



SAR EVALUATION REPORT

Applicant Name:

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Date of Testing:

10/03/13 -10/08/13; 12/12/13-12/16/13

Test Site/Location:

PCTEST Lab, Columbia, MD, USA

Document Serial No.:

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FCC ID:

A3LSMP901A

APPLICANT:

SAMSUNG ELECTRONICS, CO. LTD.

DUT Type:

Portable Tablet

Application Type:

Certification

FCC Rule Part(s):

CFR §2.1093

Model(s):

SM-P901

Equipment Class	Band & Mode	Tx Frequency	Measured Conducted Power [dBm]	SAR
				1 gm Body (W/kg)
PCB	GSM/GPRS/EDGE 850	824.20 - 848.80 MHz	28.94	0.94
PCB	UMTS 850	826.40 - 846.60 MHz	22.18	0.69
PCB	GSM/GPRS/EDGE 1900	1850.20 - 1909.80 MHz	25.62	0.75
PCB	UMTS 1900	1852.4 - 1907.6 MHz	22.54	0.91
DTS	2.4 GHz WLAN	2412 - 2462 MHz	13.26	1.02
DTS	5.8 GHz WLAN	5745 - 5825 MHz	10.32	0.26
NII	5.2 GHz WLAN	5180 - 5240 MHz	10.23	0.57
NII	5.3 GHz WLAN	5260 - 5320 MHz	10.34	0.67
NII	5.5 GHz WLAN	5500 - 5700 MHz	10.39	0.61
DSS/DTS	Bluetooth	2402 - 2480 MHz	7.49	N/A
Simultaneous SAR per KDB 690783 D01v01r02:				1.59

Note: Powers in the above table represent output powers for the SAR test configurations and may not represent the highest output powers for all configurations for each mode.

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



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1 DEVICE UNDER TEST

1.1 Device Overview

Band & Mode	Operating Modes	Tx Frequency
GSM/GPRS/EDGE 850	Voice/Data	824.20 - 848.80 MHz
UMTS 850	Voice/Data	826.40 - 846.60 MHz
GSM/GPRS/EDGE 1900	Voice/Data	1850.20 - 1909.80 MHz
UMTS 1900	Voice/Data	1852.4 - 1907.6 MHz
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 proximity sensor for SAR compliance. The capacitive proximity sensor is activated when used in close proximity to the user's body. The capacitive proximity sensor triggers power reduction for data and voice modes and is only applicable for tablet operations.

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.

Maximum Power – Capacitive Sensor Not Active:

Mode / Band		Voice (dBm)	Burst Average GMSK (dBm)					Burst Average 8-PSK (dBm)			
		1 TX Slot	1 TX Slots	2 TX Slots	3 TX Slots	4 TX Slots	1 TX Slots	2 TX Slots	3 TX Slots	4 TX Slots	
GSM/GPRS/EDGE 850	Maximum	33.0	33.0	31.0	29.5	28.0	27.5	26.5	25.5	24.5	
	Nominal	32.5	32.5	30.5	29.0	27.5	27.0	26.0	25.0	24.0	
GSM/GPRS/EDGE 1900	Maximum	30.0	30.0	29.0	27.0	26.0	26.5	25.5	24.5	23.5	
	Nominal	29.5	29.5	28.5	26.5	25.5	26.0	25.0	24.0	23.0	

Mode / Band		Modulated Average (dBm)		
		3GPP Rel 99 WCDMA	3GPP Rel 5 HSDPA	3GPP Rel 6 HSUPA
UMTS Band 5 (850 MHz)	Maximum	22.75	22.75	22.75
	Nominal	22.25	22.25	22.25
UMTS Band 2 (1900 MHz)	Maximum	22.75	22.75	22.75
	Nominal	22.25	22.25	22.25

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Mode / Band		Modulated Average (in dBm)
IEEE 802.11b (2.4 GHz)	Maximum	13.5
	Nominal	13.0
IEEE 802.11g (2.4 GHz)	Maximum	12.5
	Nominal	12.0
IEEE 802.11n (2.4 GHz)	Maximum	10.5
	Nominal	10.0
IEEE 802.11a (5 GHz)	Maximum	10.5
	Nominal	10.0
IEEE 802.11n (5 GHz)	Maximum	10.5
	Nominal	10.0
IEEE 802.11ac (5 GHz)	Maximum	10.5
	Nominal	10.0
Bluetooth	Maximum	7.5
	Nominal	7.0
Bluetooth LE	Maximum	4.5
	Nominal	4.0

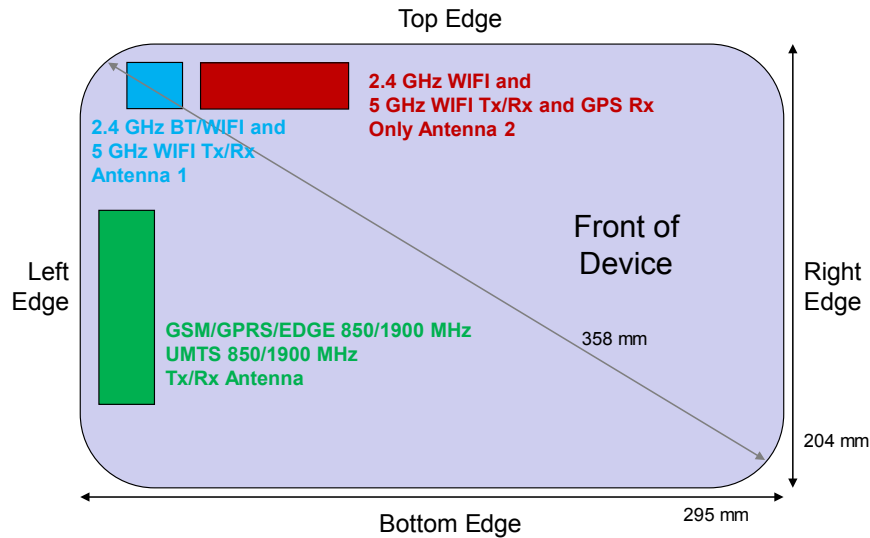
Reduced Power – Capacitive Sensor Active:

Mode / Band		Voice (dBm)	Burst Average GMSK (dBm)				Burst Average 8-PSK (dBm)			
		1 TX Slot	1 TX Slots	2 TX Slots	3 TX Slots	4 TX Slots	1 TX Slots	2 TX Slots	3 TX Slots	4 TX Slots
GSM/GPRS/EDGE 850	Maximum	28.0	28.0	26.0	24.5	23.0	22.5	21.5	20.5	19.5
	Nominal	27.5	27.5	25.5	24.0	22.5	22.0	21.0	20.0	19.0
GSM/GPRS/EDGE 1900	Maximum	20.0	20.0	19.0	17.0	16.0	16.5	15.5	14.5	13.5
	Nominal	19.5	19.5	18.5	16.5	15.5	16.0	15.0	14.0	13.0

Mode / Band		Modulated Average (dBm)		
		3GPP Rel 99 WCDMA	3GPP Rel 5 HSDPA	3GPP Rel 6 HSUPA
UMTS Band 5 (850 MHz)	Maximum	17.75	17.75	17.75
	Nominal	17.25	17.25	17.25
UMTS Band 2 (1900 MHz)	Maximum	13.75	13.75	13.75
	Nominal	13.25	13.25	13.25

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1.4 DUT Antenna Locations



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

Figure 1-1
DUT Antenna Locations

1.5 Simultaneous Transmission Capabilities

According to FCC KDB Publication 447498 D05v01, transmitters are considered to be transmitting simultaneously when there is overlapping transmission, with the exception of transmissions during network hand-offs with maximum hand-off duration less than 30 seconds. This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis according to FCC KDB Publication 447498 D01v05 3) procedures.

Table 1-1
Simultaneous Transmission Scenarios

No.	Capable Transmit Configurations	Body	Note
		FCC KDB 616217	
1	GSM/GPRS/EDGE 850/1900 Voice/Data + WIFI 2.4 GHz	Yes	2.4 GHz WIFI Direct
2	UMTS 850/1900 Voice/Data + WIFI 2.4 GHz	Yes	2.4 GHz WIFI Direct
4	GSM/GPRS/EDGE 850/1900 Voice/Data + 2.4 GHz Bluetooth	Yes	
5	UMTS 850/1900 Voice/Data + 2.4 GHz Bluetooth	Yes	
7	GSM/GPRS/EDGE 850/1900 Voice/Data + WIFI 5 GHz	Yes	5 GHz WIFI Direct
8	UMTS 850/1900 Voice/Data + WIFI 5 GHz	Yes	5 GHz WIFI Direct

Notes:

- Per FCC KDB 616217 D04 4.3, when voice mode is limited to speaker mode or headset operations only, additional SAR testing for tablet voice use is not required. Therefore, voice standalone and simultaneous combinations are not evaluated for body configurations. Corresponding data modes are used for summation with Bluetooth when applicable.
- 2.4 GHz WLAN, 2.4 GHz Bluetooth, and 5 GHz WLAN share the same antenna path and cannot transmit simultaneously.
- When the user utilizes multiple services in UMTS 3G mode it uses multi-Radio Access Bearer or multi-RAB. The power control is based on a physical control channel (Dedicated Physical Control Channel [DPCCH]) and power control will be adjusted to meet the needs of both services. Therefore, the UMTS+WLAN scenario also represents the UMTS Voice/DATA + WLAN Hotspot scenario

This device supports MIMO Tx for WLAN 802.11n/ac. Each WLAN antenna can transmit independently or together when operating with MIMO.

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1.6 SAR Test Exclusions Applied

(A) WIFI/BT

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

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

Based on the maximum conducted power of Bluetooth (rounded to the nearest mW) and the antenna to user separation distance, Bluetooth SAR was not required; $[(6/5) * \sqrt{2.441}] = 1.9 < 3.0$. Per KDB Publication 447498 D01v05, the maximum power of the channel was rounded to the nearest mW before calculation.

Based on the maximum conducted power of Bluetooth LE (rounded to the nearest mW) and the antenna to user separation distance, Bluetooth LE SAR was not required; $[(3/5) * \sqrt{2.44}] = 0.9 < 3.0$. Per KDB Publication 447498 D01v05, the maximum power of the channel was rounded to the nearest mW before calculation.

This device supports 20 MHz and 40 MHz Bandwidths for IEEE 802.11n for 5 GHz WIFI only. IEEE 802.11n was not evaluated for SAR since the average output power of 20 MHz and 40 MHz bandwidths was not more than 0.25 dB higher than the average output power of IEEE 802.11a.

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

Per April 2013 TCB Workshop notes, full 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 was evaluated for the highest IEEE 802.11a position in each 5 GHz band and exposure condition.

(B) Licensed Transmitter(s)

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

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

1.7 Guidance Applied

- FCC KDB Publication 941225 D01-D06 (2G/3G)
- FCC KDB Publication 248227 D01v01r02 (SAR Considerations for 802.11 Devices)
- FCC KDB Publication 447498 D01v05 (General SAR Guidance)
- FCC KDB Publication 865664 D01-D02 (SAR Measurements up to 6 GHz)
- FCC KDB Publication 616217 D04 (Tablet SAR Considerations)
- April 2013 TCB Workshop Notes (IEEE 802.11ac)

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1.8 Device Serial Numbers

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

Mode	Maximum Power Body Serial Number	Reduced Power Body Serial Number
GSM/GPRS/EDGE 850	310-3	310-1
UMTS 850	310-3	310-1
GSM/GPRS/EDGE 1900	310-3	310-1
UMTS 1900	310-3	310-1
2.4 GHz WLAN	2710-4	-
5 GHz WLAN	2710-5	-

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

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [3] and Health Canada RF Exposure Guidelines Safety Code 6 [24]. The measurement procedure described in IEEE/ANSI C95.3-2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave [4] is used for guidance in measuring the Specific Absorption Rate (SAR) due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the International Committee for Non-Ionizing Radiation Protection (ICNIRP) in Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields,” Report No. Vol 74. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

2.1 SAR Definition

Specific Absorption Rate is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (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/m³)
- E = Total RMS electric field strength (V/m)

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

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3 DOSIMETRIC ASSESSMENT

3.1 Measurement Procedure

The evaluation was performed using the following procedure:

1. The SAR distribution at the exposed side of the head or body was measured at a distance no greater than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the device-head and body interface and the horizontal grid resolution was determined per FCC KDB Publication 865664 D01v01 (See Table 3-1).
2. The point SAR measurement was taken at the maximum SAR region determined from Step 1 to enable the monitoring of SAR fluctuations/drifts during the 1g/10g cube evaluation. SAR at this fixed point was measured and used as a reference value.
3. Based on the area scan data, the peak of the region with maximum SAR was determined by spline interpolation. Around this point, a volume was assessed according to the measurement resolution and volume size requirements of FCC KDB Publication 865664 D01v01 (See Table 3-1). On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the DASY manual online for more details):
 - a. The data was extrapolated to the surface of the outer-shell of the phantom. The combined distance extrapolated was the combined distance from the center of the dipoles 2.7mm away from the tip of the probe housing plus the 1.2 mm distance between the surface and the lowest measuring point. The extrapolation was based on a least-squares algorithm. A polynomial of the fourth order was calculated through the points in the z-axis (normal to the phantom shell).
 - b. After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1g or 10g) using a 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the "Not a knot" condition (in x, y, and z directions). The volume was then integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were obtained through interpolation, in order to calculate the averaged SAR.
 - c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as step 2, was re-measured after the zoom scan was complete to calculate the SAR drift. If the drift deviated by more than 5%, the SAR test and drift measurements were repeated.

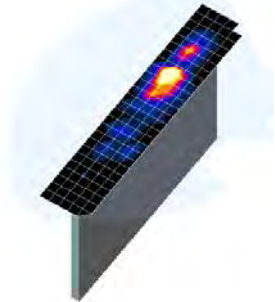


Figure 3-1
Sample SAR Area Scan

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

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

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4 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 voice/data powers in tablet-device use conditions.

While the device is touching the user on the antenna, the capacitive proximity sensor activates and thus reduces the maximum output power allowed. However, when the device is moved beyond the sensor triggering distance, the sensor will no longer be active and thus 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 capacitive proximity sensor activation distance for the back side of the device is 14 mm, a conservative distance of 13 mm was tested for SAR on the back side at maximum power. Since the capacitive proximity sensor activation distance for the left edge of the device is 16 mm, a conservative distance of 15 mm was tested for SAR on the left edge, at maximum power. Sensor triggering distance summary data is included in Appendix G. The capacitive proximity sensor does not trigger power reduction from the front side, bottom edge, top edge, or right edge of the device.

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 <i>General Population</i> (W/kg) or (mW/g)	CONTROLLED ENVIRONMENT <i>Occupational</i> (W/kg) or (mW/g)
Peak Spatial Average SAR Head	1.6	8.0
Whole Body SAR	0.08	0.4
Peak Spatial Average SAR Hands, Feet, Ankle, Wrists, etc.	4.0	20

1. The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
2. The Spatial Average value of the SAR averaged over the whole body.
3. The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

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

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 or AMR with TPC (transmit power control) set to all "1s".

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

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} (Note 1, Note 2)	CM (dB) (Note 3)	MPR (dB) (Note 3)
1	2/15	15/15	64	2/15	4/15	0.0	0.0
2	12/15 (Note 4)	15/15 (Note 4)	64	12/15 (Note 4)	24/15	1.0	0.0
3	15/15	8/15	64	15/8	30/15	1.5	0.5
4	15/15	4/15	64	15/4	30/15	1.5	0.5
Note 1: Δ_{ACK} , Δ_{NACK} and $\Delta_{CQI} = 8 \Leftrightarrow A_{HS} = \beta_{HS}/\beta_c = 30/15 \Leftrightarrow \beta_{HS} = 30/15 * \beta_c$. Note 2: For the HS-DPCCH power mask requirement test in clause 5.2C, 5.7A, and the Error Vector Magnitude (EVM) with HS-DPCCH test in clause 5.13.1A, and HSDPA EVM with phase discontinuity in clause 5.13.1AA, Δ_{ACK} and $\Delta_{NACK} = 8$ ($A_{HS} = 30/15$) with $\beta_{HS} = 30/15 * \beta_c$, and $\Delta_{CQI} = 7$ ($A_{HS} = 24/15$) with $\beta_{HS} = 24/15 * \beta_c$. Note 3: CM = 1 for $\beta_c/\beta_d = 12/15$, $\beta_{HS}/\beta_c = 24/15$. For all other combinations of DPDCCH, 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 23.121-1

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_a (SF)	β_c/β_d	$\beta_{ac}^{(1)}$	β_{ec}	β_{ed}	β_{ed} (SF)	β_{ed} (codes)	CM ⁽²⁾ (dB)	MPR (dB)	AG ⁽⁴⁾ Index	E-TFCI
1	11/15 ⁽³⁾	15/15 ⁽³⁾	64	11/15 ⁽³⁾	22/15	209/225	1039/225	4	1	1.0	0.0	20	75
2	6/15	15/15	64	6/15	12/15	12/15	94/75	4	1	3.0	2.0	12	67
3	15/15	9/15	64	15/9	30/15	30/15	$\beta_{ed} = 47/15$ $\beta_{ed} = 47/15$	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 $\Delta_{OOF} = 8 \Leftrightarrow A_{15} = \beta_{15}/\beta_c = 30/15 \Leftrightarrow \beta_{15} = 30/15 * \beta_c$.

Note 2: CM = 1 for $\beta_c/\beta_d = 12/15$, $\beta_{15}/\beta_c = 24/15$. For all other combinations of DPDCH, DPCCCH, 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 [27]

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

For 5 GHz, the highest average RF output power channel across the default test channels at the lowest data rate was selected for SAR evaluation in 802.11a. When the adjacent channels are higher in power than the default channels, these "required channels" were considered instead of the default channels for SAR testing. 802.11n modes and higher data rates for 802.11a/n were evaluated only if the respective mode was 0.25 dB or higher than the 802.11a mode. 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 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.

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 GHz MIMO, 802.11n was evaluated. For 5 GHz MIMO, 802.11ac was evaluated since the maximum allowed output power was the same for both 802.11n/a

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7 RF CONDUCTED POWERS

7.1 GSM Conducted Powers

Table 7-1
Maximum GSM/GPRS/EDGE Average RF Conducted Powers
Representing Capacitive Sensor Not Active

		Maximum Burst-Averaged Output Power								
		Voice	GPRS/EDGE Data (GMSK)				EDGE Data (8-PSK)			
Band	Channel	GSM [dBm] CS (1 Slot)	GPRS [dBm] 1 Tx Slot	GPRS [dBm] 2 Tx Slot	GPRS [dBm] 3 Tx Slot	GPRS [dBm] 4 Tx Slot	EDGE [dBm] 1 Tx Slot	EDGE [dBm] 2 Tx Slot	EDGE [dBm] 3 Tx Slot	EDGE [dBm] 4 Tx Slot
GSM 850	128	32.40	32.39	30.44	29.02	27.48	26.95	25.93	24.90	23.93
	190	32.34	32.30	30.38	28.94	27.37	26.85	25.84	24.82	23.86
	251	32.35	32.33	30.37	28.90	27.38	26.90	25.88	24.82	23.85
GSM 1900	512	29.67	29.65	28.57	26.60	25.60	25.98	24.86	23.77	22.97
	661	29.64	29.64	28.60	26.63	25.62	25.92	24.87	23.82	22.96
	810	29.67	29.63	28.57	26.63	25.61	25.91	24.86	23.79	22.93
		Calculated Maximum Frame-Averaged Output Power								
		Voice	GPRS/EDGE Data (GMSK)				EDGE Data (8-PSK)			
Band	Channel	GSM [dBm] CS (1 Slot)	GPRS [dBm] 1 Tx Slot	GPRS [dBm] 2 Tx Slot	GPRS [dBm] 3 Tx Slot	GPRS [dBm] 4 Tx Slot	EDGE [dBm] 1 Tx Slot	EDGE [dBm] 2 Tx Slot	EDGE [dBm] 3 Tx Slot	EDGE [dBm] 4 Tx Slot
GSM 850	128	23.37	23.36	24.42	24.76	24.47	17.92	19.91	20.64	20.92
	190	23.31	23.27	24.36	24.68	24.36	17.82	19.82	20.56	20.85
	251	23.32	23.30	24.35	24.64	24.37	17.87	19.86	20.56	20.84
GSM 1900	512	20.64	20.62	22.55	22.34	22.59	16.95	18.84	19.51	19.96
	661	20.61	20.61	22.58	22.37	22.61	16.89	18.85	19.56	19.95
	810	20.64	20.60	22.55	22.37	22.60	16.88	18.84	19.53	19.92

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Table 7-2
Reduced GSM/GPRS/EDGE Average RF Conducted Powers
Representing Capacitive Sensor Active

		Maximum Burst-Averaged Output Power								
		Voice	GPRS/EDGE Data (GMSK)				EDGE Data (8-PSK)			
Band	Channel	GSM [dBm] CS (1 Slot)	GPRS [dBm] 1 Tx Slot	GPRS [dBm] 2 Tx Slot	GPRS [dBm] 3 Tx Slot	GPRS [dBm] 4 Tx Slot	EDGE [dBm] 1 Tx Slot	EDGE [dBm] 2 Tx Slot	EDGE [dBm] 3 Tx Slot	EDGE [dBm] 4 Tx Slot
GSM 850	128	27.57	27.64	25.61	24.41	22.60	22.08	21.05	20.04	18.67
	190	27.62	27.56	25.59	24.39	22.54	22.06	21.01	20.09	18.73
	251	27.55	27.54	25.55	24.33	22.57	22.03	21.04	20.01	18.71
GSM 1900	512	19.56	19.58	18.56	16.55	15.59	15.96	15.05	14.12	13.03
	661	19.60	19.62	18.60	16.61	15.66	16.08	15.06	14.10	13.02
	810	19.58	19.62	18.56	16.52	15.65	16.04	15.04	14.13	13.05
		Calculated Maximum Frame-Averaged Output Power								
		Voice	GPRS/EDGE Data (GMSK)				EDGE Data (8-PSK)			
Band	Channel	GSM [dBm] CS (1 Slot)	GPRS [dBm] 1 Tx Slot	GPRS [dBm] 2 Tx Slot	GPRS [dBm] 3 Tx Slot	GPRS [dBm] 4 Tx Slot	EDGE [dBm] 1 Tx Slot	EDGE [dBm] 2 Tx Slot	EDGE [dBm] 3 Tx Slot	EDGE [dBm] 4 Tx Slot
GSM 850	128	18.54	18.61	19.59	20.15	19.59	13.05	15.03	15.78	15.66
	190	18.59	18.53	19.57	20.13	19.53	13.03	14.99	15.83	15.72
	251	18.52	18.51	19.53	20.07	19.56	13.00	15.02	15.75	15.70
GSM 1900	512	10.53	10.55	12.54	12.29	12.58	6.93	9.03	9.86	10.02
	661	10.57	10.59	12.58	12.35	12.65	7.05	9.04	9.84	10.01
	810	10.55	10.59	12.54	12.26	12.64	7.01	9.02	9.87	10.04

Notes:

- Both burst-averaged and calculated frame-averaged powers are included. Frame-averaged power was calculated from the measured burst-averaged power by converting the slot powers into linear units and calculating the energy over 8 timeslots.
- 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.
- GPRS/EDGE (GMSK) output powers were measured with coding scheme setting of 1 (CS1) on the base station simulator. CS1 was configured to measure GPRS output power measurements and SAR to ensure GMSK modulation in the signal. Our investigation has shown that CS1 - CS4 settings do not have any impact on the output levels or modulation in the GPRS modes.
- EDGE (8-PSK) output powers were measured with MCS7 on the base station simulator. MCS7 coding scheme was used to measure the output powers for EDGE since investigation has shown that choosing MCS7 coding scheme will ensure 8-PSK modulation. It has been shown that MCS levels that produce 8PSK modulation do not have an impact on output power.

GSM Class: B
GPRS Multislot class: 33 (Max 4 Tx uplink slots)
EDGE Multislot class: 33 (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 Average RF Conducted Powers
Representing Capacitive Sensor Not Active

3GPP Release Version	Mode	3GPP 34.121 Subtest	Cellular Band [dBm]			PCS Band [dBm]			3GPP MPR [dB]
			4132	4183	4233	9262	9400	9538	
99	WCDMA	12.2 kbps RMC	22.34	22.18	22.11	22.54	22.41	22.37	-
99		12.2 kbps AMR	22.32	22.15	22.10	22.53	22.40	22.26	-
6	HSDPA	Subtest 1	21.92	21.80	21.69	22.19	22.17	22.06	0
6		Subtest 2	21.69	21.54	21.46	22.05	21.96	21.84	0
6		Subtest 3	21.45	21.30	21.24	21.80	21.77	21.68	0.5
6		Subtest 4	21.25	21.06	21.02	21.57	21.54	21.43	0.5
6	HSUPA	Subtest 1	21.43	21.31	21.21	21.29	21.08	21.01	0
6		Subtest 2	19.94	19.91	19.88	20.42	20.38	20.32	2
6		Subtest 3	20.83	20.59	20.74	21.21	21.17	21.14	1
6		Subtest 4	20.31	20.17	20.13	20.71	20.64	20.58	2
6		Subtest 5	21.68	21.66	21.69	21.34	21.24	21.19	0

Table 7-4
Reduced UMTS Average RF Conducted Powers
Representing Capacitive Sensor Active

3GPP Release Version	Mode	3GPP 34.121 Subtest	Cellular Band [dBm]			PCS Band [dBm]			3GPP MPR [dB]
			4132	4183	4233	9262	9400	9538	
99	WCDMA	12.2 kbps RMC	17.71	17.56	17.52	13.72	13.47	13.48	-
99		12.2 kbps AMR	17.68	17.52	17.53	13.75	13.55	13.55	-
6	HSDPA	Subtest 1	17.51	17.33	17.45	13.74	13.53	13.57	0
6		Subtest 2	17.31	17.08	17.16	13.54	13.26	13.34	0
6		Subtest 3	17.03	16.86	16.91	13.25	13.10	13.11	0.5
6		Subtest 4	16.83	16.59	16.66	13.10	12.82	12.84	0.5
6	HSUPA	Subtest 1	16.52	16.40	16.47	12.31	12.06	12.04	0
6		Subtest 2	15.20	15.05	15.15	11.71	11.42	11.50	2
6		Subtest 3	16.22	16.05	16.14	12.50	12.35	12.35	1
6		Subtest 4	15.50	15.33	15.35	11.93	11.59	11.58	2
6		Subtest 5	17.19	17.07	17.00	12.51	12.27	12.25	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 HSUPA subtests may be up to 1 dB more than specified by 3GPP, but also as low as 0 dB according to the chipset implementation in this model.



Figure 7-2
Power Measurement Setup

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7.3 Antenna 1 WLAN Conducted Powers

Table 7-5
IEEE 802.11b Average RF Power

Mode	Freq [MHz]	Channel	802.11b Conducted Power [dBm]			
			Data Rate [Mbps]			
			1	2	5.5	11
802.11b	2412	1*	13.26	13.08	13.11	13.13
802.11b	2437	6*	12.70	12.97	13.00	13.04
802.11b	2462	11*	12.58	12.97	12.88	12.91

Table 7-6
IEEE 802.11g Average RF Power

Mode	Freq [MHz]	Channel	802.11g Conducted Power [dBm]							
			Data Rate [Mbps]							
			6	9	12	18	24	36	48	54
802.11g	2412	1	12.22	12.33	12.30	12.29	12.24	12.20	12.30	11.96
802.11g	2437	6	12.13	12.20	12.16	12.17	12.12	12.13	12.23	11.90
802.11g	2462	11	12.08	12.15	12.16	12.16	12.16	12.08	12.08	11.86

Table 7-7
IEEE 802.11n Average RF Power

Mode	Freq [MHz]	Channel	802.11n (2.4GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			6.5	13	19.5	26	39	52	58.5	65
802.11n	2412	1	10.15	10.13	10.21	10.21	10.25	10.11	10.20	10.25
802.11n	2437	6	10.08	10.06	10.17	10.13	10.24	10.04	10.11	10.15
802.11n	2462	11	10.00	9.96	10.10	10.06	10.13	9.95	10.07	10.08

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Table 7-8
IEEE 802.11a Average RF Power

Mode	Freq [MHz]	Channel	802.11a Conducted Power [dBm]							
			Data Rate [Mbps]							
			6	9	12	18	24	36	48	54
802.11a	5180	36*	9.65	9.42	9.47	9.49	9.48	9.56	9.65	9.41
802.11a	5200	40	9.35	9.14	9.13	9.25	9.13	9.19	9.30	9.13
802.11a	5220	44	9.06	8.79	8.87	8.91	8.91	8.98	9.03	8.85
802.11a	5240	48*	8.86	8.59	8.64	8.72	8.72	8.74	8.88	8.59
802.11a	5260	52*	10.22	10.17	10.15	10.22	10.10	10.07	10.24	9.91
802.11a	5280	56	9.72	9.72	9.62	9.73	9.59	9.57	9.66	9.34
802.11a	5300	60	9.44	9.44	9.35	9.50	9.28	9.28	9.38	9.14
802.11a	5320	64*	9.35	9.30	9.25	9.38	9.20	9.21	9.30	9.07
802.11a	5500	100	10.39	10.41	10.41	10.38	10.35	10.48	10.40	10.34
802.11a	5520	104*	9.33	9.34	9.34	9.50	9.26	9.40	9.48	9.22
802.11a	5540	108	9.53	9.61	9.59	9.62	9.51	9.59	9.81	9.49
802.11a	5560	112	10.00	9.51	9.61	9.64	9.42	9.61	9.74	9.43
802.11a	5580	116*	9.59	9.60	9.57	9.69	9.63	9.67	9.87	9.57
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	9.97	9.99	9.98	10.06	10.02	10.05	10.19	9.93
802.11a	5680	136*	10.10	10.13	10.05	10.17	10.08	10.21	10.34	10.08
802.11a	5700	140	10.10	10.18	10.13	10.19	10.00	10.13	10.24	9.95
802.11a	5745	149*	10.06	9.98	10.07	9.83	9.96	9.77	9.95	9.81
802.11a	5765	153	10.02	10.13	10.19	10.04	10.18	9.84	10.12	9.90
802.11a	5785	157*	9.91	10.05	10.16	9.90	10.08	9.80	10.07	9.91
802.11a	5805	161	9.90	10.04	10.13	9.89	9.91	9.79	9.96	9.89
802.11a	5825	165*	10.05	10.16	10.02	10.00	10.22	10.01	10.18	10.09

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 7-9
IEEE 802.11n Average RF Power – 20 MHz Bandwidth

Mode	Freq [MHz]	Channel	20MHz BW 802.11n (5GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			6.5	13	19.5	26	39	52	58.5	65
802.11n	5180	36	9.62	9.56	9.66	9.61	9.64	9.44	9.55	9.63
802.11n	5200	40	9.48	9.41	9.48	9.43	9.49	9.30	9.35	9.46
802.11n	5220	44	9.60	9.50	9.66	9.58	9.57	9.43	9.57	9.62
802.11n	5240	48	9.70	9.67	9.69	9.66	9.72	9.45	9.66	9.70
802.11n	5260	52	10.12	10.21	10.09	10.16	10.13	10.16	10.18	10.26
802.11n	5280	56	10.16	10.20	10.17	10.25	10.19	10.25	10.24	10.32
802.11n	5300	60	10.20	10.32	10.17	10.23	10.19	10.26	10.33	10.34
802.11n	5320	64	10.19	10.28	10.18	10.27	10.17	10.22	10.30	10.35
802.11n	5500	100	10.35	10.36	10.29	10.36	10.32	10.31	10.27	10.26
802.11n	5520	104	10.45	10.47	10.35	10.49	10.44	10.41	10.30	10.27
802.11n	5540	108	9.66	9.69	9.58	9.72	9.66	9.66	9.55	9.54
802.11n	5560	112	9.76	9.75	9.66	9.75	9.76	9.68	9.69	9.75
802.11n	5580	116	9.83	9.85	9.82	9.83	9.88	9.74	9.73	9.73
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
802.11n	5660	132	10.10	10.07	10.06	10.20	10.02	10.14	10.01	9.98
802.11n	5680	136	10.17	10.21	10.16	10.17	10.10	10.09	10.10	10.03
802.11n	5700	140	10.31	10.35	10.24	10.33	10.30	10.28	10.18	10.17
802.11n	5745	149	9.75	9.82	9.73	9.65	9.75	9.69	9.77	9.68
802.11n	5765	153	9.74	9.87	9.76	9.61	9.69	9.73	9.71	9.70
802.11n	5785	157	9.85	9.92	9.82	9.75	9.81	9.77	9.89	9.80
802.11n	5805	161	9.91	10.02	9.92	9.82	9.92	9.85	9.89	9.81
802.11n	5825	165	9.92	10.05	9.94	9.86	9.91	9.78	9.97	9.91

Table 7-10
IEEE 802.11n Average RF Power – 40 MHz Bandwidth

Mode	Freq [MHz]	Channel	40MHz BW 802.11n (5GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			13.5	27	40.5	54	81	108	121.5	135
802.11n	5190	38	9.81	9.87	9.88	9.69	9.78	9.83	9.78	9.67
802.11n	5230	46	9.74	9.82	9.80	9.81	9.79	9.77	9.79	9.85
802.11n	5270	54	10.00	10.03	10.00	9.86	9.82	9.65	9.91	9.80
802.11n	5310	62	10.00	9.99	9.93	9.85	9.76	9.58	9.82	9.80
802.11n	5510	102	9.88	9.82	9.93	10.09	10.24	10.08	10.33	10.25
802.11n	5550	110	9.20	9.11	9.32	9.43	9.51	9.35	9.64	9.64
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	9.18	9.16	9.18	9.44	9.49	9.43	9.71	9.61
802.11n	5755	151	9.89	9.67	9.77	9.80	9.80	9.81	9.71	9.89
802.11n	5795	159	9.84	9.68	9.72	9.76	9.72	9.78	9.58	9.79

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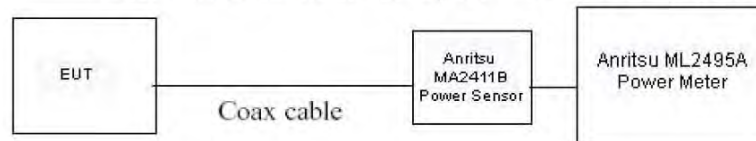
Table 7-11
IEEE 802.11ac Average RF Power – 80 MHz Bandwidth

Mode	Freq [MHz]	Channel	80MHz BW 802.11ac (5GHz) 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	9.68	9.62	9.57	9.67	9.66	9.62	9.51	9.67	9.64	9.58
802.11ac	5290	58	10.34	10.24	10.32	10.17	10.33	10.29	10.30	10.33	10.27	10.38
802.11ac	5530	106	9.67	9.70	9.65	9.67	9.77	9.67	9.59	9.64	9.50	9.68
802.11ac	5775	155	10.14	10.09	10.14	10.04	10.13	10.08	10.14	10.03	10.18	10.11

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

- For 2.4 GHz, highest average RF output power channel for the lowest data rate for IEEE 802.11b were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11g/n) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11b mode.
- For 5 GHz, highest average RF output power channel for the lowest data rate for IEEE 802.11a were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11n 20 MHz and 40 MHz) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11a mode.
- Full 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 was evaluated for the highest IEEE 802.11a position in each 5 GHz band and exposure condition.
- 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.

Power measurement for signal < 50 MHz Bandwidth



Power measurement for signal > 50 MHz Bandwidth

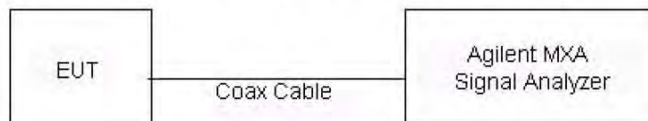


Figure 7-3
Power Measurement Setup

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7.4 Antenna 2 WLAN Conducted Powers

Table 7-12
IEEE 802.11b Average RF Power

Mode	Freq [MHz]	Channel	802.11b Conducted Power [dBm]			
			Data Rate [Mbps]			
			1	2	5.5	11
802.11b	2412	1*	12.76	12.87	13.06	13.02
802.11b	2437	6*	12.84	12.89	12.83	12.85
802.11b	2462	11*	12.44	12.56	12.77	12.71

Table 7-13
IEEE 802.11g Average RF Power

Mode	Freq [MHz]	Channel	802.11g Conducted Power [dBm]							
			Data Rate [Mbps]							
			6	9	12	18	24	36	48	54
802.11g	2412	1	12.25	12.14	12.12	12.17	12.12	12.06	12.25	11.90
802.11g	2437	6	12.04	11.91	11.92	12.02	11.88	11.92	12.00	11.74
802.11g	2462	11	11.64	11.52	11.57	11.52	11.52	11.38	11.60	11.30

Table 7-14
IEEE 802.11n Average RF Power

Mode	Freq [MHz]	Channel	802.11n (2.4GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			6.5	13	19.5	26	39	52	58.5	65
802.11n	2412	1	10.22	10.37	10.38	10.29	10.36	10.26	10.24	10.26
802.11n	2437	6	10.29	10.38	10.44	10.34	10.33	10.35	10.32	10.30
802.11n	2462	11	9.78	9.94	9.90	9.80	9.87	9.85	9.84	9.82

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Table 7-15
IEEE 802.11a Average RF Power

Mode	Freq [MHz]	Channel	802.11a Conducted Power [dBm]							
			Data Rate [Mbps]							
			6	9	12	18	24	36	48	54
802.11a	5180	36*	10.23	10.18	10.15	10.14	10.17	10.08	10.08	9.88
802.11a	5200	40	10.14	10.02	10.09	10.07	10.08	10.00	10.00	9.74
802.11a	5220	44	9.89	9.84	9.81	9.85	9.84	9.70	9.82	9.50
802.11a	5240	48*	9.85	9.84	9.79	9.78	9.77	9.66	9.63	9.49
802.11a	5260	52*	10.02	10.10	10.05	10.08	10.04	10.16	10.26	9.81
802.11a	5280	56	10.07	10.07	10.03	10.15	10.08	10.22	10.22	9.88
802.11a	5300	60	9.81	9.85	9.84	9.89	9.77	9.97	10.12	9.55
802.11a	5320	64*	9.89	10.00	9.99	9.97	9.94	10.04	10.15	9.73
802.11a	5500	100	10.08	10.16	9.95	9.96	9.84	9.81	9.95	9.79
802.11a	5520	104	9.90	10.03	9.75	9.80	9.60	9.57	9.78	9.60
802.11a	5540	108	9.76	9.85	9.64	9.71	9.51	9.54	9.71	9.48
802.11a	5560	112	9.77	9.60	9.41	9.46	9.37	9.34	9.50	9.31
802.11a	5580	116*	9.35	9.39	9.20	9.21	9.06	9.11	9.23	9.07
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	9.17	9.26	8.97	9.09	8.98	8.92	9.04	8.83
802.11a	5680	136*	10.13	9.51	9.28	9.24	9.15	9.14	9.25	9.05
802.11a	5700	140	9.64	9.75	9.47	9.56	9.32	9.42	9.49	9.34
802.11a	5745	149*	9.84	9.81	9.83	9.91	9.85	9.67	9.66	9.57
802.11a	5765	153	10.13	10.14	10.16	10.26	10.16	9.98	9.88	9.92
802.11a	5785	157*	10.08	10.06	10.09	10.14	10.13	9.87	9.85	9.80
802.11a	5805	161	10.19	10.23	10.20	10.18	10.18	9.99	9.97	9.84
802.11a	5825	165*	10.32	10.24	10.35	10.35	10.31	10.09	10.18	10.00

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

Mode	Freq [MHz]	Channel	20MHz BW 802.11n (5GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			6.5	13	19.5	26	39	52	58.5	65
802.11n	5180	36	9.93	9.98	9.99	9.89	10.05	9.90	10.00	9.99
802.11n	5200	40	10.06	10.07	10.17	10.06	10.17	10.04	10.15	10.09
802.11n	5220	44	9.99	10.06	10.13	9.93	10.06	9.95	10.11	10.04
802.11n	5240	48	9.94	9.95	10.07	9.92	10.07	9.87	9.95	9.95
802.11n	5260	52	9.71	9.58	9.75	9.77	9.79	9.74	9.69	9.88
802.11n	5280	56	9.82	9.67	9.88	9.88	9.96	9.82	9.81	10.02
802.11n	5300	60	9.70	9.50	9.75	9.73	9.76	9.73	9.66	9.82
802.11n	5320	64	9.91	9.78	9.95	10.02	9.96	10.00	9.81	10.09
802.11n	5500	100	10.17	10.02	9.99	10.03	10.00	10.05	10.15	10.15
802.11n	5520	104	10.15	10.02	9.97	9.95	9.97	10.01	10.08	10.16
802.11n	5540	108	10.17	9.99	9.97	10.04	9.98	10.06	10.24	10.16
802.11n	5560	112	9.95	9.75	9.82	9.85	9.77	9.85	10.00	9.93
802.11n	5580	116	9.91	9.73	9.74	9.77	9.84	9.85	9.92	9.84
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
802.11n	5660	132	9.86	9.77	9.69	9.70	9.78	9.75	9.78	9.78
802.11n	5680	136	9.93	9.75	9.71	9.76	9.77	9.76	9.95	9.90
802.11n	5700	140	9.91	9.79	9.65	9.76	9.76	9.79	9.91	9.85
802.11n	5745	149	10.19	10.22	10.28	10.23	10.29	10.17	10.29	10.03
802.11n	5765	153	10.36	10.44	10.40	10.36	10.47	10.42	10.42	10.19
802.11n	5785	157	10.26	10.29	10.36	10.29	10.30	10.22	10.31	10.12
802.11n	5805	161	10.23	10.25	10.27	10.23	10.31	10.22	10.39	10.09
802.11n	5825	165	10.24	10.26	10.28	10.36	10.34	10.19	10.36	10.01

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

Mode	Freq [MHz]	Channel	40MHz BW 802.11n (5GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			13.5	27	40.5	54	81	108	121.5	135
802.11n	5190	38	10.23	10.44	10.26	10.11	10.20	10.13	10.26	10.22
802.11n	5230	46	10.06	10.31	10.10	9.87	10.01	9.99	10.12	10.06
802.11n	5270	54	9.81	9.64	9.94	9.81	9.75	9.66	9.91	9.85
802.11n	5310	62	9.85	9.65	9.95	9.79	9.71	9.67	9.95	9.91
802.11n	5510	102	9.72	9.73	9.84	9.69	9.73	9.73	9.83	9.74
802.11n	5550	110	9.80	9.75	9.91	9.82	9.83	9.75	10.00	9.87
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	9.72	9.70	9.81	9.76	9.66	9.69	9.82	9.72
802.11n	5755	151	9.81	9.89	9.90	9.76	9.70	9.85	9.93	10.02
802.11n	5795	159	9.95	10.01	10.03	9.93	9.86	9.91	10.06	10.14

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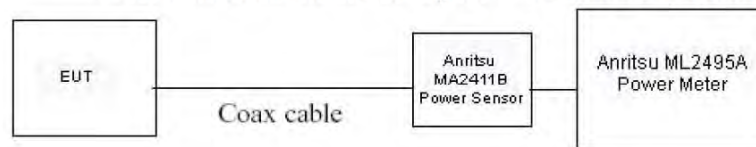
Table 7-18
IEEE 802.11ac Average RF Power – 80 MHz Bandwidth

Mode	Freq [MHz]	Channel	80MHz BW 802.11ac (5GHz) 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	9.65	9.86	9.66	9.61	9.63	9.62	9.65	9.42	9.52	9.63
802.11ac	5290	58	9.22	9.37	9.25	9.18	9.18	9.14	9.12	9.21	9.20	9.46
802.11ac	5530	106	9.57	9.54	9.55	9.18	9.39	9.35	8.89	9.26	9.19	9.43
802.11ac	5775	155	9.49	9.57	9.55	9.50	9.56	9.36	9.38	9.51	9.45	9.40

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

- For 2.4 GHz, highest average RF output power channel for the lowest data rate for IEEE 802.11b were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11g/n) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11b mode.
- For 5 GHz, highest average RF output power channel for the lowest data rate for IEEE 802.11a were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11n 20 MHz and 40 MHz) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11a mode.
- Full 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 was evaluated for the highest IEEE 802.11a position in each 5 GHz band and exposure condition.
- 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.

Power measurement for signal < 50 MHz Bandwidth



Power measurement for signal > 50 MHz Bandwidth

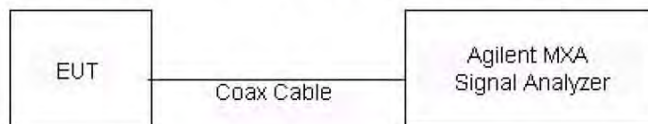


Figure 7-4
Power Measurement Setup

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7.5 MIMO WLAN Conducted Powers

Table 7-19
IEEE 802.11n Average RF Power

Mode	Freq [MHz]	Channel	802.11n (2.4GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			13	26	39	52	78	104	117	130
802.11n	2412	1*	10.04	9.94	10.01	9.98	9.98	9.93	9.93	9.90
802.11n	2437	6*	9.96	9.92	9.88	9.93	9.91	9.79	9.73	9.97
802.11n	2462	11*	9.73	9.71	9.64	9.67	9.69	9.68	9.64	9.63

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

Mode	Freq [MHz]	Channel	20MHz BW 802.11n (5GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			13	26	39	52	78	104	117	130
802.11n	5180	36	10.30	10.39	10.17	10.23	10.24	10.26	10.07	10.03
802.11n	5200	40	10.23	10.35	10.05	10.13	10.14	10.19	10.00	9.96
802.11n	5220	44	10.18	10.24	10.11	10.07	10.19	10.15	9.95	9.92
802.11n	5240	48	9.97	10.07	9.85	9.90	9.88	9.93	9.76	9.71
802.11n	5260	52	10.17	9.97	9.96	10.19	10.07	9.94	9.98	9.85
802.11n	5280	56	10.11	9.90	9.93	10.14	10.01	9.95	9.87	9.86
802.11n	5300	60	9.93	9.73	9.72	9.89	9.86	9.69	9.78	9.60
802.11n	5320	64	10.02	9.84	9.79	10.01	9.98	9.86	9.86	9.73
802.11n	5500	100	9.57	9.44	9.56	9.29	9.25	9.29	9.19	9.25
802.11n	5520	104	10.31	10.22	10.31	10.06	9.99	10.01	9.93	9.97
802.11n	5540	108	10.47	10.30	10.45	10.21	10.14	10.10	10.07	10.12
802.11n	5560	112	10.33	10.18	10.30	10.05	10.00	10.03	9.93	10.02
802.11n	5580	116	10.32	10.16	10.29	10.08	10.01	10.04	9.95	10.00
802.11n	5600	120	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11n	5620	124	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11n	5640	128	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
802.11n	5660	132	10.31	10.21	10.32	10.11	9.97	10.07	10.01	9.98
802.11n	5680	136	10.32	10.24	10.29	10.11	10.04	10.10	9.93	10.02
802.11n	5700	140	10.39	10.26	10.37	10.05	10.11	10.07	10.01	10.07
802.11n	5745	149	9.99	9.98	10.14	10.09	10.21	10.05	9.95	10.14
802.11n	5765	153	10.25	10.35	10.49	10.34	10.50	10.39	10.19	10.43
802.11n	5785	157	10.18	10.26	10.36	10.38	10.46	10.29	10.13	10.38
802.11n	5805	161	10.24	10.30	10.46	10.37	10.48	10.28	10.12	10.43
802.11n	5825	165	10.18	10.25	10.35	10.32	10.49	10.21	10.10	10.44

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

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Table 7-21
IEEE 802.11n Average RF Power – 40 MHz Bandwidth

Mode	Freq [MHz]	Channel	40MHz BW 802.11n (5GHz) Conducted Power [dBm]							
			Data Rate [Mbps]							
			27	54	81	108	162	216	243	270
802.11n	5190	38	10.10	10.07	9.99	9.95	9.98	9.96	9.88	9.94
802.11n	5230	46	9.80	9.82	9.74	9.67	9.70	9.69	9.60	9.65
802.11n	5270	54	9.93	9.84	9.93	9.79	9.88	10.05	9.75	10.01
802.11n	5310	62	9.89	9.79	9.91	9.70	9.76	10.00	9.69	9.99
802.11n	5510	102	9.47	9.61	9.45	9.33	9.35	9.26	9.43	9.40
802.11n	5550	110	9.55	9.71	9.50	9.41	9.50	9.34	9.51	9.39
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	9.29	9.40	9.20	9.25	9.19	9.14	9.31	9.17
802.11n	5755	151	9.28	9.07	9.16	9.33	9.29	8.96	9.12	9.15
802.11n	5795	159	9.21	9.02	9.10	9.21	9.22	8.85	9.05	9.04

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

Mode	Freq [MHz]	Channel	80MHz BW 802.11ac (5GHz) Conducted Power [dBm]									
			Data Rate [Mbps]									
			58.6	117	175.6	234	351	468	526.6	585	702	780
802.11ac	5210	42*	10.32	10.15	10.12	10.10	10.07	10.10	10.13	10.13	10.06	10.06
802.11ac	5290	58*	10.09	9.92	10.09	9.50	9.61	9.88	9.89	9.58	9.77	9.70
802.11ac	5530	106*	9.55	9.37	9.63	9.35	9.25	9.24	9.65	9.61	9.59	9.50
802.11ac	5775	155*	8.78	8.79	8.65	8.69	8.79	8.72	8.72	8.70	8.53	8.42

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

- For 2.4 GHz, highest average RF output power channel for the lowest data rate for IEEE 802.11n were selected for SAR evaluation
- For 5 GHz, highest average RF output power channel for the lowest data rate for IEEE 802.11ac were selected for SAR evaluation.
- 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.

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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
10/03/2013	835B	23.7	820	1.003	54.116	0.969	55.258	3.51%	-2.07%
			835	1.016	53.879	0.970	55.200	4.74%	-2.39%
			850	1.031	53.787	0.988	55.154	4.35%	-2.48%
10/08/2013	835B	23.3	820	0.998	53.808	0.969	55.258	2.99%	-2.62%
			835	1.012	53.646	0.970	55.200	4.33%	-2.82%
			850	1.027	53.462	0.988	55.154	3.95%	-3.07%
10/08/2013	1900B	22.5	1850	1.457	52.102	1.520	53.300	-4.14%	-2.25%
			1880	1.496	51.974	1.520	53.300	-1.58%	-2.49%
			1910	1.519	51.881	1.520	53.300	-0.07%	-2.66%
12/12/2013	2450B	23.3	2401	1.891	52.927	1.903	52.765	-0.63%	0.31%
			2450	1.958	52.752	1.950	52.700	0.41%	0.10%
			2499	2.025	52.586	2.019	52.638	0.30%	-0.10%
12/16/2013	5200B-5800B	22.1	5180	5.335	47.789	5.276	49.041	1.12%	-2.55%
			5200	5.362	47.667	5.299	49.014	1.19%	-2.75%
			5220	5.398	47.610	5.323	48.987	1.41%	-2.81%
			5260	5.465	47.600	5.369	48.933	1.79%	-2.72%
			5280	5.479	47.528	5.393	48.906	1.59%	-2.82%
			5300	5.495	47.472	5.416	48.879	1.46%	-2.88%
			5320	5.533	47.352	5.439	48.851	1.73%	-3.07%
			5500	5.818	46.965	5.650	48.607	2.97%	-3.38%
			5520	5.845	46.924	5.673	48.580	3.03%	-3.41%
			5540	5.876	46.849	5.696	48.553	3.16%	-3.51%
			5560	5.899	46.822	5.720	48.526	3.13%	-3.51%
			5600	5.965	46.694	5.766	48.471	3.45%	-3.67%
			5680	6.077	46.508	5.860	48.363	3.70%	-3.84%
			5700	6.122	46.421	5.883	48.336	4.06%	-3.96%
			5745	6.212	46.373	5.936	48.275	4.65%	-3.94%
			5765	6.227	46.314	5.959	48.248	4.50%	-4.01%
			5785	6.247	46.275	5.982	48.220	4.43%	-4.03%
			5800	6.272	46.208	6.000	48.200	4.53%	-4.13%
			5805	6.273	46.194	6.006	48.193	4.45%	-4.15%
			5825	6.317	46.156	6.029	48.166	4.78%	-4.17%

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

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8.2 Test System Verification

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

Table 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} (%)
G	835	BODY	10/03/2013	24.5	23.7	0.100	4d119	3209	0.990	9.540	9.900	3.77%
D	835	BODY	10/08/2013	22.3	23.3	0.100	4d119	3022	0.998	9.540	9.980	4.61%
D	1900	BODY	10/08/2013	23.4	22.8	0.100	5d148	3022	4.110	40.800	41.100	0.74%
D	2450	BODY	12/12/2013	23.8	23.3	0.100	797	3022	4.860	49.600	48.600	-2.02%
E	5200	BODY	12/16/2013	22.8	22.1	0.100	1120	3914	7.570	76.600	75.700	-1.17%
E	5300	BODY	12/16/2013	22.7	22.1	0.100	1120	3914	7.740	76.800	77.400	0.78%
E	5500	BODY	12/16/2013	22.5	22.1	0.100	1120	3914	7.890	79.800	78.900	-1.13%
E	5600	BODY	12/16/2013	22.8	22.1	0.100	1120	3914	8.320	80.700	83.200	3.10%
E	5800	BODY	12/16/2013	22.9	22.1	0.100	1120	3914	7.110	75.500	71.100	-5.83%

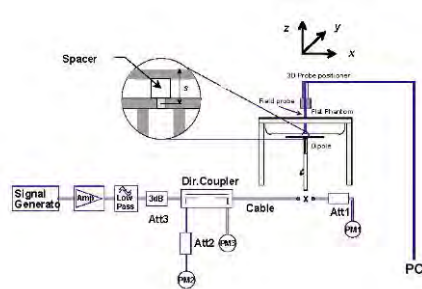


Figure 8-1
System Verification Setup Diagram



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	GSM 850	GPRS	29.50	28.94	-0.07	13 mm	310-3	3	1:2.76	back	0.526	1.138	0.599	
836.60	190	GSM 850	GPRS	29.50	28.94	-0.03	15 mm	310-3	3	1:2.76	left	0.366	1.138	0.417	
824.20	128	GSM 850	GPRS	24.50	24.41	0.00	0 mm	310-1	3	1:2.76	back	0.896	1.021	0.915	
836.60	190	GSM 850	GPRS	24.50	24.39	-0.07	0 mm	310-1	3	1:2.76	back	0.914	1.026	0.938	A1
848.80	251	GSM 850	GPRS	24.50	24.33	-0.03	0 mm	310-1	3	1:2.76	back	0.791	1.040	0.823	
836.60	190	GSM 850	GPRS	24.50	24.39	0.20	0 mm	310-1	3	1:2.76	left	0.533	1.026	0.547	
836.60	190	GSM 850	GPRS	24.50	24.39	0.02	0 mm	310-1	3	1:2.76	back	0.900	1.026	0.923	
836.60	4183	UMTS 850	RMC	22.75	22.18	-0.02	13 mm	310-3	N/A	1:1	back	0.350	1.140	0.399	
836.60	4183	UMTS 850	RMC	22.75	22.18	0.01	15 mm	310-3	N/A	1:1	left	0.520	1.140	0.593	
836.60	4183	UMTS 850	RMC	17.75	17.56	0.00	0 mm	310-1	N/A	1:1	back	0.662	1.045	0.692	A2
836.60	4183	UMTS 850	RMC	17.75	17.56	-0.15	0 mm	310-1	N/A	1:1	left	0.458	1.045	0.479	
1880.00	661	GSM 1900	GPRS	26.00	25.62	-0.03	13 mm	310-3	4	1:2.076	back	0.684	1.091	0.746	A3
1880.00	661	GSM 1900	GPRS	26.00	25.62	-0.05	15 mm	310-3	4	1:2.076	left	0.567	1.091	0.619	
1880.00	661	GSM 1900	GPRS	16.00	15.66	-0.01	0 mm	310-1	4	1:2.076	back	0.569	1.081	0.615	
1880.00	661	GSM 1900	GPRS	16.00	15.66	-0.07	0 mm	310-1	4	1:2.076	left	0.326	1.081	0.352	
1852.40	9262	UMTS 1900	RMC	22.75	22.54	0.00	13 mm	310-3	N/A	1:1	back	0.842	1.050	0.884	
1880.00	9400	UMTS 1900	RMC	22.75	22.41	-0.01	13 mm	310-3	N/A	1:1	back	0.814	1.081	0.880	
1907.60	9538	UMTS 1900	RMC	22.75	22.37	-0.01	13 mm	310-3	N/A	1:1	back	0.731	1.091	0.798	
1880.00	9400	UMTS 1900	RMC	22.75	22.41	0.00	15 mm	310-3	N/A	1:1	left	0.632	1.081	0.683	
1852.40	9262	UMTS 1900	RMC	13.75	13.72	0.00	0 mm	310-1	N/A	1:1	back	0.859	1.007	0.865	A4
1880.00	9400	UMTS 1900	RMC	13.75	13.47	-0.02	0 mm	310-1	N/A	1:1	back	0.848	1.067	0.905	
1907.60	9538	UMTS 1900	RMC	13.75	13.48	-0.05	0 mm	310-1	N/A	1:1	back	0.819	1.064	0.871	
1880.00	9400	UMTS 1900	RMC	13.75	13.47	0.00	0 mm	310-1	N/A	1:1	left	0.483	1.067	0.515	
1852.40	9262	UMTS 1900	RMC	13.75	13.72	-0.02	0 mm	310-1	N/A	1:1	back	0.823	1.007	0.829	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Body 1.6 W/kg (mW/g) averaged over 1 gram								

Note: Blue entries represent variability measurements.

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Table 9-2
Antenna 1 DTS Body SAR

MEASUREMENT RESULTS															
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
2412	1	IEEE 802.11b	DSSS	13.5	13.26	0.01	0 mm	2710-4	1	back	1:1	0.663	1.057	0.701	
2437	6	IEEE 802.11b	DSSS	13.5	12.70	0.16	0 mm	2710-4	1	back	1:1	0.807	1.202	0.970	
2462	11	IEEE 802.11b	DSSS	13.5	12.58	-0.03	0 mm	2710-4	1	back	1:1	0.808	1.236	0.999	
2412	1	IEEE 802.11b	DSSS	13.5	13.26	0.04	0 mm	2710-4	1	top	1:1	0.126	1.057	0.133	
2412	1	IEEE 802.11b	DSSS	13.5	13.26	-0.04	0 mm	2710-4	1	left	1:1	0.053	1.057	0.056	
2462	11	IEEE 802.11b	DSSS	13.5	12.58	-0.04	0 mm	2710-4	1	back	1:1	0.822	1.236	1.016	A5
5745	149	IEEE 802.11a	OFDM	10.5	10.06	-0.21	0 mm	2710-5	6	back	1:1	0.230	1.107	0.255	A6
5775	155	IEEE 802.11ac	OFDM	10.5	10.14	0.16	0 mm	2710-5	29.3	back	1:1	0.214	1.086	0.232	
5745	149	IEEE 802.11a	OFDM	10.5	10.06	-0.05	0 mm	2710-5	6	top	1:1	0.109	1.107	0.121	
5745	149	IEEE 802.11a	OFDM	10.5	10.06	-0.12	0 mm	2710-5	6	left	1:1	0.002	1.107	0.002	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Body 1.6 W/kg (mW/g) averaged over 1 gram								

Note: Blue entry represents variability measurement

Table 9-3
Antenna 2 DTS Body SAR

MEASUREMENT RESULTS															
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle	SAR(1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
2412	1	IEEE 802.11b	DSSS	13.5	12.76	-0.03	0 mm	2710-4	1	back	1:1	0.481	1.186	0.570	
2437	6	IEEE 802.11b	DSSS	13.5	12.84	-0.12	0 mm	2710-4	1	back	1:1	0.509	1.164	0.592	
2462	11	IEEE 802.11b	DSSS	13.5	12.44	0.13	0 mm	2710-4	1	back	1:1	0.527	1.276	0.672	
2437	6	IEEE 802.11b	DSSS	13.5	12.84	-0.02	0 mm	2710-4	1	top	1:1	0.199	1.164	0.232	
2437	6	IEEE 802.11b	DSSS	13.5	12.84	0.02	0 mm	2710-4	1	left	1:1	0.001	1.164	0.001	
5825	165	IEEE 802.11a	OFDM	10.5	10.32	-0.21	0 mm	2710-5	6	back	1:1	0.196	1.042	0.204	
5775	155	IEEE 802.11ac	OFDM	10.5	9.49	0.16	0 mm	2710-5	29.3	back	1:1	0.112	1.262	0.141	
5825	165	IEEE 802.11a	OFDM	10.5	10.32	0.05	0 mm	2710-5	6	top	1:1	0.008	1.042	0.008	
5825	165	IEEE 802.11a	OFDM	10.5	10.32	-0.12	0 mm	2710-5	6	left	1:1	0.003	1.042	0.003	
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
MIMO DTS Body SAR

MEASUREMENT RESULTS															
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
2412	1	IEEE 802.11n	OFDM	10.5	10.04	-0.15	0 mm	2710-4	13	back	1:1	0.414	1.112	0.460	
2437	6	IEEE 802.11n	OFDM	10.5	9.96	0.08	0 mm	2710-4	13	back	1:1	0.585	1.132	0.662	
2462	11	IEEE 802.11n	OFDM	10.5	9.73	-0.02	0 mm	2710-4	13	back	1:1	0.595	1.194	0.710	
2412	1	IEEE 802.11n	OFDM	10.5	10.04	-0.12	0 mm	2710-4	13	top	1:1	0.357	1.112	0.397	
2412	1	IEEE 802.11n	OFDM	10.5	10.04	-0.04	0 mm	2710-4	13	left	1:1	0.037	1.112	0.041	
5775	155	IEEE 802.11ac	OFDM	10.5	8.78	-0.21	0 mm	2710-5	58.6	back	1:1	0.197	1.486	0.293	
5775	155	IEEE 802.11ac	OFDM	10.5	8.78	-0.17	0 mm	2710-5	58.6	top	1:1	0.019	1.486	0.028	
5775	155	IEEE 802.11ac	OFDM	10.5	8.78	-0.12	0 mm	2710-5	58.6	left	1:1	0.002	1.486	0.003	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Body 1.6 W/kg (mW/g) averaged over 1 gram								

Table 9-5
Antenna 1 NII Body SAR

MEASUREMENT RESULTS															
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
5180	36	IEEE 802.11a	OFDM	10.5	9.65	0.11	0 mm	2710-5	6	back	1:1	0.147	1.216	0.179	
5210	42	IEEE 802.11ac	OFDM	10.5	9.68	-0.17	0 mm	2710-5	29.3	back	1:1	0.127	1.208	0.153	
5180	36	IEEE 802.11a	OFDM	10.5	9.65	-0.16	0 mm	2710-5	6	top	1:1	0.117	1.216	0.142	
5180	36	IEEE 802.11a	OFDM	10.5	9.65	-0.17	0 mm	2710-5	6	left	1:1	0.016	1.216	0.019	
5260	52	IEEE 802.11a	OFDM	10.5	10.22	0.18	0 mm	2710-5	6	back	1:1	0.164	1.067	0.175	
5290	58	IEEE 802.11ac	OFDM	10.5	10.34	-0.17	0 mm	2710-5	29.3	back	1:1	0.153	1.038	0.159	
5260	52	IEEE 802.11a	OFDM	10.5	10.22	0.03	0 mm	2710-5	6	top	1:1	0.098	1.067	0.105	
5260	52	IEEE 802.11a	OFDM	10.5	10.22	-0.03	0 mm	2710-5	6	left	1:1	0.014	1.067	0.015	
5500	100	IEEE 802.11a	OFDM	10.5	10.39	0.16	0 mm	2710-5	6	back	1:1	0.190	1.026	0.195	
5560	112	IEEE 802.11a	OFDM	10.5	10.00	0.00	0 mm	2710-5	6	back	1:1	0.144	1.122	0.162	
5680	136	IEEE 802.11a	OFDM	10.5	10.10	-0.13	0 mm	2710-5	6	back	1:1	0.246	1.096	0.270	
5530	106	IEEE 802.11ac	OFDM	10.5	9.67	-0.15	0 mm	2710-5	29.3	back	1:1	0.168	1.211	0.203	
5500	100	IEEE 802.11a	OFDM	10.5	10.39	0.06	0 mm	2710-5	6	top	1:1	0.090	1.026	0.092	
5500	100	IEEE 802.11a	OFDM	10.5	10.39	-0.15	0 mm	2710-5	6	left	1:1	0.001	1.026	0.001	
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 9-6
Antenna 2 NII Body SAR

MEASUREMENT RESULTS															
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
5180	36	IEEE 802.11a	OFDM	10.5	10.23	0.11	0 mm	2710-5	6	back	1:1	0.494	1.064	0.526	
5220	44	IEEE 802.11a	OFDM	10.5	9.89	-0.14	0 mm	2710-5	6	back	1:1	0.493	1.151	0.567	
5210	42	IEEE 802.11ac	OFDM	10.5	9.65	-0.05	0 mm	2710-5	29.3	back	1:1	0.172	1.216	0.209	
5180	36	IEEE 802.11a	OFDM	10.5	10.23	0.04	0 mm	2710-5	6	top	1:1	0.056	1.064	0.060	
5180	36	IEEE 802.11a	OFDM	10.5	10.23	-0.17	0 mm	2710-5	6	left	1:1	0.007	1.064	0.007	
5280	56	IEEE 802.11a	OFDM	10.5	10.07	0.18	0 mm	2710-5	6	back	1:1	0.347	1.104	0.383	
5320	64	IEEE 802.11a	OFDM	10.5	9.89	0.00	0 mm	2710-5	6	back	1:1	0.578	1.151	0.665	
5290	58	IEEE 802.11ac	OFDM	10.5	9.22	-0.17	0 mm	2710-5	29.3	back	1:1	0.455	1.343	0.611	
5280	56	IEEE 802.11a	OFDM	10.5	10.07	0.03	0 mm	2710-5	6	top	1:1	0.128	1.104	0.141	
5280	56	IEEE 802.11a	OFDM	10.5	10.07	-0.03	0 mm	2710-5	6	left	1:1	0.019	1.104	0.021	
5500	100	IEEE 802.11a	OFDM	10.5	10.08	0.16	0 mm	2710-5	6	back	1:1	0.294	1.102	0.324	
5560	112	IEEE 802.11a	OFDM	10.5	9.77	-0.17	0 mm	2710-5	6	back	1:1	0.249	1.183	0.295	
5680	136	IEEE 802.11a	OFDM	10.5	10.13	-0.13	0 mm	2710-5	6	back	1:1	0.557	1.089	0.607	
5530	106	IEEE 802.11ac	OFDM	10.5	9.57	-0.15	0 mm	2710-5	29.3	back	1:1	0.218	1.239	0.270	
5680	136	IEEE 802.11a	OFDM	10.5	10.13	0.07	0 mm	2710-5	6	top	1:1	0.035	1.089	0.038	
5680	136	IEEE 802.11a	OFDM	10.5	10.13	-0.15	0 mm	2710-5	6	left	1:1	0.008	1.089	0.009	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Body 1.6 W/kg (mW/g) averaged over 1 gram								

Table 9-7
MIMO NII Body SAR

MEASUREMENT RESULTS															
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle	SAR (1g)	Scaling Factor	Scaled SAR (1g)	Plot #
MHz	Ch.											(W/kg)		(W/kg)	
5210	42	IEEE 802.11ac	OFDM	10.5	10.32	0.11	0 mm	2710-5	58.6	back	1:1	0.659	1.042	0.687	A7
5210	42	IEEE 802.11ac	OFDM	10.5	10.32	-0.05	0 mm	2710-5	58.6	top	1:1	0.142	1.042	0.148	
5210	42	IEEE 802.11ac	OFDM	10.5	10.32	-0.17	0 mm	2710-5	58.6	left	1:1	0.021	1.042	0.022	
5290	58	IEEE 802.11ac	OFDM	10.5	10.09	0.18	0 mm	2710-5	58.6	back	1:1	0.633	1.099	0.696	
5290	58	IEEE 802.11ac	OFDM	10.5	10.09	0.02	0 mm	2710-5	58.6	top	1:1	0.169	1.099	0.186	
5290	58	IEEE 802.11ac	OFDM	10.5	10.09	-0.03	0 mm	2710-5	58.6	left	1:1	0.027	1.099	0.030	
5530	106	IEEE 802.11ac	OFDM	10.5	9.55	0.16	0 mm	2710-5	58.6	back	1:1	0.332	1.245	0.413	
5530	106	IEEE 802.11ac	OFDM	10.5	9.55	0.07	0 mm	2710-5	58.6	top	1:1	0.054	1.245	0.067	
5530	106	IEEE 802.11ac	OFDM	10.5	9.55	-0.15	0 mm	2710-5	58.6	left	1:1	0.008	1.245	0.010	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Body 1.6 W/kg (mW/g) averaged over 1 gram								

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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 D04 and FCC KDB Publication 447498 D01v05.
2. Batteries are fully charged at the beginning of the SAR measurements.
3. Liquid tissue depth was at least 15.0 cm for all frequencies.
4. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
5. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01v05.
6. 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 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. Left edge SAR tests were required for the main antenna. SAR tests were required for the top and left edges for the WLAN antenna.

GSM 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. Since the maximum output power variation across the required test channels is $< \frac{1}{2}$ dB, middle channel was the default channel used. Per FCC KDB Publication 447498 D01v05, when the reported (scaled) SAR measured at the middle channel for each test configuration is ≤ 0.8 W/kg then testing at the other channels is not required for such test configuration(s).

UMTS Notes:

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

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WLAN Notes:

1. Justification for reduced test configurations for SISO WIFI channels per KDB Publication 248227 D01v01r02 and October 2012 FCC/TCB Meeting Notes for 2.4 GHz WIFI: Highest average RF output power channel for the lowest data rate was selected for SAR evaluation in 802.11b. Other IEEE 802.11 modes (including 802.11g/n) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11b mode.
2. Justification for reduced test configurations for SISO WIFI channels per KDB Publication 248227 D01v01r02 and October 2012 FCC/TCB Meeting Notes for 5 GHz WIFI: Highest average RF output power channel for the lowest data rate was selected for SAR evaluation in 802.11a. Other IEEE 802.11 modes (including 802.11n 20 MHz and 40 MHz bandwidths) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11a mode.
3. This device supports MIMO Tx for WLAN 802.11n/ac. Each WLAN antenna can transmit independently or together when operating with MIMO. Per KDB 248227, SAR for MIMO was measured with both transmitting simultaneously and was evaluated independently of SISO operation. For 2.4 GHz MIMO, 802.11n was evaluated. For 5 GHz MIMO, 802.11ac was evaluated since the maximum allowed output power was the same for both 802.11n/a
4. Per April 2013 TCB Workshop notes, full SAR tests for 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 was evaluated for the highest IEEE 802.11a position in each 5 GHz band and exposure condition
5. WIFI transmission was verified using an uncalibrated spectrum analyzer.
6. When the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is >1.6 W/kg or the reported 1g averaged SAR is >0.8 W/kg, SAR testing on other default channels was required.
7. There is no proximity sensor power reduction mechanism applied for WLAN or Bluetooth.

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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 802.11a/b/g/n/ac 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, simultaneous transmission SAR test exclusion may be applied when the sum of the 1-g SAR for all the simultaneous transmitting antennas in a specific a physical test configuration is ≤ 1.6 W/kg. When standalone SAR is not required to be measured, per FCC KDB 447498 D01v05 4.3.2 2), the following equation must be used to estimate the standalone 1g SAR for simultaneous transmission assessment involving that transmitter.

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

Table 10-1
Estimated SAR

Mode	Frequency	Maximum Allowed Power	Configuration	Separation Distance (Body)	Estimated SAR (Body)
	[MHz]	[dBm]		[mm]	[W/kg]
Bluetooth	2441	7.50	Touching* (Back,Top,Left)	5	0.250
Bluetooth	2441	7.50	Back	13	0.096
Bluetooth	2441	7.50	Left	15	0.083

Notes:

- Per FCC KDB Publication 447498 D01v05, the maximum power of the channel was rounded to the nearest mW before calculation.
- (*) Per FCC KDB Publication 447298, when the test separation distance is < 5mm, a distance of 5mm is applied to determine estimated SAR.
- Per FCC KDB Publication 447498 D01v05, an estimated SAR of 0.400 W/kg was used to determine simultaneous transmission SAR exclusion when the test separation distance was >50mm.

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10.3 Body SAR Simultaneous Transmission Analysis

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

Simult Tx	Configuration	GPRS 850 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLSR	Simult Tx	Configuration	UMTS 850 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLSR
Body SAR	Back	0.938	1.016	See note 1	0.03	Body SAR	Back	0.692	1.016	See note 1	0.03
	Top	0.400	0.133	0.533	N/A		Top	0.400	0.133	0.533	N/A
	Bottom	0.400	0.400	0.800	N/A		Bottom	0.400	0.400	0.800	N/A
	Right	0.400	0.400	0.800	N/A		Right	0.400	0.400	0.800	N/A
	Left	0.547	0.056	0.603	N/A		Left	0.479	0.056	0.535	N/A
Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLSR	Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLSR
Body SAR	Back	0.615	1.016	See note 1	0.03	Body SAR	Back	0.905	1.016	See note 1	0.04
	Top	0.400	0.133	0.533	N/A		Top	0.400	0.133	0.533	N/A
	Bottom	0.400	0.400	0.800	N/A		Bottom	0.400	0.400	0.800	N/A
	Right	0.400	0.400	0.800	N/A		Right	0.400	0.400	0.800	N/A
	Left	0.352	0.056	0.408	N/A		Left	0.515	0.056	0.571	N/A

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

Simult Tx	Configuration	GPRS 850 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLSR	Simult Tx	Configuration	UMTS 850 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.938	0.672	See note 1	0.02	Body SAR	Back	0.692	0.672	1.364
	Top	0.400	0.232	0.632	N/A		Top	0.400	0.232	0.632
	Bottom	0.400	0.400	0.800	N/A		Bottom	0.400	0.400	0.800
	Right	0.400	0.400	0.800	N/A		Right	0.400	0.400	0.800
	Left	0.547	0.001	0.548	N/A		Left	0.479	0.001	0.480
Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLSR	Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.615	0.672	1.287		Body SAR	Back	0.905	0.672	1.577
	Top	0.400	0.232	0.632			Top	0.400	0.232	0.632
	Bottom	0.400	0.400	0.800			Bottom	0.400	0.400	0.800
	Right	0.400	0.400	0.800			Right	0.400	0.400	0.800
	Left	0.352	0.001	0.353			Left	0.515	0.001	0.516

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

Simult Tx	Configuration	GPRS 850 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLSR	Simult Tx	Configuration	UMTS 850 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
Body SAR	Back	0.938	0.710	See note 1	0.03	Body SAR	Back	0.692	0.710	1.402	
	Top	0.400	0.397	0.797	N/A		Top	0.400	0.397	0.797	
	Bottom	0.400	0.400	0.800	N/A		Bottom	0.400	0.400	0.800	
	Right	0.400	0.400	0.800	N/A		Right	0.400	0.400	0.800	
	Left	0.547	0.041	0.588	N/A		Left	0.479	0.041	0.520	
Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLSR	Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLSR
Body SAR	Back	0.615	0.710	1.325		Body SAR	Back	0.905	0.710	See note 1	0.03
	Top	0.400	0.397	0.797			Top	0.400	0.397	0.797	N/A
	Bottom	0.400	0.400	0.800			Bottom	0.400	0.400	0.800	N/A
	Right	0.400	0.400	0.800			Right	0.400	0.400	0.800	N/A
	Left	0.352	0.041	0.393			Left	0.515	0.041	0.556	N/A

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Table 10-5
Simultaneous Transmission Scenario with 5 GHz WLAN Antenna 1 (Body SAR at 0.0 cm)

Simult Tx	Configuration	GPRS 850 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	UMTS 850 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.938	0.270	1.208	Body SAR	Back	0.692	0.270	0.962
	Top	0.400	0.142	0.542		Top	0.400	0.142	0.542
	Bottom	0.400	0.400	0.800		Bottom	0.400	0.400	0.800
	Right	0.400	0.400	0.800		Right	0.400	0.400	0.800
	Left	0.547	0.019	0.566		Left	0.479	0.019	0.498
Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.615	0.270	0.885	Body SAR	Back	0.905	0.270	1.175
	Top	0.400	0.142	0.542		Top	0.400	0.142	0.542
	Bottom	0.400	0.400	0.800		Bottom	0.400	0.400	0.800
	Right	0.400	0.400	0.800		Right	0.400	0.400	0.800
	Left	0.352	0.019	0.371		Left	0.515	0.019	0.534

Table 10-6
Simultaneous Transmission Scenario with 5 GHz WLAN Antenna 2 (Body SAR at 0.0 cm)

Simult Tx	Configuration	GPRS 850 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLSR	Simult Tx	Configuration	UMTS 850 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.938	0.665	See note 1	0.02	Body SAR	Back	0.692	0.665	1.357
	Top	0.400	0.141	0.541	N/A		Top	0.400	0.141	0.541
	Bottom	0.400	0.400	0.800	N/A		Bottom	0.400	0.400	0.800
	Right	0.400	0.400	0.800	N/A		Right	0.400	0.400	0.800
	Left	0.547	0.021	0.568	N/A		Left	0.479	0.021	0.500
Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)		Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.615	0.665	1.280		Body SAR	Back	0.905	0.665	1.570
	Top	0.400	0.141	0.541			Top	0.400	0.141	0.541
	Bottom	0.400	0.400	0.800			Bottom	0.400	0.400	0.800
	Right	0.400	0.400	0.800			Right	0.400	0.400	0.800
	Left	0.352	0.021	0.373			Left	0.515	0.021	0.536

Table 10-7
Simultaneous Transmission Scenario with 5 GHz WLAN MIMO (Body SAR at 0.0 cm)

Simult Tx	Configuration	GPRS 850 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLSR	Simult Tx	Configuration	UMTS 850 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.938	0.696	See note 1	0.02	Body SAR	Back	0.692	0.696	1.388
	Top	0.400	0.186	0.586	N/A		Top	0.400	0.186	0.586
	Bottom	0.400	0.400	0.800	N/A		Bottom	0.400	0.400	0.800
	Right	0.400	0.400	0.800	N/A		Right	0.400	0.400	0.800
	Left	0.547	0.030	0.577	N/A		Left	0.479	0.030	0.509

Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLSR
Body SAR	Back	0.615	0.696	1.311	Body SAR	Back	0.905	0.696	See note 1	0.03
	Top	0.400	0.186	0.586		Top	0.400	0.186	0.586	N/A
	Bottom	0.400	0.400	0.800		Bottom	0.400	0.400	0.800	N/A
	Right	0.400	0.400	0.800		Right	0.400	0.400	0.800	N/A
	Left	0.352	0.030	0.382		Left	0.515	0.030	0.545	N/A

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Table 10-8
Simultaneous Transmission Scenario with Bluetooth (Body SAR at 0.0 cm)

Simult Tx	Configuration	GPRS 850 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	UMTS 850 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.938	0.250	1.188	Body SAR	Back	0.692	0.250	0.942
	Top	0.400	0.250	0.650		Top	0.400	0.250	0.650
	Bottom	0.400	0.400	0.800		Bottom	0.400	0.400	0.800
	Right	0.400	0.400	0.800		Right	0.400	0.400	0.800
	Left	0.547	0.250	0.797		Left	0.479	0.250	0.729
Simult Tx	Configuration	GPRS 1900 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	UMTS 1900 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.615	0.250	0.865	Body SAR	Back	0.905	0.250	1.155
	Top	0.400	0.250	0.650		Top	0.400	0.250	0.650
	Bottom	0.400	0.400	0.800		Bottom	0.400	0.400	0.800
	Right	0.400	0.400	0.800		Right	0.400	0.400	0.800
	Left	0.352	0.250	0.602		Left	0.515	0.250	0.765

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

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Table 10-9
Simultaneous Transmission Scenario with 2.4 GHz WLAN Ant 1 (Back Side at 1.3 cm)

Configuration	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	SPLSR
Back Side	GPRS 850	0.599	< 1.016	See note 1	< 0.03
Back Side	UMTS 850	0.399	< 1.016	< 1.415	N/A
Back Side	GPRS 1900	0.746	< 1.016	See note 1	< 0.03
Back Side	UMTS 1900	0.884	< 1.016	See note 1	< 0.03

Table 10-10
Simultaneous Transmission Scenario with 2.4 GHz WLAN Ant 2 (Back Side at 1.3 cm)

Configuration	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Back Side	GPRS 850	0.599	< 0.672	< 1.271
Back Side	UMTS 850	0.399	< 0.672	< 1.071
Back Side	GPRS 1900	0.746	< 0.672	< 1.418
Back Side	UMTS 1900	0.884	< 0.672	< 1.556

Table 10-11
Simultaneous Transmission Scenario with 2.4 GHz WLAN MIMO (Back Side at 1.3 cm)

Configuration	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Back Side	GPRS 850	0.599	< 0.71	< 1.309
Back Side	UMTS 850	0.399	< 0.71	< 1.109
Back Side	GPRS 1900	0.746	< 0.71	< 1.456
Back Side	UMTS 1900	0.884	< 0.71	< 1.594

Table 10-12
Simultaneous Transmission Scenario with 5 GHz WLAN Ant 1 (Back Side at 1.3 cm)

Configuration	Mode	2G/3G SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Back Side	GPRS 850	0.599	< 0.27	< 0.869
Back Side	UMTS 850	0.399	< 0.27	< 0.669
Back Side	GPRS 1900	0.746	< 0.27	< 1.016
Back Side	UMTS 1900	0.884	< 0.27	< 1.154

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Table 10-13
Simultaneous Transmission Scenario with 5 GHz WLAN Ant 2 (Back Side at 1.3 cm)

Configuration	Mode	2G/3G SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Back Side	GPRS 850	0.599	< 0.665	< 1.264
Back Side	UMTS 850	0.399	< 0.665	< 1.064
Back Side	GPRS 1900	0.746	< 0.665	< 1.411
Back Side	UMTS 1900	0.884	< 0.665	< 1.549

Table 10-14
Simultaneous Transmission Scenario with 5 GHz WLAN MIMO (Back Side at 1.3 cm)

Configuration	Mode	2G/3G SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Back Side	GPRS 850	0.599	< 0.696	< 1.295
Back Side	UMTS 850	0.399	< 0.696	< 1.095
Back Side	GPRS 1900	0.746	< 0.696	< 1.442
Back Side	UMTS 1900	0.884	< 0.696	< 1.58

Table 10-15
Simultaneous Transmission Scenario with Bluetooth (Back Side at 1.3 cm)

Configuration	Mode	2G/3G SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)
Back Side	GPRS 850	0.599	0.096	0.695
Back Side	UMTS 850	0.399	0.096	0.495
Back Side	GPRS 1900	0.746	0.096	0.842
Back Side	UMTS 1900	0.884	0.096	0.980

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 10-16
Simultaneous Transmission Scenario with 2.4 GHz WLAN Ant 1 (Left Edge at 1.5 cm)

Configuration	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Left Edge	GPRS 850	0.417	< 0.056	< 0.473
Left Edge	UMTS 850	0.593	< 0.056	< 0.649
Left Edge	GPRS 1900	0.619	< 0.056	< 0.675
Left Edge	UMTS 1900	0.683	< 0.056	< 0.739

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Table 10-17
Simultaneous Transmission Scenario with 2.4 GHz WLAN Ant 2 (Left Edge at 1.5 cm)

Configuration	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Left Edge	GPRS 850	0.417	< 0.001	< 0.418
Left Edge	UMTS 850	0.593	< 0.001	< 0.594
Left Edge	GPRS 1900	0.619	< 0.001	< 0.62
Left Edge	UMTS 1900	0.683	< 0.001	< 0.684

Table 10-18
Simultaneous Transmission Scenario with 2.4 GHz WLAN MIMO (Left Edge at 1.5 cm)

Configuration	Mode	2G/3G SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Left Edge	GPRS 850	0.417	< 0.041	< 0.458
Left Edge	UMTS 850	0.593	< 0.041	< 0.634
Left Edge	GPRS 1900	0.619	< 0.041	< 0.66
Left Edge	UMTS 1900	0.683	< 0.041	< 0.724

Table 10-19
Simultaneous Transmission Scenario with 5 GHz WLAN Ant 1 (Left Edge at 1.5 cm)

Configuration	Mode	2G/3G SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Left Edge	GPRS 850	0.417	< 0.019	< 0.436
Left Edge	UMTS 850	0.593	< 0.019	< 0.612
Left Edge	GPRS 1900	0.619	< 0.019	< 0.638
Left Edge	UMTS 1900	0.683	< 0.019	< 0.702

Table 10-20
Simultaneous Transmission Scenario with 5 GHz WLAN Ant 2 (Left Edge at 1.5 cm)

Configuration	Mode	2G/3G SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Left Edge	GPRS 850	0.417	< 0.021	< 0.438
Left Edge	UMTS 850	0.593	< 0.021	< 0.614
Left Edge	GPRS 1900	0.619	< 0.021	< 0.64
Left Edge	UMTS 1900	0.683	< 0.021	< 0.704

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Table 10-21
Simultaneous Transmission Scenario with 5 GHz WLAN MIMO (Left Edge at 1.5 cm)

Configuration	Mode	2G/3G SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Left Edge	GPRS 850	0.417	< 0.03	< 0.447
Left Edge	UMTS 850	0.593	< 0.03	< 0.623
Left Edge	GPRS 1900	0.619	< 0.03	< 0.649
Left Edge	UMTS 1900	0.683	< 0.03	< 0.713

Table 10-22
Simultaneous Transmission Scenario with Bluetooth (Left Edge at 1.5 cm)

Configuration	Mode	2G/3G SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)
Left Edge	GPRS 850	0.417	0.083	0.500
Left Edge	UMTS 850	0.593	0.083	0.676
Left Edge	GPRS 1900	0.619	0.083	0.702
Left Edge	UMTS 1900	0.683	0.083	0.766

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 Publication 447498 D01v05r01. See Section 10.4 for SPLS ratio analysis.
2. For SAR summations for body back side at 13 mm and body left edge at 15 mm, 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 configurations excluded per FCC KDB Publication 447498 D01v05, an estimated SAR of 0.400 W/kg was used to determine simultaneous transmission SAR exclusion when the test separation distance was >50mm.
4. The worst case 5 GHz WLAN reported SAR for each configuration was used for SAR summation, regardless of whether the WLAN channel has WIFI Direct / WIFI Display capability. Therefore, the summations above represent the absolute worst cases for simultaneous transmission with 5 GHz WLAN.

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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.

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

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

The sum of the standalone SAR values was above 1.6 W/kg for the Body Back side configuration at a separation distance of 0 mm with GPRS 850 MHz antenna operating at limited output power with 2.4 GHz WIFI Antenna 1.

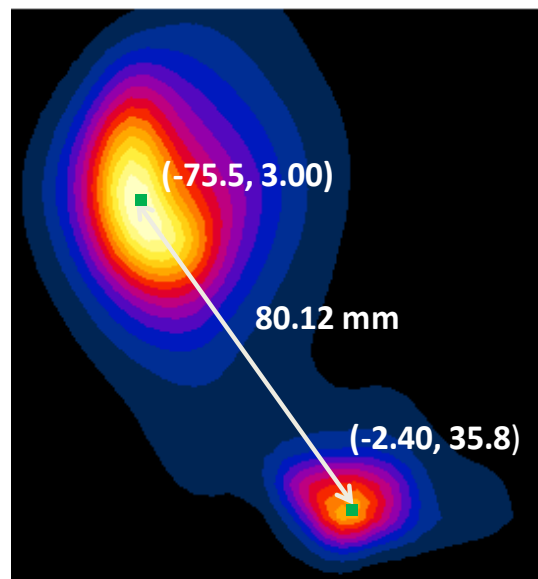


Figure 10-1
Peak SAR Location Plot of GPRS 850 MHz and 2.4 GHz WLAN Antenna 1

Table 10-23
Peak SAR Locations for Body Back Side at 0 cm GPRS 850 MHz and 2.4 GHz WLAN Antenna 1

Mode/Band	x (mm)	y (mm)
GPRS 850 MHz	-75.50	3.00
IEEE 802.11b	-2.40	35.80

Table 10-24
SAR Sum to Peak Location Separation Ratio Calculation

Antenna Pair		Standalone 1g SAR (W/kg)		Standalone SAR Sum (W/kg)	Peak SAR Separation Distance (mm)	SPLS Ratio
Ant "a"	Ant "b"	a	b	a+b	D _{a-b}	(a+b) ^{1.5} /D _{a-b}
GPRS 850 MHz	IEEE 802.11b	0.938	1.016	1.954	80.12	0.03

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The sum of the standalone SAR values was above 1.6 W/kg for the Body Back side configuration at a separation distance of 0 mm with UMTS 850 MHz antenna operating at limited output power with 2.4 GHz WIFI Antenna 1.

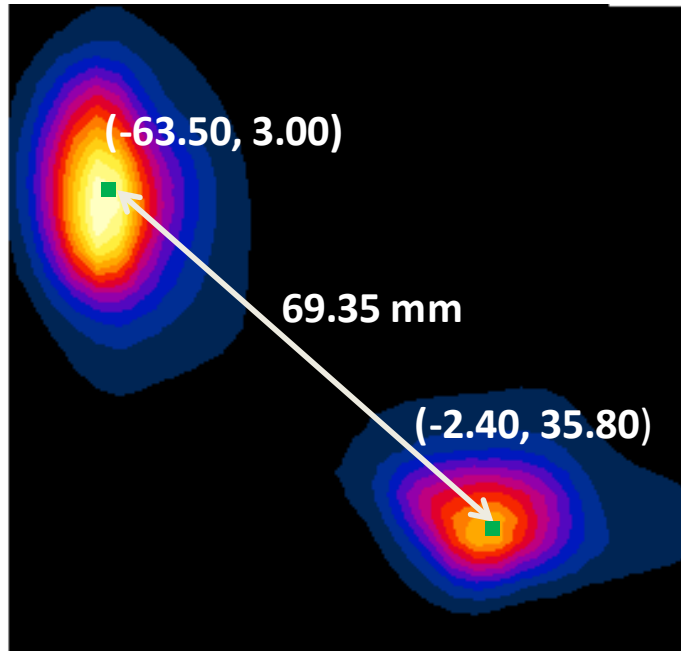


Figure 10-2
Peak SAR Location Plot of UMTS 850 MHz and 2.4 GHz WLAN Antenna 1

Table 10-25
Peak SAR Locations for Body Back Side at 0 cm UMTS 850 MHz and 2.4 GHz WLAN Antenna 1

Mode/Band	x (mm)	y (mm)
UMTS 850 MHz	-63.50	3.00
IEEE 802.11b	-2.40	35.80

Table 10-26
SAR Sum to Peak Location Separation Ratio Calculation

Antenna Pair		Standalone 1g SAR (W/kg)		Standalone SAR Sum (W/kg)	Peak SAR Separation Distance (mm)	SPLS Ratio
Ant "a"	Ant "b"	a	b	a+b	D_{a-b}	$(a+b)^{1.5}/D_{a-b}$
UMTS 850 MHz	IEEE 802.11b	0.692	1.016	1.708	69.35	0.03

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The sum of the standalone SAR values was above 1.6 W/kg for the Body Back side configuration at a separation distance of 0 mm with GPRS 1900 MHz antenna operating at limited output power with 2.4 GHz WIFI Antenna 1.

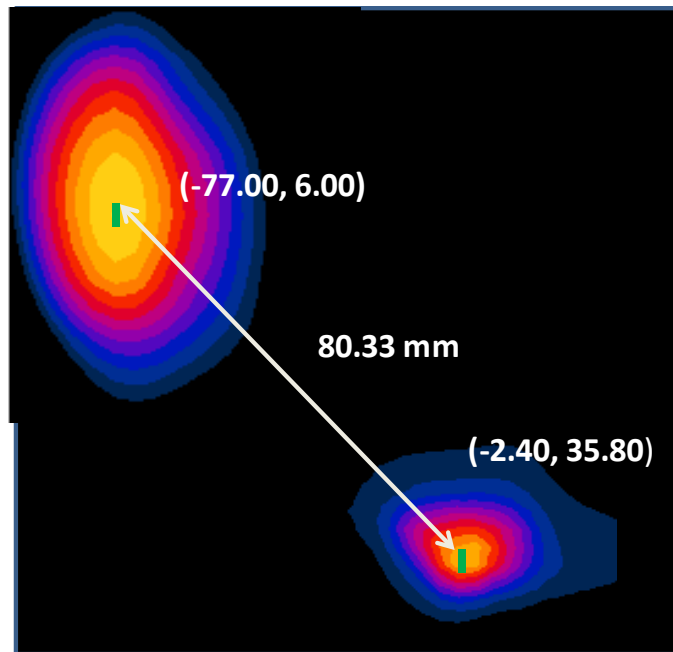


Figure 10-3
Peak SAR Location Plot of GPRS 1900 MHz and 2.4 GHz WLAN Antenna 1

Table 10-27
Peak SAR Locations for Body Back Side at 0 cm GPRS 1900 MHz and 2.4 GHz WLAN Antenna 1

Mode/Band	x (mm)	y (mm)
GPRS 1900 MHz	-77.00	6.00
IEEE 802.11b	-2.40	35.80

Table 10-28
SAR Sum to Peak Location Separation Ratio Calculation

Antenna Pair		Standalone 1g SAR (W/kg)		Standalone SAR Sum (W/kg)	Peak SAR Separation Distance (mm)	SPLS Ratio
Ant "a"	Ant "b"	a	b	a+b	D_{a-b}	$(a+b)^{1.5}/D_{a-b}$
GPRS 1900 MHz	IEEE 802.11b	0.615	1.016	1.631	80.33	0.03

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The sum of the standalone SAR values was above 1.6 W/kg for the Body Back side configuration at a separation distance of 0 mm with UMTS 1900 MHz antenna operating at limited output power with 2.4 GHz WIFI Antenna 1.

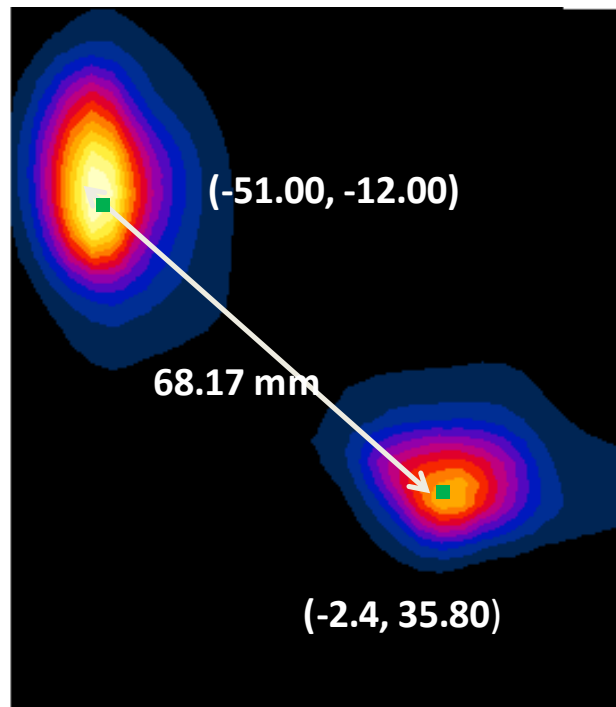


Figure 10-4
Peak SAR Location Plot of UMTS 1900 MHz and 2.4 GHz WLAN Antenna 1

Table 10-29
Peak SAR Locations for Body Back Side at 0 cm UMTS 1900 MHz and 2.4 GHz WLAN Antenna 1

Mode/Band	x (mm)	y (mm)
UMTS 1900 MHz	-51.00	-12.00
IEEE 802.11b	-2.40	35.80

Table 10-30
SAR Sum to Peak Location Separation Ratio Calculation

Antenna Pair		Standalone 1g SAR (W/kg)		Standalone SAR Sum (W/kg)	Peak SAR Separation Distance (mm)	SPLS Ratio
Ant "a"	Ant "b"	a	b	a+b	D_{a-b}	$(a+b)^{1.5}/D_{a-b}$
UMTS 1900 MHz	IEEE 802.11b	0.905	1.016	1.921	68.17	0.04

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The sum of the standalone SAR values was above 1.6 W/kg for the Body Back side configuration at a separation distance of 0 mm with GPRS 850 MHz antenna operating at limited output power with 2.4 GHz WIFI Antenna 2.

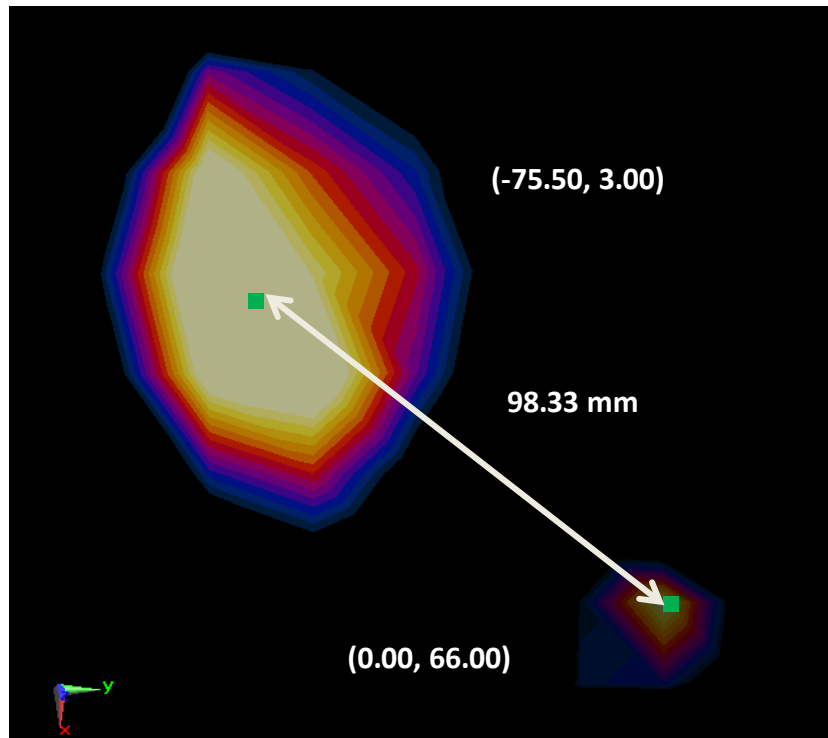


Figure 10-5
Peak SAR Location Plot of GPRS 850 MHz and 2.4 GHz WLAN Antenna 2

Table 10-31
Peak SAR Locations for Body Back Side at 0 cm GPRS 850 MHz and 2.4 GHz WLAN Antenna 2

Mode/Band	x (mm)	y (mm)
GPRS 850 MHz	-75.50	3.00
IEEE 802.11b	0.00	66.00

Table 10-32
SAR Sum to Peak Location Separation Ratio Calculation

Antenna Pair		Standalone 1g SAR (W/kg)		Standalone SAR Sum (W/kg)	Peak SAR Separation Distance (mm)	SPLS Ratio
Ant "a"	Ant "b"	a	b	a+b	D_{a-b}	$(a+b)^{1.5}/D_{a-b}$
GPRS 850 MHz	IEEE 802.11b	0.938	0.672	1.61	98.33	0.02

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The sum of the standalone SAR values was above 1.6 W/kg for the Body Back side configuration at a separation distance of 0 mm with GPRS 850 MHz antenna operating at limited output power with 2.4 GHz WIFI MIMO.

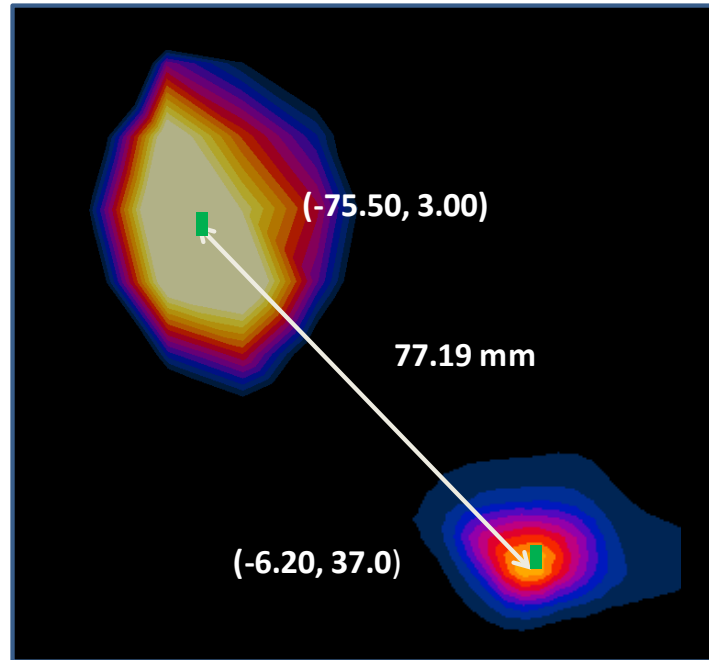


Figure 10-6
Peak SAR Location Plot of GPRS 850 MHz and 2.4 GHz WLAN MIMO

Table 10-33
Peak SAR Locations for Body Back Side at 0 cm GPRS 850 MHz and 2.4 GHz WLAN MIMO

Mode/Band	x (mm)	y (mm)
GPRS 850 MHz	-75.50	3.00
IEEE 802.11n	-6.20	37.00

Table 10-34
SAR Sum to Peak Location Separation Ratio Calculation

Antenna Pair		Standalone 1g SAR (W/kg)		Standalone SAR Sum (W/kg)	Peak SAR Separation Distance (mm)	SPLS Ratio
Ant "a"	Ant "b"	a	b	a+b	D_{a-b}	$(a+b)^{1.5}/D_{a-b}$
GPRS 850 MHz	IEEE 802.11n	0.938	0.71	1.648	77.19	0.03

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The sum of the standalone SAR values was above 1.6 W/kg for the Body Back side configuration at a separation distance of 0 mm with UMTS 1900 MHz antenna operating at limited output power with 2.4 GHz WIFI MIMO.

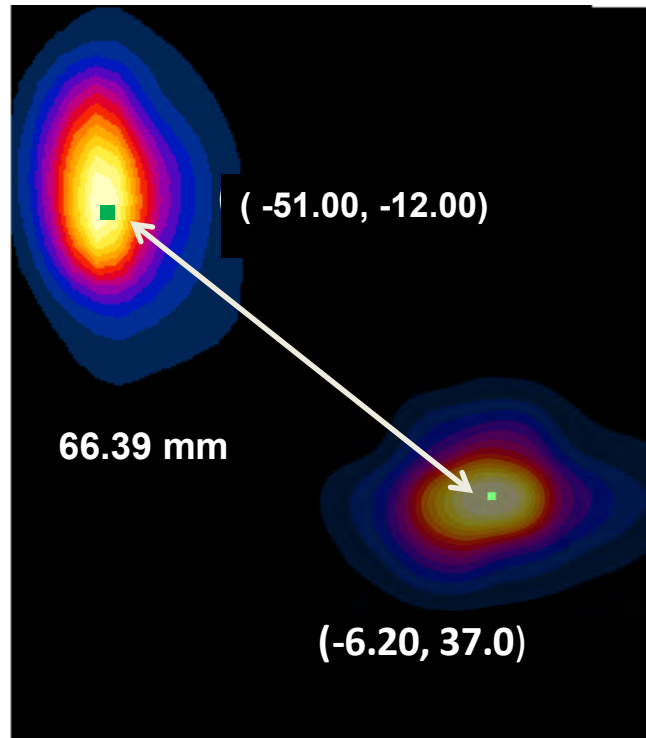


Figure 10-7
Peak SAR Location Plot of UMTS 1900 MHz and 2.4 GHz WLAN MIMO

Table 10-35
Peak SAR Locations for Body Back Side at 0 cm UMTS 1900 MHz and 2.4 GHz WLAN MIMO

Mode/Band	x (mm)	y (mm)
UMTS 1900 MHz	-51.00	-12.00
IEEE 802.11n	-6.20	37.00

Table 10-36
SAR Sum to Peak Location Separation Ratio Calculation

Antenna Pair		Standalone 1g SAR (W/kg)		Standalone SAR Sum (W/kg)	Peak SAR Separation Distance (mm)	SPLS Ratio
Ant "a"	Ant "b"	a	b	a+b	D_{a-b}	$(a+b)^{1.5}/D_{a-b}$
UMTS 1900 MHz	IEEE 802.11n	0.905	0.71	1.615	66.39	0.03

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The sum of the standalone SAR values was above 1.6 W/kg for the Body Back side configuration at a separation distance of 0 mm with GPRS 850 MHz antenna operating at limited output power with 5 GHz WIFI Antenna 2.

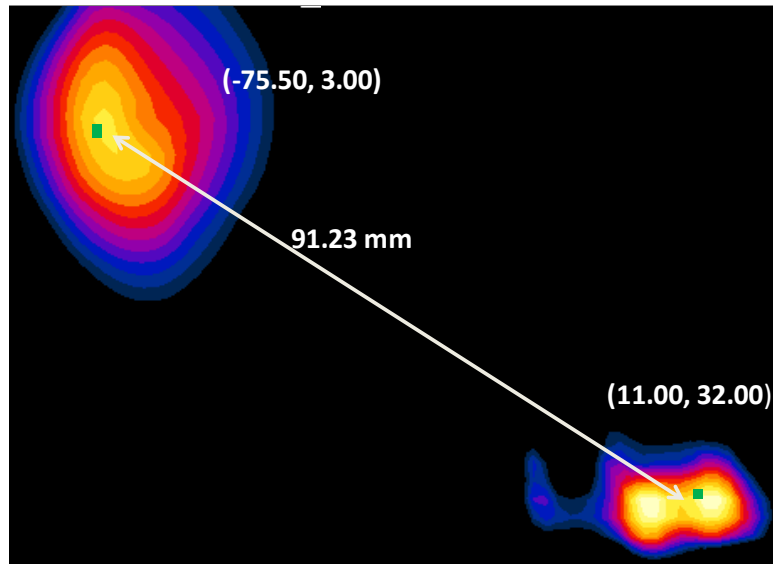


Figure 10-8
Peak SAR Location Plot of GPRS 850 MHz and 5 GHz WLAN Antenna 2

Table 10-37
Peak SAR Locations for Body Back Side at 0 cm GPRS 850 MHz and 5 GHz WLAN Antenna 2

Mode/Band	x (mm)	y (mm)
GPRS 850 MHz	-75.50	3.00
IEEE 802.11a	11.00	32.00

Table 10-38
SAR Sum to Peak Location Separation Ratio Calculation

Antenna Pair		Standalone 1g SAR (W/kg)		Standalone SAR Sum (W/kg)	Peak SAR Separation Distance (mm)	SPLS Ratio
Ant "a"	Ant "b"	a	b	a+b	D_{a-b}	$(a+b)^{1.5}/D_{a-b}$
GPRS 850 MHz	IEEE 802.11a	0.938	0.665	1.603	91.23	0.02

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The sum of the standalone SAR values was above 1.6 W/kg for the Body Back side configuration at a separation distance of 0 mm with GPRS 850 MHz antenna operating at limited output power with 5 GHz WIFI MIMO.

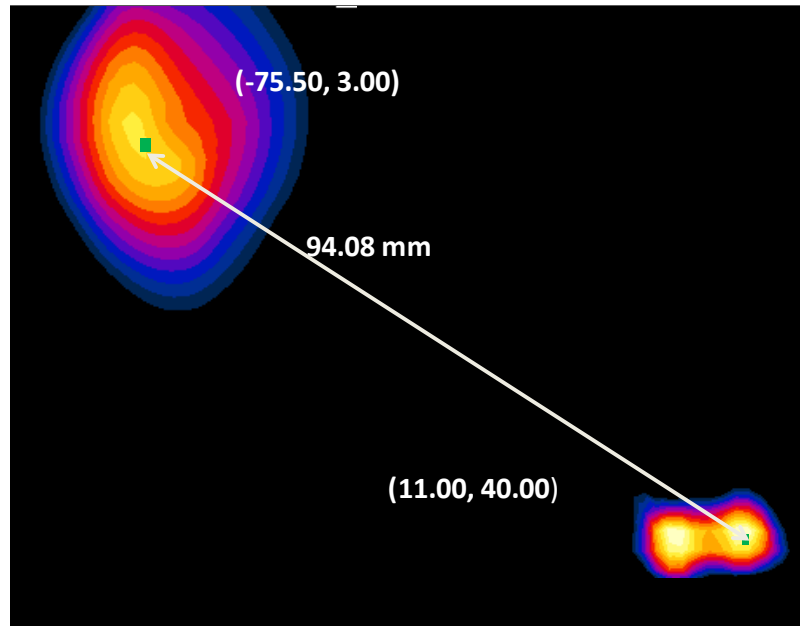


Figure 10-9
Peak SAR Location Plot of GPRS 850 MHz and 5 GHz WLAN MIMO

Table 10-39
Peak SAR Locations for Body Back Side at 0 cm GPRS 850 MHz and 5 GHz WLAN MIMO

Mode/Band	x (mm)	y (mm)
GPRS 850 MHz	-75.50	3.00
IEEE 802.11ac	11.00	40.00

Table 10-40
SAR Sum to Peak Location Separation Ratio Calculation

Antenna Pair		Standalone 1g SAR (W/kg)		Standalone SAR Sum (W/kg)	Peak SAR Separation Distance (mm)	SPLS Ratio
Ant "a"	Ant "b"	a	b	a+b	D_{a-b}	$(a+b)^{1.5}/D_{a-b}$
GPRS 850 MHz	IEEE 802.11ac	0.938	0.696	1.634	94.08	0.02

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The sum of the standalone SAR values was above 1.6 W/kg for the Body Back side configuration at a separation distance of 0 mm with UMTS 1900 MHz antenna operating at limited output power with 5 GHz WLAN MIMO.

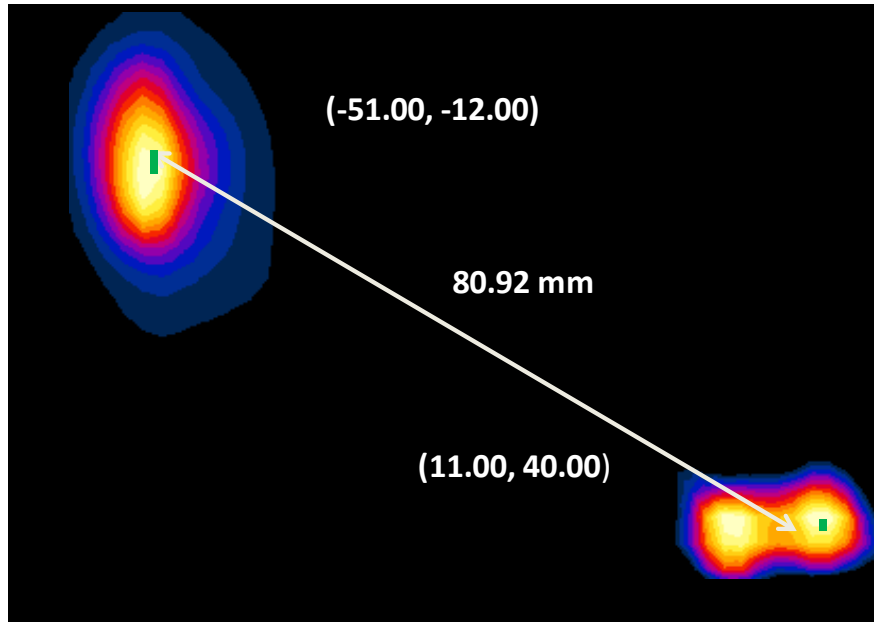


Figure 10-10
Peak SAR Location Plot of UMTS 1900 MHz and 5 GHz WLAN MIMO

Table 10-41
Peak SAR Locations for Body Back Side at 0 cm UMTS 1900 MHz and 5 GHz WLAN MIMO

Mode/Band	x (mm)	y (mm)
UMTS 1900 MHz	-51.00	-12.00
IEEE 802.11ac	11.00	40.00

Table 10-42
SAR Sum to Peak Location Separation Ratio Calculation

Antenna Pair		Standalone 1g SAR (W/kg)		Standalone SAR Sum (W/kg)	Peak SAR Separation Distance (mm)	SPLS Ratio
Ant "a"	Ant "b"	a	b	a+b	D_{a-b}	$(a+b)^{1.5}/D_{a-b}$
UMTS 1900 MHz	IEEE 802.11ac	0.905	0.696	1.601	80.92	0.03

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The sum of the standalone SAR values was above 1.6 W/kg for the Body Back side configuration at a separation distance of 13 mm with GPRS 850 MHz antenna operating at maximum output power with 2.4 GHz WIFI Antenna 1.

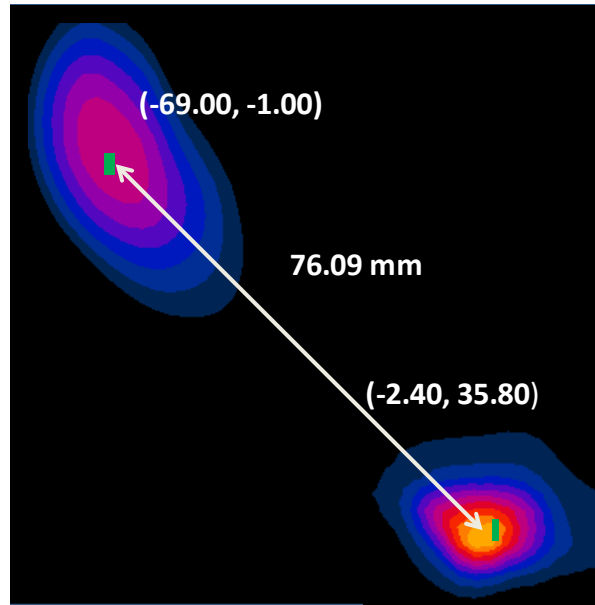


Figure 10-11
Peak SAR Location Plot of GPRS 850 MHz and 2.4 GHz WLAN Antenna 1

Table 10-43
Peak SAR Locations for Body Back Side at 1.3 cm GPRS 850 MHz and 2.4 GHz WLAN Antenna1

Mode/Band	x (mm)	y (mm)
GPRS 850 MHz	-69.00	-1.00
IEEE 802.11b	-2.40	35.80

Table 10-44
SAR Sum to Peak Location Separation Ratio Calculation

Antenna Pair		Standalone 1g SAR (W/kg)		Standalone SAR Sum (W/kg)	Peak SAR Separation Distance (mm)	SPLS Ratio
Ant "a"	Ant "b"	a	b	a+b	D_{a-b}	$(a+b)^{1.5}/D_{a-b}$
GPRS 850 MHz	IEEE 802.11b	0.599	< 1.016	< 1.615	76.09	< 0.03

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The sum of the standalone SAR values was above 1.6 W/kg for the Body Back side configuration at a separation distance of 13 mm with GPRS 1900 MHz antenna operating at maximum output power with 2.4 GHz WIFI Antenna 1.

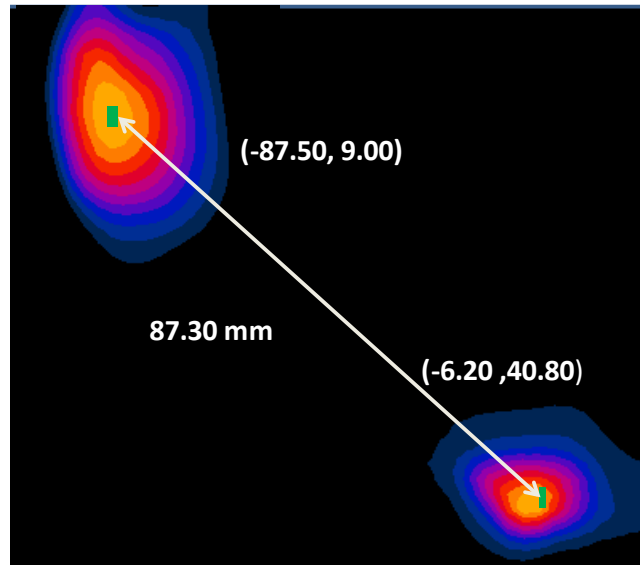


Figure 10-12
Peak SAR Location Plot of GPRS 1900 MHz and 2.4 GHz WLAN Antenna 1

Table 10-45
Peak SAR Locations for Body Back Side at 1.3 cm GPRS 1900 MHz and 2.4 GHz WLAN Antenna1

Mode/Band	x (mm)	y (mm)
GPRS 1900 MHz	-87.50	9.00
IEEE 802.11b	-6.20	40.80

Table 10-46
SAR Sum to Peak Location Separation Ratio Calculation

Antenna Pair		Standalone 1g SAR (W/kg)		Standalone SAR Sum (W/kg)	Peak SAR Separation Distance (mm)	SPLS Ratio
Ant "a"	Ant "b"	a	b	a+b	D_{a-b}	$(a+b)^{1.5}/D_{a-b}$
GPRS 1900 MHz	IEEE 802.11b	0.746	< 1.016	< 1.762	87.30	< 0.03

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The sum of the standalone SAR values was above 1.6 W/kg for the Body Back side configuration at a separation distance of 13 mm with UMTS 1900 MHz antenna operating at maximum output power with 2.4 GHz WIFI antenna 1.

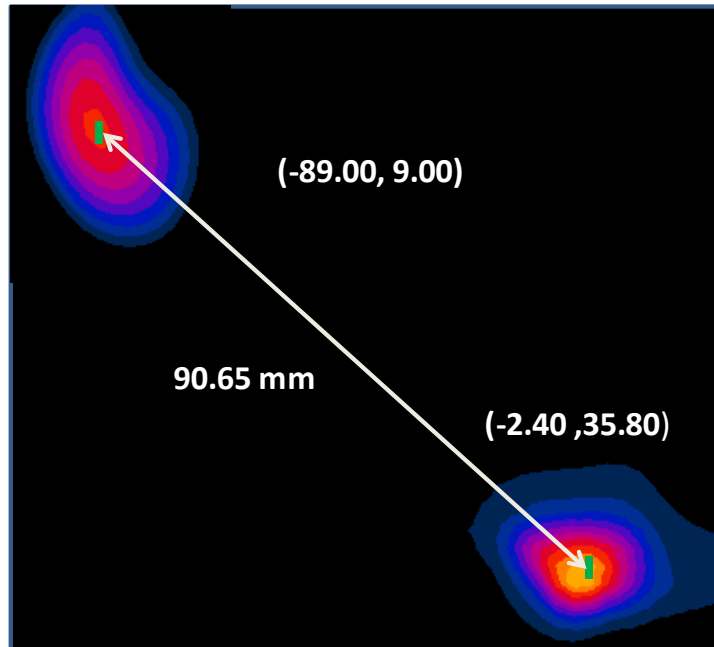


Figure 10-13
Peak SAR Location Plot of UMTS 1900 MHz and 2.4 GHz WLAN Antenna 1

Table 10-47
Peak SAR Locations for Body Back Side at 1.3 cm UMTS 1900 MHz and 2.4 GHz antenna 1

Mode/Band	x (mm)	y (mm)
UMTS 1900 MHz	-89.00	9.00
IEEE 802.11b	-2.40	35.80

Table 10-48
SAR Sum to Peak Location Separation Ratio Calculation

Antenna Pair		Standalone 1g SAR (W/kg)		Standalone SAR Sum (W/kg)	Peak SAR Separation Distance (mm)	SPLS Ratio
Ant "a"	Ant "b"	a	b	a+b	D_{a-b}	$(a+b)^{1.5}/D_{a-b}$
UMTS 1900 MHz	IEEE 802.11b	0.884	< 1.016	< 1.9	90.65	< 0.03

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.

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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 performed only if the ratio of largest to smallest SAR for the original and first repeated measurements was > 1.20 or when the original or repeated measurement was ≥ 1.45 W/kg ($\sim 10\%$ 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	WLAN Antenna	# 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)	
835	836.60	190	GSM 850	GPRS	N/A	3	N/A	back	0 mm	0.914	0.900	1.02	N/A	N/A	N/A	N/A
1900	1852.40	9262	UMTS 1900	RMC	N/A	N/A	N/A	back	0 mm	0.859	0.823	1.04	N/A	N/A	N/A	N/A
2450	2462.00	11	IEEE 802.11b	DSSS	1	N/A	1	back	0 mm	0.808	0.822	1.02	N/A	N/A	N/A	N/A
ANSI / IEEE C95.1 1992 - SAFETY LIMIT									Body							
Spatial Peak									1.6 W/kg (mW/g)							
Uncontrolled Exposure/General Population									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

For testing performed between 10/03/2013 to 10/08/2013:

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	85047A	S-Parameter Test Set	N/A	N/A	N/A	2904A00579
Agilent	N4010A	Wireless Connectivity Test Set	N/A	N/A	N/A	GB46170464
Agilent	85070C	Dielectric Probe Kit	2/14/2013	Annual	2/14/2014	MY44300633
Agilent	8753E	(30kHz-6GHz) Network Analyzer	4/16/2013	Annual	4/16/2014	JP38020182
Agilent	8648D	(9kHz-4GHz) Signal Generator	4/17/2013	Annual	4/17/2014	3629U00687
Amplifier Research	5S1G4	5W, 800MHz-4.2GHz	CBT	N/A	CBT	21910
Anritsu	MA2481A	Power Sensor	2/14/2013	Annual	2/14/2014	5821
Anritsu	ML2438A	Power Meter	12/4/2012	Annual	12/4/2013	1070030
Anritsu	MA2481A	Power Sensor	2/14/2013	Annual	2/14/2014	2400
Anritsu	ML2438A	Power Meter	2/14/2013	Annual	2/14/2014	98150041
Anritsu	MA2411B	Pulse Power Sensor	12/4/2012	Annual	12/4/2013	1207364
Anritsu	MA2411B	Pulse Power Sensor	12/5/2012	Annual	12/5/2013	1126066
Anritsu	MA2481D	Universal Sensor	12/17/2012	Annual	12/17/2013	1204343
Anritsu	MT8820C	Radio Communication Tester	11/6/2012	Annual	11/6/2013	6200901190
Anritsu	MA24106A	USB Power Sensor	12/7/2012	Annual	12/7/2013	1244512
Anritsu	MA24106A	USB Power Sensor	12/7/2012	Annual	12/7/2013	1244524
Anritsu	MA24106A	USB Power Sensor	12/7/2012	Annual	12/7/2013	1244515
Anritsu	MA24106A	USB Power Sensor	12/6/2012	Annual	12/6/2013	1248508
COMTech	AR85729-5	Solid State Amplifier	CBT	N/A	CBT	M155A00-009
COMTECH	AR85729-5/5759B	Solid State Amplifier	CBT	N/A	CBT	M3W1A00-1002
Control Company	36934-158	Wall-Mounted Thermometer	1/4/2012	Biennial	1/4/2014	122014488
Control Company	36934-158	Wall-Mounted Thermometer	1/4/2012	Biennial	1/4/2014	122014497
Control Company	4353	Long Stem Thermometer	9/25/2012	Biennial	9/25/2014	122541139
Control Company	4353	Long Stem Thermometer	9/25/2012	Biennial	9/25/2014	122539615
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
MiniCircuits	VLF-6000+	Low Pass Filter	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-1200+	Low Pass Filter DC to 1000 MHz	CBT	N/A	CBT	N/A
Mini-Circuits	BW-N20W5	Power Attenuator	CBT	N/A	CBT	1226
Mini-Circuits	BW-N20W5+	DC to 18 GHz Precision Fixed 20 dB Attenuator	CBT	N/A	CBT	N/A
Narda	BW-S3W2	Attenuator (3dB)	CBT	N/A	CBT	120
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Pasternack	PE2209-10	Bidirectional Coupler	CBT	N/A	CBT	N/A
Pasternack	PE2208-6	Bidirectional Coupler	CBT	N/A	CBT	N/A
Rohde & Schwarz	CMU200	Base Station Simulator	5/3/2013	Annual	5/3/2014	836371/0079
Rohde & Schwarz	NRVD	Dual Channel Power Meter	10/12/2012	Biennial	10/12/2014	101695
Seekonk	NC-100	Torque Wrench (8" lb)	3/5/2012	Triennial	3/5/2015	N/A
Seekonk	NC-100	Torque Wrench (8" lb)	3/5/2012	Triennial	3/5/2015	N/A
SPEAG	DAK-3.5	Dielectric Assessment Kit	12/11/2012	Annual	12/11/2013	1091
SPEAG	DAK-3.5	Dielectric Assessment Kit	5/14/2013	Annual	5/14/2014	1070
SPEAG	D835V2	835 MHz SAR Dipole	4/25/2013	Annual	4/25/2014	4d119
SPEAG	D1900V2	1900 MHz SAR Dipole	2/6/2013	Annual	2/6/2014	5d148
SPEAG	ES3DV2	SAR Probe	8/22/2013	Annual	8/22/2014	3022
SPEAG	ES3DV3	SAR Probe	3/15/2013	Annual	3/15/2014	3209
SPEAG	DAE4	Dasy Data Acquisition Electronics	3/8/2013	Annual	3/8/2014	1334
SPEAG	DAE4	Dasy Data Acquisition Electronics	8/21/2013	Annual	8/21/2014	1322
Tektronix	RSA6114A	Real Time Spectrum Analyzer	4/17/2013	Annual	4/17/2014	B010177
VWR	62344-925	Mini-Thermometer	10/24/2011	Biennial	10/24/2013	111886443
VWR	23226-658	Long Stem Thermometer	3/30/2012	Biennial	3/30/2014	122179874

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For testing performed between 12/12/2013 to 12/16/2013:

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	85047A	S-Parameter Test Set	N/A	N/A	N/A	2904A00579
Agilent	N9020A	MXA Signal Analyzer	10/29/2013	Annual	10/29/2014	US46470561
Agilent	N4010A	Wireless Connectivity Test Set	N/A	N/A	N/A	GB46170464
Agilent	85070C	Dielectric Probe Kit	2/14/2013	Annual	2/14/2014	MY44300633
Agilent	8753E	(30kHz-6GHz) Network Analyzer	4/16/2013	Annual	4/16/2014	JP38020182
Agilent	8648D	(9kHz-4GHz) Signal Generator	4/17/2013	Annual	4/17/2014	3629U00687
Amplifier Research	5S1G4	5W, 800MHz-4.2GHz	CBT	N/A	CBT	21910
Anritsu	MA2481A	Power Sensor	2/14/2013	Annual	2/14/2014	5821
Anritsu	MA2481A	Power Sensor	2/14/2013	Annual	2/14/2014	2400
Anritsu	ML2438A	Power Meter	2/14/2013	Annual	2/14/2014	98150041
Anritsu	MA2481D	Universal Sensor	12/17/2012	Annual	12/17/2013	1204343
COMTech	AR85729-5	Solid State Amplifier	CBT	N/A	CBT	M155A00-009
COMTECH	AR85729-5/5759B	Solid State Amplifier	CBT	N/A	CBT	M3W1A00-1002
Control Company	36934-158	Wall-Mounted Thermometer	1/4/2012	Biennial	1/4/2014	122014488
Control Company	36934-158	Wall-Mounted Thermometer	1/4/2012	Biennial	1/4/2014	122014497
Control Company	4353	Long Stem Thermometer	9/25/2012	Biennial	9/25/2014	122541139
Control Company	4353	Long Stem Thermometer	9/25/2012	Biennial	9/25/2014	122539615
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
MiniCircuits	VLF-6000+	Low Pass Filter	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-1200+	Low Pass Filter DC to 1000 MHz	CBT	N/A	CBT	N/A
Mini-Circuits	BW-N20W5	Power Attenuator	CBT	N/A	CBT	1226
Mini-Circuits	BW-N20W5+	DC to 18 GHz Precision Fixed 20 dB Attenuator	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-2950+	Low Pass Filter DC to 2700 MHz	CBT	N/A	CBT	N/A
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
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Pasternack	PE2209-10	Bidirectional Coupler	CBT	N/A	CBT	N/A
Pasternack	PE2208-6	Bidirectional Coupler	CBT	N/A	CBT	N/A
Rohde & Schwarz	CMU200	Base Station Simulator	5/3/2013	Annual	5/3/2014	836371/0079
Rohde & Schwarz	NRVD	Dual Channel Power Meter	10/12/2012	Biennial	10/12/2014	101695
Seekonk	NC-100	Torque Wrench (8" lb)	3/5/2012	Triennial	3/5/2015	N/A
Seekonk	NC-100	Torque Wrench (8" lb)	3/5/2012	Triennial	3/5/2015	N/A
SPEAG	DAK-3.5	Dielectric Assessment Kit	5/14/2013	Annual	5/14/2014	1070
SPEAG	D2450V2	2450 MHz SAR Dipole	1/8/2013	Annual	1/8/2014	797
SPEAG	D5GHzV2	5 GHz SAR Dipole	2/14/2013	Annual	2/14/2014	1120
SPEAG	ES3DV2	SAR Probe	8/22/2013	Annual	8/22/2014	3022
SPEAG	EX3DV4	SAR Probe	10/23/2013	Annual	10/23/2014	3914
SPEAG	DAE4	Dasy Data Acquisition Electronics	11/19/2013	Annual	11/19/2014	1333
SPEAG	DAE4	Dasy Data Acquisition Electronics	8/21/2013	Annual	8/21/2014	1322
Tektronix	RSA6114A	Real Time Spectrum Analyzer	4/17/2013	Annual	4/17/2014	B010177
VWR	23226-658	Long Stem Thermometer	3/30/2012	Biennial	3/30/2014	122179874

Note:

1. 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.
2. Each equipment item was used solely within its respective calibration period.

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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
Expanded Uncertainty (95% CONFIDENCE LEVEL)							k=2	24.2	23.5
									299

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

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Applicable for frequencies up to 6 GHz.

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

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

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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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FCC ID: A3LSMP901A	 SAR EVALUATION REPORT 		Reviewed by: Quality Manager
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APPENDIX A: SAR TEST DATA

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSMP901A; Type: Portable Tablet; Serial: 310-1

Communication System: UID 0, GSM GPRS; 3 Tx slots; Frequency: 836.6 MHz; Duty Cycle: 1:2.76

Medium: 835 Body Medium parameters used (interpolated):

$f = 836.6 \text{ MHz}$; $\sigma = 1.018 \text{ S/m}$; $\epsilon_r = 53.869$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 0.0 cm

Test Date: 10-03-2013; Ambient Temp: 24.5°C; Tissue Temp: 23.7°C

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

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

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

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

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

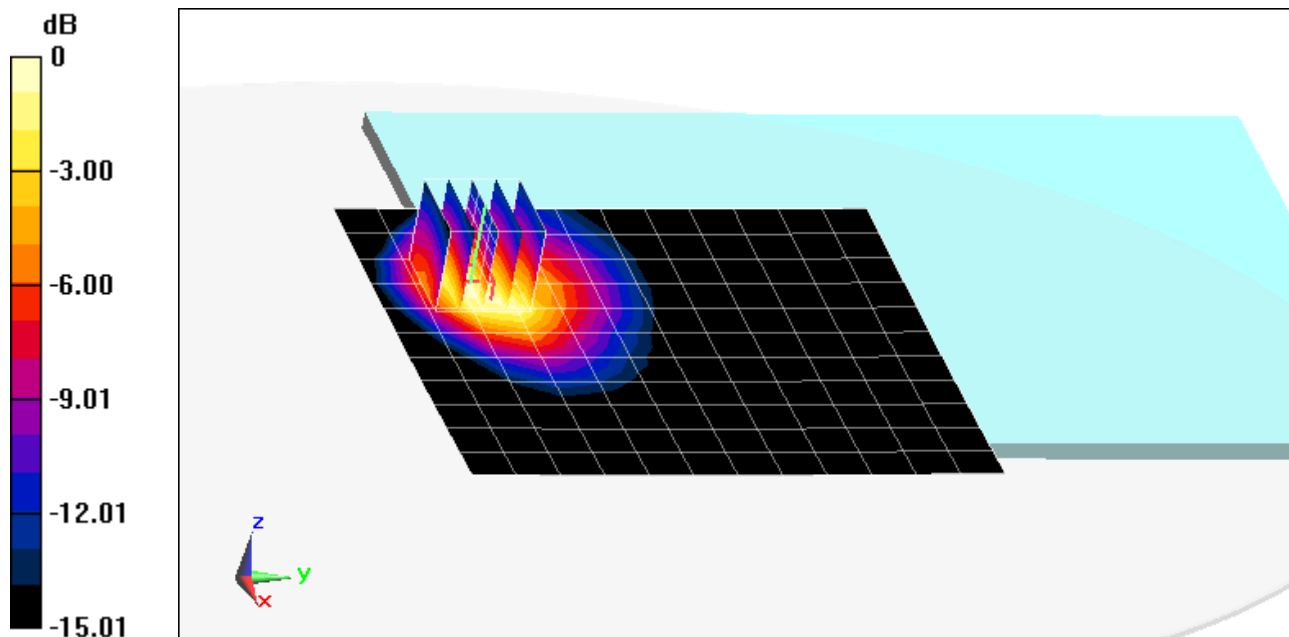
Area Scan (12x13x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 31.666 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 1.74 W/kg

SAR(1 g) = 0.914 W/kg



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

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSMP901A; Type: Portable Tablet; Serial: 310-1

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

Medium: 835 Body Medium parameters used (interpolated):

$f = 836.6 \text{ MHz}$; $\sigma = 1.014 \text{ S/m}$; $\epsilon_r = 53.626$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 0.0 cm

Test Date: 10-08-2013; Ambient Temp: 22.3°C; Tissue Temp: 23.3°C

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

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

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

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

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

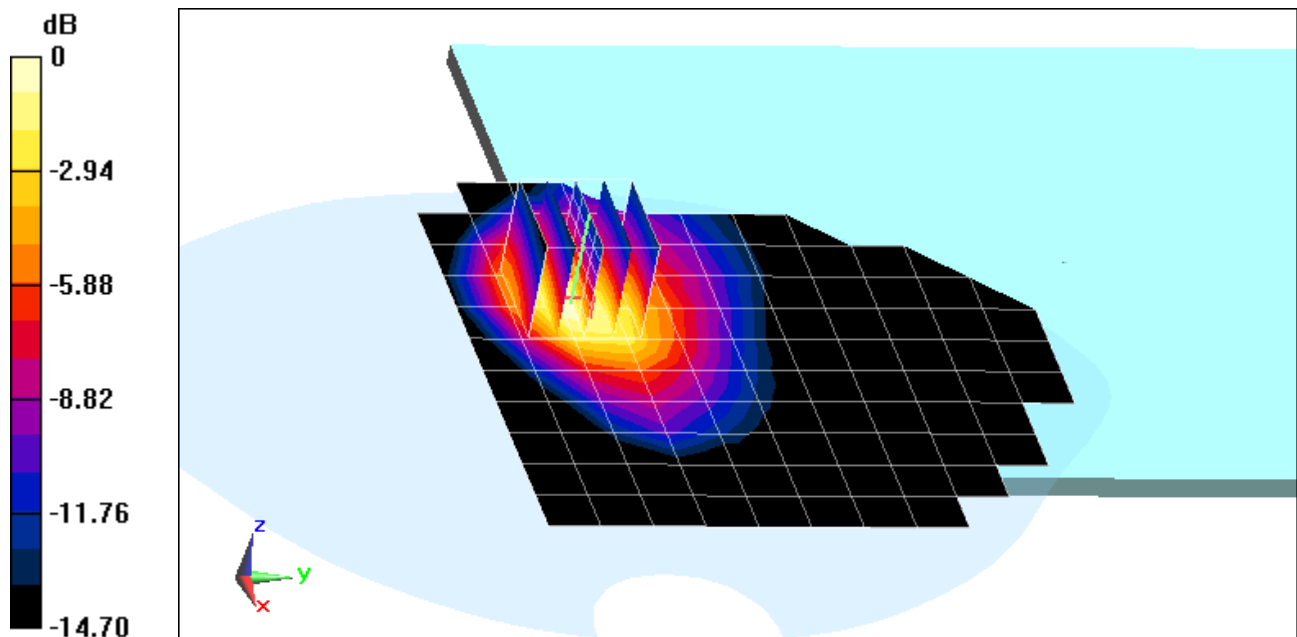
Area Scan (12x13x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 27.145 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 1.30 W/kg

SAR(1 g) = 0.662 W/kg



0 dB = 0.730 W/kg = -1.37 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSMP901A; Type: Portable Tablet; Serial: 310-3

Communication System: UID 0, GSM GPRS; 4 Tx slots; Frequency: 1880 MHz; Duty Cycle: 1:2.076

Medium: 1900 Body Medium parameters used:

$f = 1880 \text{ MHz}$; $\sigma = 1.496 \text{ S/m}$; $\epsilon_r = 51.974$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.3 cm

Test Date: 10-08-2013; Ambient Temp: 23.4°C; Tissue Temp: 22.8°C

Probe: ES3DV2 - SN3022; ConvF(4.49, 4.49, 4.49); Calibrated: 8/22/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

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

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

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

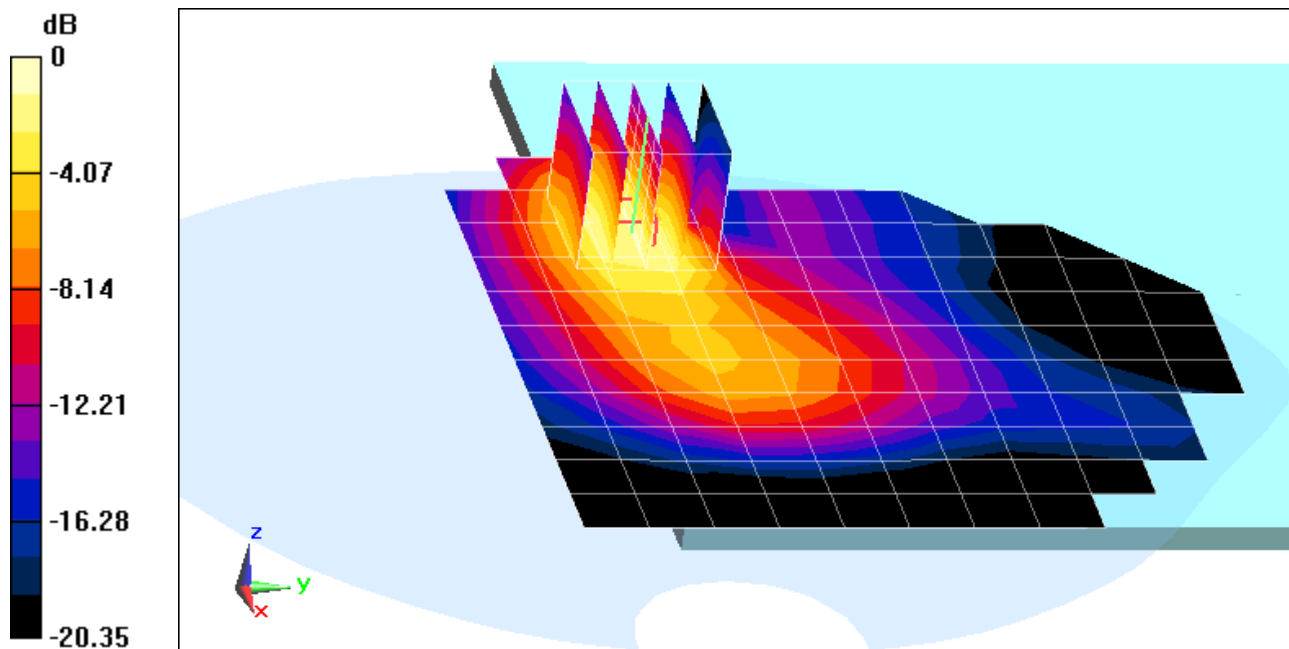
Area Scan (12x13x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 19.175 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 1.26 W/kg

SAR(1 g) = 0.684 W/kg



0 dB = 0.766 W/kg = -1.16 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSMP901A; Type: Portable Tablet; Serial: 310-1

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

Medium: 1900 Body Medium parameters used (interpolated):

$f = 1852.4 \text{ MHz}$; $\sigma = 1.46 \text{ S/m}$; $\epsilon_r = 52.092$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 0.0 cm

Test Date: 10-08-2013; Ambient Temp: 23.4°C; Tissue Temp: 22.8°C

Probe: ES3DV2 - SN3022; ConvF(4.49, 4.49, 4.49); Calibrated: 8/22/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

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

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

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

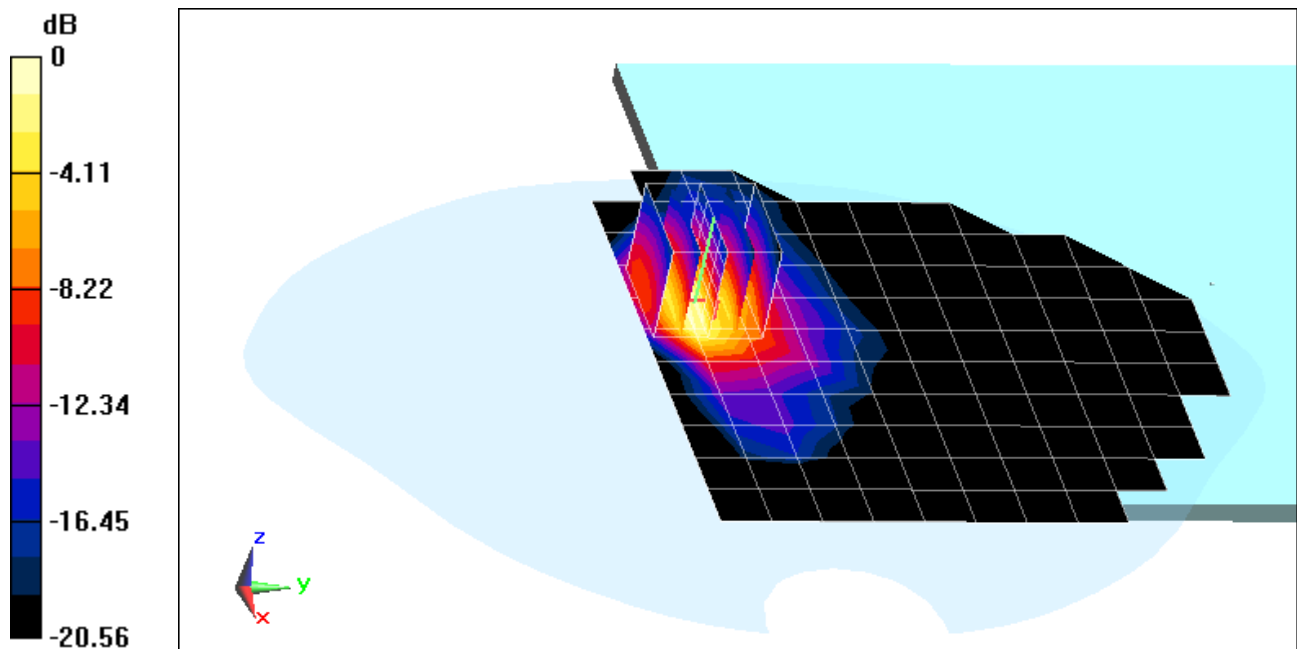
Area Scan (12x13x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 26.874 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 1.95 W/kg

SAR(1 g) = 0.859 W/kg



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

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSMP901A; Type: Portable Tablet; Serial: 2710-4

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

Medium: 2450 Body Medium parameters used (interpolated):

$f = 2462 \text{ MHz}$; $\sigma = 1.974 \text{ S/m}$; $\epsilon_r = 52.711$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 0.0 cm

Test Date: 12-12-2013; Ambient Temp: 23.8°C; Tissue Temp: 23.3°C

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

Sensor-Surface: 3mm (Mechanical Surface Detection)

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

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

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

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

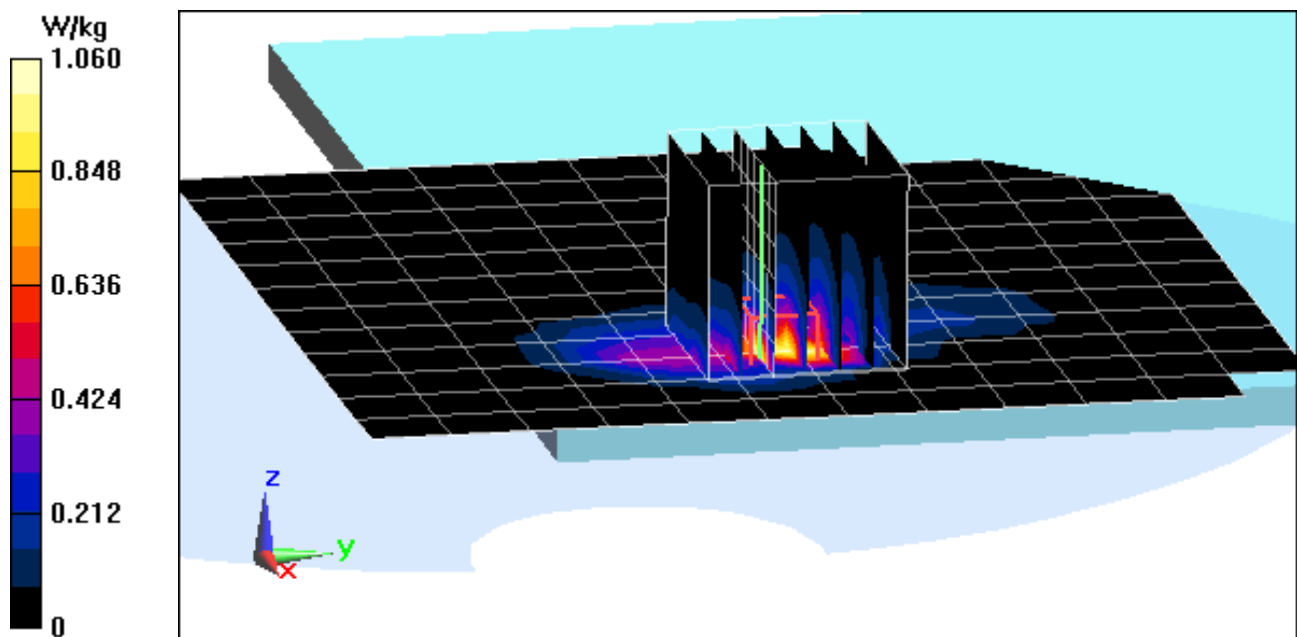
Area Scan (13x13x1): Measurement grid: $dx=12\text{mm}$, $dy=12\text{mm}$

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

Reference Value = 21.577 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 2.49 W/kg

SAR(1 g) = 0.822 W/kg



PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSMP901A; Type: Portable Tablet; Serial: 2710-5

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

Medium: 5GHz Body Medium parameters used:

$f = 5745 \text{ MHz}$; $\sigma = 6.212 \text{ S/m}$; $\epsilon_r = 46.373$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 0.0 cm

Test Date: 12-16-2013; Ambient Temp: 22.9°C; Tissue Temp: 22.1°C

Probe: EX3DV4 - SN3914; ConvF(4.14, 4.14, 4.14); Calibrated: 10/23/2013;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 11/19/2013

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

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

Mode: Antenna 1, IEEE 802.11a, 5.8 GHz, Body SAR, Ch 149, 6 Mbps, Back Side

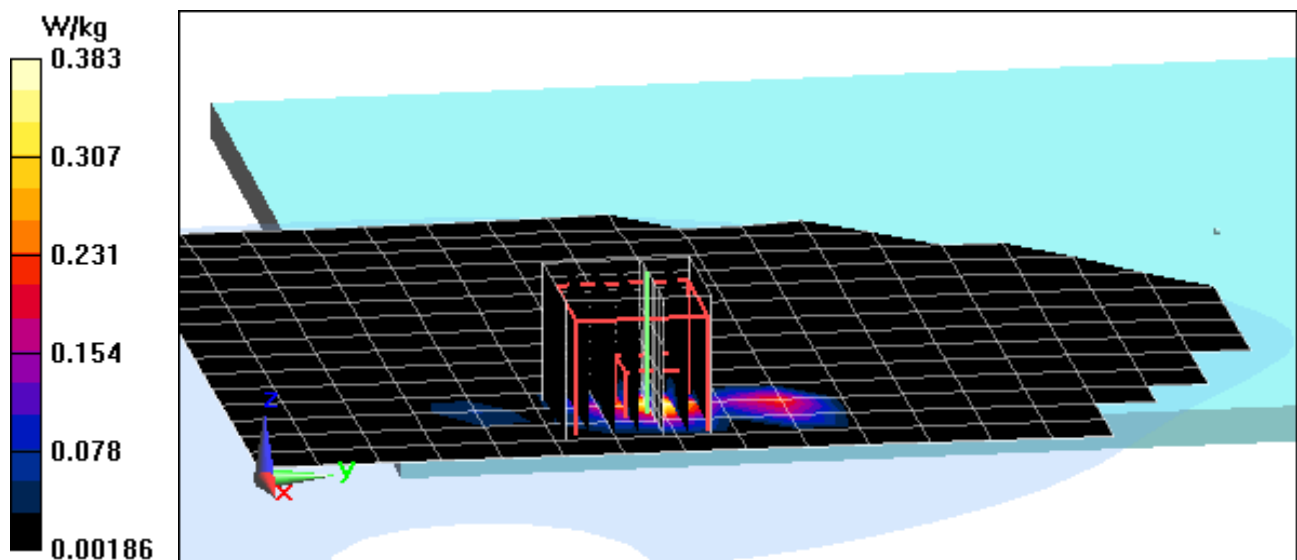
Area Scan (16x18x1): Measurement grid: dx=10mm, dy=10mm

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

Reference Value = 4.379 V/m; Power Drift = -0.21 dB

Peak SAR (extrapolated) = 1.54 W/kg

SAR(1 g) = 0.230 W/kg



PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSMP901A; Type: Portable Tablet; Serial: 2710-5

Communication System: UID 0, IEEE 802.11ac (0); Frequency: 5210 MHz; Duty Cycle: 1:1

Medium: 5GHz Body Medium parameters used (interpolated):

$f = 5210 \text{ MHz}$; $\sigma = 5.38 \text{ S/m}$; $\epsilon_r = 47.639$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 0.0 cm

Test Date: 12-16-2013; Ambient Temp: 22.8°C; Tissue Temp: 22.1°C

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

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 11/19/2013

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

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

Mode: MIMO, IEEE 802.11ac, 5.2 GHz, Body SAR, Ch 42, 58.6 Mbps, Back Side

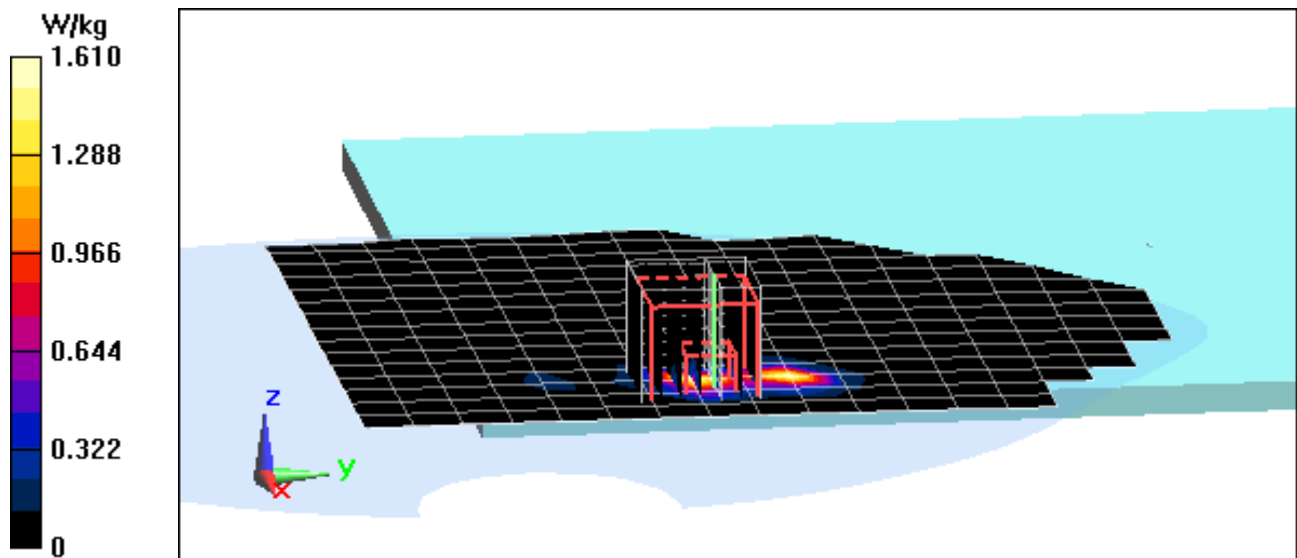
Area Scan (16x18x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

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

Reference Value = 12.645 V/m; Power Drift = 0.11 dB

Peak SAR (extrapolated) = 5.32 W/kg

SAR(1 g) = 0.659 W/kg



APPENDIX B: SYSTEM VERIFICATION

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 835 Body Medium parameters used:

$f = 835 \text{ MHz}$; $\sigma = 1.016 \text{ S/m}$; $\epsilon_r = 53.879$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.5 cm

Test Date: 10-03-2013; Ambient Temp: 24.5°C; Tissue Temp: 23.7°C

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

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

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

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

835 MHz System Verification

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

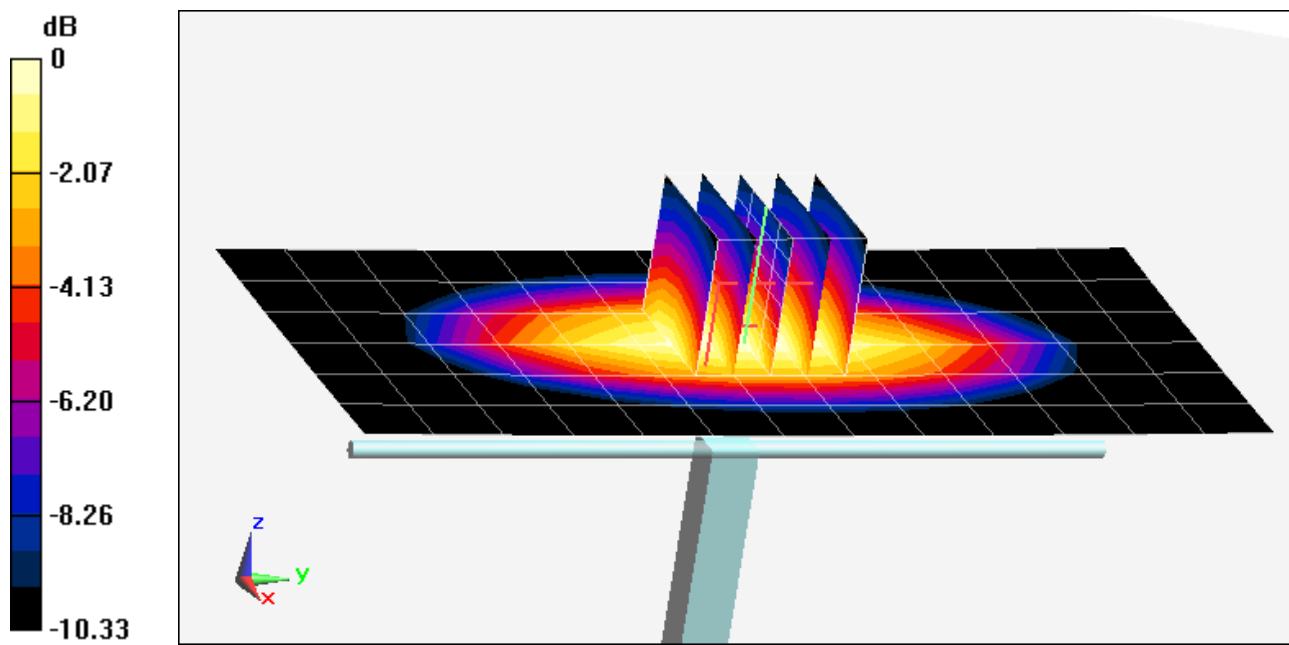
Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 1.44 W/kg

SAR(1 g) = 0.990 W/kg

Deviation = 3.77%



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

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 835 Body Medium parameters used:

$f = 835 \text{ MHz}$; $\sigma = 1.012 \text{ S/m}$; $\epsilon_r = 53.646$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.5 cm

Test Date: 10-08-2013; Ambient Temp: 22.3°C; Tissue Temp: 23.3°C

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

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

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

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

835 MHz System Verification

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

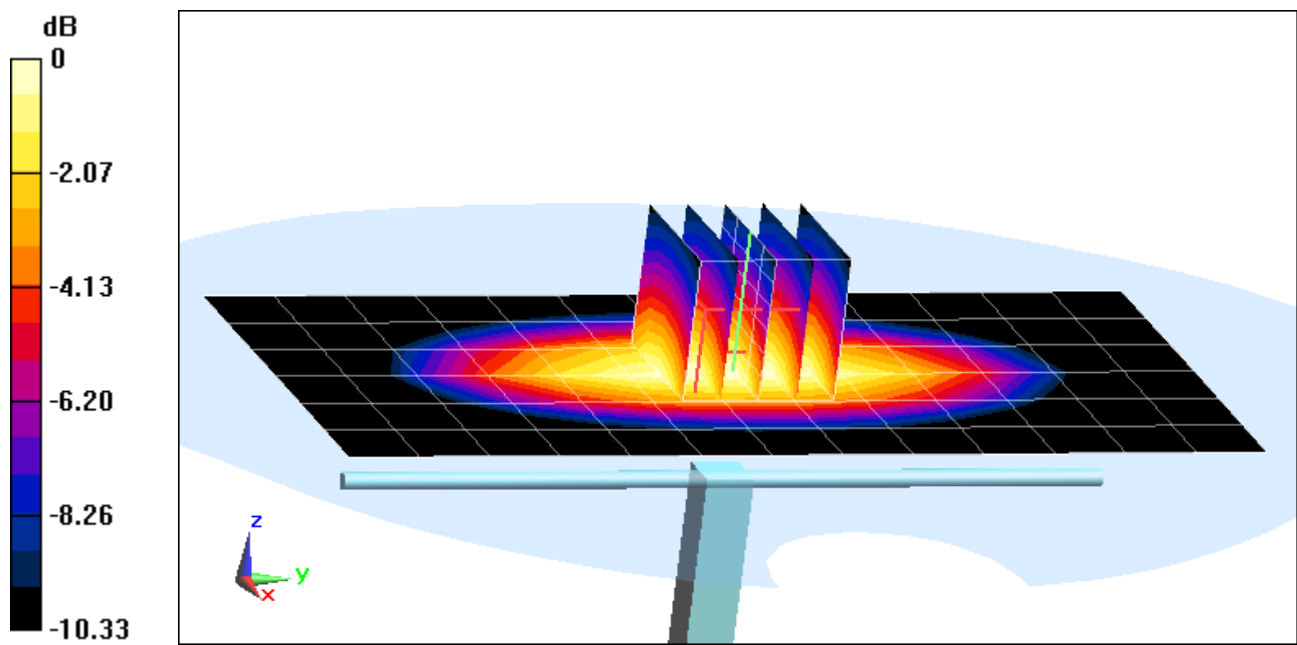
Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 1.44 W/kg

SAR(1 g) = 0.998 W/kg

Deviation = 4.61%



0 dB = 1.08 W/kg = 0.33 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 1900 Body Medium parameters used (interpolated):

$f = 1900 \text{ MHz}$; $\sigma = 1.511 \text{ S/m}$; $\epsilon_r = 51.912$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 10-08-2013; Ambient Temp: 23.4°C; Tissue Temp: 22.8°C

Probe: ES3DV2 - SN3022; ConvF(4.49, 4.49, 4.49); Calibrated: 8/22/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

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

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

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

1900 MHz System Verification

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

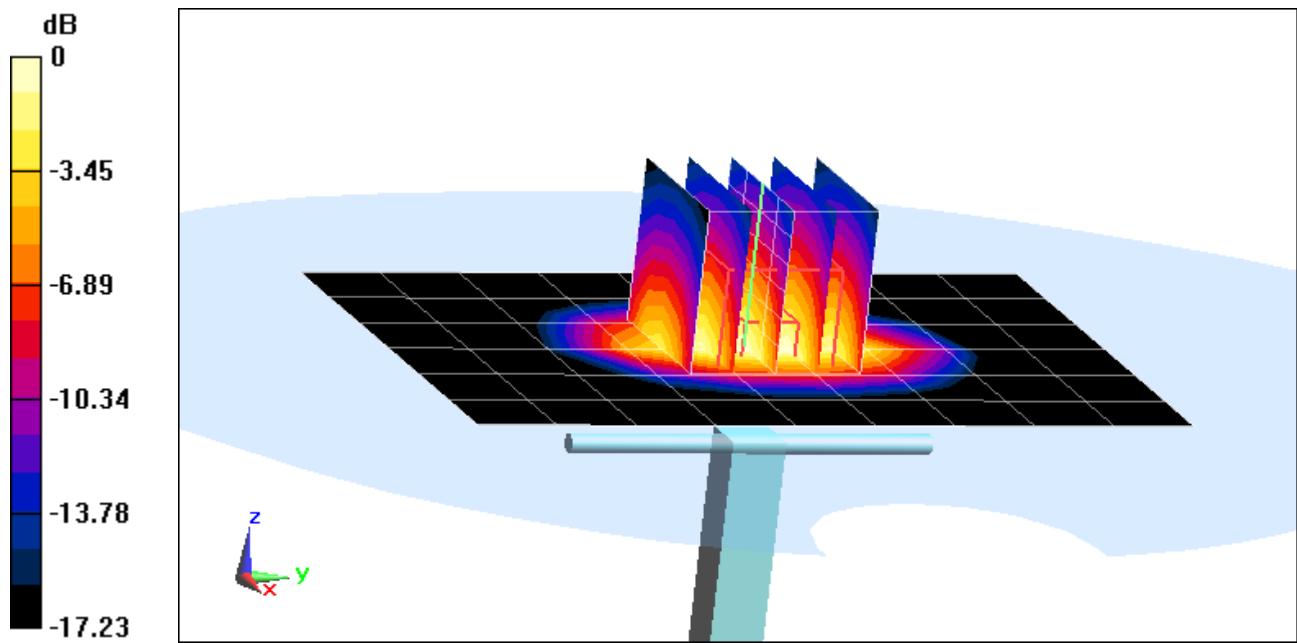
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 7.30 W/kg

SAR(1 g) = 4.11 W/kg

Deviation = 0.74%



0 dB = 4.60 W/kg = 6.63 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 2450 Body Medium parameters used:

$f = 2450 \text{ MHz}$; $\sigma = 1.958 \text{ S/m}$; $\epsilon_r = 52.752$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-12-2013; Ambient Temp: 23.8°C; Tissue Temp: 23.3°C

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

Sensor-Surface: 3mm (Mechanical Surface Detection)

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

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

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

2450 MHz System Verification

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

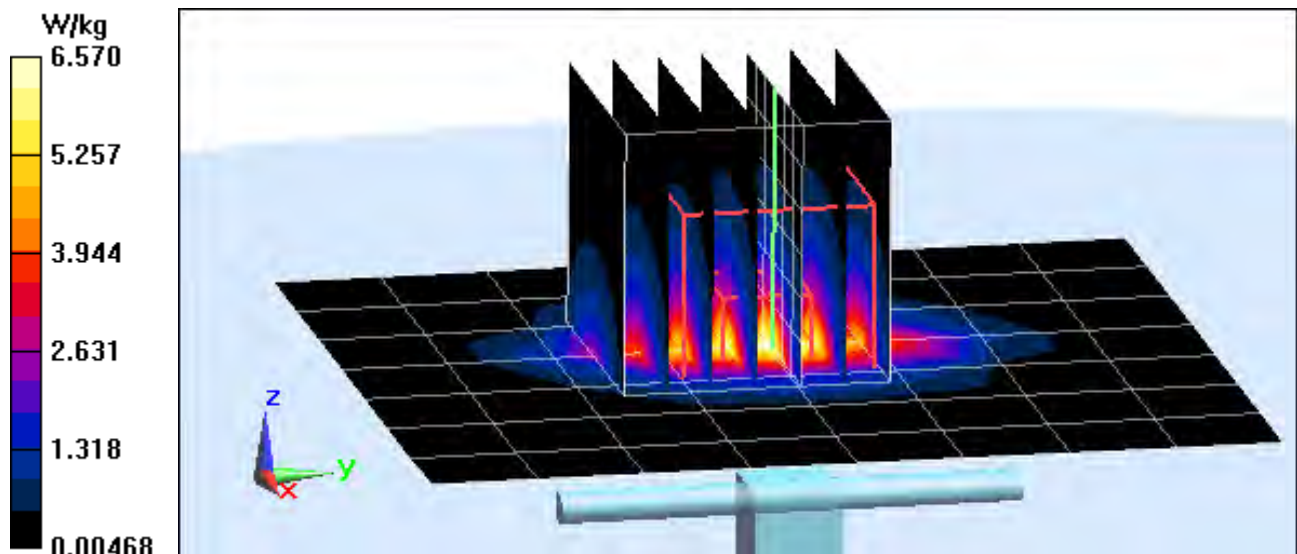
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 10.4 W/kg

SAR(1 g) = 4.86 W/kg

Deviation = -2.02%



PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5GHz Body Medium parameters used:

$f = 5200 \text{ MHz}$; $\sigma = 5.362 \text{ S/m}$; $\epsilon_r = 47.667$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-16-2013; Ambient Temp: 22.8°C; Tissue Temp: 22.1°C

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

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 11/19/2013

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

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

5200 MHz System Verification

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

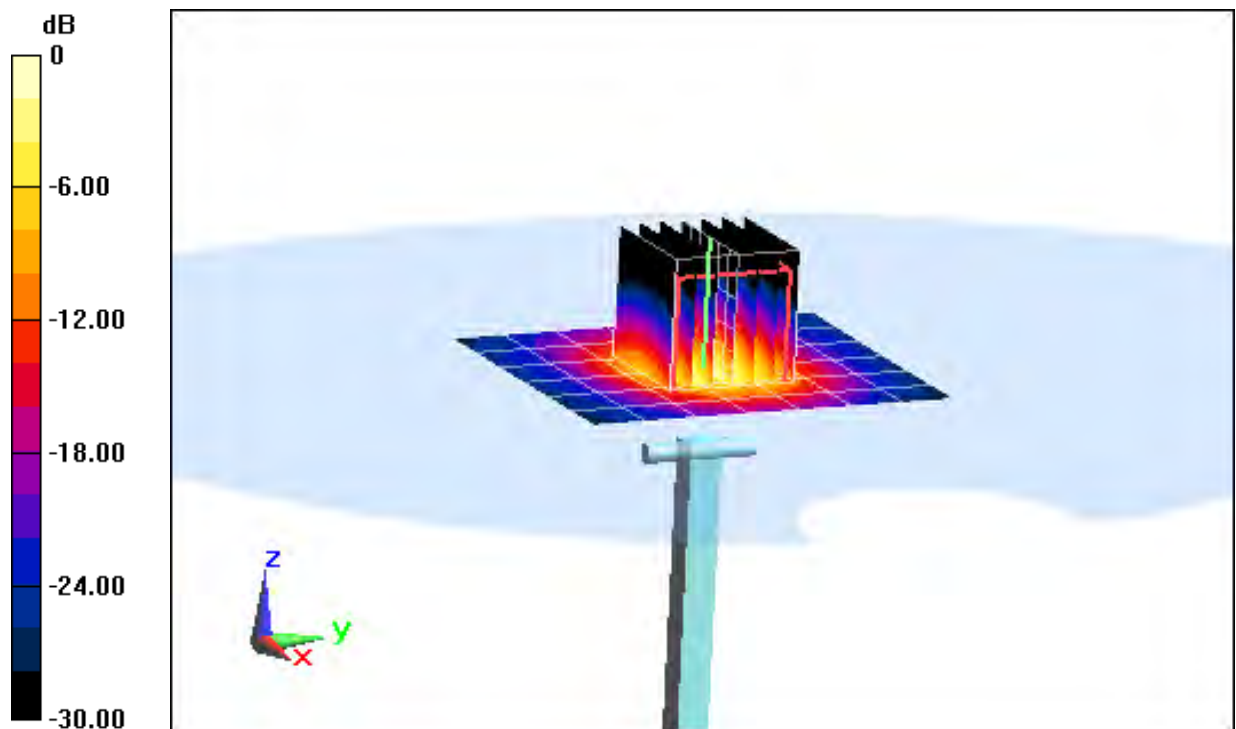
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$; Graded Ratio: 1.4

Input Power= 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 33.2 W/kg

SAR(1 g) = 7.57 W/kg

Deviation= -1.17%



0 dB = 19.5 W/kg = 12.90 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5GHz Body Medium parameters used:

$f = 5300 \text{ MHz}$; $\sigma = 5.495 \text{ S/m}$; $\epsilon_r = 47.472$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space 1.0 cm

Test Date: 12-16-2013; Ambient Temp: 22.7°C; Tissue Temp: 22.1°C

Probe: EX3DV4 - SN3914; ConvF(4.32, 4.32, 4.32); Calibrated: 10/23/2013;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 11/19/2013

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

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

5300 MHz System Verification

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

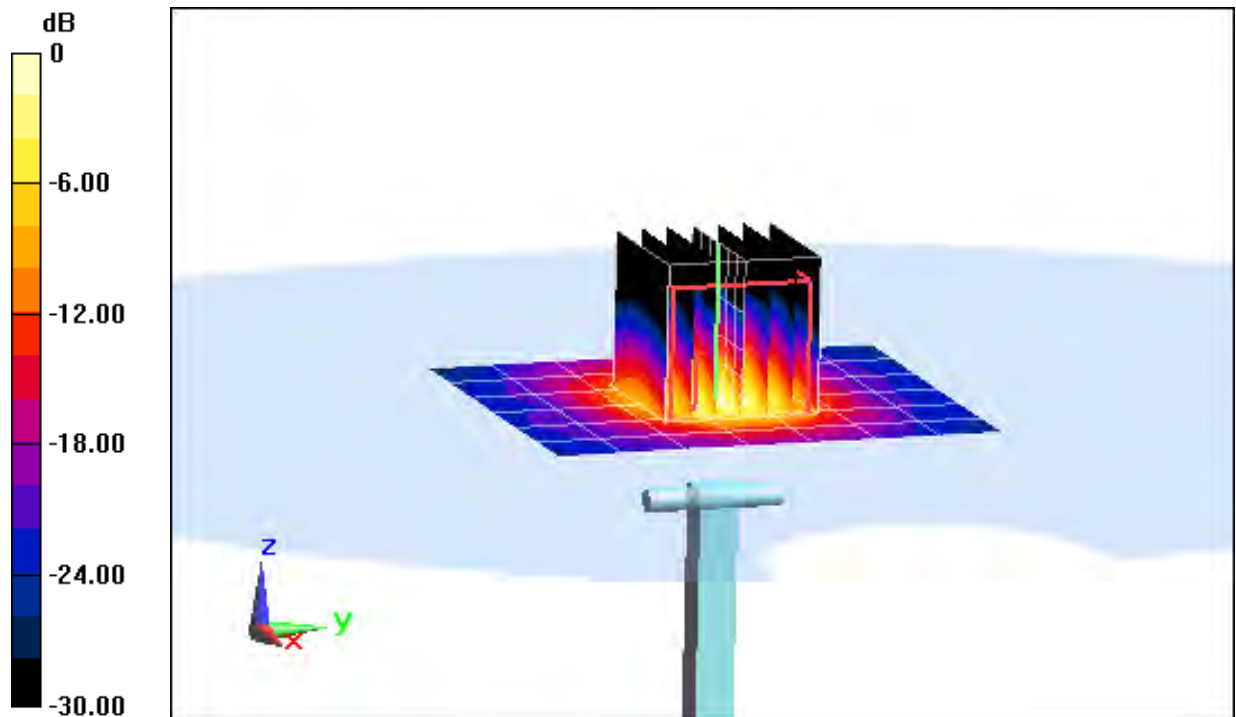
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$; Graded Ratio: 1.4

Input Power= 20 dBm (100 mW)

Peak SAR (extrapolated) = 35.5 W/kg

SAR(1 g) = 7.74 W/kg

Deviation=0.78%



0 dB = 20.4 W/kg = 13.10 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5GHz Body Medium parameters used:

$f = 5500 \text{ MHz}$; $\sigma = 5.818 \text{ S/m}$; $\epsilon_r = 46.965$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-16-2013; Ambient Temp: 22.5°C; Tissue Temp: 22.1°C

Probe: EX3DV4 - SN3914; ConvF(4.07, 4.07, 4.07); Calibrated: 10/23/2013;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 11/19/2013

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

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

5500 MHz System Verification

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

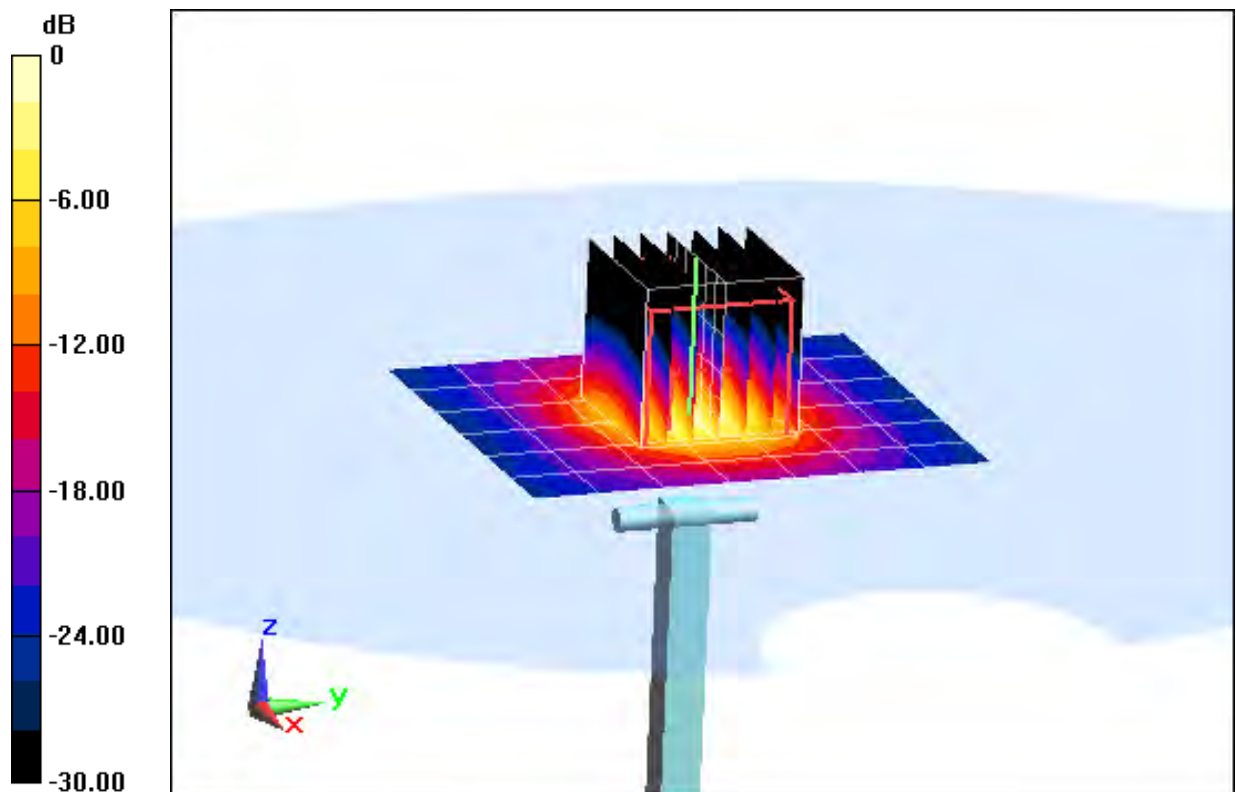
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$; Graded Ratio: 1.4

Input Power= 20 dBm (100 mW)

Peak SAR (extrapolated) = 37.6 W/kg

SAR(1 g) = 7.89 W/kg

Deviation= -1.13%



0 dB = 20.9 W/kg = 13.20 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5GHz Body Medium parameters used:

$f = 5600 \text{ MHz}$; $\sigma = 5.965 \text{ S/m}$; $\epsilon_r = 46.694$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-16-2013; Ambient Temp: 22.8°C; Tissue Temp: 22.1°C

Probe: EX3DV4 - SN3914; ConvF(3.97, 3.97, 3.97); Calibrated: 10/23/2013;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 11/19/2013

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

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

5600 MHz System Verification

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

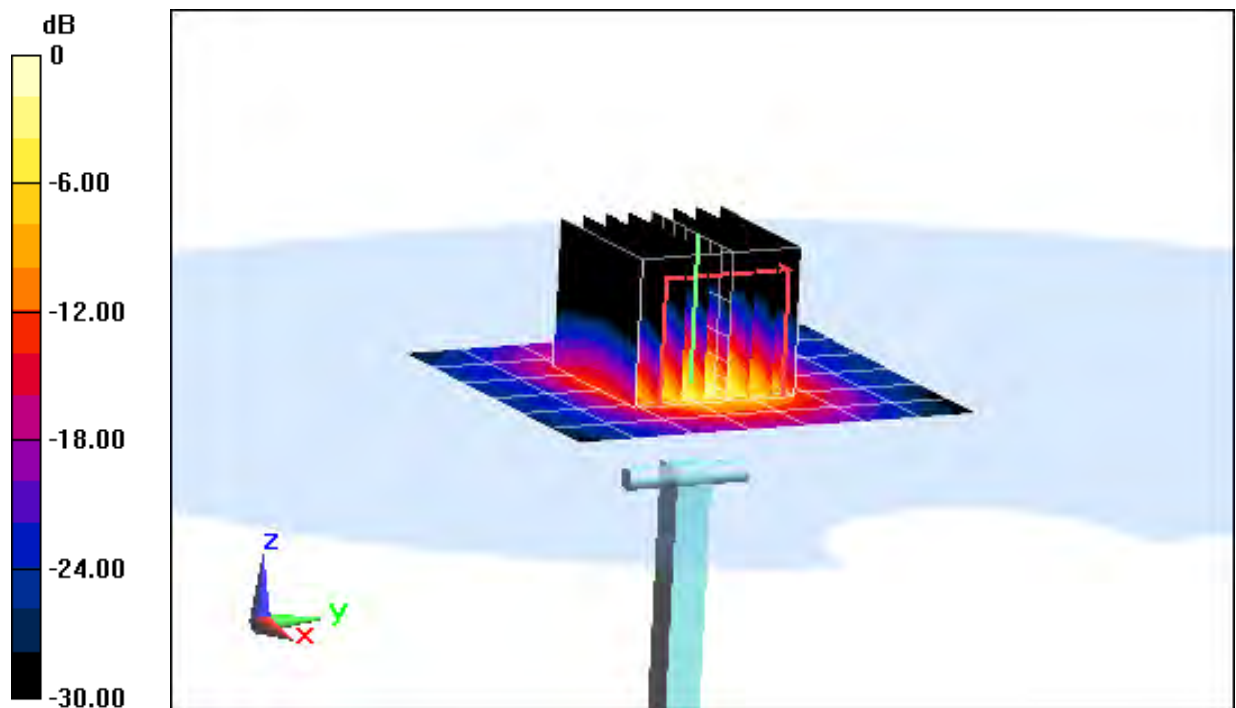
Zoom Scan (8x8x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$; Graded Ratio: 1.4

Input Power= 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 41.0 W/kg

SAR(1 g) = 8.32 W/kg

Deviation= 3.10%



0 dB = 22.3 W/kg = 13.48 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 5GHz Body Medium parameters used:

$f = 5800 \text{ MHz}$; $\sigma = 6.272 \text{ S/m}$; $\epsilon_r = 46.208$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 12-16-2013; Ambient Temp: 22.9°C; Tissue Temp: 22.1°C

Probe: EX3DV4 - SN3914; ConvF(4.14, 4.14, 4.14); Calibrated: 10/23/2013;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1333; Calibrated: 11/19/2013

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

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

5800 MHz System Verification

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

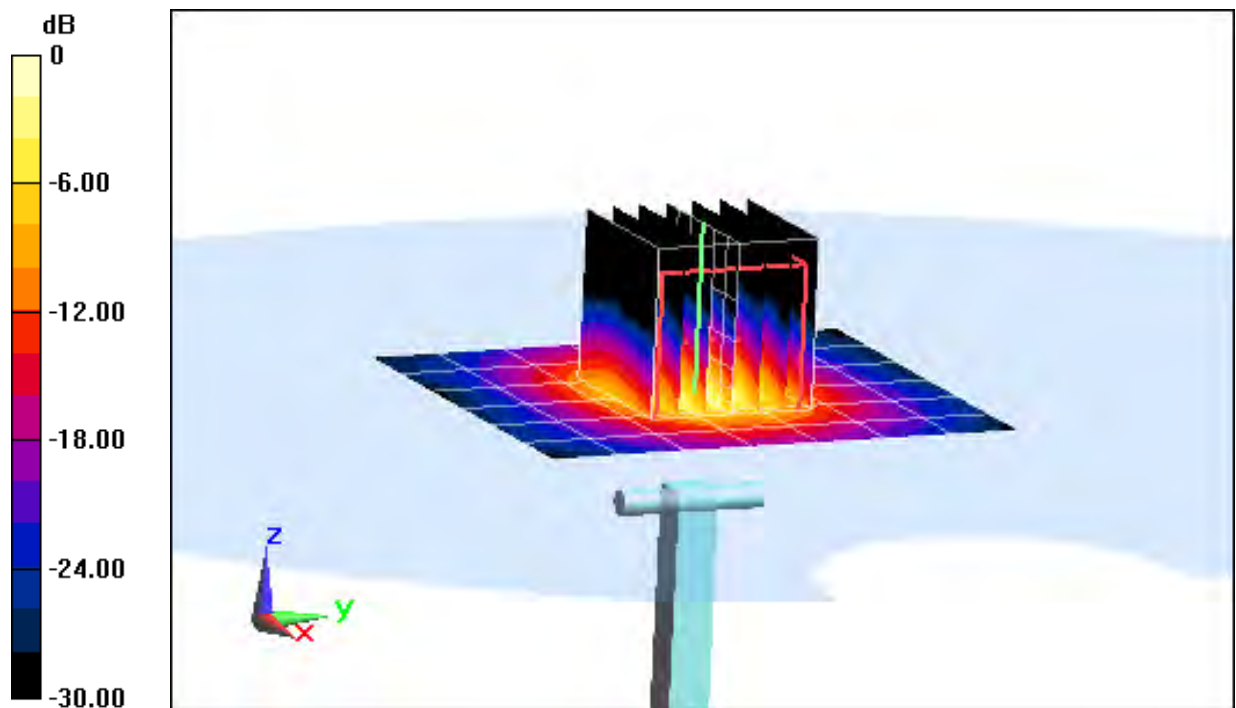
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$; Graded Ratio: 1.4

Input Power= 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 36.6 W/kg

SAR(1 g) = 7.11 W/kg

Deviation= -5.83%



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

APPENDIX C: PROBE CALIBRATION



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

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **ES3-3209_Mar13**

CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3209**

Calibration procedure(s) **QA CAL-01.v8, QA CAL-23.v4, QA CAL-25.v4**
Calibration procedure for dosimetric E-field probes

Calibration date: **March 15, 2013**

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

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

Calibration Equipment used (M&TE critical for calibration)

✓ KOK
3/24/13

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	29-Mar-12 (No. 217-01508)	Apr-13
Power sensor E4412A	MY41498087	29-Mar-12 (No. 217-01508)	Apr-13
Reference 3 dB Attenuator	SN: S5054 (3c)	27-Mar-12 (No. 217-01531)	Apr-13
Reference 20 dB Attenuator	SN: S5086 (20b)	27-Mar-12 (No. 217-01529)	Apr-13
Reference 30 dB Attenuator	SN: S5129 (30b)	27-Mar-12 (No. 217-01532)	Apr-13
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-11)	In house check: Apr-13
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

Calibrated by:	Name Israe El-Naouq	Function Laboratory Technician	Signature
Approved by:	Name Katja Pokovic	Function Technical Manager	Signature
			Issued: March 15, 2013
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

Glossary:

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,y,z}
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization ϕ	ϕ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

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

Probe ES3DV3

SN:3209

Manufactured: October 14, 2008
Calibrated: March 15, 2013

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	1.35	1.33	1.14	$\pm 10.1 \%$
DCP (mV) ^B	99.2	97.8	98.3	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	163.6	$\pm 3.5 \%$
		Y	0.0	0.0	1.0		170.3	
		Z	0.0	0.0	1.0		158.7	

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

^A The uncertainties of NormX,Y,Z do not affect the E^2 -field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	6.74	6.74	6.74	0.76	1.18	± 12.0 %
835	41.5	0.90	6.46	6.46	6.46	0.31	1.81	± 12.0 %
1750	40.1	1.37	5.39	5.39	5.39	0.80	1.21	± 12.0 %
1900	40.0	1.40	5.21	5.21	5.21	0.78	1.26	± 12.0 %
2450	39.2	1.80	4.57	4.57	4.57	0.65	1.43	± 12.0 %
2600	39.0	1.96	4.43	4.43	4.43	0.75	1.36	± 12.0 %

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

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209

Calibration Parameter Determined in Body Tissue Simulating Media

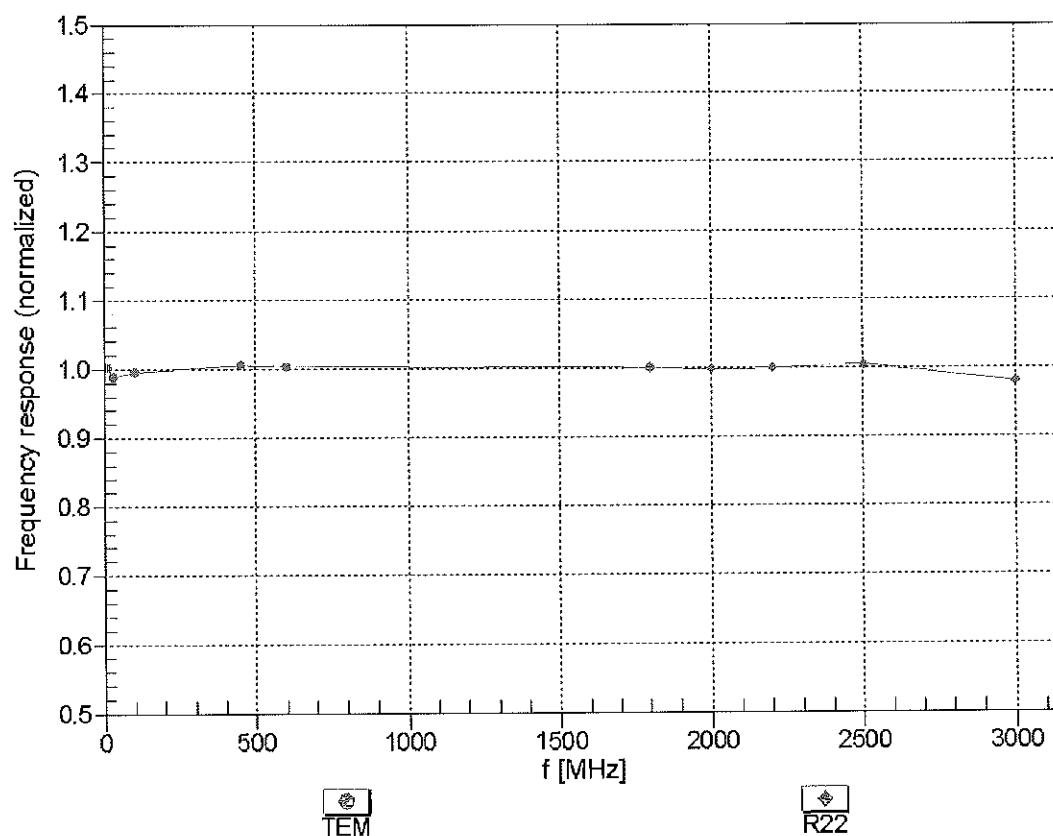
f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	6.38	6.38	6.38	0.80	1.16	± 12.0 %
835	55.2	0.97	6.28	6.28	6.28	0.52	1.45	± 12.0 %
1750	53.4	1.49	5.03	5.03	5.03	0.58	1.45	± 12.0 %
1900	53.3	1.52	4.77	4.77	4.77	0.70	1.36	± 12.0 %
2450	52.7	1.95	4.34	4.34	4.34	0.80	1.15	± 12.0 %
2600	52.5	2.16	4.11	4.11	4.11	0.80	1.00	± 12.0 %

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

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

Frequency Response of E-Field

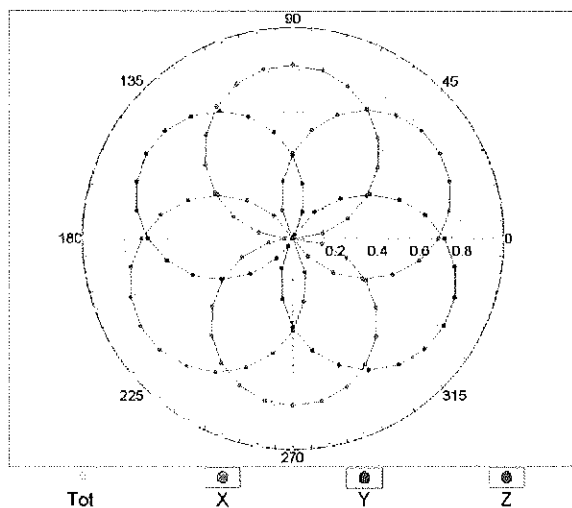
(TEM-Cell:ifi110 EXX, Waveguide: R22)



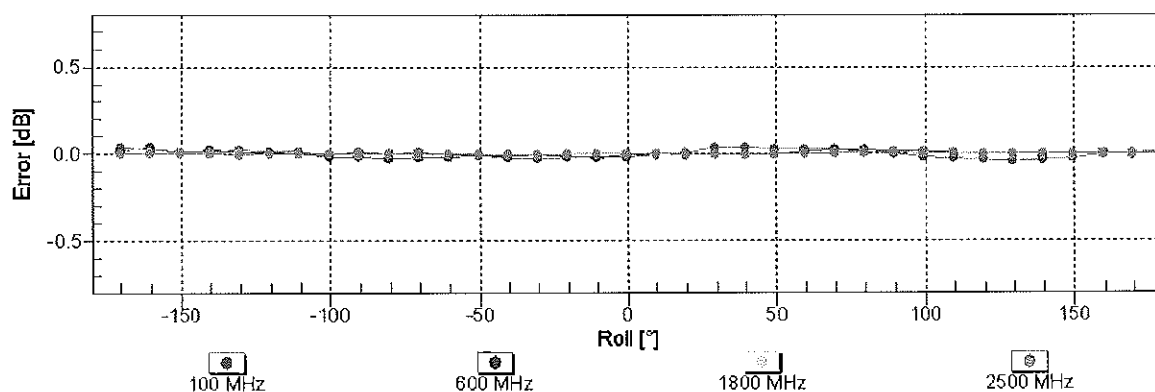
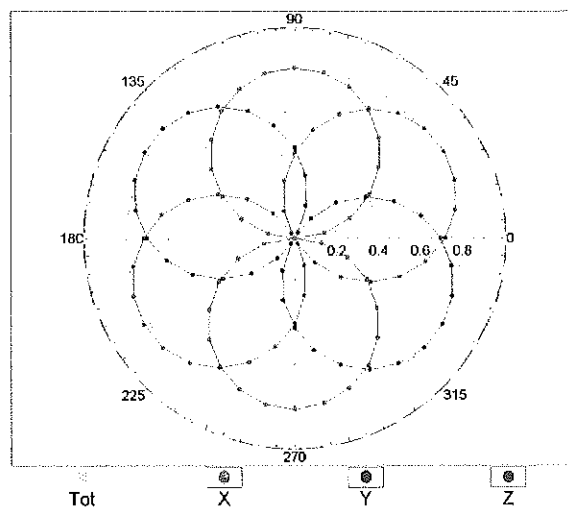
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

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

f=600 MHz,TEM

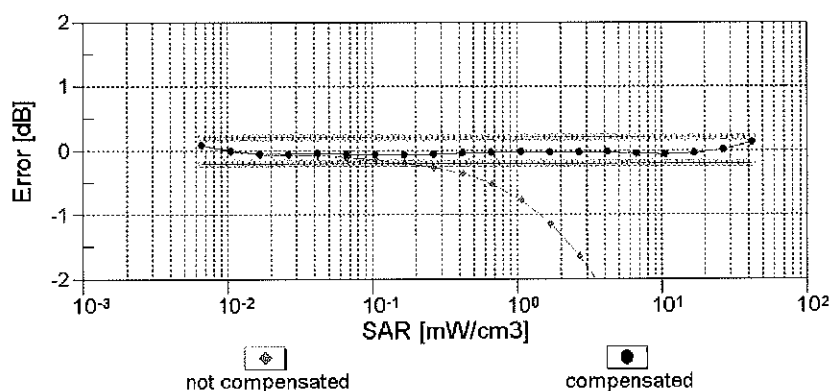
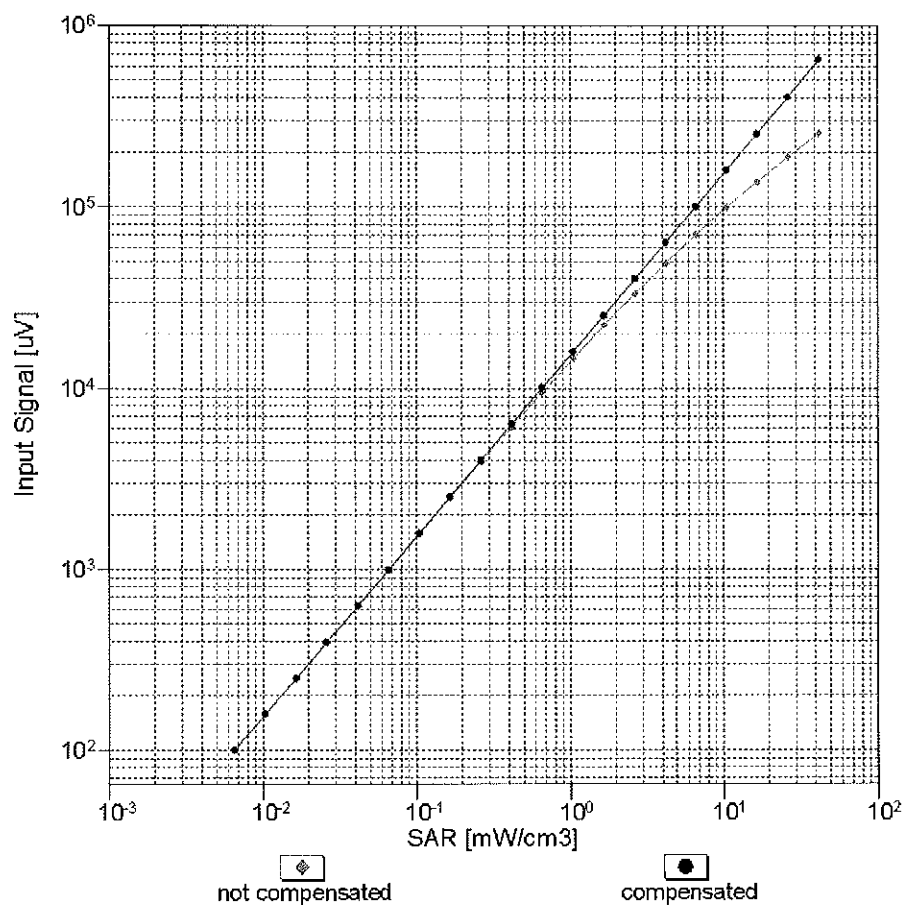


f=1800 MHz,R22



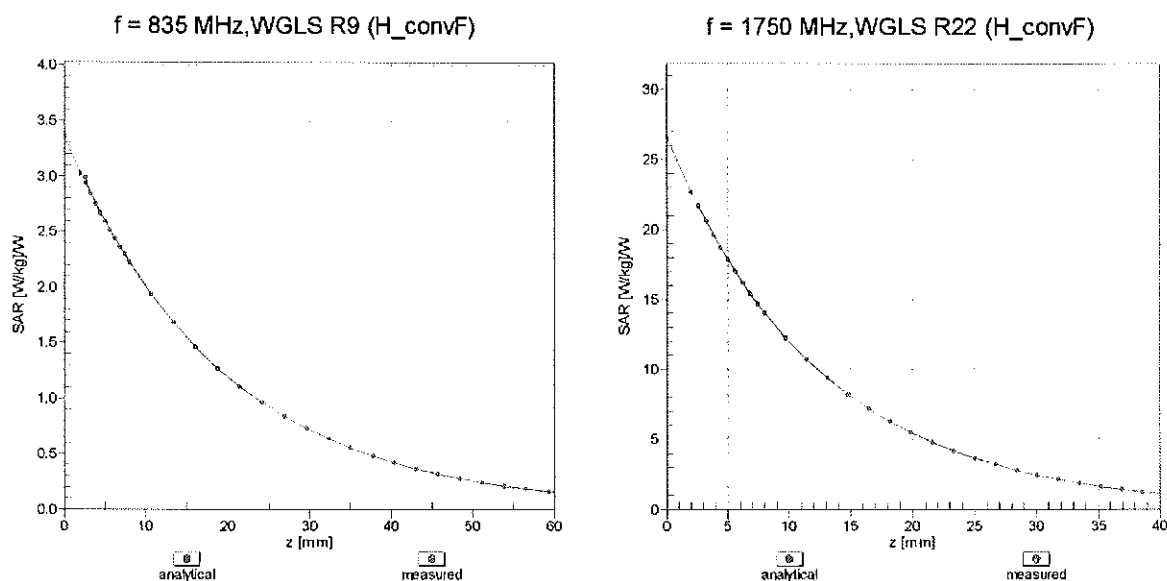
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell , $f = 900 \text{ MHz}$)



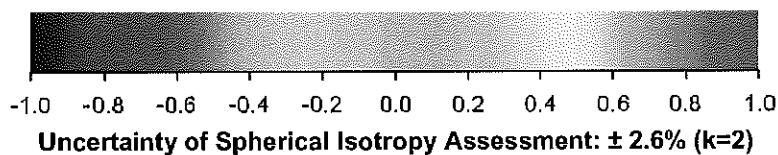
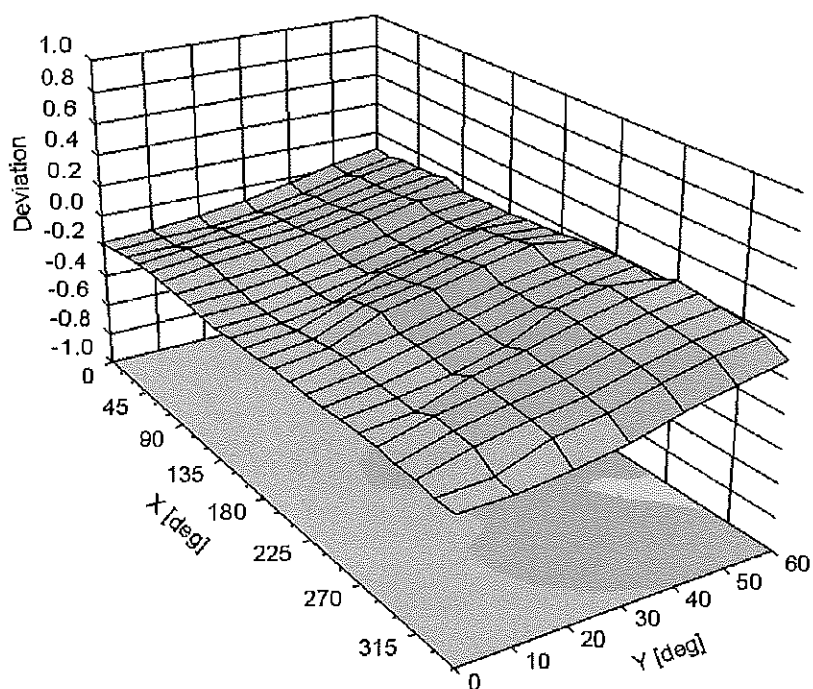
Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, θ), $f = 900 \text{ MHz}$



DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-40.6
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm



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Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **ES3-3022_Aug13**

CALIBRATION CERTIFICATE

Object **ES3DV2 - SN:3022**

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

Calibration date: **August 22, 2013**

UTC
9/13/13

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
Issued: August 23, 2013			
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			



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Accreditation No.: **SCS 108**

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Glossary:

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,y,z}
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

Probe ES3DV2

SN:3022

Manufactured: April 15, 2003
Calibrated: August 22, 2013

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

DASY/EASY - Parameters of Probe: ES3DV2 - SN:3022

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	1.00	1.04	0.99	± 10.1 %
DCP (mV) ^B	100.7	97.4	99.7	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	178.6	±3.0 %
		Y	0.0	0.0	1.0		141.9	
		Z	0.0	0.0	1.0		134.7	

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

^A The uncertainties of NormX,Y,Z do not affect the E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: ES3DV2 - SN:3022

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	6.21	6.21	6.21	0.19	2.37	± 12.0 %
835	41.5	0.90	6.09	6.09	6.09	0.30	1.70	± 12.0 %
1750	40.1	1.37	5.19	5.19	5.19	0.65	1.23	± 12.0 %
1900	40.0	1.40	5.03	5.03	5.03	0.51	1.43	± 12.0 %
2450	39.2	1.80	4.36	4.36	4.36	0.51	1.51	± 12.0 %
2600	39.0	1.96	4.16	4.16	4.16	0.74	1.29	± 12.0 %

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

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

DASY/EASY - Parameters of Probe: ES3DV2 - SN:3022

Calibration Parameter Determined in Body Tissue Simulating Media

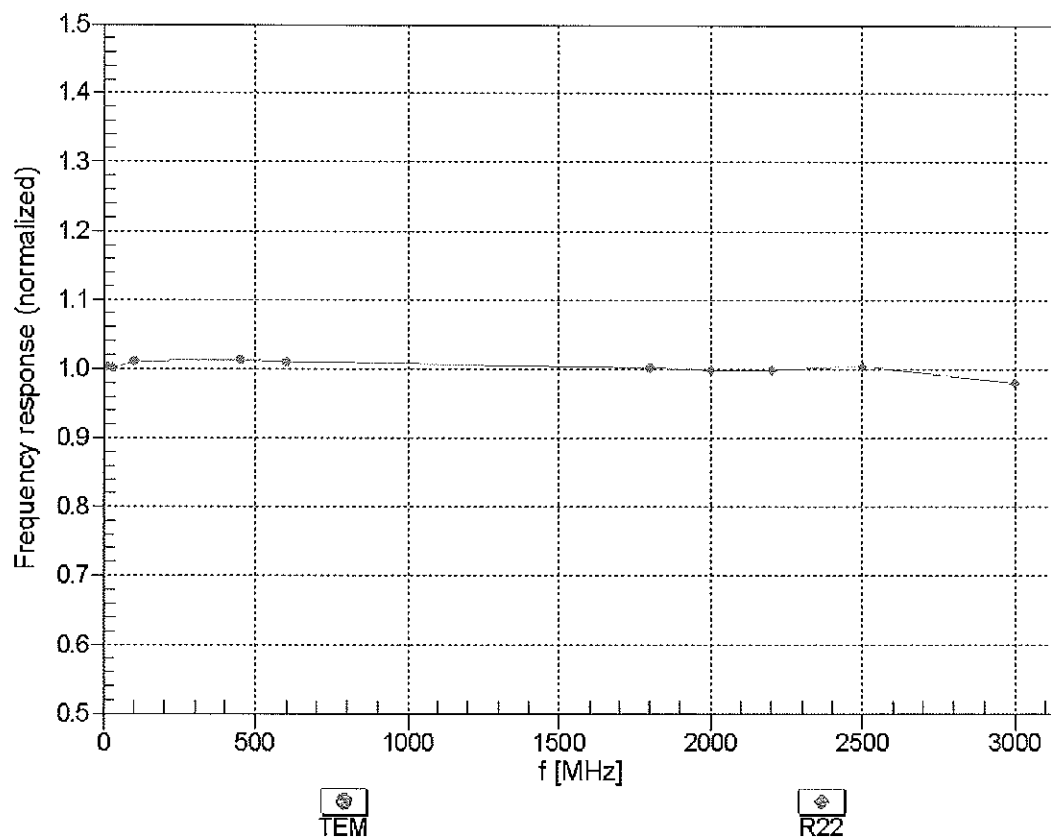
f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	5.92	5.92	5.92	0.24	1.99	± 12.0 %
835	55.2	0.97	5.91	5.91	5.91	0.29	1.85	± 12.0 %
1750	53.4	1.49	4.75	4.75	4.75	0.52	1.52	± 12.0 %
1900	53.3	1.52	4.49	4.49	4.49	0.49	1.56	± 12.0 %
2450	52.7	1.95	4.01	4.01	4.01	0.70	1.02	± 12.0 %
2600	52.5	2.16	3.85	3.85	3.85	0.58	0.90	± 12.0 %

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

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

Frequency Response of E-Field

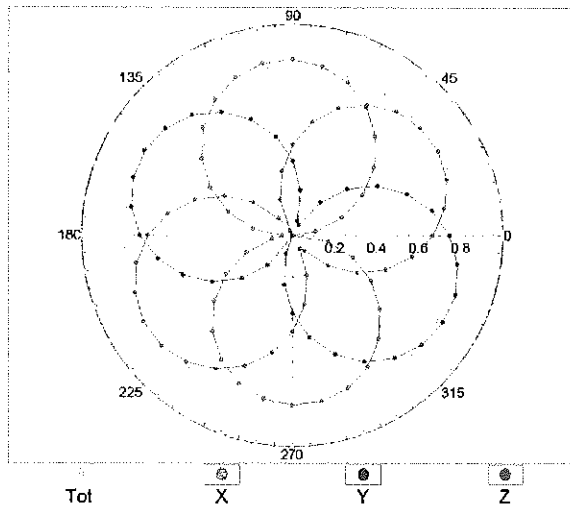
(TEM-Cell:ifi110 EXX, Waveguide: R22)



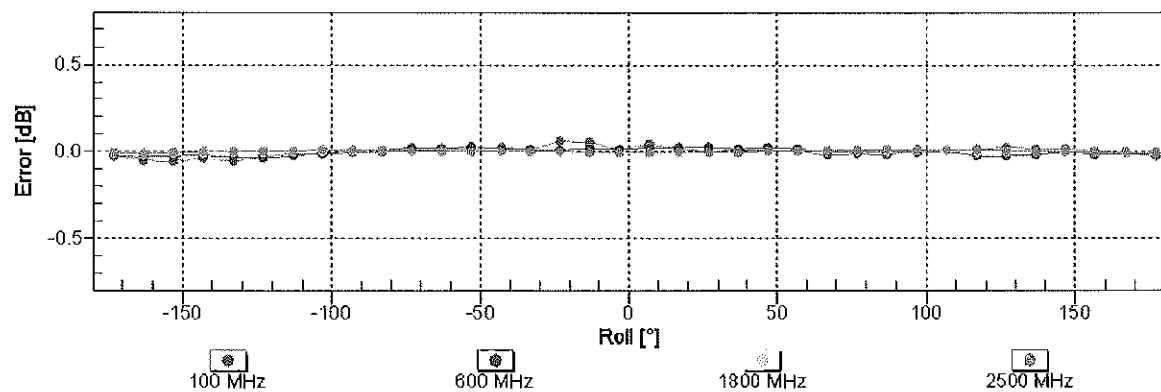
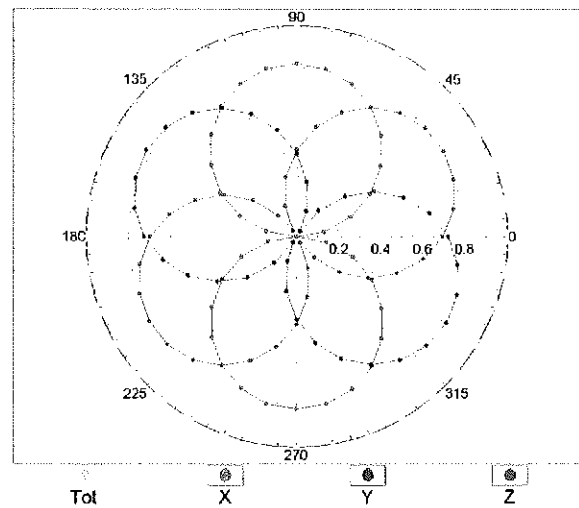
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz,TEM

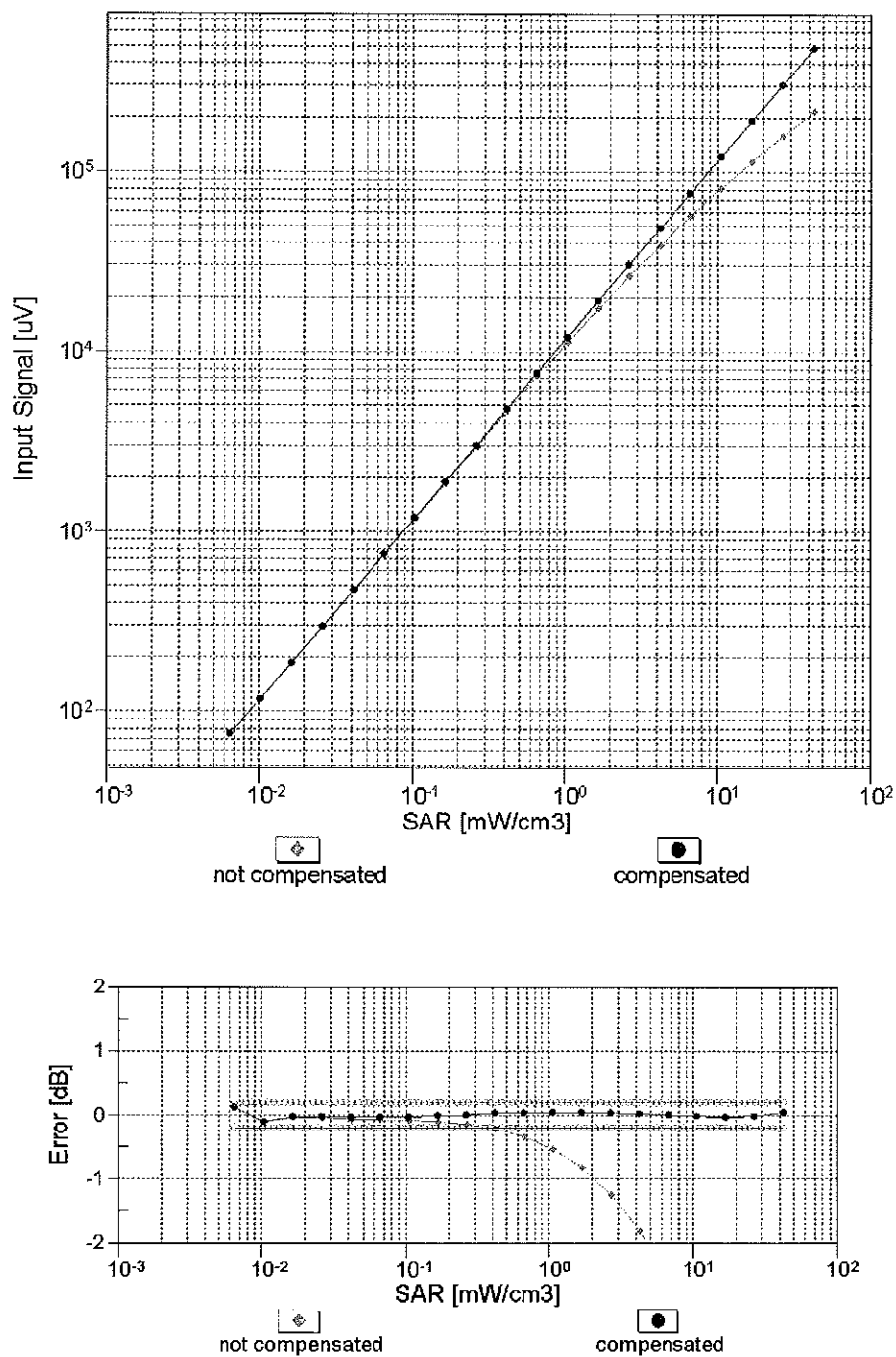


f=1800 MHz,R22



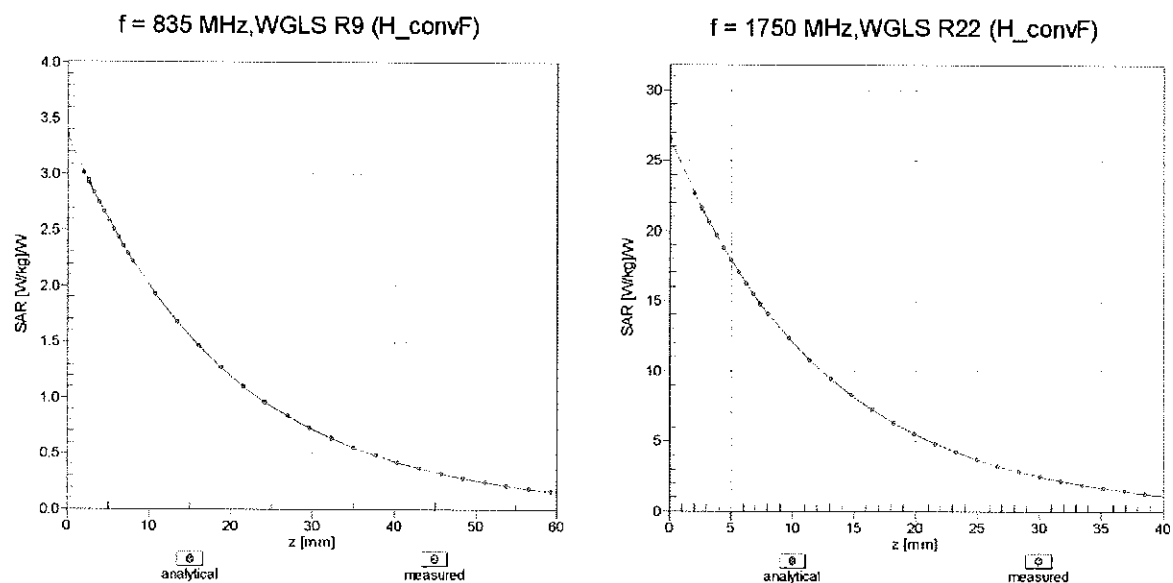
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

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



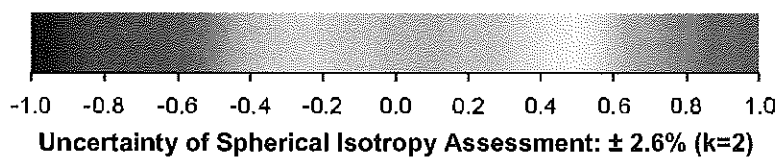
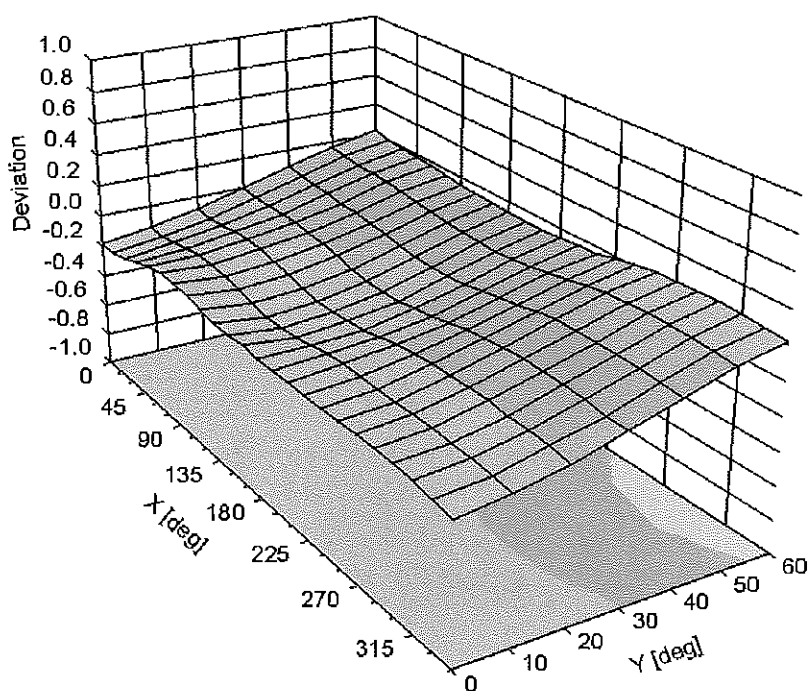
Uncertainty of Linearity Assessment: $\pm 0.6\%$ (k=2)

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, θ), $f = 900 \text{ MHz}$



DASY/EASY - Parameters of Probe: ES3DV2 - SN:3022

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-83.1
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm



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Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D835V2-4d119_Apr13**

CALIBRATION CERTIFICATE

Object **D835V2 - SN: 4d119**

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

Calibration date: **April 25, 2013**

✓
KOK
5/8/13

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 909	11-Sep-12 (No. DAE4-909_Sep12)	Sep-13
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

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

Approved by: **Katja Pokovic** Technical Manager

Signature

Issued: April 26, 2013

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Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

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

Head TSL parameters

The following parameters and calculations were applied.

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

SAR result with Head TSL

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

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

Body TSL parameters

The following parameters and calculations were applied.

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

SAR result with Body TSL

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

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

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.1 Ω - 4.7 j Ω
Return Loss	- 26.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.8 Ω - 6.3 j Ω
Return Loss	- 22.1 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.385 ns
----------------------------------	----------

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

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	June 29, 2010

DASY5 Validation Report for Head TSL

Date: 25.04.2013

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.94 \text{ S/m}$; $\epsilon_r = 40.8$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

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

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

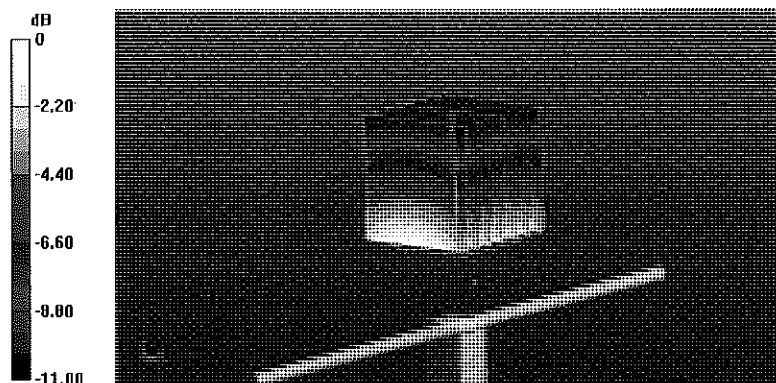
Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

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

Peak SAR (extrapolated) = 3.86 W/kg

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

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



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

Impedance Measurement Plot for Head TSL

25 Apr 2013 09:11:06
 CH1 S11 1 U FS 1: 50.061 Ω -4.6621 Ω 40.884 pF 835.000 000 MHz

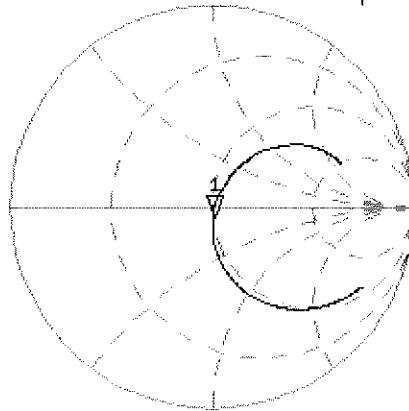
*

Del

CA

Avg
16

H1 d

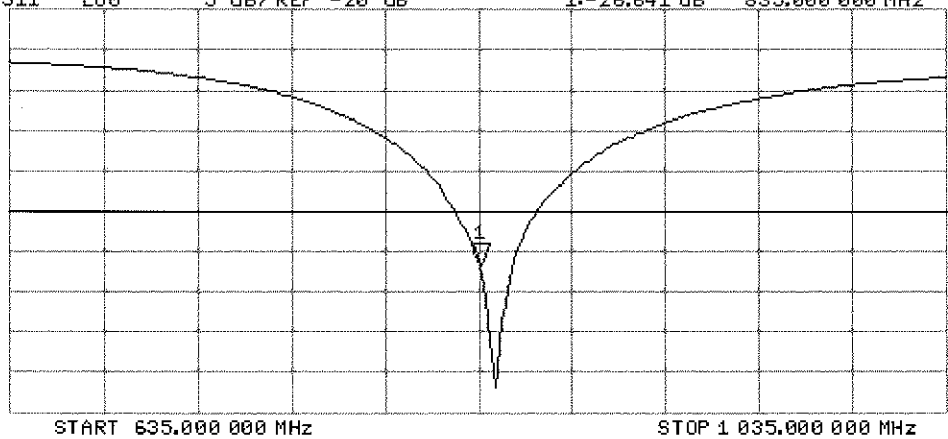


CH2 S11 LOG 5 dB/REF -20 dB 1:-26.641 dB 835.000 000 MHz

CA

Avg
16

H1 d



DASY5 Validation Report for Body TSL

Date: 24.04.2013

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 1.01 \text{ S/m}$; $\epsilon_r = 54$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

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

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

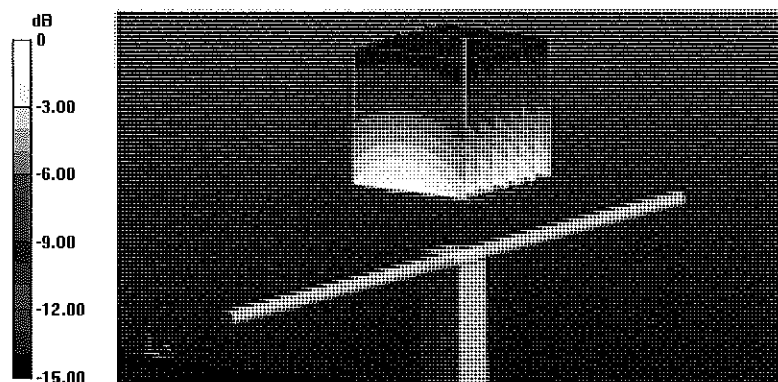
Measurement grid: dx=5mm, dy=5mm, dz=5mm

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

Peak SAR (extrapolated) = 3.68 W/kg

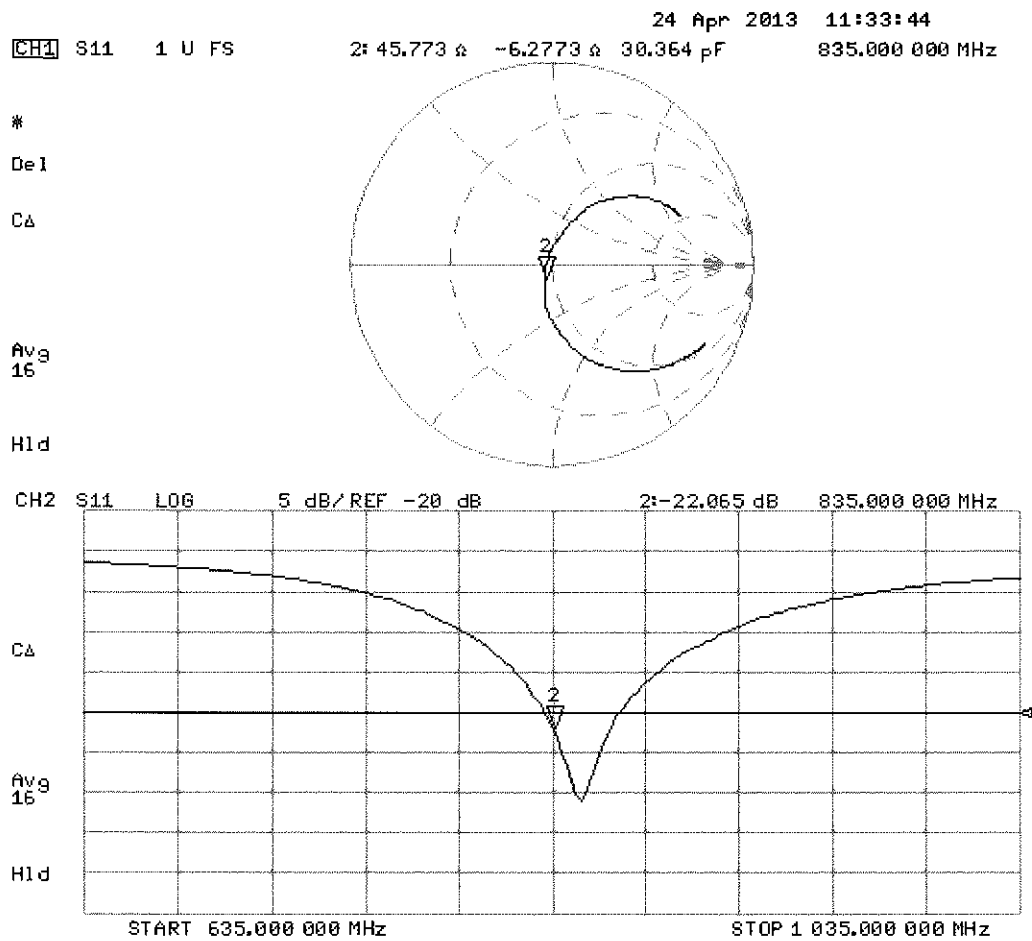
SAR(1 g) = 2.47 W/kg; SAR(10 g) = 1.62 W/kg

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



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

Impedance Measurement Plot for Body TSL





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Accreditation No.: **SCS 108**

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Client **PC Test**

Certificate No: **D1900V2-5d148_Feb13**

CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d148**

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

Calibration date: **February 06, 2013**

✓
KOK
2/21/13

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Reference 20 dB Attenuator	SN: 5058 (20k)	27-Mar-12 (No. 217-01530)	Apr-13
Type-N mismatch combination	SN: 5047.3 / 06327	27-Mar-12 (No. 217-01533)	Apr-13
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 601	27-Jun-12 (No. DAE4-601_Jun12)	Jun-13
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

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

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

Signature

Issued: February 6, 2013

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Accreditation No.: **SCS 108**

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

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

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

Head TSL parameters

The following parameters and calculations were applied.

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

SAR result with Head TSL

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

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

Body TSL parameters

The following parameters and calculations were applied.

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

SAR result with Body TSL

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

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

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.1 Ω + 5.9 j Ω
Return Loss	- 24.3 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.3 Ω + 6.3 j Ω
Return Loss	- 23.6 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.199 ns
----------------------------------	----------

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

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	March 11, 2011

DASY5 Validation Report for Head TSL

Date: 06.02.2013

Test Laboratory: SPEAG, Zurich, Switzerland

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

Communication System: CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.38$ S/m; $\epsilon_r = 39.4$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.98, 4.98, 4.98); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

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

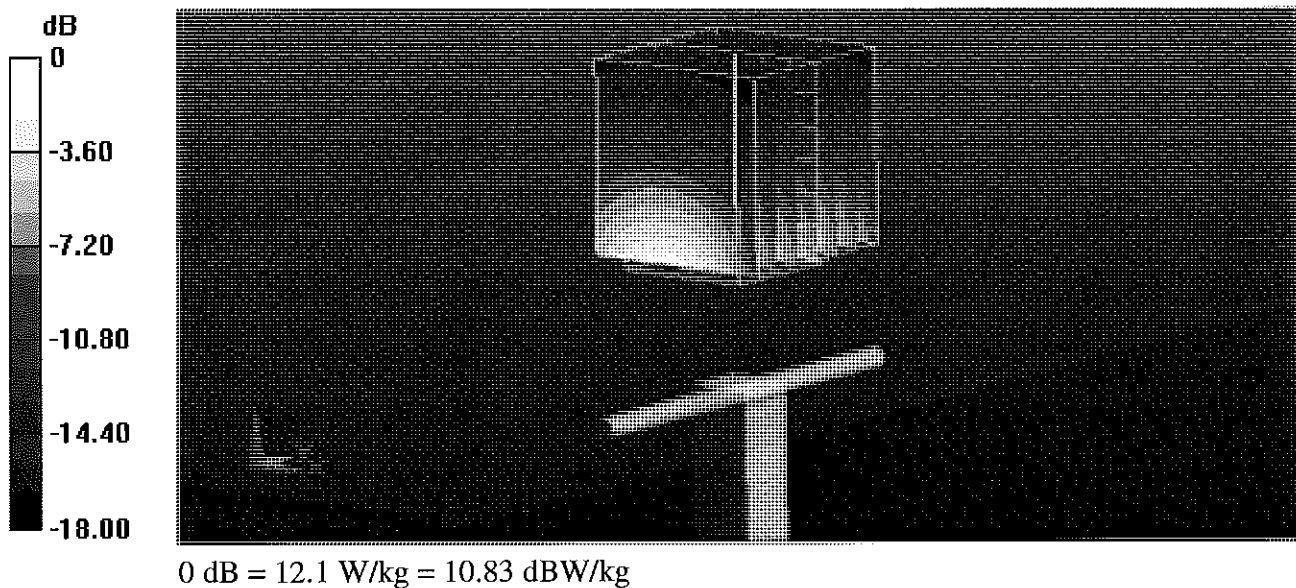
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.534 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 17.8 W/kg

SAR(1 g) = 9.87 W/kg; SAR(10 g) = 5.18 W/kg

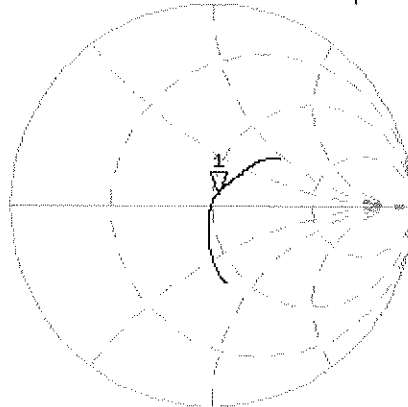
Maximum value of SAR (measured) = 12.1 W/kg



Impedance Measurement Plot for Head TSL

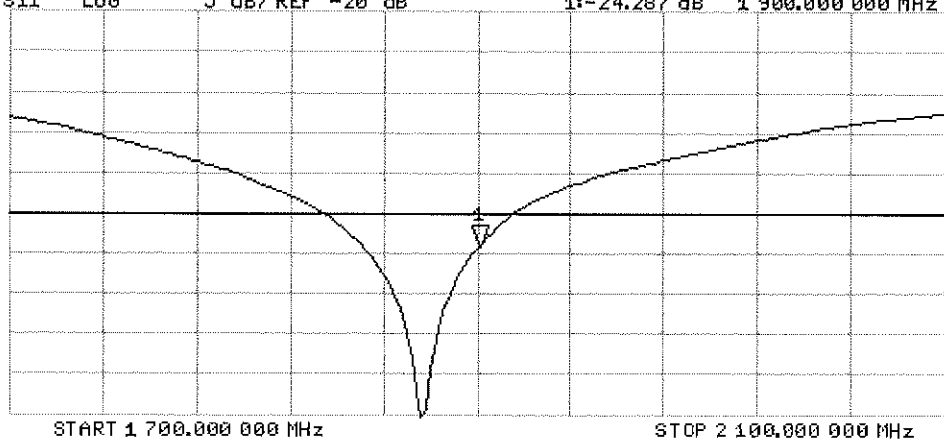
6 Feb 2013 09:25:10
 CH1 S11 1 U FS 1: 52.125 $\angle$ 5.8711 $\angle$ 491.80 μ H 1 900.000 000 MHz

*
 Del
 CA
 Avg
 16
 H1d



CH2 S11 LOG 5 dB/REF -20 dB 1: -24.287 dB 1 900.000 000 MHz

CA
 Avg
 16
 H1d



DASY5 Validation Report for Body TSL

Date: 06.02.2013

Test Laboratory: SPEAG, Zurich, Switzerland

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

Communication System: CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.53$ S/m; $\epsilon_r = 51.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.6, 4.6, 4.6); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

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

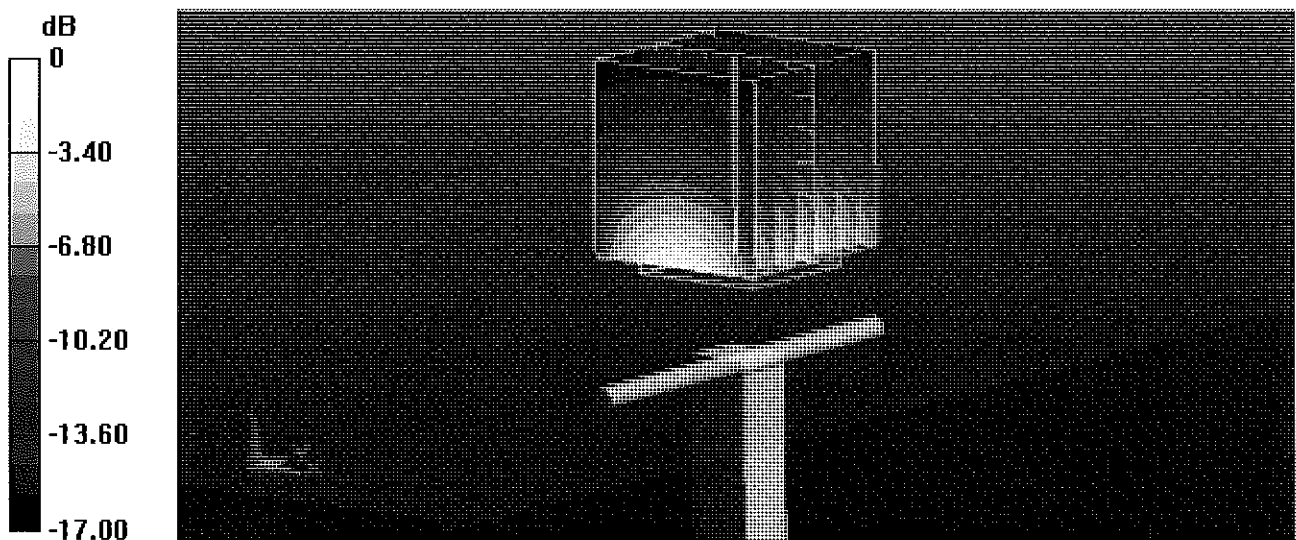
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.534 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 17.9 W/kg

SAR(1 g) = 10.3 W/kg; SAR(10 g) = 5.45 W/kg

Maximum value of SAR (measured) = 13.1 W/kg

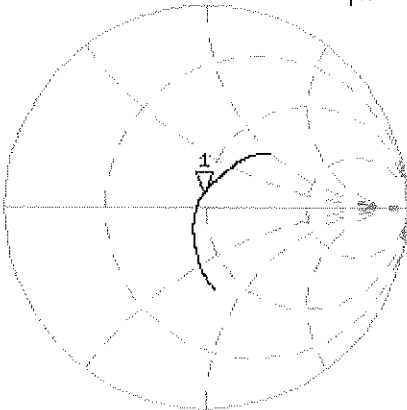


0 dB = 13.1 W/kg = 11.17 dBW/kg

Impedance Measurement Plot for Body TSL

6 Feb 2013 09:24:17
CH1 S11 1 U FS 1: 48.344 Ω 6.2715 Ω 525.34 μ H 1 900.000 000 MHz

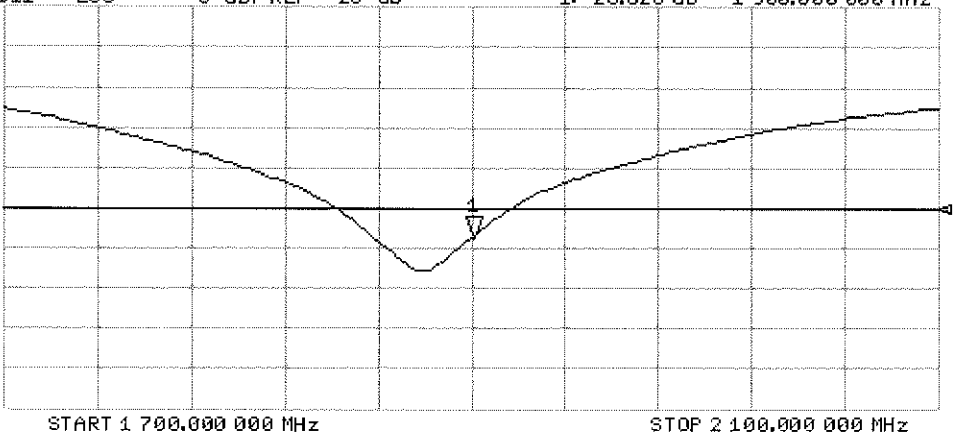
*
De1
CA



Avg
16
H1d

CH2 S11 LOG 5 dB/REF -20 dB 1:-23.628 dB 1 900.000 000 MHz

CA
Avg
16
H1d





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Accreditation No.: **SCS 108**

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Client **PC Test**

Certificate No: **D2450V2-797_Jan13**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 797**

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

Calibration date: **January 08, 2013**

✓
KOK
1/28/13

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Reference 20 dB Attenuator	SN: 5058 (20k)	27-Mar-12 (No. 217-01530)	Apr-13
Type-N mismatch combination	SN: 5047.3 / 06327	27-Mar-12 (No. 217-01533)	Apr-13
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 601	27-Jun-12 (No. DAE4-601_Jun12)	Jun-13
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

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

Issued: January 8, 2013

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Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

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

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.5 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.20 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.5 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	50.5 $\pm$ 6 %	2.01 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.7 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	49.6 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.88 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.2 W/kg $\pm$ 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$53.3 \Omega + 3.1 j\Omega$
Return Loss	- 27.1 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$49.1 \Omega + 4.9 j\Omega$
Return Loss	- 26.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.152 ns
----------------------------------	----------

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

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	January 24, 2006

DASY5 Validation Report for Head TSL

Date: 08.01.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 797

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.85$ S/m; $\epsilon_r = 37.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.52, 4.52, 4.52); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.4(1052); SEMCAD X 14.6.8(7028)

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

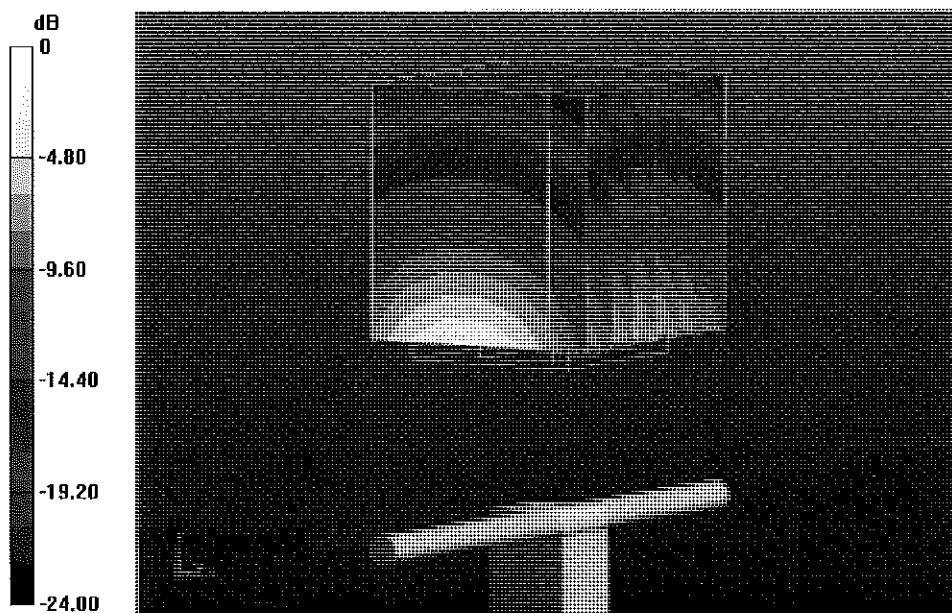
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 99.154 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 27.8 W/kg

SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.2 W/kg

Maximum value of SAR (measured) = 17.0 W/kg

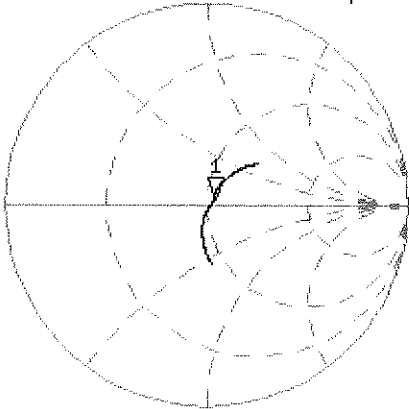


0 dB = 17.0 W/kg = 12.30 dBW/kg

Impedance Measurement Plot for Head TSL

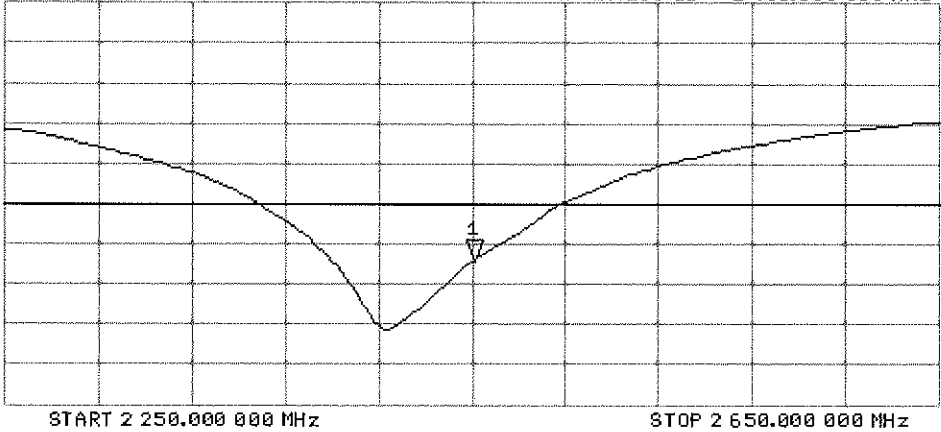
8 Jan 2013 12:37:14
CH1 S11 1 U FS 1: 53.346 $\angle$ 3.0762 $\angle$ 199.83 pH 2 450.000 000 MHz

*
De1
Cor
Avg
16
H1d



CH2 S11 LOG 5 dB/REF -20 dB 1: -27.136 dB 2 450.000 000 MHz

Cor
Avg
16
H1d



DASY5 Validation Report for Body TSL

Date: 08.01.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 797

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.01$ S/m; $\epsilon_r = 50.5$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.42, 4.42, 4.42); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.4(1052); SEMCAD X 14.6.8(7028)

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

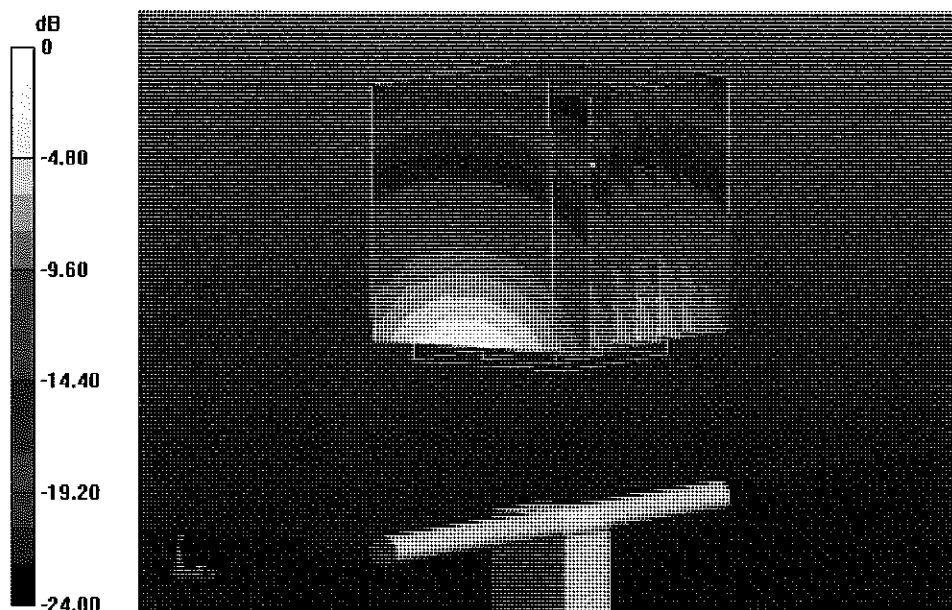
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.935 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 26.7 W/kg

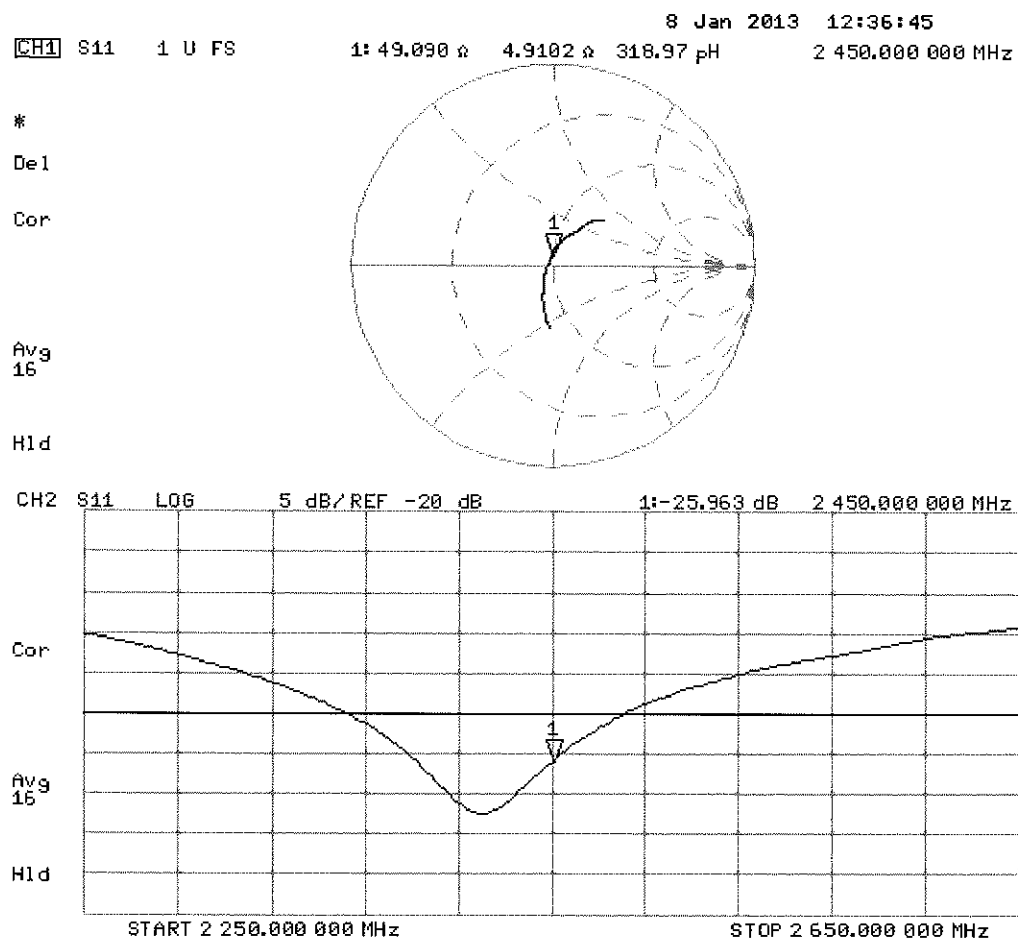
SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.88 W/kg

Maximum value of SAR (measured) = 16.7 W/kg



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

Impedance Measurement Plot for Body TSL





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Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D5GHzV2-1120_Feb13**

CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN: 1120**

Calibration procedure(s) **QA CAL-22.v2**
Calibration procedure for dipole validation kits between 3-6 GHz

Calibration date: **February 14, 2013**

✓
Kok
2/2/13

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Reference 20 dB Attenuator	SN: 5058 (20k)	27-Mar-12 (No. 217-01530)	Apr-13
Type-N mismatch combination	SN: 5047.3 / 06327	27-Mar-12 (No. 217-01533)	Apr-13
Reference Probe EX3DV4	SN: 3503	28-Dec-12 (No. EX3-3503_Dec12)	Dec-13
DAE4	SN: 601	27-Jun-12 (No. DAE4-601_Jun12)	Jun-13
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

Calibrated by: **Israe El-Naouq** Function: **Laboratory Technician**

Approved by: **Katja Pokovic** Technical Manager

Signature

Israe El-Naouq
Katja Pokovic

Issued: February 14, 2013

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- c) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.5
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz $\pm$ 1 MHz 5300 MHz $\pm$ 1 MHz 5500 MHz $\pm$ 1 MHz 5600 MHz $\pm$ 1 MHz 5800 MHz $\pm$ 1 MHz	

Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	34.7 $\pm$ 6 %	4.47 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5200 MHz

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

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

Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.5 ± 6 %	4.57 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.94 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.7 W / kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.4 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.2 ± 6 %	4.74 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.09 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.1 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.6 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.1 ± 6 %	4.83 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.08 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.5 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	33.9 ± 6 %	5.05 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.57 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	74.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.13 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.0 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.9 ± 6 %	5.36 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.73 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	76.6 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.17 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.5 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.42 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.7 ± 6 %	5.48 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5300 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.75 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	76.8 W/kg ± 19.9 % (k=2)

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

Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.6	5.65 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.3 ± 6 %	5.71 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5500 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.06 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	79.8 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	22.1 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.2 ± 6 %	5.83 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.15 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	80.7 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.26 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	22.3 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	45.9 ± 6 %	6.12 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.62 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	75.5 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.12 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.9 W/kg ± 19.5 % (k=2)

Appendix

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	$53.8 \Omega - 6.3 j\Omega$
Return Loss	- 23.0 dB

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	$50.1 \Omega + 0.5 j\Omega$
Return Loss	- 45.3 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	$51.0 \Omega - 0.9 j\Omega$
Return Loss	- 37.9 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	$55.3 \Omega - 0.9 j\Omega$
Return Loss	- 25.8 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	$53.5 \Omega + 3.3 j\Omega$
Return Loss	- 26.7 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	$53.7 \Omega - 4.8 j\Omega$
Return Loss	- 24.8 dB

Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	$50.2 \Omega + 2.4 j\Omega$
Return Loss	- 32.5 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	$51.6 \Omega - 1.5 j\Omega$
Return Loss	- 33.3 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	$57.4 \Omega + 0.9 j\Omega$
Return Loss	- 23.2 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	$53.5 \Omega + 3.2 j\Omega$
Return Loss	- 26.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.206 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	September 08, 2011

DASY5 Validation Report for Head TSL

Date: 08.02.2013

Test Laboratory: SPEAG, Zurich, Switzerland

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

Communication System: CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz

Medium parameters used: $f = 5200$ MHz; $\sigma = 4.47$ S/m; $\epsilon_r = 34.7$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5300$ MHz; $\sigma = 4.57$ S/m; $\epsilon_r = 34.5$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5500$ MHz; $\sigma = 4.74$ S/m; $\epsilon_r = 34.2$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 4.83$ S/m; $\epsilon_r = 34.1$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 5.05$ S/m; $\epsilon_r = 33.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.41, 5.41, 5.41); Calibrated: 28.12.2012, ConvF(5.1, 5.1, 5.1); Calibrated: 28.12.2012, ConvF(4.91, 4.91, 4.91); Calibrated: 28.12.2012, ConvF(4.76, 4.76, 4.76); Calibrated: 28.12.2012, ConvF(4.81, 4.81, 4.81); Calibrated: 28.12.2012;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 61.561 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 28.8 W/kg

SAR(1 g) = 7.67 W/kg; SAR(10 g) = 2.18 W/kg

Maximum value of SAR (measured) = 17.7 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 62.429 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 30.3 W/kg

SAR(1 g) = 7.94 W/kg; SAR(10 g) = 2.27 W/kg

Maximum value of SAR (measured) = 18.5 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 61.998 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 32.7 W/kg

SAR(1 g) = 8.09 W/kg; SAR(10 g) = 2.29 W/kg

Maximum value of SAR (measured) = 19.3 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 62.540 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 33.3 W/kg

SAR(1 g) = 8.08 W/kg; SAR(10 g) = 2.28 W/kg

Maximum value of SAR (measured) = 19.5 W/kg

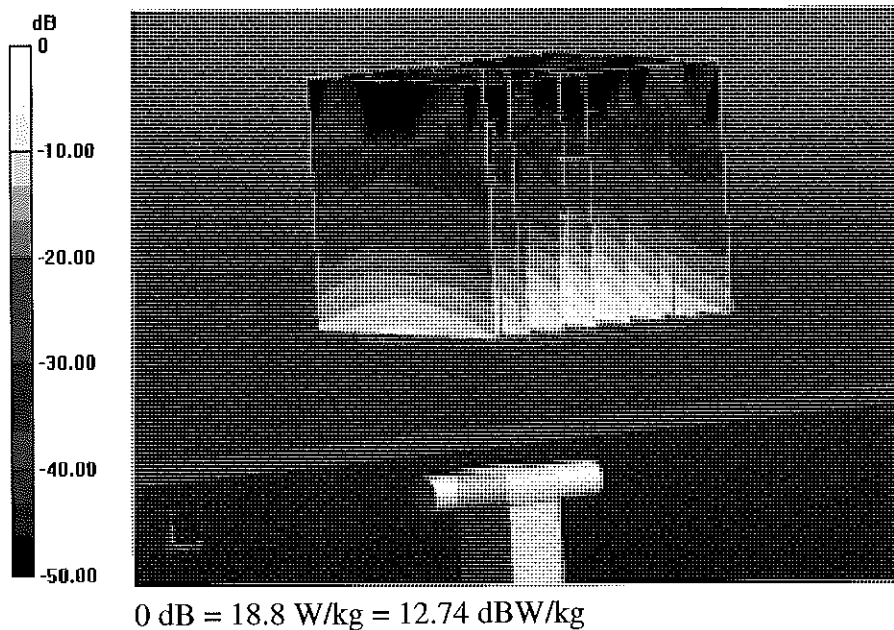
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 58.600 V/m; Power Drift = 0.09 dB

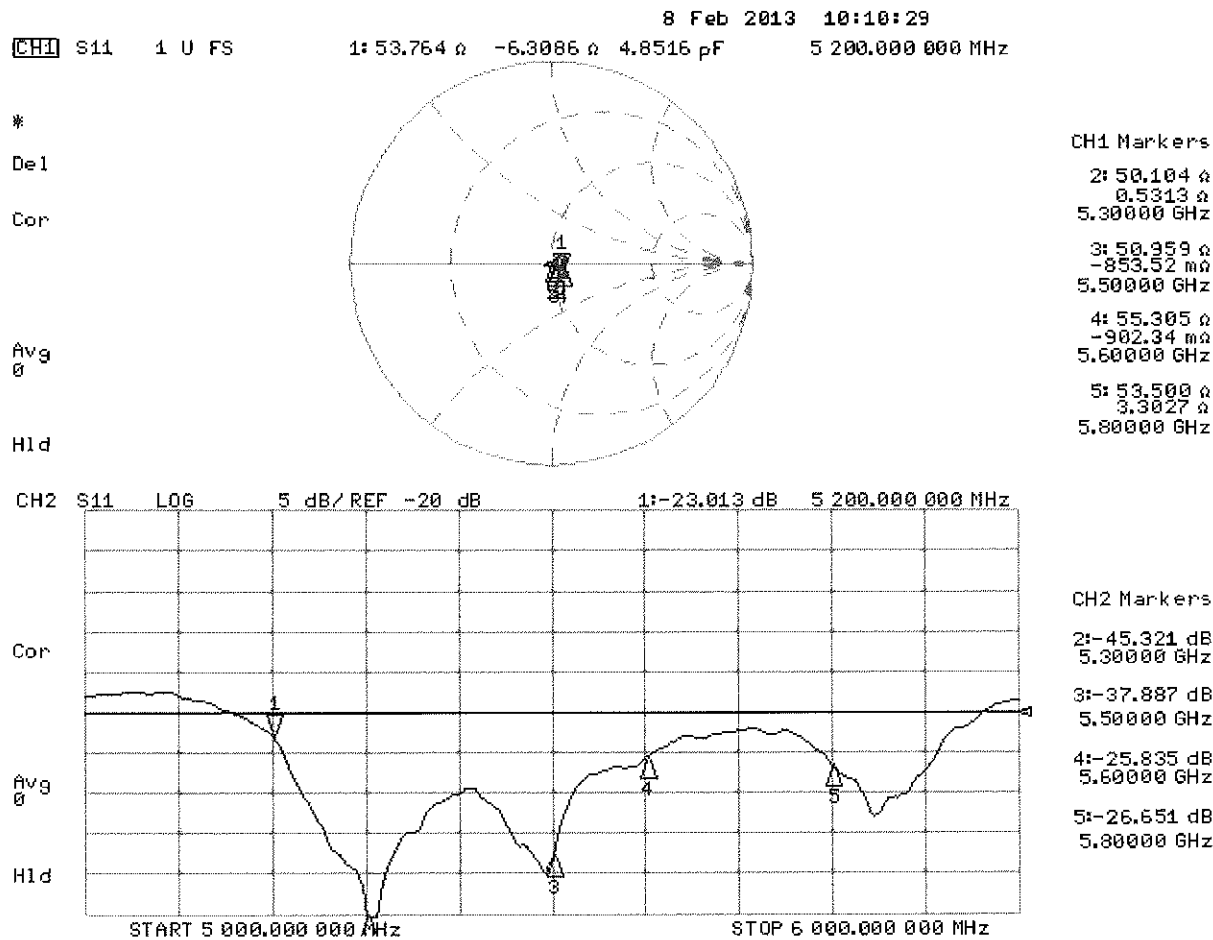
Peak SAR (extrapolated) = 32.9 W/kg

SAR(1 g) = 7.57 W/kg; SAR(10 g) = 2.13 W/kg

Maximum value of SAR (measured) = 18.8 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 14.02.2013

Test Laboratory: SPEAG, Zurich, Switzerland

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

Communication System: CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz

Medium parameters used: $f = 5200$ MHz; $\sigma = 5.36$ S/m; $\epsilon_r = 46.9$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5300$ MHz; $\sigma = 5.48$ S/m; $\epsilon_r = 46.7$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5500$ MHz; $\sigma = 5.71$ S/m; $\epsilon_r = 46.3$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 5.83$ S/m; $\epsilon_r = 46.2$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 6.12$ S/m; $\epsilon_r = 45.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.91, 4.91, 4.91); Calibrated: 28.12.2012, ConvF(4.67, 4.67, 4.67); Calibrated: 28.12.2012, ConvF(4.43, 4.43, 4.43); Calibrated: 28.12.2012, ConvF(4.22, 4.22, 4.22); Calibrated: 28.12.2012, ConvF(4.38, 4.38, 4.38); Calibrated: 28.12.2012;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 61.053 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 31.1 W/kg

SAR(1 g) = 7.73 W/kg; SAR(10 g) = 2.17 W/kg

Maximum value of SAR (measured) = 18.2 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 60.021 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 32.1 W/kg

SAR(1 g) = 7.75 W/kg; SAR(10 g) = 2.18 W/kg

Maximum value of SAR (measured) = 18.5 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 59.894 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 35.3 W/kg

SAR(1 g) = 8.06 W/kg; SAR(10 g) = 2.24 W/kg

Maximum value of SAR (measured) = 19.4 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 59.730 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 36.8 W/kg

SAR(1 g) = 8.15 W/kg; SAR(10 g) = 2.26 W/kg

Maximum value of SAR (measured) = 19.9 W/kg

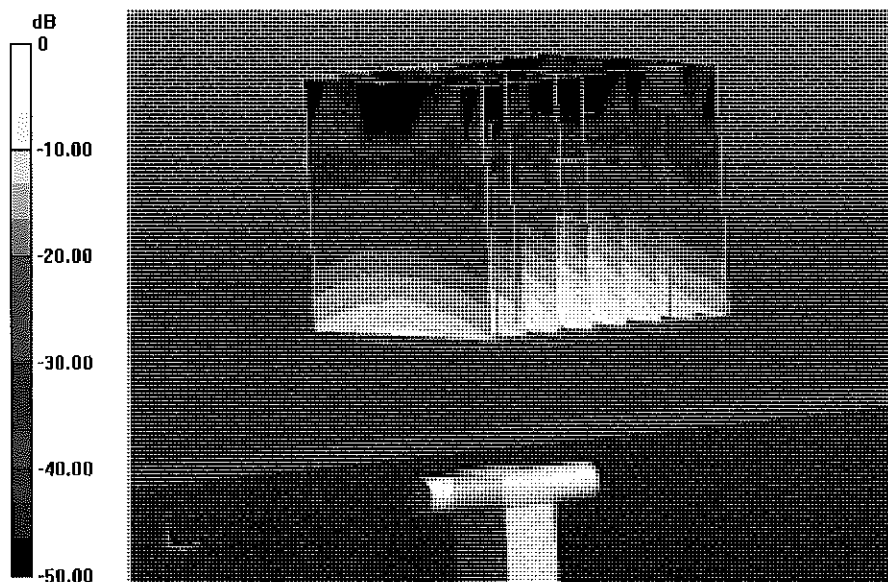
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 56.663 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 36.4 W/kg

SAR(1 g) = 7.62 W/kg; SAR(10 g) = 2.12 W/kg

Maximum value of SAR (measured) = 19.0 W/kg

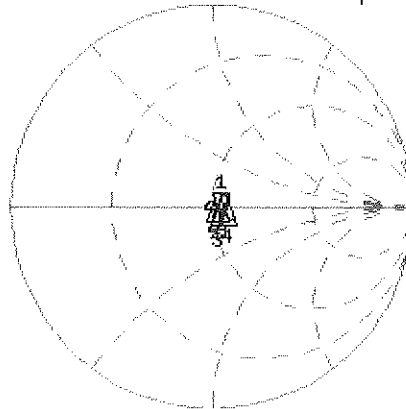


0 dB = 19.0 W/kg = 12.79 dBW/kg

Impedance Measurement Plot for Body TSL

14 Feb 2013 15:47:05
 CH1 S11 1 U FS 1: 53.672 Ω -4.7539 Ω 6.4382 pF 5 200.000 000 MHz

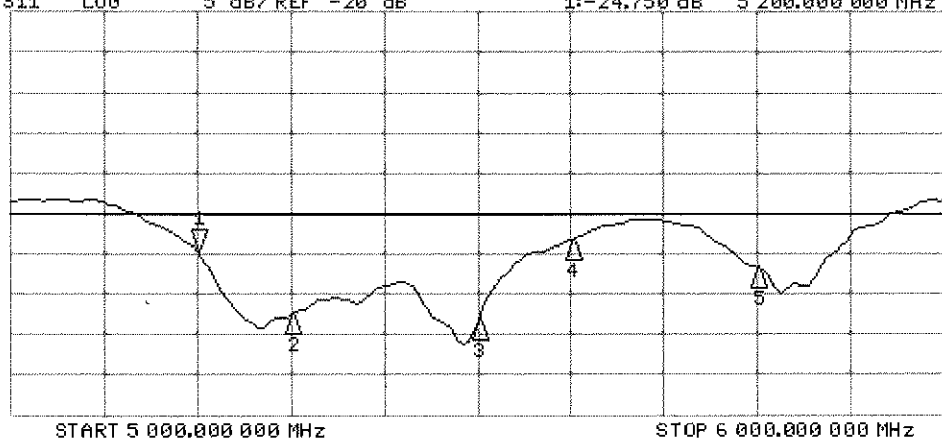
*
 Del
 Cor
 Avg
 16
 H1d



CH1 Markers
 2: 50.250 Ω
 2.3555 Ω
 5.30000 GHz
 3: 51.629 Ω
 -1.4824 Ω
 5.50000 GHz
 4: 57.389 Ω
 0.9180 Ω
 5.60000 GHz
 5: 53.543 Ω
 3.2441 Ω
 5.80000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 1:-24.750 dB 5 200.000 000 MHz

Cor
 Avg
 16
 H1d



CH2 Markers
 2:-32.508 dB
 5.30000 GHz
 3:-33.267 dB
 5.50000 GHz
 4:-23.183 dB
 5.60000 GHz
 5:-26.672 dB
 5.80000 GHz



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: **EX3-3914_Oct13**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3914**

Calibration procedure(s) **QA CAL-01 v3, QA CAL-14 v4, QA CAL-23 v5, QA CAL-25 v6**
Calibration procedure for dosimetric E-field probes

Calibration date: **October 23, 2013**

VCC
11/20/2013

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	4-Sep-13 (No. DAE4-660_Sep13)	Sep-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	<i>Leif Klysner</i>
Approved by:	Katja Pokovic	Technical Manager	<i>Katja Pokovic</i>
Issued: October 25, 2013			
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

PCT # 81072



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Accreditation No.: **SCS 108**

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Glossary:

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

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

Probe EX3DV4

SN:3914

Manufactured: December 18, 2012
Calibrated: October 23, 2013

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3914

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.47	0.49	0.51	$\pm 10.1 \%$
DCP (mV) ^B	99.2	98.9	98.2	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	158.3	$\pm 3.0 \%$
		Y	0.0	0.0	1.0		154.6	
		Z	0.0	0.0	1.0		170.8	
10010-CAA	SAR Validation (Square, 100ms, 10ms)	X	0.71	53.3	6.1	10.00	48.4	$\pm 2.5 \%$
		Y	2.43	67.0	13.8		39.9	
		Z	4.18	68.7	13.8		45.7	
10011-CAA	UMTS-FDD (WCDMA)	X	3.05	64.4	16.5	2.91	122.4	$\pm 0.5 \%$
		Y	3.31	66.5	18.2		123.5	
		Z	3.34	66.3	17.8		136.6	
10012-CAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	X	2.49	64.8	16.1	1.87	120.6	$\pm 0.5 \%$
		Y	2.94	68.6	18.7		123.6	
		Z	2.63	65.9	17.0		135.4	
10021-DAA	GSM-FDD (TDMA, GMSK)	X	1.52	61.5	10.9	9.39	83.6	$\pm 1.2 \%$
		Y	2.22	67.4	15.0		116.0	
		Z	2.47	66.8	14.7		95.9	
10023-DAA	GPRS-FDD (TDMA, GMSK, TN 0)	X	1.73	63.3	11.9	9.57	81.5	$\pm 1.7 \%$
		Y	2.11	66.2	14.2		111.8	
		Z	2.76	69.0	16.0		93.6	
10024-DAA	GPRS-FDD (TDMA, GMSK, TN 0-1)	X	1.34	62.1	9.4	6.56	121.0	$\pm 1.2 \%$
		Y	4.24	78.6	17.9		130.0	
		Z	2.91	70.7	14.9		141.4	
10027-DAA	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	X	1.25	63.5	9.7	4.80	143.5	$\pm 1.4 \%$
		Y	1.59	66.9	12.2		149.7	
		Z	2.98	71.5	14.0		123.3	
10028-DAA	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	X	0.51	58.3	7.4	3.55	113.4	$\pm 1.2 \%$
		Y	25.43	100.0	22.6		121.3	
		Z	38.67	97.5	20.6		133.3	
10032-CAA	IEEE 802.15.1 Bluetooth (GFSK, DH5)	X	0.28	58.6	5.3	1.16	134.7	$\pm 0.9 \%$
		Y	65.75	99.6	18.6		141.3	
		Z	0.20	55.6	4.1		112.1	
10039-CAA	CDMA2000 (1xRTT, RC1)	X	4.33	64.6	17.4	4.57	113.8	$\pm 0.7 \%$
		Y	4.55	66.0	18.6		120.8	
		Z	4.85	66.2	18.4		135.9	
10062-CAA	IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps)	X	9.83	67.6	20.7	8.68	109.0	$\pm 2.5 \%$
		Y	10.06	68.4	21.5		118.2	
		Z	10.66	69.2	21.7		134.0	

10081-CAA	CDMA2000 (1xRTT, RC3)	X	3.59	63.9	16.9	3.97	113.6	±0.7 %
		Y	3.84	65.6	18.2		119.6	
		Z	3.95	65.4	17.8		134.5	
10098-CAA	UMTS-FDD (HSUPA, Subtest 2)	X	4.41	65.2	17.3	3.98	126.0	±0.7 %
		Y	4.73	66.9	18.6		132.5	
		Z	4.51	65.5	17.7		105.6	
10100-CAB	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	6.26	66.2	18.6	5.67	130.5	±1.2 %
		Y	6.61	67.7	19.8		139.3	
		Z	6.21	66.0	18.7		107.7	
10108-CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	6.13	65.8	18.6	5.80	126.3	±1.2 %
		Y	6.40	67.1	19.6		135.6	
		Z	6.10	65.5	18.5		107.4	
10110-CAB	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK)	X	5.78	65.3	18.3	5.75	123.1	±1.2 %
		Y	5.97	66.3	19.2		131.5	
		Z	5.86	65.3	18.4		104.9	
10114-CAA	IEEE 802.11n (HT Greenfield, 13.5 Mbps, BPSK)	X	9.92	67.7	20.3	8.10	115.7	±2.5 %
		Y	10.25	68.7	21.2		126.8	
		Z	10.71	69.4	21.3		146.0	
10117-CAA	IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK)	X	9.95	67.8	20.3	8.07	116.6	±2.5 %
		Y	10.26	68.7	21.1		128.3	
		Z	10.70	69.4	21.3		146.9	
10151-CAB	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	7.19	67.3	21.5	9.28	145.0	±2.2 %
		Y	7.40	68.3	22.4		110.8	
		Z	7.79	68.4	22.0		128.0	
10154-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	5.79	65.3	18.3	5.75	124.2	±1.2 %
		Y	6.03	66.5	19.4		131.9	
		Z	6.29	66.9	19.3		149.7	
10160-CAB	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK)	X	6.23	65.9	18.6	5.82	128.3	±1.2 %
		Y	6.51	67.2	19.7		136.9	
		Z	6.24	65.7	18.6		107.3	
10169-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	4.83	66.0	18.9	5.73	147.5	±1.2 %
		Y	4.72	65.8	19.2		113.8	
		Z	5.03	66.1	19.1		129.7	
10172-CAB	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	5.83	69.2	22.8	9.21	149.9	±1.9 %
		Y	5.81	69.4	23.4		120.3	
		Z	6.38	70.0	23.2		137.2	
10175-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	4.86	66.1	18.9	5.72	149.8	±1.2 %
		Y	4.72	65.8	19.2		113.3	
		Z	5.09	66.4	19.1		126.0	
10181-CAB	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	X	4.83	66.0	18.9	5.72	146.3	±1.2 %
		Y	4.69	65.6	19.1		112.2	
		Z	5.02	66.1	19.0		125.1	
10193-CAA	IEEE 802.11n (HT Greenfield, 6.5 Mbps, BPSK)	X	9.51	67.4	20.2	8.09	108.6	±2.5 %
		Y	9.72	68.1	20.9		118.2	
		Z	10.30	68.9	21.1		135.0	

10196-CAA	IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK)	X	9.52	67.4	20.2	8.10	111.6	±2.5 %
		Y	9.79	68.3	21.1		121.3	
		Z	10.30	68.9	21.2		139.2	
10219-CAA	IEEE 802.11n (HT Mixed, 7.2 Mbps, BPSK)	X	9.47	67.4	20.2	8.03	111.8	±2.2 %
		Y	9.67	68.3	21.0		120.0	
		Z	10.20	68.9	21.1		138.0	
10222-CAA	IEEE 802.11n (HT Mixed, 15 Mbps, BPSK)	X	9.96	67.9	20.4	8.06	118.4	±2.5 %
		Y	10.25	68.8	21.2		128.2	
		Z	10.65	69.3	21.3		144.5	
10225-CAA	UMTS-FDD (HSPA+)	X	6.96	66.7	18.9	5.97	140.0	±1.4 %
		Y	7.23	67.9	20.0		148.9	
		Z	7.03	66.4	18.9		115.6	
10237-CAB	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	5.51	67.5	21.8	9.21	114.2	±1.9 %
		Y	5.82	69.4	23.4		123.0	
		Z	6.49	70.6	23.6		140.2	
10252-CAB	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	6.83	67.1	21.4	9.24	136.6	±1.9 %
		Y	7.30	69.4	23.2		147.3	
		Z	7.36	68.1	22.0		117.5	
10267-CAB	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	7.26	67.5	21.6	9.30	142.7	±1.9 %
		Y	7.44	68.4	22.4		110.5	
		Z	7.84	68.7	22.2		122.6	
10274-CAA	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.10)	X	5.86	66.2	18.2	4.87	135.4	±0.9 %
		Y	6.12	67.5	19.2		142.3	
		Z	5.91	65.9	18.2		107.6	
10275-CAA	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.4)	X	4.17	64.8	17.3	3.96	115.6	±0.7 %
		Y	4.42	66.4	18.5		124.6	
		Z	4.47	66.0	18.0		132.6	
10291-AAA	CDMA2000, RC3, SO55, Full Rate	X	3.36	64.7	17.1	3.46	109.4	±0.5 %
		Y	3.55	66.2	18.3		118.2	
		Z	3.60	65.6	17.7		120.9	
10292-AAA	CDMA2000, RC3, SO32, Full Rate	X	3.34	64.9	17.2	3.39	110.1	±0.5 %
		Y	3.57	66.7	18.5		121.0	
		Z	3.54	65.6	17.7		123.9	
10297-AAA	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	6.14	65.8	18.6	5.81	125.1	±1.2 %
		Y	6.44	67.2	19.7		135.7	
		Z	6.52	67.0	19.3		142.2	
10311-AAA	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK)	X	6.76	66.6	19.1	6.06	131.8	±1.4 %
		Y	7.03	67.8	20.0		142.5	
		Z	7.15	67.7	19.7		148.6	
10315-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 96pc duty cycle)	X	2.42	64.6	16.1	1.71	116.8	±0.5 %
		Y	3.00	69.3	19.0		126.9	
		Z	2.61	66.3	17.2		128.2	
10317-AAA	IEEE 802.11a WiFi 5 GHz (OFDM, 6 Mbps, 96pc duty cycle)	X	9.71	67.6	20.5	8.36	111.7	±2.5 %
		Y	9.99	68.6	21.4		122.2	
		Z	10.38	68.9	21.3		129.5	

10400-AAA	IEEE 802.11ac WiFi (20MHz, 64-QAM, 99pc duty cycle)	X	9.83	67.8	20.6	8.37	112.9	±2.5 %
		Y	10.09	68.7	21.4		123.9	
		Z	10.48	68.9	21.3		130.5	
10402-AAA	IEEE 802.11ac WiFi (80MHz, 64-QAM, 99pc duty cycle)	X	10.61	68.3	20.7	8.53	121.1	±2.5 %
		Y	11.25	70.0	21.9		135.4	
		Z	11.15	69.4	21.4		137.4	
10403-AAA	CDMA2000 (1xEV-DO, Rev. 0)	X	4.51	67.4	17.8	3.76	119.2	±0.5 %
		Y	4.91	69.5	19.3		128.3	
		Z	4.84	67.5	18.1		135.4	
10404-AAA	CDMA2000 (1xEV-DO, Rev. A)	X	4.51	67.7	18.0	3.77	117.4	±0.5 %
		Y	4.92	69.8	19.5		125.4	
		Z	4.71	67.3	18.0		131.9	

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

^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:3914

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	9.70	9.70	9.70	0.34	1.01	± 12.0 %
835	41.5	0.90	9.34	9.34	9.34	0.67	0.67	± 12.0 %
1750	40.1	1.37	7.99	7.99	7.99	0.79	0.56	± 12.0 %
1900	40.0	1.40	7.69	7.69	7.69	0.80	0.58	± 12.0 %
2450	39.2	1.80	6.95	6.95	6.95	0.41	0.77	± 12.0 %
2600	39.0	1.96	6.79	6.79	6.79	0.40	0.82	± 12.0 %
5200	36.0	4.66	4.99	4.99	4.99	0.30	1.80	± 13.1 %
5300	35.9	4.76	4.82	4.82	4.82	0.30	1.80	± 13.1 %
5500	35.6	4.96	4.55	4.55	4.55	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.37	4.37	4.37	0.35	1.80	± 13.1 %
5800	35.3	5.27	4.52	4.52	4.52	0.35	1.80	± 13.1 %

^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:3914

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	9.39	9.39	9.39	0.63	0.74	± 12.0 %
835	55.2	0.97	9.31	9.31	9.31	0.56	0.76	± 12.0 %
1750	53.4	1.49	7.89	7.89	7.89	0.32	1.03	± 12.0 %
1900	53.3	1.52	7.51	7.51	7.51	0.51	0.76	± 12.0 %
2450	52.7	1.95	7.02	7.02	7.02	0.80	0.50	± 12.0 %
2600	52.5	2.16	6.81	6.81	6.81	0.80	0.50	± 12.0 %
5200	49.0	5.30	4.52	4.52	4.52	0.35	1.90	± 13.1 %
5300	48.9	5.42	4.32	4.32	4.32	0.35	1.90	± 13.1 %
5500	48.6	5.65	4.07	4.07	4.07	0.35	1.90	± 13.1 %
5600	48.5	5.77	3.97	3.97	3.97	0.35	1.90	± 13.1 %
5800	48.2	6.00	4.14	4.14	4.14	0.40	1.90	± 13.1 %

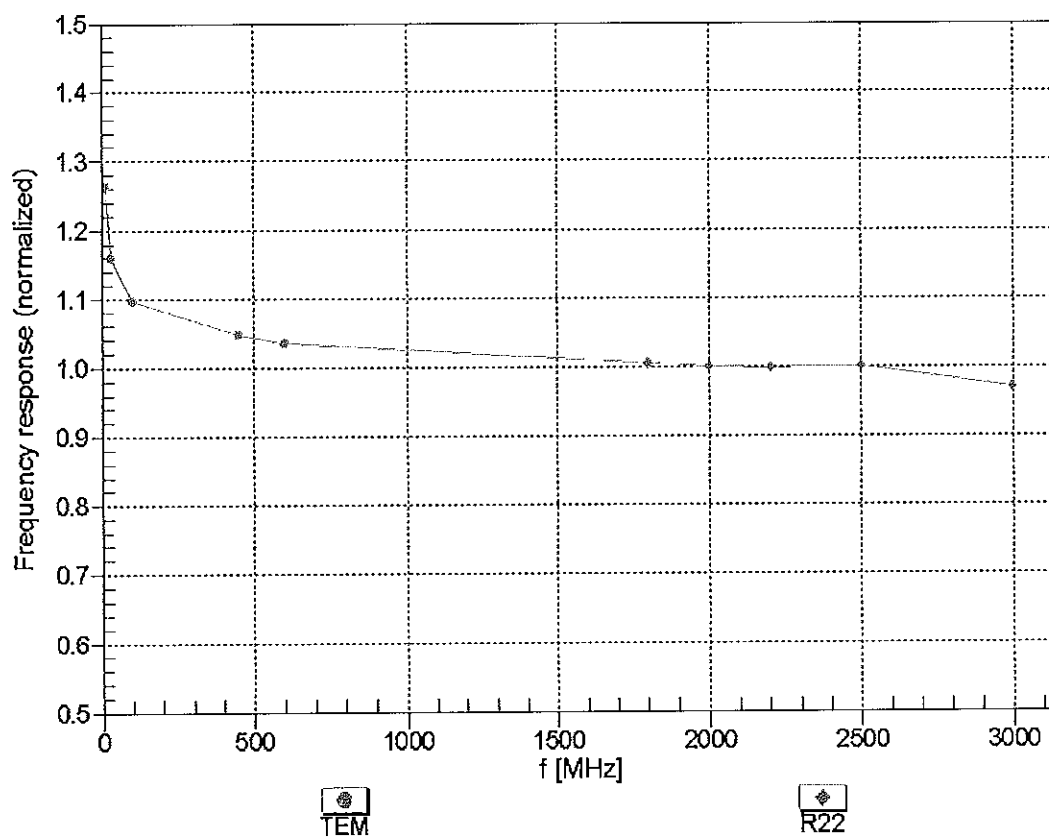
^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^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

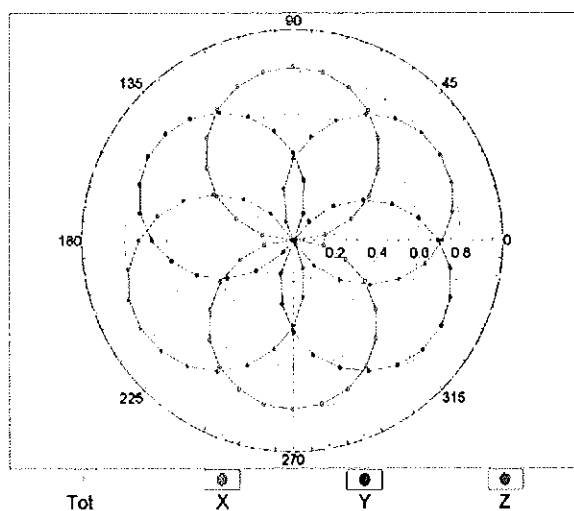
(TEM-Cell: ifi110 EXX, Waveguide: R22)



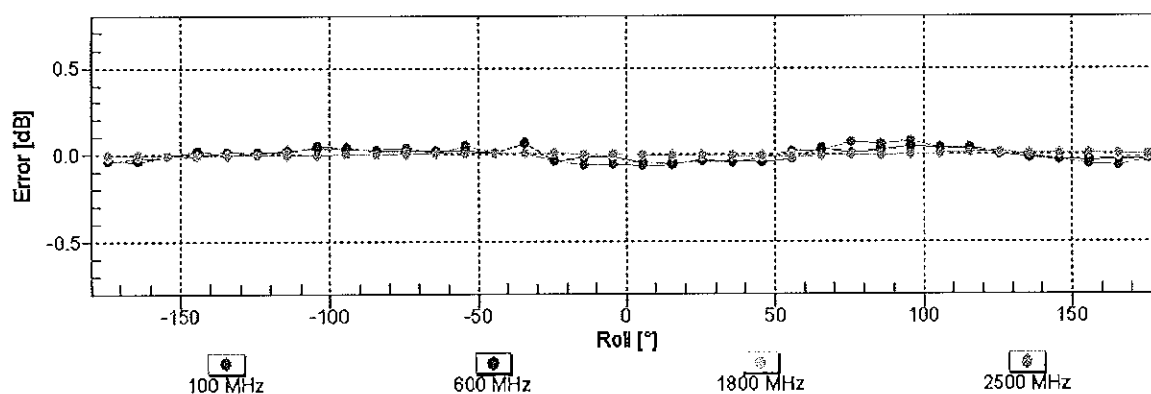
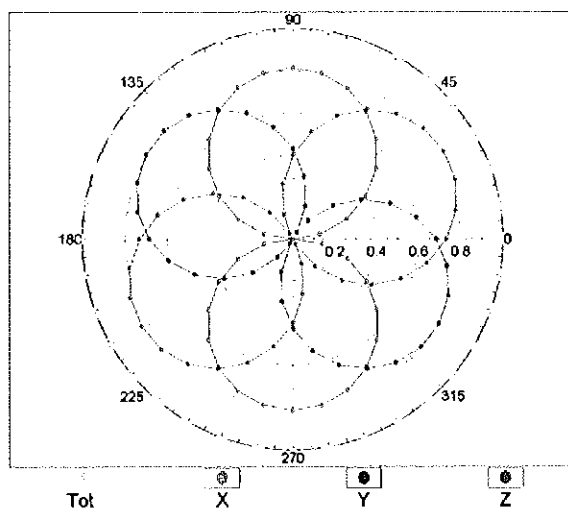
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

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

$f=600$ MHz, TEM

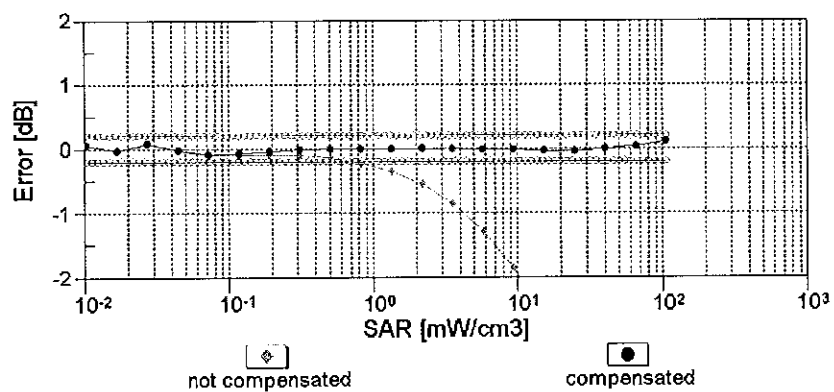
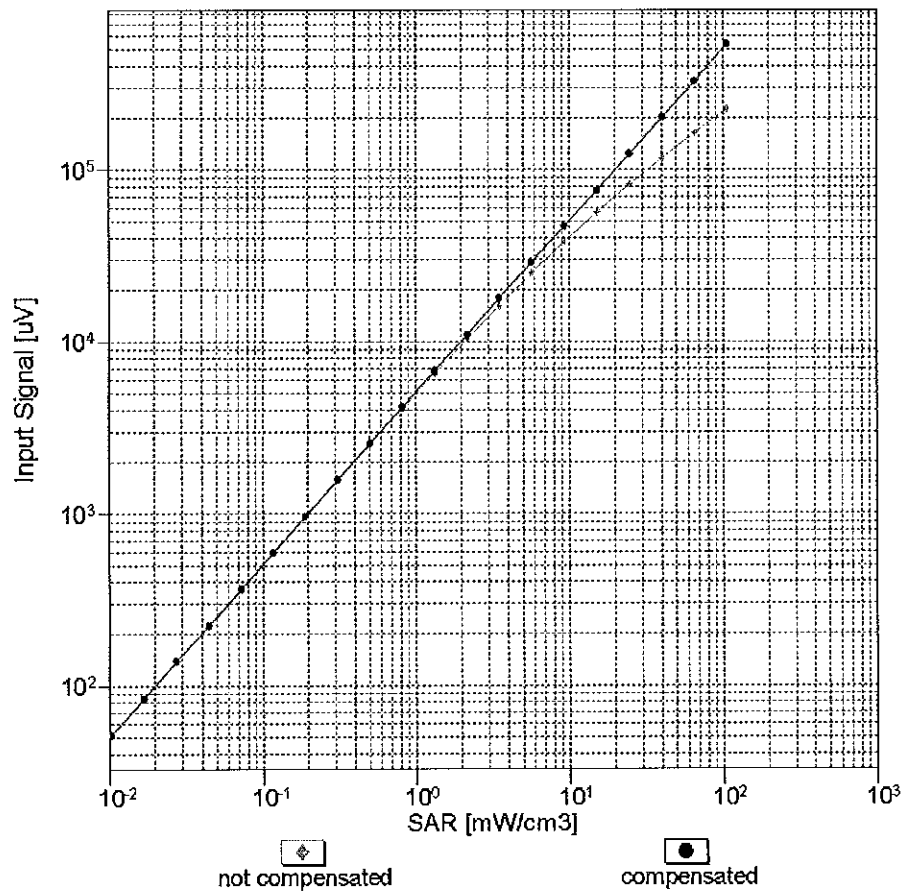


$f=1800$ MHz, R22



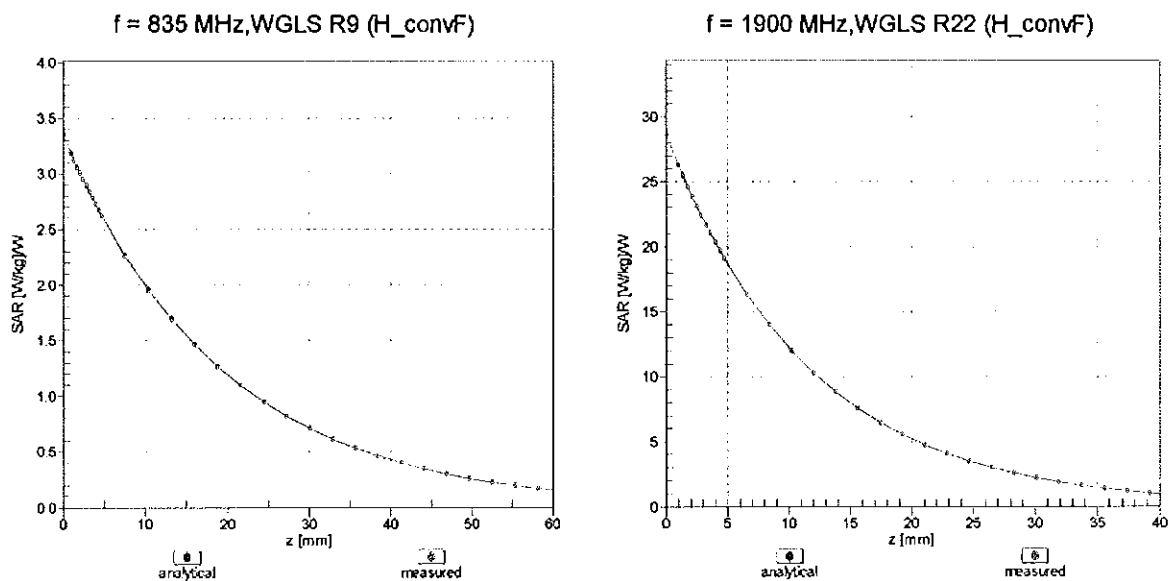
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell , $f = 900 \text{ MHz}$)



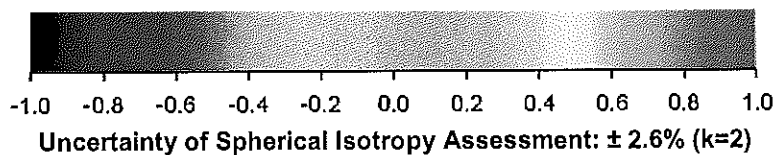
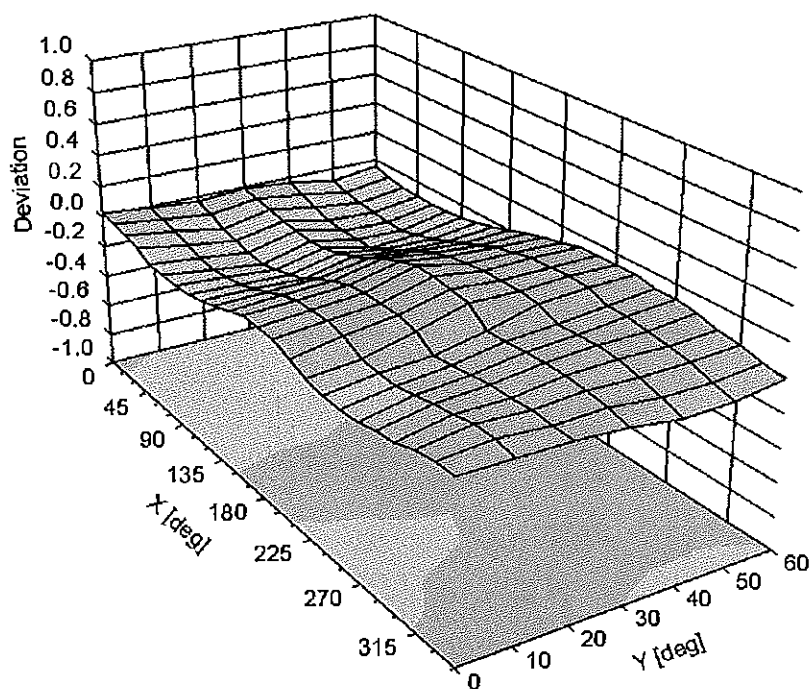
Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, θ), $f = 900 \text{ MHz}$



DASY/EASY - Parameters of Probe: EX3DV4 - SN:3914

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-24.3
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm

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):

$$Y = \frac{j2\omega\epsilon_r\epsilon_0}{[\ln(b/a)]^2} \int_a^b \int_a^b \int_0^\pi \cos\phi' \frac{\exp[-j\omega r(\mu_0\epsilon_r'\epsilon_0)^{1/2}]}{r} d\phi' d\rho' d\rho$$

where Y is the admittance of the probe in contact with the sample, the primed and unprimed coordinates refer to source and observation points, respectively, $r^2 = \rho^2 + \rho'^2 - 2\rho\rho'\cos\phi'$, 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 IEEE 1528-2003 and FCC KDB 865664 D01 v01. Since SAR probe calibrations are frequency dependent, each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media.

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

Table E-I
SAR System Validation Summary

SAR SYSTEM #	FREQ. [MHz]	DATE	PROBE SN	PROBE TYPE	PROBE CAL. POINT		COND.	PERM.	CW VALIDATION			MOD. VALIDATION		
							(σ)	(ϵ_r)	SENSI- TIVITY	PROBE LINEARITY	PROBE ISOTROPY	MOD. TYPE	DUTY FACTOR	PAR
G	835	3/26/2013	3209	ES3DV3	835	Body	1.006	54.42	PASS	PASS	PASS	GMSK	PASS	N/A
D	835	10/8/2013	3022	ES3DV2	835	Body	1.012	53.65	PASS	PASS	PASS	GMSK	PASS	N/A
D	1900	9/10/2013	3022	ES3DV2	1900	Body	1.516	52.49	PASS	PASS	PASS	GMSK	PASS	N/A
D	2450	10/11/2013	3022	ES3DV2	2450	Body	2.008	52.50	PASS	PASS	PASS	OFDM	N/A	PASS
E	5200	12/7/2013	3914	EX3DV4	5200	Body	5.330	48.16	PASS	PASS	PASS	OFDM	N/A	PASS
E	5300	12/7/2013	3914	EX3DV4	5300	Body	5.481	47.91	PASS	PASS	PASS	OFDM	N/A	PASS
E	5500	12/7/2013	3914	EX3DV4	5500	Body	5.807	47.39	PASS	PASS	PASS	OFDM	N/A	PASS
E	5600	12/7/2013	3914	EX3DV4	5600	Body	5.933	47.15	PASS	PASS	PASS	OFDM	N/A	PASS
E	5800	12/7/2013	3914	EX3DV4	5800	Body	6.240	46.70	PASS	PASS	PASS	OFDM	N/A	PASS

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

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APPENDIX G: SENSOR TRIGGERING DATA SUMMARY

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A3LSMP901 Sensor Triggering Data Summary

Per FCC KDB Publication 616217 D04, this device was tested by the manufacturer to determine the proximity sensor triggering distances for the back side and left 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. The output power data in the tables below was measured and provided by the applicant.

To ensure all production units are compliant it is necessary to test SAR at a distance 1mm less than the smallest distance from the device and SAR phantom (determined from these triggering tests according to the KDB 616217 D04) with the device at maximum output power without power reduction. These additional SAR Tests are included additionally 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.

Back Side

Moving device toward the phantom:

Measured Power [dBm]											
Distance [mm]	19	18	17	16	15	14	13	12	11	10	9
GSM850	32.42	32.4	32.39	32.43	32.41	27.53	27.52	27.55	27.56	27.54	27.56
GSM1900	29.77	29.74	29.76	29.77	29.75	19.46	19.47	19.44	19.45	19.47	19.49
GPRS850 1Tx	32.42	32.43	32.4	32.41	32.39	27.5	27.52	27.48	27.49	27.51	27.52
GPRS850 2Tx	30.52	30.51	30.5	30.47	30.45	25.44	25.46	25.41	25.42	25.45	25.47
GPRS850 3Tx	29.02	28.94	28.97	28.95	28.93	23.98	23.99	23.98	23.99	23.99	23.97
GPRS850 4Tx	27.52	27.5	27.51	27.54	27.52	22.46	22.42	22.42	22.43	22.47	22.45
GPRS1900 1Tx	29.77	29.76	29.75	29.79	29.77	19.51	19.49	19.49	19.5	19.52	19.51
GPRS1900 2Tx	28.74	28.72	28.75	28.71	28.69	18.41	18.39	18.39	18.4	18.42	18.41
GPRS1900 3Tx	26.77	26.73	26.75	26.79	26.77	16.32	16.29	16.34	16.35	16.33	16.3
GPRS1900 4Tx	25.72	25.74	25.73	25.7	25.68	15.37	15.35	15.39	15.4	15.38	15.43
WCDMA850	22.22	22.2	22.23	22.24	22.22	17.12	17.13	17.09	17.1	17.13	17.17
WCDMA1900	22.46	22.44	22.45	22.43	22.44	13.07	13.08	13.05	13.03	13.05	13.08
EDGE850 1Tx	26.96	26.92	26.93	26.96	26.97	21.94	21.92	21.91	21.89	21.92	21.94
EDGE850 2Tx	25.72	25.78	25.76	25.71	25.68	21.07	21.05	21.03	21.01	21.05	21.08
EDGE850 3Tx	25.01	24.98	25.03	25.08	25.02	19.88	19.85	19.86	19.84	19.86	19.88
EDGE850 4Tx	23.79	23.69	23.74	23.75	23.76	18.88	18.89	18.87	18.85	18.86	18.89
EDGE1900 1Tx	25.98	25.93	25.89	25.9	25.91	15.98	15.99	15.94	15.92	15.96	15.97
EDGE1900 2Tx	25.02	25.06	25.08	25.04	25.05	15.11	15.13	15.1	15.08	15.09	15.1
EDGE1900 3Tx	23.88	23.8	23.81	23.84	23.85	14.04	14.02	14.01	13.99	14.02	14.04
EDGE1900 4Tx	22.79	22.84	22.83	22.82	22.83	12.96	12.95	12.93	12.91	12.94	12.94

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Moving device away from the phantom:

KDB616217 6.2.4																		
Measured Power [dBm]																		
Distance[mm]	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	7	4	1
GSM850	32.42	32.4	32.39	32.43	32.41	32.41	32.39	32.38	32.42	32.4	27.52	27.51	27.54	27.55	27.53	27.53	27.54	27.52
GSM1900	29.77	29.74	29.76	29.77	29.75	29.76	29.73	29.75	29.76	29.74	19.45	19.46	19.43	19.44	19.46	19.42	19.43	19.45
GPRS850 1Tx	32.42	32.43	32.4	32.41	32.39	32.41	32.42	32.39	32.4	32.38	27.49	27.51	27.47	27.48	27.5	27.46	27.47	27.49
GPRS850 2Tx	30.52	30.51	30.5	30.47	30.45	30.51	30.5	30.49	30.46	30.44	25.43	25.45	25.4	25.41	25.44	25.39	25.4	25.43
GPRS850 3Tx	28.02	28.94	28.97	28.95	28.93	29.01	28.93	28.96	28.94	28.92	23.97	23.98	23.97	23.98	23.98	23.96	23.97	23.97
GPRS850 4Tx	27.52	27.5	27.51	27.54	27.52	27.51	27.49	27.5	27.53	27.51	22.56	22.45	22.48	22.52	23.49	22.4	22.52	22.48
GPRS1900 1Tx	29.8	29.79	29.78	29.82	29.8	29.79	29.78	29.77	29.81	29.79	19.53	19.51	19.51	19.52	19.54	19.5	19.51	19.53
GPRS1900 2Tx	28.77	28.75	28.78	28.74	28.72	28.76	28.74	28.77	28.73	28.71	18.43	18.41	18.41	18.42	18.44	18.4	18.41	18.43
GPRS1900 3Tx	26.8	26.76	26.78	26.82	26.8	26.79	26.75	26.77	26.81	26.79	16.34	16.31	16.36	16.37	16.35	16.35	16.36	16.34
GPRS1900 4Tx	25.75	25.77	25.76	25.73	25.71	25.74	25.76	25.75	25.72	25.7	15.39	15.37	15.41	15.42	15.4	15.4	15.41	15.39
WCDMA850	22.25	22.23	22.26	22.27	22.25	22.24	22.22	22.25	22.26	22.24	17.14	17.15	17.11	17.12	17.15	17.1	17.11	17.14
WCDMA1900	22.49	22.47	22.48	22.46	22.47	22.48	22.46	22.47	22.45	22.46	13.09	13.1	13.07	13.05	13.07	13.06	13.04	13.06
EDGE850 1Tx	26.33	26.31	26.32	26.35	26.36	26.32	26.3	26.31	26.34	26.35	21.92	21.9	21.89	21.87	21.9	21.88	21.86	21.89
EDGE850 2Tx	25.81	25.74	25.79	25.75	25.76	25.79	25.71	25.68	25.74	25.75	21.05	21.03	21.01	20.99	21.03	21	20.98	21.02
EDGE850 3Tx	25.01	24.99	25.02	25.01	25.02	25.07	24.99	24.99	25.02	25.01	19.86	19.83	19.84	19.82	19.84	19.83	19.81	19.83
EDGE850 4Tx	23.78	23.68	23.73	23.74	23.75	23.77	23.67	23.72	23.73	23.74	18.86	18.87	18.85	18.83	18.84	18.84	18.82	18.83
EDGE1900 1Tx	25.97	25.92	25.88	25.89	25.9	25.96	25.91	25.87	25.88	25.89	15.96	15.97	15.92	15.9	15.94	15.91	15.89	15.93
EDGE1900 2Tx	25.01	25.05	25.07	25.03	25.04	25	25.04	25.06	25.02	25.03	15.09	15.11	15.08	15.06	15.07	15.07	15.05	15.06
EDGE1900 3Tx	23.87	23.79	23.8	23.83	23.84	23.86	23.78	23.79	23.82	23.83	14.02	14	13.99	13.97	14	13.98	13.96	13.99
EDGE1900 4Tx	22.78	22.83	22.82	22.81	22.82	22.77	22.82	22.81	22.8	22.81	12.94	12.93	12.91	12.89	12.92	12.9	12.88	12.91

Based on the most conservative measured triggering distance of 14 mm, additional SAR measurements were required at 13 mm from the back side.

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Left Edge

Moving device toward the phantom:

Measured Power [dBm]											
Distance[mm]	21	20	19	18	17	16	15	14	13	12	11
GSM850	32.41	32.39	32.38	32.42	32.4	27.52	27.51	27.54	27.55	27.53	27.55
GSM1900	29.76	29.73	29.75	29.76	29.74	19.45	19.46	19.43	19.44	19.46	19.47
GPRS850 1Tx	32.41	32.42	32.39	32.4	32.38	27.49	27.51	27.47	27.48	27.5	27.54
GPRS850 2Tx	30.51	30.5	30.49	30.46	30.44	25.43	25.45	25.4	25.41	25.44	25.45
GPRS850 3Tx	29.01	28.93	28.96	28.94	28.92	23.97	23.98	23.97	23.98	23.98	23.98
GPRS850 4Tx	27.51	27.49	27.5	27.53	27.51	22.45	22.41	22.41	22.42	22.46	22.48
GPRS1900 1Tx	29.76	29.75	29.74	29.78	29.76	19.5	19.48	19.48	19.49	19.51	19.52
GPRS1900 2Tx	28.73	28.71	28.74	28.7	28.68	18.4	18.38	18.38	18.39	18.41	18.41
GPRS1900 3Tx	26.76	26.72	26.74	26.78	26.76	16.31	16.28	16.33	16.34	16.32	16.32
GPRS1900 4Tx	25.71	25.73	25.72	25.69	25.67	15.36	15.34	15.38	15.39	15.37	15.39
WCDMA850	22.21	22.19	22.22	22.23	22.21	17.11	17.12	17.08	17.09	17.12	17.13
WCDMA1900	22.45	22.43	22.44	22.42	22.43	13.06	13.07	13.04	13.02	13.04	13.04
EDGE850 1Tx	26.93	26.91	26.92	26.95	26.96	21.93	21.91	21.9	21.88	21.91	21.93
EDGE850 2Tx	25.78	25.72	25.66	25.79	25.76	21.06	21.04	21.02	21	21.04	21.02
EDGE850 3Tx	25.01	24.97	25	25.03	25.02	19.87	19.84	19.85	19.83	19.85	19.85
EDGE850 4Tx	23.78	23.68	23.73	23.74	23.75	18.87	18.88	18.86	18.84	18.85	18.85
EDGE1900 1Tx	25.97	25.92	25.88	25.89	25.9	15.97	15.98	15.93	15.91	15.95	15.91
EDGE1900 2Tx	25.01	25.05	25.07	25.03	25.04	15.1	15.12	15.09	15.07	15.08	15.06
EDGE1900 3Tx	23.87	23.79	23.8	23.83	23.84	14.03	14.01	14	13.98	14.01	14.03
EDGE1900 4Tx	22.78	22.83	22.82	22.81	22.82	12.95	12.94	12.92	12.9	12.93	12.91

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Moving device away from the phantom:

KDB 616217 6.2.4																
Measured Power [dBm]																
Distance[mm]	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	9
GSM850	32.41	32.39	32.38	32.42	32.4	32.4	32.38	32.37	32.41	32.39	27.51	27.5	27.53	27.54	27.53	27.53
GSM1900	29.76	29.73	29.75	29.76	29.74	29.75	29.72	29.74	29.75	29.73	19.44	19.45	19.42	19.43	19.42	19.42
GPR S850 1Tx	32.41	32.42	32.39	32.4	32.38	32.4	32.41	32.38	32.39	32.37	27.48	27.5	27.46	27.47	27.45	27.45
GPR S850 2Tx	30.51	30.5	30.49	30.46	30.44	30.5	30.49	30.48	30.45	30.43	25.42	25.44	25.39	25.4	25.41	25.41
GPR S850 3Tx	29.01	28.93	28.96	28.94	28.92	29	28.92	28.95	28.93	28.91	23.96	23.97	23.96	23.97	23.93	23.93
GPR S850 4Tx	27.51	27.49	27.5	27.53	27.51	27.5	27.48	27.49	27.52	27.5	22.44	22.4	22.4	22.41	22.42	22.42
GPR S1900 1Tx	29.79	29.78	29.77	29.81	29.79	29.78	29.77	29.76	29.8	29.78	19.52	19.5	19.5	19.51	19.51	19.51
GPR S1900 2Tx	28.76	28.74	28.77	28.73	28.71	28.75	28.73	28.76	28.72	28.7	18.42	18.4	18.4	18.41	18.41	18.41
GPR S1900 3Tx	26.79	26.75	26.77	26.81	26.79	26.78	26.74	26.76	26.8	26.78	16.33	16.3	16.35	16.36	16.34	16.34
GPR S1900 4Tx	25.74	25.76	25.75	25.72	25.7	25.73	25.75	25.74	25.71	25.69	15.38	15.36	15.4	15.41	15.33	15.33
WCDMA850	22.24	22.22	22.25	22.26	22.24	22.23	22.21	22.24	22.25	22.23	17.13	17.14	17.1	17.11	17.12	17.12
WCDMA1900	22.48	22.46	22.47	22.45	22.46	22.47	22.45	22.46	22.44	22.45	13.08	13.09	13.06	13.04	13.01	13.01
EDGE850 1Tx	26.92	26.9	26.91	26.94	26.95	26.91	26.89	26.9	26.93	26.94	21.91	21.89	21.88	21.86	21.82	21.82
EDGE850 2Tx	25.76	25.68	25.72	25.77	25.71	25.74	25.7	25.63	25.72	25.78	21.04	21.02	21	20.98	21.01	21.01
EDGE850 3Tx	25.02	24.99	24.97	25.03	25.07	25	24.98	24.99	25.03	25.05	19.85	19.82	19.83	19.81	19.82	19.82
EDGE850 4Tx	23.77	23.67	23.72	23.73	23.74	23.76	23.66	23.71	23.72	23.73	18.85	18.86	18.84	18.82	18.81	18.81
EDGE1900 1Tx	25.96	25.91	25.87	25.88	25.89	25.95	25.9	25.86	25.87	25.88	15.95	15.96	15.91	15.89	15.91	15.91
EDGE1900 2Tx	25	25.04	25.06	25.02	25.03	24.99	25.03	25.05	25.01	25.02	15.08	15.1	15.07	15.05	15.02	15.02
EDGE1900 3Tx	23.86	23.78	23.79	23.82	23.83	23.85	23.77	23.78	23.81	23.82	14.01	13.99	13.98	13.96	13.95	13.95
EDGE1900 4Tx	22.77	22.82	22.81	22.8	22.81	22.76	22.81	22.8	22.79	22.8	12.93	12.92	12.9	12.88	12.92	12.92

Based on the most conservative measured triggering distance of 16 mm, additional SAR measurements were required at 15 mm from the left edge.

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