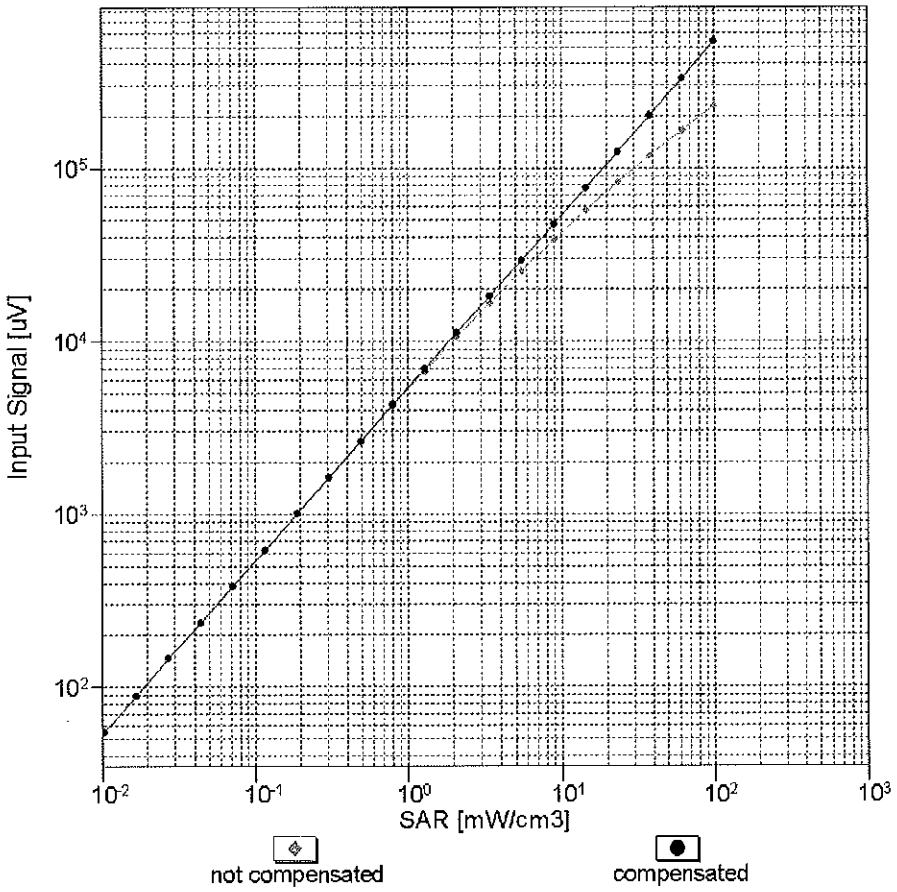
f=1800 MHz,R22

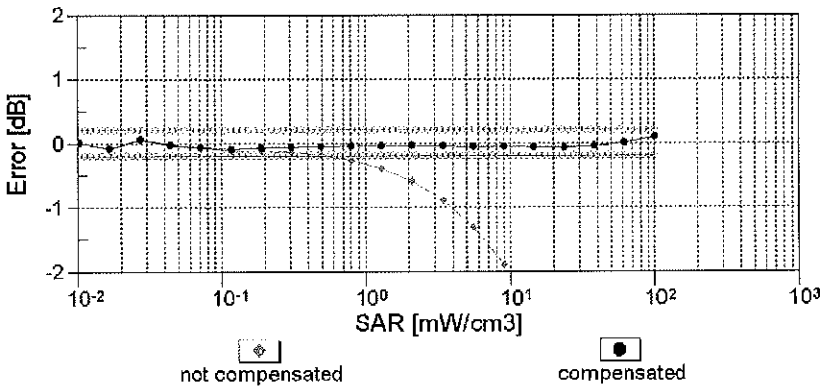




Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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

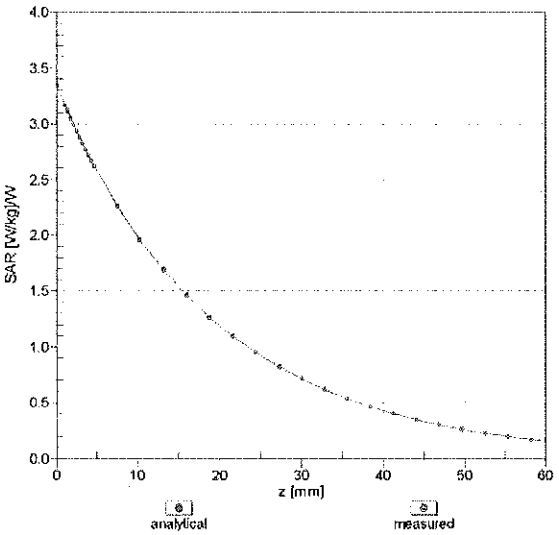




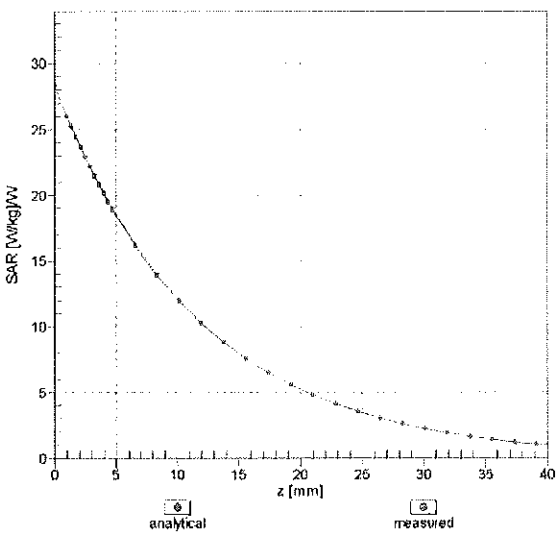
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

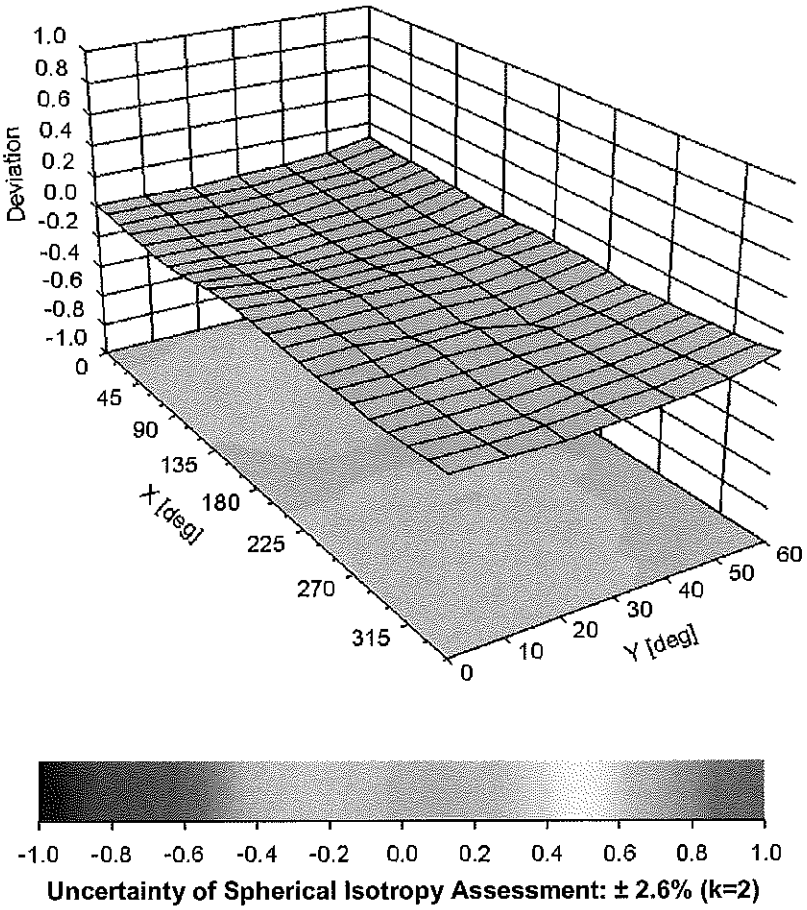


f = 1900 MHz,WGLS R22 (H_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

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

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-22.4
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm

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: D835V2-4d132_Jul14

CALIBRATION CERTIFICATE

Object D835V2 - SN: 4d132

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

Calibration date: July 10, 2014

✓ KOK 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 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	
Approved by:	Katja Pokovic	Technical Manager	

Issued: July 11, 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	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**9.27 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.55 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**6.03 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	2.50 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**9.58 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.63 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**6.30 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.0 Ω - 1.6 jΩ
Return Loss	- 31.9 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.7 Ω - 3.4 jΩ
Return Loss	- 27.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.386 ns

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	July 22, 2011

DASY5 Validation Report for Head TSL

Date: 10.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d132

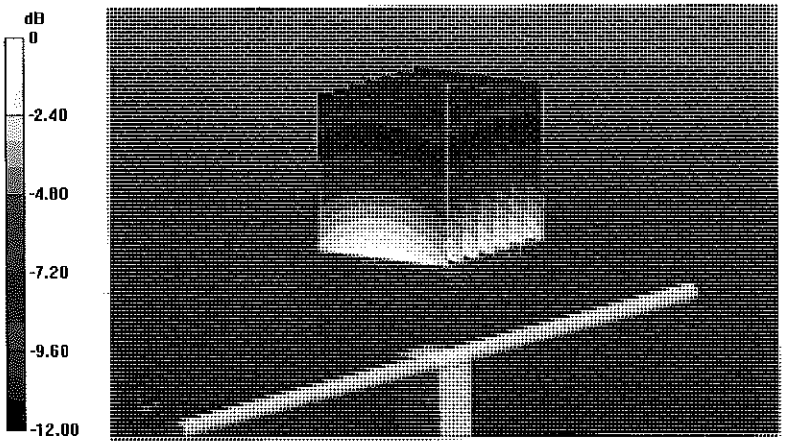
Communication System: UID 0 - CW; Frequency: 835 MHz
Medium parameters used: f = 835 MHz; σ = 0.94 S/m; ε_r = 41.1; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

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)

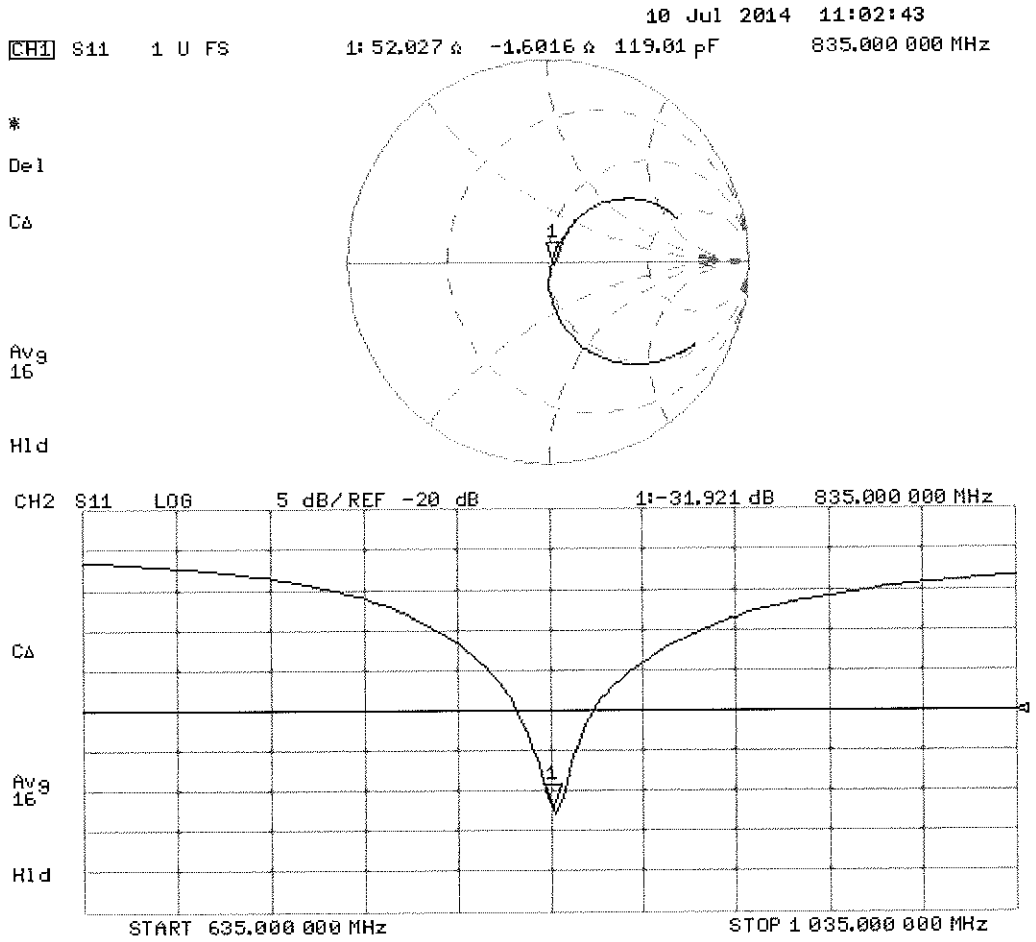
Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 56.43 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 3.62 W/kg
SAR(1 g) = 2.4 W/kg; SAR(10 g) = 1.55 W/kg
Maximum value of SAR (measured) = 2.83 W/kg



0 dB = 2.83 W/kg = 4.52 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 09.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d132

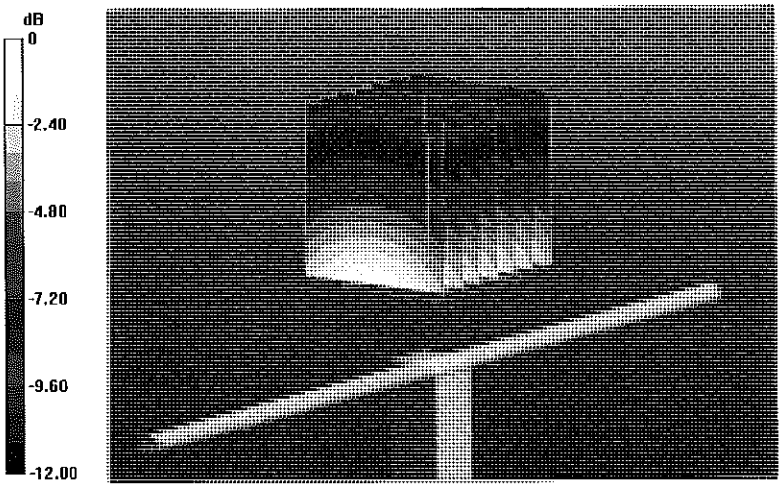
Communication System: UID 0 - CW; Frequency: 835 MHz
Medium parameters used: f = 835 MHz; σ = 1.02 S/m; ε_r = 53.8; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

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)

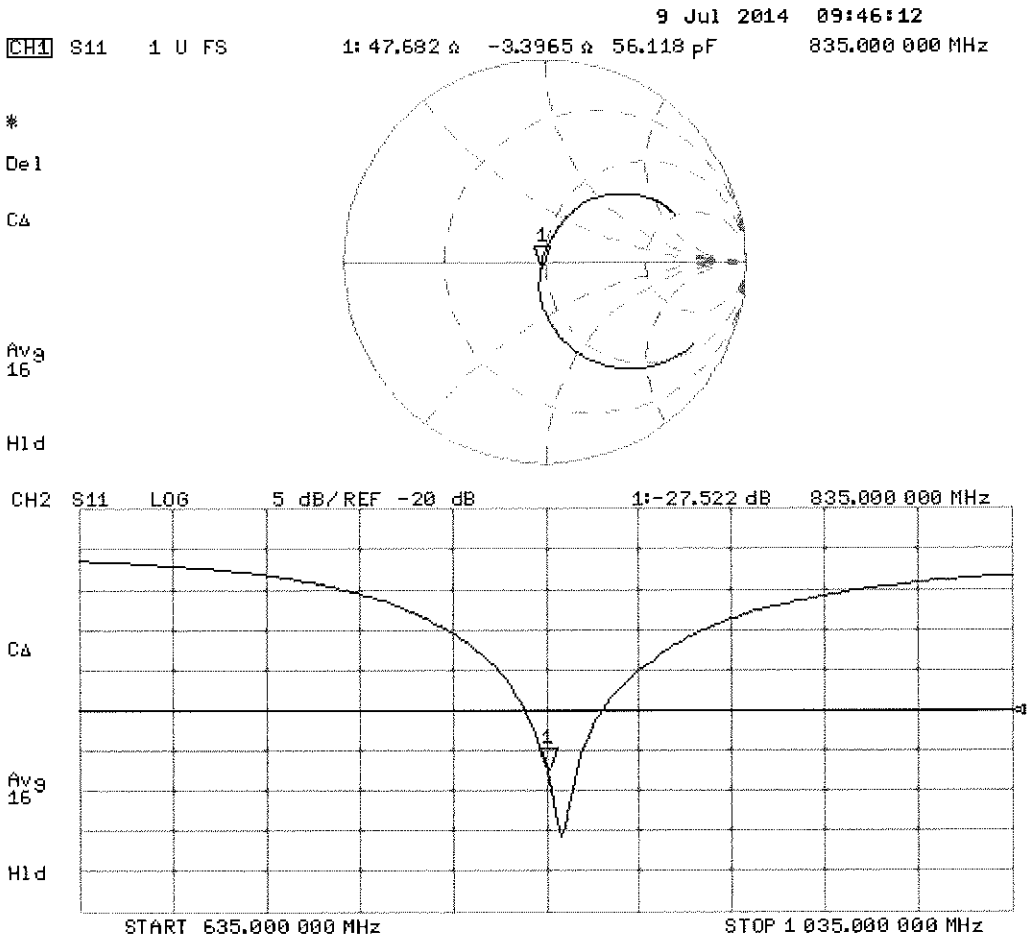
Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 55.35 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 3.72 W/kg
SAR(1 g) = 2.5 W/kg; SAR(10 g) = 1.63 W/kg
Maximum value of SAR (measured) = 2.91 W/kg



0 dB = 2.91 W/kg = 4.64 dBW/kg

Impedance Measurement Plot for Body TSL



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Accreditation No.: SCS 108

Client **PC Test**

Certificate No: D1900V2-5d141_Apr14

CALIBRATION CERTIFICATE

Object	D1900V2 - SN: 5d141
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	April 09, 2014

✓ KOK 5/7/14

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

Issued: April 9, 2014

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Accreditation No.: SCS 108

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz ± 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	39.1 ± 6 %	1.36 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	9.91 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**40.1 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.17 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**20.8 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	52.4 ± 6 %	1.52 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	10.2 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**40.6 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.41 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.6 W/kg ± 16.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.8 Ω + 5.5 jΩ
Return Loss	- 24.5 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.8 Ω + 6.3 jΩ
Return Loss	- 23.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.199 ns

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	March 11, 2011

DASY5 Validation Report for Head TSL

Date: 09.04.2014

Test Laboratory: SPEAG, Zurich, Switzerland

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

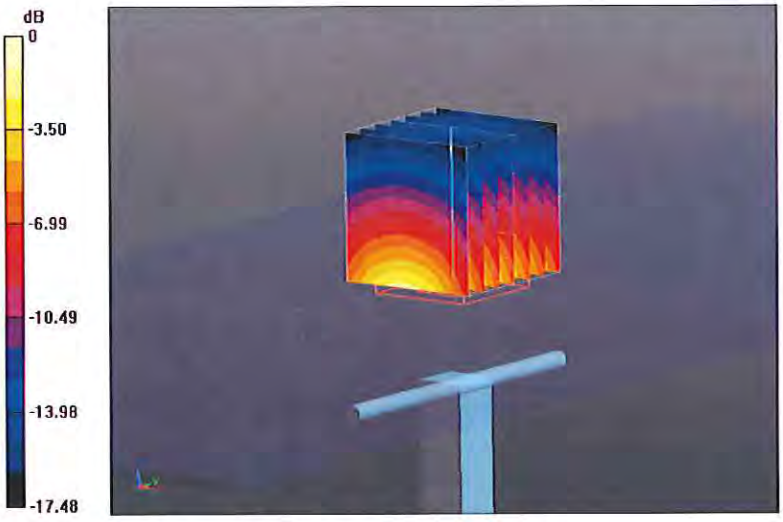
Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; σ = 1.36 S/m; ε_r = 39.1; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.06, 5.06, 5.06); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

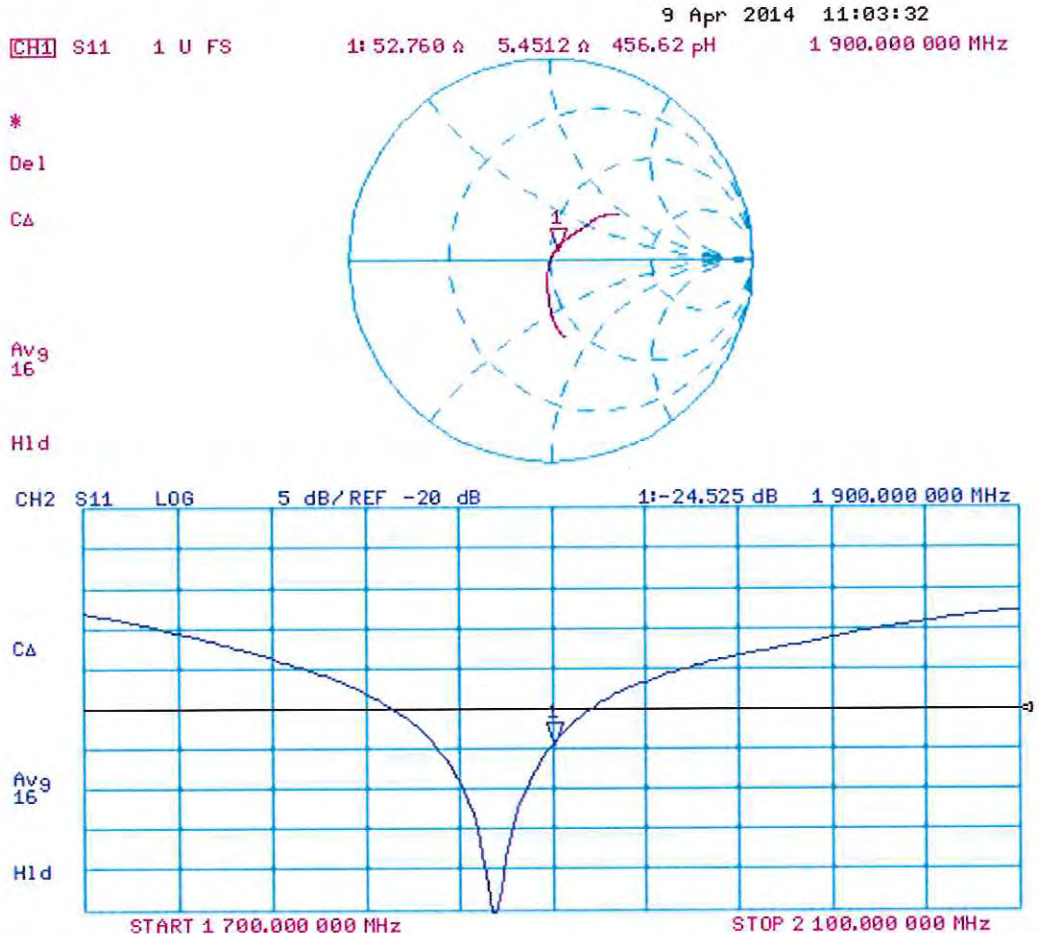
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 99.080 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 18.2 W/kg
SAR(1 g) = 9.91 W/kg; SAR(10 g) = 5.17 W/kg
Maximum value of SAR (measured) = 12.5 W/kg



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

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 09.04.2014

Test Laboratory: SPEAG, Zurich, Switzerland

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

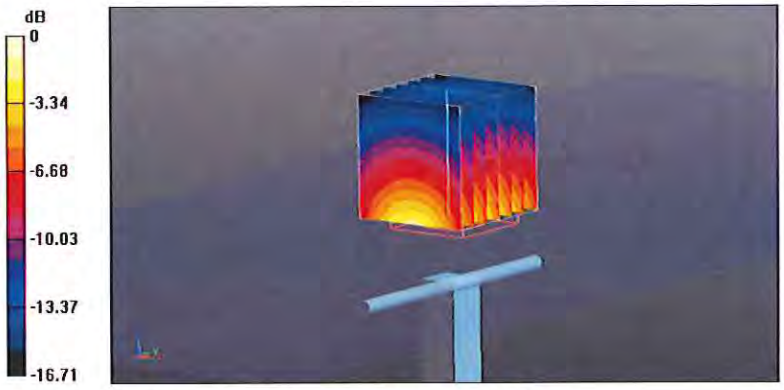
Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; σ = 1.52 S/m; ε_r = 52.4; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.76, 4.76, 4.76); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

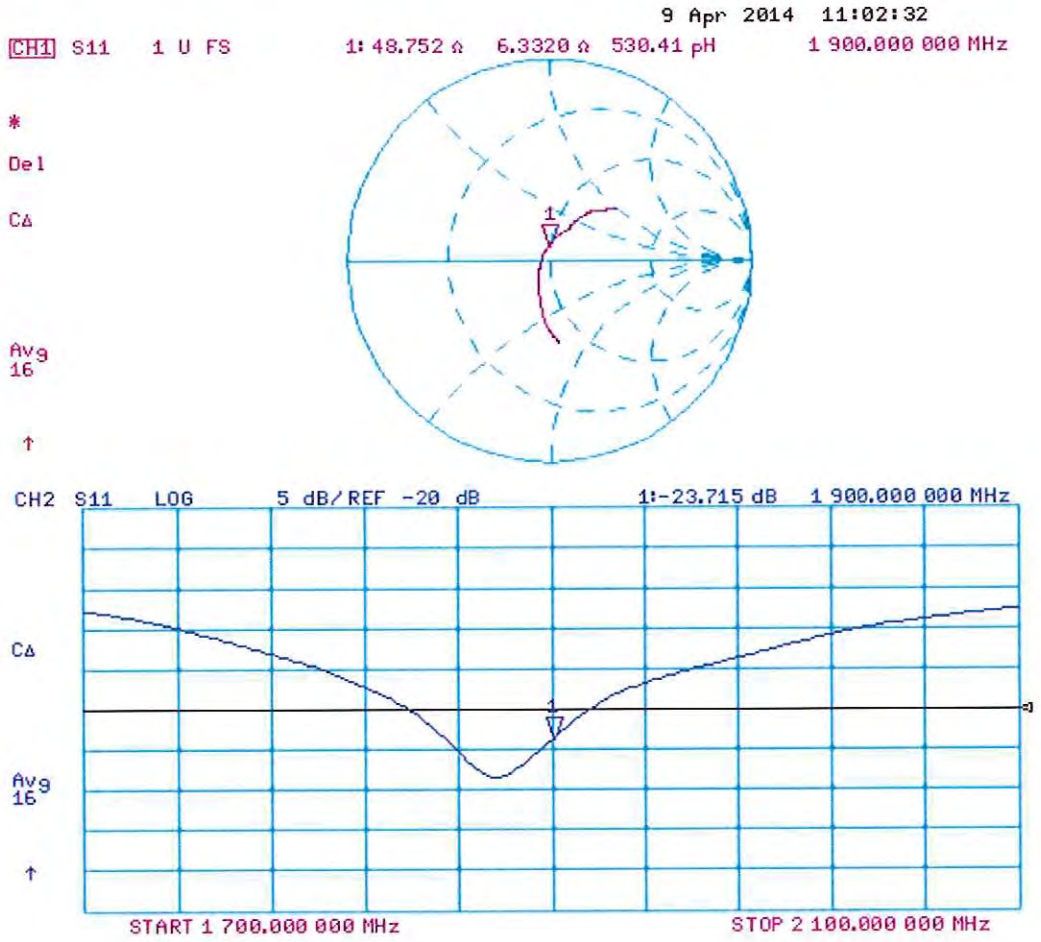
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 95.820 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 17.9 W/kg
SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.41 W/kg
Maximum value of SAR (measured) = 12.9 W/kg



0 dB = 12.9 W/kg = 11.11 dBW/kg

Impedance Measurement Plot for Body TSL



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Accreditation No.: SCS 108

Client PC Test

Certificate No: D2450V2-882_Feb14

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 882
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	February 24, 2014

CCV 3/6/14

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)	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	
Approved by:	Katja Pokovic	Technical Manager	

Issued: February 25, 2014

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

PCTH 80826

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	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	38.1 ± 6 %	1.86 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	13.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**52.0 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.12 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	50.7 ± 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	12.7 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**49.5 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.87 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**23.1 W/kg ± 16.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.5 Ω - 0.9 jΩ
Return Loss	- 29.1 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.1 Ω + 1.5 jΩ
Return Loss	- 36.3 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.159 ns

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	October 06, 2011

DASY5 Validation Report for Head TSL

Date: 24.02.2014

Test Laboratory: SPEAG, Zurich, Switzerland

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

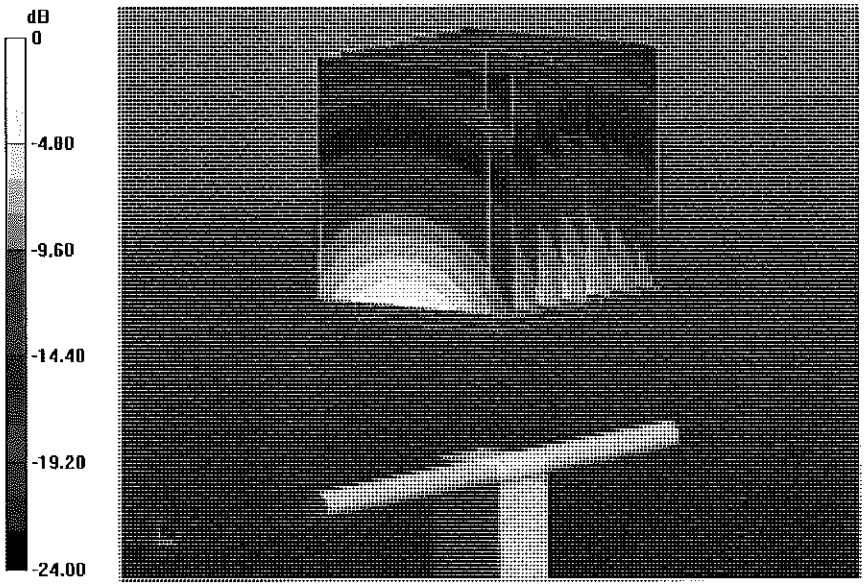
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.86 S/m; ε_r = 38.1; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

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: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

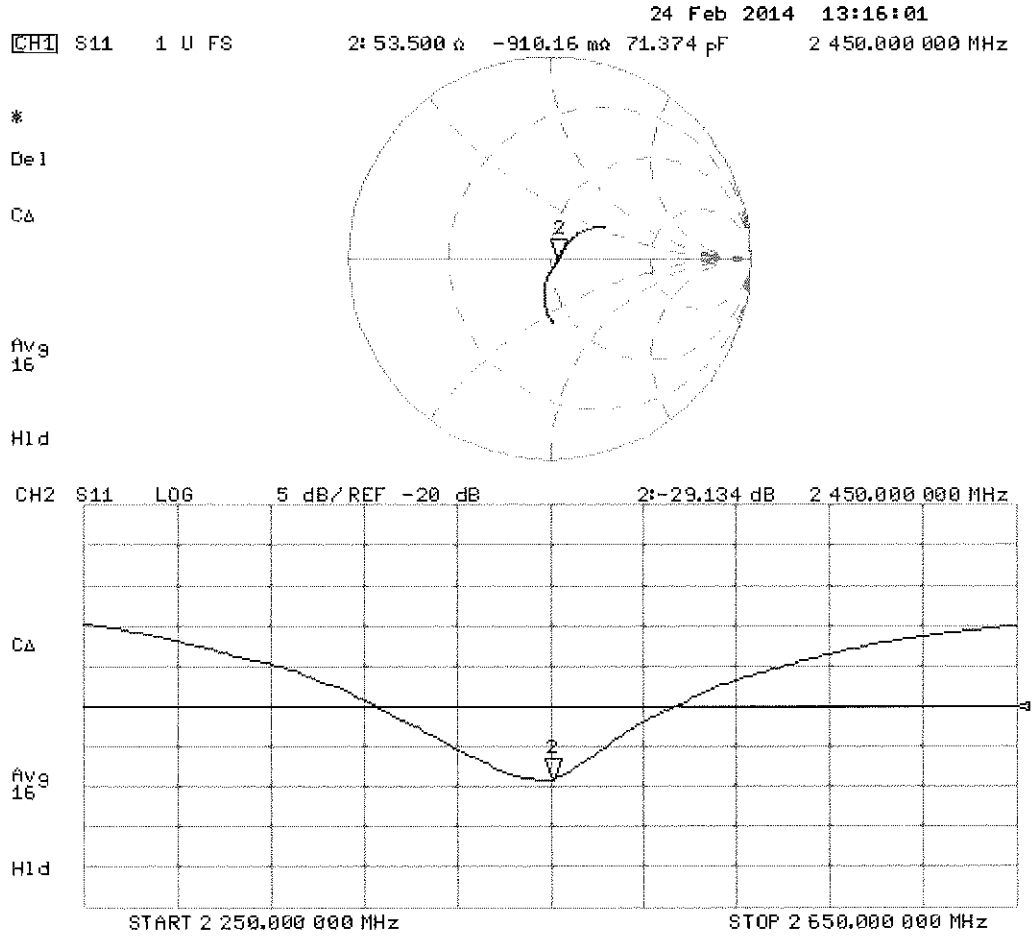
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 99.531 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 27.8 W/kg
SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.12 W/kg
Maximum value of SAR (measured) = 17.0 W/kg



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

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 24.02.2014

Test Laboratory: SPEAG, Zurich, Switzerland

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

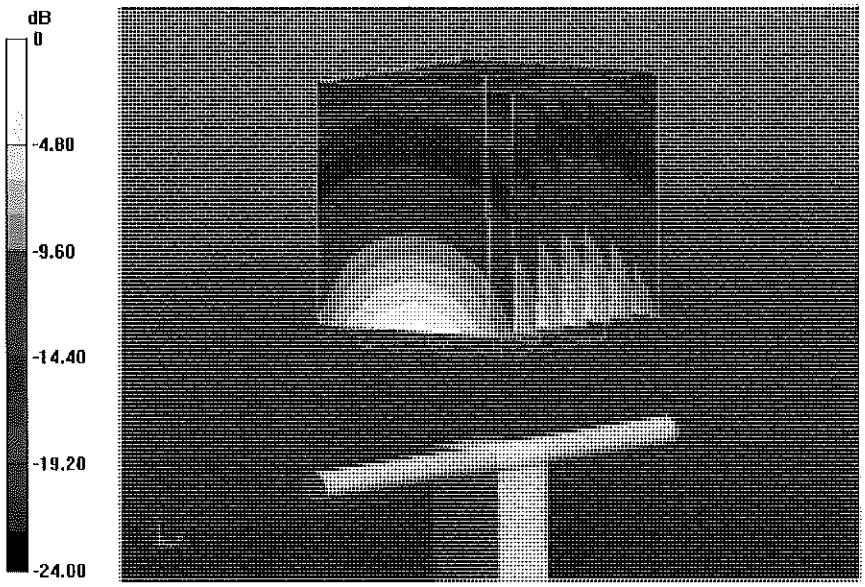
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.02 S/m; ε_r = 50.7; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

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: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

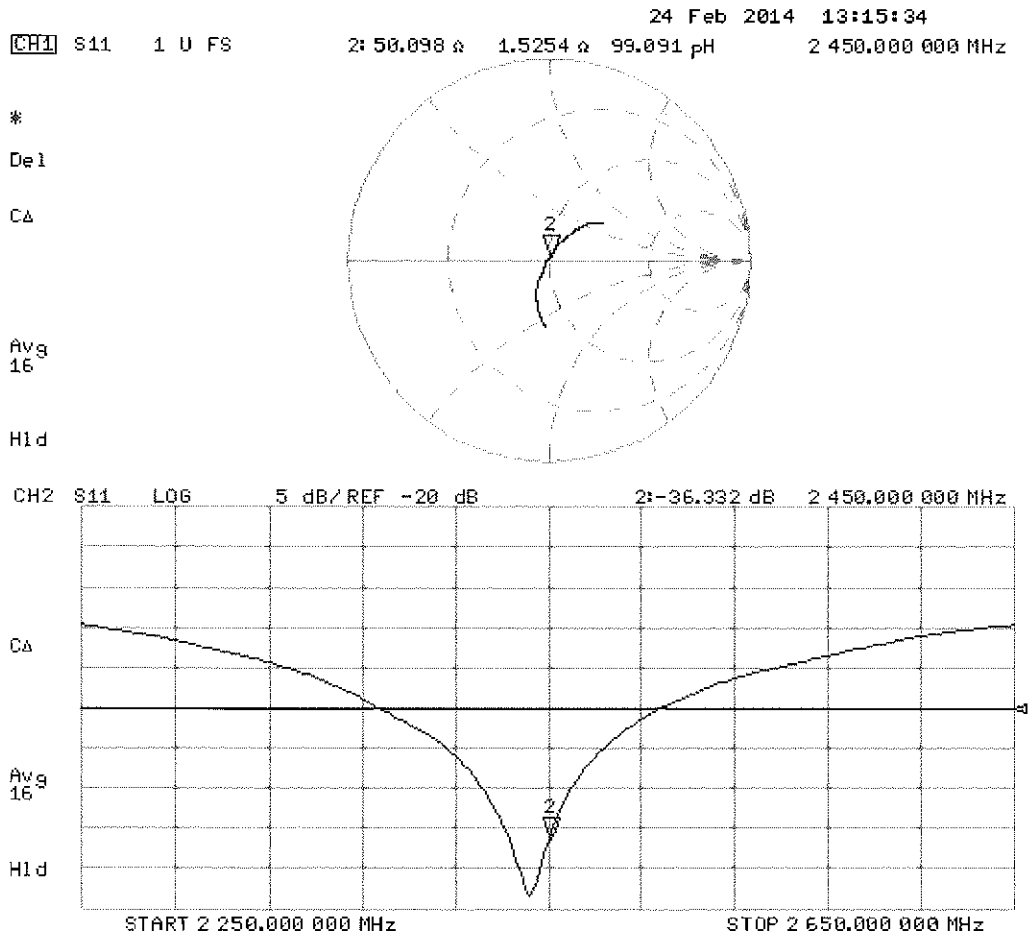
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scau (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 94.329 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 26.8 W/kg
SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.87 W/kg
Maximum value of SAR (measured) = 16.9 W/kg



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

Impedance Measurement Plot for Body TSL



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Accreditation No.: SCS 108

Client PC Test

Certificate No: D5GHzV2-1120_Feb14

CALIBRATION CERTIFICATE

CCV 3/6/14

Object	D5GHzV2 - SN: 1120
Calibration procedure(s)	QA CAL-22.v2 Calibration procedure for dipole validation kits between 3-6 GHz
Calibration date:	February 26, 2014

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe EX3DV4	SN: 3503	30-Dec-13 (No. EX3-3503_Dec13)	Dec-14
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

Issued: February 27, 2014

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

PCT# 80834

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

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Accreditation No.: SCS 108
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEC 62209-2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation, and Procedures"; Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", March 2010
b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"
c) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz ± 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	37.1 ± 6 %	4.52 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.87 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**79.1 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.5 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.9 ± 6 %	4.63 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**83.4 W / kg ± 19.9 % (k=2)**

SAR averaged over 10 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	**23.8 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.7 ± 6 %	4.84 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.45 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**84.9 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.1 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.6 ± 6 %	4.95 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**82.2 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.5 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.3 ± 6 %	5.16 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.87 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**79.1 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.23 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.4 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.8 ± 6 %	5.40 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.43 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**74.0 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 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	**20.7 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.42 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.6 ± 6 %	5.53 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5300 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.62 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**75.8 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.14 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.3 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.6	5.65 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.3 ± 6 %	5.80 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5500 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.96 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**79.2 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.21 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**22.0 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.1 ± 6 %	5.94 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.98 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**79.4 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.21 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**22.0 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.8 ± 6 %	6.21 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.47 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**74.4 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.07 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.6 W/kg ± 19.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	54.0 Ω - 5.6 jΩ
Return Loss	- 23.6 dB

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	51.1 Ω + 1.6 jΩ
Return Loss	- 34.6 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	51.1 Ω - 2.3 jΩ
Return Loss	- 31.9 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	58.4 Ω - 0.2 jΩ
Return Loss	- 22.2 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	52.9 Ω + 2.8 jΩ
Return Loss	- 28.2 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	52.3 Ω - 5.9 jΩ
Return Loss	- 24.2 dB

Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	51.1 Ω + 1.2 jΩ
Return Loss	- 35.8 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	50.5 Ω - 2.6 jΩ
Return Loss	- 31.6 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	59.5 Ω - 2.9 jΩ
Return Loss	- 20.9 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	54.2 Ω + 1.1 jΩ
Return Loss	- 27.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.206 ns

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	September 08, 2011

DASY5 Validation Report for Head TSL

Date: 26.02.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1120

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 4.52 S/m; ε_r = 37.1; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5300 MHz; σ = 4.63 S/m; ε_r = 36.9; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5500 MHz; σ = 4.84 S/m; ε_r = 36.7; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5600 MHz; σ = 4.95 S/m; ε_r = 36.6; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5800 MHz; σ = 5.16 S/m; ε_r = 36.3; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.52, 5.52, 5.52); Calibrated: 30.12.2013, ConvF(5.2, 5.2, 5.2); Calibrated: 30.12.2013, ConvF(5.01, 5.01, 5.01); Calibrated: 30.12.2013, ConvF(4.86, 4.86, 4.86); Calibrated: 30.12.2013, ConvF(4.91, 4.91, 4.91); Calibrated: 30.12.2013;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

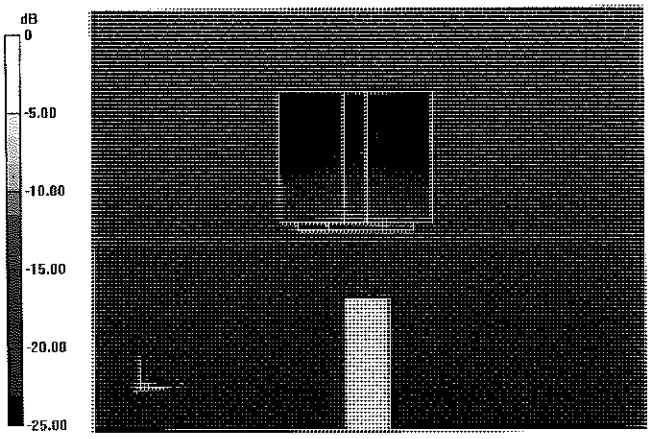
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 62.794 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 28.6 W/kg
SAR(1 g) = 7.87 W/kg; SAR(10 g) = 2.24 W/kg
Maximum value of SAR (measured) = 18.0 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.390 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 31.5 W/kg
SAR(1 g) = 8.3 W/kg; SAR(10 g) = 2.37 W/kg
Maximum value of SAR (measured) = 19.2 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.321 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 33.6 W/kg
SAR(1 g) = 8.45 W/kg; SAR(10 g) = 2.4 W/kg
Maximum value of SAR (measured) = 20.0 W/kg

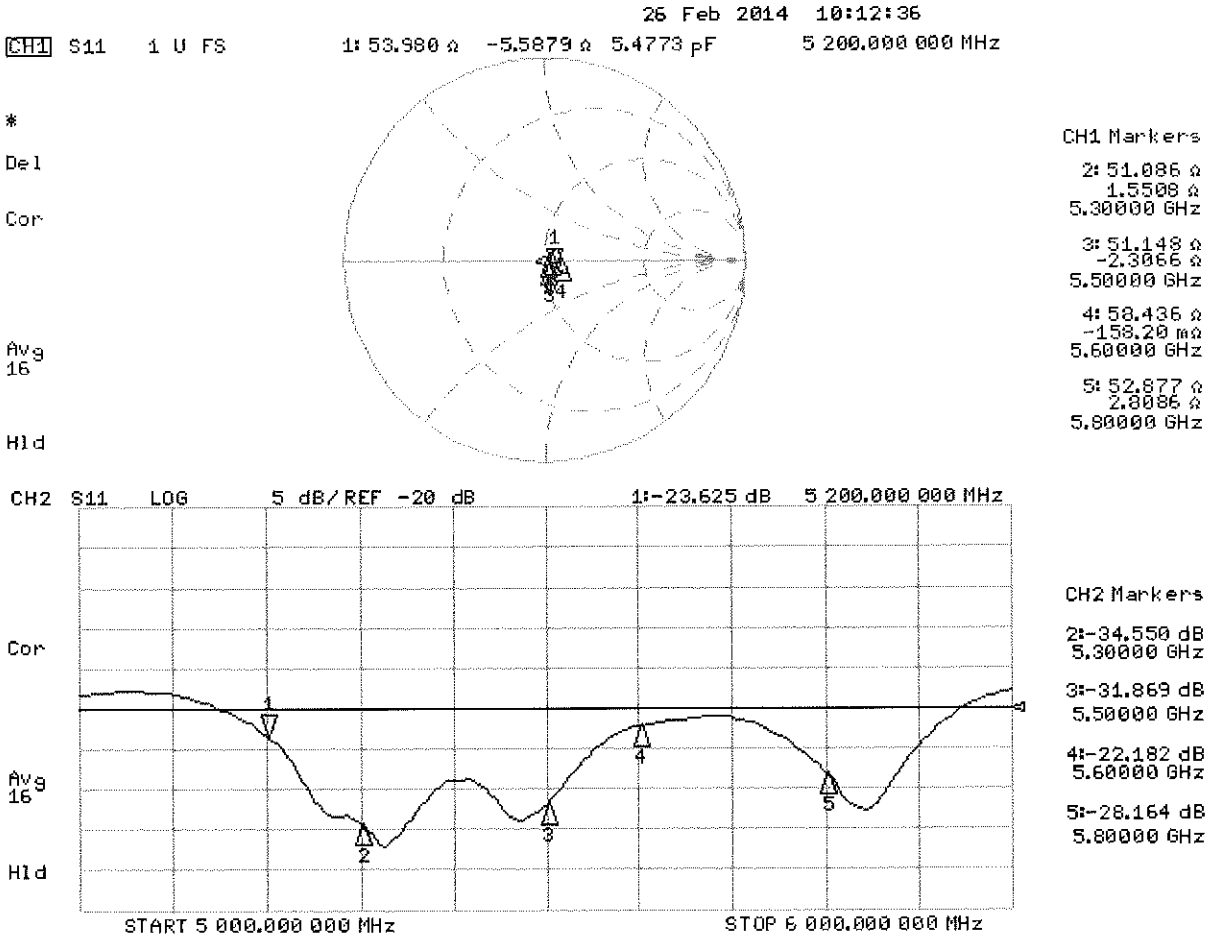
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 62.007 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 32.7 W/kg
SAR(1 g) = 8.18 W/kg; SAR(10 g) = 2.33 W/kg
Maximum value of SAR (measured) = 19.4 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.638 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 33.0 W/kg
SAR(1 g) = 7.87 W/kg; SAR(10 g) = 2.23 W/kg
Maximum value of SAR (measured) = 19.0 W/kg



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

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 25.02.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1120

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 5.4 S/m; ε_r = 47.8; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5300 MHz; σ = 5.53 S/m; ε_r = 47.6; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5500 MHz; σ = 5.8 S/m; ε_r = 47.3; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5600 MHz; σ = 5.94 S/m; ε_r = 47.1; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5800 MHz; σ = 6.21 S/m; ε_r = 46.8; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.01, 5.01, 5.01); Calibrated: 30.12.2013, ConvF(4.76, 4.76, 4.76); Calibrated: 30.12.2013, ConvF(4.52, 4.52, 4.52); Calibrated: 30.12.2013, ConvF(4.3, 4.3, 4.3); Calibrated: 30.12.2013, ConvF(4.47, 4.47, 4.47); Calibrated: 30.12.2013;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

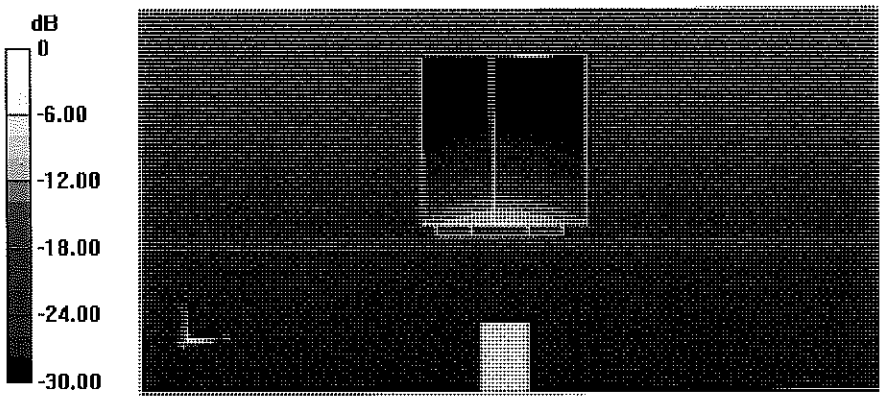
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.562 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 29.5 W/kg
SAR(1 g) = 7.43 W/kg; SAR(10 g) = 2.08 W/kg
Maximum value of SAR (measured) = 17.7 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 58.903 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 31.1 W/kg
SAR(1 g) = 7.62 W/kg; SAR(10 g) = 2.14 W/kg
Maximum value of SAR (measured) = 18.4 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.015 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 34.5 W/kg
SAR(1 g) = 7.96 W/kg; SAR(10 g) = 2.21 W/kg
Maximum value of SAR (measured) = 19.5 W/kg

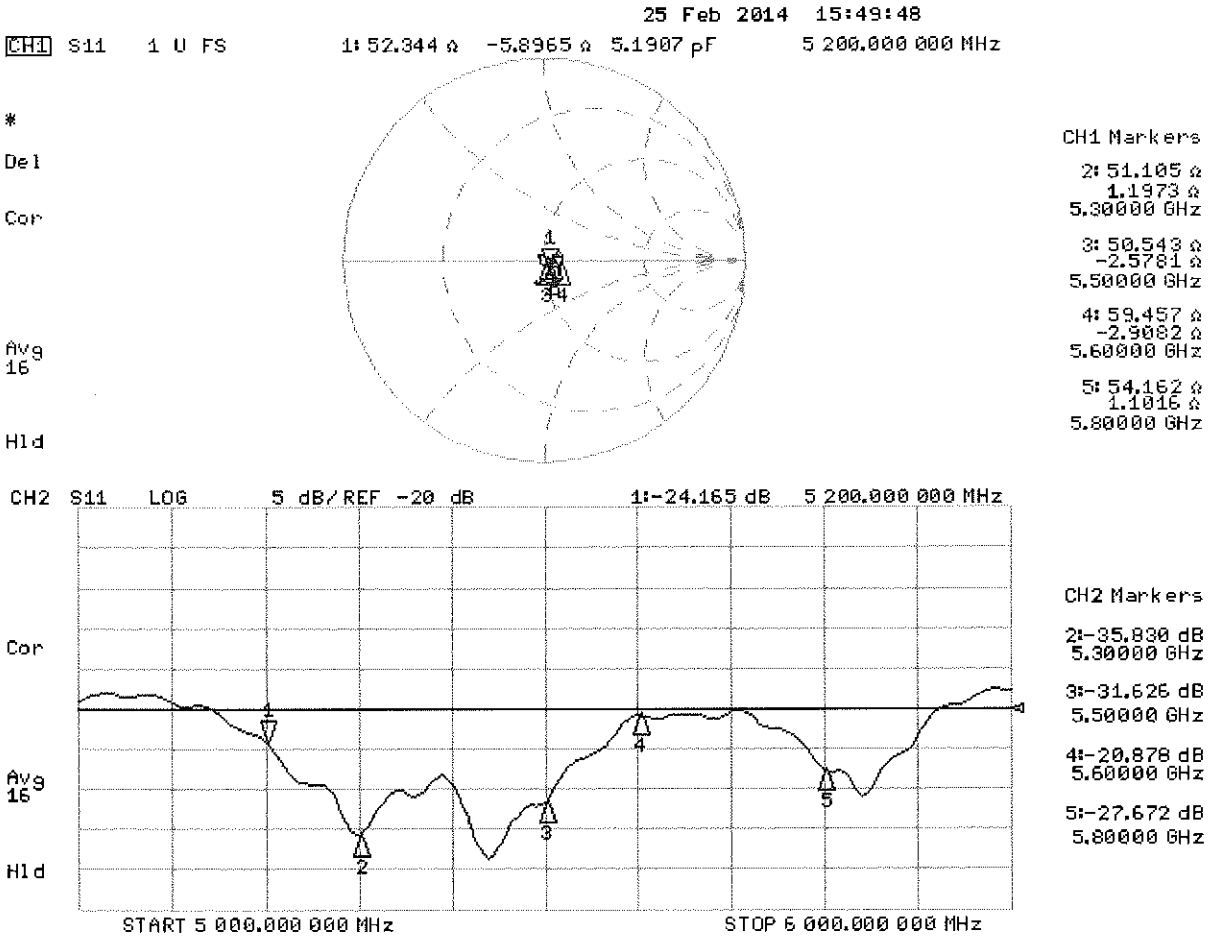
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 58.626 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 35.6 W/kg
SAR(1 g) = 7.98 W/kg; SAR(10 g) = 2.21 W/kg
Maximum value of SAR (measured) = 19.8 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 55.428 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 34.9 W/kg
SAR(1 g) = 7.47 W/kg; SAR(10 g) = 2.07 W/kg
Maximum value of SAR (measured) = 18.8 W/kg



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

Impedance Measurement Plot for Body TSL



APPENDIX D: SAR TISSUE SPECIFICATIONS

Measurement Procedure for Tissue verification:

1) The network analyzer and probe system was configured and calibrated.
2) The probe was immersed in the tissue. The tissue was placed in a nonmetallic container. Trapped air bubbles beneath the flange were minimized by placing the probe at a slight angle.
3) The complex admittance with respect to the probe aperture was measured
4) The complex relative permittivity 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)	835	1900	2450	5200-5800
Tissue	Body	Body	Body	Body
Ingredients (% by weight)				
Bactericide	0.1			
DGBE		29.44	26.7	
HEC	1			
NaCl	0.94	0.39	0.1	
Sucrose	44.9			
Polysorbate (Tween) 80				20
Water	53.06	70.17	73.2	80

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APPENDIX E: SAR SYSTEM VALIDATION

Per FCC KDB 865664 D02v01, SAR system validation status should be documented to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the required tissue- equivalent media for system validation, according to the procedures outlined in 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
C	835	9/10/2014	3213	ES3DV3	835	Body	0.973	53.81	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
B	2450	10/20/2014	3318	ES3DV3	2450	Body	2.039	50.74	PASS	PASS	PASS	OFDM	N/A	PASS
A	5200	9/15/2014	3920	EX3DV4	5200	Body	5.404	47.69	PASS	PASS	PASS	OFDM	N/A	PASS
A	5300	9/15/2014	3920	EX3DV4	5300	Body	5.542	47.51	PASS	PASS	PASS	OFDM	N/A	PASS
A	5500	9/15/2014	3920	EX3DV4	5500	Body	5.804	47.22	PASS	PASS	PASS	OFDM	N/A	PASS
A	5600	9/15/2014	3920	EX3DV4	5600	Body	5.948	47.06	PASS	PASS	PASS	OFDM	N/A	PASS
A	5800	9/15/2014	3920	EX3DV4	5800	Body	6.220	46.75	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.

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APPENDIX G: SENSOR TRIGGERING DATA SUMMARY

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A3LSC03G Sensor Triggering Data Summary

Per FCC KDB Publication 616217 D04v01, this device was tested by the manufacturer to determine the proximity sensor triggering distances for the back and top edge of the device. The measured output power within ± 5 mm of the triggering points (or until touching the phantom) is included for back side and each applicable edge.

To ensure all production units are compliant it is necessary to test SAR at a distance 1 mm less than the smallest distance from the device and SAR phantom (determined from these triggering tests according to the KDB 616217 D04v01) with the device at maximum output power without power reduction. These SAR Tests are included in addition to the SAR tests for the device touching the SAR phantom, with reduced power.

The operational description contains information explaining how this device remains compliant in the event of a sensor malfunction.

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Back Side

Moving device toward the phantom:

KDB 616217 6.2.6 Measured Power [dBm]											
Distance[mm]	22	21	20	19	18	17	16	15	14	13	12
GPRS 850 1Tx	32.67	32.63	32.62	32.94	32.65	24.72	24.8	24.64	24.78	24.66	24.63
GPRS 850 2Tx	28.92	28.82	28.61	28.83	28.78	23.11	23.25	23.31	23.42	23.2	23.24
GPRS 850 3Tx	27.86	27.92	27.77	27.7	27.75	21.94	21.6	21.95	21.64	21.8	21.62
GPRS 850 4Tx	26.8	26.87	26.65	26.74	26.83	20.3	20.23	20.1	20.2	20.37	20.29
EDGE850 1Tx	26.73	26.67	26.6	26.88	26.69	21.45	21.27	21.13	21.23	21.4	21.3
EDGE850 2Tx	26.4	26.26	26.44	26.28	26.13	19.81	19.93	19.88	19.66	19.8	19.64
EDGE850 3Tx	22.45	22.17	22.4	22.13	22.4	15.84	15.94	15.88	15.87	15.64	15.71
EDGE850 4Tx	21.16	21.39	21.16	21.34	21.41	14.72	14.95	14.65	14.93	14.67	14.84
GPRS 1900 1Tx	29.44	29.21	29.32	29.35	29.23	19.43	19.22	19.38	19.26	19.29	19.39
GPRS 1900 2Tx	28.64	28.86	28.68	28.7	28.75	18.28	18.14	18.1	18.22	18.11	18.43
GPRS 1900 3Tx	27.37	27.14	27.42	27.34	27.31	17.36	17.22	17.13	17.13	17.36	17.38
GPRS 1900 4Tx	25.82	25.86	25.78	25.83	25.85	15.79	15.89	15.63	15.82	15.85	15.77
EDGE1900 1Tx	25.74	25.81	25.85	25.88	25.81	18.18	18.38	18.4	18.23	18.14	18.39
EDGE1900 2Tx	25.13	25.35	25.28	25.32	25.12	15.75	15.74	15.93	15.9	15.89	15.86
EDGE1900 3Tx	20.19	20.21	20.34	20.13	20.32	10.77	10.73	10.88	10.81	10.73	10.92
EDGE1900 4Tx	19.13	19.31	19.12	19.24	19.2	10.45	10.3	10.27	10.11	10.11	10.41
WCDMA 850	23.23	23.18	23.15	23.37	23.15	15.2	15.22	15.17	15.37	15.14	15.14

Moving device away from the phantom:

KDB 616217 6.2.8 Measured Power [dBm]											
Distance[mm]	22	21	20	19	18	17	16	15	14	13	12
GPRS 850 1Tx	32.82	32.78	32.73	32.67	32.87	24.83	24.71	24.74	24.88	24.95	24.7
GPRS 850 2Tx	28.91	28.79	28.67	28.81	28.62	23.18	23.45	23.33	23.27	23.35	23.24
GPRS 850 3Tx	27.61	27.62	27.88	27.79	27.77	21.66	21.71	21.62	21.89	21.77	21.88
GPRS 850 4Tx	26.72	26.82	26.83	26.73	26.86	20.24	20.1	20.21	20.42	20.32	20.44
EDGE850 1Tx	26.94	26.9	26.81	26.6	26.85	21.45	21.12	21.13	21.26	21.17	21.42
EDGE850 2Tx	26.43	26.27	26.36	26.34	26.27	19.82	19.93	19.74	19.79	19.6	19.81
EDGE850 3Tx	22.2	22.32	22.36	22.12	22.23	15.77	15.77	15.73	15.82	15.93	15.81
EDGE850 4Tx	21.34	21.16	21.4	21.41	21.4	14.77	14.72	14.65	14.79	14.79	14.82
GPRS 1900 1Tx	29.37	29.3	29.29	29.26	29.11	19.2	19.24	19.17	19.16	19.14	19.1
GPRS 1900 2Tx	28.6	28.66	28.65	28.79	28.87	18.44	18.37	18.27	18.3	18.24	18.32
GPRS 1900 3Tx	27.31	27.17	27.21	27.2	27.11	17.26	17.22	17.38	17.41	17.23	17.23
GPRS 1900 4Tx	25.86	25.61	25.69	25.78	25.95	15.81	15.67	15.71	15.64	15.95	15.71
EDGE1900 1Tx	25.88	25.78	25.89	25.76	25.75	18.11	18.11	18.42	18.1	18.43	18.33
EDGE1900 2Tx	25.39	25.33	25.14	25.39	25.33	15.68	15.77	15.6	15.63	15.7	15.69
EDGE1900 3Tx	20.14	20.34	20.23	20.25	20.12	10.84	10.9	10.77	10.76	10.7	10.92
EDGE1900 4Tx	19.33	19.4	19.22	19.29	19.43	10.11	10.21	10.26	10.17	10.36	10.45
WCDMA 850	23.31	23.4	23.13	23.39	23.21	15.17	15.43	15.38	15.22	15.2	15.28

Based on the most conservative measured triggering distance of 17 mm, additional SAR measurements were required at 16 mm from the back side.

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Bottom Edge

Moving device toward the phantom:

KDB 616217 6.2.6 Measured Power [dBm]											
Distance[mm]	17	16	15	14	13	12	11	10	9	8	7
GPRS 850 1Tx	32.76	32.65	32.86	32.84	32.93	24.66	24.82	24.8	24.81	24.87	24.79
GPRS 850 2Tx	28.75	28.89	28.83	28.6	28.86	23.17	23.14	23.4	23.41	23.42	23.39
GPRS 850 3Tx	27.6	27.66	27.9	27.92	27.8	21.61	21.66	21.69	21.62	21.63	21.71
GPRS 850 4Tx	26.93	26.72	26.91	26.75	26.62	20.11	20.17	20.44	20.1	20.33	20.23
EDGE850 1Tx	26.8	26.75	26.85	26.76	26.85	21.45	21.25	21.45	21.21	21.1	21.14
EDGE850 2Tx	26.29	26.34	26.34	26.42	26.42	19.76	19.95	19.8	19.92	19.72	19.92
EDGE850 3Tx	22.44	22.24	22.38	22.45	22.36	15.74	15.72	15.73	15.79	15.82	15.83
EDGE850 4Tx	21.1	21.13	21.34	21.29	21.31	14.95	14.81	14.92	14.67	14.84	14.66
GPRS 1900 1Tx	29.33	29.13	29.33	29.32	29.4	19.41	19.22	19.4	19.45	19.17	19.22
GPRS 1900 2Tx	28.72	28.71	28.93	28.85	28.62	18.39	18.14	18.41	18.15	18.24	18.31
GPRS 1900 3Tx	27.31	27.13	27.21	27.29	27.17	17.13	17.17	17.19	17.14	17.16	17.39
GPRS 1900 4Tx	25.68	25.67	25.69	25.63	25.86	15.76	15.73	15.82	15.65	15.75	15.76
EDGE1900 1Tx	25.72	25.87	25.79	25.95	25.95	18.17	18.4	18.1	18.33	18.16	18.22
EDGE1900 2Tx	25.28	25.42	25.21	25.13	25.21	15.92	15.86	15.81	15.89	15.61	15.76
EDGE1900 3Tx	20.16	20.25	20.29	20.4	20.44	10.92	10.94	10.86	10.78	10.72	10.63
EDGE1900 4Tx	19.37	19.24	19.13	19.13	19.15	10.29	10.2	10.27	10.18	10.2	10.12
WCDMA 850	23.22	23.18	23.24	23.16	23.23	15.13	15.42	15.38	15.27	15.18	15.23

Moving device away from the phantom:

KDB 616217 6.2.8 Measured Power [dBm]											
Distance[mm]	17	16	15	14	13	12	11	10	9	8	7
GPRS 850 1Tx	32.8	32.64	32.85	32.89	32.95	24.89	24.85	24.76	24.85	24.62	24.91
GPRS 850 2Tx	28.94	28.75	28.65	28.75	28.7	23.23	23.19	23.39	23.39	23.14	23.44
GPRS 850 3Tx	27.89	27.6	27.69	27.87	27.78	21.93	21.6	21.67	21.71	21.68	21.64
GPRS 850 4Tx	26.9	26.83	26.63	26.91	26.79	20.41	20.22	20.14	20.14	20.45	20.45
EDGE850 1Tx	26.7	26.62	26.61	26.94	26.82	21.27	21.28	21.11	21.14	21.14	21.25
EDGE850 2Tx	26.36	26.13	26.2	26.32	26.15	19.75	19.79	19.76	19.68	19.84	19.93
EDGE850 3Tx	22.43	22.32	22.18	22.15	22.14	15.74	15.93	15.72	15.83	15.61	15.95
EDGE850 4Tx	21.27	21.41	21.16	21.25	21.26	14.78	14.7	14.9	14.71	14.81	14.79
GPRS 1900 1Tx	29.1	29.3	29.37	29.2	29.4	19.41	19.37	19.24	19.2	19.12	19.21
GPRS 1900 2Tx	28.66	28.77	28.9	28.89	28.87	18.13	18.23	18.31	18.31	18.4	18.37
GPRS 1900 3Tx	27.39	27.25	27.21	27.15	27.13	17.33	17.17	17.14	17.42	17.24	17.3
GPRS 1900 4Tx	25.76	25.92	25.77	25.76	25.71	15.64	15.61	15.63	15.88	15.95	15.93
EDGE1900 1Tx	25.64	25.92	25.7	25.84	25.79	18.13	18.21	18.35	18.42	18.31	18.13
EDGE1900 2Tx	25.1	25.45	25.4	25.37	25.36	15.64	15.65	15.62	15.84	15.6	15.65
EDGE1900 3Tx	20.22	20.11	20.38	20.31	20.41	10.73	10.95	10.77	10.82	10.84	10.66
EDGE1900 4Tx	19.16	19.39	19.15	19.13	19.39	10.27	10.26	10.13	10.24	10.16	10.28
WCDMA 850	23.16	23.19	23.12	23.34	23.13	15.36	15.32	15.35	15.36	15.18	15.22

Based on the most conservative measured triggering distance of 12 mm, additional SAR measurements were required at 11 mm from the bottom edge.

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Right Edge

Moving device toward the phantom:

KDB 616217 6.2.6 Measured Power [dBm]											
Distance[mm]	11	10	9	8	7	6	5	4	3	2	1
GPRS 850 1Tx	32.87	32.79	32.88	32.9	32.82	24.66	24.82	24.71	24.85	24.78	24.93
GPRS 850 2Tx	28.86	28.86	28.73	28.9	28.69	23.21	23.41	23.23	23.44	23.28	23.13
GPRS 850 3Tx	27.7	27.93	27.76	27.95	27.67	21.68	21.7	21.71	21.8	21.69	21.66
GPRS 850 4Tx	26.92	26.84	26.81	26.64	26.79	20.13	20.3	20.27	20.19	20.15	20.19
EDGE850 1Tx	26.91	26.68	26.78	26.88	26.72	21.19	21.42	21.15	21.19	21.2	21.35
EDGE850 2Tx	26.35	26.36	26.3	26.31	26.22	19.68	19.73	19.92	19.91	19.61	19.81
EDGE850 3Tx	22.31	22.1	22.12	22.12	22.36	15.6	15.62	15.73	15.71	15.73	15.66
EDGE850 4Tx	21.11	21.34	21.43	21.16	21.41	14.81	14.74	14.9	14.66	14.75	14.75
GPRS 1900 1Tx	29.12	29.24	29.45	29.29	29.22	19.21	19.28	19.1	19.44	19.22	19.18
GPRS 1900 2Tx	28.82	28.63	28.65	28.94	28.81	18.39	18.23	18.29	18.22	18.4	18.42
GPRS 1900 3Tx	27.33	27.18	27.16	27.19	27.11	17.16	17.44	17.24	17.18	17.2	17.31
GPRS 1900 4Tx	25.7	25.68	25.85	25.6	25.74	15.8	15.69	15.8	15.93	15.77	15.81
EDGE1900 1Tx	25.88	25.88	25.65	25.84	25.81	18.31	18.18	18.3	18.34	18.45	18.21
EDGE1900 2Tx	25.33	25.17	25.38	25.26	25.16	15.93	15.7	15.61	15.78	15.64	15.69
EDGE1900 3Tx	20.45	20.23	20.24	20.19	20.29	10.73	10.85	10.85	10.92	10.86	10.89
EDGE1900 4Tx	19.16	19.25	19.32	19.26	19.37	10.41	10.27	10.27	10.16	10.17	10.26
WCDMA 850	23.36	23.3	23.42	23.24	23.23	15.39	15.17	15.39	15.35	15.32	15.15

Moving device away from the phantom:

KDB 616217 6.2.8 Measured Power [dBm]											
Distance[mm]	11	10	9	8	7	6	5	4	3	2	1
GPRS 850 1Tx	32.64	32.82	32.79	32.7	32.63	24.85	24.68	24.9	24.77	24.84	24.78
GPRS 850 2Tx	28.62	28.9	28.61	28.66	28.79	23.29	23.39	23.12	23.37	23.23	23.42
GPRS 850 3Tx	27.94	27.91	27.92	27.95	27.65	21.87	21.66	21.81	21.9	21.7	21.6
GPRS 850 4Tx	26.62	26.76	26.66	26.85	26.73	20.31	20.31	20.29	20.1	20.1	20.3
EDGE850 1Tx	26.89	26.6	26.81	26.9	26.76	21.3	21.21	21.18	21.11	21.14	21.23
EDGE850 2Tx	26.11	26.43	26.33	26.32	26.2	19.95	19.69	19.94	19.77	19.87	19.74
EDGE850 3Tx	22.32	22.19	22.13	22.44	22.44	15.92	15.75	15.64	15.69	15.94	15.78
EDGE850 4Tx	21.37	21.1	21.36	21.27	21.17	14.89	14.78	14.6	14.69	14.75	14.82
GPRS 1900 1Tx	29.27	29.1	29.17	29.32	29.1	19.35	19.15	19.18	19.38	19.26	19.11
GPRS 1900 2Tx	28.67	28.73	28.75	28.63	28.87	18.34	18.31	18.26	18.36	18.2	18.45
GPRS 1900 3Tx	27.37	27.36	27.21	27.39	27.18	17.11	17.33	17.23	17.42	17.1	17.27
GPRS 1900 4Tx	25.82	25.63	25.62	25.84	25.95	15.83	15.6	15.75	15.95	15.81	15.7
EDGE1900 1Tx	25.68	25.64	25.9	25.78	25.62	18.28	18.26	18.22	18.24	18.35	18.45
EDGE1900 2Tx	25.19	25.33	25.15	25.32	25.22	15.71	15.9	15.76	15.88	15.76	15.76
EDGE1900 3Tx	20.28	20.44	20.43	20.43	20.11	10.61	10.85	10.8	10.63	10.8	10.79
EDGE1900 4Tx	19.11	19.4	19.26	19.3	19.21	10.28	10.16	10.19	10.3	10.34	10.36
WCDMA 850	23.25	23.29	23.21	23.43	23.19	15.22	15.4	15.44	15.22	15.37	15.15

Based on the most conservative measured triggering distance of 6 mm, additional SAR measurements were required at 5 mm from the right edge.

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