



SAR EVALUATION REPORT

Applicant Name:
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Date of Testing:
 07/17/14 - 07/24/14
Test Site/Location:
 PCTEST Lab, Columbia, MD, USA
Document Serial No.:
 0Y1407221438.A3L

FCC ID:	A3LSMN900R4
APPLICANT:	SAMSUNG ELECTRONICS, CO. LTD.


DUT Type:	Portable Handset
Application Type:	Class II Permissive Change
FCC Rule Part(s):	CFR §2.1093
Model(s):	SM-N900R4
Sample Serial Number:	32F89
Permissive Change(s):	Adding 15MHz and 20MHz BWs to LTE B4 and B2
Date of Original Certification:	9/11/2013

Equipment Class	Band & Mode	Tx Frequency	SAR		
			1 gm Head (W/kg)	1 gm Body-Worn (W/kg)	1 gm Hotspot (W/kg)
PCE	LTE Band 4 (AWS)	1712.5 - 1752.5 MHz	0.43	0.23	0.23
PCE	LTE Band 2 (PCS)	1852.5 - 1907.5 MHz	0.17	0.24	0.24
Simultaneous SAR per KDB 690783 D01v01r03:			1.09	1.12	1.12

The table above shows Test Data evaluated for the current test report. Please refer to RF Exposure Technical Report S/N 0Y1307161255-R1.A3L for compliance evaluation.



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 1.9 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
Cell. CDMA/EVDO	Voice/Data	824.70 - 848.31 MHz
PCS CDMA/EVDO	Voice/Data	1851.25 - 1908.75 MHz
LTE Band 12	Data	701.5 - 713.5 MHz
LTE Band 17	Data	706.5 - 713.5 MHz
LTE Band 5 (Cell)	Data	826.5 - 846.5 MHz
LTE Band 4 (AWS)	Data	1712.5 - 1752.5 MHz
LTE Band 2 (PCS)	Data	1852.5 - 1907.5 MHz
LTE Band 25 (PCS)	Data	1852.5 - 1912.5 MHz
2.4 GHz WLAN	Data	2412 - 2462 MHz
5.8 GHz WLAN	Data	5745 - 5825 MHz
5.2 GHz WLAN	Data	5180 - 5240 MHz
5.3 GHz WLAN	Data	5260 - 5320 MHz
5.5 GHz WLAN	Data	5500 - 5700 MHz
Bluetooth	Data	2402 - 2480 MHz
NFC	Data	13.56 MHz
ANT+	Data	2402-2480 MHz

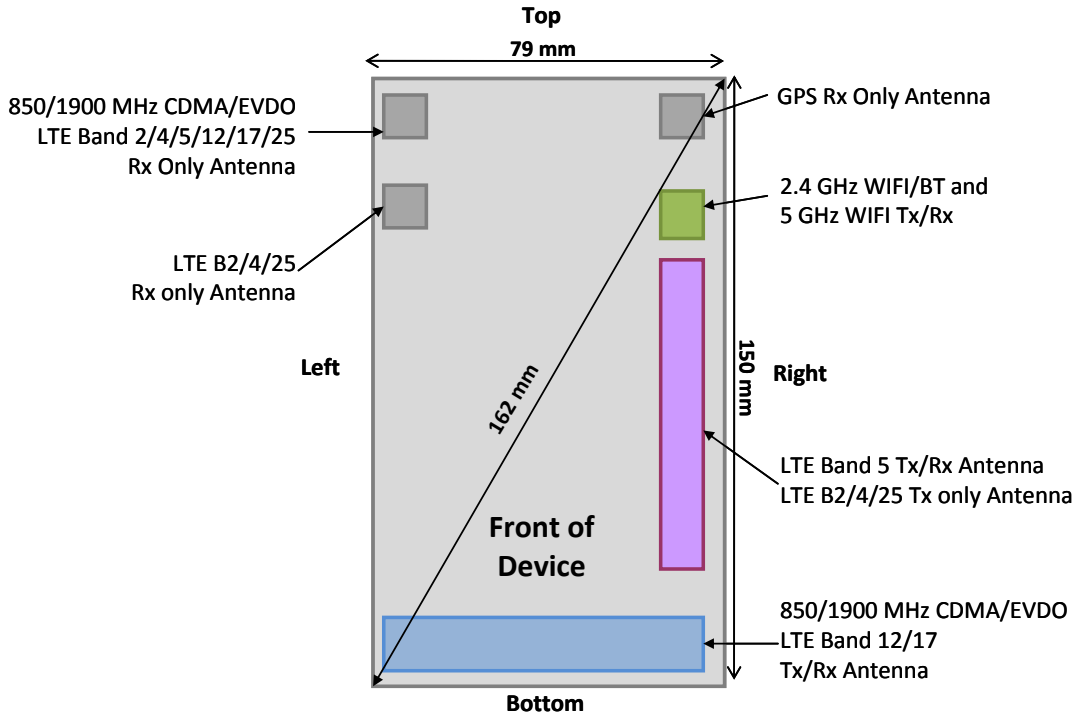
1.2 Nominal and Maximum Output Power Specifications

This device operates using the following maximum and nominal output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498 D01v05.

Mode / Band		Modulated Average (dBm)
LTE Band 4 (AWS)	Maximum	23.0
	Nominal	22.5
LTE Band 2 (PCS)	Maximum	23.0
	Nominal	22.5

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1.3 DUT Antenna Locations



Notes:

1. Exact antenna dimensions and separation distances are shown in the Technical Descriptions in the FCC Filing.
2. Since the diagonal distance of the device is > 160 mm and <200 mm, it is considered a “phablet.”

**Figure 1-1
DUT Antenna Locations**

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

Mode	Back	Front	Top	Bottom	Right	Left
LTE Band 4 (AWS)	Yes	Yes	No	Yes	Yes	No
LTE Band 2 (PCS)	Yes	Yes	No	Yes	Yes	No

Note: Particular DUT edges were not required to be evaluated for Wireless Router SAR or Extremity SAR if the edges were greater than 2.5 cm from the transmitting antenna according to FCC KDB Publication 941225 D06v01 guidance, page 2 and FCC KDB 648474 D04v01r01.

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1.4 Near Field Communications (NFC) Antenna

This DUT has NFC operations. The NFC antenna is integrated into the specialized battery. The SAR tests were performed with the standard battery (model: B800BU).

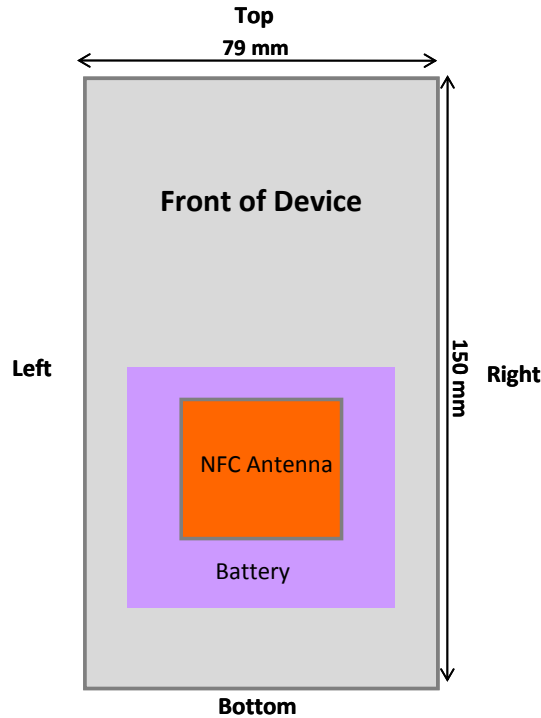


Figure 1-2
NFC Antenna Locations



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. Possible transmission paths for the DUT are shown in Figure 1-3 and are color-coded to indicate communication modes which share the same path. Modes which share the same transmission path cannot transmit simultaneously with one another.



Figure 1-3
Simultaneous Transmission Paths

This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis according to FCC KDB Publication 447498 D01v05 3) procedures.

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**Table 1-2
Simultaneous Transmission Scenarios**

No.	Capable Transmit Configurations	Head	Body- Worn Accessory	Hot Spot	Hand	Note
1	1X CDMA Voice + LTE Data	√	√	N/A	√	SVLTE
2	1X CDMA Voice + LTE Data + 2.4 GHz WIFI	√	√	√	√	Voice and LTE+WIFI Hotspot
3	1X CDMA Voice + LTE Data + 5.8 GHz WIFI	√	√	√	√	Voice and LTE+WIFI Hotspot
4	1X CDMA Voice + LTE Data + 2.4 GHz Bluetooth	N/A	√	N/A	√	Voice and LTE+Bluetooth
5	1X CDMA Voice + 2.4 GHz WIFI	√	√	N/A	√	1X voice and WiFi Data
6	1X CDMA Voice + 2.4 GHz Bluetooth	N/A	√	N/A	√	1X voice and Bluetooth
7	1X CDMA Voice + 5 GHz WIFI	√	√	N/A	√	1X voice and WiFi Data
8	1X/EVDO Data + 2.4 GHz WIFI	√	√	√	√	EVDO+WIFI Hotspot
9	1X/EVDO Data + 2.4 GHz Bluetooth	N/A	√	N/A	√	EVDO+Bluetooth
10	1X/EVDO Data + 5.8 GHz WIFI	√	√	√	√	EVDO+WIFI Hotspot
11	LTE Data + 2.4 GHz WIFI	√	√	√	√	LTE+WIFI Hotspot
12	LTE Data + 2.4 GHz Bluetooth	N/A	√	N/A	√	LTE+Bluetooth
13	LTE Data + 5.8 GHz WIFI	√	√	√	√	LTE+WIFI Hotspot
14	1X CDMA Voice + EVDO	N/A	N/A	N/A	N/A	Not supported by HW
15	EVDO data + LTE Data	N/A	N/A	N/A	N/A	Not supported by SW
16	1X CDMA Voice + LTE Data + 5.2-5.5 GHz WIFI	N/A	N/A	N/A	N/A	Not supported by SW
17	1X/EVDO Data + 5.2-5.7 GHz WIFI	N/A	N/A	N/A	N/A	Not supported by SW
18	LTE Data + 5.2-5.7 GHz WIFI	N/A	N/A	N/A	N/A	Not supported by SW

Notes:

1. Per the manufacturer, WIFI Direct is not expected to be used in conjunction with a held-to-ear or body-worn accessory voice call. Therefore, the only new simultaneous capabilities involving WIFI direct are for hand-held operations only.
2. 2.4 GHz WLAN, 2.4 GHz Bluetooth, and 5 GHz WLAN share the same antenna path and cannot transmit simultaneously

1.6 SAR Test Exclusions Applied

This report evaluates SAR compliance for LTE Band 2 and LTE Band 4. Please refer to RF Exposure Technical Report 0Y1307161255-R1.A3L for original compliance report containing data for other main antenna and WLAN modes. No changes were made to any other mode or band.

(A) Licensed Transmitter(s)

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



Per FCC KDB Publication 648474 D03-D04, this device is considered a "phablet" since its diagonal distance is greater than 160 mm, but less than 200 mm. Therefore hand SAR tests are required, however hand SAR was not evaluated for LTE B2 or LTE B4 since Hotspot SAR when scaled up to the maximum output power tolerances is < 1.2 W/kg.

1.7 Power Reduction for SAR

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



1.8 Wireless Charging Battery Cover

This DUT may be used with a standard battery cover or with an optional wireless charging battery cover. Per FCC KDB Publication 648474 D04, SAR was measured using the standard battery cover and then repeated with the wireless charging battery cover for the configuration with the highest reported SAR for each wireless technology, frequency band, operating mode, and exposure condition. Since reported SAR did not exceed 1.2 W/kg, additional testing with the wireless charging battery cover was not required.

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1.9 Guidance Applied



- IEEE 1528-2003
- FCC KDB Publication 941225 D01v02, D03v01, D05v02r03, D06v01r01 (4G and Hotspot)
- FCC KDB Publication 447498 D01v05r02 (General SAR Guidance)
- FCC KDB Publication 865664 D01v01r03, D02v01r01 (SAR Measurements up to 6 GHz)
- FCC KDB Publication 648474 D03-D04 (Phablet Procedures, Wireless Charging Cover)

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LTE INFORMATION

LTE Information			
FCC ID	A3LSMN900R4		
Form Factor	Portable Handset		
Frequency Range of each LTE transmission band	LTE Band 4 (AWS) (1712.5 - 1752.5 MHz) LTE Band 2 (PCS) (1852.5 - 1907.5 MHz)		
Channel Bandwidths	LTE Band 4 (AWS): 5 MHz, 10 MHz, 15 MHz, 20 MHz LTE Band 2 (PCS): 5 MHz, 10 MHz, 15 MHz, 20 MHz		
Channel Numbers and Frequencies (MHz)	Low	Mid	High
LTE Band 4 (AWS): 5 MHz	1712.5 (19975)	1732.5 (20175)	1752.5 (20375)
LTE Band 4 (AWS): 10 MHz	1715 (20000)	1732.5 (20175)	1750 (20350)
LTE Band 4 (AWS): 15 MHz	1717.5 (20025)	1732.5 (20175)	1747.5 (20325)
LTE Band 4 (AWS): 20 MHz	1720 (20050)	1732.5 (20175)	1745 (20300)
LTE Band 2 (PCS): 5 MHz	1852.5 (18625)	1880 (18900)	1907.5 (19175)
LTE Band 2 (PCS): 10 MHz	1855 (18650)	1880 (18900)	1905 (19150)
LTE Band 2 (PCS): 15 MHz	1857.5 (18675)	1880 (18900)	1902.5 (19125)
LTE Band 2 (PCS): 20 MHz	1860 (18700)	1880 (18900)	1900 (19100)
UE Category	3		
Modulations Supported in UL	QPSK, 16QAM		
LTE MPR Permanently implemented per 3GPP TS 36.101 section 6.2.3-6.2.5? (manufacturer attestation to be provided)	YES		
A-MPR (Additional MPR) disabled for SAR Testing?	YES		

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3 INTRODUCTION

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

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [3] and Health Canada RF Exposure Guidelines Safety Code 6 [22]. The measurement procedure described in IEEE/ANSI C95.3-2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave [4] is used for guidance in measuring the Specific Absorption Rate (SAR) due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the International Committee for Non-Ionizing Radiation Protection (ICNIRP) in Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields,” Report No. Vol 74. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

3.1 SAR Definition

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

Equation 3-1
SAR Mathematical Equation

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



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

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

where:

- σ = conductivity of the tissue-simulating material (S/m)
- ρ = mass density of the tissue-simulating material (kg/m³)
- E = Total RMS electric field strength (V/m)

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

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4 DOSIMETRIC ASSESSMENT

4.1 Measurement Procedure

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

1. The SAR distribution at the exposed side of the head or body was measured at a distance no greater than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the device-head and body interface and the horizontal grid resolution was determined per FCC KDB Publication 865664 D01v01 (See Table 4-1) and IEEE 1528-2013.
2. The point SAR measurement was taken at the maximum SAR region determined from Step 1 to enable the monitoring of SAR fluctuations/drifts during the 1g/10g cube evaluation. SAR at this fixed point was measured and used as a reference value.
3. Based on the area scan data, the peak of the region with maximum SAR was determined by spline interpolation. Around this point, a volume was assessed according to the measurement resolution and volume size requirements of FCC KDB Publication 865664 D01v01 (See Table 4-1) and IEEE 1528-2013. On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the DASY manual online for more details):
 - a. SAR values at the inner surface of the phantom are extrapolated from the measured values along the line away from the surface with spacing no greater than that in Table 4-1. The extrapolation was based on a least-squares algorithm. A polynomial of the fourth order was calculated through the points in the z-axis (normal to the phantom shell).
 - b. After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1g or 10g) using a 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the “Not a knot” condition (in x, y, and z directions). The volume was then integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were obtained through interpolation, in order to calculate the averaged SAR.
 - c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as step 2, was re-measured after the zoom scan was complete to calculate the SAR drift. If the drift deviated by more than 5%, the SAR test and drift measurements were repeated.

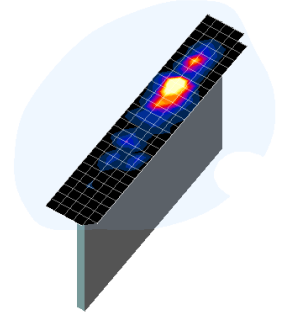




Figure 4-1
Sample SAR Area Scan

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

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

*Also compliant to IEEE 1528-2013 Table 6

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DEFINITION OF REFERENCE POINTS

5.1 EAR REFERENCE POINT

Figure 5-2 shows the front, back and side views of the SAM Twin Phantom. The point “M” is the reference point for the center of the mouth, “LE” is the left ear reference point (ERP), and “RE” is the right ERP. The ERP is 15mm posterior to the entrance to the ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 5-1. The plane passing through the two ear canals and M is defined as the Reference Plane. The line N-F (Neck-Front), also called the Reference Pivoting Line, is not perpendicular to the reference plane (see Figure 5-1). Line B-M is perpendicular to the N-F line. Both N-F and B-M lines are marked on the external phantom shell to facilitate handset positioning [5].

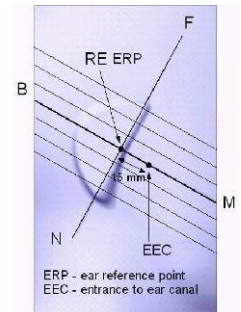


Figure 5-1
Close-Up Side view of ERP

5.2 HANDSET REFERENCE POINTS

Two imaginary lines on the handset were established: the vertical centerline and the horizontal line. The test device was placed in a normal operating position with the acoustic output located along the “vertical centerline” on the front of the device aligned to the “ear reference point” (See Figure 5-3). The acoustic output was then located at the same level as the center of the ear reference point. The test device was positioned so that the “vertical centerline” was bisecting the front surface of the handset at its top and bottom edges, positioning the “ear reference point” on the outer surface of the both the left and right head phantoms on the ear reference point.



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

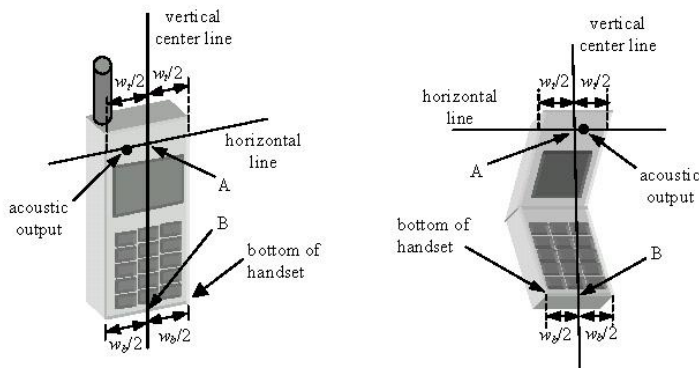




Figure 5-3
Handset Vertical Center & Horizontal Line Reference Points

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6 TEST CONFIGURATION POSITIONS FOR HANDSETS

6.1 Device Holder

The device holder is made out of low-loss POM material having the following dielectric parameters: relative permittivity $\epsilon = 3$ and loss tangent $\delta = 0.02$.

6.2 Positioning for Cheek

1. The test device was positioned with the device close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 6-1), such that the plane defined by the vertical center line and the horizontal line of the phone is approximately parallel to the sagittal plane of the phantom.

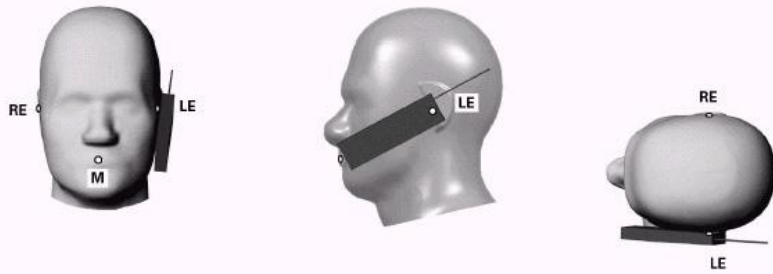




Figure 6-1 Front, Side and Top View of Cheek Position

2. The handset was translated towards the phantom along the line passing through RE & LE until the handset touches the pinna.
3. While maintaining the handset in this plane, the handset was rotated around the LE-RE line until the vertical centerline was in the reference plane.
4. The phone was then rotated around the vertical centerline until the phone (horizontal line) was symmetrical with respect to the line NF.
5. While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the device contact with the ear, the device was rotated about the NF line until any point on the handset made contact with a phantom point below the ear (cheek) (See Figure 6-2).

6.3 Positioning for Ear / 15° Tilt

With the test device aligned in the “Cheek Position”:

1. While maintaining the orientation of the phone, the phone was retracted parallel to the reference plane far enough to enable a rotation of the phone by 15 degrees.
2. The phone was then rotated around the horizontal line by 15 degrees.
3. While maintaining the orientation of the phone, the phone was moved parallel to the reference plane until any part of the handset touched the head. (In this position, point A was located on the line RE-LE). The tilted position is obtained when the contact is on the pinna. If the contact was at any location other than the pinna, the angle of the phone would then be reduced. In this situation, the tilted position was obtained when any part of the phone was in contact of the ear as well as a second part of the phone was in contact with the head (see Figure 6-2).

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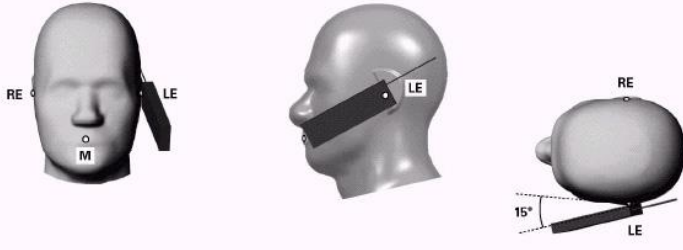


Figure 6-2 Front, Side and Top View of Ear/15° Tilt Position

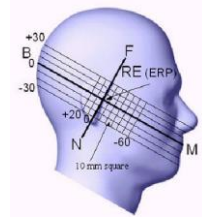


Figure 6-3 Side view w/ relevant markings

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

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

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

6.5 Body-Worn Accessory Configurations

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

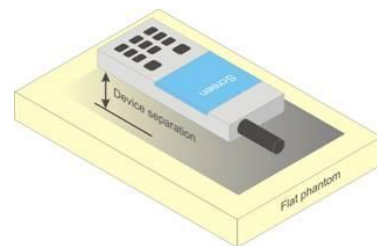




Figure 6-4 Sample Body-Worn Diagram

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Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are tested with the device with each accessory. If multiple accessories share an identical metallic component (i.e. the same metallic belt-clip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.

Body-worn accessories may not always be supplied or available as options for some devices intended to be authorized for body-worn use. In this case, a test configuration with a separation distance between the back of the device and the flat phantom is used. Test position spacing was documented. Transmitters that are designed to operate in front of a person's face, as in push-to-talk configurations, are tested for SAR compliance with the front of the device positioned to face the flat phantom in head fluid. For devices that are carried next to the body such as a shoulder, waist or chest-worn transmitters, SAR compliance is tested with the accessories, including headsets and microphones, attached to the device and positioned against a flat phantom in a normal use configuration.

6.6 Extremity Exposure Configurations



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

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

6.7 Wireless Router Configurations

Some battery-operated handsets have the capability to transmit and receive user data through simultaneous transmission of WIFI simultaneously with a separate licensed transmitter. The FCC has provided guidance in FCC KDB Publication 941225 D06 v01 where SAR test considerations for handsets ($L \times W \geq 9$ cm x 5 cm) are based on a composite test separation distance of 10 mm from the front, back and edges of the device containing transmitting antennas within 2.5 cm of their edges, determined from general mixed use conditions for this type of devices. Since the hotspot SAR results may overlap with the body-worn accessory SAR requirements, the more conservative configurations can be considered, thus excluding some body-worn accessory SAR tests.

When the user enables the personal wireless router functions for the handset, actual operations include simultaneous transmission of both the WIFI transmitter and another licensed transmitter. Both transmitters often do not transmit at the same transmitting frequency and thus cannot be evaluated for SAR under actual use conditions due to the limitations of the SAR assessment probes. Therefore, SAR must be evaluated for each frequency transmission and mode separately and spatially summed with the WIFI transmitter according to FCC KDB Publication 447498 D01v05 publication procedures. The "Portable Hotspot" feature on the handset was NOT activated during SAR assessments, to ensure the SAR measurements were evaluated for a single transmission frequency RF signal at a time.

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7 RF EXPOSURE LIMITS

7.1 Uncontrolled Environment

UNCONTROLLED ENVIRONMENTS are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.



7.2 Controlled Environment

CONTROLLED ENVIRONMENTS are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

**Table 7-1
SAR Human Exposure Specified in ANSI/IEEE C95.1-1992 and Health Canada Safety Code 6**

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

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

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8 FCC MEASUREMENT PROCEDURES

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

8.1 Measured and Reported SAR

Per FCC KDB Publication 447498 D01v05, When SAR is not measured at the maximum power level allowed for production units, the results must be scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested to determine compliance. For simultaneous transmission, the measured aggregate SAR must be scaled according to the sum of the differences between the maximum tune-up tolerance and actual power used to test each transmitter. When SAR is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as *reported* SAR. The highest *reported* SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r02.

8.2 Procedures Used to Establish RF Signal for SAR

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

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

8.3 SAR Measurement Conditions for LTE

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

8.3.1 Spectrum Plots for RB Configurations



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

8.3.2 MPR

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

8.3.3 A-MPR



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

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8.3.4 Required RB Size and RB Offsets for SAR Testing

According to FCC KDB 941225 D05v02r01:

- a. Per Section 5.2.1, SAR is required for QPSK 1 RB Allocation for the largest bandwidth
 - i. The required channel and offset combination with the highest maximum output power is required for SAR.
 - ii. When the reported SAR is ≤ 0.8 W/kg, testing of the remaining RB offset configurations and required test channels is not required. Otherwise, SAR is required for the remaining required test channels using the RB offset configuration with highest output power for that channel.
 - iii. When the reported SAR for a required test channel is > 1.45 W/kg, SAR is required for all RB offset configurations for that channel.
- b. Per Section 5.2.2, SAR is required for 50% RB allocation using the largest bandwidth following the same procedures outlined in Section 5.2.1.
- c. Per Section 5.2.3, QPSK SAR is not required for the 100% allocation when the highest maximum output power for the 100% allocation is less than the highest maximum output power of the 1 RB and 50% RB allocations and the reported SAR for the 1 RB and 50% RB allocations is < 0.8 W/kg.
- d. Per Section 5.2.4 and 5.3, SAR tests for higher order modulations and lower bandwidths configurations are not required when the conducted power of the required test configurations determined by Sections 5.2.1 through 5.2.3 is less than or equal to $\frac{1}{2}$ dB higher than the equivalent configuration using QPSK modulation and when the QPSK SAR for those configurations is < 1.45 W/kg.

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9.1 LTE Conducted Powers

9.1.1 LTE Band 4 (AWS)



Table 9-1
LTE Band 4 (AWS) Conducted Powers - 20 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Mid	1732.5	20175	20	QPSK	1	0	22.46	0	0
	1732.5	20175	20	QPSK	1	50	22.94	0	0
	1732.5	20175	20	QPSK	1	99	22.81	0	0
	1732.5	20175	20	QPSK	50	0	21.75	0-1	1
	1732.5	20175	20	QPSK	50	25	21.68	0-1	1
	1732.5	20175	20	QPSK	50	50	21.77	0-1	1
	1732.5	20175	20	QPSK	100	0	21.67	0-1	1
	1732.5	20175	20	16QAM	1	0	21.74	0-1	1
	1732.5	20175	20	16QAM	1	50	21.94	0-1	1
	1732.5	20175	20	16QAM	1	99	21.82	0-1	1
	1732.5	20175	20	16QAM	50	0	20.95	0-2	2
	1732.5	20175	20	16QAM	50	25	20.83	0-2	2
	1732.5	20175	20	16QAM	50	50	20.85	0-2	2
	1732.5	20175	20	16QAM	100	0	20.83	0-2	2

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

Table 9-2
LTE Band 4 (AWS) Conducted Powers - 15 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1717.5	20025	15	QPSK	1	0	22.80	0	0
	1717.5	20025	15	QPSK	1	36	22.91	0	0
	1717.5	20025	15	QPSK	1	74	22.95	0	0
	1717.5	20025	15	QPSK	36	0	21.69	0-1	1
	1717.5	20025	15	QPSK	36	18	21.84	0-1	1
	1717.5	20025	15	QPSK	36	37	21.89	0-1	1
	1717.5	20025	15	QPSK	75	0	21.78	0-1	1
	1717.5	20025	15	16QAM	1	0	21.75	0-1	1
	1717.5	20025	15	16QAM	1	36	21.98	0-1	1
	1717.5	20025	15	16QAM	1	74	22.00	0-1	1
	1717.5	20025	15	16QAM	36	0	20.78	0-2	2
	1717.5	20025	15	16QAM	36	18	20.93	0-2	2
	1717.5	20025	15	16QAM	36	37	20.99	0-2	2
	1717.5	20025	15	16QAM	75	0	20.85	0-2	2
	1732.5	20175	15	QPSK	1	0	22.82	0	0
	1732.5	20175	15	QPSK	1	36	22.90	0	0
1732.5	20175	15	QPSK	1	74	22.70	0	0	
1732.5	20175	15	QPSK	36	0	21.87	0-1	1	
1732.5	20175	15	QPSK	36	18	21.73	0-1	1	
1732.5	20175	15	QPSK	36	37	21.75	0-1	1	
1732.5	20175	15	QPSK	75	0	21.76	0-1	1	
1732.5	20175	15	16QAM	1	0	22.00	0-1	1	
1732.5	20175	15	16QAM	1	36	21.89	0-1	1	
1732.5	20175	15	16QAM	1	74	21.68	0-1	1	
1732.5	20175	15	16QAM	36	0	21.00	0-2	2	
1732.5	20175	15	16QAM	36	18	20.94	0-2	2	
1732.5	20175	15	16QAM	36	37	20.93	0-2	2	
1732.5	20175	15	16QAM	75	0	20.92	0-2	2	
High	1747.5	20325	15	QPSK	1	0	22.97	0	0
	1747.5	20325	15	QPSK	1	36	22.90	0	0
	1747.5	20325	15	QPSK	1	74	22.80	0	0
	1747.5	20325	15	QPSK	36	0	21.81	0-1	1
	1747.5	20325	15	QPSK	36	18	21.92	0-1	1
	1747.5	20325	15	QPSK	36	37	21.92	0-1	1
	1747.5	20325	15	QPSK	75	0	21.82	0-1	1
	1747.5	20325	15	16QAM	1	0	21.94	0-1	1
	1747.5	20325	15	16QAM	1	36	21.87	0-1	1
	1747.5	20325	15	16QAM	1	74	21.84	0-1	1
	1747.5	20325	15	16QAM	36	0	20.92	0-2	2
	1747.5	20325	15	16QAM	36	18	20.98	0-2	2
	1747.5	20325	15	16QAM	36	37	20.99	0-2	2
	1747.5	20325	15	16QAM	75	0	20.96	0-2	2

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**Table 9-3
LTE Band 4 (AWS) Conducted Powers - 10 MHz Bandwidth**

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1715	20000	10	QPSK	1	0	22.45	0	0
	1715	20000	10	QPSK	1	25	22.31	0	0
	1715	20000	10	QPSK	1	49	22.53	0	0
	1715	20000	10	QPSK	25	0	21.41	0-1	1
	1715	20000	10	QPSK	25	12	21.46	0-1	1
	1715	20000	10	QPSK	25	25	21.55	0-1	1
	1715	20000	10	QPSK	50	0	21.30	0-1	1
	1715	20000	10	16QAM	1	0	21.68	0-1	1
	1715	20000	10	16QAM	1	25	21.57	0-1	1
	1715	20000	10	16QAM	1	49	21.66	0-1	1
	1715	20000	10	16QAM	25	0	20.51	0-2	2
	1715	20000	10	16QAM	25	12	20.53	0-2	2
	1715	20000	10	16QAM	25	25	20.60	0-2	2
	1715	20000	10	16QAM	50	0	20.45	0-2	2
	Mid	1732.5	20175	10	QPSK	1	0	22.86	0
1732.5		20175	10	QPSK	1	25	22.77	0	0
1732.5		20175	10	QPSK	1	49	22.60	0	0
1732.5		20175	10	QPSK	25	0	21.72	0-1	1
1732.5		20175	10	QPSK	25	12	21.56	0-1	1
1732.5		20175	10	QPSK	25	25	21.53	0-1	1
1732.5		20175	10	QPSK	50	0	21.43	0-1	1
1732.5		20175	10	16QAM	1	0	21.83	0-1	1
1732.5		20175	10	16QAM	1	25	21.52	0-1	1
1732.5		20175	10	16QAM	1	49	21.62	0-1	1
1732.5		20175	10	16QAM	25	0	20.74	0-2	2
1732.5		20175	10	16QAM	25	12	20.87	0-2	2
1732.5		20175	10	16QAM	25	25	20.69	0-2	2
1732.5		20175	10	16QAM	50	0	20.55	0-2	2
High		1750	20350	10	QPSK	1	0	22.69	0
	1750	20350	10	QPSK	1	25	22.59	0	0
	1750	20350	10	QPSK	1	49	22.48	0	0
	1750	20350	10	QPSK	25	0	21.67	0-1	1
	1750	20350	10	QPSK	25	12	21.69	0-1	1
	1750	20350	10	QPSK	25	25	21.57	0-1	1
	1750	20350	10	QPSK	50	0	21.56	0-1	1
	1750	20350	10	16QAM	1	0	21.49	0-1	1
	1750	20350	10	16QAM	1	25	21.57	0-1	1
	1750	20350	10	16QAM	1	49	21.43	0-1	1
	1750	20350	10	16QAM	25	0	20.48	0-2	2
	1750	20350	10	16QAM	25	12	20.53	0-2	2
	1750	20350	10	16QAM	25	25	20.64	0-2	2
	1750	20350	10	16QAM	50	0	20.57	0-2	2

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

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1712.5	19975	5	QPSK	1	0	22.78	0	0
	1712.5	19975	5	QPSK	1	12	22.70	0	0
	1712.5	19975	5	QPSK	1	24	22.61	0	0
	1712.5	19975	5	QPSK	12	0	21.80	0-1	1
	1712.5	19975	5	QPSK	12	6	21.67	0-1	1
	1712.5	19975	5	QPSK	12	13	21.78	0-1	1
	1712.5	19975	5	QPSK	25	0	21.56	0-1	1
	1712.5	19975	5	16-QAM	1	0	21.62	0-1	1
	1712.5	19975	5	16-QAM	1	12	21.66	0-1	1
	1712.5	19975	5	16-QAM	1	24	21.64	0-1	1
	1712.5	19975	5	16-QAM	12	0	20.61	0-2	2
	1712.5	19975	5	16-QAM	12	6	20.83	0-2	2
	1712.5	19975	5	16-QAM	12	13	20.79	0-2	2
	1712.5	19975	5	16-QAM	25	0	20.64	0-2	2
	Mid	1732.5	20175	5	QPSK	1	0	22.57	0
1732.5		20175	5	QPSK	1	12	22.69	0	0
1732.5		20175	5	QPSK	1	24	22.73	0	0
1732.5		20175	5	QPSK	12	0	21.54	0-1	1
1732.5		20175	5	QPSK	12	6	21.64	0-1	1
1732.5		20175	5	QPSK	12	13	21.61	0-1	1
1732.5		20175	5	QPSK	25	0	21.45	0-1	1
1732.5		20175	5	16-QAM	1	0	21.62	0-1	1
1732.5		20175	5	16-QAM	1	12	21.71	0-1	1
1732.5		20175	5	16-QAM	1	24	21.49	0-1	1
1732.5		20175	5	16-QAM	12	0	20.86	0-2	2
1732.5		20175	5	16-QAM	12	6	20.75	0-2	2
1732.5		20175	5	16-QAM	12	13	20.51	0-2	2
1732.5		20175	5	16-QAM	25	0	20.64	0-2	2
High		1752.5	20375	5	QPSK	1	0	22.79	0
	1752.5	20375	5	QPSK	1	12	22.71	0	0
	1752.5	20375	5	QPSK	1	24	22.64	0	0
	1752.5	20375	5	QPSK	12	0	21.72	0-1	1
	1752.5	20375	5	QPSK	12	6	21.69	0-1	1
	1752.5	20375	5	QPSK	12	13	21.70	0-1	1
	1752.5	20375	5	QPSK	25	0	21.44	0-1	1
	1752.5	20375	5	16-QAM	1	0	21.56	0-1	1
	1752.5	20375	5	16-QAM	1	12	21.65	0-1	1
	1752.5	20375	5	16-QAM	1	24	21.66	0-1	1
	1752.5	20375	5	16-QAM	12	0	20.79	0-2	2
	1752.5	20375	5	16-QAM	12	6	20.80	0-2	2
	1752.5	20375	5	16-QAM	12	13	20.83	0-2	2
	1752.5	20375	5	16-QAM	25	0	20.91	0-2	2

9.1.2

LTE Band 2 (PCS)

Table 9-5
 LTE Band 2 (PCS) Conducted Powers - 20 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]	
Low	1860	18700	20	QPSK	1	0	22.73	0	0	
	1860	18700	20	QPSK	1	50	22.88	0	0	
	1860	18700	20	QPSK	1	99	22.80	0	0	
	1860	18700	20	QPSK	50	0	21.86	0-1	1	
	1860	18700	20	QPSK	50	25	21.87	0-1	1	
	1860	18700	20	QPSK	50	50	21.84	0-1	1	
	1860	18700	20	QPSK	100	0	21.92	0-1	1	
	1860	18700	20	16QAM	1	0	21.78	0-1	1	
	1860	18700	20	16QAM	1	50	21.87	0-1	1	
	1860	18700	20	16QAM	1	99	21.94	0-1	1	
	1860	18700	20	16QAM	50	0	20.96	0-2	2	
	1860	18700	20	16QAM	50	25	21.00	0-2	2	
	1860	18700	20	16QAM	50	50	20.93	0-2	2	
	1860	18700	20	16QAM	100	0	21.00	0-2	2	
	Mid	1880.0	18900	20	QPSK	1	0	22.94	0	0
		1880.0	18900	20	QPSK	1	50	22.97	0	0
		1880.0	18900	20	QPSK	1	99	22.88	0	0
		1880.0	18900	20	QPSK	50	0	22.00	0-1	1
1880.0		18900	20	QPSK	50	25	21.89	0-1	1	
1880.0		18900	20	QPSK	50	50	21.91	0-1	1	
1880.0		18900	20	QPSK	100	0	21.99	0-1	1	
1880.0		18900	20	16QAM	1	0	21.94	0-1	1	
1880.0		18900	20	16QAM	1	50	21.92	0-1	1	
1880.0		18900	20	16QAM	1	99	21.85	0-1	1	
1880.0		18900	20	16QAM	50	0	21.00	0-2	2	
1880.0		18900	20	16QAM	50	25	20.99	0-2	2	
1880.0		18900	20	16QAM	50	50	20.98	0-2	2	
1880.0		18900	20	16QAM	100	0	21.00	0-2	2	
High		1900	19100	20	QPSK	1	0	22.90	0	0
		1900	19100	20	QPSK	1	50	22.85	0	0
		1900	19100	20	QPSK	1	99	22.71	0	0
		1900	19100	20	QPSK	50	0	21.96	0-1	1
	1900	19100	20	QPSK	50	25	21.93	0-1	1	
	1900	19100	20	QPSK	50	50	21.83	0-1	1	
	1900	19100	20	QPSK	100	0	21.92	0-1	1	
	1900	19100	20	16QAM	1	0	21.95	0-1	1	
	1900	19100	20	16QAM	1	50	21.84	0-1	1	
	1900	19100	20	16QAM	1	99	21.74	0-1	1	
	1900	19100	20	16QAM	50	0	21.00	0-2	2	
	1900	19100	20	16QAM	50	25	20.99	0-2	2	
	1900	19100	20	16QAM	50	50	20.97	0-2	2	
	1900	19100	20	16QAM	100	0	20.99	0-2	2	



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Table 9-6
LTE Band 2 (PCS) Conducted Powers - 15 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1857.5	18675	15	QPSK	1	0	22.75	0	0
	1857.5	18675	15	QPSK	1	36	22.89	0	0
	1857.5	18675	15	QPSK	1	74	22.85	0	0
	1857.5	18675	15	QPSK	36	0	21.85	0-1	1
	1857.5	18675	15	QPSK	36	18	21.89	0-1	1
	1857.5	18675	15	QPSK	36	37	21.92	0-1	1
	1857.5	18675	15	QPSK	75	0	21.89	0-1	1
	1857.5	18675	15	16QAM	1	0	21.77	0-1	1
	1857.5	18675	15	16QAM	1	36	21.88	0-1	1
	1857.5	18675	15	16QAM	1	74	21.93	0-1	1
	1857.5	18675	15	16QAM	36	0	20.98	0-2	2
	1857.5	18675	15	16QAM	36	18	21.00	0-2	2
	1857.5	18675	15	16QAM	36	37	21.00	0-2	2
	1857.5	18675	15	16QAM	75	0	20.98	0-2	2
	Mid	1880.0	18900	15	QPSK	1	0	23.00	0
1880.0		18900	15	QPSK	1	36	22.98	0	0
1880.0		18900	15	QPSK	1	74	22.97	0	0
1880.0		18900	15	QPSK	36	0	22.00	0-1	1
1880.0		18900	15	QPSK	36	18	21.95	0-1	1
1880.0		18900	15	QPSK	36	37	21.96	0-1	1
1880.0		18900	15	QPSK	75	0	21.99	0-1	1
1880.0		18900	15	16QAM	1	0	22.00	0-1	1
1880.0		18900	15	16QAM	1	36	21.98	0-1	1
1880.0		18900	15	16QAM	1	74	21.99	0-1	1
1880.0		18900	15	16QAM	36	0	21.00	0-2	2
1880.0		18900	15	16QAM	36	18	20.93	0-2	2
1880.0		18900	15	16QAM	36	37	20.95	0-2	2
1880.0		18900	15	16QAM	75	0	20.94	0-2	2
High		1902.5	19125	15	QPSK	1	0	23.00	0
	1902.5	19125	15	QPSK	1	36	22.98	0	0
	1902.5	19125	15	QPSK	1	74	22.89	0	0
	1902.5	19125	15	QPSK	36	0	22.00	0-1	1
	1902.5	19125	15	QPSK	36	18	21.98	0-1	1
	1902.5	19125	15	QPSK	36	37	21.96	0-1	1
	1902.5	19125	15	QPSK	75	0	21.98	0-1	1
	1902.5	19125	15	16QAM	1	0	22.00	0-1	1
	1902.5	19125	15	16QAM	1	36	21.97	0-1	1
	1902.5	19125	15	16QAM	1	74	21.87	0-1	1
	1902.5	19125	15	16QAM	36	0	21.00	0-2	2
	1902.5	19125	15	16QAM	36	18	20.98	0-2	2
	1902.5	19125	15	16QAM	36	37	20.99	0-2	2
	1902.5	19125	15	16QAM	75	0	21.00	0-2	2

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

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1855	18650	10	QPSK	1	0	22.62	0	0
	1855	18650	10	QPSK	1	25	22.71	0	0
	1855	18650	10	QPSK	1	49	22.66	0	0
	1855	18650	10	QPSK	25	0	21.75	0-1	1
	1855	18650	10	QPSK	25	12	21.73	0-1	1
	1855	18650	10	QPSK	25	25	21.74	0-1	1
	1855	18650	10	QPSK	50	0	21.70	0-1	1
	1855	18650	10	16QAM	1	0	21.80	0-1	1
	1855	18650	10	16QAM	1	25	21.83	0-1	1
	1855	18650	10	16QAM	1	49	21.84	0-1	1
	1855	18650	10	16QAM	25	0	20.82	0-2	2
	1855	18650	10	16QAM	25	12	20.66	0-2	2
	1855	18650	10	16QAM	25	25	20.67	0-2	2
	1855	18650	10	16QAM	50	0	20.74	0-2	2
	Mid	1880.0	18900	10	QPSK	1	0	22.70	0
1880.0		18900	10	QPSK	1	25	22.64	0	0
1880.0		18900	10	QPSK	1	49	22.60	0	0
1880.0		18900	10	QPSK	25	0	21.63	0-1	1
1880.0		18900	10	QPSK	25	12	21.66	0-1	1
1880.0		18900	10	QPSK	25	25	21.67	0-1	1
1880.0		18900	10	QPSK	50	0	21.65	0-1	1
1880.0		18900	10	16QAM	1	0	21.51	0-1	1
1880.0		18900	10	16QAM	1	25	21.50	0-1	1
1880.0		18900	10	16QAM	1	49	21.55	0-1	1
1880.0		18900	10	16QAM	25	0	20.66	0-2	2
1880.0		18900	10	16QAM	25	12	20.70	0-2	2
1880.0		18900	10	16QAM	25	25	20.71	0-2	2
1880.0		18900	10	16QAM	50	0	20.61	0-2	2
High		1905	19150	10	QPSK	1	0	22.65	0
	1905	19150	10	QPSK	1	25	22.73	0	0
	1905	19150	10	QPSK	1	49	22.50	0	0
	1905	19150	10	QPSK	25	0	21.64	0-1	1
	1905	19150	10	QPSK	25	12	21.56	0-1	1
	1905	19150	10	QPSK	25	25	21.62	0-1	1
	1905	19150	10	QPSK	50	0	21.63	0-1	1
	1905	19150	10	16QAM	1	0	21.54	0-1	1
	1905	19150	10	16QAM	1	25	21.62	0-1	1
	1905	19150	10	16QAM	1	49	21.32	0-1	1
	1905	19150	10	16QAM	25	0	20.67	0-2	2
	1905	19150	10	16QAM	25	12	20.68	0-2	2
	1905	19150	10	16QAM	25	25	20.76	0-2	2
	1905	19150	10	16QAM	50	0	20.66	0-2	2





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

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]	
Low	1852.5	18625	5	QPSK	1	0	22.89	0	0	
	1852.5	18625	5	QPSK	1	12	22.72	0	0	
	1852.5	18625	5	QPSK	1	24	22.71	0	0	
	1852.5	18625	5	QPSK	12	0	21.94	0-1	1	
	1852.5	18625	5	QPSK	12	6	21.84	0-1	1	
	1852.5	18625	5	QPSK	12	13	21.75	0-1	1	
	1852.5	18625	5	QPSK	25	0	21.75	0-1	1	
	1852.5	18625	5	16-QAM	1	0	21.49	0-1	1	
	1852.5	18625	5	16-QAM	1	12	21.44	0-1	1	
	1852.5	18625	5	16-QAM	1	24	21.37	0-1	1	
	1852.5	18625	5	16-QAM	12	0	20.52	0-2	2	
	1852.5	18625	5	16-QAM	12	6	20.48	0-2	2	
	1852.5	18625	5	16-QAM	12	13	20.56	0-2	2	
	1852.5	18625	5	16-QAM	25	0	20.41	0-2	2	
	1880.0	18900	5	QPSK	1	0	22.78	0	0	
	1880.0	18900	5	QPSK	1	12	22.61	0	0	
	1880.0	18900	5	QPSK	1	24	22.60	0	0	
	1880.0	18900	5	QPSK	12	0	21.83	0-1	1	
	1880.0	18900	5	QPSK	12	6	21.73	0-1	1	
	1880.0	18900	5	QPSK	12	13	21.64	0-1	1	
1880.0	18900	5	QPSK	25	0	21.64	0-1	1		
1880.0	18900	5	16-QAM	1	0	21.60	0-1	1		
1880.0	18900	5	16-QAM	1	12	21.55	0-1	1		
1880.0	18900	5	16-QAM	1	24	21.48	0-1	1		
1880.0	18900	5	16-QAM	12	0	20.62	0-2	2		
1880.0	18900	5	16-QAM	12	6	20.58	0-2	2		
1880.0	18900	5	16-QAM	12	13	20.66	0-2	2		
1880.0	18900	5	16-QAM	25	0	20.51	0-2	2		
Mid	1907.5	19175	5	QPSK	1	0	22.67	0	0	
	1907.5	19175	5	QPSK	1	12	22.50	0	0	
	1907.5	19175	5	QPSK	1	24	22.49	0	0	
	1907.5	19175	5	QPSK	12	0	21.72	0-1	1	
	1907.5	19175	5	QPSK	12	6	21.62	0-1	1	
	1907.5	19175	5	QPSK	12	13	21.53	0-1	1	
	1907.5	19175	5	QPSK	25	0	21.53	0-1	1	
	1907.5	19175	5	16-QAM	1	0	21.71	0-1	1	
	1907.5	19175	5	16-QAM	1	12	21.66	0-1	1	
	1907.5	19175	5	16-QAM	1	24	21.59	0-1	1	
	1907.5	19175	5	16-QAM	12	0	20.72	0-2	2	
	1907.5	19175	5	16-QAM	12	6	20.68	0-2	2	
	1907.5	19175	5	16-QAM	12	13	20.76	0-2	2	
	1907.5	19175	5	16-QAM	25	0	20.60	0-2	2	
	High	1907.5	19175	5	QPSK	1	0	22.67	0	0
		1907.5	19175	5	QPSK	1	12	22.50	0	0
		1907.5	19175	5	QPSK	1	24	22.49	0	0
		1907.5	19175	5	QPSK	12	0	21.72	0-1	1
		1907.5	19175	5	QPSK	12	6	21.62	0-1	1
		1907.5	19175	5	QPSK	12	13	21.53	0-1	1
1907.5		19175	5	QPSK	25	0	21.53	0-1	1	
1907.5		19175	5	16-QAM	1	0	21.71	0-1	1	
1907.5		19175	5	16-QAM	1	12	21.66	0-1	1	
1907.5		19175	5	16-QAM	1	24	21.59	0-1	1	
1907.5		19175	5	16-QAM	12	0	20.72	0-2	2	
1907.5		19175	5	16-QAM	12	6	20.68	0-2	2	
1907.5		19175	5	16-QAM	12	13	20.76	0-2	2	
1907.5		19175	5	16-QAM	25	0	20.60	0-2	2	

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10 SYSTEM VERIFICATION

10.1 Tissue Verification

**Table 10-1
Measured Tissue Properties**

Calibrated for Tests Performed on:	Tissue Type	Tissue Temp During Calibration (C)	Measured Frequency (MHz)	Measured Conductivity, σ (S/m)	Measured Dielectric Constant, ϵ	TARGET Conductivity, σ (S/m)	TARGET Dielectric Constant, ϵ	% dev σ	% dev ϵ
7/24/2014	1750H	23.4	1710	1.320	40.046	1.348	40.142	-2.08%	-0.24%
			1750	1.359	39.861	1.371	40.079	-0.88%	-0.54%
			1790	1.399	39.679	1.394	40.016	0.36%	-0.84%
7/17/2014	1900H	23.0	1850	1.389	40.140	1.400	40.000	-0.79%	0.35%
			1880	1.422	40.014	1.400	40.000	1.57%	0.04%
			1910	1.455	39.872	1.400	40.000	3.93%	-0.32%
7/21/2014	1750B	22.4	1710	1.400	52.108	1.463	53.537	-4.31%	-2.67%
			1750	1.441	51.958	1.488	53.432	-3.16%	-2.76%
			1790	1.481	51.839	1.514	53.326	-2.18%	-2.79%
7/17/2014	1900B	23.2	1850	1.470	51.610	1.520	53.300	-3.29%	-3.17%
			1880	1.504	51.527	1.520	53.300	-1.05%	-3.33%
			1910	1.540	51.403	1.520	53.300	1.32%	-3.56%

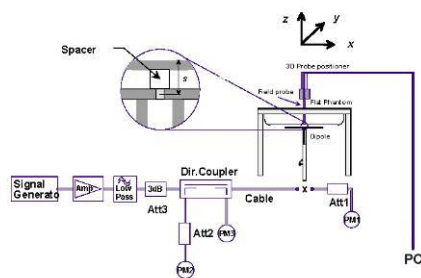
The above measured tissue parameters were used in the DASY software. The DASY software was used to perform interpolation to determine the dielectric parameters at the SAR test device frequencies (per KDB Publication 865664 and IEEE 1528-2013 6.6.1.2). The tissue parameters listed in the SAR test plots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

10.2 Test System Verification

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

**Table 10-2
System Verification Results**



System Verification TARGET & MEASURED												
SAR System #	Tissue Frequency (MHz)	Tissue Type	Date:	Amb. Temp (°C)	Liquid Temp (°C)	Input Power (W)	Dipole SN	Probe SN	Measured SAR _{1g} (W/kg)	1 W Target SAR _{1g} (W/kg)	1 W Normalized SAR _{1g} (W/kg)	Deviation _{1g} (%)
E	1750	HEAD	07/24/2014	24.3	23.5	0.100	1051	3914	3.560	36.200	35.600	-1.66%
D	1900	HEAD	07/17/2014	24.3	23.0	0.100	5d141	3022	3.900	40.100	39.000	-2.74%
H	1750	BODY	07/21/2014	23.4	22.4	0.100	1051	3319	3.680	37.400	36.800	-1.60%
K	1900	BODY	07/17/2014	24.4	23.2	0.100	5d141	3287	4.270	40.600	42.700	5.17%



**Figure 10-1
System Verification Setup Diagram**



**Figure 10-2
System Verification Setup Photo**

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11 SAR DATA SUMMARY

11.1 Standalone Head SAR Data

**Table 11-1
LTE Band 4 (AWS) Head SAR**

MEASUREMENT RESULTS																				
FREQUENCY		Mode	Bandwidth [MHz]	Cover Type	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Side	Test Position	Modulation	RB Size	RB Offset	Device Serial Number	Duty Cycle	SAR (1g) (W/kg)	Scaling Factor	Scaled SAR (1g) (W/kg)	Plot #	
MHz	Ch.																			
1732.50	20175	Md	LTE Band 4 (AWS)	20	Standard	23.0	22.94	-0.01	0	Right	Cheek	QPSK	1	50	32F89	1:1	0.108	1.014	0.110	
1732.50	20175	Md	LTE Band 4 (AWS)	20	Standard	22.0	21.77	0.01	1	Right	Cheek	QPSK	50	50	32F89	1:1	0.091	1.054	0.096	
1732.50	20175	Md	LTE Band 4 (AWS)	20	Standard	23.0	22.94	-0.01	0	Right	Tilt	QPSK	1	50	32F89	1:1	0.127	1.014	0.129	
1732.50	20175	Md	LTE Band 4 (AWS)	20	Standard	22.0	21.77	0.10	1	Right	Tilt	QPSK	50	50	32F89	1:1	0.107	1.054	0.113	
1732.50	20175	Md	LTE Band 4 (AWS)	20	Standard	23.0	22.94	0.07	0	Left	Cheek	QPSK	1	50	32F89	1:1	0.423	1.014	0.429	A1
1732.50	20175	Md	LTE Band 4 (AWS)	20	Wireless Charming	23.0	22.94	-0.09	0	Left	Cheek	QPSK	1	50	32F89	1:1	0.385	1.014	0.390	
1732.50	20175	Md	LTE Band 4 (AWS)	20	Standard	22.0	21.77	-0.04	1	Left	Cheek	QPSK	50	50	32F89	1:1	0.182	1.054	0.192	
1732.50	20175	Md	LTE Band 4 (AWS)	20	Standard	23.0	22.94	0.17	0	Left	Tilt	QPSK	1	50	32F89	1:1	0.114	1.014	0.116	
1732.50	20175	Md	LTE Band 4 (AWS)	20	Standard	22.0	21.77	0.10	1	Left	Tilt	QPSK	50	50	32F89	1:1	0.096	1.054	0.101	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population										Head 1.6 W/kg (mW/g) averaged over 1 gram										



**Table 11-2
LTE Band 2 (PCS) Head SAR**

MEASUREMENT RESULTS																				
FREQUENCY		Mode	Bandwidth [MHz]	Cover Type	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Side	Test Position	Modulation	RB Size	RB Offset	Device Serial Number	Duty Cycle	SAR (1g) (W/kg)	Scaling Factor	Scaled SAR (1g) (W/kg)	Plot #	
MHz	Ch.																			
1880.00	18900	Md	LTE Band 2 (PCS)	20	Standard	23.0	22.97	0.06	0	Right	Cheek	QPSK	1	50	32F89	1:1	0.085	1.007	0.086	
1880.00	18900	Md	LTE Band 2 (PCS)	20	Standard	22.0	22.00	0.15	1	Right	Cheek	QPSK	50	0	32F89	1:1	0.081	1.000	0.081	
1880.00	18900	Md	LTE Band 2 (PCS)	20	Standard	23.0	22.97	0.01	0	Right	Tilt	QPSK	1	50	32F89	1:1	0.059	1.007	0.059	
1880.00	18900	Md	LTE Band 2 (PCS)	20	Standard	22.0	22.00	0.03	1	Right	Tilt	QPSK	50	0	32F89	1:1	0.058	1.000	0.058	
1880.00	18900	Md	LTE Band 2 (PCS)	20	Standard	23.0	22.97	0.14	0	Left	Cheek	QPSK	1	50	32F89	1:1	0.167	1.007	0.168	A2
1880.00	18900	Md	LTE Band 2 (PCS)	20	Wireless Charming	23.0	22.97	0.06	0	Left	Cheek	QPSK	1	50	32F89	1:1	0.144	1.007	0.145	
1880.00	18900	Md	LTE Band 2 (PCS)	20	Standard	22.0	22.00	0.11	1	Left	Cheek	QPSK	50	0	32F89	1:1	0.157	1.000	0.157	
1880.00	18900	Md	LTE Band 2 (PCS)	20	Standard	23.0	22.97	0.05	0	Left	Tilt	QPSK	1	50	32F89	1:1	0.048	1.007	0.048	
1880.00	18900	Md	LTE Band 2 (PCS)	20	Standard	22.0	22.00	0.04	1	Left	Tilt	QPSK	50	0	32F89	1:1	0.046	1.000	0.046	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population										Head 1.6 W/kg (mW/g) averaged over 1 gram										

11.2 Standalone Body-Worn SAR Data

**Table 11-3
LTE Body-Worn SAR**

MEASUREMENT RESULTS																				
FREQUENCY		Mode	Bandwidth [MHz]	Cover Type	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Device Serial Number	Modulation	RB Size	RB Offset	Spacing	Side	Duty Cycle	SAR (1g) (W/kg)	Scaling Factor	Scaled SAR (1g) (W/kg)	Plot #	
MHz	Ch.																			
1732.50	20175	Md	LTE Band 4 (AWS)	20	Standard	23.0	22.94	0.00	0	32F89	QPSK	1	50	10 mm	back	1:1	0.227	1.014	0.230	A3
1732.50	20175	Md	LTE Band 4 (AWS)	20	Wireless Charming	23.0	22.94	0.01	0	32F89	QPSK	1	50	10 mm	back	1:1	0.172	1.014	0.174	
1732.50	20175	Md	LTE Band 4 (AWS)	20	Standard	22.0	21.77	0.09	1	32F89	QPSK	50	50	10 mm	back	1:1	0.202	1.054	0.213	
1880.00	18900	Md	LTE Band 2 (PCS)	20	Standard	23.0	22.97	0.05	0	32F89	QPSK	1	50	10 mm	back	1:1	0.236	1.007	0.238	A4
1880.00	18900	Md	LTE Band 2 (PCS)	20	Wireless Charming	23.0	22.97	-0.03	0	32F89	QPSK	1	50	10 mm	back	1:1	0.231	1.007	0.233	
1880.00	18900	Md	LTE Band 2 (PCS)	20	Standard	22.0	22.00	0.02	1	32F89	QPSK	50	0	10 mm	back	1:1	0.210	1.000	0.210	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population										Body 1.6 W/kg (mW/g) averaged over 1 gram										

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11.3 Standalone Wireless Router SAR Data

Table 11-4
LTE Band 4 (AWS) Hotspot SAR

MEASUREMENT RESULTS																				
FREQUENCY		Mode	Bandwidth [MHz]	Cover Type	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Device Serial Number	Modulation	RB Size	RB Offset	Spacing	Side	Duty Cycle	SAR (1g) (W/kg)	Scaling Factor	Scaled SAR (1g) (W/kg)	Plot #	
MHz	Ch.																			
1732.50	20175	Mid	LTE Band 4 (AWS)	20	Standard	23.0	22.94	0.00	0	32F89	QPSK	1	50	10 mm	back	1:1	0.227	1.014	0.230	A3
1732.50	20175	Mid	LTE Band 4 (AWS)	20	Wireless Characterization	23.0	22.94	0.01	0	32F89	QPSK	1	50	10 mm	back	1:1	0.172	1.014	0.174	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	Standard	22.0	21.77	0.09	1	32F89	QPSK	50	50	10 mm	back	1:1	0.202	1.054	0.213	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	Standard	23.0	22.94	0.02	0	32F89	QPSK	1	50	10 mm	front	1:1	0.132	1.014	0.134	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	Standard	22.0	21.77	0.12	1	32F89	QPSK	50	50	10 mm	front	1:1	0.107	1.054	0.113	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	Standard	23.0	22.94	0.01	0	32F89	QPSK	1	50	10 mm	bottom	1:1	0.002	1.014	0.002	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	Standard	22.0	21.77	0.14	1	32F89	QPSK	50	50	10 mm	bottom	1:1	0.001	1.054	0.001	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	Standard	23.0	22.94	0.03	0	32F89	QPSK	1	50	10 mm	right	1:1	0.092	1.014	0.093	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	Standard	22.0	21.77	-0.04	1	32F89	QPSK	50	50	10 mm	right	1:1	0.080	1.054	0.084	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population									Body 1.6 W/kg (mW/g) averaged over 1 gram											



Table 11-5
LTE Band 2 (PCS) Hotspot SAR

MEASUREMENT RESULTS																				
FREQUENCY		Mode	Bandwidth [MHz]	Cover Type	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Device Serial Number	Modulation	RB Size	RB Offset	Spacing	Side	Duty Cycle	SAR (1g) (W/kg)	Scaling Factor	Scaled SAR (1g) (W/kg)	Plot #	
MHz	Ch.																			
1880.00	18900	Mid	LTE Band 2 (PCS)	20	Standard	23.0	22.97	0.05	0	32F89	QPSK	1	50	10 mm	back	1:1	0.236	1.007	0.238	A4
1880.00	18900	Mid	LTE Band 2 (PCS)	20	Wireless Characterization	23.0	22.97	-0.03	0	32F89	QPSK	1	50	10 mm	back	1:1	0.231	1.007	0.233	
1880.00	18900	Mid	LTE Band 2 (PCS)	20	Standard	22.0	22.00	0.02	1	32F89	QPSK	50	0	10 mm	back	1:1	0.210	1.000	0.210	
1880.00	18900	Mid	LTE Band 2 (PCS)	20	Standard	23.0	22.97	0.06	0	32F89	QPSK	1	50	10 mm	front	1:1	0.040	1.007	0.040	
1880.00	18900	Mid	LTE Band 2 (PCS)	20	Standard	22.0	22.00	-0.03	1	32F89	QPSK	50	0	10 mm	front	1:1	0.035	1.000	0.035	
1880.00	18900	Mid	LTE Band 2 (PCS)	20	Standard	23.0	22.97	0.09	0	32F89	QPSK	1	50	10 mm	bottom	1:1	0.006	1.007	0.006	
1880.00	18900	Mid	LTE Band 2 (PCS)	20	Standard	22.0	22.00	0.02	1	32F89	QPSK	50	0	10 mm	bottom	1:1	0.004	1.000	0.004	
1880.00	18900	Mid	LTE Band 2 (PCS)	20	Standard	23.0	22.97	0.00	0	32F89	QPSK	1	50	10 mm	right	1:1	0.201	1.007	0.202	
1880.00	18900	Mid	LTE Band 2 (PCS)	20	Standard	22.0	22.00	0.04	1	32F89	QPSK	50	0	10 mm	right	1:1	0.176	1.000	0.176	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population									Body 1.6 W/kg (mW/g) averaged over 1 gram											

11.4 SAR Test Notes

General Notes:



- The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2003, and FCC KDB Publication 447498 D01v05.
- Batteries are fully charged at the beginning of the SAR measurements.
- Liquid tissue depth was at least 15.0 cm for all frequencies.
- 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.
- SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01v05.
- Device was tested using a fixed spacing for body-worn accessory testing. A separation distance of 10 mm was considered because the manufacturer has determined that there will be body-worn accessories available in the marketplace for users to support this separation distance.
- Per FCC KDB Publication 648474 D04v01, body-worn SAR was evaluated without a headset connected to the device. Since the standalone reported body-worn SAR was ≤ 1.2 W/kg, no additional body-worn SAR evaluations using a headset cable were required.
- Per FCC KDB 865664 D01 v01, variability SAR tests were not required since the measured SAR results for all frequency bands were < 0.8 W/kg. Please see Section 13 for variability analysis.

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9. During SAR Testing for the Wireless Router conditions per FCC KDB Publication 941225 D06v01, the actual Portable Hotspot operation (with actual simultaneous transmission of a transmitter with WIFI) was not activated (See Section 6.7 for more details).
10. Per FCC KDB Publication 648474 D04v01r01, this device is considered a "phablet" since the diagonal distance is greater than 160 mm and less than 200 mm. Therefore, hand SAR tests are required when hotspot mode does not apply or if hotspot 1g SAR > 1.2 W/kg. Extremity SAR was not evaluated for the licensed transmitter since Hotspot SAR is < 1.2 W/kg.
11. Per FCC KDB Publication 648474 D04, SAR was measured using the standard battery cover and then repeated with the wireless charging battery cover for the configuration with the highest reported SAR for each wireless technology, frequency band, operating mode, and exposure condition. Since reported SAR did not exceed 1.2 W/kg, additional testing with the wireless charging battery cover was not required.

LTE Notes:

1. LTE Considerations: LTE test configurations are determined according to SAR Evaluation Considerations for LTE Devices in FCC KDB Publication 941225 D05v02r01. The general test procedures used for testing can be found in Section 8.3.4.
2. MPR is permanently implemented for this device by the manufacturer. The specific manufacturer target MPR is indicated alongside the SAR results. MPR is enabled for this device, according to 3GPP TS36.101 Section 6.2.3 – 6.2.5 under Table 6.2.3-1.
3. A-MPR was disabled for all SAR tests by setting NS=01 on the base station simulator. SAR tests were performed with the same number of RB and RB offsets transmitting on all TTI frames (maximum TTI).

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12 FCC MULTI-TX AND ANTENNA SAR CONSIDERATIONS

12.1 Introduction

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

12.2 Simultaneous Transmission Procedures

This device contains transmitters that may operate simultaneously. Therefore simultaneous transmission analysis is required. Per FCC KDB 447498 D01v05 IV.C.1.iii and IEEE 1528-2013 Section 6.3.4.1.2, simultaneous transmission SAR test exclusion may be applied when the sum of the 1-g SAR for all the simultaneous transmitting antennas in a specific a physical test configuration is ≤ 1.6 W/kg. When standalone SAR is not required to be measured, per FCC KDB 447498 D01v05 4.3.2.2), the following equation must be used to estimate the standalone 1g SAR for simultaneous transmission assessment involving that transmitter.

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

**Table 12-1
Estimated SAR**

Mode	Frequency	Maximum Allowed Power	Separation Distance (Body)	Estimated SAR (Body)
	[MHz]	[dBm]	[mm]	[W/kg]
Bluetooth	2441	9.50	10	0.187

Notes:

- Held-to ear configurations are not applicable to Bluetooth operations and therefore were not considered for simultaneous transmission. Per KDB Publication 447498 D01v05, the maximum power of the channel was rounded to the nearest mW before calculation.
- Main antenna SAR testing was not required per FCC KDB 648474 for extremity exposure conditions. Therefore, no further analysis was required to determine that possible simultaneous scenarios would not exceed the SAR limit.

Please see RF Exposure Technical Report 0Y1307161255-R1.A3L with simultaneous SAR assessments for the other combinations not referred to in these tables. This report only contains the combinations applicable to this permissive change.

12.3 Head SAR Simultaneous Transmission Analysis



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

Simult Tx	Configuration	LTE Band 4 (AWS) SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	LTE Band 2 (PCS) SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.110	0.190	0.300	Head SAR	Right Cheek	0.086	0.190	0.276
	Right Tilt	0.129	0.201	0.330		Right Tilt	0.059	0.201	0.260
	Left Cheek	0.429	0.322	0.751		Left Cheek	0.168	0.322	0.490
	Left Tilt	0.116	0.288	0.404		Left Tilt	0.048	0.288	0.336

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

Simult Tx	Configuration	LTE Band 4 (AWS) SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	LTE Band 2 (PCS) SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Head SAR	Right Cheek	0.110	0.057	0.167	Head SAR	Right Cheek	0.086	0.057	0.143
	Right Tilt	0.129	0.042	0.171		Right Tilt	0.059	0.042	0.101
	Left Cheek	0.429	0.206	0.635		Left Cheek	0.168	0.206	0.374
	Left Tilt	0.116	0.104	0.220		Left Tilt	0.048	0.104	0.152

The worst case 5 GHz WLAN reported SAR for each head configuration was used for SAR summation, regardless of whether the WLAN channel has WIFI Hotspot capability. Therefore, the summations above represent the absolute worst cases for simultaneous transmission with 5 GHz WLAN

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12.4 Body-Worn Simultaneous Transmission Analysis

Table 12-4
Simultaneous Transmission Scenario with 2.4 GHz WLAN (Body-Worn at 1.0 cm)

Configuration	Mode	LTE SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Back Side	LTE Band 4 (AWS)	0.230	0.268	0.498
Back Side	LTE Band 2 (PCS)	0.238	0.268	0.506

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

Configuration	Mode	LTE SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Back Side	LTE Band 4 (AWS)	0.230	0.218	0.448
Back Side	LTE Band 2 (PCS)	0.238	0.218	0.456

The worst case 5 GHz WLAN reported SAR for each bodyworn configuration was used for SAR summation, regardless of whether the WLAN channel has WIFI Hotspot capability. Therefore, the summations above represent the absolute worst cases for simultaneous transmission with 5 GHz WLAN

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

Configuration	Mode	LTE SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)
Back Side	LTE Band 4 (AWS)	0.230	0.187	0.417
Back Side	LTE Band 2 (PCS)	0.238	0.187	0.425

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

12.5 Hotspot SAR Simultaneous Transmission Analysis



Per FCC KDB Publication 941225 D06v01, the devices edges with antennas more than 2.5 cm from edge are not required to be evaluated for SAR (“-”).

Table 12-7
Simultaneous Transmission Scenario (2.4 GHz Hotspot at 1.0 cm)

Simult Tx	Configuration	LTE Band 4 (AWS) SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	LTE Band 2 (PCS) SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.230	0.268	0.498	Body SAR	Back	0.238	0.268	0.506
	Front	0.134	0.093	0.227		Front	0.040	0.093	0.133
	Top	-	0.075	0.075		Top	-	0.075	0.075
	Bottom	0.002	-	0.002		Bottom	0.006	-	0.006
	Right	0.093	0.079	0.172		Right	0.202	0.079	0.281
	Left	-	-	0.000		Left	-	-	0.000

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

Simult Tx	Configuration	LTE Band 4 (AWS) SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	LTE Band 2 (PCS) SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
Body SAR	Back	0.230	0.192	0.422	Body SAR	Back	0.238	0.192	0.430
	Front	0.134	0.027	0.161		Front	0.040	0.027	0.067
	Top	-	0.071	0.071		Top	-	0.071	0.071
	Bottom	0.002	-	0.002		Bottom	0.006	-	0.006
	Right	0.093	0.146	0.239		Right	0.202	0.146	0.348
	Left	-	-	0.000		Left	-	-	0.000

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12.6 SVLTE Simultaneous Transmission Analysis

Table 12-9
Simultaneous Transmission Scenario with 2.4 GHz WLAN (Held to Ear)

Simult Tx	Configuration	Cell. CDMA SAR (W/kg)	LTE Band 4 (AWS) SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)		Simult Tx	Configuration	PCS CDMA SAR (W/kg)	LTE Band 4 (AWS) SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3			1	2	3	1+2	1+2+3
Head SAR	Right Cheek	0.244	0.110	0.190	0.354	0.544	Head SAR	Right Cheek	0.149	0.110	0.190	0.259	0.449
	Right Tilt	0.133	0.129	0.201	0.262	0.463		Right Tilt	0.159	0.129	0.201	0.288	0.489
	Left Cheek	0.246	0.429	0.322	0.675	0.997		Left Cheek	0.340	0.429	0.322	0.769	1.091
	Left Tilt	0.147	0.116	0.288	0.263	0.551		Left Tilt	0.126	0.116	0.288	0.242	0.530
Simult Tx	Configuration	Cell. CDMA SAR (W/kg)	LTE Band 2 (PCS) SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)		Simult Tx	Configuration	PCS CDMA SAR (W/kg)	LTE Band 2 (PCS) SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3			1	2	3	1+2	1+2+3
Head SAR	Right Cheek	0.244	0.086	0.190	0.330	0.520	Head SAR	Right Cheek	0.149	0.086	0.190	0.235	0.425
	Right Tilt	0.133	0.059	0.201	0.192	0.393		Right Tilt	0.159	0.059	0.201	0.218	0.419
	Left Cheek	0.246	0.168	0.322	0.414	0.736		Left Cheek	0.340	0.168	0.322	0.508	0.830
	Left Tilt	0.147	0.048	0.288	0.195	0.483		Left Tilt	0.126	0.048	0.288	0.174	0.462

Table 12-10
Simultaneous Transmission Scenario with 5 GHz WLAN (Held to Ear)

Simult Tx	Configuration	Cell. CDMA SAR (W/kg)	LTE Band 4 (AWS) SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)		Simult Tx	Configuration	PCS CDMA SAR (W/kg)	LTE Band 4 (AWS) SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3			1	2	3	1+2	1+2+3
Head SAR	Right Cheek	0.244	0.110	0.057	0.354	0.411	Head SAR	Right Cheek	0.149	0.110	0.057	0.259	0.316
	Right Tilt	0.133	0.129	0.042	0.262	0.304		Right Tilt	0.159	0.129	0.042	0.288	0.330
	Left Cheek	0.246	0.429	0.206	0.675	0.881		Left Cheek	0.340	0.429	0.206	0.769	0.975
	Left Tilt	0.147	0.116	0.104	0.263	0.367		Left Tilt	0.126	0.116	0.104	0.242	0.346
Simult Tx	Configuration	Cell. CDMA SAR (W/kg)	LTE Band 2 (PCS) SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)		Simult Tx	Configuration	PCS CDMA SAR (W/kg)	LTE Band 2 (PCS) SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3			1	2	3	1+2	1+2+3
Head SAR	Right Cheek	0.244	0.086	0.057	0.330	0.387	Head SAR	Right Cheek	0.149	0.086	0.057	0.235	0.292
	Right Tilt	0.133	0.059	0.042	0.192	0.234		Right Tilt	0.159	0.059	0.042	0.218	0.260
	Left Cheek	0.246	0.168	0.206	0.414	0.620		Left Cheek	0.340	0.168	0.206	0.508	0.714
	Left Tilt	0.147	0.048	0.104	0.195	0.299		Left Tilt	0.126	0.048	0.104	0.174	0.278

The worst case 5 GHz WLAN reported SAR for each head configuration was used for SAR summation, regardless of whether the WLAN channel has WIFI Hotspot capability. Therefore, the summations above represent the absolute worst cases for simultaneous transmission with 5 GHz WLAN

Table 12-11
Simultaneous Transmission Scenario with 2.4 GHz WLAN (Body-Worn at 1.0 cm)

Configuration	Mode	CDMA SAR (W/kg)	LTE Band 4 (AWS) SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3
Back Side	Cell. CDMA	0.551	0.230	0.268	0.781	1.049
Back Side	PCS CDMA	0.614	0.230	0.268	0.844	1.112
Configuration	Mode	CDMA SAR (W/kg)	LTE Band 2 (PCS) SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3
Back Side	Cell. CDMA	0.551	0.238	0.268	0.789	1.057
Back Side	PCS CDMA	0.614	0.238	0.268	0.852	1.120



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

Configuration	Mode	CDMA SAR (W/kg)	LTE Band 4 (AWS) SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3
Back Side	Cell. CDMA	0.551	0.230	0.218	0.781	0.999
Back Side	PCS CDMA	0.614	0.230	0.218	0.844	1.062

Configuration	Mode	CDMA SAR (W/kg)	LTE Band 2 (PCS) SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3
Back Side	Cell. CDMA	0.551	0.238	0.218	0.789	1.007
Back Side	PCS CDMA	0.614	0.238	0.218	0.852	1.070

The worst case 5 GHz WLAN reported SAR for each bodyworn configuration was used for SAR summation, regardless of whether the WLAN channel has WIFI Hotspot capability. Therefore, the summations above represent the absolute worst cases for simultaneous transmission with 5 GHz WLAN

Table 12-13
Simultaneous Transmission Scenario with Bluetooth (Body-Worn at 1.0 cm)

Configuration	Mode	CDMA SAR (W/kg)	LTE Band 4 (AWS) SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3
Back Side	Cell. CDMA	0.551	0.230	0.187	0.781	0.968
Back Side	PCS CDMA	0.614	0.230	0.187	0.844	1.031

Configuration	Mode	CDMA SAR (W/kg)	LTE Band 2 (PCS) SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	
		1	2	3	1+2	1+2+3
Back Side	Cell. CDMA	0.551	0.238	0.187	0.789	0.976
Back Side	PCS CDMA	0.614	0.238	0.187	0.852	1.039

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

Table 12-14
Simultaneous Transmission Scenario with 2.4 GHz WLAN (Hotspot at 1.0 cm)

Simult Tx	Configuration	Cell. CDMA SAR (W/kg)	LTE Band 4 (AWS) SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	PCS CDMA SAR (W/kg)	LTE Band 4 (AWS) SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3			1	2	3	1+2+3
Body SAR	Back	0.551	0.230	0.268	1.049	Body SAR	Back	0.614	0.230	0.268	1.112
	Front	0.273	0.134	0.093	0.500		Front	0.779	0.134	0.093	1.006
	Top	-	-	0.075	0.075		Top	-	-	0.075	0.075
	Bottom	0.287	0.002	-	0.289		Bottom	0.536	0.002	-	0.538
	Right	0.156	0.093	0.079	0.328		Right	0.077	0.093	0.079	0.249
	Left	0.403	-	-	0.403		Left	0.224	-	-	0.224

Simult Tx	Configuration	Cell. CDMA SAR (W/kg)	LTE Band 2 (PCS) SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	PCS CDMA SAR (W/kg)	LTE Band 2 (PCS) SAR (W/kg)	2.4 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3			1	2	3	1+2+3
Body SAR	Back	0.551	0.238	0.268	1.057	Body SAR	Back	0.614	0.238	0.268	1.120
	Front	0.273	0.040	0.093	0.406		Front	0.779	0.040	0.093	0.912
	Top	-	-	0.075	0.075		Top	-	-	0.075	0.075
	Bottom	0.287	0.006	-	0.293		Bottom	0.536	0.006	-	0.542
	Right	0.156	0.202	0.079	0.437		Right	0.077	0.202	0.079	0.358
	Left	0.403	-	-	0.403		Left	0.224	-	-	0.224





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Table 12-15
Simultaneous Transmission Scenario with 5 GHz WLAN (Hotspot at 1.0 cm)

Simult Tx	Configuration	Cell. CDMA SAR (W/kg)	LTE Band 4 (AWS) SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	PCS CDMA SAR (W/kg)	LTE Band 4 (AWS) SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3			1	2	3	1+2+3
Body SAR	Back	0.551	0.230	0.192	0.973	Body SAR	Back	0.614	0.230	0.192	1.036
	Front	0.273	0.134	0.027	0.434		Front	0.779	0.134	0.027	0.940
	Top	-	-	0.071	0.071		Top	-	-	0.071	0.071
	Bottom	0.287	0.002	-	0.289		Bottom	0.536	0.002	-	0.538
	Right	0.156	0.093	0.146	0.395		Right	0.077	0.093	0.146	0.316
	Left	0.403	-	-	0.403		Left	0.224	-	-	0.224
Simult Tx	Configuration	Cell. CDMA SAR (W/kg)	LTE Band 2 (PCS) SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)	Simult Tx	Configuration	PCS CDMA SAR (W/kg)	LTE Band 2 (PCS) SAR (W/kg)	5 GHz WLAN SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3			1	2	3	1+2+3
Body SAR	Back	0.551	0.238	0.192	0.981	Body SAR	Back	0.614	0.238	0.192	1.044
	Front	0.273	0.040	0.027	0.340		Front	0.779	0.040	0.027	0.846
	Top	-	-	0.071	0.071		Top	-	-	0.071	0.071
	Bottom	0.287	0.006	-	0.293		Bottom	0.536	0.006	-	0.542
	Right	0.156	0.202	0.146	0.504		Right	0.077	0.202	0.146	0.425
	Left	0.403	-	-	0.403		Left	0.224	-	-	0.224

12.7 Simultaneous Transmission Conclusion

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

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13 SAR MEASUREMENT VARIABILITY

13.1 Measurement Variability

Per FCC KDB Publication 865664 D01v01r01, SAR measurement variability is assessed for each frequency band when measured 1g SAR is > 0.80 W/kg. Since all measured SAR for this device is < 0.80 W/kg, SAR measurement variability was not assessed.

13.2 Measurement Uncertainty



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

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14 EQUIPMENT LIST

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	E8257D	(250kHz-20GHz) Signal Generator	4/15/2014	Annual	4/15/2015	MY45470194
Agilent	8594A	(9kHz-2.9GHz) Spectrum Analyzer	N/A	N/A	N/A	3051A00187
Agilent	E4438C	ESG Vector Signal Generator	4/1/2014	Annual	4/1/2015	MY47270002
Agilent	N9020A	MXA Signal Analyzer	10/29/2013	Annual	10/29/2014	US46470561
Agilent	N5182A	MXG Vector Signal Generator	4/15/2014	Annual	4/15/2015	MY47420651
Agilent	8753ES	S-Parameter Network Analyzer	10/29/2013	Annual	10/29/2014	US39170122
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	433977
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	433978
Anritsu	ML2495A	Power Meter	10/31/2013	Annual	10/31/2014	1039008
Anritsu	ML2469A	Power Meter	3/14/2014	Annual	3/14/2015	1306009
Anritsu	MA2411B	Pulse Power Sensor	11/14/2013	Annual	11/14/2014	1126066
Anritsu	MA2411B	Pulse Power Sensor	3/25/2014	Annual	3/25/2015	1207470
Anritsu	MT8820C	Radio Communication Analyzer	12/12/2013	Annual	12/12/2014	6201300731
Anritsu	MA24106A	USB Power Sensor	1/3/2014	Annual	1/3/2015	1349509
Anritsu	MA24106A	USB Power Sensor	1/3/2014	Annual	1/3/2015	1349514
COMTech	AR85729-5	Solid State Amplifier	CBT	N/A	CBT	M155A00-009
Fisher Scientific	15-077-960	Digital Thermometer	12/4/2013	Biennial	12/4/2015	130764551
Fisher Scientific	15-077-960	Digital Thermometer	12/4/2013	Biennial	12/4/2015	130764558
Fisher Scientific	15-078J	Long Stem Thermometer	10/30/2012	Biennial	10/30/2014	122626059
Fisher Scientific	15-078J	Long Stem Thermometer	1/7/2013	Biennial	1/7/2015	130018204
Gigatronics	80701A	(0.05-18GHz) Power Sensor	10/30/2013	Annual	10/30/2014	1833460
Gigatronics	8651A	Universal Power Meter	10/30/2013	Annual	10/30/2014	8650319
MCL	BW-N6W5+	6dB Attenuator	CBT	N/A	CBT	1139
MiniCircuits	VLF-6000+	Low Pass Filter	CBT	N/A	CBT	N/A
MiniCircuits	SLP-2400+	Low Pass Filter	CBT	N/A	CBT	R8979500903
Mini-Circuits	BW-N20W5+	DC to 18 GHz Precision Fixed 20 dB Attenuator	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-2950+	Low Pass Filter DC to 2700 MHz	CBT	N/A	CBT	N/A
Mini-Circuits	BW-N20W5	Power Attenuator	CBT	N/A	CBT	1226
Mitutoyo	CD-6"CSX	Digital Caliper	5/8/2014	Biennial	5/8/2016	13264165
Narda	4014C-6	4 - 8 GHz SMA 6 dB Directional Coupler	CBT	N/A	CBT	N/A
Narda	BW-S3W2	Attenuator (3dB)	CBT	N/A	CBT	120
Pasternack	PE2209-10	Bidirectional Coupler	CBT	N/A	CBT	N/A
Rohde & Schwarz	CMU200	Base Station Simulator	6/6/2014	Annual	6/6/2015	109892
Rohde & Schwarz	NRVD	Dual Channel Power Meter	10/12/2012	Biennial	10/12/2014	101695
Rohde & Schwarz	NRV-Z32	Peak Power Sensor	10/12/2012	Biennial	10/12/2014	836019/013
Rohde & Schwarz	CMW500	Radio Communication Tester	2/20/2014	Annual	2/20/2015	128633
Rohde & Schwarz	SME06	Signal Generator	10/30/2013	Annual	10/30/2014	832026
Rohde & Schwarz	NRVS	Single Channel Power Meter	10/31/2013	Annual	10/31/2014	835360/0079
Seekonk	NC-100	Torque Wrench	3/18/2014	Biennial	3/18/2016	22313
Seekonk	NC-100	Torque Wrench	3/18/2014	Biennial	3/18/2016	N/A
SPEAG	D1750V2	1750 MHz SAR Dipole	4/10/2014	Annual	4/10/2015	1051
SPEAG	D1900V2	1900 MHz SAR Dipole	4/9/2014	Annual	4/9/2015	5d141
SPEAG	DAE4	Dasy Data Acquisition Electronics	8/21/2013	Annual	8/21/2014	1322
SPEAG	DAE4	Dasy Data Acquisition Electronics	11/19/2013	Annual	11/19/2014	1333
SPEAG	DAE4	Dasy Data Acquisition Electronics	4/11/2014	Annual	4/11/2015	1368
SPEAG	DAE4	Dasy Data Acquisition Electronics	11/19/2013	Annual	11/19/2014	1408
SPEAG	DAK-3.5	Dielectric Assessment Kit	5/6/2014	Annual	5/6/2015	1070
SPEAG	DAK-3.5	Dielectric Assessment Kit	11/13/2013	Annual	11/13/2014	1091
SPEAG	ES3DV2	SAR Probe	8/22/2013	Annual	8/22/2014	3022
SPEAG	ES3DV3	SAR Probe	11/20/2013	Annual	11/20/2014	3287
SPEAG	ES3DV3	SAR Probe	4/17/2014	Annual	4/17/2015	3319
SPEAG	EX3DV4	SAR Probe	10/23/2013	Annual	10/23/2014	3914

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



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MEASUREMENT UNCERTAINTIES

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

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



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16 CONCLUSION

16.1 Measurement Conclusion



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

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



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- [28] FCC General RF Exposure Guidance and SAR Procedures for Dongles, KDB Publication 447498, D01-D02
- [29] Anexo à Resolução No. 533, de 10 de Setembro de 2009.
- [30] IEC 62209-2, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz), Mar. 2010.

FCC ID: A3LSMN900R4		SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: OY1407221438.A3L	Test Dates: 07/17/14 - 07/24/14	DUT Type: Portable Handset		Page 37 of 37

APPENDIX A: SAR TEST DATA

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSMN900R4; Type: Portable Handset; Serial: 32F89

Communication System: UID 0, LTE Band 4 (AWS); Frequency: 1732.5 MHz; Duty Cycle: 1:1
Medium: 1750 Head Medium parameters used (interpolated):
 $f = 1732.5 \text{ MHz}$; $\sigma = 1.342 \text{ S/m}$; $\epsilon_r = 39.942$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Left Section

Test Date: 07-24-2014; Ambient Temp: 24.3°C; Tissue Temp: 23.5°C

Probe: EX3DV4 - SN3914; ConvF(7.99, 7.99, 7.99); Calibrated: 10/23/2013;
Sensor-Surface: 2mm (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 (8); SEMCAD X Version 14.6.10 (7164)

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

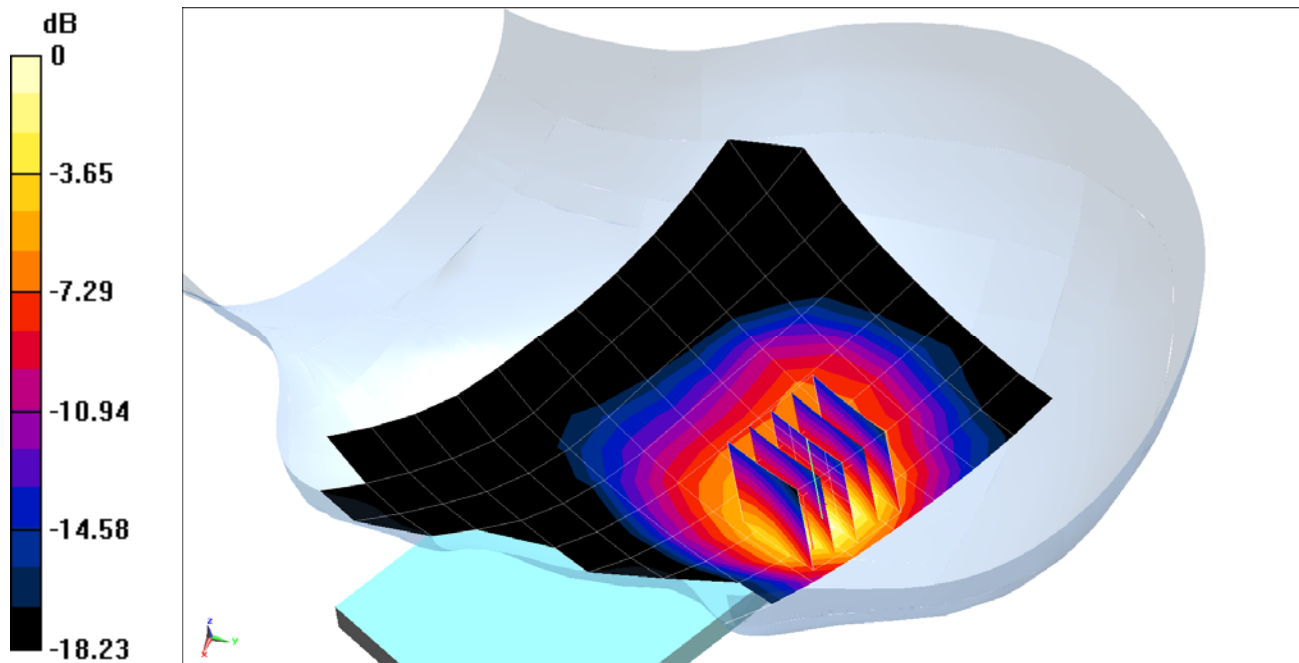
Area Scan (9x15x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

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

Reference Value = 20.042 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 0.750 W/kg

SAR(1 g) = 0.423 W/kg



0 dB = 0.544 W/kg = -2.64 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSMN900R4; Type: Portable Handset; Serial: 32F89

Communication System: UID 0, LTE Band 2 (PCS); Frequency: 1880 MHz; Duty Cycle: 1:1

Medium: 1900 Head Medium parameters used:

$f = 1880 \text{ MHz}$; $\sigma = 1.422 \text{ S/m}$; $\epsilon_r = 40.014$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Left Section

Test Date: 07-17-2014; Ambient Temp: 24.3°C; Tissue Temp: 23.0°C

Probe: ES3DV2 - SN3022; ConvF(5.03, 5.03, 5.03); Calibrated: 8/22/2013;

Sensor-Surface: 3mm (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 (8); SEMCAD X Version 14.6.10 (7164)

**Mode: LTE Band 2 (PCS), Left Head, Cheek, Mid.ch, Standard Cover
QPSK, 20 MHz Bandwidth, 1 RB, 50 RB Offset**

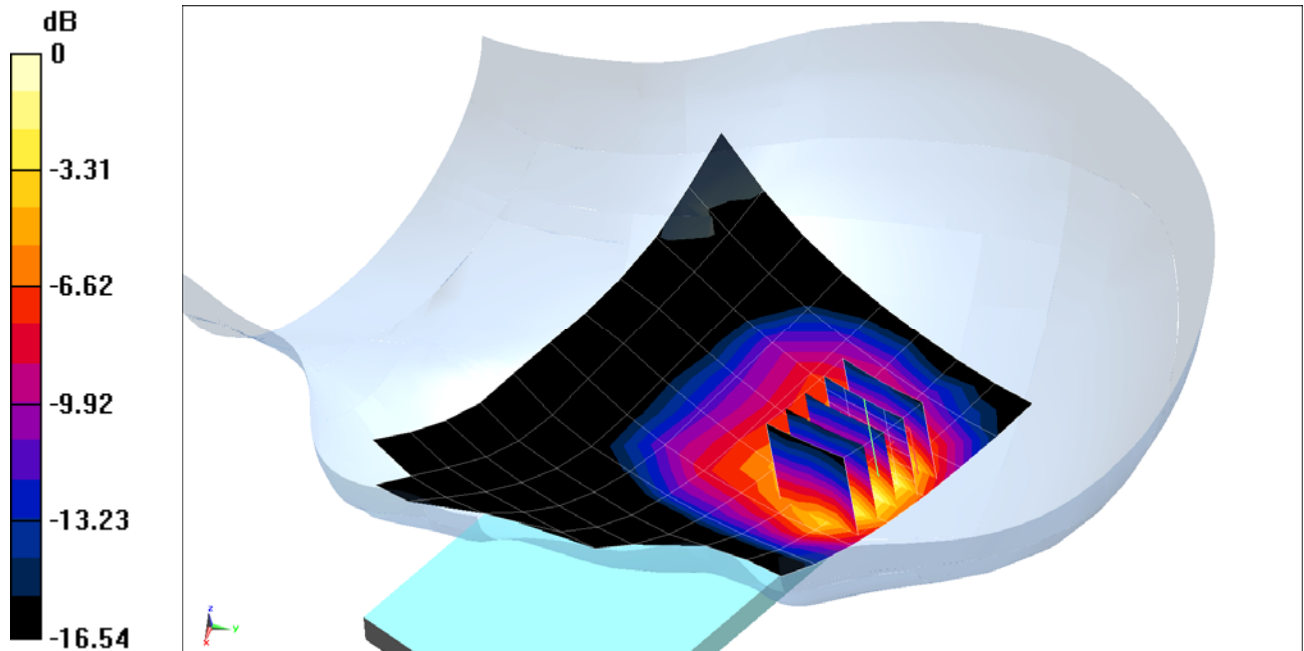
Area Scan (9x14x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 12.027 V/m; Power Drift = 0.14 dB

Peak SAR (extrapolated) = 0.304 W/kg

SAR(1 g) = 0.167 W/kg



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

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSMN900R4; Type: Portable Handset; Serial: 32F89

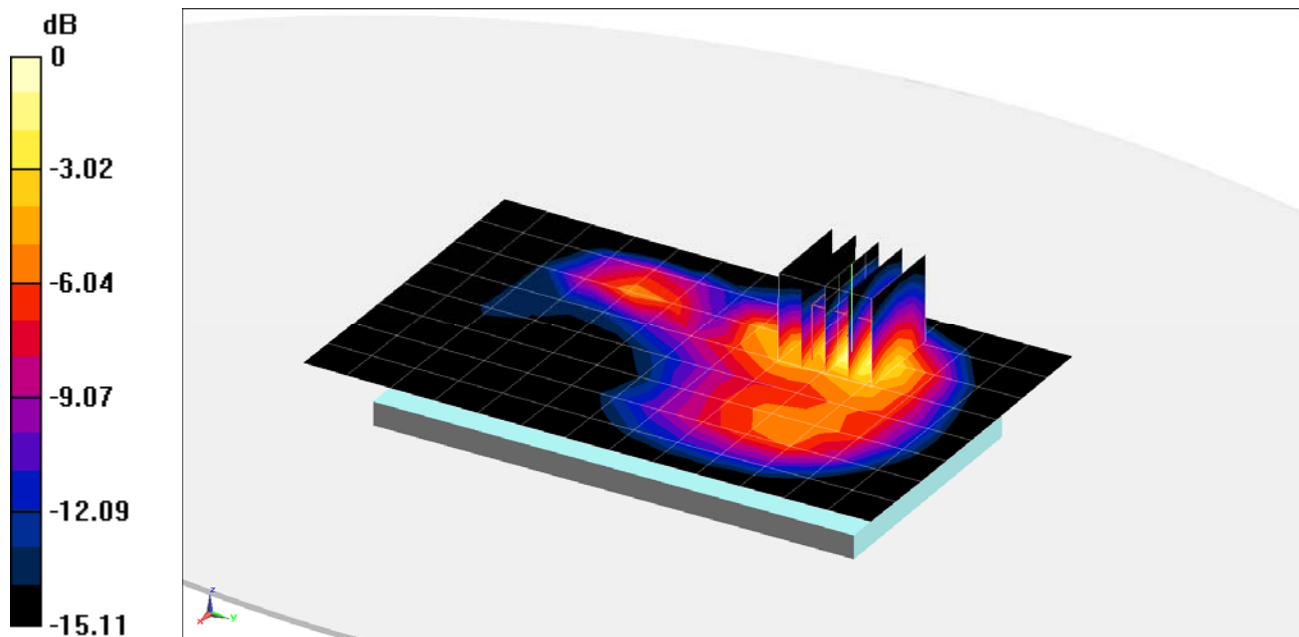
Communication System: UID 0, LTE Band 4 (AWS); Frequency: 1732.5 MHz; Duty Cycle: 1:1
Medium: 1750 Body Medium parameters used (interpolated):
 $f = 1732.5 \text{ MHz}$; $\sigma = 1.423 \text{ S/m}$; $\epsilon_r = 52.024$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-21-2014; Ambient Temp: 23.4°C; Tissue Temp: 22.4°C

Probe: ES3DV3 - SN3319; ConvF(4.85, 4.85, 4.85); Calibrated: 4/17/2014;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1368; Calibrated: 4/11/2014
Phantom: ELI left; Type: QDOVA002AA; Serial: TP:1202
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7164)

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

Area Scan (9x14x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 13.801 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 0.450 W/kg
SAR(1 g) = 0.227 W/kg



0 dB = 0.298 W/kg = -5.26 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSMN900R4; Type: Portable Handset; Serial: 32F89

Communication System: UID 0, LTE Band 2 (PCS); Frequency: 1880 MHz; Duty Cycle: 1:1

Medium: 1900 Body Medium parameters used:

$f = 1880 \text{ MHz}$; $\sigma = 1.504 \text{ S/m}$; $\epsilon_r = 51.527$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-17-2014; Ambient Temp: 24.4°C; Tissue Temp: 23.2°C

Probe: ES3DV3 - SN3287; ConvF(4.67, 4.67, 4.67); Calibrated: 11/20/2013;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1408; Calibrated: 11/19/2013

Phantom: ELI v5.0; Type: QDOVA001BB; Serial: 1229

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7164)

**Mode: LTE Band 2 (PCS), Body SAR, Back Side, Mid.ch, Standard Cover
20 MHz Bandwidth, QPSK, 1 RB, 50 RB Offset**

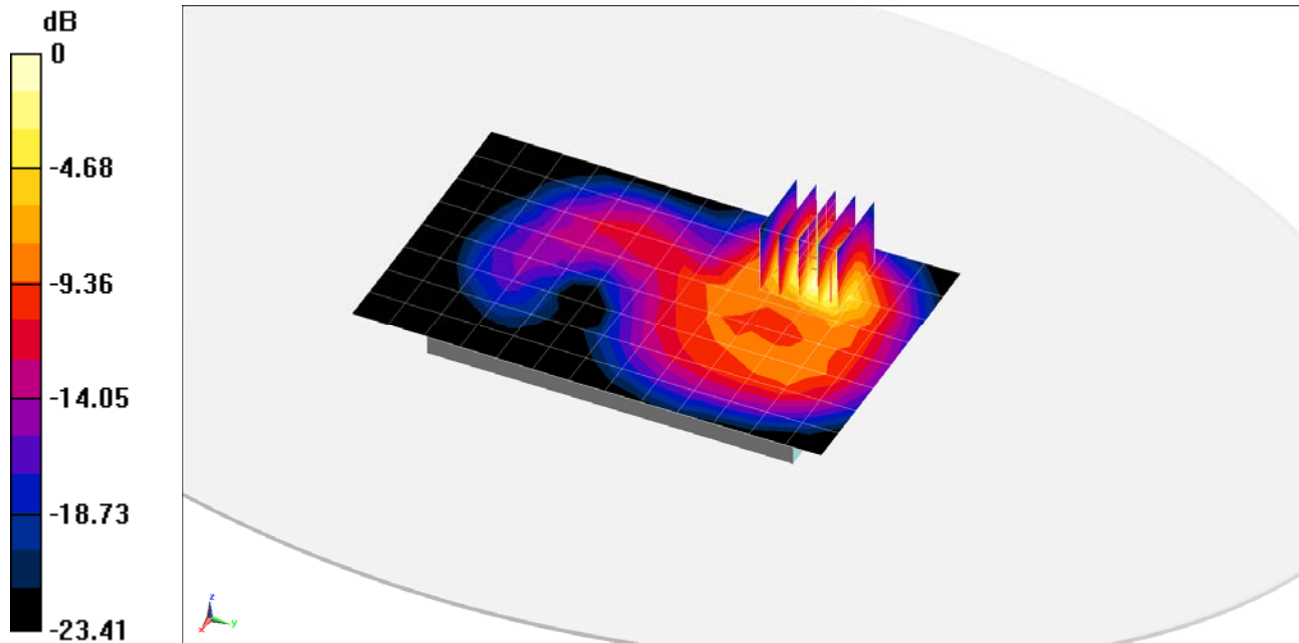
Area Scan (9x14x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 13.742 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 0.458 W/kg

SAR(1 g) = 0.236 W/kg



0 dB = 0.315 W/kg = -5.02 dBW/kg

APPENDIX B: SYSTEM VERIFICATION

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 1750 Head Medium parameters used:

$f = 1750 \text{ MHz}$; $\sigma = 1.359 \text{ S/m}$; $\epsilon_r = 39.861$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-24-2014; Ambient Temp: 24.3°C; Tissue Temp: 23.5°C

Probe: EX3DV4 - SN3914; ConvF(7.99, 7.99, 7.99); Calibrated: 10/23/2013;

Sensor-Surface: 2mm (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 (8); SEMCAD X Version 14.6.10 (7164)

1750 MHz System Verification

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

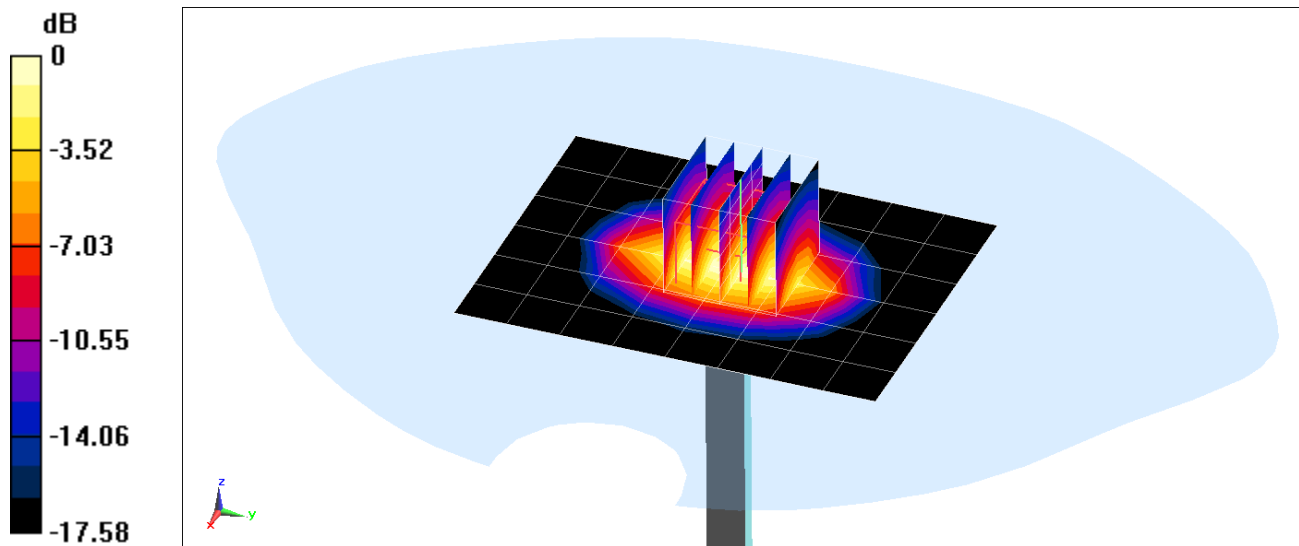
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 6.45 W/kg

SAR(1 g) = 3.56 W/kg

Deviation = -1.66%



0 dB = 4.99 W/kg = 6.98 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 1900 Head Medium parameters used (interpolated):

$f = 1900 \text{ MHz}$; $\sigma = 1.444 \text{ S/m}$; $\epsilon_r = 39.919$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-17-2014; Ambient Temp: 24.3°C; Tissue Temp: 23.0°C

Probe: ES3DV2 - SN3022; ConvF(5.03, 5.03, 5.03); Calibrated: 8/22/2013;

Sensor-Surface: 3mm (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 (8); SEMCAD X Version 14.6.10 (7164)

1900 MHz System Verification

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

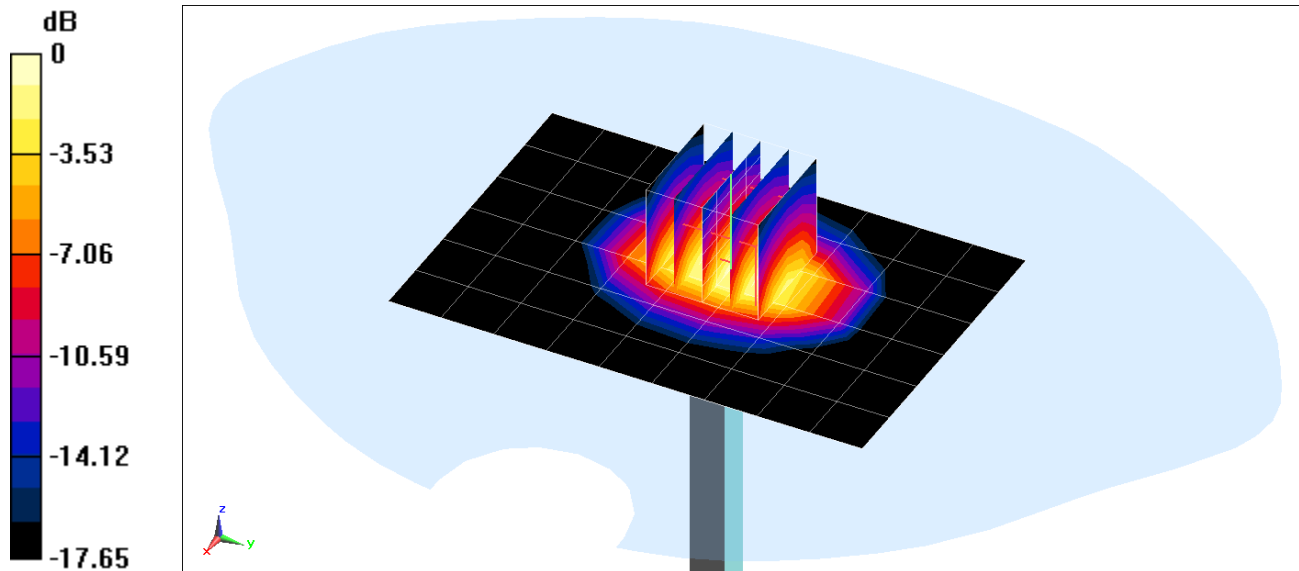
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 6.96 W/kg

SAR(1 g) = 3.9 W/kg

Deviation = -2.74%



0 dB = 4.92 W/kg = 6.92 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 1750 Body Medium parameters used:

$f = 1750 \text{ MHz}$; $\sigma = 1.441 \text{ S/m}$; $\epsilon_r = 51.958$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-21-2014; Ambient Temp: 23.4°C; Tissue Temp: 22.4°C

Probe: ES3DV3 - SN3319; ConvF(4.85, 4.85, 4.85); Calibrated: 4/17/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

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

Phantom: ELI left; Type: QDOVA002AA; Serial: TP:1202

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7164)

1750 MHz System Verification

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

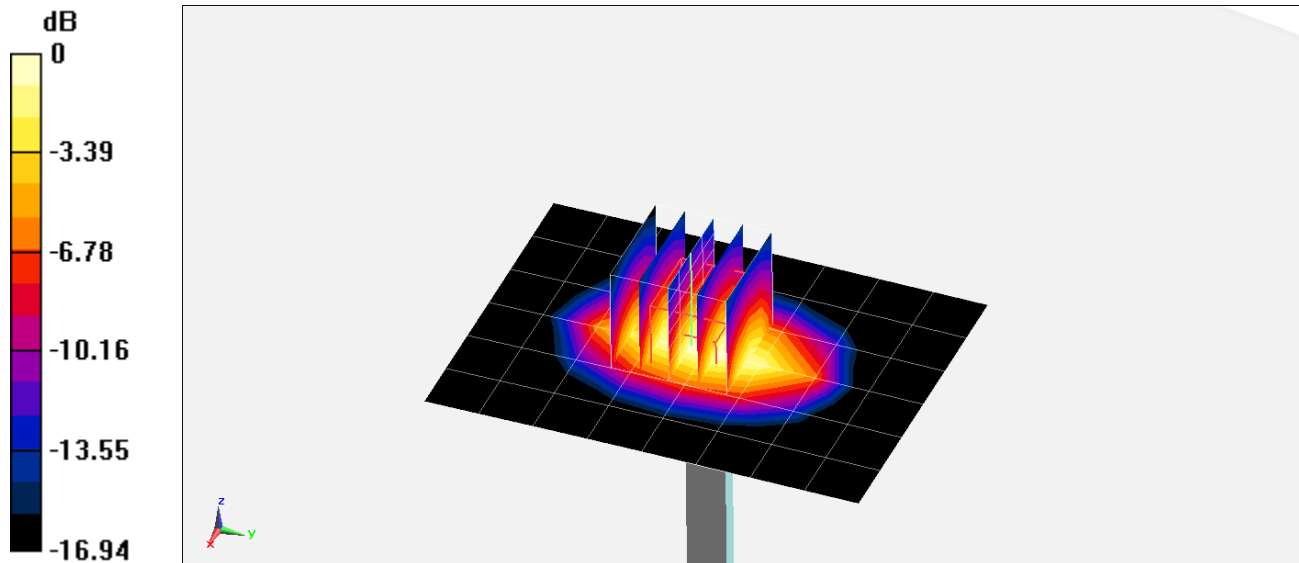
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 6.35 W/kg

SAR(1 g) = 3.68 W/kg

Deviation = -1.60%



0 dB = 4.53 W/kg = 6.56 dBW/kg

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 1900 Body Medium parameters used (interpolated):

$f = 1900 \text{ MHz}$; $\sigma = 1.528 \text{ S/m}$; $\epsilon_r = 51.444$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-17-2014; Ambient Temp: 24.4°C; Tissue Temp: 23.2°C

Probe: ES3DV3 - SN3287; ConvF(4.67, 4.67, 4.67); Calibrated: 11/20/2013;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1408; Calibrated: 11/19/2013

Phantom: ELI v5.0; Type: QDOVA001BB; Serial: 1229

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7164)

1900 MHz System Verification

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

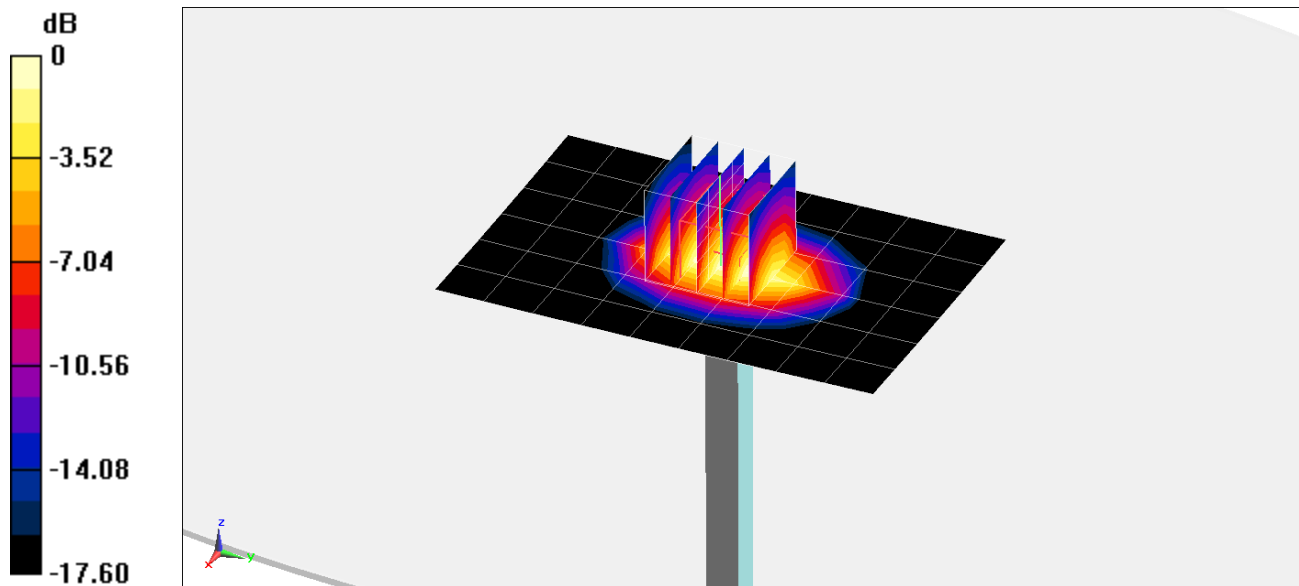
Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 7.51 W/kg

SAR(1 g) = 4.27 W/kg

Deviation = 5.17%



0 dB = 5.32 W/kg = 7.26 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: **ES3-3022_Aug13**

CALIBRATION CERTIFICATE

Object **ES3DV2 - SN:3022**

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

Calibration date: **August 22, 2013** *UTC*
9/13/13

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

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

Calibration Equipment used (M&TE critical for calibration)

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

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

Issued: August 23, 2013

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 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

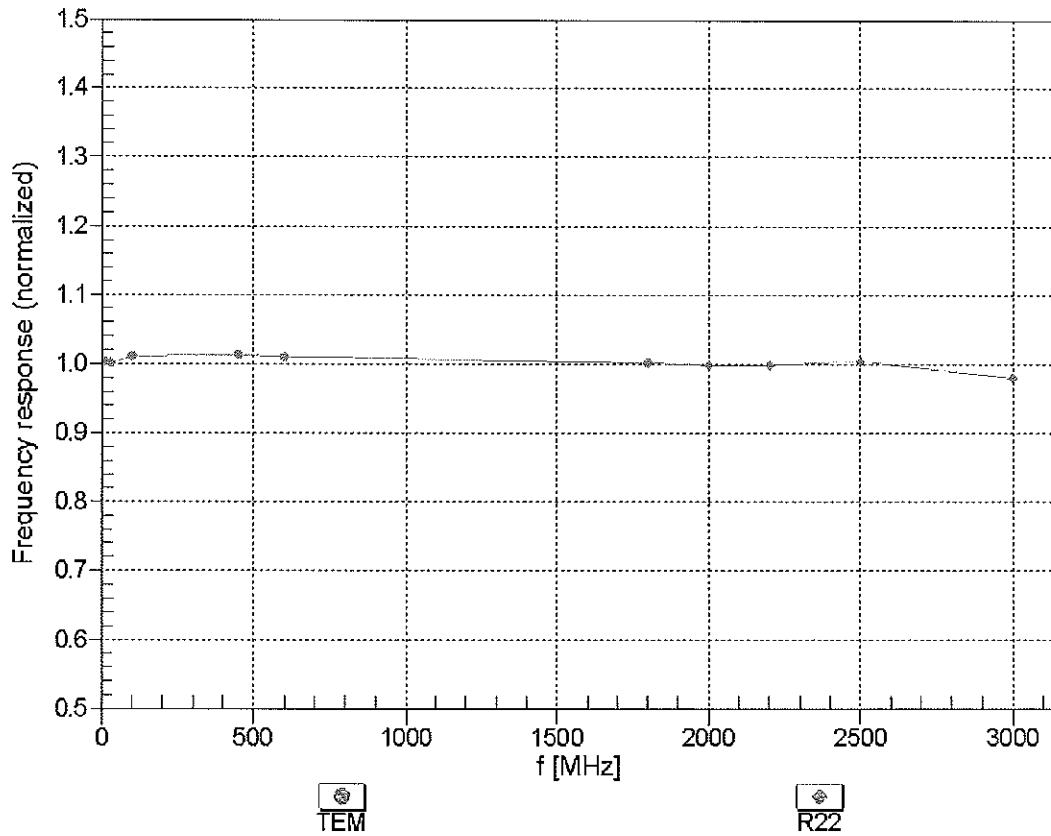
Calibration Parameter Determined in Body Tissue Simulating Media

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)

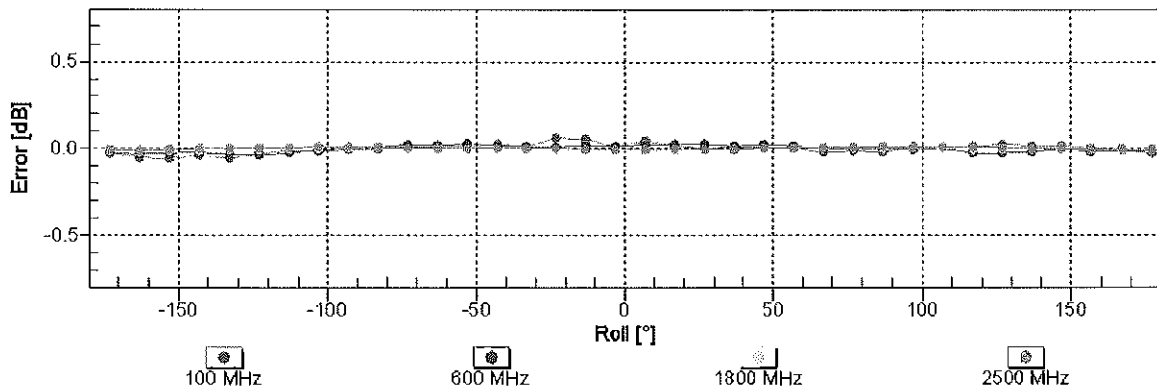
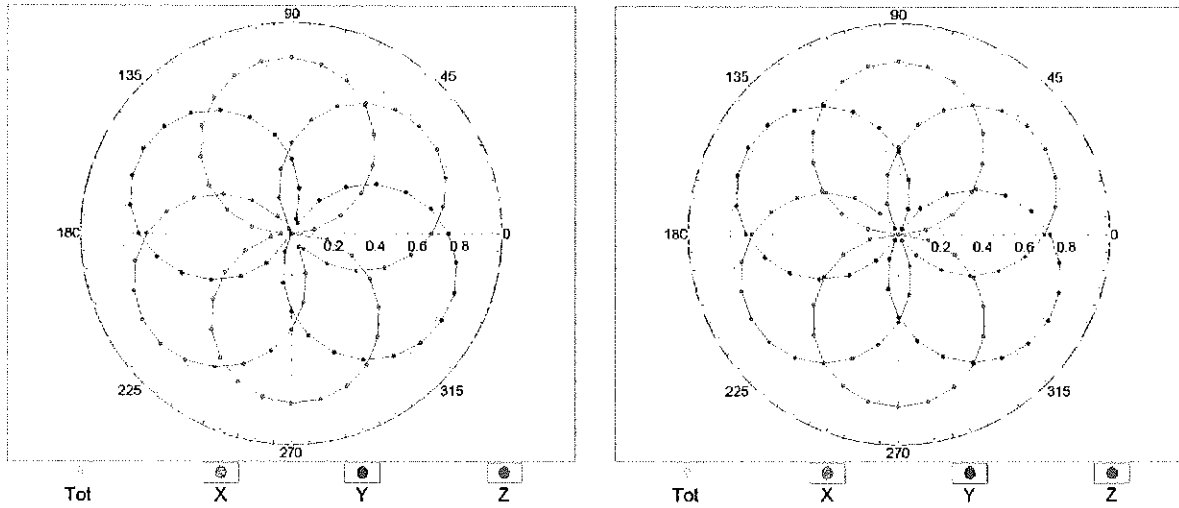


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

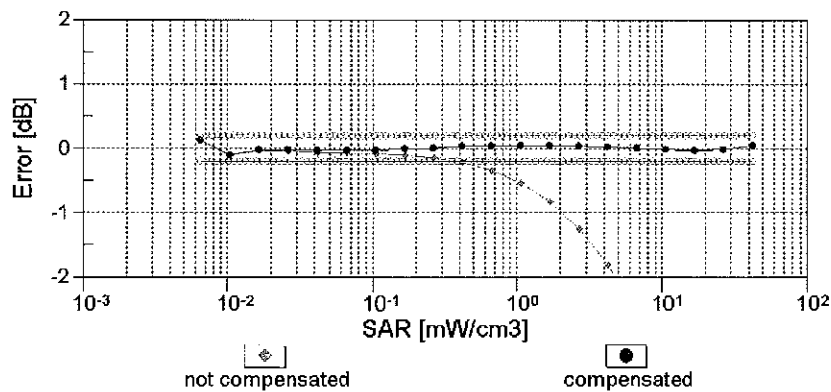
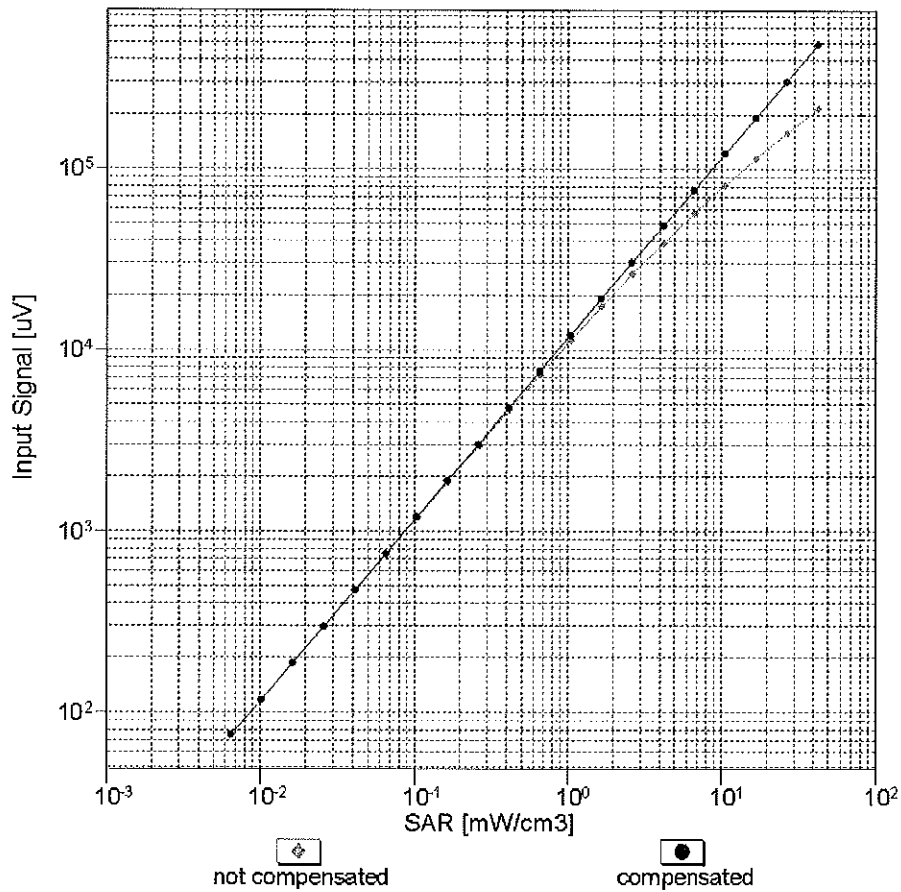
f=600 MHz,TEM

f=1800 MHz,R22



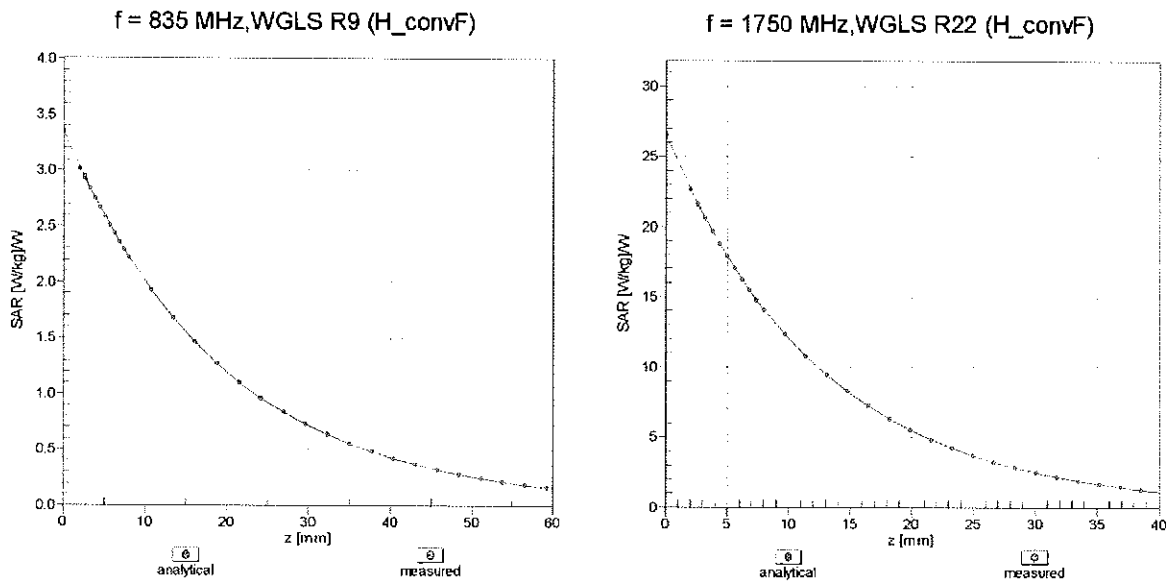
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

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

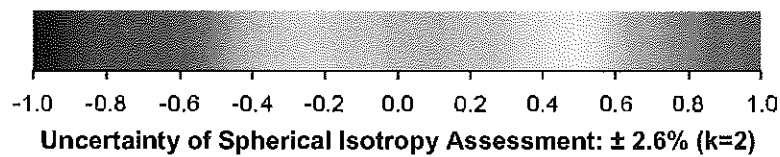
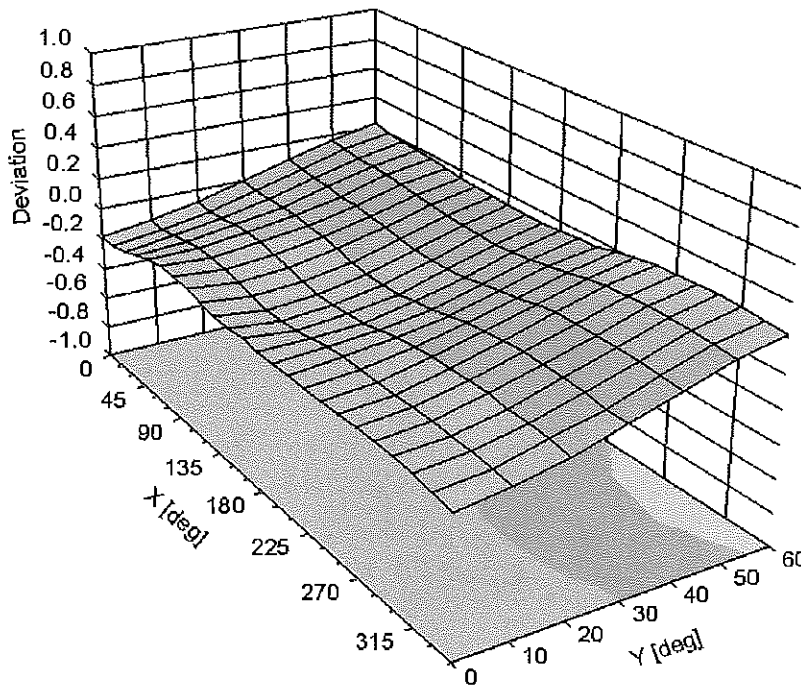


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment



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



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

Other Probe Parameters

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

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



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

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

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **ES3-3287_Nov13**

CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3287**

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

Calibration date: **November 20, 2013** ✓ CC 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 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	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	
Approved by:	Kalja Pokovic	Technical Manager	
			Issued: November 20, 2013
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			



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

Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

- **NORM_{x,y,z}**: Assessed for E-field polarization ϑ = 0 (f ≤ 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 ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- **Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- **Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- **Connector Angle**: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).

Probe ES3DV3

SN:3287

Manufactured: June 7, 2010
Calibrated: November 20, 2013

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3287

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	1.31	1.25	1.25	$\pm 10.1\%$
DCP (mV) ^B	102.6	102.5	100.4	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	157.3	$\pm 2.7\%$
		Y	0.0	0.0	1.0		159.9	
		Z	0.0	0.0	1.0		152.5	
10010- CAA	SAR Validation (Square, 100ms, 10ms)	X	2.23	57.9	9.9	10.00	45.7	$\pm 1.4\%$
		Y	2.13	57.6	9.8		46.6	
		Z	3.31	61.1	11.8		47.6	
10011- CAA	UMTS-FDD (WCDMA)	X	3.25	66.3	17.9	2.91	124.8	$\pm 0.5\%$
		Y	3.16	65.7	17.4		127.4	
		Z	3.15	65.5	17.4		122.8	
10012- CAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	X	3.08	68.7	18.3	1.87	127.2	$\pm 0.7\%$
		Y	3.03	68.2	17.9		129.4	
		Z	2.87	67.0	17.3		126.5	
10021- DAA	GSM-FDD (TDMA, GMSK)	X	15.99	90.6	25.0	9.39	99.9	$\pm 1.2\%$
		Y	12.41	86.6	23.6		101.5	
		Z	29.18	99.9	28.5		109.2	
10023- DAA	GPRS-FDD (TDMA, GMSK, TN 0)	X	25.67	98.9	27.8	9.57	97.9	$\pm 1.7\%$
		Y	14.20	88.5	24.3		100.6	
		Z	27.68	99.8	28.8		107.7	
10024- DAA	GPRS-FDD (TDMA, GMSK, TN 0-1)	X	42.95	99.6	24.9	6.56	124.4	$\pm 1.4\%$
		Y	45.27	99.9	24.8		128.8	
		Z	42.64	99.6	25.5		135.7	
10027- DAA	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	X	27.78	91.3	21.1	4.80	136.0	$\pm 1.4\%$
		Y	32.74	93.9	21.9		146.6	
		Z	23.93	89.5	21.1		144.8	
10028- DAA	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	X	59.17	99.6	22.4	3.55	142.5	$\pm 1.2\%$
		Y	78.76	99.7	21.7		104.9	
		Z	38.06	94.2	21.4		148.8	
10032- CAA	IEEE 802.15.1 Bluetooth (GFSK, DH5)	X	93.35	99.7	19.5	1.16	108.1	$\pm 0.9\%$
		Y	96.67	94.0	16.9		114.7	
		Z	98.17	96.2	18.2		108.9	
10039- CAA	CDMA2000 (1xRTT, RC1)	X	4.84	66.7	18.8	4.57	126.5	$\pm 0.9\%$
		Y	4.83	66.6	18.6		134.4	
		Z	4.76	66.0	18.3		125.9	
10081- CAA	CDMA2000 (1xRTT, RC3)	X	4.00	66.2	18.5	3.97	121.9	$\pm 0.7\%$
		Y	3.91	65.5	17.9		128.9	
		Z	3.88	65.2	17.8		120.7	

10098-CAA	UMTS-FDD (HSUPA, Subtest 2)	X	4.66	66.6	18.4	3.98	132.5	±0.7 %
		Y	4.66	66.5	18.2		141.3	
		Z	4.54	65.9	17.9		130.7	
10100-CAB	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	6.65	68.3	20.1	5.67	139.5	±1.4 %
		Y	6.69	68.3	19.9		148.9	
		Z	6.60	67.9	19.8		137.5	
10108-CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	6.52	67.8	20.0	5.80	137.3	±1.4 %
		Y	6.53	67.6	19.7		147.5	
		Z	6.51	67.6	19.8		135.3	
10110-CAB	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK)	X	6.19	67.2	19.7	5.75	134.3	±1.2 %
		Y	6.24	67.3	19.6		142.9	
		Z	6.23	67.1	19.6		132.3	
10151-CAB	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	11.56	79.1	27.9	9.28	130.1	±3.0 %
		Y	11.01	76.8	26.2		141.9	
		Z	12.98	81.2	28.7		135.7	
10154-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	6.25	67.4	19.8	5.75	135.1	±1.2 %
		Y	6.17	66.9	19.3		143.6	
		Z	6.16	66.8	19.4		132.8	
10160-CAB	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK)	X	6.66	67.8	20.0	5.82	140.3	±1.4 %
		Y	6.72	67.9	19.9		148.8	
		Z	6.66	67.6	19.8		137.4	
10169-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	5.05	66.7	19.5	5.73	117.8	±0.9 %
		Y	4.93	66.0	18.9		125.0	
		Z	5.08	66.3	19.3		116.3	
10172-CAB	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	8.47	76.8	26.9	9.21	100.3	±2.2 %
		Y	8.06	74.6	25.3		107.5	
		Z	9.43	78.2	27.4		102.5	
10175-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	4.98	66.3	19.3	5.72	118.2	±0.9 %
		Y	4.96	66.1	19.0		119.9	
		Z	5.03	66.1	19.1		116.1	
10181-CAB	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	X	5.06	66.7	19.6	5.72	118.7	±0.9 %
		Y	4.97	66.2	19.1		120.0	
		Z	5.03	66.1	19.1		116.3	
10225-CAA	UMTS-FDD (HSPA+)	X	6.78	66.1	18.9	5.97	105.3	±1.2 %
		Y	6.68	65.7	18.6		106.8	
		Z	7.32	67.6	19.7		148.0	
10237-CAB	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	8.56	77.1	27.1	9.21	100.8	±1.9 %
		Y	8.33	75.8	26.1		103.8	
		Z	9.39	78.0	27.3		101.9	
10252-CAB	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	10.58	77.8	27.4	9.24	123.3	±2.5 %
		Y	10.48	76.9	26.5		128.1	
		Z	11.79	79.6	28.0		127.0	
10267-CAB	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	11.52	79.1	27.9	9.30	130.1	±2.7 %
		Y	11.24	77.7	26.9		136.0	
		Z	12.96	81.2	28.8		134.8	

10274-CAA	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.10)	X	6.14	67.4	19.0	4.87	145.5	±1.2 %
		Y	6.19	67.4	19.0		149.2	
		Z	6.10	66.9	18.8		142.3	
10275-CAA	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.4)	X	4.41	66.4	18.3	3.96	126.4	±0.7 %
		Y	4.43	66.3	18.2		130.4	
		Z	4.36	65.9	18.0		123.8	
10291-AAA	CDMA2000, RC3, SO55, Full Rate	X	3.57	65.9	17.9	3.46	120.0	±0.5 %
		Y	3.55	65.6	17.6		121.7	
		Z	3.50	65.1	17.5		117.2	
10292-AAA	CDMA2000, RC3, SO32, Full Rate	X	3.55	66.1	18.0	3.39	121.3	±0.5 %
		Y	3.54	66.0	17.8		123.6	
		Z	3.45	65.2	17.4		118.9	
10297-AAA	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	6.53	67.8	20.0	5.81	136.2	±1.2 %
		Y	6.48	67.5	19.6		139.3	
		Z	6.52	67.6	19.8		134.1	
10311-AAA	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK)	X	7.12	68.4	20.4	6.06	141.7	±1.4 %
		Y	7.11	68.3	20.1		145.3	
		Z	7.14	68.4	20.3		139.8	
10315-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 96pc duty cycle)	X	2.79	67.6	18.0	1.71	125.5	±0.5 %
		Y	2.71	66.9	17.3		128.2	
		Z	2.64	66.2	17.0		123.5	
10403-AAA	CDMA2000 (1xEV-DO, Rev. 0)	X	4.78	67.5	18.3	3.76	130.6	±0.5 %
		Y	4.77	67.5	18.2		133.8	
		Z	4.65	66.5	17.8		130.0	
10404-AAA	CDMA2000 (1xEV-DO, Rev. A)	X	4.83	68.2	18.6	3.77	129.2	±0.7 %
		Y	4.68	67.4	18.0		131.9	
		Z	4.52	66.3	17.7		128.7	

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

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

^B Numerical linearization parameter: uncertainty not required.

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3287

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unct. (k=2)
750	41.9	0.89	6.52	6.52	6.52	0.47	1.46	± 12.0 %
835	41.5	0.90	6.30	6.30	6.30	0.40	1.59	± 12.0 %
1750	40.1	1.37	5.27	5.27	5.27	0.63	1.34	± 12.0 %
1900	40.0	1.40	5.08	5.08	5.08	0.62	1.37	± 12.0 %
2450	39.2	1.80	4.43	4.43	4.43	0.79	1.28	± 12.0 %
2600	39.0	1.96	4.29	4.29	4.29	0.77	1.38	± 12.0 %

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

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

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3287

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unct. (k=2)
750	55.5	0.96	6.09	6.09	6.09	0.55	1.37	± 12.0 %
835	55.2	0.97	6.04	6.04	6.04	0.55	1.39	± 12.0 %
1750	53.4	1.49	4.93	4.93	4.93	0.39	1.73	± 12.0 %
1900	53.3	1.52	4.67	4.67	4.67	0.38	1.75	± 12.0 %
2450	52.7	1.95	4.17	4.17	4.17	0.60	1.20	± 12.0 %
2600	52.5	2.16	4.00	4.00	4.00	0.60	1.10	± 12.0 %

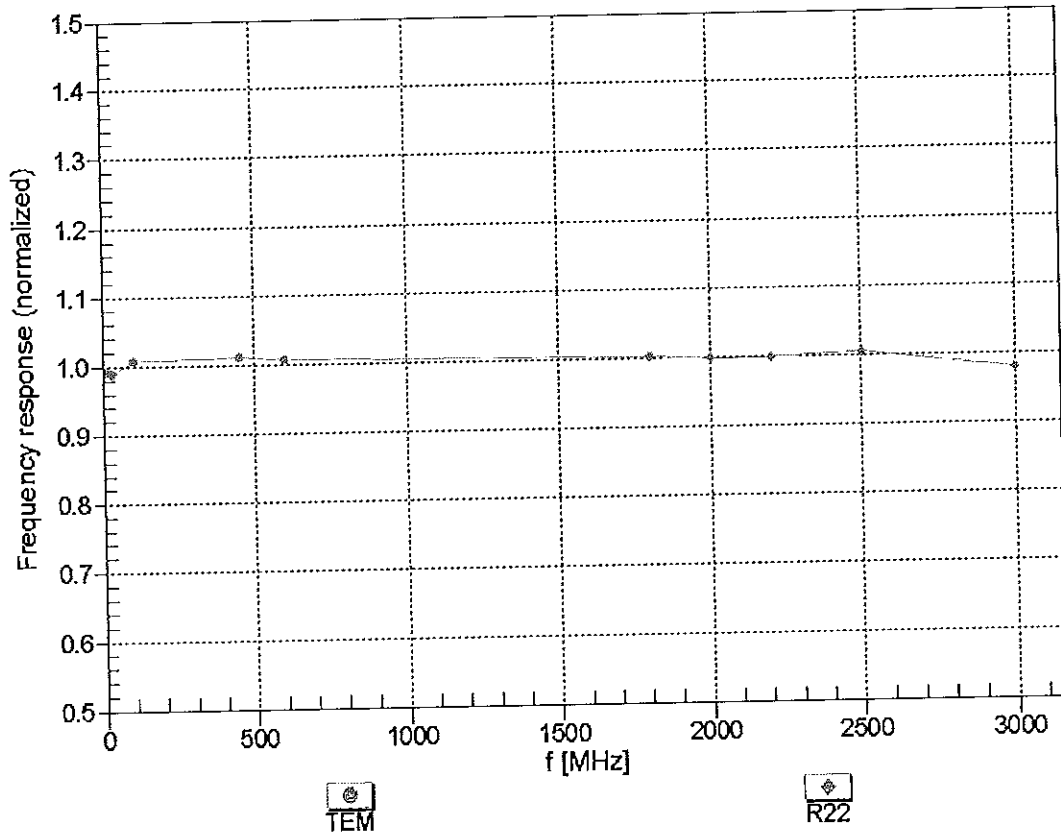
^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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

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

Frequency Response of E-Field

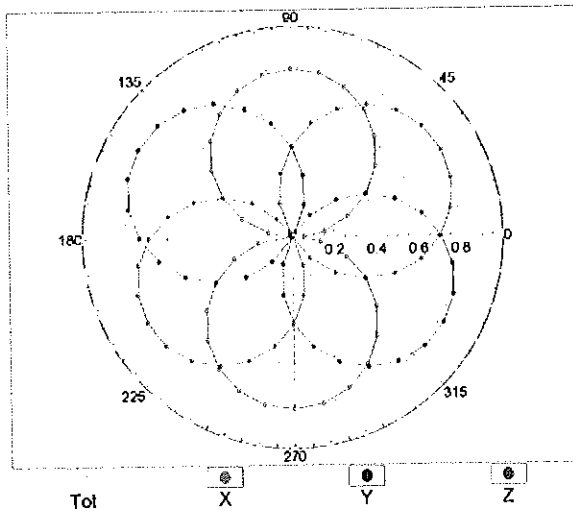
(TEM-Cell:ifi110 EXX, Waveguide: R22)



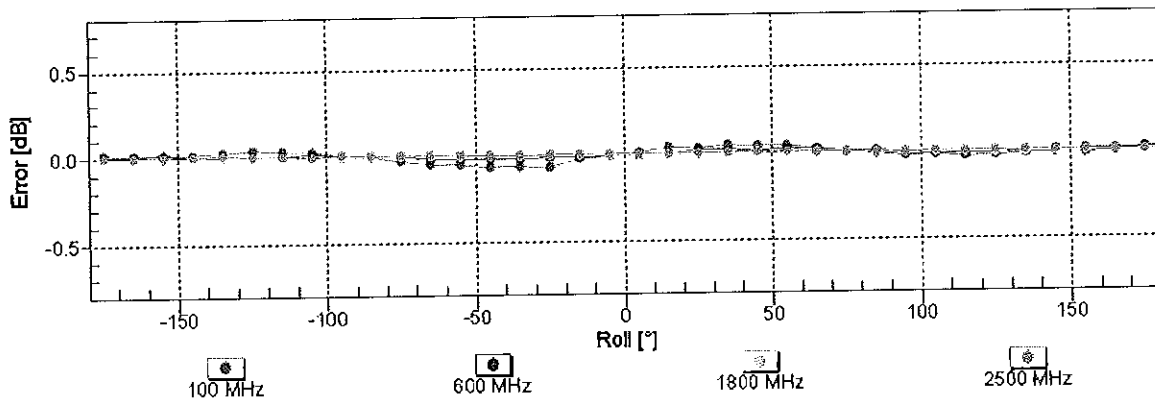
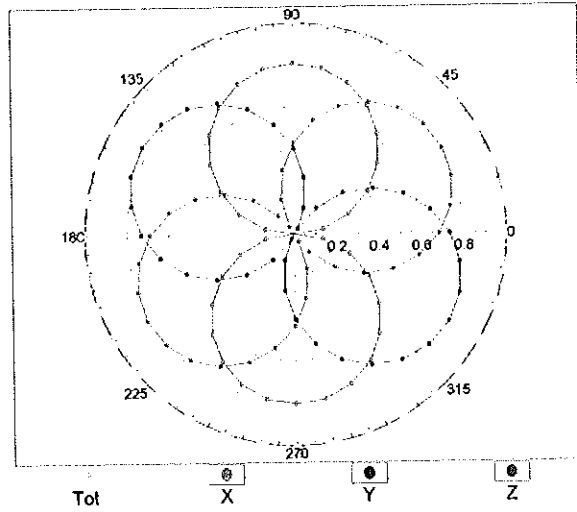
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz, TEM

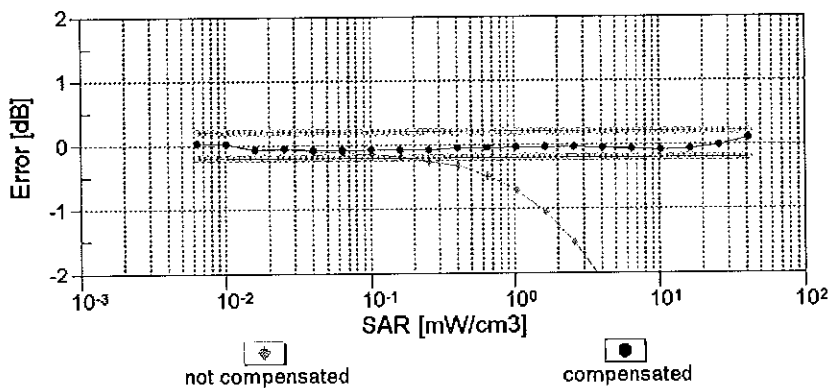
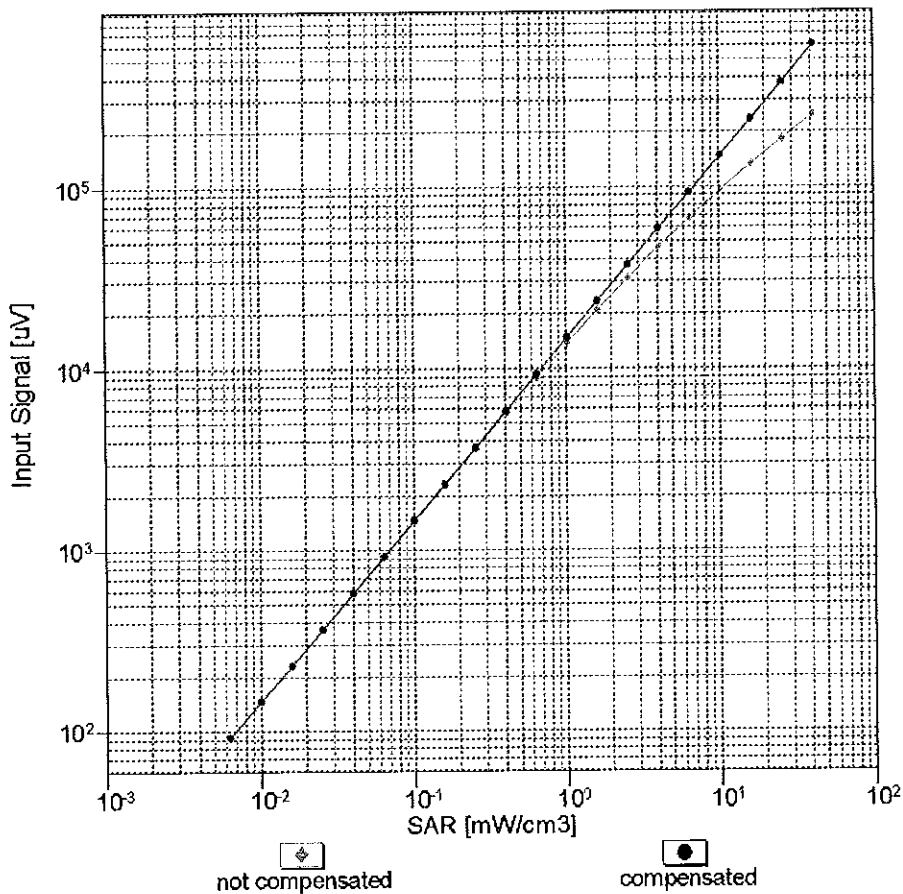


f=1800 MHz, R22



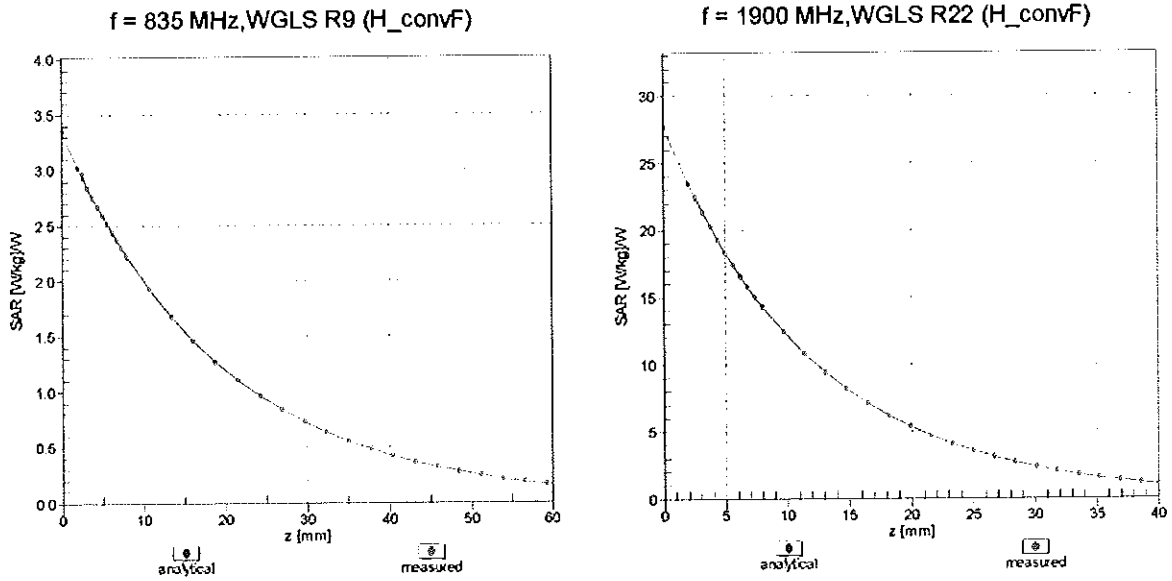
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

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

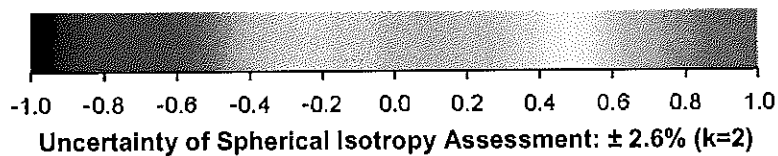
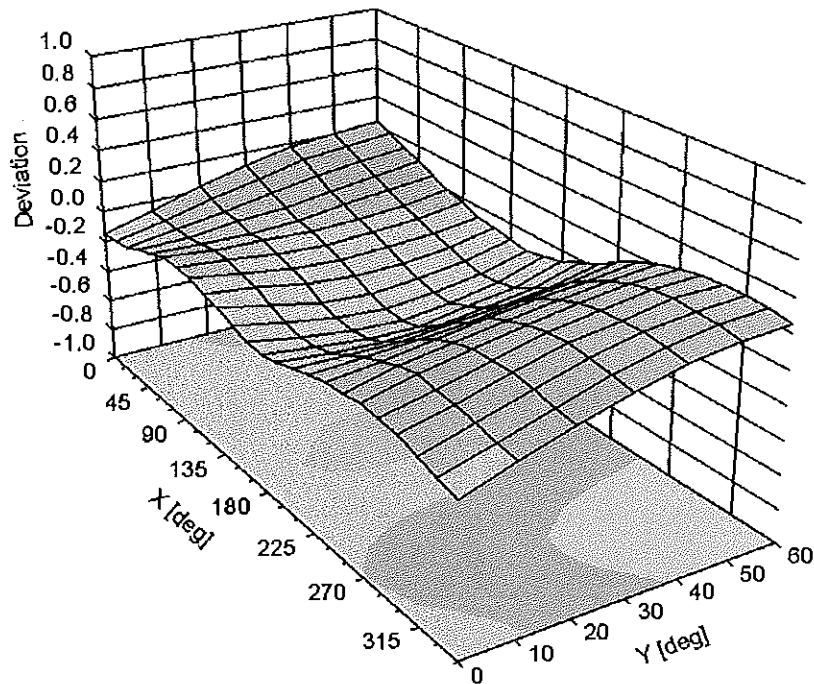


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment



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



DASY/EASY - Parameters of Probe: ES3DV3 - SN:3287**Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-15
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm



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

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **ES3-3319_Apr14**

CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3319**

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

Calibration date: **April 17, 2014**

*CCV
5/7/14*

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

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

Calibration Equipment used (M&TE critical for calibration)

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

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

Issued: April 21, 2014

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



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Glossary:

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

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

Probe ES3DV3

SN:3319

Manufactured:	January 10, 2012
Repaired:	April 11, 2014
Calibrated:	April 17, 2014

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3319

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	1.11	1.08	1.15	$\pm 10.1\%$
DCP (mV) ^B	102.6	104.2	103.7	

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	199.6	$\pm 3.5\%$
		Y	0.0	0.0	1.0		188.8	
		Z	0.0	0.0	1.0		178.5	
10010- CAA	SAR Validation (Square, 100ms, 10ms)	X	3.31	63.3	12.9	10.00	42.6	$\pm 2.2\%$
		Y	5.10	68.0	14.1		38.8	
		Z	2.84	61.7	12.1		44.3	
10011- CAB	UMTS-FDD (WCDMA)	X	3.30	66.9	18.4	2.91	136.7	$\pm 0.5\%$
		Y	3.32	67.1	18.4		127.0	
		Z	3.45	68.0	19.1		145.1	
10012- CAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	X	3.12	69.3	19.0	1.87	138.7	$\pm 0.7\%$
		Y	3.22	70.2	19.3		127.0	
		Z	3.40	71.3	19.9		146.4	
10021- DAB	GSM-FDD (TDMA, GMSK)	X	25.66	99.7	28.3	9.39	139.0	$\pm 1.4\%$
		Y	16.30	92.5	25.7		141.7	
		Z	25.20	99.5	28.1		144.9	
10023- DAB	GPRS-FDD (TDMA, GMSK, TN 0)	X	25.81	100.0	28.5	9.57	128.3	$\pm 2.2\%$
		Y	13.99	89.5	24.6		129.0	
		Z	25.39	99.7	28.3		141.2	
10024- DAB	GPRS-FDD (TDMA, GMSK, TN 0-1)	X	37.04	99.8	25.7	6.56	131.4	$\pm 2.2\%$
		Y	37.62	99.7	25.0		139.6	
		Z	38.36	99.8	25.3		145.5	
10027- DAB	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	X	48.04	99.6	23.8	4.80	144.6	$\pm 1.9\%$
		Y	29.62	94.2	22.1		129.3	
		Z	43.87	99.7	24.0		129.9	
10028- DAB	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	X	54.95	99.9	22.9	3.55	149.6	$\pm 1.7\%$
		Y	57.76	99.6	22.2		138.2	
		Z	54.27	99.8	22.7		137.3	
10032- CAA	IEEE 802.15.1 Bluetooth (GFSK, DH5)	X	44.58	99.9	21.1	1.16	134.6	$\pm 1.7\%$
		Y	96.74	98.9	18.8		149.0	
		Z	59.46	99.9	20.4		149.1	
10039- CAB	CDMA2000 (1xRTT, RC1)	X	4.70	66.3	18.7	4.57	130.9	$\pm 0.9\%$
		Y	4.85	67.1	19.0		147.5	
		Z	4.88	67.3	19.3		147.2	

10081-CAB	CDMA2000 (1xRTT, RC3)	X	3.90	65.8	18.4	3.97	130.0	±0.7 %
		Y	4.00	66.5	18.6		140.8	
		Z	3.99	66.5	18.7		142.5	
10098-CAB	UMTS-FDD (HSUPA, Subtest 2)	X	4.64	66.7	18.6	3.98	143.1	±0.9 %
		Y	4.58	66.5	18.4		132.8	
		Z	4.60	66.7	18.6		131.9	
10100-CAB	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	6.32	67.1	19.5	5.67	125.8	±1.4 %
		Y	6.41	67.4	19.5		138.4	
		Z	6.51	67.9	19.9		143.6	
10108-CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	6.48	67.7	20.0	5.80	148.0	±1.4 %
		Y	6.28	66.9	19.4		135.8	
		Z	6.39	67.4	19.8		141.0	
10110-CAB	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK)	X	6.17	67.2	19.8	5.75	141.0	±1.4 %
		Y	5.94	66.3	19.1		132.2	
		Z	6.08	67.0	19.6		137.9	
10114-CAA	IEEE 802.11n (HT Greenfield, 13.5 Mbps, BPSK)	X	10.35	69.2	21.5	8.10	133.6	±2.2 %
		Y	9.93	68.1	20.7		124.5	
		Z	10.29	69.2	21.5		131.9	
10117-CAA	IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK)	X	10.42	69.4	21.6	8.07	140.6	±2.2 %
		Y	9.93	68.1	20.7		125.5	
		Z	10.28	69.1	21.5		132.6	
10151-CAB	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	11.18	78.2	27.5	9.28	143.6	±3.3 %
		Y	9.33	73.0	24.5		124.3	
		Z	10.45	76.4	26.6		132.7	
10154-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	6.16	67.2	19.8	5.75	145.7	±1.4 %
		Y	5.96	66.4	19.1		133.0	
		Z	6.08	66.9	19.6		138.6	
10160-CAB	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK)	X	6.32	66.6	19.4	5.82	126.2	±1.4 %
		Y	6.40	66.9	19.4		137.3	
		Z	6.51	67.4	19.8		143.8	
10169-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	5.12	67.3	20.0	5.73	147.9	±1.2 %
		Y	4.90	66.4	19.4		134.4	
		Z	5.07	67.2	20.0		141.5	
10172-CAB	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	9.44	80.0	28.6	9.21	128.7	±3.3 %
		Y	8.63	77.8	27.1		143.9	
		Z	10.62	83.7	30.3		148.2	
10175-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	5.04	66.9	19.8	5.72	140.4	±1.4 %
		Y	4.92	66.6	19.5		133.7	
		Z	5.01	66.9	19.8		134.9	
10181-CAB	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	X	5.05	67.0	19.9	5.72	140.6	±1.4 %
		Y	4.90	66.5	19.4		132.4	
		Z	4.97	66.7	19.7		134.1	

10193-CAA	IEEE 802.11n (HT Greenfield, 6.5 Mbps, BPSK)	X	9.98	68.8	21.4	8.09	131.1	±2.5 %
		Y	10.00	68.8	21.2		145.5	
		Z	10.14	69.4	21.7		144.7	
10196-CAA	IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK)	X	9.99	68.9	21.5	8.10	132.0	±2.7 %
		Y	10.05	69.0	21.3		148.1	
		Z	10.16	69.5	21.8		145.8	
10219-CAA	IEEE 802.11n (HT Mixed, 7.2 Mbps, BPSK)	X	9.88	68.8	21.4	8.03	131.3	±2.5 %
		Y	9.96	69.0	21.3		147.8	
		Z	10.03	69.3	21.6		144.7	
10222-CAA	IEEE 802.11n (HT Mixed, 15 Mbps, BPSK)	X	10.34	69.3	21.6	8.06	137.1	±2.2 %
		Y	9.93	68.2	20.8		127.8	
		Z	10.07	68.6	21.2		125.1	
10225-CAB	UMTS-FDD (HSPA+)	X	6.97	66.8	19.4	5.97	133.6	±1.4 %
		Y	6.90	66.7	19.2		129.7	
		Z	7.14	67.5	19.8		147.4	
10237-CAB	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	9.18	79.3	28.2	9.21	128.1	±3.5 %
		Y	8.54	77.6	27.0		144.1	
		Z	9.99	81.9	29.4		141.7	
10252-CAB	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	9.65	75.1	26.1	9.24	126.1	±3.5 %
		Y	9.34	74.2	25.3		141.3	
		Z	10.46	77.6	27.3		144.1	
10267-CAB	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	10.46	76.2	26.5	9.30	133.6	±3.5 %
		Y	9.23	72.7	24.4		122.8	
		Z	9.90	74.8	25.7		123.8	
10274-CAB	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.10)	X	6.04	67.1	19.0	4.87	149.9	±1.2 %
		Y	6.02	67.1	18.9		142.8	
		Z	6.00	67.1	19.0		141.0	
10275-CAB	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.4)	X	4.22	65.6	18.1	3.96	131.0	±0.9 %
		Y	4.49	66.9	18.6		144.3	
		Z	4.55	67.3	19.1		147.0	
10291-AAB	CDMA2000, RC3, SO55, Full Rate	X	3.74	67.2	18.9	3.46	145.6	±0.5 %
		Y	3.66	66.8	18.5		136.7	
		Z	3.71	67.2	18.9		136.5	
10292-AAB	CDMA2000, RC3, SO32, Full Rate	X	3.65	67.0	18.7	3.39	147.2	±0.7 %
		Y	3.61	66.8	18.4		139.6	
		Z	3.64	67.1	18.8		139.6	
10297-AAA	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	6.37	67.3	19.8	5.81	140.5	±1.4 %
		Y	6.24	66.8	19.3		134.0	
		Z	6.33	67.2	19.8		134.8	
10311-AAA	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK)	X	7.00	68.0	20.2	6.06	146.8	±1.7 %
		Y	6.82	67.4	19.7		140.3	
		Z	6.90	67.8	20.1		141.4	

10315-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 96pc duty cycle)	X	2.85	68.5	18.8	1.71	129.5	±0.5 %
		Y	3.09	70.0	19.2		146.1	
		Z	3.15	70.6	19.8		146.8	
10403-AAB	CDMA2000 (1xEV-DO, Rev. 0)	X	4.73	67.9	18.7	3.76	137.5	±0.5 %
		Y	4.77	68.3	18.7		126.5	
		Z	4.77	68.1	18.8		128.1	
10404-AAB	CDMA2000 (1xEV-DO, Rev. A)	X	4.55	67.6	18.6	3.77	132.0	±0.7 %
		Y	4.89	69.1	19.1		148.8	
		Z	4.90	69.1	19.3		148.0	

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 8 and 9).
^B Numerical linearization parameter: uncertainty not required.
^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3319

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unct. (k=2)
750	41.9	0.89	6.48	6.48	6.48	0.28	2.09	± 12.0 %
835	41.5	0.90	6.27	6.27	6.27	0.34	1.72	± 12.0 %
1750	40.1	1.37	5.24	5.24	5.24	0.80	1.14	± 12.0 %
1900	40.0	1.40	5.05	5.05	5.05	0.72	1.24	± 12.0 %
2450	39.2	1.80	4.45	4.45	4.45	0.77	1.23	± 12.0 %
2600	39.0	1.96	4.29	4.29	4.29	0.80	1.27	± 12.0 %

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

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

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3319

Calibration Parameter Determined in Body Tissue Simulating Media

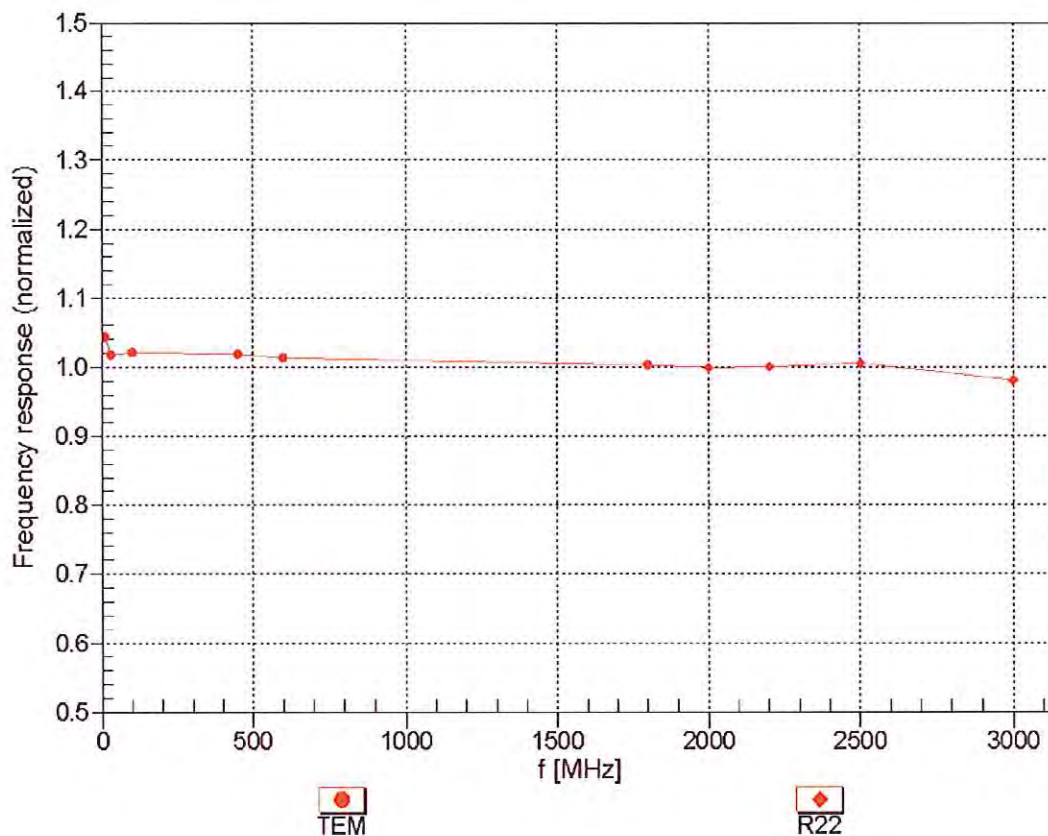
f (MHz) ^c	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unct. (k=2)
750	55.5	0.96	6.25	6.25	6.25	0.39	1.65	± 12.0 %
835	55.2	0.97	6.18	6.18	6.18	0.56	1.37	± 12.0 %
1750	53.4	1.49	4.85	4.85	4.85	0.57	1.46	± 12.0 %
1900	53.3	1.52	4.67	4.67	4.67	0.53	1.58	± 12.0 %
2450	52.7	1.95	4.24	4.24	4.24	0.74	1.10	± 12.0 %
2600	52.5	2.16	4.05	4.05	4.05	0.80	1.02	± 12.0 %

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

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

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

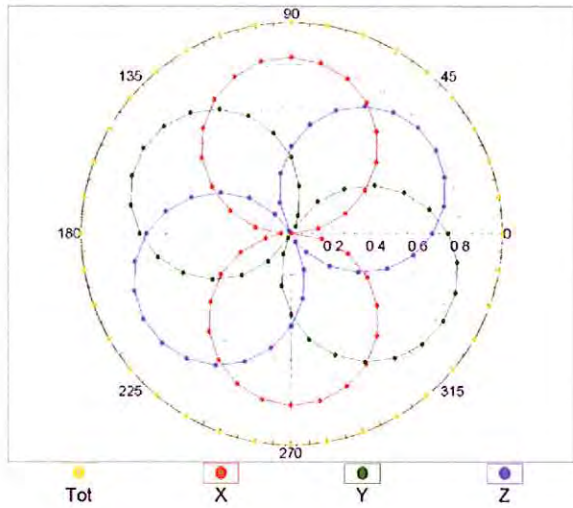
Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



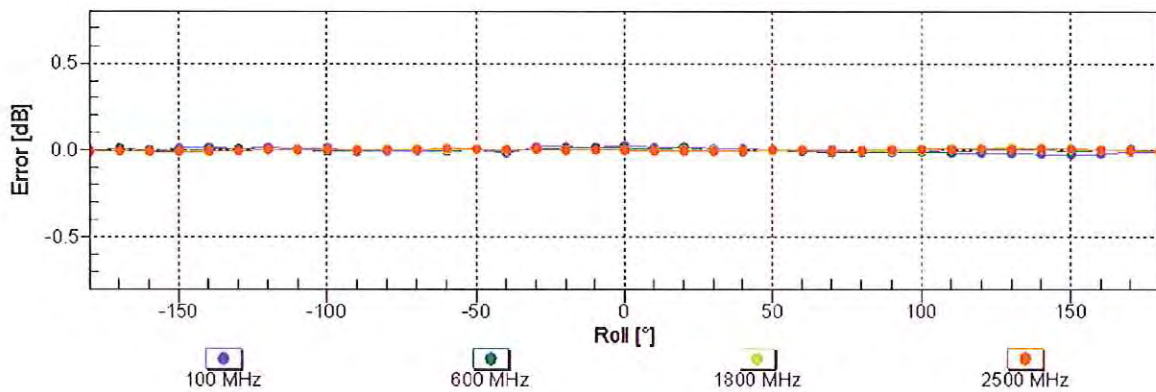
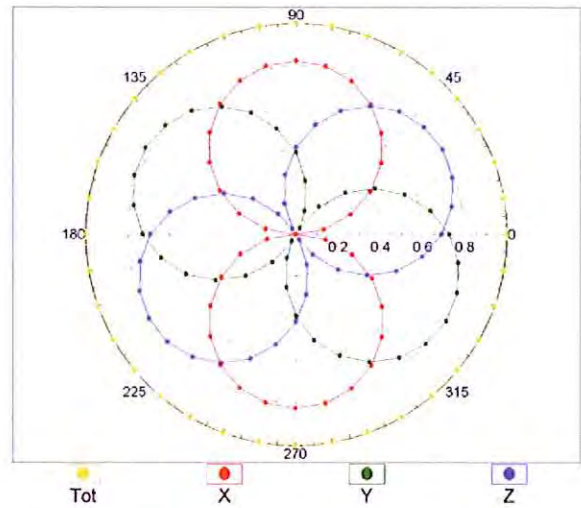
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz,TEM

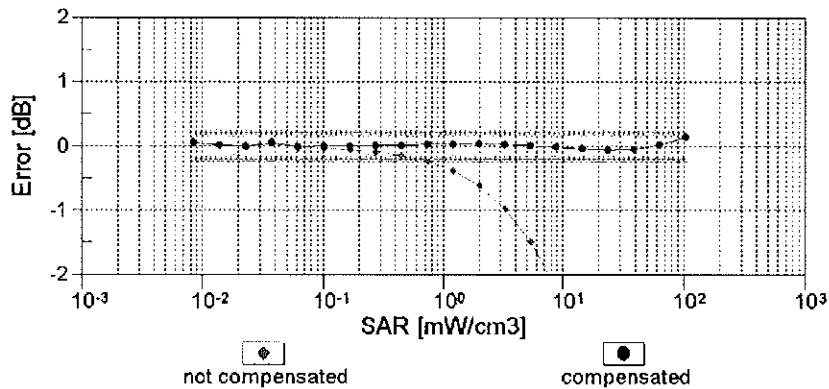
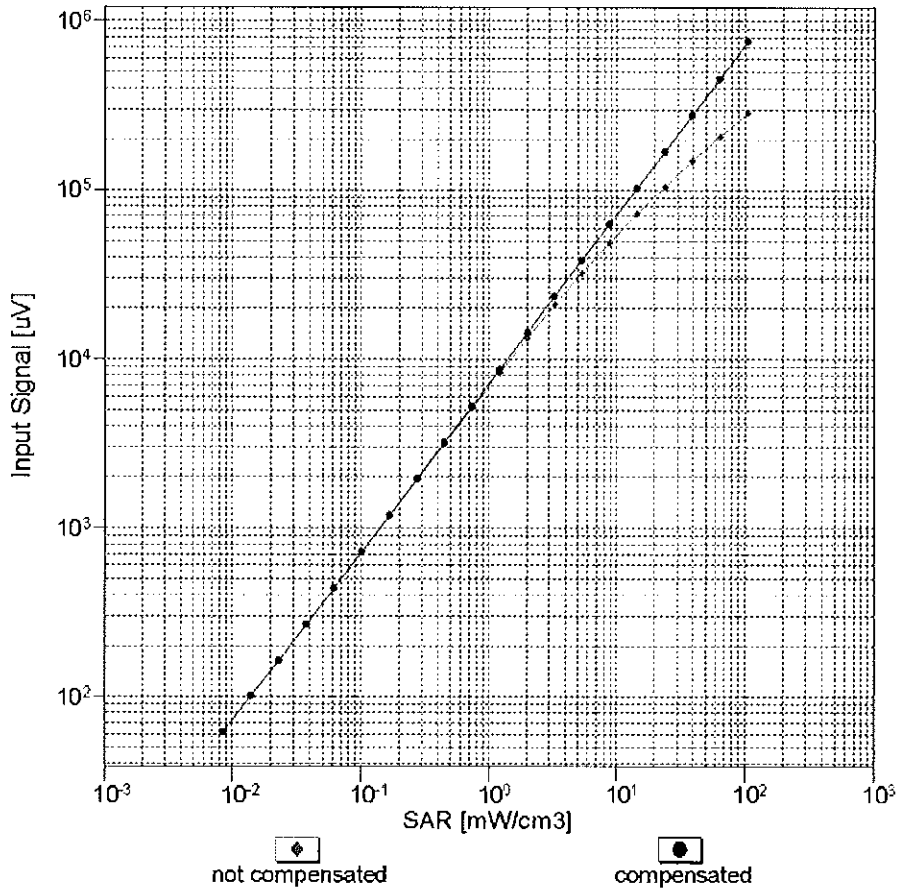


f=1800 MHz,R22



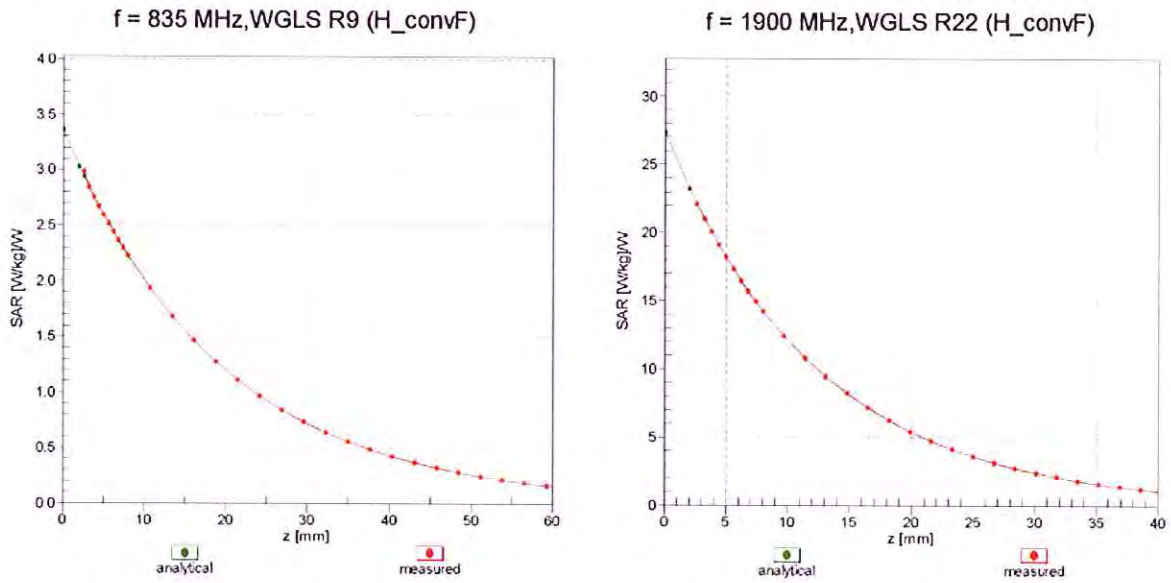
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

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

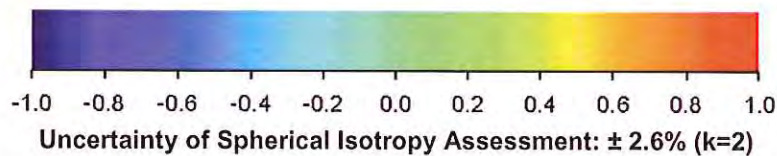
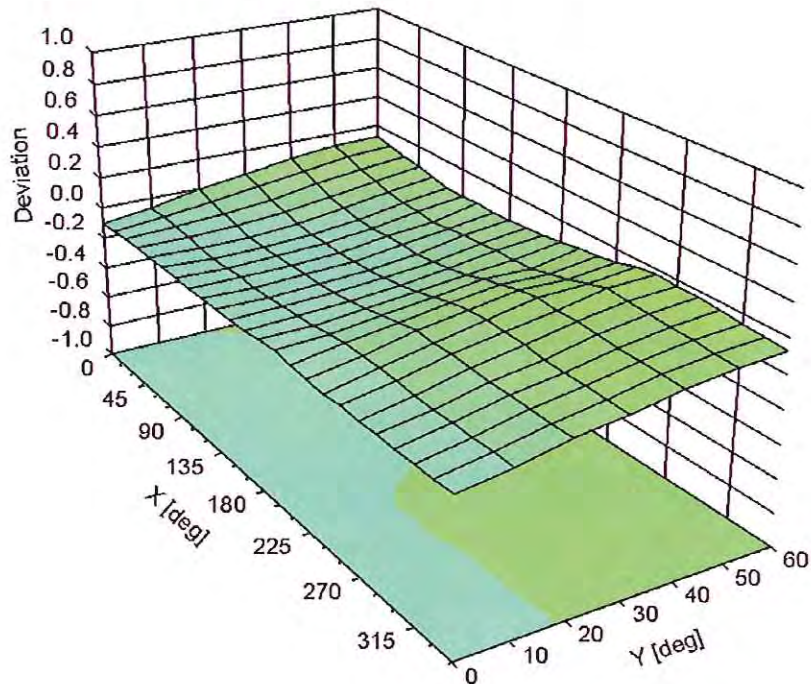


Uncertainty of Linearity Assessment: $\pm 0.6\%$ (k=2)

Conversion Factor Assessment



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



DASY/EASY - Parameters of Probe: ES3DV3 - SN:3319**Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-119.8
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

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



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

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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) **DIA CAL-01 v3, GA CAL-14 v4, GA CAL-23 v5, DIA CAL-25 v6
Calibration procedure for dielectric 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 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	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

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

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**

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:

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

Methods Applied and Interpretation of Parameters:

- *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 %

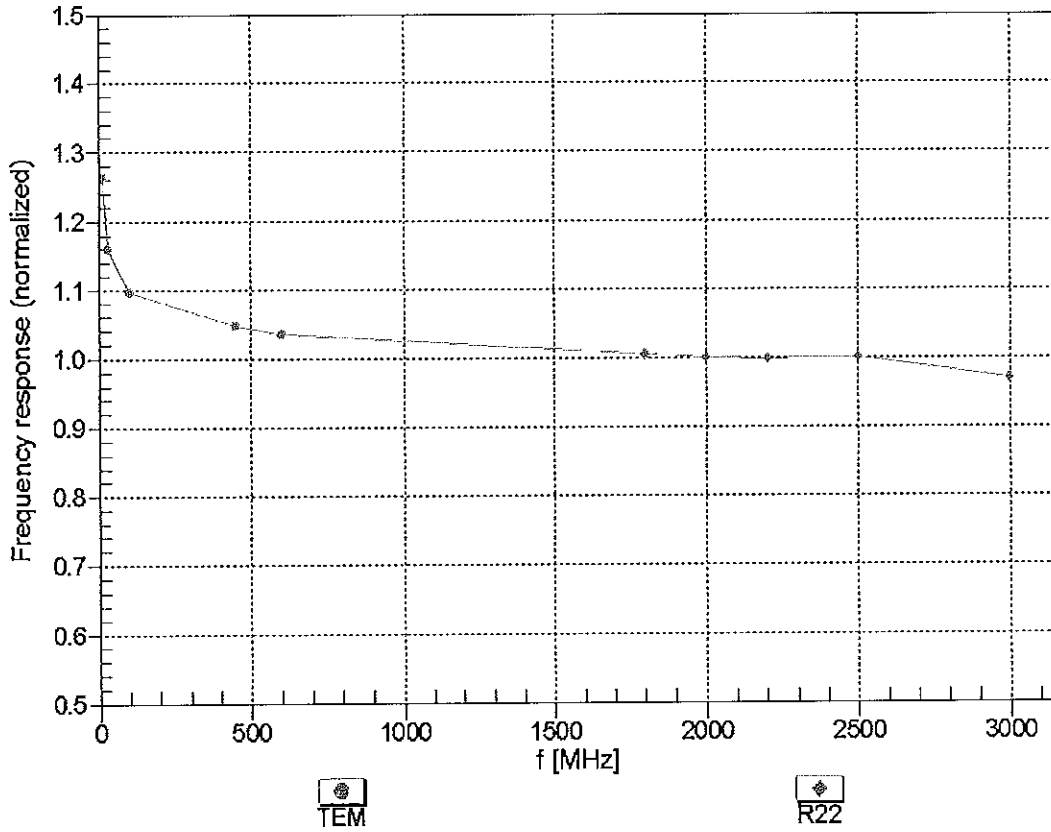
^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^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

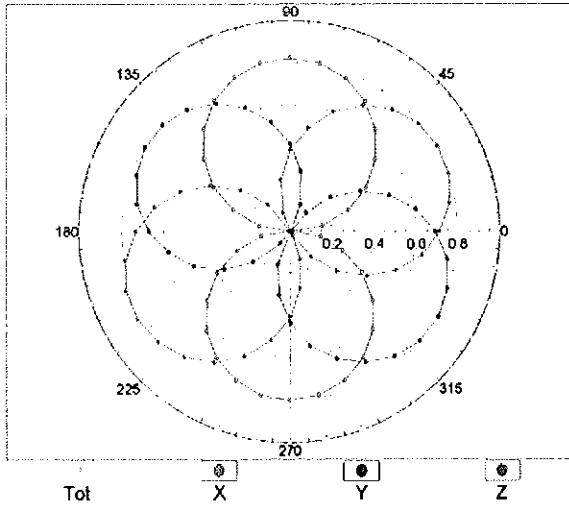
(TEM-Cell:ifi110 EXX, Waveguide: R22)



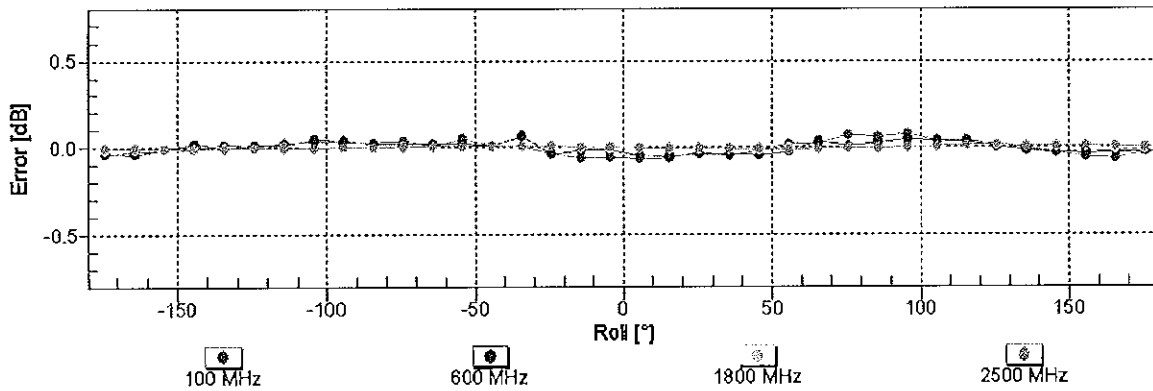
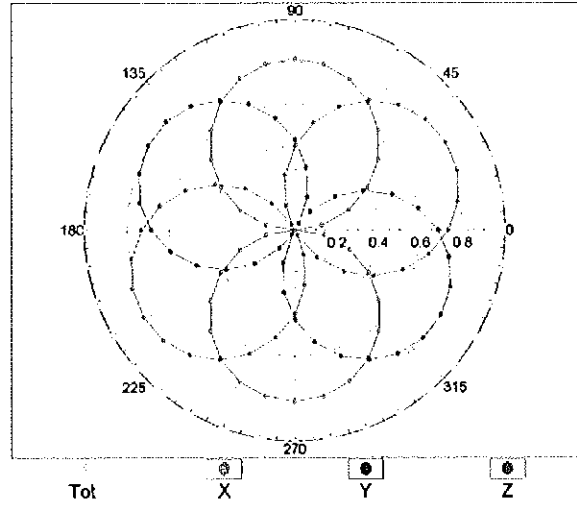
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz,TEM

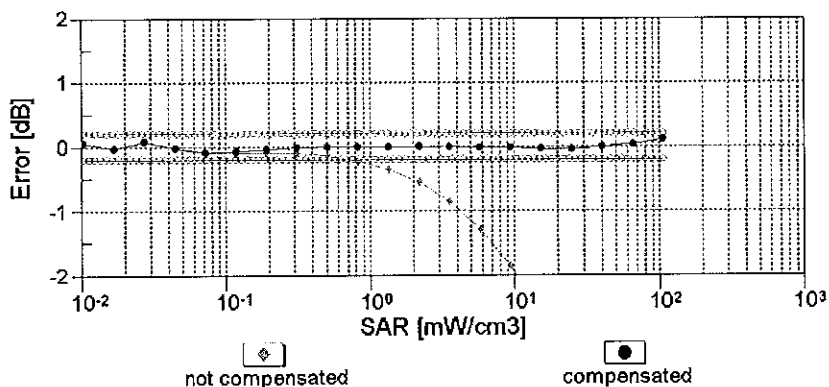
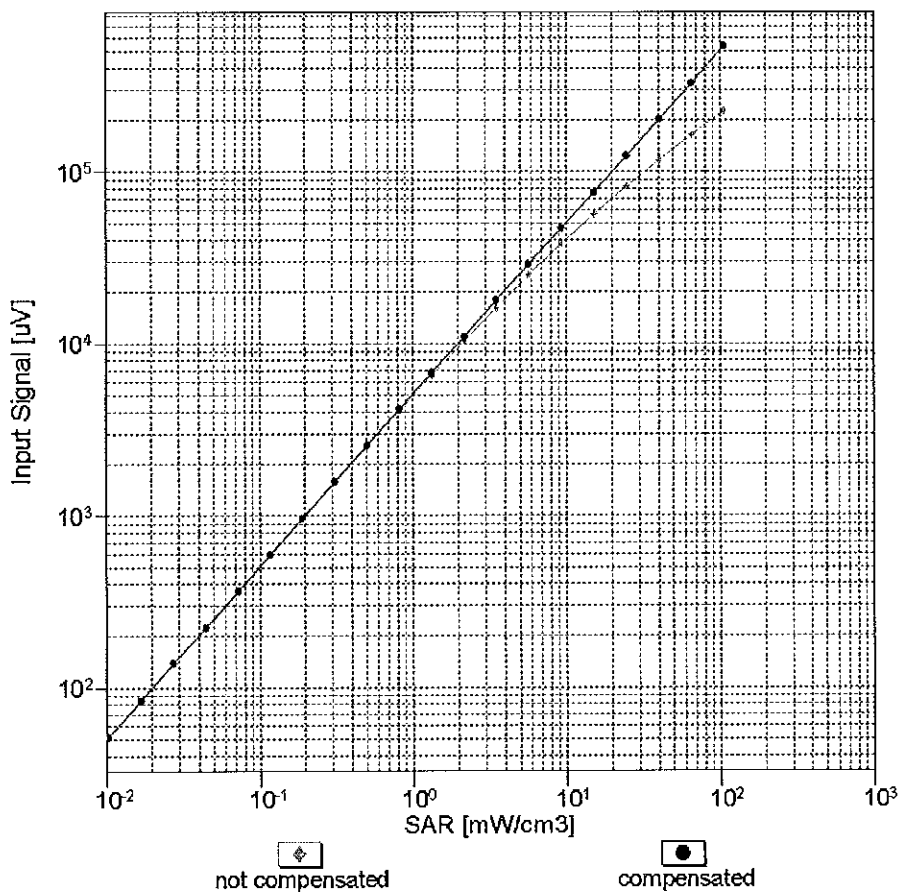


f=1800 MHz,R22



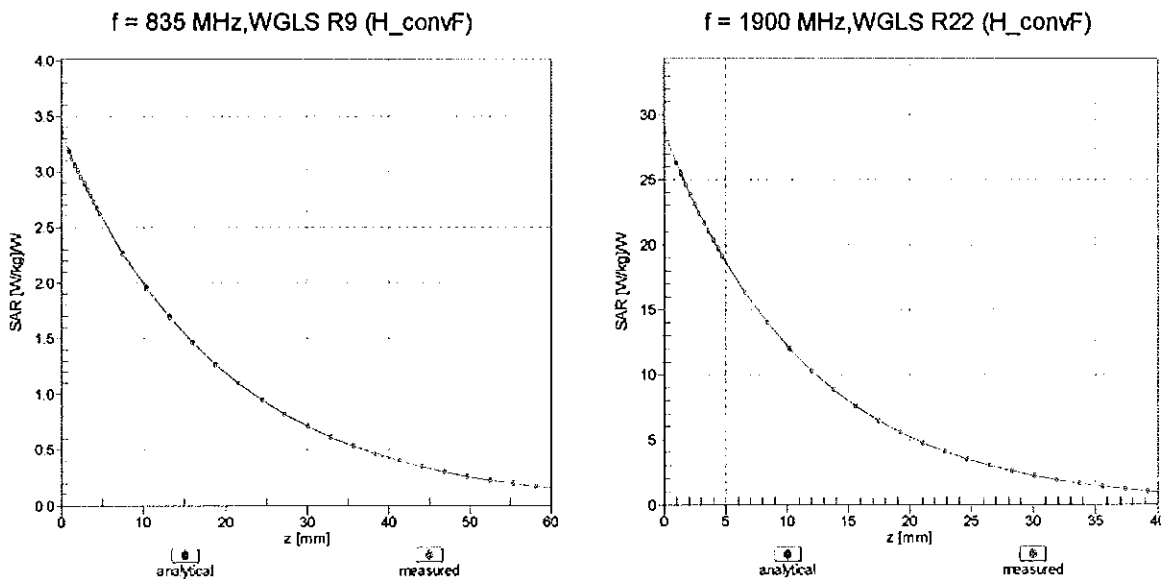
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

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



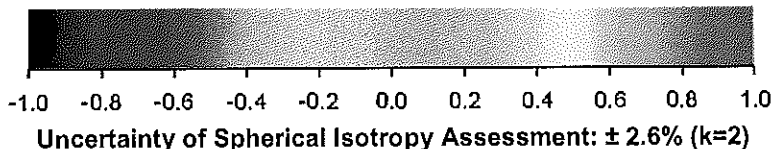
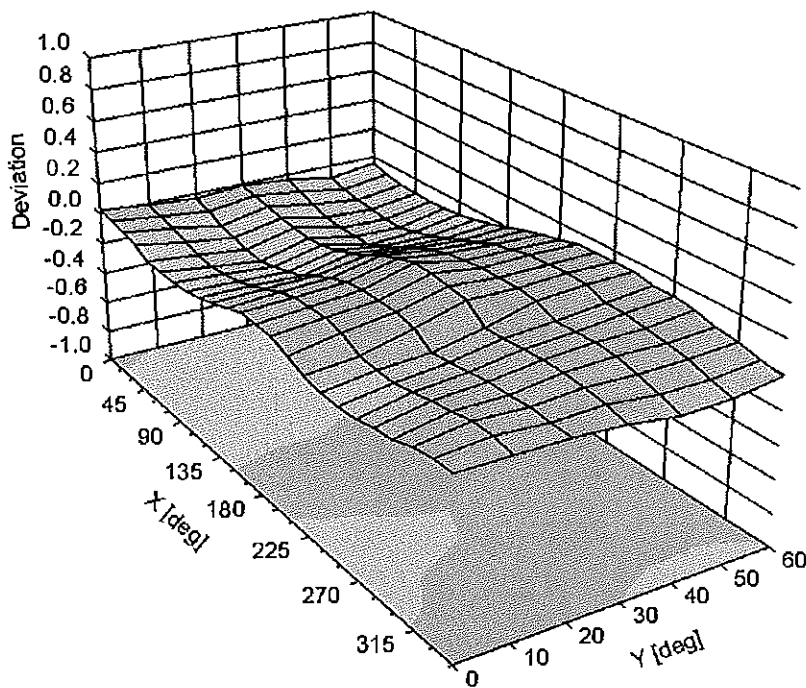
Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, θ), f = 900 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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D1750V2-1051_Apr14**

CALIBRATION CERTIFICATE

Object **D1750V2 - SN: 1051**

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

Calibration date: **April 10, 2014**

✓
KOK
5/7/14

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

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

Calibration Equipment used (M&TE critical for calibration)

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

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

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

Issued: April 10, 2014

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Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1750 MHz \pm 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.1	1.37 mho/m
Measured Head TSL parameters	(22.0 \pm 0.2) °C	39.1 \pm 6 %	1.35 mho/m \pm 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.02 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	36.2 W/kg \pm 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	4.79 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	19.2 W/kg \pm 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.4	1.49 mho/m
Measured Body TSL parameters	(22.0 \pm 0.2) °C	52.0 \pm 6 %	1.48 mho/m \pm 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	9.37 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	37.4 W/kg \pm 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.04 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.1 W/kg \pm 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.7 Ω + 0.4 j Ω
Return Loss	- 41.5 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.8 Ω + 0.8 j Ω
Return Loss	- 29.3 dB

General Antenna Parameters and Design

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

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

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	February 19, 2010

DASY5 Validation Report for Head TSL

Date: 10.04.2014

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

Medium parameters used: $f = 1750$ MHz; $\sigma = 1.35$ S/m; $\epsilon_r = 39.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.23, 5.23, 5.23); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

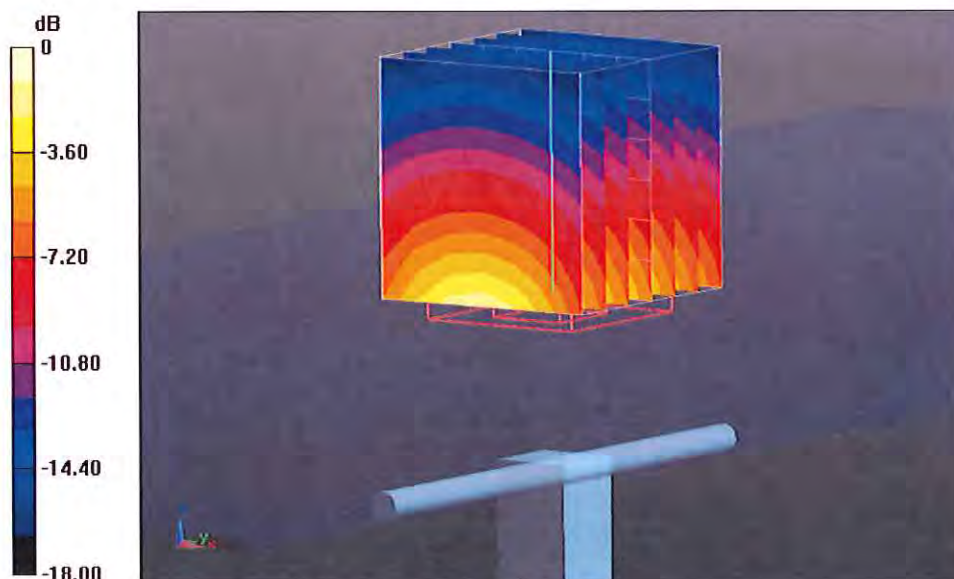
Measurement grid: dx=5mm, dy=5mm, dz=5mm

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

Peak SAR (extrapolated) = 16.2 W/kg

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

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

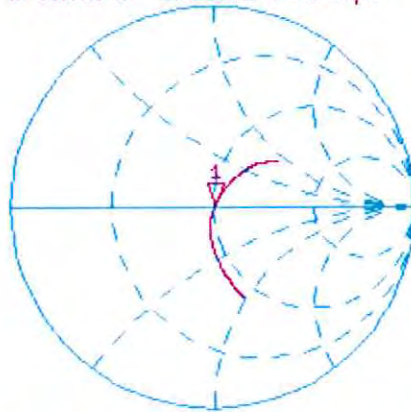


Impedance Measurement Plot for Head TSL

10 Apr 2014 12:21:05

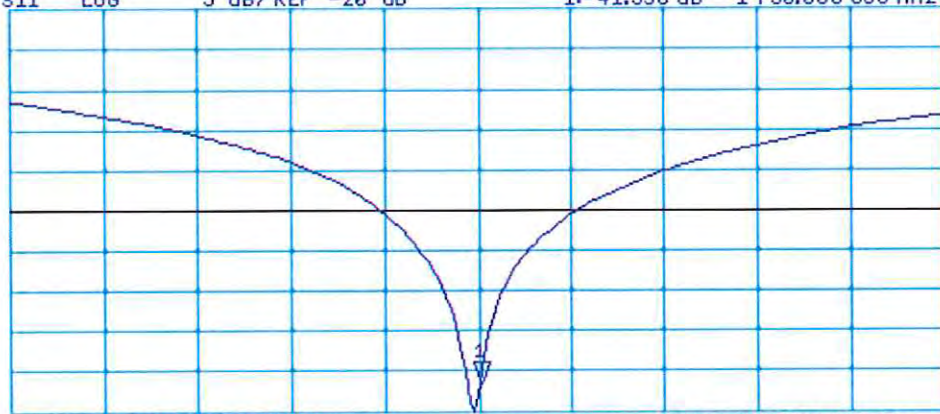
CH1 S11 1 U FS 1: 50.727 Ω 0.4238 Ω 38.545 μH 1 750.000 000 MHz

*
Del
CA
Avg
16
H1d



CH2 S11 LOG 5 dB/REF -20 dB 1:-41.536 dB 1 750.000 000 MHz

CA
Avg
16
H1d



START 1 550.000 000 MHz

STOP 1 950.000 000 MHz

DASY5 Validation Report for Body TSL

Date: 10.04.2014

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

Medium parameters used: $f = 1750$ MHz; $\sigma = 1.48$ S/m; $\epsilon_r = 52$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

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

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

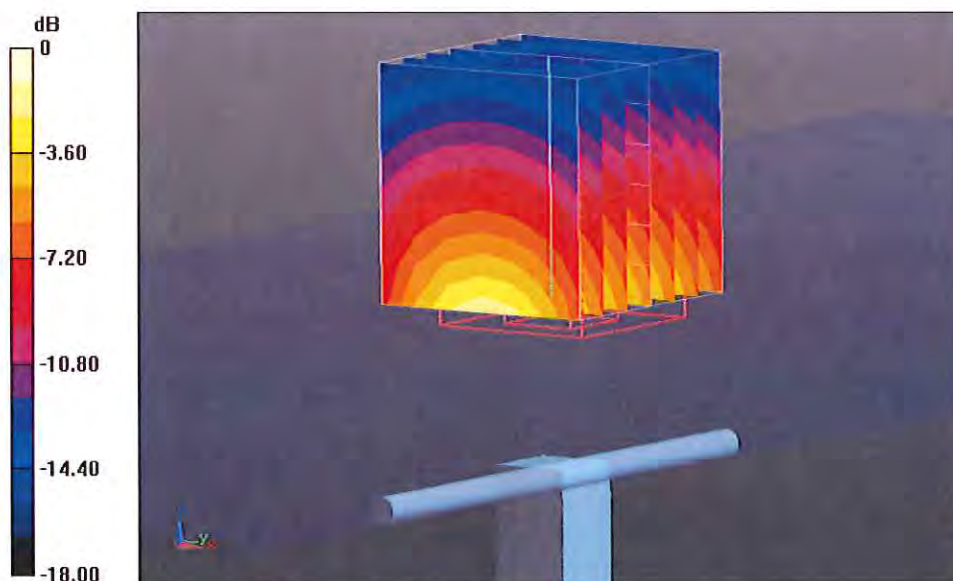
Measurement grid: dx=5mm, dy=5mm, dz=5mm

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

Peak SAR (extrapolated) = 16.1 W/kg

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

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

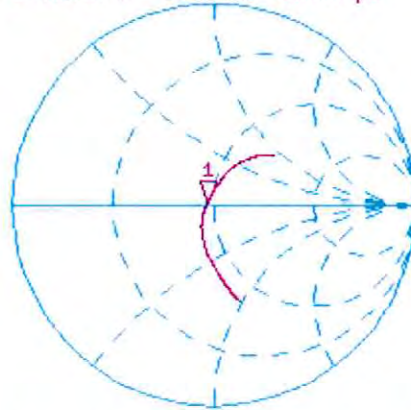


Impedance Measurement Plot for Body TSL

10 Apr 2014 12:28:40

[CH1] S11 1 U FS 1: 46.787 Ω 0.8086 Ω 73.538 pF 1 750.000 000 MHz

*
De l
CA



Avg
16

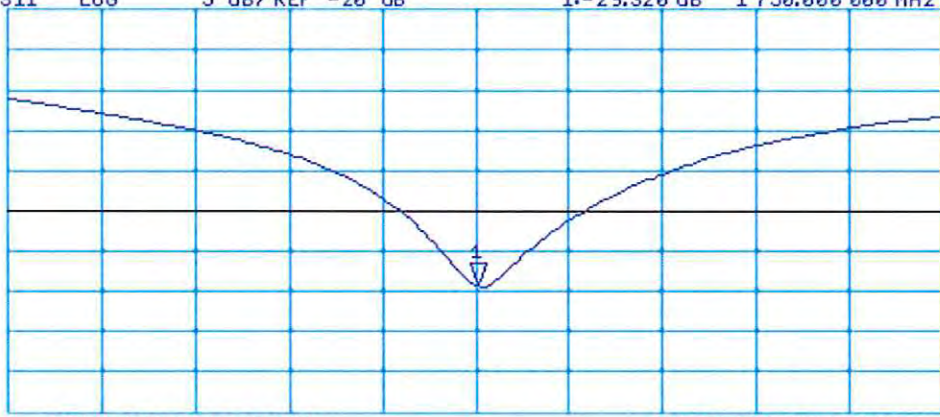
H1 d

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

CA

Avg
16

H1 d



START 1 550.000 000 MHz

STOP 1 950.000 000 MHz



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Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D1900V2-5d141_Apr14**

CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d141**

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

Calibration date: **April 09, 2014**

✓
KOK
5/7/14

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

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

Calibration Equipment used (M&TE critical for calibration)

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

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

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

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

Signature

Issued: April 9, 2014

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Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz \pm 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 \pm 0.2) °C	39.1 \pm 6 %	1.36 mho/m \pm 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.91 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	40.1 W/kg \pm 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.17 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	20.8 W/kg \pm 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 \pm 0.2) °C	52.4 \pm 6 %	1.52 mho/m \pm 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.2 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	40.6 W/kg \pm 17.0 % (k=2)

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

Appendix

Antenna Parameters with Head TSL

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

Antenna Parameters with Body TSL

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

General Antenna Parameters and Design

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

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

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	March 11, 2011

DASY5 Validation Report for Head TSL

Date: 09.04.2014

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.36$ S/m; $\epsilon_r = 39.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

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

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

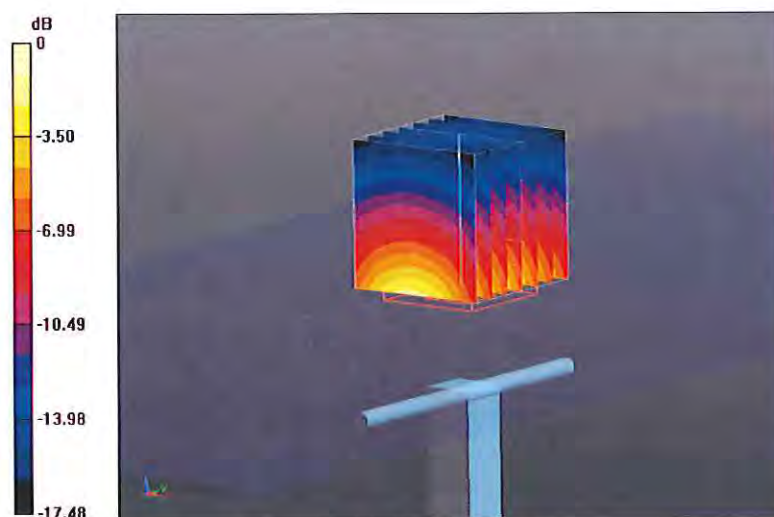
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 99.080 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 18.2 W/kg

SAR(1 g) = 9.91 W/kg; SAR(10 g) = 5.17 W/kg

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



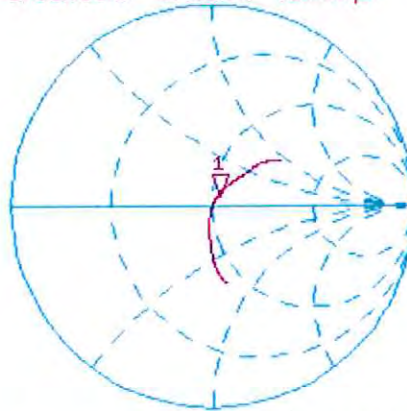
0 dB = 12.5 W/kg = 10.97 dBW/kg

Impedance Measurement Plot for Head TSL

9 Apr 2014 11:03:32

CH1 S11 1 U FS 1: 52.760 Ω 5.4512 Ω 456.62 pF 1 900.000 000 MHz

*
De1
CA



Avg
16

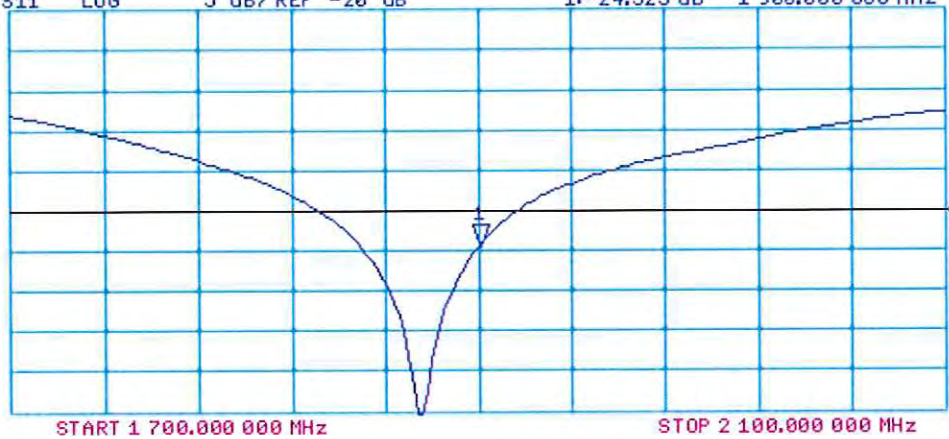
H1 d

CH2 S11 LOG 5 dB/REF -20 dB 1:-24.525 dB 1 900.000 000 MHz

CA

Avg
16

H1 d



DASY5 Validation Report for Body TSL

Date: 09.04.2014

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.52$ S/m; $\epsilon_r = 52.4$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

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

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

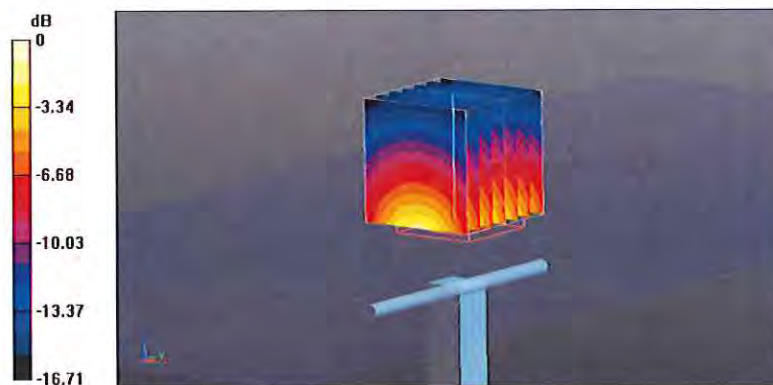
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.820 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 17.9 W/kg

SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.41 W/kg

Maximum value of SAR (measured) = 12.9 W/kg



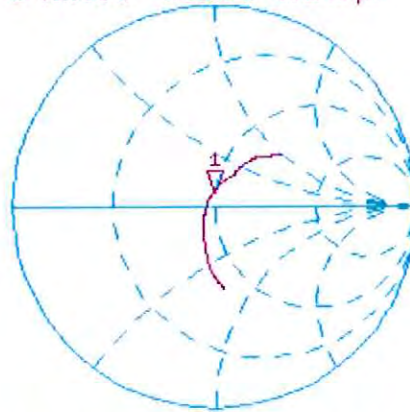
0 dB = 12.9 W/kg = 11.11 dBW/kg

Impedance Measurement Plot for Body TSL

9 Apr 2014 11:02:32

CH1 S11 1 U FS 1: 48.752 Ω 6.3320 Ω 530.41 pF 1 900.000 000 MHz

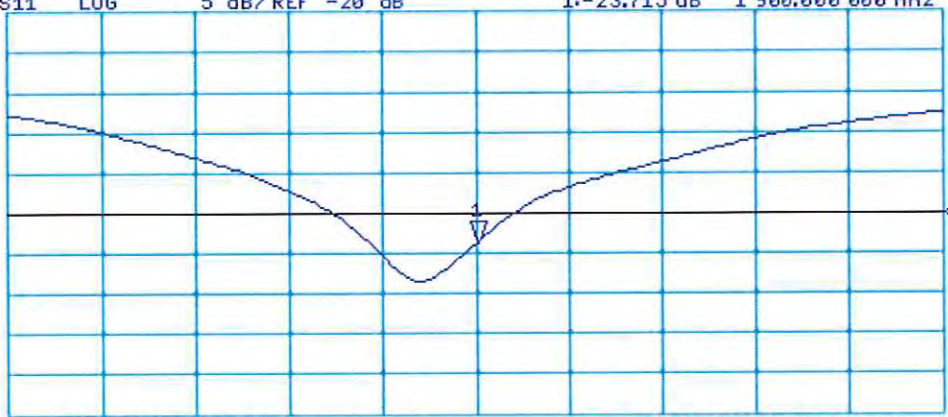
*
Del
CA



Avg
16
↑

CH2 S11 LOG 5 dB/REF -20 dB 1:-23.715 dB 1 900.000 000 MHz

CA
Avg
16
↑



START 1 700.000 000 MHz

STOP 2 100.000 000 MHz

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)	1750	1750	1900	1900
Tissue	Head	Body	Head	Body
Ingredients (% by weight)				
DGBE	47	31	44.92	29.44
NaCl	0.4	0.2	0.18	0.39
Water	52.6	68.8	54.9	70.17

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APPENDIX E: SAR SYSTEM VALIDATION



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

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

Table E-I
SAR System Validation Summary

SAR SYSTEM #	FREQ. [MHz]	DATE	PROBE SN	PROBE TYPE	PROBE CAL. POINT		COND.	PERM.	CW VALIDATION			MOD. VALIDATION		
							(σ)	(ϵ_r)	SENSI-TIVITY	PROBE LINEARITY	PROBE ISOTROPY	MOD. TYPE	DUTY FACTOR	PAR
E	1750	7/2/2014	3914	EX3DV4	1750	Head	1.367	41.18	PASS	PASS	PASS	N/A	N/A	N/A
D	1900	6/25/2014	3022	ES3DV2	1900	Head	1.400	39.22	PASS	PASS	PASS	GMSK	PASS	N/A
H	1750	6/27/2014	3319	ES3DV3	1750	Body	1.449	51.91	PASS	PASS	PASS	N/A	N/A	N/A
K	1900	6/25/2014	3287	ES3DV3	1900	Body	1.523	51.28	PASS	PASS	PASS	GMSK	PASS	N/A

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

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