



SAR EVALUATION REPORT

Applicant Name:

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Date of Testing:

07/21/14

Test Site/Location:

PCTEST Lab, Columbia, MD, USA

Document Serial No.:

0Y1407221424.A3L

FCC ID:
A3LSCHLC11R
APPLICANT:
SAMSUNG ELECTRONICS, CO. LTD.
DUT Type:

Portable Wireless Router

Application Type:

Class II Permissive Change

FCC Rule Part(s):

CFR §2.1093

Model(s):

SCH-LC11R

Permissive Change(s):

Adding 15 and 20 MHz BW to LTE B4

Adding 10, 15 and 20 MHz BW to LTE B2

Date of Original Certification:

03/22/2012

Equipment Class	Band & Mode	Tx Frequency	SAR
			1 gm Hotspot (W/kg)
PCB	LTE Band 4 (AWS)	1712.5 - 1752.5 MHz	0.59
PCB	LTE Band 2 (PCS)	1850.7 - 1909.3 MHz	0.13
Simultaneous SAR per KDB 690783 D01v01r03:			0.80

The table above shows Test Data evaluated for the current test report. Please refer to RF Exposure Technical Reports 0Y1201230103-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 1.7 of this report; for North American frequency bands only.

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


 Randy Ortanez
 President


TESTING CERT#2041.01

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FCC ID: A3LSCHLC11R		SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 1 of 32

T A B L E O F C O N T E N T S

1	DEVICE UNDER TEST	3
2	LTE INFORMATION.....	6
3	INTRODUCTION	7
4	DOSIMETRIC ASSESSMENT	8
5	TEST CONFIGURATION POSITIONS	9
6	RF EXPOSURE LIMITS	10
7	FCC MEASUREMENT PROCEDURES.....	11
8	RF CONDUCTED POWERS.....	13
9	SYSTEM VERIFICATION.....	23
10	SAR DATA SUMMARY	24
11	FCC MULTI-TX AND ANTENNA SAR CONSIDERATIONS.....	26
12	SAR MEASUREMENT VARIABILITY	27
13	EQUIPMENT LIST.....	28
14	MEASUREMENT UNCERTAINTIES	29
15	CONCLUSION.....	30
16	REFERENCES	31
APPENDIX A: SAR TEST PLOTS		
APPENDIX B: SAR DIPOLE VERIFICATION PLOTS		
APPENDIX C: PROBE AND DIPOLE CALIBRATION CERTIFICATES		
APPENDIX D: SAR TISSUE SPECIFICATIONS		
APPENDIX E: SAR SYSTEM VALIDATION		
APPENDIX F: SAR TEST SETUP PHOTOGRAPHS		

FCC ID: A3LSCHLC11R	 PCTEST <small>Engineering Laboratory, Inc.</small>	SAR EVALUATION REPORT	
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router	Reviewed by: Quality Manager Page 2 of 32

1 DEVICE UNDER TEST

1.1 Device Overview

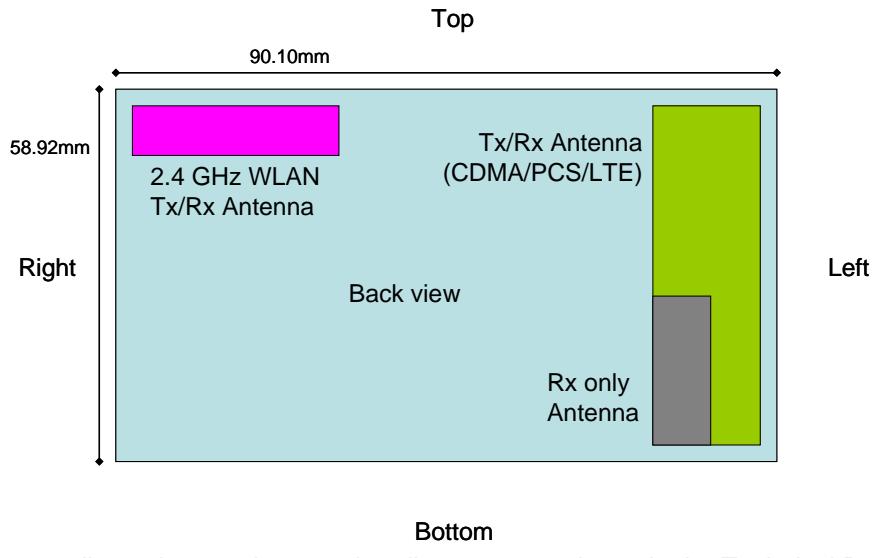
Band & Mode	Operating Modes	Tx Frequency
Cell. CDMA/EVDO	Data	824.70 - 848.31 MHz
PCS CDMA/EVDO	Data	1851.25 - 1908.75 MHz
LTE Band 12	Data	701.5 - 713.5 MHz
LTE Band 5 (Cell)	Data	824.7 - 848.3 MHz
LTE Band 4 (AWS)	Data	1712.5 - 1752.5 MHz
LTE Band 2 (PCS)	Data	1850.7 - 1909.3 MHz
2.4 GHz WLAN	Data	2412 - 2462 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

1.3 DUT Antenna Locations



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

Figure 1-1
DUT Antenna Locations

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 3 of 32

Table 1-1
Mobile Hotspot Sides for SAR Testing

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

Note: Particular DUT edges were not required to be evaluated for Wireless Router SAR if the edges were greater than 2.5 cm from the transmitting antenna according to FCC KDB Publication 941225 D06v01 guidance, page 2 and FCC KDB 648474 D04v01r01. The distances between the transmit antennas and the edges of the device are included in the filing.

1.4 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 1-2 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.

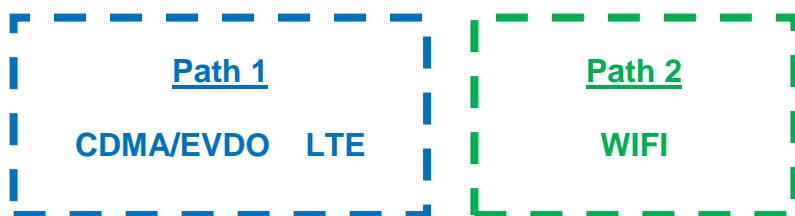


Figure 1-2
Simultaneous Transmission Paths

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

Table 1-2
Simultaneous Transmission Scenarios

No.	Capable Transmit Configurations	Hot Spot	Note
		FCC KDB 941225	
1	Cell./PCS CDMA/EVDO Data + WIFI 2.4GHz	Yes	Hotspot
2	LTE Band 2/4/5/12 Data + WIFI 2.4 GHz	Yes	4G Hotspot
3	Cell./PCS CDMA/EVDO Data + LTE Band 2/4/5/12 Data	No	N/S by Hardware
4	Cell./PCS CDMA 1x/EVDO Data + LTE Band 2/4/5/12 Data + 2.4 GHz WIFI	No	N/S by Hardware

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 4 of 32

1.5 SAR Test Exclusions Applied

This report evaluates SAR compliance for LTE Band 2 and LTE Band 4. Please refer to RF Exposure Technical Report 0Y1201230103-R1.A3L for original compliance report containing data for other main antenna and WLAN modes. No changes were made to any other modes or bands.

(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.

1.6 Power Reduction for SAR

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

1.7 Guidance Applied

- FCC KDB Publication 941225 D05 v02r03 (4G)
- FCC KDB Publication 941225 D06 v01r01 (Hotspot)
- FCC KDB Publication 447498 D01 v05r02 (General SAR Guidance)
- FCC KDB Publication 865664 D01 v01r03 (SAR Measurements up to 6 GHz)
- FCC KDB Publication 865664 D02 v01r01 (RF Exposure Reporting)

1.8 Device Serial Numbers

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

	Hotspot Serial Number
LTE Band 4 (AWS)	FCC #4
LTE Band 2 (PCS)	B-U#2

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 5 of 32

2 LTE INFORMATION

LTE Information			
FCC ID	A3LSCHLC11R		
Form Factor	Portable Wireless Router		
Frequency Range of each LTE transmission band	LTE Band 4 (AWS) (1712.5 - 1752.5 MHz) LTE Band 2 (PCS) (1850.7 - 1909.3 MHz)		
Channel Bandwidths	LTE Band 4 (AWS): 5 MHz, 10 MHz, 15 MHz, 20 MHz LTE Band 2 (PCS): 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz		
Channel Numbers and Frequencies (MHz)	Low	Mid	High
LTE Band 4 (AWS): 5 MHz	1712.5 (19975)	1732.5 (20175)	1752.5 (20375)
LTE Band 4 (AWS): 10 MHz	1715 (20000)	1732.5 (20175)	1750 (20350)
LTE Band 4 (AWS): 15 MHz	1717.5 (20025)	1732.5 (20175)	1747.5 (20325)
LTE Band 4 (AWS): 20 MHz	1720 (20050)	1732.5 (20175)	1745 (20300)
LTE Band 2 (PCS): 1.4 MHz	1850.7 (18607)	1880 (18900)	1909.3 (19193)
LTE Band 2 (PCS): 3 MHz	1851.5 (18615)	1880 (18900)	1908.5 (19185)
LTE Band 2 (PCS): 5 MHz	1852.5 (18625)	1880 (18900)	1907.5 (19175)
LTE Band 2 (PCS): 10 MHz	1855 (18650)	1880 (18900)	1905 (19150)
LTE Band 2 (PCS): 15 MHz	1857.5 (18675)	1880 (18900)	1902.5 (19125)
LTE Band 2 (PCS): 20 MHz	1860 (18700)	1880 (18900)	1900 (19100)
UE Category	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		

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 6 of 32

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]

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 7 of 32

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 ($10 \times 10 \times 10$) were obtained through interpolation, in order to calculate the averaged SAR.
 - c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as step 2, was re-measured after the zoom scan was complete to calculate the SAR drift. If the drift deviated by more than 5%, the SAR test and drift measurements were repeated.

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

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

*Also compliant to IEEE 1528-2013 Table 6

4.2 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 $\delta = 0.02$.

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT			Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router			Page 8 of 32

5 TEST CONFIGURATION POSITIONS

5.1 Wireless Router Configurations

Some battery-operated devices 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 portable devices ($L \times W \geq 9 \text{ cm} \times 5 \text{ cm}$) are based on a composite test separation distance of 10 mm from the front, back and edges of the device containing transmitting antennas within 2.5 cm of their edges, determined from general mixed use conditions for this type of devices.

When the user enables the personal wireless router functions for the device, 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 was NOT activated during SAR assessments, to ensure the SAR measurements were evaluated for a single transmission frequency RF signal at a time.

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 9 of 32

6 RF EXPOSURE LIMITS

6.1 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.

6.2 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 6-1
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.

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 10 of 32

7 FCC MEASUREMENT PROCEDURES

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

7.1 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.

7.2 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.

7.3 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).

7.3.1 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.

7.3.2 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.

7.3.3 A-MPR

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

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 11 of 32

7.3.4 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.

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 12 of 32

8 RF CONDUCTED POWERS

8.1 LTE Conducted Powers

8.1.1 LTE Band 4 (AWS)

Table 8-1
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]
1732.5	20175	20	QPSK	1	0	22.91	0	0
1732.5	20175	20	QPSK	1	50	23.00	0	0
1732.5	20175	20	QPSK	1	99	22.75	0	0
1732.5	20175	20	QPSK	50	0	22.00	0-1	1
1732.5	20175	20	QPSK	50	25	21.96	0-1	1
1732.5	20175	20	QPSK	50	50	21.98	0-1	1
1732.5	20175	20	QPSK	100	0	21.99	0-1	1
Mid	20175	20	16QAM	1	0	21.91	0-1	1
	20175	20	16QAM	1	50	21.93	0-1	1
	20175	20	16QAM	1	99	22.00	0-1	1
	20175	20	16QAM	50	0	21.00	0-2	2
	20175	20	16QAM	50	25	20.97	0-2	2
	20175	20	16QAM	50	50	20.93	0-2	2
	20175	20	16QAM	100	0	20.92	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.

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 13 of 32

Table 8-2
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	23.00	0
	1717.5	20025	15	QPSK	1	36	22.99	0
	1717.5	20025	15	QPSK	1	74	22.94	0
	1717.5	20025	15	QPSK	36	0	22.00	0-1
	1717.5	20025	15	QPSK	36	18	21.98	0-1
	1717.5	20025	15	QPSK	36	37	21.94	0-1
	1717.5	20025	15	QPSK	75	0	21.93	0-1
	1717.5	20025	15	16QAM	1	0	21.96	0-1
	1717.5	20025	15	16QAM	1	36	21.86	0-1
	1717.5	20025	15	16QAM	1	74	21.84	0-1
	1717.5	20025	15	16QAM	36	0	21.00	0-2
	1717.5	20025	15	16QAM	36	18	20.99	0-2
	1717.5	20025	15	16QAM	36	37	20.96	0-2
	1717.5	20025	15	16QAM	75	0	21.00	0-2
Mid	1732.5	20175	15	QPSK	1	0	22.79	0
	1732.5	20175	15	QPSK	1	36	22.82	0
	1732.5	20175	15	QPSK	1	74	22.61	0
	1732.5	20175	15	QPSK	36	0	22.00	0-1
	1732.5	20175	15	QPSK	36	18	21.86	0-1
	1732.5	20175	15	QPSK	36	37	22.00	0-1
	1732.5	20175	15	QPSK	75	0	21.95	0-1
	1732.5	20175	15	16QAM	1	0	21.87	0-1
	1732.5	20175	15	16QAM	1	36	21.95	0-1
	1732.5	20175	15	16QAM	1	74	21.87	0-1
	1732.5	20175	15	16QAM	36	0	21.00	0-2
	1732.5	20175	15	16QAM	36	18	21.00	0-2
	1732.5	20175	15	16QAM	36	37	20.91	0-2
	1732.5	20175	15	16QAM	75	0	20.94	0-2
High	1747.5	20325	15	QPSK	1	0	22.55	0
	1747.5	20325	15	QPSK	1	36	22.86	0
	1747.5	20325	15	QPSK	1	74	22.75	0
	1747.5	20325	15	QPSK	36	0	21.94	0-1
	1747.5	20325	15	QPSK	36	18	21.99	0-1
	1747.5	20325	15	QPSK	36	37	21.94	0-1
	1747.5	20325	15	QPSK	75	0	21.95	0-1
	1747.5	20325	15	16QAM	1	0	21.89	0-1
	1747.5	20325	15	16QAM	1	36	21.98	0-1
	1747.5	20325	15	16QAM	1	74	21.98	0-1
	1747.5	20325	15	16QAM	36	0	20.96	0-2
	1747.5	20325	15	16QAM	36	18	21.00	0-2
	1747.5	20325	15	16QAM	36	37	20.91	0-2
	1747.5	20325	15	16QAM	75	0	20.87	0-2

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 14 of 32

Table 8-3
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	23.00	0
	1715	20000	10	QPSK	1	25	23.00	0
	1715	20000	10	QPSK	1	49	22.94	0
	1715	20000	10	QPSK	25	0	22.00	0-1
	1715	20000	10	QPSK	25	12	21.94	0-1
	1715	20000	10	QPSK	25	25	21.87	0-1
	1715	20000	10	QPSK	50	0	21.99	0-1
	1715	20000	10	16QAM	1	0	22.00	0-1
	1715	20000	10	16QAM	1	25	21.91	0-1
	1715	20000	10	16QAM	1	49	21.76	0-1
	1715	20000	10	16QAM	25	0	21.00	0-2
	1715	20000	10	16QAM	25	12	20.94	0-2
	1715	20000	10	16QAM	25	25	20.92	0-2
	1715	20000	10	16QAM	50	0	20.91	0-2
Mid	1732.5	20175	10	QPSK	1	0	22.96	0
	1732.5	20175	10	QPSK	1	25	22.87	0
	1732.5	20175	10	QPSK	1	49	22.80	0
	1732.5	20175	10	QPSK	25	0	21.95	0-1
	1732.5	20175	10	QPSK	25	12	21.87	0-1
	1732.5	20175	10	QPSK	25	25	21.97	0-1
	1732.5	20175	10	QPSK	50	0	22.00	0-1
	1732.5	20175	10	16QAM	1	0	21.92	0-1
	1732.5	20175	10	16QAM	1	25	21.81	0-1
	1732.5	20175	10	16QAM	1	49	21.69	0-1
	1732.5	20175	10	16QAM	25	0	21.00	0-2
	1732.5	20175	10	16QAM	25	12	21.00	0-2
	1732.5	20175	10	16QAM	25	25	20.92	0-2
	1732.5	20175	10	16QAM	50	0	20.98	0-2
High	1750	20350	10	QPSK	1	0	22.85	0
	1750	20350	10	QPSK	1	25	22.86	0
	1750	20350	10	QPSK	1	49	22.74	0
	1750	20350	10	QPSK	25	0	22.00	0-1
	1750	20350	10	QPSK	25	12	22.00	0-1
	1750	20350	10	QPSK	25	25	21.92	0-1
	1750	20350	10	QPSK	50	0	21.88	0-1
	1750	20350	10	16QAM	1	0	22.00	0-1
	1750	20350	10	16QAM	1	25	21.96	0-1
	1750	20350	10	16QAM	1	49	21.94	0-1
	1750	20350	10	16QAM	25	0	21.00	0-2
	1750	20350	10	16QAM	25	12	21.00	0-2
	1750	20350	10	16QAM	25	25	20.98	0-2
	1750	20350	10	16QAM	50	0	20.98	0-2

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT				Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router			Page 15 of 32	

Table 8-4
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	22.91	0	0
	1712.5	19975	5	QPSK	1	12	22.99	0	0
	1712.5	19975	5	QPSK	1	24	22.81	0	0
	1712.5	19975	5	QPSK	12	0	22.00	0-1	1
	1712.5	19975	5	QPSK	12	6	22.00	0-1	1
	1712.5	19975	5	QPSK	12	13	21.97	0-1	1
	1712.5	19975	5	QPSK	25	0	21.98	0-1	1
	1712.5	19975	5	16-QAM	1	0	21.87	0-1	1
	1712.5	19975	5	16-QAM	1	12	21.72	0-1	1
	1712.5	19975	5	16-QAM	1	24	21.78	0-1	1
	1712.5	19975	5	16-QAM	12	0	21.00	0-2	2
	1712.5	19975	5	16-QAM	12	6	20.97	0-2	2
	1712.5	19975	5	16-QAM	12	13	20.92	0-2	2
	1712.5	19975	5	16-QAM	25	0	21.00	0-2	2
Mid	1732.5	20175	5	QPSK	1	0	23.00	0	0
	1732.5	20175	5	QPSK	1	12	22.99	0	0
	1732.5	20175	5	QPSK	1	24	23.00	0	0
	1732.5	20175	5	QPSK	12	0	21.89	0-1	1
	1732.5	20175	5	QPSK	12	6	21.90	0-1	1
	1732.5	20175	5	QPSK	12	13	21.90	0-1	1
	1732.5	20175	5	QPSK	25	0	21.89	0-1	1
	1732.5	20175	5	16-QAM	1	0	22.00	0-1	1
	1732.5	20175	5	16-QAM	1	12	21.99	0-1	1
	1732.5	20175	5	16-QAM	1	24	22.00	0-1	1
	1732.5	20175	5	16-QAM	12	0	20.95	0-2	2
	1732.5	20175	5	16-QAM	12	6	20.97	0-2	2
	1732.5	20175	5	16-QAM	12	13	21.00	0-2	2
	1732.5	20175	5	16-QAM	25	0	20.98	0-2	2
High	1752.5	20375	5	QPSK	1	0	22.76	0	0
	1752.5	20375	5	QPSK	1	12	22.78	0	0
	1752.5	20375	5	QPSK	1	24	22.62	0	0
	1752.5	20375	5	QPSK	12	0	21.84	0-1	1
	1752.5	20375	5	QPSK	12	6	21.86	0-1	1
	1752.5	20375	5	QPSK	12	13	21.83	0-1	1
	1752.5	20375	5	QPSK	25	0	21.78	0-1	1
	1752.5	20375	5	16-QAM	1	0	21.70	0-1	1
	1752.5	20375	5	16-QAM	1	12	21.59	0-1	1
	1752.5	20375	5	16-QAM	1	24	21.60	0-1	1
	1752.5	20375	5	16-QAM	12	0	20.86	0-2	2
	1752.5	20375	5	16-QAM	12	6	20.83	0-2	2
	1752.5	20375	5	16-QAM	12	13	20.79	0-2	2
	1752.5	20375	5	16-QAM	25	0	21.00	0-2	2

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT			Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 16 of 32	

8.1.2

LTE Band 2 (PCS)

Table 8-5
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	22.50	0
	1860	18700	20	QPSK	1	50	22.45	0
	1860	18700	20	QPSK	1	99	22.44	0
	1860	18700	20	QPSK	50	0	21.39	0-1
	1860	18700	20	QPSK	50	25	21.44	0-1
	1860	18700	20	QPSK	50	50	21.45	0-1
	1860	18700	20	QPSK	100	0	21.50	0-1
	1860	18700	20	16QAM	1	0	21.71	0-1
	1860	18700	20	16QAM	1	50	21.68	0-1
	1860	18700	20	16QAM	1	99	21.76	0-1
	1860	18700	20	16QAM	50	0	20.72	0-2
	1860	18700	20	16QAM	50	25	20.52	0-2
	1860	18700	20	16QAM	50	50	20.62	0-2
	1860	18700	20	16QAM	100	0	20.56	0-2
Mid	1880.0	18900	20	QPSK	1	0	22.06	0
	1880.0	18900	20	QPSK	1	50	22.33	0
	1880.0	18900	20	QPSK	1	99	22.31	0
	1880.0	18900	20	QPSK	50	0	21.90	0-1
	1880.0	18900	20	QPSK	50	25	21.73	0-1
	1880.0	18900	20	QPSK	50	50	21.58	0-1
	1880.0	18900	20	QPSK	100	0	21.66	0-1
	1880.0	18900	20	16QAM	1	0	21.52	0-1
	1880.0	18900	20	16QAM	1	50	21.56	0-1
	1880.0	18900	20	16QAM	1	99	21.53	0-1
	1880.0	18900	20	16QAM	50	0	20.73	0-2
	1880.0	18900	20	16QAM	50	25	20.83	0-2
	1880.0	18900	20	16QAM	50	50	20.73	0-2
	1880.0	18900	20	16QAM	100	0	20.85	0-2
High	1900	19100	20	QPSK	1	0	22.35	0
	1900	19100	20	QPSK	1	50	22.76	0
	1900	19100	20	QPSK	1	99	22.46	0
	1900	19100	20	QPSK	50	0	21.86	0-1
	1900	19100	20	QPSK	50	25	22.00	0-1
	1900	19100	20	QPSK	50	50	21.84	0-1
	1900	19100	20	QPSK	100	0	21.89	0-1
	1900	19100	20	16QAM	1	0	21.85	0-1
	1900	19100	20	16QAM	1	50	21.98	0-1
	1900	19100	20	16QAM	1	99	21.74	0-1
	1900	19100	20	16QAM	50	0	20.76	0-2
	1900	19100	20	16QAM	50	25	20.91	0-2
	1900	19100	20	16QAM	50	50	20.83	0-2
	1900	19100	20	16QAM	100	0	20.94	0-2

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 17 of 32

Table 8-6
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	22.35	0	0
	1857.5	18675	15	QPSK	1	36	22.33	0	0
	1857.5	18675	15	QPSK	1	74	22.44	0	0
	1857.5	18675	15	QPSK	36	0	21.59	0-1	1
	1857.5	18675	15	QPSK	36	18	21.40	0-1	1
	1857.5	18675	15	QPSK	36	37	21.37	0-1	1
	1857.5	18675	15	QPSK	75	0	21.48	0-1	1
	1857.5	18675	15	16QAM	1	0	21.70	0-1	1
	1857.5	18675	15	16QAM	1	36	21.65	0-1	1
	1857.5	18675	15	16QAM	1	74	21.63	0-1	1
	1857.5	18675	15	16QAM	36	0	20.70	0-2	2
	1857.5	18675	15	16QAM	36	18	20.58	0-2	2
	1857.5	18675	15	16QAM	36	37	20.64	0-2	2
	1857.5	18675	15	16QAM	75	0	20.61	0-2	2
Mid	1880.0	18900	15	QPSK	1	0	22.02	0	0
	1880.0	18900	15	QPSK	1	36	22.16	0	0
	1880.0	18900	15	QPSK	1	74	22.32	0	0
	1880.0	18900	15	QPSK	36	0	21.89	0-1	1
	1880.0	18900	15	QPSK	36	18	21.60	0-1	1
	1880.0	18900	15	QPSK	36	37	21.56	0-1	1
	1880.0	18900	15	QPSK	75	0	21.67	0-1	1
	1880.0	18900	15	16QAM	1	0	21.73	0-1	1
	1880.0	18900	15	16QAM	1	36	21.93	0-1	1
	1880.0	18900	15	16QAM	1	74	22.00	0-1	1
	1880.0	18900	15	16QAM	36	0	20.76	0-2	2
	1880.0	18900	15	16QAM	36	18	20.68	0-2	2
	1880.0	18900	15	16QAM	36	37	20.68	0-2	2
	1880.0	18900	15	16QAM	75	0	20.66	0-2	2
High	1902.5	19125	15	QPSK	1	0	22.55	0	0
	1902.5	19125	15	QPSK	1	36	22.64	0	0
	1902.5	19125	15	QPSK	1	74	22.41	0	0
	1902.5	19125	15	QPSK	36	0	22.00	0-1	1
	1902.5	19125	15	QPSK	36	18	21.97	0-1	1
	1902.5	19125	15	QPSK	36	37	21.81	0-1	1
	1902.5	19125	15	QPSK	75	0	21.71	0-1	1
	1902.5	19125	15	16QAM	1	0	21.93	0-1	1
	1902.5	19125	15	16QAM	1	36	21.00	0-1	1
	1902.5	19125	15	16QAM	1	74	21.89	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	20.91	0-2	2
	1902.5	19125	15	16QAM	75	0	20.88	0-2	2

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT			Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router			Page 18 of 32

Table 8-7
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	22.12	0	0
	1855	18650	10	QPSK	1	25	22.17	0	0
	1855	18650	10	QPSK	1	49	22.05	0	0
	1855	18650	10	QPSK	25	0	21.31	0-1	1
	1855	18650	10	QPSK	25	12	21.26	0-1	1
	1855	18650	10	QPSK	25	25	21.23	0-1	1
	1855	18650	10	QPSK	50	0	21.21	0-1	1
	1855	18650	10	16QAM	1	0	21.35	0-1	1
	1855	18650	10	16QAM	1	25	21.44	0-1	1
	1855	18650	10	16QAM	1	49	21.28	0-1	1
	1855	18650	10	16QAM	25	0	20.46	0-2	2
	1855	18650	10	16QAM	25	12	20.54	0-2	2
	1855	18650	10	16QAM	25	25	20.57	0-2	2
	1855	18650	10	16QAM	50	0	20.41	0-2	2
	1880.0	18900	10	QPSK	1	0	22.34	0	0
Mid	1880.0	18900	10	QPSK	1	25	22.37	0	0
	1880.0	18900	10	QPSK	1	49	22.49	0	0
	1880.0	18900	10	QPSK	25	0	21.61	0-1	1
	1880.0	18900	10	QPSK	25	12	21.44	0-1	1
	1880.0	18900	10	QPSK	25	25	21.48	0-1	1
	1880.0	18900	10	QPSK	50	0	21.51	0-1	1
	1880.0	18900	10	16QAM	1	0	21.29	0-1	1
	1880.0	18900	10	16QAM	1	25	21.33	0-1	1
	1880.0	18900	10	16QAM	1	49	21.35	0-1	1
	1880.0	18900	10	16QAM	25	0	20.75	0-2	2
	1880.0	18900	10	16QAM	25	12	20.61	0-2	2
	1880.0	18900	10	16QAM	25	25	20.57	0-2	2
	1880.0	18900	10	16QAM	50	0	20.65	0-2	2
	1905	19150	10	QPSK	1	0	22.60	0	0
High	1905	19150	10	QPSK	1	25	22.53	0	0
	1905	19150	10	QPSK	1	49	22.20	0	0
	1905	19150	10	QPSK	25	0	21.70	0-1	1
	1905	19150	10	QPSK	25	12	21.79	0-1	1
	1905	19150	10	QPSK	25	25	21.61	0-1	1
	1905	19150	10	QPSK	50	0	21.53	0-1	1
	1905	19150	10	16QAM	1	0	21.54	0-1	1
	1905	19150	10	16QAM	1	25	21.87	0-1	1
	1905	19150	10	16QAM	1	49	21.21	0-1	1
	1905	19150	10	16QAM	25	0	20.92	0-2	2
	1905	19150	10	16QAM	25	12	21.00	0-2	2
	1905	19150	10	16QAM	25	25	20.88	0-2	2
	1905	19150	10	16QAM	50	0	20.77	0-2	2

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT			Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 19 of 32	

Table 8-8
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	22.11	0	0
	1852.5	18625	5	QPSK	1	12	22.13	0	0
	1852.5	18625	5	QPSK	1	24	22.08	0	0
	1852.5	18625	5	QPSK	12	0	21.31	0-1	1
	1852.5	18625	5	QPSK	12	6	21.28	0-1	1
	1852.5	18625	5	QPSK	12	13	21.25	0-1	1
	1852.5	18625	5	QPSK	25	0	21.24	0-1	1
	1852.5	18625	5	16-QAM	1	0	21.08	0-1	1
	1852.5	18625	5	16-QAM	1	12	21.00	0-1	1
	1852.5	18625	5	16-QAM	1	24	21.03	0-1	1
	1852.5	18625	5	16-QAM	12	0	20.41	0-2	2
	1852.5	18625	5	16-QAM	12	6	20.39	0-2	2
	1852.5	18625	5	16-QAM	12	13	20.36	0-2	2
	1852.5	18625	5	16-QAM	25	0	20.91	0-2	2
Mid	1880.0	18900	5	QPSK	1	0	22.56	0	0
	1880.0	18900	5	QPSK	1	12	22.47	0	0
	1880.0	18900	5	QPSK	1	24	22.61	0	0
	1880.0	18900	5	QPSK	12	0	21.49	0-1	1
	1880.0	18900	5	QPSK	12	6	21.37	0-1	1
	1880.0	18900	5	QPSK	12	13	21.37	0-1	1
	1880.0	18900	5	QPSK	25	0	21.49	0-1	1
	1880.0	18900	5	16-QAM	1	0	21.84	0-1	1
	1880.0	18900	5	16-QAM	1	12	21.71	0-1	1
	1880.0	18900	5	16-QAM	1	24	21.89	0-1	1
	1880.0	18900	5	16-QAM	12	0	20.62	0-2	2
	1880.0	18900	5	16-QAM	12	6	20.59	0-2	2
	1880.0	18900	5	16-QAM	12	13	20.55	0-2	2
	1880.0	18900	5	16-QAM	25	0	20.76	0-2	2
High	1907.5	19175	5	QPSK	1	0	22.54	0	0
	1907.5	19175	5	QPSK	1	12	22.35	0	0
	1907.5	19175	5	QPSK	1	24	22.00	0	0
	1907.5	19175	5	QPSK	12	0	21.59	0-1	1
	1907.5	19175	5	QPSK	12	6	21.62	0-1	1
	1907.5	19175	5	QPSK	12	13	21.30	0-1	1
	1907.5	19175	5	QPSK	25	0	21.29	0-1	1
	1907.5	19175	5	16-QAM	1	0	21.49	0-1	1
	1907.5	19175	5	16-QAM	1	12	21.38	0-1	1
	1907.5	19175	5	16-QAM	1	24	21.00	0-1	1
	1907.5	19175	5	16-QAM	12	0	20.57	0-2	2
	1907.5	19175	5	16-QAM	12	6	20.60	0-2	2
	1907.5	19175	5	16-QAM	12	13	20.34	0-2	2
	1907.5	19175	5	16-QAM	25	0	20.70	0-2	2

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT			Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 20 of 32	

Table 8-9
LTE Band 2 (PCS) Conducted Powers - 3 MHz Bandwidth

Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1851.5	18615	3	QPSK	1	0	22.50	0
	1851.5	18615	3	QPSK	1	7	22.19	0
	1851.5	18615	3	QPSK	1	14	22.60	0
	1851.5	18615	3	QPSK	8	0	21.16	0-1
	1851.5	18615	3	QPSK	8	4	21.74	0-1
	1851.5	18615	3	QPSK	8	7	21.14	0-1
	1851.5	18615	3	QPSK	15	0	21.69	0-1
	1851.5	18615	3	16-QAM	1	0	21.31	0-1
	1851.5	18615	3	16-QAM	1	7	21.00	0-1
	1851.5	18615	3	16-QAM	1	14	21.37	0-1
	1851.5	18615	3	16-QAM	8	0	20.34	0-2
	1851.5	18615	3	16-QAM	8	4	20.90	0-2
	1851.5	18615	3	16-QAM	8	7	20.26	0-2
	1851.5	18615	3	16-QAM	15	0	20.54	0-2
	1880.0	18900	3	QPSK	1	0	22.51	0
Mid	1880.0	18900	3	QPSK	1	7	22.22	0
	1880.0	18900	3	QPSK	1	14	22.50	0
	1880.0	18900	3	QPSK	8	0	21.20	0-1
	1880.0	18900	3	QPSK	8	4	21.53	0-1
	1880.0	18900	3	QPSK	8	7	21.25	0-1
	1880.0	18900	3	QPSK	15	0	21.52	0-1
	1880.0	18900	3	16-QAM	1	0	21.32	0-1
	1880.0	18900	3	16-QAM	1	7	21.15	0-1
	1880.0	18900	3	16-QAM	1	14	21.30	0-1
	1880.0	18900	3	16-QAM	8	0	20.18	0-2
	1880.0	18900	3	16-QAM	8	4	20.67	0-2
	1880.0	18900	3	16-QAM	8	7	20.10	0-2
	1880.0	18900	3	16-QAM	15	0	20.53	0-2
	1908.5	19185	3	QPSK	1	0	22.61	0
High	1908.5	19185	3	QPSK	1	7	22.00	0
	1908.5	19185	3	QPSK	1	14	22.04	0
	1908.5	19185	3	QPSK	8	0	21.13	0-1
	1908.5	19185	3	QPSK	8	4	21.51	0-1
	1908.5	19185	3	QPSK	8	7	21.00	0-1
	1908.5	19185	3	QPSK	15	0	21.45	0-1
	1908.5	19185	3	16-QAM	1	0	21.44	0-1
	1908.5	19185	3	16-QAM	1	7	21.16	0-1
	1908.5	19185	3	16-QAM	1	14	21.01	0-1
	1908.5	19185	3	16-QAM	8	0	20.06	0-2
	1908.5	19185	3	16-QAM	8	4	20.68	0-2
	1908.5	19185	3	16-QAM	8	7	20.00	0-2
	1908.5	19185	3	16-QAM	15	0	20.29	0-2
	1908.5	19185	3	16-QAM	15	0	20.29	0-2

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 21 of 32

Table 8-10
LTE Band 2 (PCS) Conducted Powers - 1.4 MHz Bandwidth

	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1850.7	18607	1.4	QPSK	1	0	22.61	0	0
	1850.7	18607	1.4	QPSK	1	2	22.20	0	0
	1850.7	18607	1.4	QPSK	1	5	22.73	0	0
	1850.7	18607	1.4	QPSK	3	0	22.08	0	0
	1850.7	18607	1.4	QPSK	3	2	22.74	0	0
	1850.7	18607	1.4	QPSK	3	3	22.10	0	0
	1850.7	18607	1.4	QPSK	6	0	21.69	0-1	1
	1850.7	18607	1.4	16-QAM	1	0	21.76	0-1	1
	1850.7	18607	1.4	16-QAM	1	2	21.00	0-1	1
	1850.7	18607	1.4	16-QAM	1	5	21.83	0-1	1
	1850.7	18607	1.4	16-QAM	3	0	21.15	0-1	1
	1850.7	18607	1.4	16-QAM	3	2	21.87	0-1	1
	1850.7	18607	1.4	16-QAM	3	3	21.21	0-1	1
	1850.7	18607	1.4	16-QAM	6	0	20.57	0-2	2
Mid	1880.0	18900	1.4	QPSK	1	0	22.50	0	0
	1880.0	18900	1.4	QPSK	1	2	22.31	0	0
	1880.0	18900	1.4	QPSK	1	5	22.49	0	0
	1880.0	18900	1.4	QPSK	3	0	22.15	0	0
	1880.0	18900	1.4	QPSK	3	2	22.74	0	0
	1880.0	18900	1.4	QPSK	3	3	22.29	0	0
	1880.0	18900	1.4	QPSK	6	0	21.64	0-1	1
	1880.0	18900	1.4	16-QAM	1	0	21.89	0-1	1
	1880.0	18900	1.4	16-QAM	1	2	21.08	0-1	1
	1880.0	18900	1.4	16-QAM	1	5	21.76	0-1	1
	1880.0	18900	1.4	16-QAM	3	0	21.48	0-1	1
	1880.0	18900	1.4	16-QAM	3	2	21.70	0-1	1
	1880.0	18900	1.4	16-QAM	3	3	21.51	0-1	1
	1880.0	18900	1.4	16-QAM	6	0	20.76	0-2	2
High	1909.3	19193	1.4	QPSK	1	0	22.37	0	0
	1909.3	19193	1.4	QPSK	1	2	22.00	0	0
	1909.3	19193	1.4	QPSK	1	5	22.02	0	0
	1909.3	19193	1.4	QPSK	3	0	22.13	0	0
	1909.3	19193	1.4	QPSK	3	2	22.20	0	0
	1909.3	19193	1.4	QPSK	3	3	22.00	0	0
	1909.3	19193	1.4	QPSK	6	0	21.69	0-1	1
	1909.3	19193	1.4	16-QAM	1	0	21.51	0-1	1
	1909.3	19193	1.4	16-QAM	1	2	21.00	0-1	1
	1909.3	19193	1.4	16-QAM	1	5	21.14	0-1	1
	1909.3	19193	1.4	16-QAM	3	0	21.07	0-1	1
	1909.3	19193	1.4	16-QAM	3	2	21.67	0-1	1
	1909.3	19193	1.4	16-QAM	3	3	21.02	0-1	1
	1909.3	19193	1.4	16-QAM	6	0	20.56	0-2	2

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT				Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router			Page 22 of 32	

9 SYSTEM VERIFICATION

9.1 Tissue Verification

Table 9-1
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
7/21/2014	1750B	21.0	1710	1.496	52.641	1.463	53.537	2.26%	-1.67%
			1750	1.539	52.495	1.488	53.432	3.43%	-1.75%
			1790	1.584	52.349	1.514	53.326	4.62%	-1.83%
7/21/2014	1900B	23.7	1850	1.469	52.184	1.520	53.300	-3.36%	-2.09%
			1880	1.500	52.073	1.520	53.300	-1.32%	-2.30%
			1910	1.535	51.978	1.520	53.300	0.99%	-2.48%

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.

9.2 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 9-2
System Verification Results

System Verification TARGET & MEASURED												
SAR System #	Tissue Frequency (MHz)	Tissue Type	Date:	Amb. Temp (°C)	Liquid Temp (°C)	Input Power (W)	Dipole SN	Probe SN	Measured SAR _{1g} (W/kg)	1 W Target SAR _{1g} (W/kg)	1 W Normalized SAR _{1g} (W/kg)	Deviation _{1g} (%)
C	1750	BODY	07/21/2014	23.3	21.0	0.100	1051	3213	3.670	37.400	36.700	-1.87%
B	1900	BODY	07/21/2014	23.8	23.7	0.100	5d148	3288	4.170	39.300	41.700	6.11%

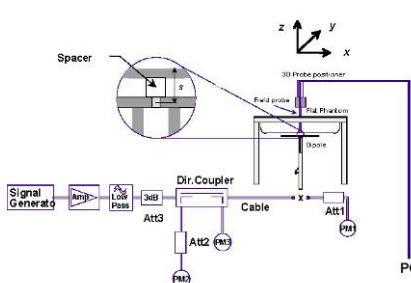


Figure 9-1
System Verification Setup Diagram



Figure 9-2
System Verification Setup Photo

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 23 of 32

10 SAR DATA SUMMARY

10.1 Standalone Wireless Router SAR Data

Table 10-1
LTE Band 4 (AWS) Hotspot SAR

MEASUREMENT RESULTS																			
FREQUENCY		Mode	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Device Serial Number	Modulation	RB Size	RB Offset	Spacing	Side	Duty Cycle	SAR (1g) (W/kg)	Scaling Factor	Scaled SAR (1g) (W/kg)	Plot #	
MHz	Ch.																		
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.0	23.00	-0.03	0	FCC #4	QPSK	1	50	10 mm	back	1:1	0.585	1.000	0.585	A1
1732.50	20175	Mid	LTE Band 4 (AWS)	20	22.0	22.00	-0.01	1	FCC #4	QPSK	50	0	10 mm	back	1:1	0.513	1.000	0.513	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.0	23.00	-0.04	0	FCC #4	QPSK	1	50	10 mm	front	1:1	0.459	1.000	0.459	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	22.0	22.00	0.12	1	FCC #4	QPSK	50	0	10 mm	front	1:1	0.433	1.000	0.433	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.0	23.00	0.04	0	FCC #4	QPSK	1	50	10 mm	top	1:1	0.261	1.000	0.261	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	22.0	22.00	0.06	1	FCC #4	QPSK	50	0	10 mm	top	1:1	0.211	1.000	0.211	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.0	23.00	0.06	0	FCC #4	QPSK	1	50	10 mm	bottom	1:1	0.187	1.000	0.187	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	22.0	22.00	0.05	1	FCC #4	QPSK	50	0	10 mm	bottom	1:1	0.159	1.000	0.159	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	23.0	23.00	0.00	0	FCC #4	QPSK	1	50	10 mm	left	1:1	0.256	1.000	0.256	
1732.50	20175	Mid	LTE Band 4 (AWS)	20	22.0	22.00	-0.04	1	FCC #4	QPSK	50	0	10 mm	left	1:1	0.229	1.000	0.229	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT										Body									
Spatial Peak										1.6 W/kg (mW/g)									
Uncontrolled Exposure/General Population										averaged over 1 gram									

Table 10-2
LTE Band 2 (PCS) Hotspot SAR

MEASUREMENT RESULTS																			
FREQUENCY		Mode	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Device Serial Number	Modulation	RB Size	RB Offset	Spacing	Side	Duty Cycle	SAR (1g) (W/kg)	Scaling Factor	Scaled SAR (1g) (W/kg)	Plot #	
MHz	Ch.																		
1900.00	19100	High	LTE Band 2 (PCS)	20	23.0	22.76	-0.18	0	B-U#2	QPSK	1	50	10 mm	back	1:1	0.112	1.057	0.118	
1900.00	19100	High	LTE Band 2 (PCS)	20	22.0	22.00	-0.04	1	B-U#2	QPSK	50	25	10 mm	back	1:1	0.082	1.000	0.082	
1900.00	19100	High	LTE Band 2 (PCS)	20	23.0	22.76	0.16	0	B-U#2	QPSK	1	50	10 mm	front	1:1	0.125	1.057	0.132	A2
1900.00	19100	High	LTE Band 2 (PCS)	20	22.0	22.00	0.08	1	B-U#2	QPSK	50	25	10 mm	front	1:1	0.095	1.000	0.095	
1900.00	19100	High	LTE Band 2 (PCS)	20	23.0	22.76	0.11	0	B-U#2	QPSK	1	50	10 mm	top	1:1	0.074	1.057	0.078	
1900.00	19100	High	LTE Band 2 (PCS)	20	22.0	22.00	0.01	1	B-U#2	QPSK	50	25	10 mm	top	1:1	0.059	1.000	0.059	
1900.00	19100	High	LTE Band 2 (PCS)	20	23.0	22.76	-0.12	0	B-U#2	QPSK	1	50	10 mm	bottom	1:1	0.043	1.057	0.045	
1900.00	19100	High	LTE Band 2 (PCS)	20	22.0	22.00	-0.13	1	B-U#2	QPSK	50	25	10 mm	bottom	1:1	0.032	1.000	0.032	
1900.00	19100	High	LTE Band 2 (PCS)	20	23.0	22.76	0.16	0	B-U#2	QPSK	1	50	10 mm	left	1:1	0.048	1.057	0.051	
1900.00	19100	High	LTE Band 2 (PCS)	20	22.0	22.00	-0.01	1	B-U#2	QPSK	50	25	10 mm	left	1:1	0.037	1.000	0.037	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT										Body									
Spatial Peak										1.6 W/kg (mW/g)									
Uncontrolled Exposure/General Population										averaged over 1 gram									

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT	 Samsung	Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 24 of 32

10.2 SAR Test Notes

General Notes:

1. The test data reported are the worst-case SAR values according to test procedures specified in FCC KDB 941225 D06v01, and FCC KDB Publication 447498 D01v05.
2. Batteries are fully charged at the beginning of the SAR measurements.
3. Liquid tissue depth was at least 15.0 cm for all frequencies.
4. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
5. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01v05.
6. Per FCC KDB 865664 D01 v01, variability SAR tests were not performed since the measured SAR results for a frequency band were less than 0.8 W/kg.
7. 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 5.1 for more details).

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 7.3.4.
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).

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 25 of 32

11 FCC MULTI-TX AND ANTENNA SAR CONSIDERATIONS

11.1 Introduction

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

11.2 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.

Please see RF Exposure Technical Reports S/N: 0Y1201230103-R1.A3L for simultaneous SAR assessments for the other combinations not referred to in these tables. This report only contains the combinations applicable to the permissive change. SAR values have been scaled according to FCC KDB Publication 447498 D01v05 to show simultaneous compliance for this C2PC.

11.3 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 11-1
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	0.585	0.219	0.804	Body SAR	Back	0.118	0.219	0.337
	Front	0.459	0.236	0.695		Front	0.132	0.236	0.368
	Top	0.261	0.197	0.458		Top	0.078	0.197	0.275
	Bottom	0.187	-	0.187		Bottom	0.045	-	0.045
	Right	-	0.181	0.181		Right	-	0.181	0.181
	Left	0.256	-	0.256		Left	0.051	-	0.051

11.4 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.

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT			Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 26 of 32	

12 SAR MEASUREMENT VARIABILITY

12.1 Measurement Variability

Per FCC KDB Publication 865664 D01v01, SAR measurement variability is assessed when the highest measured SAR is ≥ 0.80 W/kg. Since all measured SAR values are < 0.80 W/kg for this device, SAR measurement variability was not assessed.

12.2 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.

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 27 of 32

13 EQUIPMENT LIST

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	8648D	(9kHz-4GHz) Signal Generator	4/15/2014	Annual	4/15/2015	3629U00687
Agilent	8753E	(30kHz-6GHz) Network Analyzer	7/23/2013	Annual	7/23/2014	US37390350
Agilent	8753ES	S-Parameter Network Analyzer	5/22/2014	Annual	5/22/2015	US39170118
Agilent	8753ES	S-Parameter Network Analyzer	10/29/2013	Annual	10/29/2014	US39170122
Agilent	E4438C	ESG Vector Signal Generator	4/25/2014	Annual	4/25/2015	MY42082385
Agilent	E4438C	ESG Vector Signal Generator	3/31/2014	Annual	3/31/2015	MY42082659
Agilent	E8257D	(250kHz-20GHz) Signal Generator	4/15/2014	Annual	4/15/2015	MY45470194
Agilent	N5182A	MXG Vector Signal Generator	4/15/2014	Annual	4/15/2015	MY47420651
Agilent	N5182A	MXG Vector Signal Generator	4/15/2014	Annual	4/15/2015	MY47420800
Agilent	N9020A	MXA Signal Analyzer	10/29/2013	Annual	10/29/2014	US46470561
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	433971
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	433972
Anritsu	MA24106A	USB Power Sensor	5/14/2014	Annual	5/14/2015	1231535
Anritsu	MA24106A	USB Power Sensor	5/14/2014	Annual	5/14/2015	1231538
Anritsu	MA24106A	USB Power Sensor	5/15/2014	Annual	5/15/2015	1244512
Anritsu	MA24106A	USB Power Sensor	5/14/2014	Annual	5/14/2015	1244515
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	ML2469A	Power Meter	3/14/2014	Annual	3/14/2015	1306009
COMTech	AR85729-5	Solid State Amplifier	CBT	N/A	CBT	M155A00-009
COMTECH	AR85729-5/5759B	Solid State Amplifier	CBT	N/A	CBT	M3W1A00-1002
Control Company	4052	Long Stem Thermometer	9/27/2013	Biennial	9/27/2015	130567447
Control Company	36934-158	Wall-Mounted Thermometer	4/29/2014	Biennial	4/29/2016	122014488
Fisher Scientific	15-077-960	Digital Thermometer	11/6/2012	Biennial	11/6/2014	122640025
Fisher Scientific	15-078J	Long Stem Thermometer	10/30/2012	Biennial	10/30/2014	122626059
Fisher Scientific	S97611	Thermometer	4/12/2013	Biennial	4/12/2015	130219303
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	SLP-2400+	Low Pass Filter	CBT	N/A	CBT	R8979500903
Mini-Circuits	BW-N20W5	Power Attenuator	CBT	N/A	CBT	1226
Mini-Circuits	BW-N20W5+	DC to 18 GHz Precision Fixed 20 dB Attenuator	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-1200+	Low Pass Filter DC to 1000 MHz	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-2950+	Low Pass Filter DC to 2700 MHz	CBT	N/A	CBT	N/A
Mitutoyo	CD-6"CSX	Digital Caliper	5/8/2014	Biennial	5/8/2016	13264162
Mitutoyo	CD-6"CSX	Digital Caliper	5/8/2014	Biennial	5/8/2016	13264165
Narda	4014C-6	4 - 8 GHz SMA 6 dB Directional Coupler	CBT	N/A	CBT	N/A
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Narda	BW-S3W2	Attenuator (3dB)	CBT	N/A	CBT	120
Pasternack	PE2208-6	Bidirectional Coupler	CBT	N/A	CBT	N/A
Pasternack	PE2209-10	Bidirectional Coupler	CBT	N/A	CBT	N/A
Rohde & Schwarz	CMW500	Radio Communication Tester	7/22/2014	Annual	7/22/2015	116743
Rohde & Schwarz	CMW500	Radio Communication Tester	2/20/2014	Annual	2/20/2015	128633
Seekonk	NC-100	Torque Wrench	3/18/2014	Biennial	3/18/2016	22313
Seekonk	NC-100	Torque Wrench 5/16", 8" lbs	3/18/2014	Biennial	3/18/2016	N/A
Seekonk	NC-100	Torque Wrench	3/18/2014	Biennial	3/18/2016	N/A
Seekonk	NC-100	Torque Wrench	3/18/2014	Biennial	3/18/2016	N/A
SPEAG	D1750V2	1750 MHz SAR Dipole	4/10/2014	Annual	4/10/2015	1051
SPEAG	D1900V2	1900 MHz SAR Dipole	2/27/2014	Annual	2/27/2015	5d148
SPEAG	DAE4	Dasy Data Acquisition Electronics	9/17/2013	Annual	9/17/2014	1323
SPEAG	DAE4	Dasy Data Acquisition Electronics	3/17/2014	Annual	3/17/2015	1364
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	DAKS-3.5	Portable Dielectric Assessment Kit	8/18/2013	Annual	8/18/2014	1008
SPEAG	DAKS-3.5	Portable Dielectric Assessment Kit	8/18/2013	Annual	8/18/2014	1009
SPEAG	ES3DV3	SAR Probe	4/11/2014	Annual	4/11/2015	3213
SPEAG	ES3DV3	SAR Probe	9/23/2013	Annual	9/23/2014	3288
Tektronix	RSA6114A	Real Time Spectrum Analyzer	4/16/2014	Annual	4/16/2015	8010177
VWR	36934-158	Wall-Mounted Thermometer	4/29/2014	Biennial	4/29/2016	111859323

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.

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 28 of 32

14 MEASUREMENT UNCERTAINTIES

Applicable for frequencies less than 3000 MHz.

a	b	c	d	e= f(d,k)	f	g	h = c x f/e	i = c x g/e	k
Uncertainty Component	IEEE 1528 Sec.	Tol. (± %)	Prob. Dist.	Div.	c _i 1gm	c _i 10 gms	1gm u _i (± %)	10gms u _i (± %)	v _i
Measurement System									
Probe Calibration	E.2.1	6.0	N	1	1.0	1.0	6.0	6.0	∞
Axial Isotropy	E.2.2	0.25	N	1	0.7	0.7	0.2	0.2	∞
Hemispherical 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)							12.1	11.7	299
Expanded Uncertainty (95% CONFIDENCE LEVEL)							24.2	23.5	

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

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT					Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router					Page 29 of 32

15 CONCLUSION

15.1 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]

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 30 of 32

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FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router		Page 31 of 32

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FCC ID: A3LSCHLC11R	 SAR EVALUATION REPORT 			Reviewed by: Quality Manager
Document S/N: 0Y1407221424.A3L	Test Dates: 07/21/14	DUT Type: Portable Wireless Router	Page 32 of 32	
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APPENDIX A: SAR TEST DATA

PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSCHLC11R; Type: Portable Wireless Router; Serial: FCC #4

Communication System: UID 0, LTE RF; Frequency: 1732.5 MHz; Duty Cycle: 1:1

Medium: 1750 Body Medium parameters used (interpolated):

$$f = 1732.5 \text{ MHz}; \sigma = 1.52 \text{ S/m}; \epsilon_r = 52.559; \rho = 1000 \text{ kg/m}^3$$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-21-2014; Ambient Temp: 23.3°C; Tissue Temp: 21.0°C

Probe: ES3DV3 - SN3213; ConvF(4.89, 4.89, 4.89); Calibrated: 4/11/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1364; Calibrated: 3/17/2014

Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357

Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.10 (7331)

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

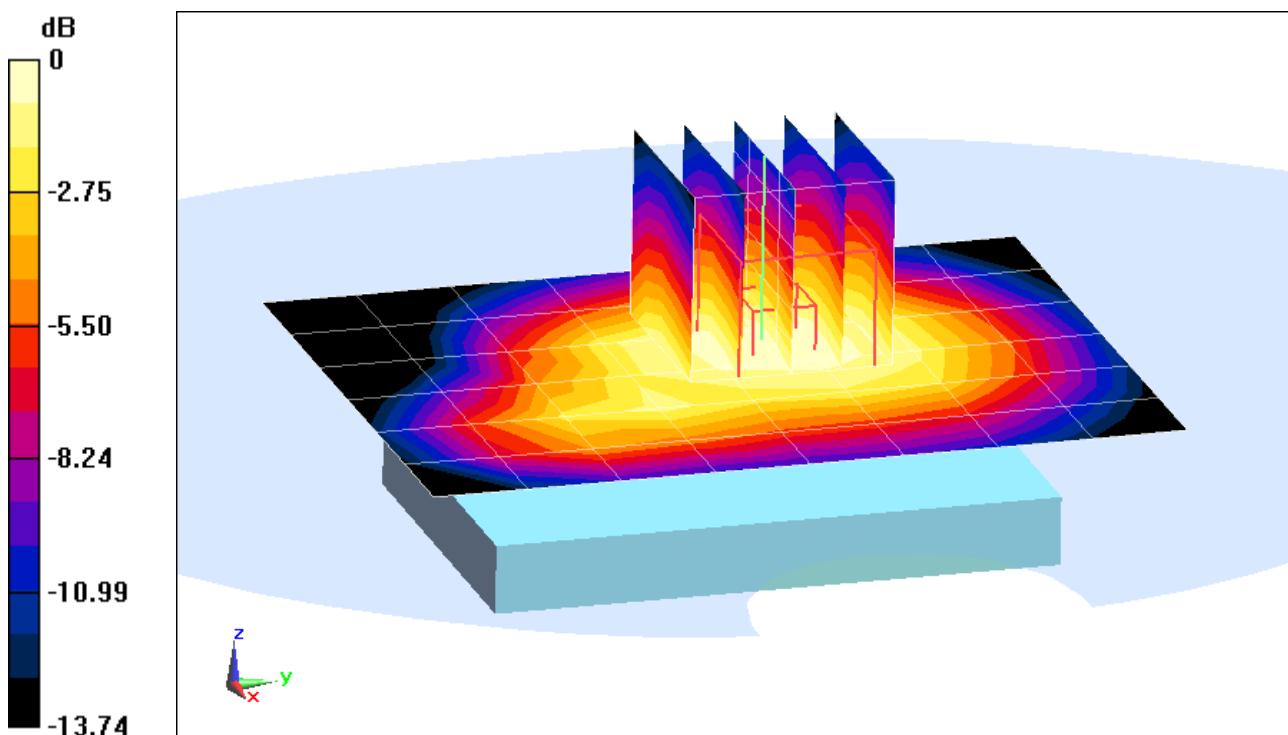
Area Scan (7x9x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 19.63 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 0.873 W/kg

SAR(1 g) = 0.585 W/kg



PCTEST ENGINEERING LABORATORY, INC.

DUT: A3LSCHLC11R; Type: Portable Wireless Router; Serial: B-U#2

Communication System: UID 0, LTE PCS20 Mhz; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: 1900 Body Medium parameters used (interpolated):

$$f = 1900 \text{ MHz}; \sigma = 1.523 \text{ S/m}; \epsilon_r = 52.01; \rho = 1000 \text{ kg/m}^3$$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-21-2014; Ambient Temp: 23.8°C; Tissue Temp: 23.7°C

Probe: ES3DV3 - SN3288; ConvF(4.82, 4.82, 4.82); Calibrated: 9/23/2013;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1323; Calibrated: 9/17/2013

Phantom: SAM with CRP; Type: SAM; Serial: TP1375

Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.10 (7331)

**Mode: LTE Band 2 (PCS), Body SAR, Front side, High.ch
20 MHz Bandwidth, QPSK, 1 RB, 50 RB Offset**

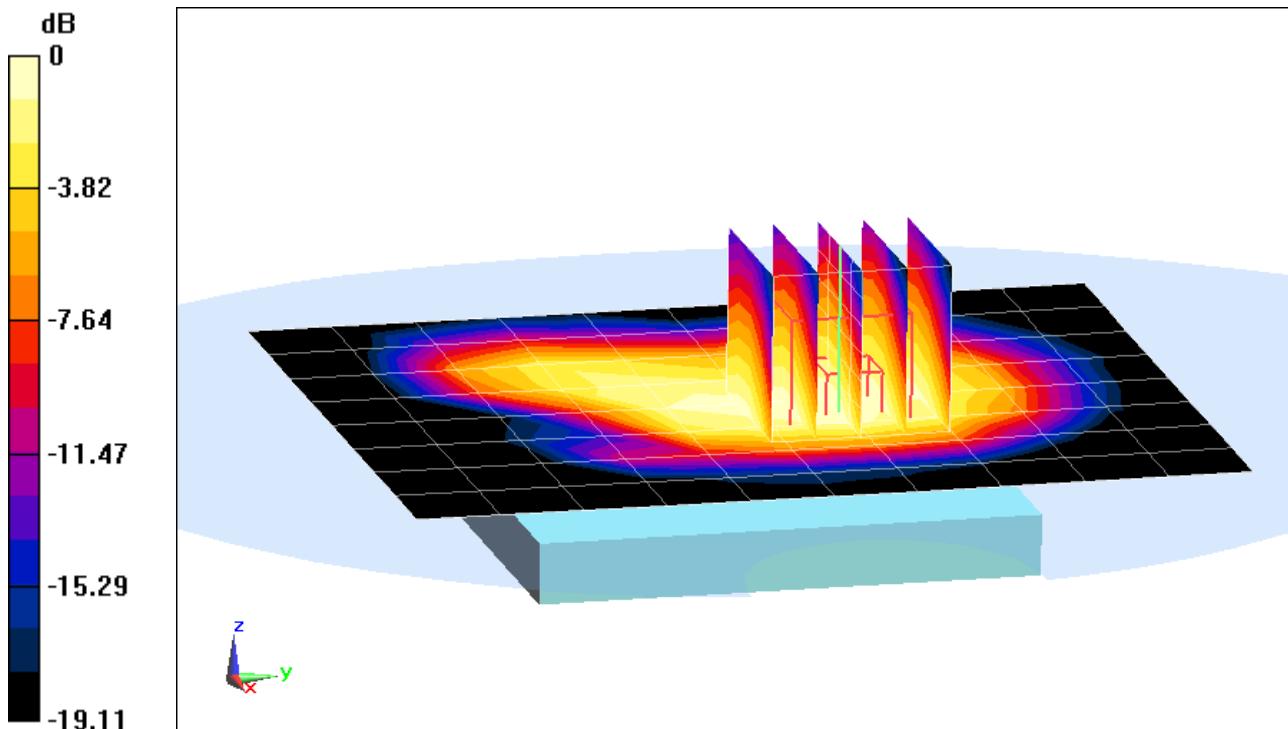
Area Scan (9x11x1): Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 9.213 V/m; Power Drift = 0.16 dB

Peak SAR (extrapolated) = 0.185 W/kg

SAR(1 g) = 0.125 W/kg



$$0 \text{ dB} = 0.141 \text{ W/kg} = -8.51 \text{ dBW/kg}$$

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 Body Medium parameters used:

$f = 1750 \text{ MHz}$; $\sigma = 1.539 \text{ S/m}$; $\epsilon_r = 52.495$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-21-2014; Ambient Temp: 23.3°C; Tissue Temp: 21.0°C

Probe: ES3DV3 - SN3213; ConvF(4.89, 4.89, 4.89); Calibrated: 4/11/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1364; Calibrated: 3/17/2014

Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357

Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.10 (7331)

1750 MHz System Verification

Area Scan (6x8x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

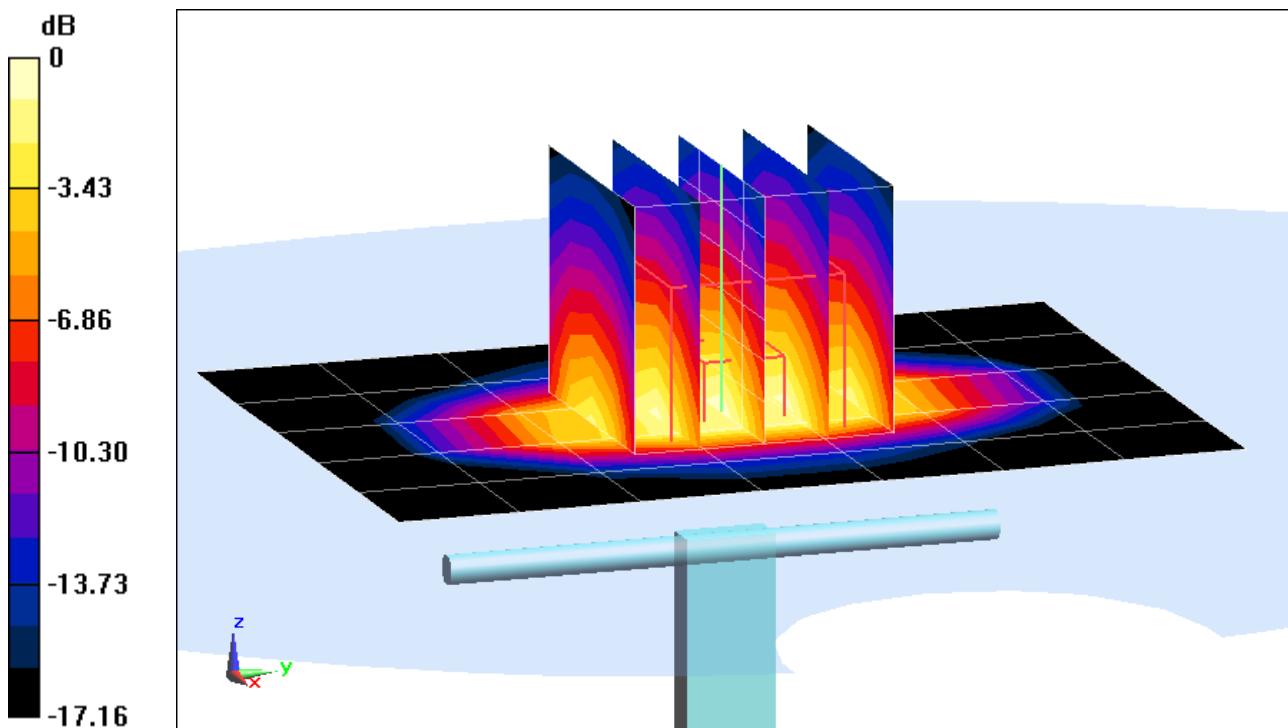
Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 6.57 W/kg

SAR(1 g) = 3.67 W/kg

Deviation = -1.87%



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

PCTEST ENGINEERING LABORATORY, INC.

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

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

Medium: 1900 Body Medium parameters used (interpolated):

$$f = 1900 \text{ MHz}; \sigma = 1.523 \text{ S/m}; \epsilon_r = 52.01; \rho = 1000 \text{ kg/m}^3$$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-21-2014; Ambient Temp: 23.8°C; Tissue Temp: 23.7°C

Probe: ES3DV3 - SN3288; ConvF(4.82, 4.82, 4.82); Calibrated: 9/23/2013;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1323; Calibrated: 9/17/2013

Phantom: SAM with CRP; Type: SAM; Serial: TP1375

Measurement SW: DASY4, Version 4.7 (80); SEMCAD X Version 14.6.10 (7331)

1900MHz System Verification

Area Scan (5x7x1): Measurement grid: dx=15mm, dy=15mm

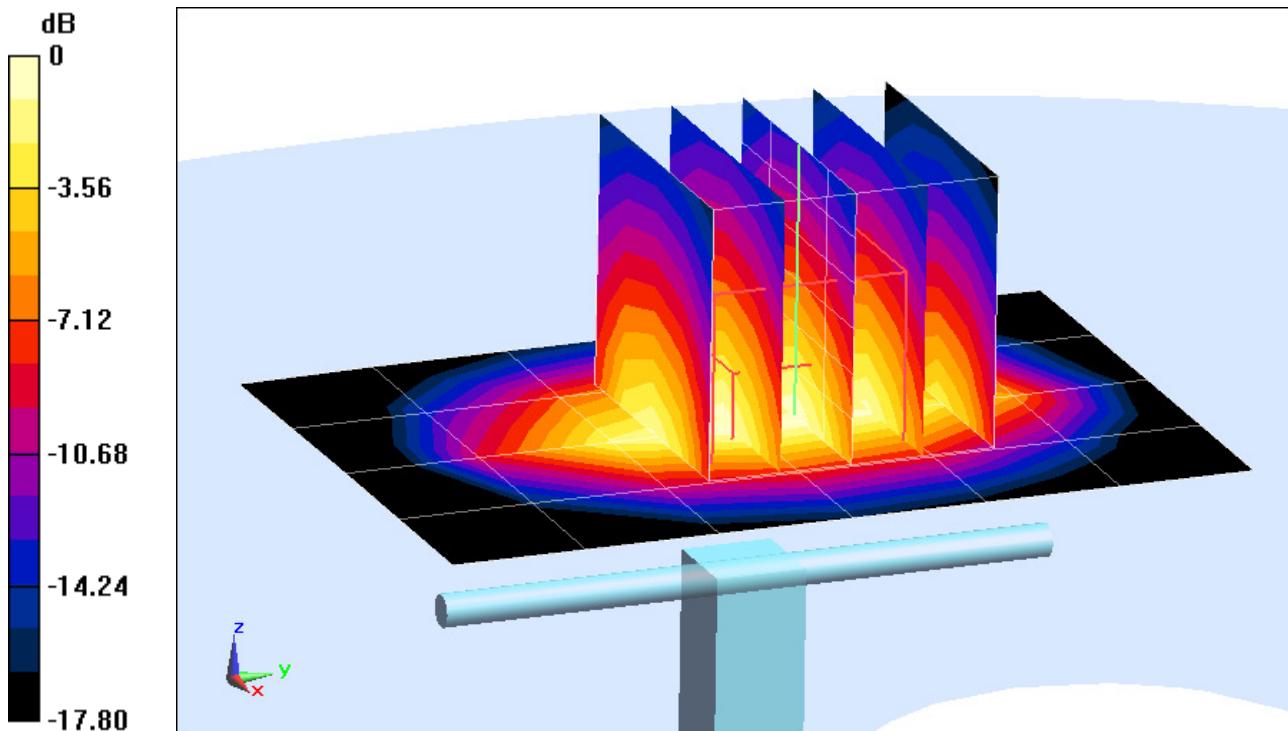
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 20 dBm (100 mW)

Peak SAR (extrapolated) = 7.25 W/kg

SAR(1 g) = 4.17 W/kg

Deviation = 6.11%



$$0 \text{ dB} = 5.14 \text{ W/kg} = 7.11 \text{ dBW/kg}$$

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: 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

✓ OK
5/7/14

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

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

Calibration Equipment used (M&TE critical for calibration)

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

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

Issued: April 10, 2014

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Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

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

Head TSL parameters

The following parameters and calculations were applied.

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

SAR result with Head TSL

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

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

Body TSL parameters

The following parameters and calculations were applied.

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

SAR result with Body TSL

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

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

Appendix

Antenna Parameters with Head TSL

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

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$46.8 \Omega + 0.8 j\Omega$
Return Loss	- 29.3 dB

General Antenna Parameters and Design

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

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

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	February 19, 2010

DASY5 Validation Report for Head TSL

Date: 10.04.2014

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

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

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.23, 5.23, 5.23); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 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:

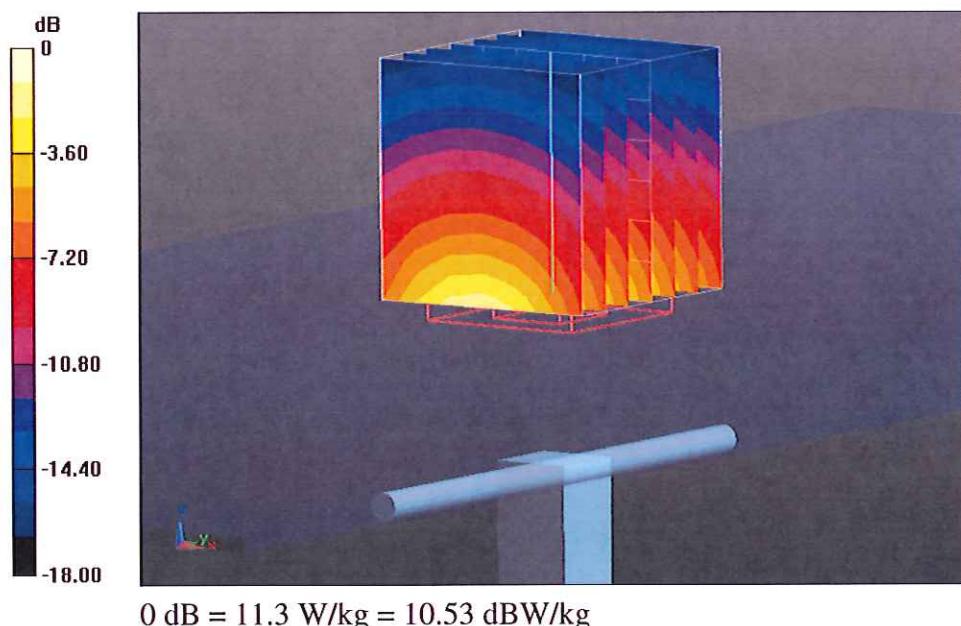
Measurement grid: dx=5mm, dy=5mm, dz=5mm

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

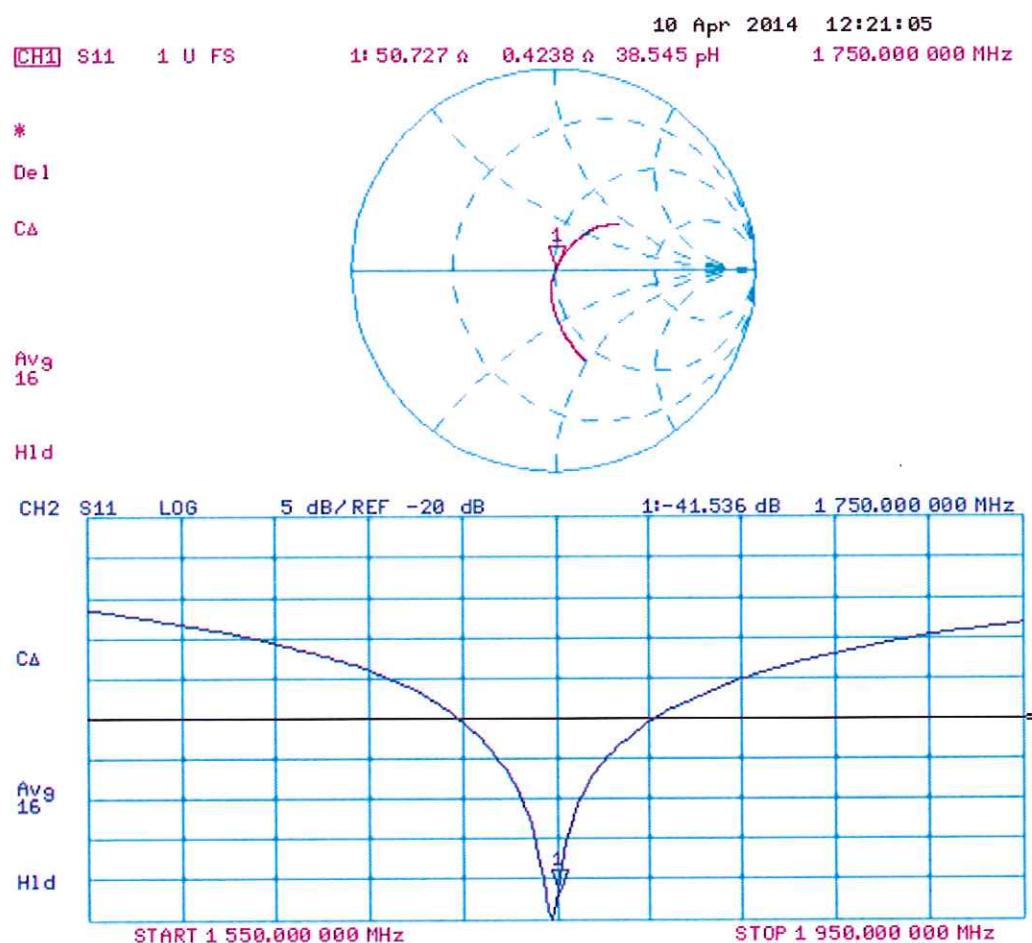
Peak SAR (extrapolated) = 16.2 W/kg

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



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:

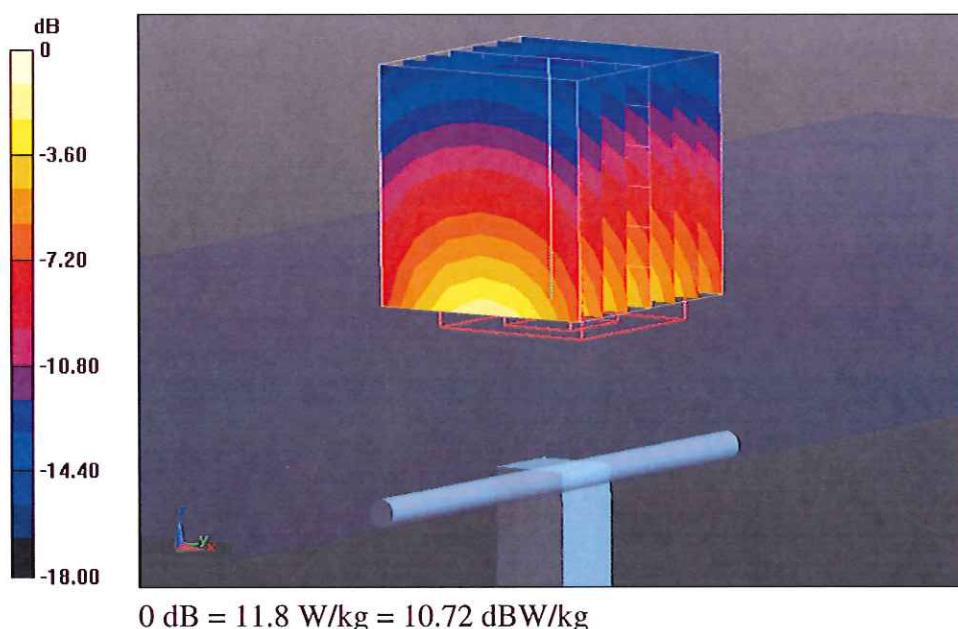
Measurement grid: dx=5mm, dy=5mm, dz=5mm

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

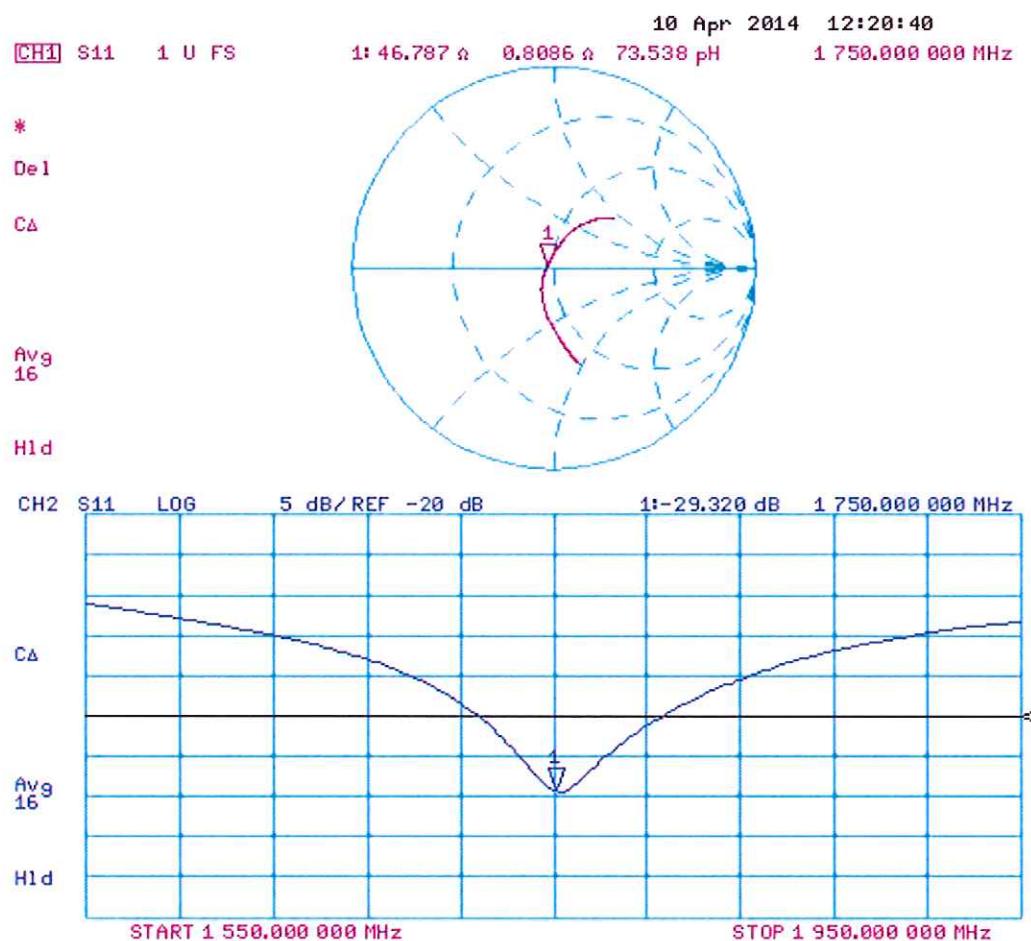
Peak SAR (extrapolated) = 16.1 W/kg

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





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 Multilateral Agreement for the recognition of calibration certificates

Client **PC Test**

Accreditation No.: **SCS 108**

Certificate No: **D1900V2-5d148_Feb14**

CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d148**

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

Calibration date: **February 27, 2014**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

Calibrated by: **Jeton Kastrati** **Laboratory Technician**

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

Signature

Issued: February 27, 2014

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



Accredited by the Swiss Accreditation Service (SAS)

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Multilateral Agreement for the recognition of calibration certificates

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

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

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	$(22.0 \pm 0.2) \text{ °C}$	$38.9 \pm 6 \text{ %}$	$1.39 \text{ mho/m} \pm 6 \text{ %}$
Head TSL temperature change during test	$< 0.5 \text{ °C}$	----	----

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	10.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	40.7 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.2 W/kg ± 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	$(22.0 \pm 0.2) \text{ °C}$	$52.8 \pm 6 \text{ %}$	$1.49 \text{ mho/m} \pm 6 \text{ %}$
Body TSL temperature change during test	$< 0.5 \text{ °C}$	----	----

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	9.73 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	39.3 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.15 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.7 W/kg ± 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$52.5 \Omega + 5.5 j\Omega$
Return Loss	- 24.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$48.0 \Omega + 6.7 j\Omega$
Return Loss	- 23.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.197 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	March 11, 2011

DASY5 Validation Report for Head TSL

Date: 27.02.2014

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.39$ S/m; $\epsilon_r = 38.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

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

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

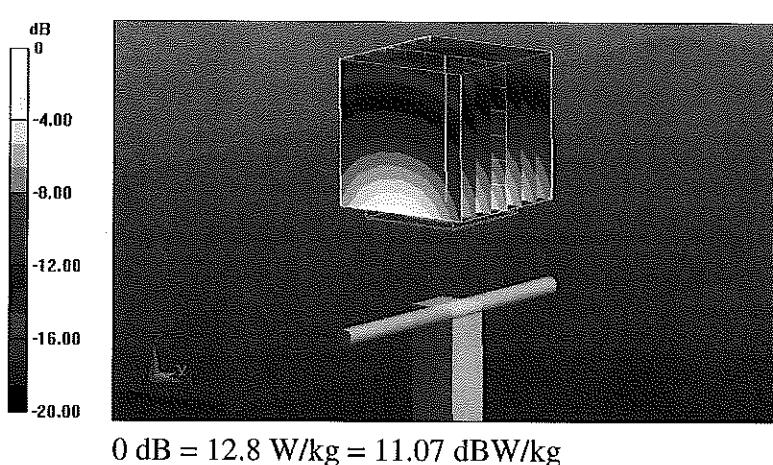
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.796 V/m; Power Drift = 0.02 dB

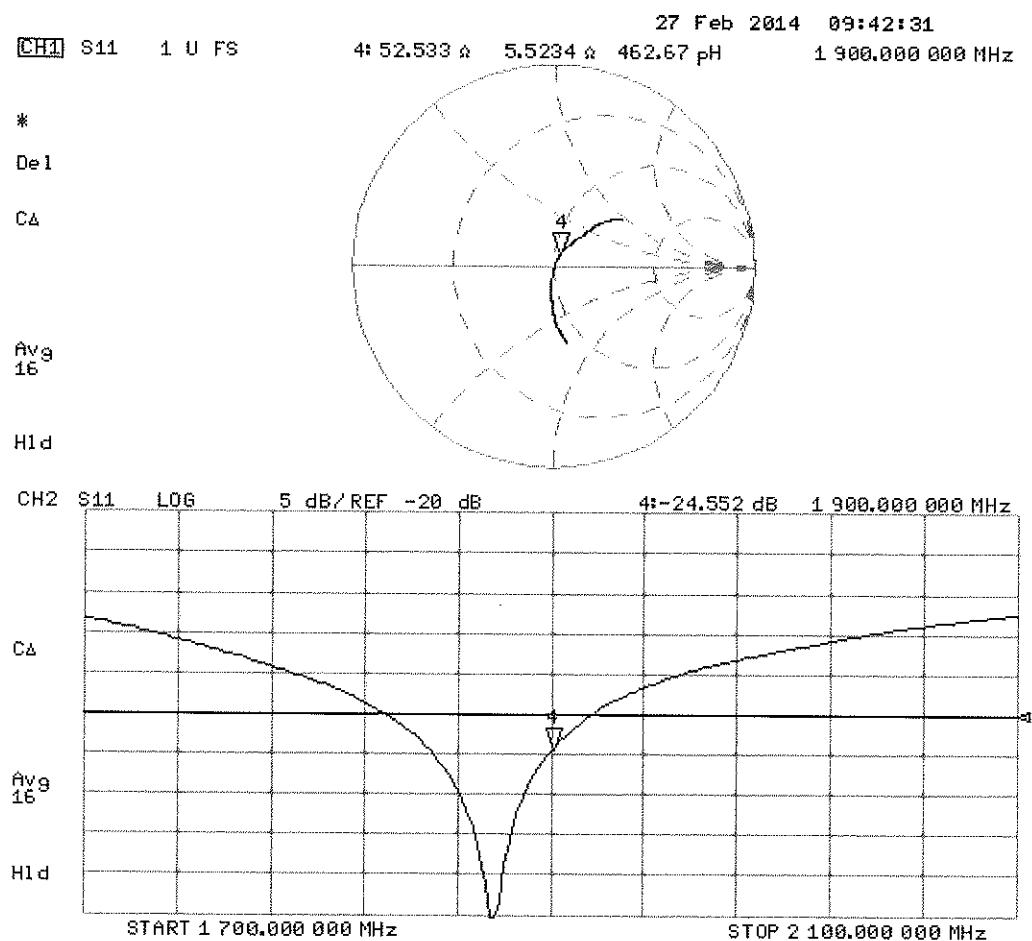
Peak SAR (extrapolated) = 18.9 W/kg

SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.31 W/kg

Maximum value of SAR (measured) = 12.8 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 27.02.2014

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.49$ S/m; $\epsilon_r = 52.8$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

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

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

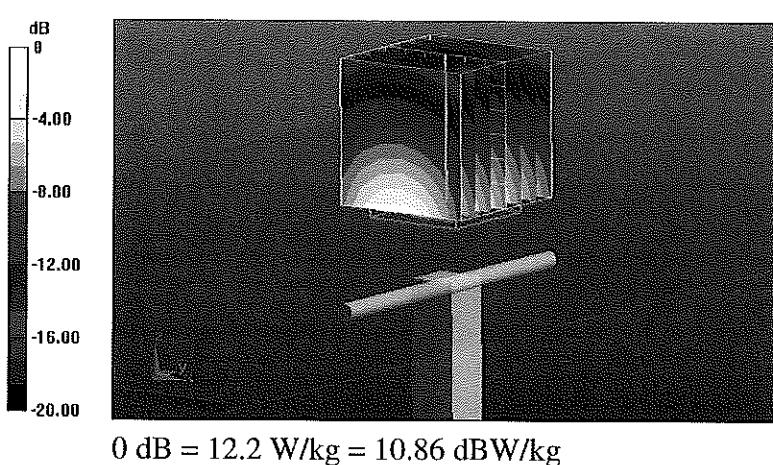
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.520 V/m; Power Drift = -0.02 dB

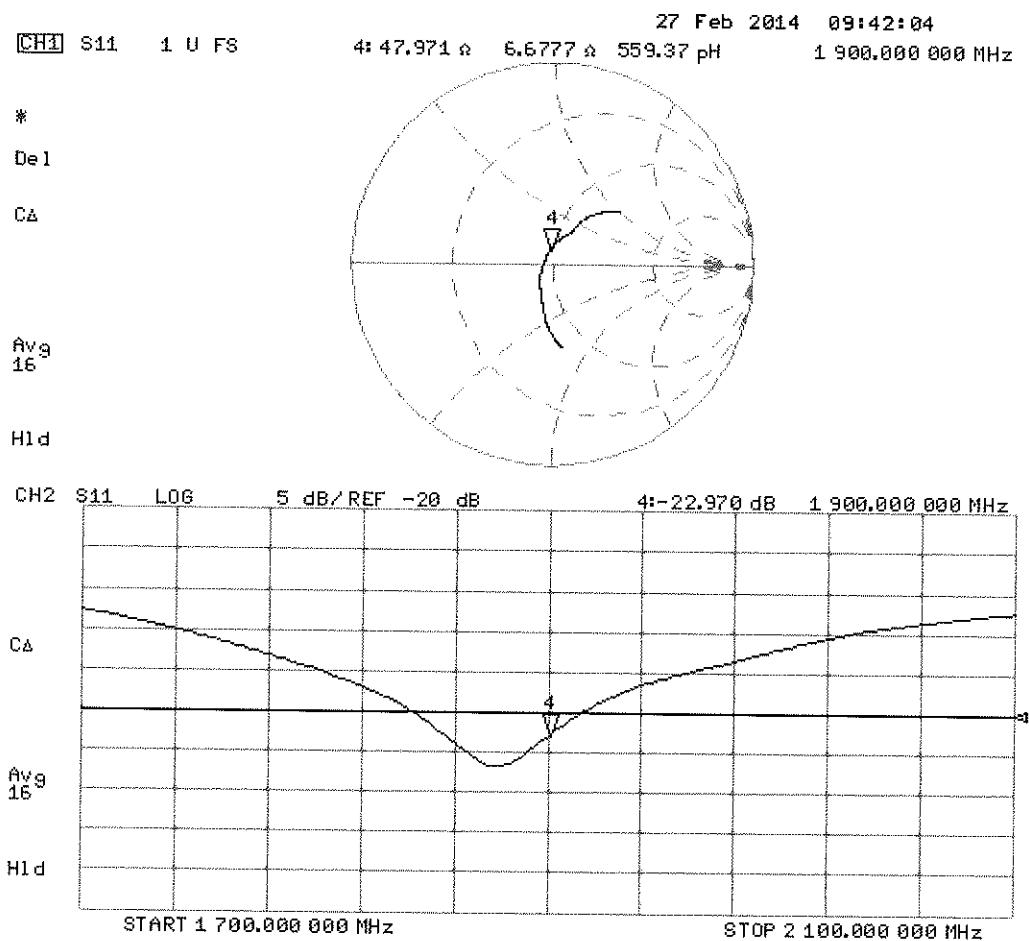
Peak SAR (extrapolated) = 17.0 W/kg

SAR(1 g) = 9.73 W/kg; SAR(10 g) = 5.15 W/kg

Maximum value of SAR (measured) = 12.2 W/kg



Impedance Measurement Plot for Body TSL



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



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

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Accreditation No.: SCS 108

Client PC Test

Certificate No: ES3-3213_Apr14

CALIBRATION CERTIFICATE

Object ES3DV3 - SN:3213

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

CCV
5/7/14

Calibration date: April 11, 2014

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

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

Calibration Equipment used (M&TE critical for calibration)

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

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

Issued: April 14, 2014

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



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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:

- 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.
- DCPx,y,z**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- 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 NORMx (no uncertainty required).

Probe ES3DV3

SN:3213

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

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

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

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	1.47	1.36	1.32	$\pm 10.1\%$
DCP (mV) ^B	102.9	101.6	102.7	

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

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

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

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

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

^A The uncertainties of NormX,Y,Z do not affect the E^2 -field uncertainty inside TSL (see Pages 8 and 9).

^B Numerical linearization parameter: uncertainty not required.

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

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

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unct. (k=2)
750	41.9	0.89	6.58	6.58	6.58	0.34	1.79	± 12.0 %
835	41.5	0.90	6.37	6.37	6.37	0.29	1.94	± 12.0 %
1750	40.1	1.37	5.18	5.18	5.18	0.79	1.17	± 12.0 %
1900	40.0	1.40	4.99	4.99	4.99	0.57	1.36	± 12.0 %
2450	39.2	1.80	4.40	4.40	4.40	0.78	1.28	± 12.0 %
2600	39.0	1.96	4.25	4.25	4.25	0.77	1.23	± 12.0 %

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

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

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

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

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unct. (k=2)
750	55.5	0.96	6.21	6.21	6.21	0.77	1.19	± 12.0 %
835	55.2	0.97	6.18	6.18	6.18	0.54	1.37	± 12.0 %
1750	53.4	1.49	4.89	4.89	4.89	0.73	1.27	± 12.0 %
1900	53.3	1.52	4.68	4.68	4.68	0.47	1.70	± 12.0 %
2450	52.7	1.95	4.26	4.26	4.26	0.70	1.16	± 12.0 %
2600	52.5	2.16	4.05	4.05	4.05	0.67	1.00	± 12.0 %

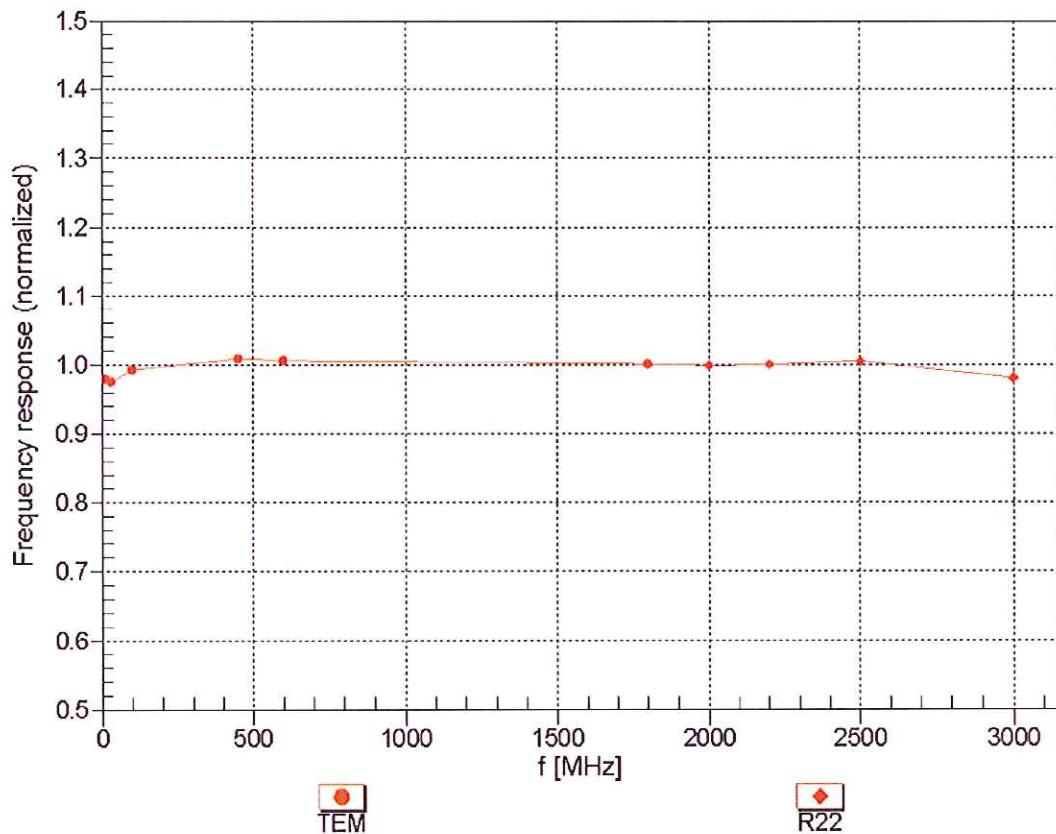
^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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

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

Frequency Response of E-Field

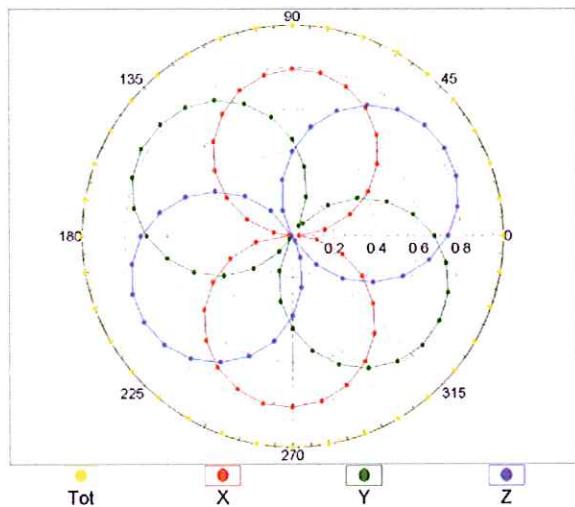
(TEM-Cell:ifi110 EXX, Waveguide: R22)



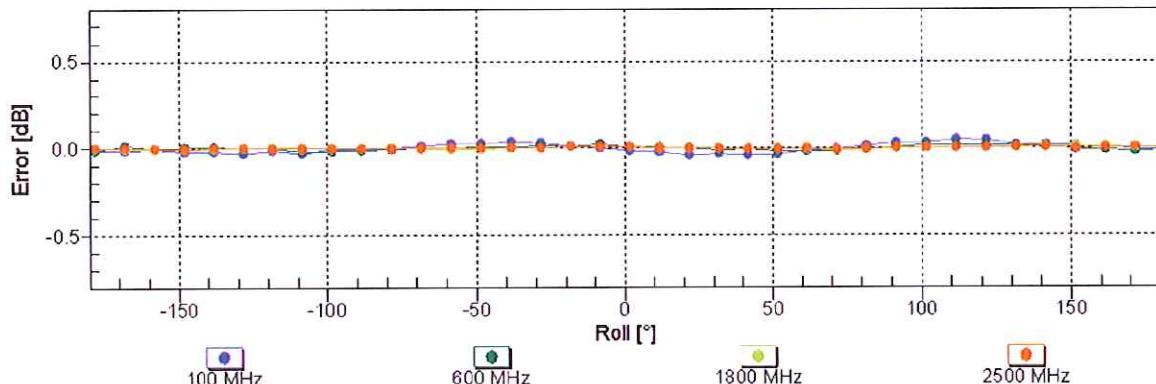
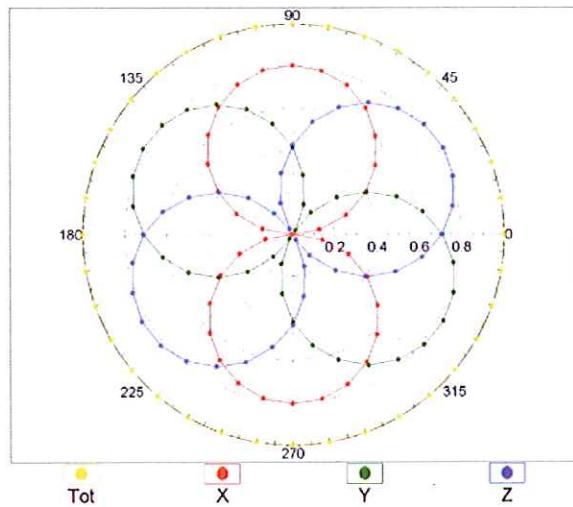
Uncertainty of Frequency Response of E-field: $\pm 6.3\% (k=2)$

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

f=600 MHz, TEM

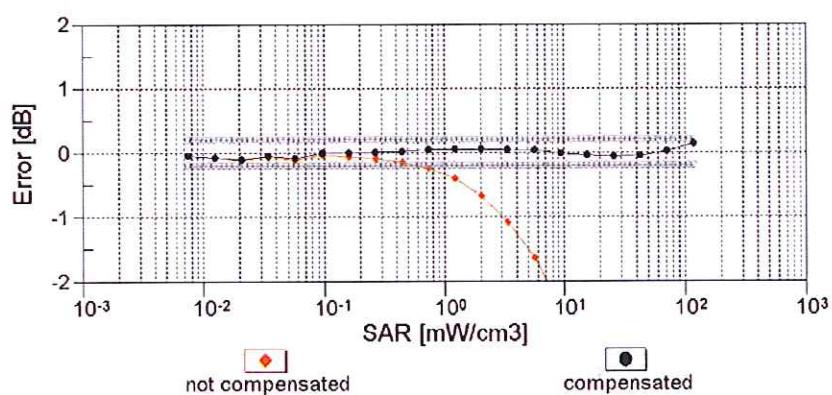
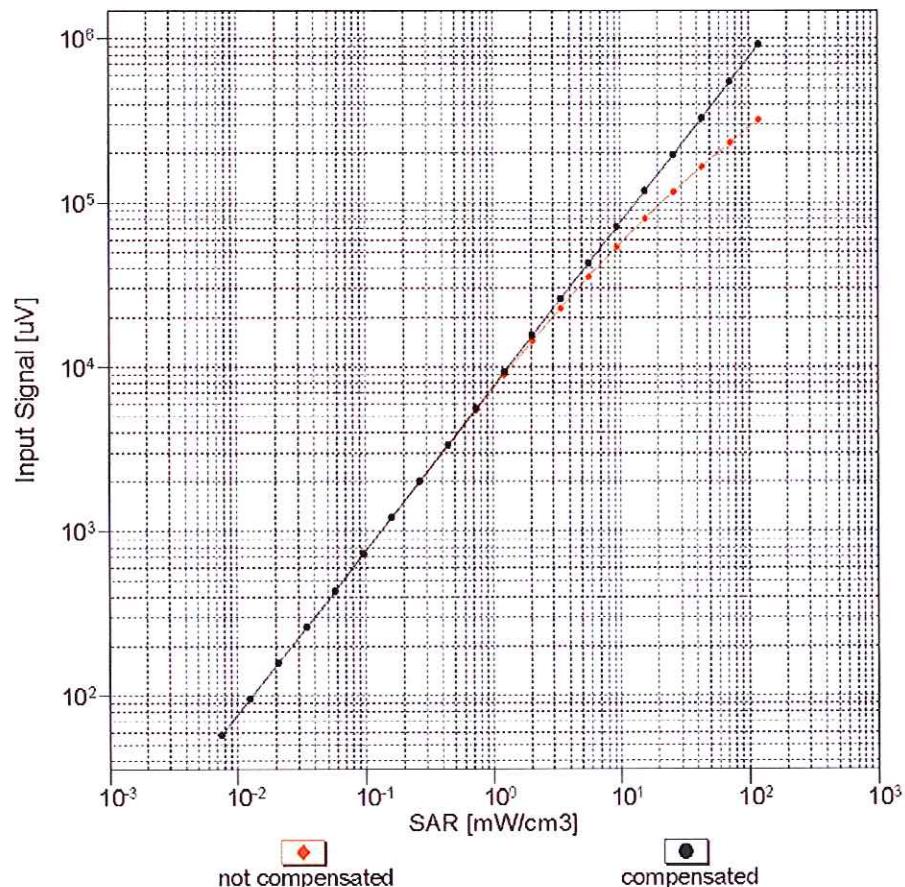


f=1800 MHz, R22

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

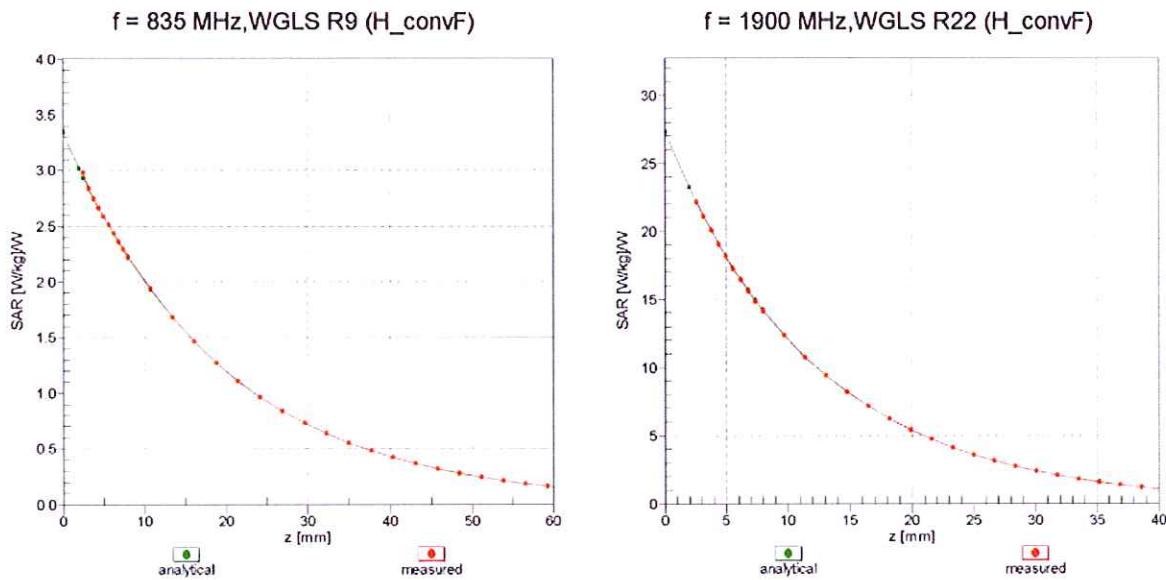
Dynamic Range f(SAR_{head})

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

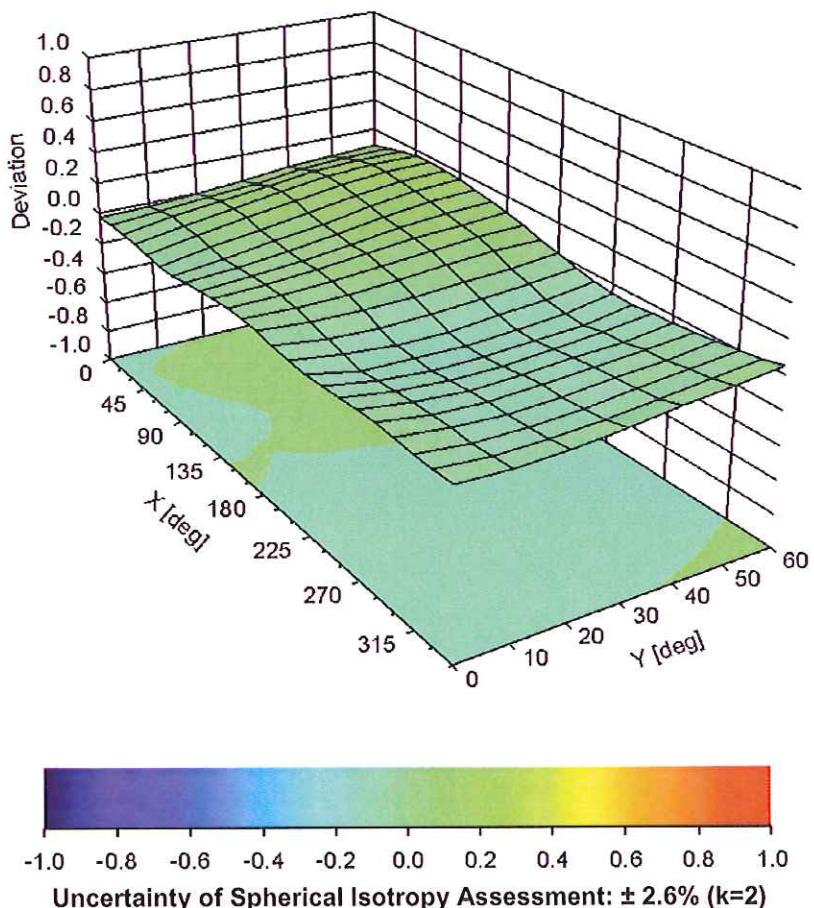


Uncertainty of Linearity Assessment: $\pm 0.6\% (k=2)$

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, θ), $f = 900 \text{ MHz}$



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

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-68.3
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

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



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

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

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **ES3-3288_Sep13/2**

CALIBRATION CERTIFICATE (Replacement of No: ES3-3288_Sep13)

Object	ES3DV3 - SN:3288	CCV 10/6/13		
Calibration procedure(s)	QA CAL-01.v9, QA CAL-23.v5, QA CAL-25.v6 Calibration procedure for dosimetric E-field probes			
Calibration date:	September 23, 2013			
This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.				
All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^\circ\text{C}$ and humidity < 70%.				
Calibration Equipment used (M&TE critical for calibration)				

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	4-Sep-13 (No. DAE4-660_Sep13)	Apr-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

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

Issued: October 4, 2013

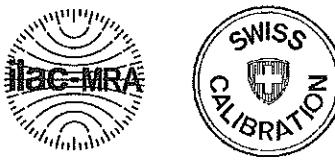
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Probe ES3DV3

SN:3288

Manufactured: July 6, 2010
Calibrated: September 23, 2013

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



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

Methods Applied and Interpretation of Parameters:

- $NORM_{x,y,z}$: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). $NORM_{x,y,z}$ are only intermediate values, i.e., the uncertainties of $NORM_{x,y,z}$ does not affect the E^2 -field uncertainty inside TSL (see below *ConvF*).
- $NORM(f,x,y,z) = NORM_{x,y,z} * frequency_response$ (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- $DCPx,y,z$: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR : PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- $A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}; A, B, C, D$ 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.

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

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.87	0.97	0.75	$\pm 10.1\%$
DCP (mV) ^B	103.3	103.2	100.2	

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	171.1	$\pm 3.5\%$
		Y	0.0	0.0	1.0		135.0	
		Z	0.0	0.0	1.0		154.3	

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: ES3DV3 - SN:3288

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	6.56	6.56	6.56	0.32	1.89	± 12.0 %
835	41.5	0.90	6.37	6.37	6.37	0.34	1.82	± 12.0 %
1750	40.1	1.37	5.67	5.67	5.67	0.56	1.51	± 12.0 %
1900	40.0	1.40	5.47	5.47	5.47	0.80	1.29	± 12.0 %
2450	39.2	1.80	4.63	4.63	4.63	0.80	1.34	± 12.0 %
2600	39.0	1.96	4.55	4.55	4.55	0.80	1.41	± 12.0 %

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

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

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

Calibration Parameter Determined in Body Tissue Simulating Media

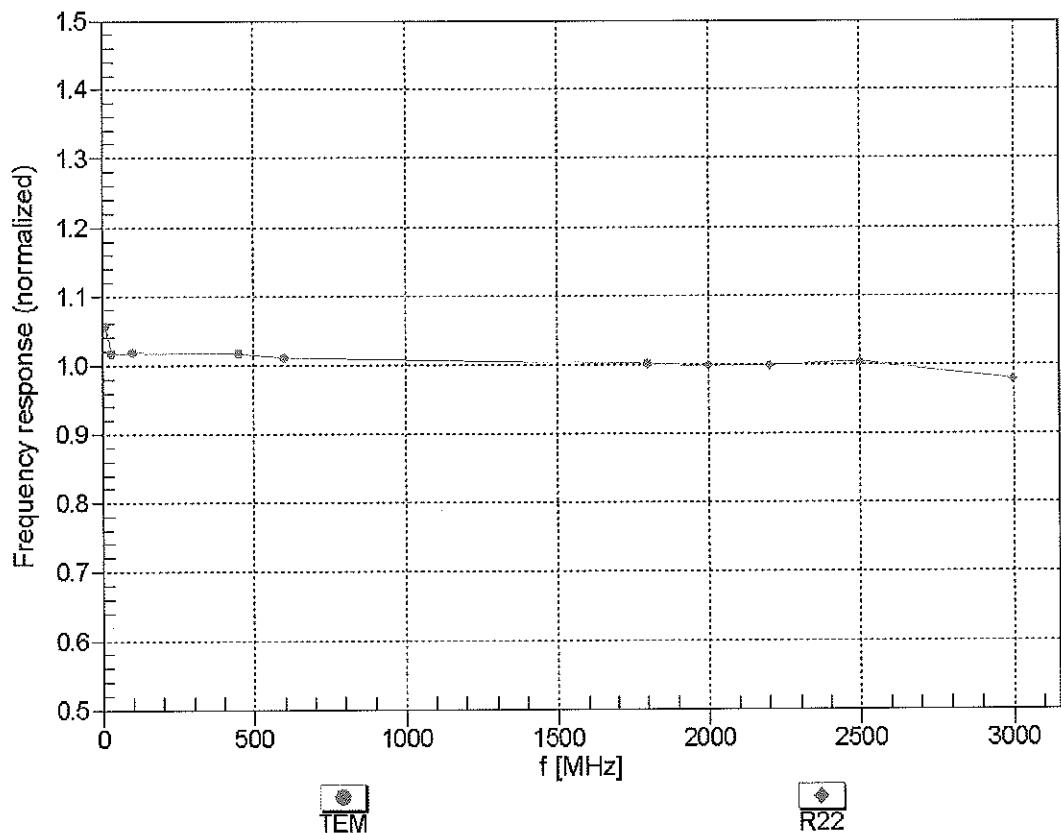
f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	6.25	6.25	6.25	0.70	1.27	± 12.0 %
835	55.2	0.97	6.27	6.27	6.27	0.75	1.22	± 12.0 %
1750	53.4	1.49	5.10	5.10	5.10	0.59	1.46	± 12.0 %
1900	53.3	1.52	4.82	4.82	4.82	0.53	1.54	± 12.0 %
2450	52.7	1.95	4.37	4.37	4.37	0.80	1.02	± 12.0 %
2600	52.5	2.16	4.14	4.14	4.14	0.64	0.94	± 12.0 %

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

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

Frequency Response of E-Field

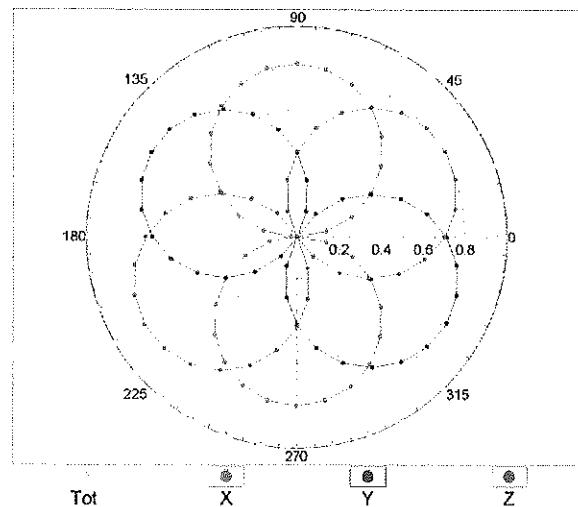
(TEM-Cell:ifi110 EXX, Waveguide: R22)



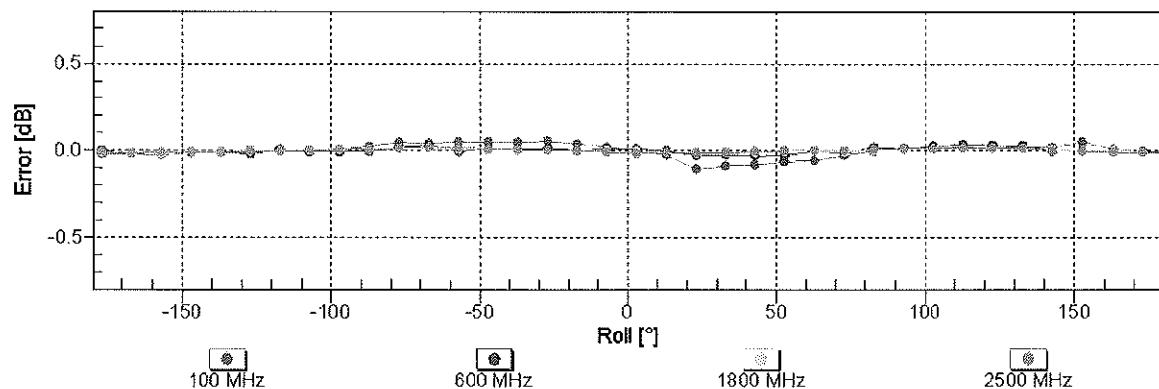
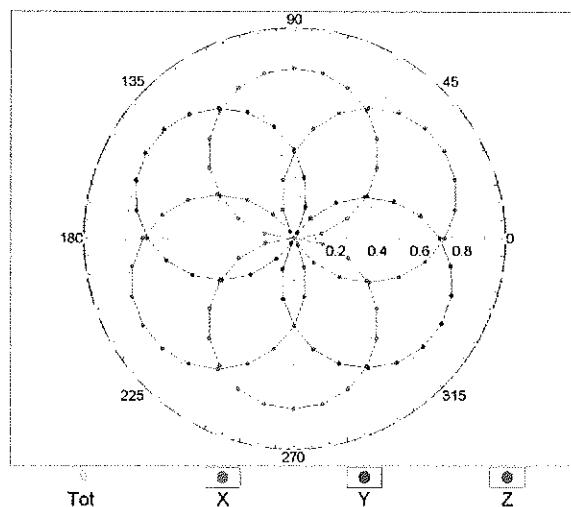
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

$f=600$ MHz, TEM



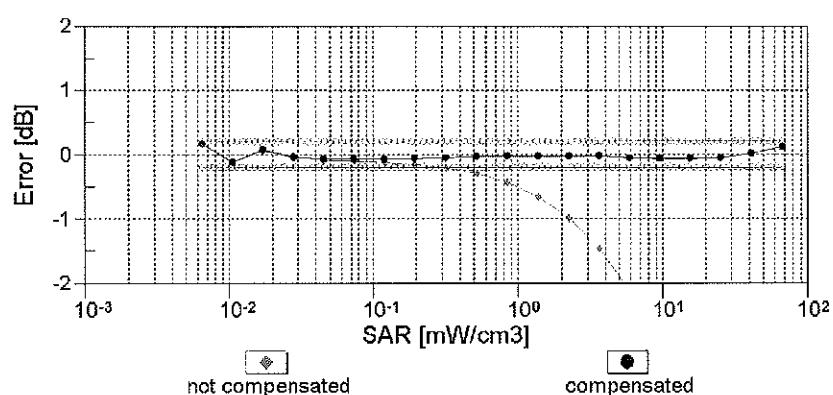
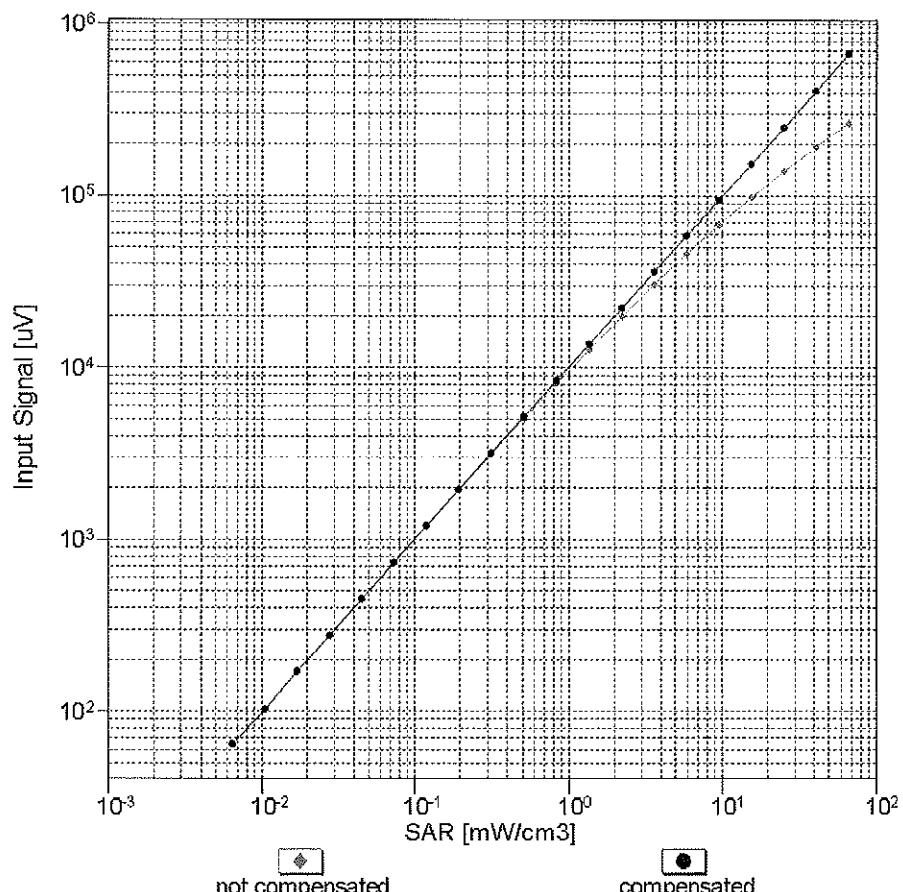
$f=1800$ MHz, R22



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

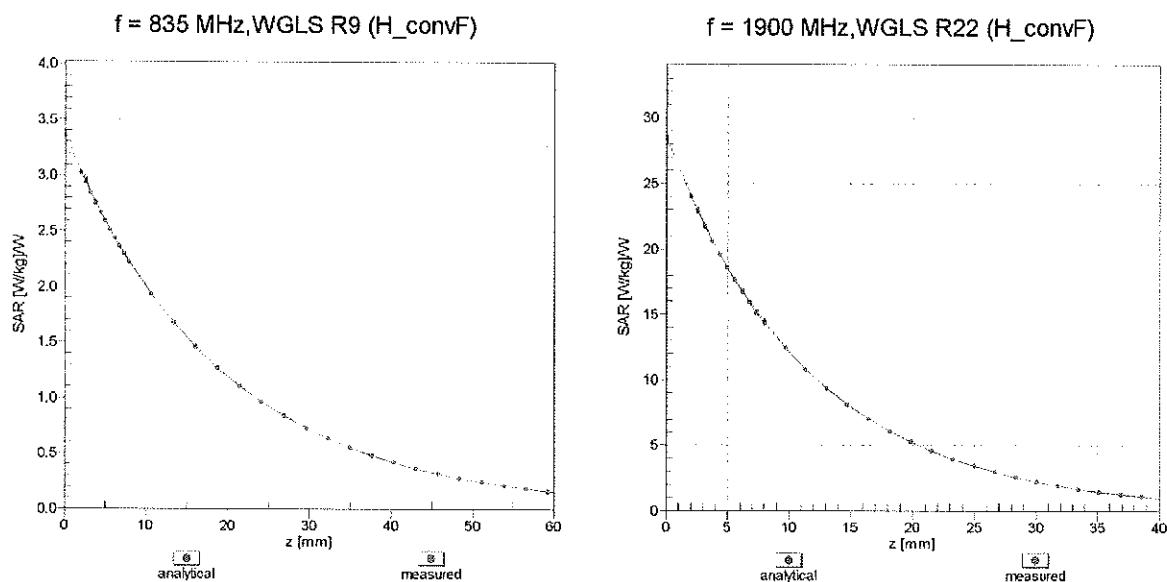
Dynamic Range f(SAR_{head})

(TEM cell , f = 900 MHz)

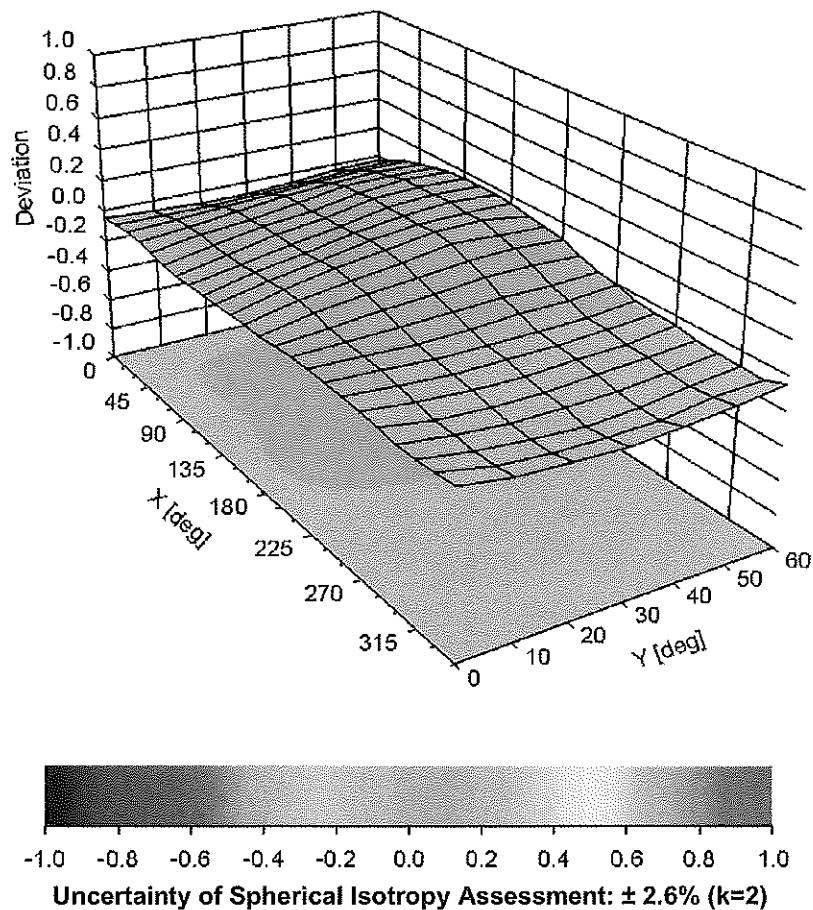


Uncertainty of Linearity Assessment: $\pm 0.6\%$ (k=2)

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ , 9), $f = 900$ MHz



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

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-127.1
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

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	1900
Tissue	Body	Body
Ingredients (% by weight)		
DGBE	31	29.44
NaCl	0.2	0.39
Water	68.8	70.17

FCC ID: A3LSCHLC11R	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Test Dates: 07/21/14	DUT Type: Portable Wireless Router			APPENDIX D: Page 1 of 1

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)	SENSITIVITY	PROBE LINEARITY	PROBE ISOTROPY	MOD. TYPE	DUTY FACTOR	PAR
B	1900	6/28/2014	3288	ES3DV3	1900	Body	1.565	52.71	PASS	PASS	PASS	GMSK	PASS	N/A
C	1750	6/18/2014	3213	ES3DV3	1750	Body	1.531	51.36	PASS	PASS	PASS	N/A	N/A	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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Test Dates: 07/21/14	DUT Type: Portable Wireless Router			APPENDIX E: Page 1 of 1