



# Variant FCC SAR Test Report

**Report No.** : SA160223W005  
**Applicant** : Lenovo (Shanghai) Electronics Technology Co., Ltd.  
**Address** : No. 68 Building, 199 Fenju Road, Wai Gao Qiao FTZ , Shanghai , China  
**Product** : Portable Tablet Computer  
**FCC ID** : O57TAB2A730GC  
**Brand** : lenovo  
**Model No.** : Lenovo TAB 2 A7-30GC  
**Standards** : FCC 47 CFR Part 2 (2.1093) / IEEE C95.1:1992 / IEEE 1528:2013  
KDB 865664 D01 v01r04 / KDB 865664 D02 v01r02  
KDB 248227 D01 v02r02 / KDB 447498 D01 v06 / KDB 616217 D04 v01r02  
KDB 648474 D04 v01r03 / KDB 941225 D01 v03r01  
**Sample Received Date** : Mar. 20, 2016  
**Date of Testing** : Mar. 22, 2016

**CERTIFICATION:** The above equipment have been tested by **Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's SAR characteristics under the conditions specified in this report. It should not be reproduced except in full, without the written approval of our laboratory. The client should not use it to claim product certification, approval, or endorsement by A2LA or any government agencies.

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## Release Control Record

Report No.	Reason for Change	Date Issued
SA150810W001	Initial release	Sep. 11, 2015
SA160223W005	Based on the original report SA150810W001 changing radio frequency power amplifier.	Mar. 28, 2016



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### 1. Summary of Maximum SAR Value

Equipment Class	Mode	Highest Reported Head SAR <sub>1q</sub> (W/kg)	Highest Reported Body SAR <sub>1q</sub> (W/kg)
PCE	GSM850	0.14	0.30
	GSM1900	0.03	1.02
DTS	2.4G WLAN	0.36	0.50
DSS	Bluetooth	N/A	N/A

**Note:**

1. The SAR limit (Head & Body: SAR<sub>1g</sub> 1.6 W/kg, Extremity: SAR<sub>10g</sub> 4.0 W/kg) for general population / uncontrolled exposure is specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992.

## 2. Description of Equipment Under Test

<b>EUT Type</b>	Portable Tablet Computer
<b>FCC ID</b>	O57TAB2A730GC
<b>Brand Name</b>	lenovo
<b>Model Name</b>	Lenovo TAB 2 A7-30GC
<b>Tx Frequency Bands (Unit: MHz)</b>	GSM850 : 824.2 ~ 848.8 GSM1900 : 1850.2 ~ 1909.8 WLAN : 2412 ~ 2462 Bluetooth : 2402 ~ 2480
<b>Uplink Modulations</b>	GSM & GPRS : GMSK EDGE : 8PSK 802.11b : DSSS 802.11g/n : OFDM Bluetooth : GFSK
<b>Maximum Tune-up Conducted Power (Unit: dBm)</b>	GSM850 : 31.5 GSM1900 : 29.0 WLAN 2.4G : 12.0 Bluetooth : 0.0
<b>Antenna Type</b>	Fixed Internal Antenna
<b>EUT Stage</b>	Production Unit

### Note:

- The above EUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.

### List of Accessory:

<b>Battery 1</b>	<b>Brand Name</b>	lenovo
	<b>Model Name</b>	L13D1P31-A
	<b>Power Rating</b>	3.8Vdc, 3550mAh
	<b>Type</b>	Li-ion
<b>Battery 2</b>	<b>Brand Name</b>	lenovo
	<b>Model Name</b>	L13D1P31-C
	<b>Power Rating</b>	3.8Vdc, 3550mAh
	<b>Type</b>	Li-ion

### **3. SAR Measurement System**

#### **3.1 Definition of Specific Absorption Rate (SAR)**

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (ρ). The equation description is as below:

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

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

SAR measurement can be related to the electrical field in the tissue by

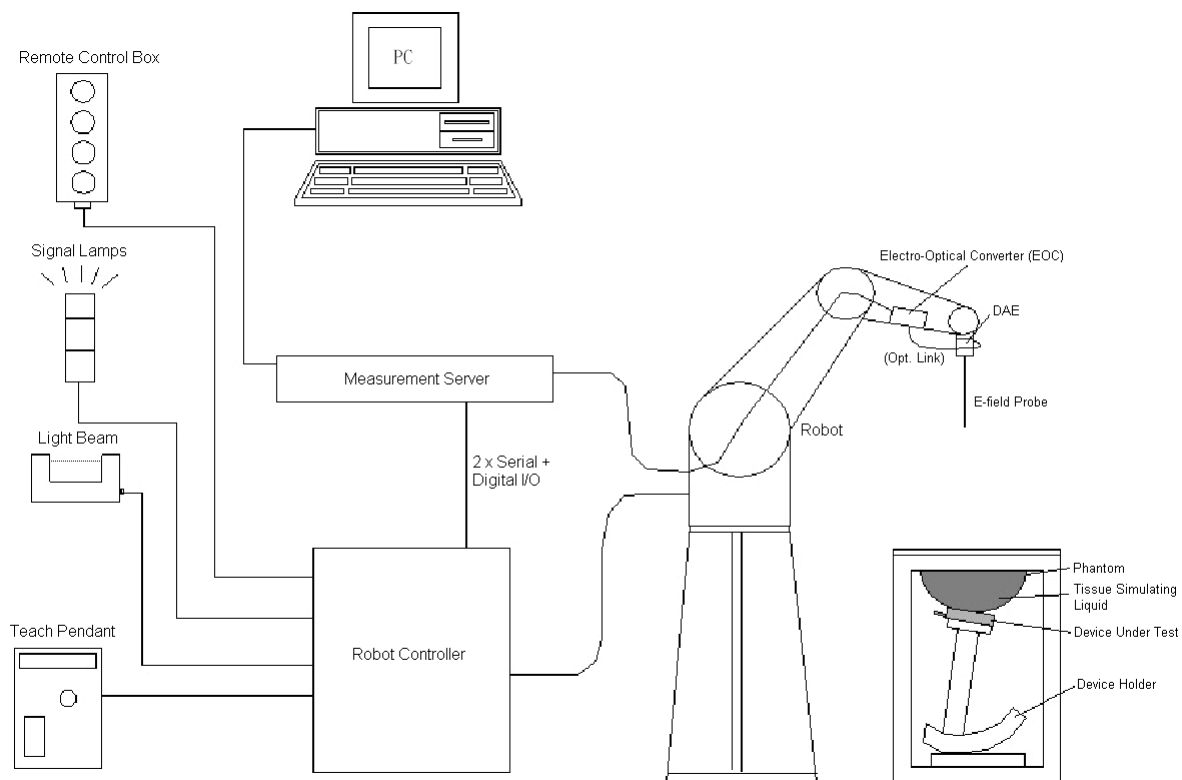
$$SAR = \frac{\sigma |E|^2}{\rho}$$

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength.

#### **3.2 SPEAG DASY System**

DASY system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY5 software defined. The DASY software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC.

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**Fig-3.1 DASY System Setup**

### 3.2.1 Robot

The DASY system uses the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY5: CS8c) from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability  $\pm 0.035$  mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)





**Fig-3.2 DASY5**

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### 3.2.2 Probes

The SAR measurement is conducted with the dosimetric probe. The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency.

<b>Model</b>	EX3DV4	
<b>Construction</b>	Symmetrical design with triangular core. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE).	
<b>Frequency</b>	10 MHz to 6 GHz Linearity: $\pm 0.2$ dB	
<b>Directivity</b>	$\pm 0.3$ dB in HSL (rotation around probe axis) $\pm 0.5$ dB in tissue material (rotation normal to probe axis)	
<b>Dynamic Range</b>	10 $\mu$ W/g to 100 mW/g Linearity: $\pm 0.2$ dB (noise: typically $< 1$ $\mu$ W/g)	
<b>Dimensions</b>	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm	


<b>Model</b>	ES3DV3	
<b>Construction</b>	Symmetrical design with triangular core. Interleaved sensors. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE).	
<b>Frequency</b>	10 MHz to 4 GHz Linearity: $\pm 0.2$ dB	
<b>Directivity</b>	$\pm 0.2$ dB in HSL (rotation around probe axis) $\pm 0.3$ dB in tissue material (rotation normal to probe axis)	
<b>Dynamic Range</b>	5 $\mu$ W/g to 100 mW/g Linearity: $\pm 0.2$ dB	
<b>Dimensions</b>	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 3.9 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.0 mm	


### 3.2.3 Data Acquisition Electronics (DAE)

<b>Model</b>	DAE3, DAE4	
<b>Construction</b>	Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop.	
<b>Measurement Range</b>	-100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV)	
<b>Input Offset Voltage</b>	$< 5\mu$ V (with auto zero)	
<b>Input Bias Current</b>	$< 50$ fA	
<b>Dimensions</b>	60 x 60 x 68 mm	

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### 3.2.4 Phantoms


<b>Model</b>	Twin SAM	
<b>Construction</b>	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.	
<b>Material</b>	Vinylester, glass fiber reinforced (VE-GF)	
<b>Shell Thickness</b>	$2 \pm 0.2$ mm ( $6 \pm 0.2$ mm at ear point)	
<b>Dimensions</b>	Length: 1000 mm Width: 500 mm Height: adjustable feet	
<b>Filling Volume</b>	approx. 25 liters	

<b>Model</b>	ELI	
<b>Construction</b>	Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.	
<b>Material</b>	Vinylester, glass fiber reinforced (VE-GF)	
<b>Shell Thickness</b>	$2.0 \pm 0.2$ mm (bottom plate)	
<b>Dimensions</b>	Major axis: 600 mm Minor axis: 400 mm	
<b>Filling Volume</b>	approx. 30 liters	


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### 3.2.5 Device Holder

<b>Model</b>	Mounting Device	
<b>Construction</b>	In combination with the Twin SAM Phantom or ELI4, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to IEC, IEEE, FCC or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat).	
<b>Material</b>	POM	

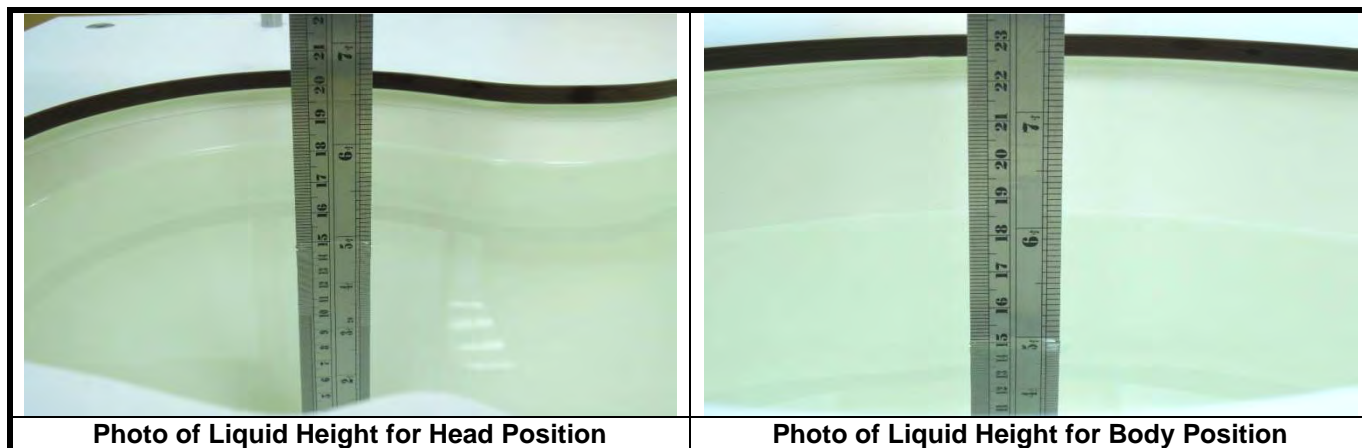
<b>Model</b>	Laptop Extensions Kit	
<b>Construction</b>	Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.). It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner.	
<b>Material</b>	POM, Acrylic glass, Foam	

### 3.2.6 System Validation Dipoles

<b>Model</b>	D-Serial	
<b>Construction</b>	Symmetrical dipole with 1/4 balun. Enables measurement of feed point impedance with NWA. Matched for use near flat phantoms filled with tissue simulating solutions.	
<b>Frequency</b>	750 MHz to 5800 MHz	
<b>Return Loss</b>	> 20 dB	
<b>Power Capability</b>	> 100 W (f < 1GHz), > 40 W (f > 1GHz)	

## 3.2.7 Tissue Simulating Liquids

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5% are listed in Table-3.1.



The dielectric properties of the head tissue simulating liquids are defined in IEEE 1528, and KDB 865664 D01 Appendix A. For the body tissue simulating liquids, the dielectric properties are defined in KDB 865664 D01 Appendix A. The dielectric properties of the tissue simulating liquids were verified prior to the SAR evaluation using a dielectric assessment kit and a network analyzer.

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**Table-3.1 Targets of Tissue Simulating Liquid**

Frequency (MHz)	Target Permittivity	Range of $\pm 5\%$	Target Conductivity	Range of $\pm 5\%$
<b>For Head</b>				
750	41.9	39.8 ~ 44.0	0.89	0.85 ~ 0.93
835	41.5	39.4 ~ 43.6	0.90	0.86 ~ 0.95
900	41.5	39.4 ~ 43.6	0.97	0.92 ~ 1.02
1450	40.5	38.5 ~ 42.5	1.20	1.14 ~ 1.26
1640	40.3	38.3 ~ 42.3	1.29	1.23 ~ 1.35
1750	40.1	38.1 ~ 42.1	1.37	1.30 ~ 1.44
1800	40.0	38.0 ~ 42.0	1.40	1.33 ~ 1.47
1900	40.0	38.0 ~ 42.0	1.40	1.33 ~ 1.47
2000	40.0	38.0 ~ 42.0	1.40	1.33 ~ 1.47
2300	39.5	37.5 ~ 41.5	1.67	1.59 ~ 1.75
2450	39.2	37.2 ~ 41.2	1.80	1.71 ~ 1.89
2600	39.0	37.1 ~ 41.0	1.96	1.86 ~ 2.06
3500	37.9	36.0 ~ 39.8	2.91	2.76 ~ 3.06
5200	36.0	34.2 ~ 37.8	4.66	4.43 ~ 4.89
5300	35.9	34.1 ~ 37.7	4.76	4.52 ~ 5.00
5500	35.6	33.8 ~ 37.4	4.96	4.71 ~ 5.21
5600	35.5	33.7 ~ 37.3	5.07	4.82 ~ 5.32
5800	35.3	33.5 ~ 37.1	5.27	5.01 ~ 5.53
<b>For Body</b>				
750	55.5	52.7 ~ 58.3	0.96	0.91 ~ 1.01
835	55.2	52.4 ~ 58.0	0.97	0.92 ~ 1.02
900	55.0	52.3 ~ 57.8	1.05	1.00 ~ 1.10
1450	54.0	51.3 ~ 56.7	1.30	1.24 ~ 1.37
1640	53.8	51.1 ~ 56.5	1.40	1.33 ~ 1.47
1750	53.4	50.7 ~ 56.1	1.49	1.42 ~ 1.56
1800	53.3	50.6 ~ 56.0	1.52	1.44 ~ 1.60
1900	53.3	50.6 ~ 56.0	1.52	1.44 ~ 1.60
2000	53.3	50.6 ~ 56.0	1.52	1.44 ~ 1.60
2300	52.9	50.3 ~ 55.5	1.81	1.72 ~ 1.90
2450	52.7	50.1 ~ 55.3	1.95	1.85 ~ 2.05
2600	52.5	49.9 ~ 55.1	2.16	2.05 ~ 2.27
3500	51.3	48.7 ~ 53.9	3.31	3.14 ~ 3.48
5200	49.0	46.6 ~ 51.5	5.30	5.04 ~ 5.57
5300	48.9	46.5 ~ 51.3	5.42	5.15 ~ 5.69
5500	48.6	46.2 ~ 51.0	5.65	5.37 ~ 5.93
5600	48.5	46.1 ~ 50.9	5.77	5.48 ~ 6.06
5800	48.2	45.8 ~ 50.6	6.00	5.70 ~ 6.30

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The following table gives the recipes for tissue simulating liquids.

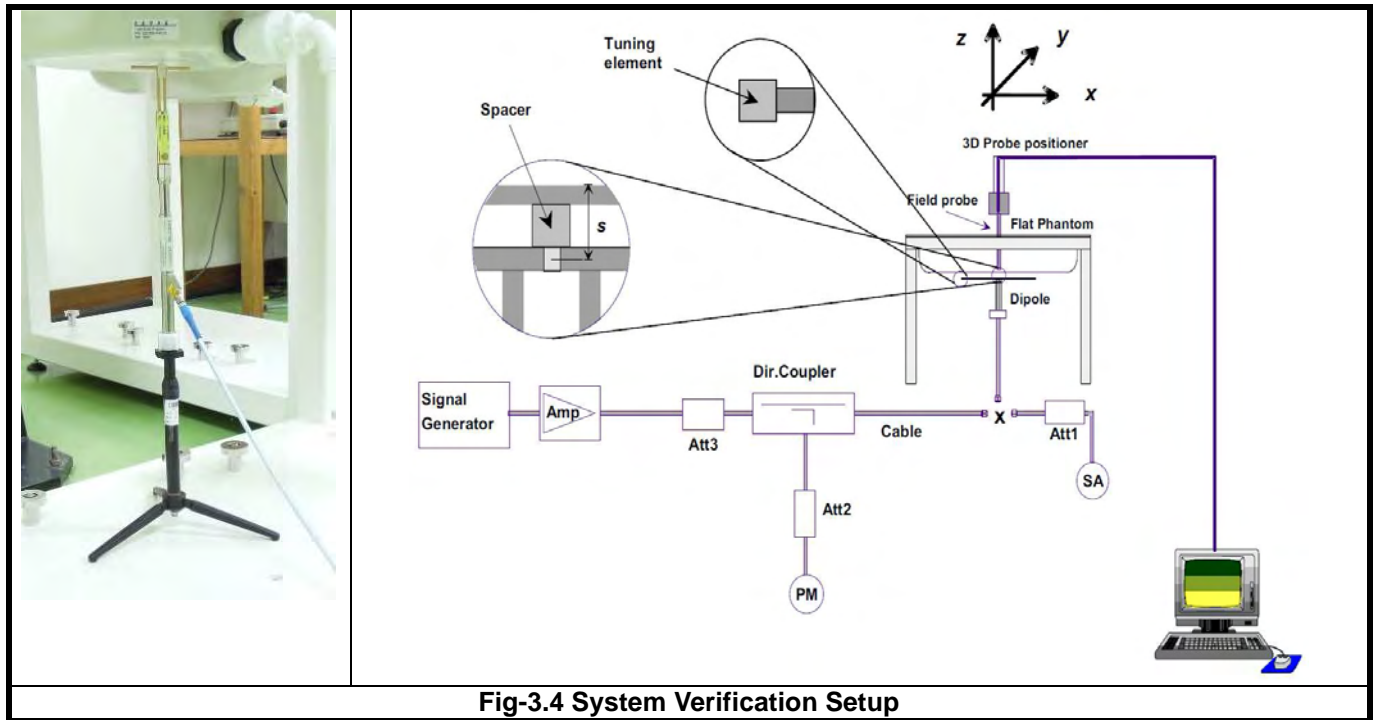
**Table-3.2 Recipes of Tissue Simulating Liquid**

Tissue Type	Bactericide	DGBE	HEC	NaCl	Sucrose	Triton X-100	Water	Diethylene Glycol Mono-hexylether
H750	0.2	-	0.2	1.5	56.0	-	42.1	-
H835	0.2	-	0.2	1.5	57.0	-	41.1	-
H900	0.2	-	0.2	1.4	58.0	-	40.2	-
H1450	-	43.3	-	0.6	-	-	56.1	-
H1640	-	45.8	-	0.5	-	-	53.7	-
H1750	-	47.0	-	0.4	-	-	52.6	-
H1800	-	44.5	-	0.3	-	-	55.2	-
H1900	-	44.5	-	0.2	-	-	55.3	-
H2000	-	44.5	-	0.1	-	-	55.4	-
H2300	-	44.9	-	0.1	-	-	55.0	-
H2450	-	45.0	-	0.1	-	-	54.9	-
H2600	-	45.1	-	0.1	-	-	54.8	-
H3500	-	8.0	-	0.2	-	20.0	71.8	-
H5G	-	-	-	-	-	17.2	65.5	17.3
B750	0.2	-	0.2	0.8	48.8	-	50.0	-
B835	0.2	-	0.2	0.9	48.5	-	50.2	-
B900	0.2	-	0.2	0.9	48.2	-	50.5	-
B1450	-	34.0	-	0.3	-	-	65.7	-
B1640	-	32.5	-	0.3	-	-	67.2	-
B1750	-	31.0	-	0.2	-	-	68.8	-
B1800	-	29.5	-	0.4	-	-	70.1	-
B1900	-	29.5	-	0.3	-	-	70.2	-
B2000	-	30.0	-	0.2	-	-	69.8	-
B2300	-	31.0	-	0.1	-	-	68.9	-
B2450	-	31.4	-	0.1	-	-	68.5	-
B2600	-	31.8	-	0.1	-	-	68.1	-
B3500	-	28.8	-	0.1	-	-	71.1	-
B5G	-	-	-	-	-	10.7	78.6	10.7

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### 3.3 SAR System Verification

The system check verifies that the system operates within its specifications. It is performed daily or before every SAR measurement. The system check uses normal SAR measurements in the flat section of the phantom with a matched dipole at a specified distance. The system verification setup is shown as below.



The validation dipole is placed beneath the flat phantom with the specific spacer in place. The distance spacer is touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The spectrum analyzer measures the forward power at the location of the system check dipole connector. The signal generator is adjusted for the desired forward power (250 mW is used for 700 MHz to 3 GHz, 100 mW is used for 3.5 GHz to 6 GHz) at the dipole connector and the power meter is read at that level. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at power meter.

After system check testing, the SAR result will be normalized to 1W forward input power and compared with the reference SAR value derived from validation dipole certificate report. The deviation of system check should be within 10 %.

## 3.4 SAR Measurement Procedure

According to the SAR test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

- Power reference measurement
- Area scan
- Zoom scan
- Power drift measurement

The SAR measurement procedures for each of test conditions are as follows:

- Make EUT to transmit maximum output power
- Measure conducted output power through RF cable
- Place the EUT in the specific position of phantom
- Perform SAR testing steps on the DASY system
- Record the SAR value

### 3.4.1 Area & Zoom Scan Procedure

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g. According to KDB 865664 D01, the resolution for Area and Zoom scan is specified in the table below.

Items	<= 2 GHz	2-3 GHz	3-4 GHz	4-5 GHz	5-6 GHz
Area Scan ( $\Delta x, \Delta y$ )	<= 15 mm	<= 12 mm	<= 12 mm	<= 10 mm	<= 10 mm
Zoom Scan ( $\Delta x, \Delta y$ )	<= 8 mm	<= 5 mm	<= 5 mm	<= 4 mm	<= 4 mm
Zoom Scan ( $\Delta z$ )	<= 5 mm	<= 5 mm	<= 4 mm	<= 3 mm	<= 2 mm
Zoom Scan Volume	>= 30 mm	>= 30 mm	>= 28 mm	>= 25 mm	>= 22 mm

#### Note:

When zoom scan is required and report SAR is <= 1.4 W/kg, the zoom scan resolution of  $\Delta x / \Delta y$  (2-3GHz: <= 8 mm, 3-4GHz: <= 7 mm, 4-6GHz: <= 5 mm) may be applied.

### 3.4.2 Volume Scan Procedure

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

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### 3.4.3 Power Drift Monitoring

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In DASY measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in dB. If the power drift more than 5%, the SAR will be retested.

### 3.4.4 Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1g and 10g, as well as for user-specific masses. The DASY software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

The base for the evaluation is a "cube" measurement. The measured volume must include the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.

The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

- (a) Extraction of the measured data (grid and values) from the Zoom Scan
- (b) Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
- (c) Generation of a high-resolution mesh within the measured volume
- (d) Interpolation of all measured values from the measurement grid to the high-resolution grid
- (e) Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
- (f) Calculation of the averaged SAR within masses of 1g and 10g

### 3.4.5 SAR Averaged Methods

In DASY, the interpolation and extrapolation are both based on the modified Quadratic Shepard's method. The interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5 mm.

## **4. SAR Measurement Evaluation**

### **4.1 EUT Configuration and Setting**

#### **<Considerations Related to Proximity Sensor>**

The device supports WWAN, WLAN, and Bluetooth capabilities. It is designed with a proximity sensor which can trigger/not trigger power reduction for GSM on Rear Face and Bottom Side of EUT for SAR compliance. Others RF capability (WLAN and Bluetooth) have no power reduction. The power levels for all wireless technologies and the power reduction please refer to section 4.6 of this report.

According to the procedures noticed in KDB 616217 D04, the proximity sensor triggering distance is 14 mm for EUT Rear Face, and 15 mm for Bottom Side. The separation distance of 15 mm determined by the smallest triggering distance on Bottom Side is used to access the tilt angle influence and the sensor does not release during  $\pm 45$  degree. Therefore, the smallest separation distance for tilt angle influence is 15 mm for the Bottom Side. The details can be found in technical document. The conservation triggering distances based on the separation distance for the sensor trigger / not triggered as EUT with power reduction at 0 mm, and EUT without power reduction at 13 mm for EUT Rear Face, and 14 mm for Bottom Side is used to test SAR.

The power reduction is depends on the proximity sensor input. For a steady SAR test, the power reduction was enabled or disabled manually by engineering software during SAR testing.

#### **<Connections between EUT and System Simulator>**

For WWAN SAR testing, the EUT was linked and controlled by base station emulator (Agilent E5515C is used for GSM/WCDMA/CDMA, and Anritsu MT8820C is used for LTE). Communication between the EUT and the emulator was established by air link. The distance between the EUT and the communicating antenna of the emulator is larger than 50 cm and the output power radiated from the emulator antenna is at least 30 dB smaller than the output power of EUT. The EUT was set from the emulator to radiate maximum output power during SAR testing.

#### **<Considerations Related to GSM / GPRS / EDGE for Setup and Testing>**

The maximum multi-slot capability supported by this device is as below.

1. This EUT is class B device
2. This EUT supports GPRS multi-slot class 12 (max. uplink: 4, max. downlink: 4, total timeslots: 5)
3. This EUT supports EDGE multi-slot class 12 (max. uplink: 4, max. downlink: 4, total timeslots: 5)

For GSM850 frequency band, the power control level is set to 5 for GSM mode and GPRS (GMSK: CS1), and set to 8 for EDGE (GMSK: MCS1, 8PSK: MCS9). For GSM1900 frequency band, the power control level is set to 0 for GSM mode and GPRS (GMSK: CS1), and set to 2 for EDGE (GMSK: MCS1, 8PSK: MCS9).

SAR test reduction for GPRS and EDGE modes is determined by the source-based time-averaged output power specified for production units, including tune-up tolerance. The data mode with highest specified time-averaged output power should be tested for SAR compliance in the applicable exposure conditions. For modes with the same specified maximum output power and tolerance, the higher number time-slot configuration should be tested.

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### <Considerations Related to WLAN for Setup and Testing>

In general, various vendor specific external test software and chipset based internal test modes are typically used for SAR measurement. These chipset based test mode utilities are generally hardware and manufacturer dependent, and often include substantial flexibility to reconfigure or reprogram a device. A Wi-Fi device must be configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools for SAR measurement. The test frequencies established using test mode must correspond to the actual channel frequencies. When 802.11 frame gaps are accounted for in the transmission, a maximum transmission duty factor of 92 - 96% is typically achievable in most test mode configurations. A minimum transmission duty factor of 85% is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. In addition, a periodic transmission duty factor is required for current generation SAR systems to measure SAR correctly. The reported SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

According to KDB 248227 D01, this device has installed WLAN engineering testing software which can provide continuous transmitting RF signal. During WLAN SAR testing, this device was operated to transmit continuously at the maximum transmission duty with specified transmission mode, operating frequency, lowest data rate, and maximum output power.

### 4.2 EUT Testing Position

This variant report is made for verification. All the worst SAR configurations specified in the original SAR report was repeated and verified to ensure the device remains compliant.

### 4.3 Tissue Verification

The measuring results for tissue simulating liquid are shown as below.

Test Date	Tissue Type	Frequency (MHz)	Liquid Temp. (°C)	Measured Conductivity ( $\sigma$ )	Measured Permittivity ( $\epsilon_r$ )	Target Conductivity ( $\sigma$ )	Target Permittivity ( $\epsilon_r$ )	Conductivity Deviation (%)	Permittivity Deviation (%)
Mar. 22, 2016	Head	835	20.8	0.910	41.454	0.90	41.50	1.11	-0.11
Mar. 22, 2016	Head	1900	20.9	1.442	39.907	1.40	40.00	3.00	-0.23
Mar. 22, 2016	Head	2450	21.0	1.786	40.406	1.80	39.20	-0.78	3.08
Mar. 22, 2016	Body	835	20.9	0.992	54.645	0.97	55.20	2.27	-1.01
Mar. 22, 2016	Body	1900	20.9	1.506	52.307	1.52	53.30	-0.92	-1.86
Mar. 22, 2016	Body	2450	21.1	1.907	51.407	1.95	52.70	-2.21	-2.45

#### Note:

The dielectric properties of the tissue simulating liquid must be measured within 24 hours before the SAR testing and within  $\pm 5\%$  of the target values. Liquid temperature during the SAR testing must be within  $\pm 2^\circ\text{C}$ .

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### 4.4 System Validation

The SAR measurement system was validated according to procedures in KDB 865664 D01. The validation status in tabulated summary is as below.

Test Date	Probe S/N	Calibration Point		Measured Conductivity ( $\sigma$ )	Measured Permittivity ( $\epsilon_r$ )	Validation for CW			Validation for Modulation		
						Sensitivity Range	Probe Linearity	Probe Isotropy	Modulation Type	Duty Factor	PAR
Mar. 22, 2016	3873	Head	835	0.910	41.454	Pass	Pass	Pass	GMSK	Pass	N/A
Mar. 22, 2016	3873	Head	1900	1.442	39.907	Pass	Pass	Pass	GMSK	Pass	N/A
Mar. 22, 2016	3873	Head	2450	1.786	40.406	Pass	Pass	Pass	OFDM	N/A	Pass
Mar. 22, 2016	3873	Body	835	0.992	54.645	Pass	Pass	Pass	GMSK	Pass	N/A
Mar. 22, 2016	3873	Body	1900	1.506	52.307	Pass	Pass	Pass	GMSK	Pass	N/A
Mar. 22, 2016	3873	Body	2450	1.907	51.407	Pass	Pass	Pass	OFDM	N/A	Pass

### 4.5 System Verification

The measuring result for system verification is tabulated as below.

Test Date	Mode	Frequency (MHz)	1W Target SAR-1g (W/kg)	Measured SAR-1g (W/kg)	Normalized to 1W SAR-1g (W/kg)	Deviation (%)	Dipole S/N	Probe S/N	DAE S/N
Mar. 22, 2016	Head	835	9.11	2.39	9.56	4.94	4d139	3873	1341
Mar. 22, 2016	Head	1900	40.70	9.93	39.72	-2.41	5d159	3873	1341
Mar. 22, 2016	Head	2450	53.00	12.50	50.00	-5.66	893	3873	1341
Mar. 22, 2016	Body	835	9.28	2.31	9.24	-0.43	4d139	3873	1341
Mar. 22, 2016	Body	1900	40.00	10.20	40.80	2.00	5d159	3873	1341
Mar. 22, 2016	Body	2450	51.10	12.70	50.80	-0.59	893	3873	1341

#### Note:

Comparing to the reference SAR value provided by SPEAG, the validation data should be within its specification of 10 %. The result indicates the system check can meet the variation criterion and the plots can be referred to Appendix A of this report.

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### 4.6 Maximum Output Power

#### 4.6.1 Maximum Conducted Power

The maximum conducted average power (Unit: dBm) including tune-up tolerance is shown as below.

Mode	GSM850 (without Power Reduction)	GSM850 (with Power Reduction)	Power Reduction (dB)
GSM (GMSK, 1Tx-slot)	31.5	26.0	5.5
GPRS (GMSK, 1Tx-slot)	31.5	26.0	5.5
GPRS (GMSK, 2Tx-slot)	30.0	23.0	7.0
GPRS (GMSK, 3Tx-slot)	28.0	21.0	7.0
GPRS (GMSK, 4Tx-slot)	26.0	20.0	6.0
EDGE (8PSK, 1Tx-slot)	28.0	22.5	5.5
EDGE (8PSK, 2Tx-slot)	27.0	20.0	7.0
EDGE (8PSK, 3Tx-slot)	25.0	18.0	7.0
EDGE (8PSK, 4Tx-slot)	24.0	18.0	6.0

Mode	GSM1900 (without Power Reduction)	GSM1900 (with Power Reduction)	Power Reduction (dB)
GSM (GMSK, 1Tx-slot)	29.0	23.0	6.0
GPRS (GMSK, 1Tx-slot)	29.0	23.0	6.0
GPRS (GMSK, 2Tx-slot)	27.0	20.0	7.0
GPRS (GMSK, 3Tx-slot)	25.0	18.0	7.0
GPRS (GMSK, 4Tx-slot)	23.0	17.0	6.0
EDGE (8PSK, 1Tx-slot)	25.0	19.0	6.0
EDGE (8PSK, 2Tx-slot)	24.0	17.0	7.0
EDGE (8PSK, 3Tx-slot)	22.0	15.0	7.0
EDGE (8PSK, 4Tx-slot)	20.0	14.0	6.0

Mode	2.4G WLAN
802.11b	12.0
802.11g	11.5
802.11n HT20	12.0
802.11n HT40	11.0

Mode	2.4G Bluetooth
All	0.0

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## 4.6.2 Measured Conducted Power Result

The measuring conducted average power (Unit: dBm) is shown as below.

Band	GSM850			GSM1900		
Channel	128	189	251	512	661	810
Frequency (MHz)	824.2	836.4	848.8	1850.2	1880.0	1909.8
<b>EUT without Power Reduction (P-Sensor NOT Triggered)</b>						
<b>Maximum Burst-Averaged Output Power</b>						
GSM (GMSK, 1Tx-slot)	31.07	<b>31.16</b>	31.15	28.67	28.78	<b>28.81</b>
GPRS (GMSK, 1Tx-slot)	31.00	31.15	31.03	28.58	28.66	28.74
GPRS (GMSK, 2Tx-slot)	29.25	29.43	29.30	26.26	26.49	26.48
GPRS (GMSK, 3Tx-slot)	27.62	27.82	27.73	24.03	24.35	24.33
GPRS (GMSK, 4Tx-slot)	25.52	25.68	25.65	22.27	22.23	22.53
EDGE (8PSK, 1Tx-slot)	27.43	27.59	27.55	24.77	24.49	24.51
EDGE (8PSK, 2Tx-slot)	26.43	26.66	26.55	23.55	23.25	23.31
EDGE (8PSK, 3Tx-slot)	24.42	24.68	24.57	21.29	20.91	20.91
EDGE (8PSK, 4Tx-slot)	23.31	23.48	23.46	19.67	19.66	19.35
<b>Maximum Frame-Averaged Output Power</b>						
GSM (GMSK, 1Tx-slot)	22.07	22.16	22.15	19.67	19.78	19.81
GPRS (GMSK, 1Tx-slot)	22.00	22.15	22.03	19.58	19.66	19.74
GPRS (GMSK, 2Tx-slot)	23.25	23.43	23.30	20.26	<b>20.49</b>	20.48
GPRS (GMSK, 3Tx-slot)	23.36	<b>23.56</b>	23.47	19.77	20.09	20.07
GPRS (GMSK, 4Tx-slot)	22.52	22.68	22.65	19.27	19.23	19.53
EDGE (8PSK, 1Tx-slot)	18.43	18.59	18.55	15.77	15.49	15.51
EDGE (8PSK, 2Tx-slot)	20.43	20.66	20.55	17.55	17.25	17.31
EDGE (8PSK, 3Tx-slot)	20.16	20.42	20.31	17.03	16.65	16.65
EDGE (8PSK, 4Tx-slot)	20.31	20.48	20.46	16.67	16.66	16.35
<b>EUT with Power Reduction (P-Sensor Triggered)</b>						
<b>Maximum Burst-Averaged Output Power</b>						
GSM (GMSK, 1Tx-slot)	<b>25.75</b>	25.73	25.61	22.33	22.56	<b>22.62</b>
GPRS (GMSK, 1Tx-slot)	25.71	25.67	25.54	22.32	22.54	22.61
GPRS (GMSK, 2Tx-slot)	22.61	22.60	22.67	19.34	19.54	19.62
GPRS (GMSK, 3Tx-slot)	20.85	20.66	20.72	17.48	17.69	17.82
GPRS (GMSK, 4Tx-slot)	19.76	19.42	19.52	16.30	16.56	16.63
EDGE (8PSK, 1Tx-slot)	22.24	22.37	22.22	18.12	18.08	18.41
EDGE (8PSK, 2Tx-slot)	19.52	19.62	19.45	15.90	15.81	16.15
EDGE (8PSK, 3Tx-slot)	17.44	17.61	17.41	14.20	14.10	14.30
EDGE (8PSK, 4Tx-slot)	17.11	17.28	17.24	12.95	12.94	13.04
<b>Maximum Frame-Averaged Output Power</b>						
GSM (GMSK, 1Tx-slot)	16.75	16.73	16.61	13.33	13.56	13.62
GPRS (GMSK, 1Tx-slot)	16.71	16.67	16.54	13.32	13.54	13.61
GPRS (GMSK, 2Tx-slot)	16.61	16.60	16.67	13.34	13.54	13.62
GPRS (GMSK, 3Tx-slot)	16.59	16.40	16.46	13.22	13.43	13.56
GPRS (GMSK, 4Tx-slot)	<b>16.76</b>	16.42	16.52	13.30	13.56	<b>13.63</b>
EDGE (8PSK, 1Tx-slot)	13.24	13.37	13.22	9.12	9.08	9.41
EDGE (8PSK, 2Tx-slot)	13.52	13.62	13.45	9.90	9.81	10.15
EDGE (8PSK, 3Tx-slot)	13.18	13.35	13.15	9.94	9.84	10.04
EDGE (8PSK, 4Tx-slot)	14.11	14.28	14.24	9.95	9.94	10.04

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## <WLAN 2.4G>

Mode	802.11b		
Channel / Frequency (MHz)	1 (2412)	6 (2437)	11 (2462)
Average Power	11.75	11.45	11.19
Mode	802.11g		
Channel / Frequency (MHz)	1 (2412)	6 (2437)	11 (2462)
Average Power	11.22	11.12	10.87
Mode	802.11n (HT20)		
Channel / Frequency (MHz)	1 (2412)	6 (2437)	11 (2462)
Average Power	11.67	11.34	10.58
Mode	802.11n (HT40)		
Channel / Frequency (MHz)	3 (2422)	6 (2437)	9 (2452)
Average Power	10.72	10.66	9.05

## 4.7 SAR Testing Results

### 4.7.1 SAR Results for Head Exposure Condition

Plot No.	Band	Mode	Test Position	Ch.	Max. Tune-up Power (dBm)	Measured Conducted Power (dBm)	Scaling Factor	Power Drift (dB)	Measured SAR-1g (W/kg)	Scaled SAR-1g (W/kg)
01	GSM850	GSM	Left Cheek	189	31.5	31.16	1.08	0.07	0.133	0.14
02	GSM1900	GSM	Right Cheek	810	29.0	28.81	1.04	0.09	0.032	0.03
03	802.11b	-	Right Cheek	1	12.0	11.75	1.06	0.12	0.337	0.36

**Note:** SAR testing above was verified based on the worst SAR configuration of the original SAR report.

### 4.7.2 SAR Results for Body Exposure Condition

Plot No.	Band	Mode	Test Position	Separation Distance (mm)	Ch.	Power Reduction	Max. Tune-up Power (dBm)	Measured Conducted Power (dBm)	Scaling Factor	Power Drift (dB)	Measured SAR-1g (W/kg)	Scaled SAR-1g (W/kg)
04	GSM850	GPRS12	Rear Face	0	128	w/	20.0	19.76	1.06	0.09	0.281	0.30
05	GSM1900	GPRS12	Bottom Side	0	810	w/	17.0	16.63	1.09	0.04	0.941	1.02
06	802.11b	-	Rear Face	0	1	-	12.0	11.45	1.14	-0.01	0.438	0.50

**Note:** SAR testing above was verified based on the worst SAR configuration of the original SAR report.

### 4.7.3 Simultaneous Multi-band Transmission Evaluation

Since all the verified SAR values are less than the values in original report. The simultaneous transmission evaluation has no effect and the simultaneous transmission SAR is not required.

**Test Engineer :** Yihu Xiong



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### 5. Calibration of Test Equipment

Equipment	Manufacturer	Model	SN	Cal. Date	Cal. Interval
System Validation Dipole	SPEAG	D835V2	4d139	08. 24, 2015	1 Year
System Validation Dipole	SPEAG	D1900V2	5d159	08. 21, 2015	1 Year
System Validation Dipole	SPEAG	D2450V2	893	08. 20, 2015	1 Year
Dosimetric E-Field Probe	SPEAG	EX3DV4	3873	08. 26, 2015	1 Year
Data Acquisition Electronics	SPEAG	DAE4	1341	08. 25, 2015	1 Year
Wireless Communication Test Set	Agilent	E5515C	MY50260600	08. 05, 2015	2 Years
ENA Series Network Analyzer	Agilent	E5071C	MY46214638	09. 07, 2015	1 Year
Spectrum Analyzer	KEYSIGHT	N9020A	MY52090163	05. 27, 2014	2 Years
MXG Analog Signal Generator	KEYSIGHT	N5183A	MY50143024	03. 18, 2015	2 Years
Power Meter	Agilent	N1914A	MY52180044	08. 28, 2014	2 Years
Power Sensor	Agilent	E9304A H18	MY52050011	10. 22, 2015	1 Year
Temp. & Humi. Recorder	HUATO	A2000TH	HE20107684	06. 25, 2015	1 Year
Electronic Thermometer	YONGFA	YF-160A	120100323	10. 15, 2015	1 Year
Coupler	Woken	0110A056020-10	CON27RW1A3	09. 18, 2015	1 Year

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## 6. Measurement Uncertainty

Source of Uncertainty	Tolerance (± %)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (± %, 1g)	Standard Uncertainty (± %, 10g)	Vi
<b>Measurement System</b>								
Probe Calibration	6.0	Normal	1	1	1	6.0	6.0	∞
Axial Isotropy	4.7	Rectangular	√3	0.707	0.707	1.9	1.9	∞
Hemispherical Isotropy	9.6	Rectangular	√3	0.707	0.707	3.9	3.9	∞
Boundary Effect	1.0	Rectangular	√3	1	1	0.6	0.6	∞
Linearity	4.7	Rectangular	√3	1	1	2.7	2.7	∞
System Detection Limits	0.25	Rectangular	√3	1	1	0.14	0.14	∞
Readout Electronics	0.3	Normal	1	1	1	0.3	0.3	∞
Response Time	0.0	Rectangular	√3	1	1	0.0	0.0	∞
Integration Time	1.7	Rectangular	√3	1	1	1.0	1.0	∞
RF Ambient Conditions - Noise	3.0	Rectangular	√3	1	1	1.7	1.7	∞
RF Ambient Conditions - Reflections	3.0	Rectangular	√3	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	0.4	Rectangular	√3	1	1	0.2	0.2	∞
Probe Positioning with Respect to Phantom Shell	2.9	Rectangular	√3	1	1	1.7	1.7	∞
Extrapolation, interpolation, and integration algorithms for max. SAR evaluation	2.0	Rectangular	√3	1	1	1.2	1.2	∞
<b>Test Sample Related</b>								
Test Sample Positioning	1.5 / 0.7	Normal	1	1	1	1.5	0.7	32
Device Holder Uncertainty	4.2 / 1.8	Normal	1	1	1	4.2	1.8	32
Output Power Variation - SAR Drift Measurement	5.0	Rectangular	√3	1	1	2.9	2.9	∞
<b>Phantom and Tissue Parameters</b>								
Phantom Uncertainty (Shape and Thickness Tolerances)	7.2	Rectangular	√3	1	1	4.2	4.2	∞
Liquid Conductivity - Deviation from Target Values	5.0	Rectangular	√3	0.64	0.43	1.8	1.2	∞
Liquid Conductivity - Measurement Uncertainty	1.0	Normal	1	0.64	0.43	0.6	0.4	25
Liquid Permittivity - Deviation from Target Values	5.0	Rectangular	√3	0.60	0.49	1.7	1.4	∞
Liquid Permittivity - Measurement Uncertainty	0.5	Normal	1	0.60	0.49	0.3	0.2	25
<b>Combined Standard Uncertainty</b>						± 11.2 %	± 10.4 %	
<b>Expanded Uncertainty (K=2)</b>						± 22.4 %	± 20.8 %	

Uncertainty budget for frequency range 300 MHz to 3 GHz

## 7. Information on the Testing Laboratories

We, Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, were founded in 2002 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

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**Web Site:** [www.adt.com.tw](http://www.adt.com.tw)

The road map of all our labs can be found in our web site also.

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## **Appendix A. SAR Plots of System Verification**

The plots for system verification with largest deviation for each SAR system combination are shown as follows.

**System Check\_H835\_160322****DUT: Dipole:835 MHz; Type:D835V2; SN;4d139**

Communication System: CW; Frequency: 835 MHz;Duty Cycle: 1:1

Medium: H835\_0322 Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.91$  S/m;  $\epsilon_r = 41.454$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 21.7 °C; Liquid Temperature : 20.8 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3873; ConvF(9.53, 9.53, 9.53); Calibrated: 2015/08/26;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2015/08/25
- Phantom: Left Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1722
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Pin=250mW/Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 2.99 W/kg

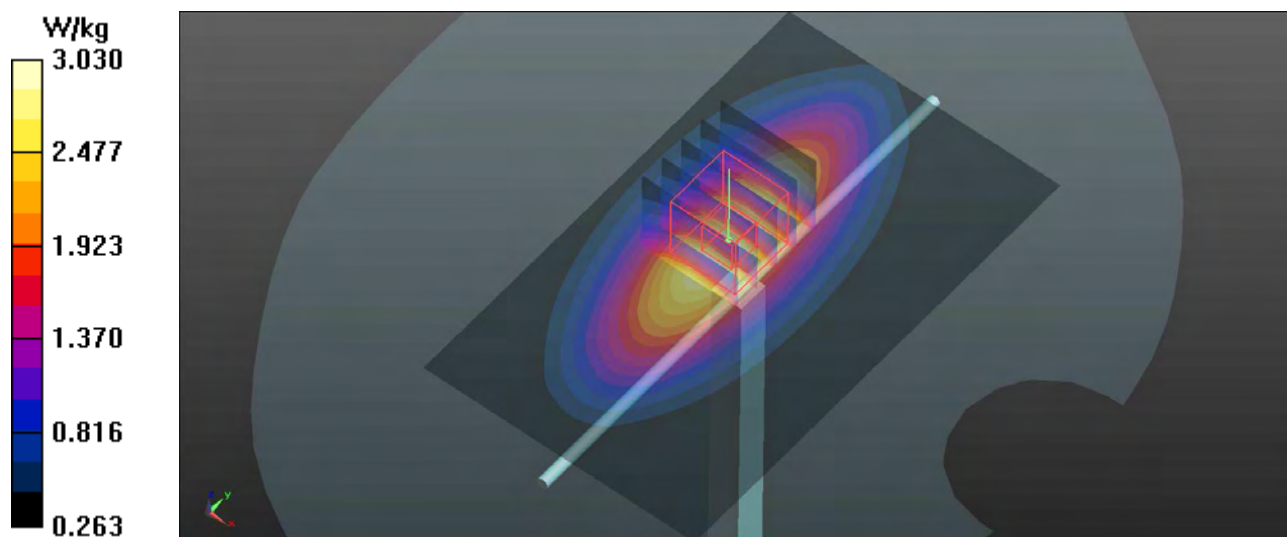
**Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 56.54 V/m; Power Drift = 0.12 dB

Peak SAR (extrapolated) = 3.54 W/kg

**SAR(1 g) = 2.39 W/kg; SAR(10 g) = 1.57 W/kg**

Maximum value of SAR (measured) = 3.03 W/kg



## System Check\_H1900\_160322

**DUT: Dipole 1900 MHz;Type: D1900V2; SN: 5d159**

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1

Medium: H1900\_0322 Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.442$  S/m;  $\epsilon_r = 39.907$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 21.7 °C; Liquid Temperature : 20.9 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3873; ConvF(7.98, 7.98, 7.98); Calibrated: 2015/08/26;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2015/08/25
- Phantom: Front Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1695
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Pin=250mW/Area Scan (61x61x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 13.9 W/kg

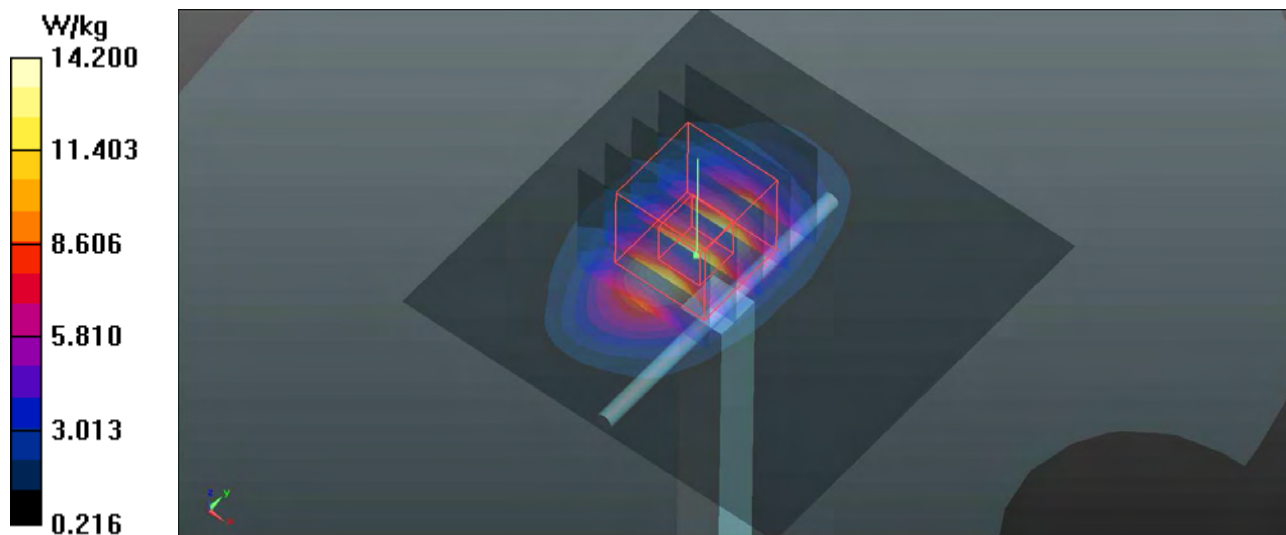
**Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 90.88 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 18.2 W/kg

**SAR(1 g) = 9.93 W/kg; SAR(10 g) = 5.15 W/kg**

Maximum value of SAR (measured) = 14.2 W/kg



**System Check\_H2450\_160322****DUT: Dipole 2450 MHz; Type:D2450V2; SN:893**

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: H2450\_0322 Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.786$  S/m;  $\epsilon_r = 40.406$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 22.1 °C; Liquid Temperature : 21.0 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3873; ConvF(7.24, 7.24, 7.24); Calibrated: 2015/08/26;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2015/08/25
- Phantom: Front Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1695
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Pin=250mW/Area Scan (81x81x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 19.6 W/kg

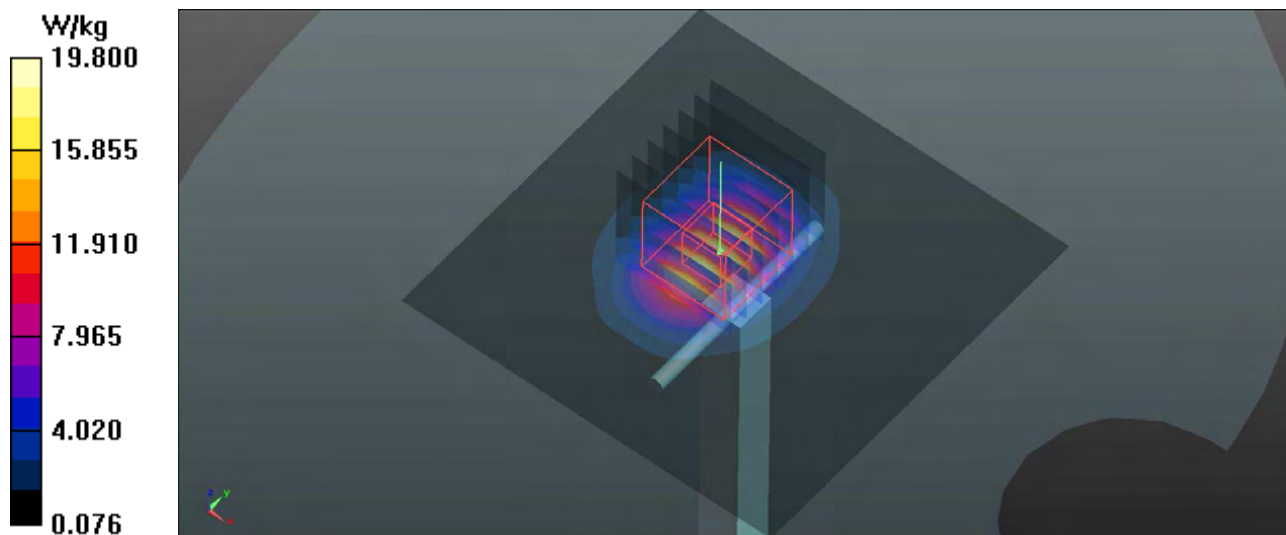
**Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.57 V/m; Power Drift = 0.14 dB

Peak SAR (extrapolated) = 27.9 W/kg

**SAR(1 g) = 12.5 W/kg; SAR(10 g) = 5.62 W/kg**

Maximum value of SAR (measured) = 19.8 W/kg



**System Check\_B835\_160322****DUT: Dipole:835 MHz; Type:D835V2; SN:4d139**

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium: B835\_0322 Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.992$  S/m;  $\epsilon_r = 54.645$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 21.8 °C; Liquid Temperature : 20.9 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3873; ConvF(9.72, 9.72, 9.72); Calibrated: 2015/08/26;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2015/08/25
- Phantom: Left Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1722
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Pin=250mW/Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

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

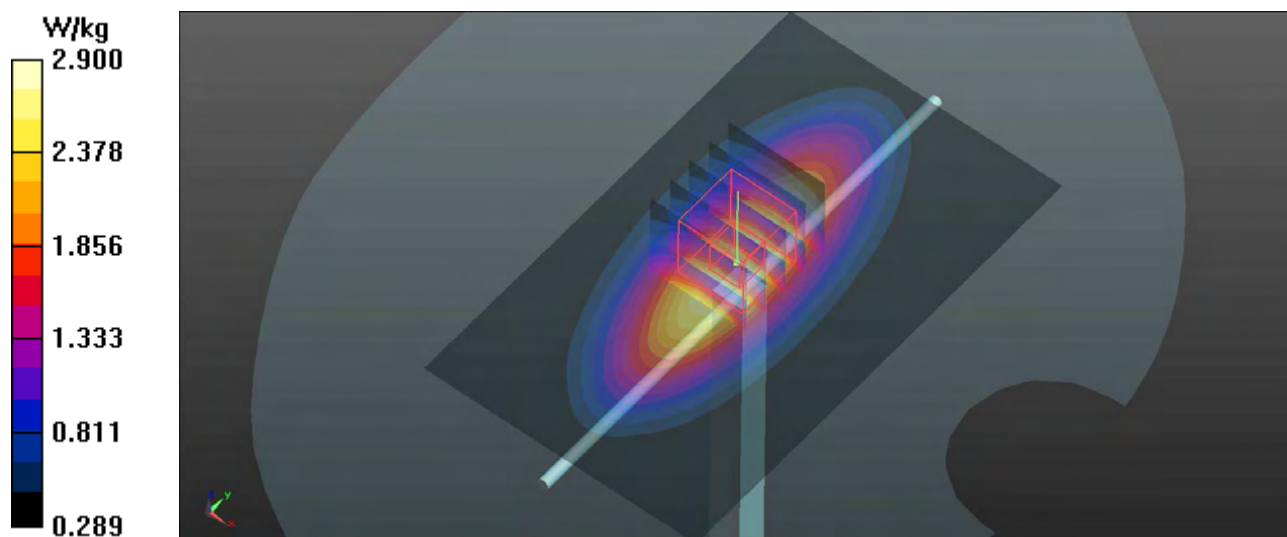
**Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 55.92 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 3.36 W/kg

**SAR(1 g) = 2.31 W/kg; SAR(10 g) = 1.54 W/kg**

Maximum value of SAR (measured) = 2.90 W/kg



**System Check\_B1900\_160322****DUT: Dipole:1900MHz; Type:D1900V2; SN:5d159**

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: B1900\_0322 Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.506$  S/m;  $\epsilon_r = 52.307$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 21.8 °C; Liquid Temperature : 20.9 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3873; ConvF(7.62, 7.62, 7.62); Calibrated: 2015/08/26;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2015/08/25
- Phantom: Front Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1695
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Pin=250mW/Area Scan (61x61x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 14.1 W/kg

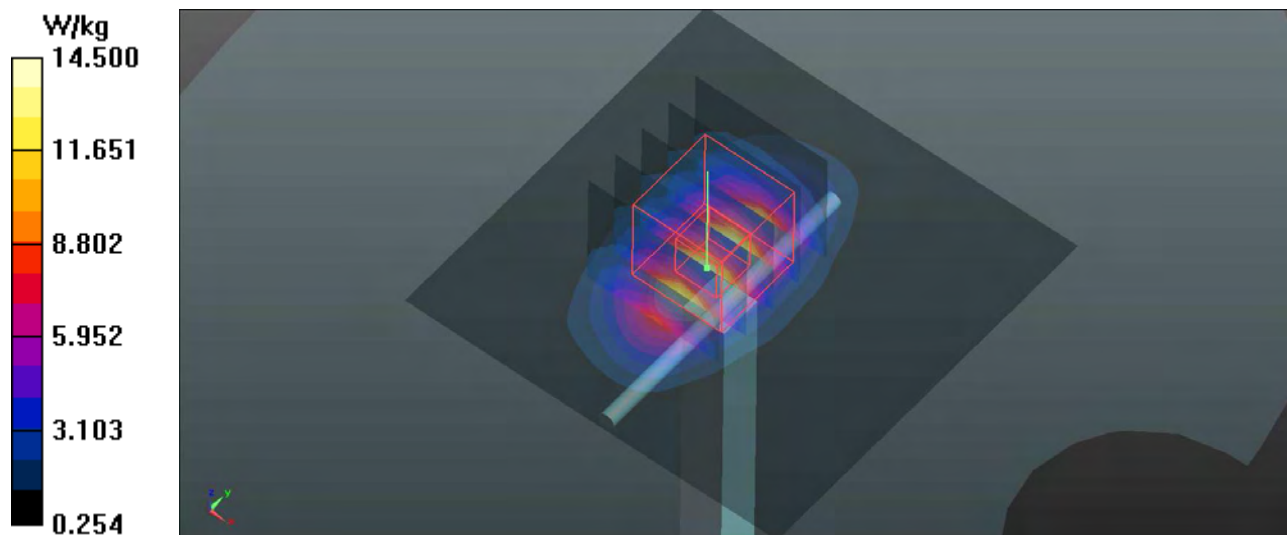
**Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 98.98 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 18.1 W/kg

**SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.36 W/kg**

Maximum value of SAR (measured) = 14.5 W/kg



**System Check\_B2450\_160322****DUT: Dipole 2450 MHz; Type:D2450V2; SN:893**

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: B2450\_0322 Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.907$  S/m;  $\epsilon_r = 51.407$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 22.1 °C; Liquid Temperature : 21.1 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3873; ConvF(7.3, 7.3, 7.3); Calibrated: 2015/08/26;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2015/08/25
- Phantom: Front Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1695
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Pin=250mW/Area Scan (61x81x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 20.0 W/kg

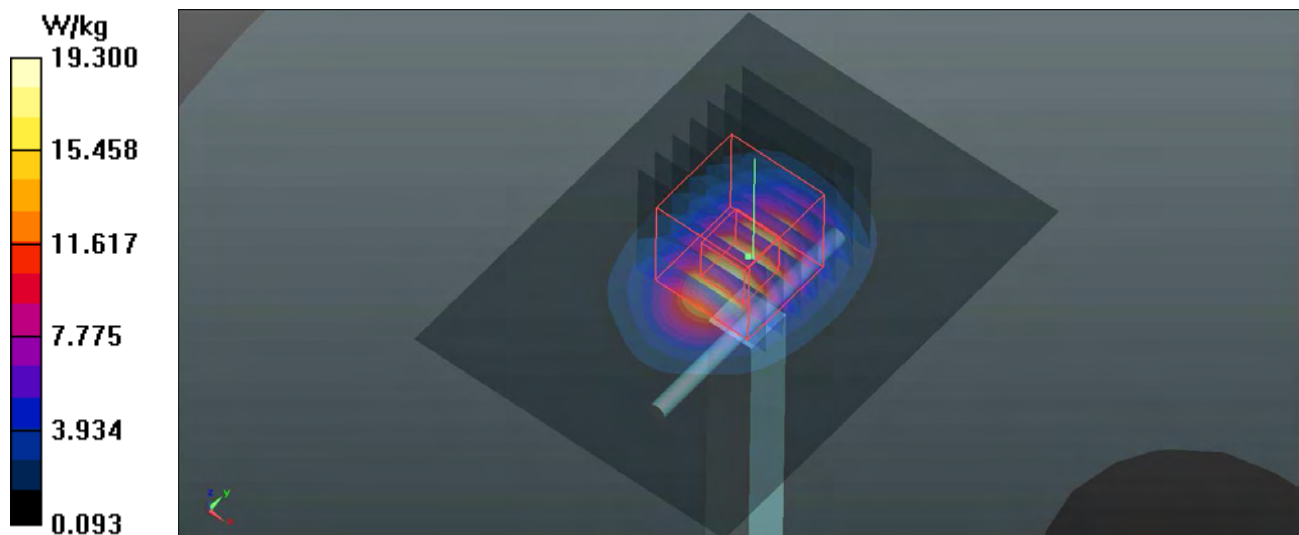
**Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 100.6 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 26.7 W/kg

**SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.75 W/kg**

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



## **Appendix B. SAR Plots of SAR Measurement**

The SAR plots for highest measured SAR in each exposure configuration, wireless mode and frequency band combination, and measured SAR > 1.5 W/kg are shown as follows.

**P01 GSM850\_GSM\_Left Cheek\_Ch189****DUT: 160223W005**

Communication System: GSM; Frequency: 836.4 MHz; Duty Cycle: 1:8.3

Medium: H835\_0322 Medium parameters used:  $f = 836.4$  MHz;  $\sigma = 0.911$  S/m;  $\epsilon_r = 41.436$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 21.7 °C; Liquid Temperature : 20.8 °C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3873; ConvF(9.53, 9.53, 9.53); Calibrated: 2015/08/26;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2015/08/25
- Phantom: Left Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1722
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**- Area Scan (91x161x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.152 W/kg

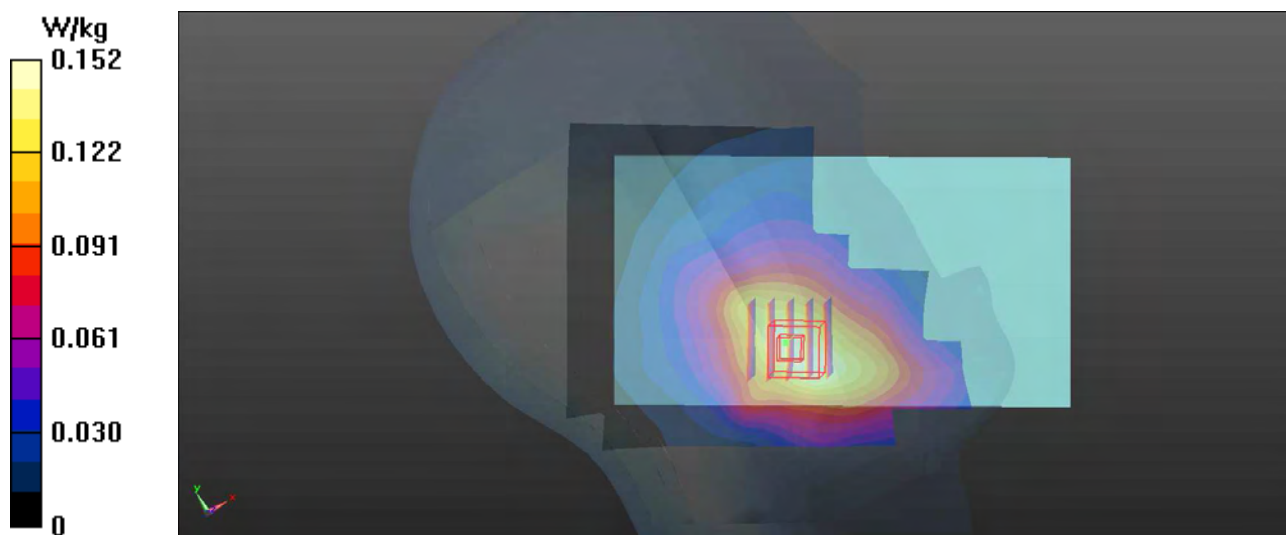
**- Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 4.254 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 0.175 W/kg

**SAR(1 g) = 0.133 W/kg; SAR(10 g) = 0.103 W/kg**

Maximum value of SAR (measured) = 0.160 W/kg



**P02 GSM1900\_GSM\_Right Cheek\_Ch810****DUT: 160223W005**

Communication System: GSM; Frequency: 1909.8 MHz; Duty Cycle: 1:8.3

Medium: H1900\_0322 Medium parameters used:  $f = 1910$  MHz;  $\sigma = 1.451$  S/m;  $\epsilon_r = 39.855$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 21.7 °C; Liquid Temperature : 20.9 °C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3873; ConvF(7.98, 7.98, 7.98); Calibrated: 2015/08/26;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2015/08/25
- Phantom: Front Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1695
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

- **Area Scan (91x161x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.0436 W/kg

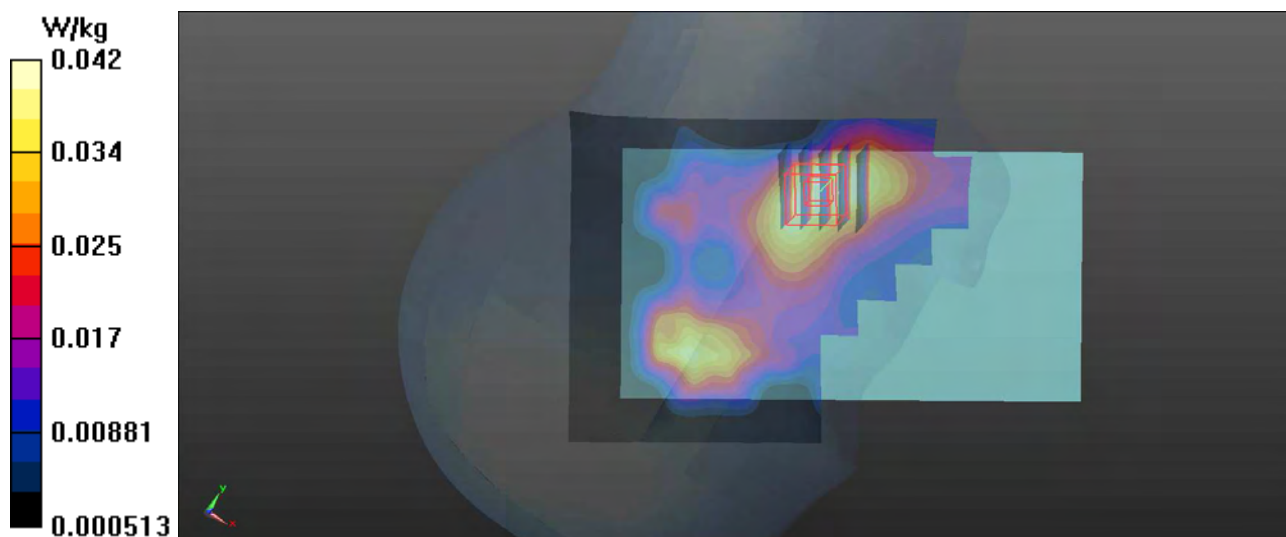
- **Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 1.321 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 0.0480 W/kg

**SAR(1 g) = 0.032 W/kg; SAR(10 g) = 0.021 W/kg**

Maximum value of SAR (measured) = 0.0420 W/kg



**P03 802.11b\_Right Cheek\_Ch1****DUT: 160223W005**

Communication System: 802.11b; Frequency: 2412 MHz; Duty Cycle: 1:1

Medium: H2450\_0322 Medium parameters used:  $f = 2412$  MHz;  $\sigma = 1.728$  S/m;  $\epsilon_r = 40.563$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 22.1 °C; Liquid Temperature : 21.0 °C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3873; ConvF(7.24, 7.24, 7.24); Calibrated: 2015/08/26;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2015/08/25
- Phantom: Front Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1695
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**- Area Scan (91x161x1):** Interpolated grid:  $dx=1.200$  mm,  $dy=1.200$  mm

Maximum value of SAR (interpolated) = 0.640 W/kg

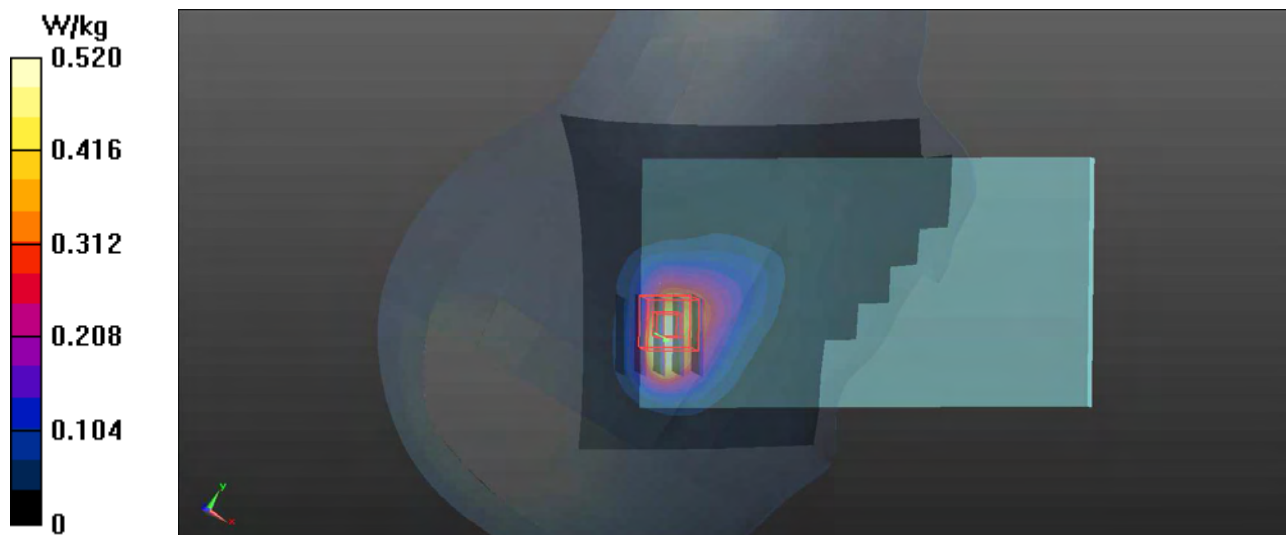
**- Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8$ mm,  $dy=8$ mm,  $dz=5$ mm

Reference Value = 9.058 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 0.679 W/kg

**SAR(1 g) = 0.337 W/kg; SAR(10 g) = 0.168 W/kg**

Maximum value of SAR (measured) = 0.520 W/kg



**P04 GSM850\_GPRS12\_Rear Face\_0cm\_Ch128\_w/****DUT: 160223W005**

Communication System: GPRS12; Frequency: 824.2 MHz; Duty Cycle: 1:2

Medium: B835\_0322 Medium parameters used:  $f = 824.2$  MHz;  $\sigma = 0.977$  S/m;  $\epsilon_r = 54.762$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 21.8 °C; Liquid Temperature : 20.9 °C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3873; ConvF(9.72, 9.72, 9.72); Calibrated: 2015/08/26;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2015/08/25
- Phantom: Left Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1722
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**- Area Scan (91x141x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.427 W/kg

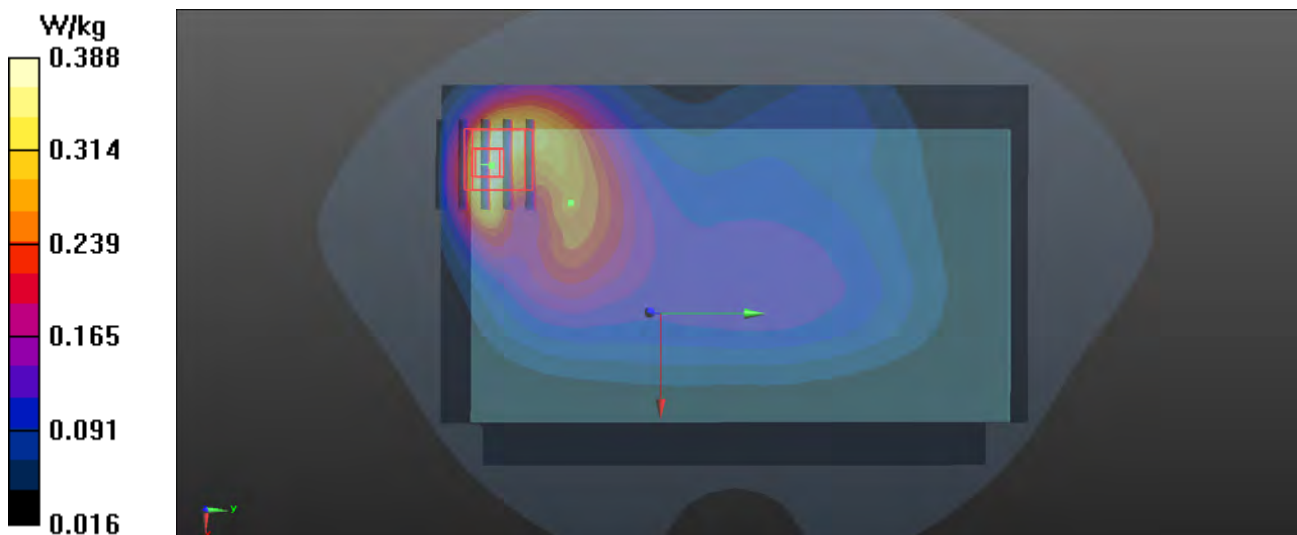
**- Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 10.99 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 0.444 W/kg

**SAR(1 g) = 0.281 W/kg; SAR(10 g) = 0.177 W/kg**

Maximum value of SAR (measured) = 0.388 W/kg



**P05 GSM1900\_GPRS12\_Bottom Side\_0cm\_Ch810\_w/****DUT: 160223W005**

Communication System: GPRS12; Frequency: 1909.8 MHz; Duty Cycle: 1:2

Medium: B1900\_0322 Medium parameters used:  $f = 1910$  MHz;  $\sigma = 1.519$  S/m;  $\epsilon_r = 52.268$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 21.8 °C; Liquid Temperature : 20.9 °C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3873; ConvF(7.62, 7.62, 7.62); Calibrated: 2015/08/26;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2015/08/25
- Phantom: Front Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1695
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

- **Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 1.43 W/kg

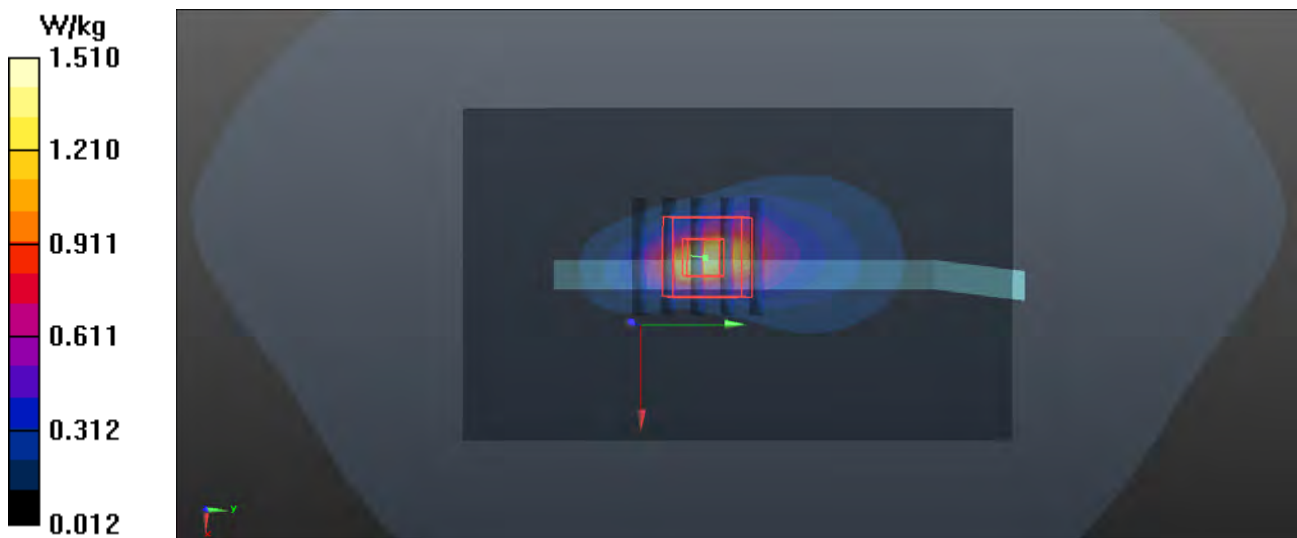
- **Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 21.77 V/m; Power Drift = 0.11 dB

Peak SAR (extrapolated) = 1.78 W/kg

**SAR(1 g) = 0.941 W/kg; SAR(10 g) = 0.444 W/kg**

Maximum value of SAR (measured) = 1.51 W/kg



**P06 802.11b\_Rear Face\_0cm\_Ch1****DUT: 160223W005**

Communication System: 802.11b; Frequency: 2412 MHz; Duty Cycle: 1:1

Medium: B2450\_0322 Medium parameters used:  $f = 2412$  MHz;  $\sigma = 1.855$  S/m;  $\epsilon_r = 51.535$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 22.1 °C; Liquid Temperature : 21.1 °C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3873; ConvF(7.3, 7.3, 7.3); Calibrated: 2015/08/26;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2015/08/25
- Phantom: Front Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1695
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

- **Area Scan (91x141x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 0.855 W/kg

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

Reference Value = 1.551 V/m; Power Drift = 0.12 dB

Peak SAR (extrapolated) = 1.04 W/kg

**SAR(1 g) = 0.438 W/kg; SAR(10 g) = 0.202 W/kg**

Maximum value of SAR (measured) = 0.803 W/kg



## **Appendix C. Calibration Certificate for Probe and Dipole**

The SPEAG calibration certificates are shown as follows.



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

Accreditation No.: **SCS 0108**

Client **BV ADT-CN (Auden)**

Certificate No: **D900V2-1d139\_Aug15**

## CALIBRATION CERTIFICATE

Object **D900V2 - SN: 1d139**

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

Calibration date: **August 24, 2015**

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 ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (20k)	01-Apr-15 (No. 217-02131)	Mar-16
Type-N mismatch combination	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02134)	Mar-16
Reference Probe ES3DV3	SN: 3205	30-Dec-14 (No. ES3-3205_Dec14)	Dec-15
DAE4	SN: 601	17-Aug-15 (No. DAE4-601_Aug15)	Aug-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

Calibrated by: **Name** Michael Weber **Function** Laboratory Technician

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

Signature

*M. Weber*

*K. Pokovic*

Issued: August 25, 2015

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



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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:

- 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
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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

## Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	900 MHz $\pm$ 1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.97 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	41.8 $\pm$ 6 %	0.95 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

## SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.58 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	10.5 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.66 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	6.73 W/kg $\pm$ 16.5 % (k=2)

## Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.0	1.05 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	56.0 $\pm$ 6 %	1.05 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

## SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.67 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	10.7 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.74 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	6.98 W/kg $\pm$ 16.5 % (k=2)

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.4 $\Omega$ - 0.1 j $\Omega$
Return Loss	- 37.1 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.5 $\Omega$ - 1.8 j $\Omega$
Return Loss	- 30.0 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.406 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	December 10, 2010

## DASY5 Validation Report for Head TSL

Date: 21.08.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN: 1d139**

Communication System: UID 0 - CW; Frequency: 900 MHz

Medium parameters used:  $f = 900$  MHz;  $\sigma = 0.95$  S/m;  $\epsilon_r = 41.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.94, 5.94, 5.94); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

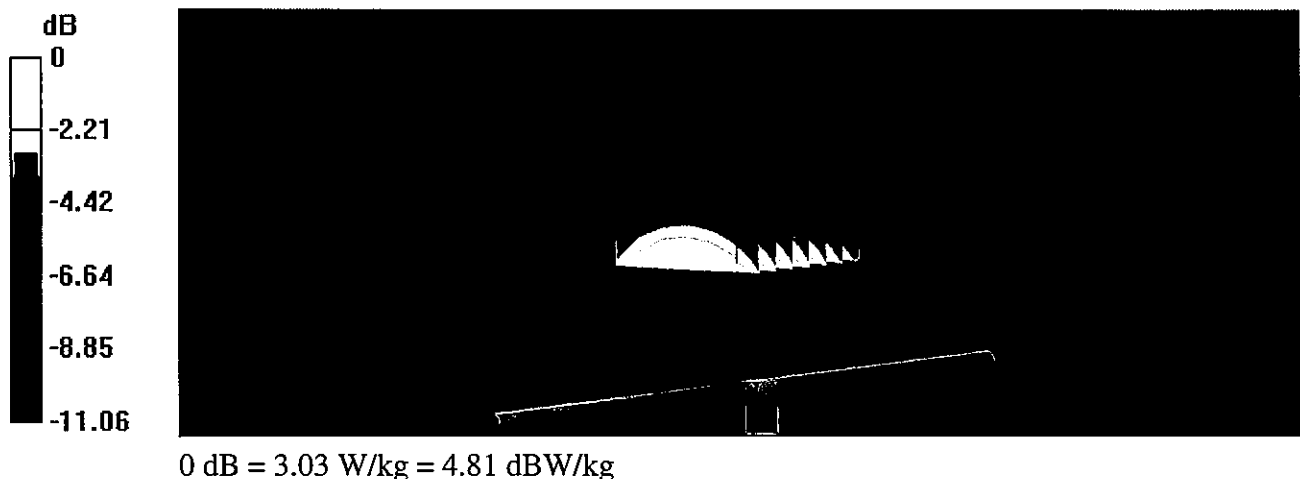
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 58.23 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 3.84 W/kg

**SAR(1 g) = 2.58 W/kg; SAR(10 g) = 1.66 W/kg**

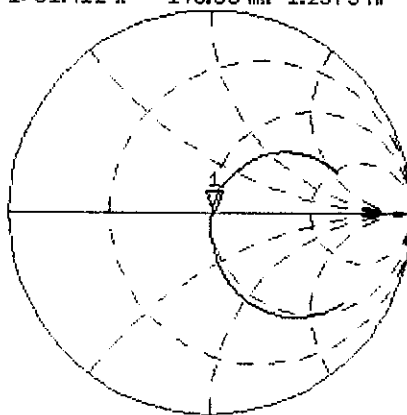
Maximum value of SAR (measured) = 3.03 W/kg



# Impedance Measurement Plot for Head TSL

21 Aug 2015 13:41:09  
 CH1 S11 1 U FS 1: 51.412  $\Omega$  -140.63 m $\Omega$  1.2575 nF 900.000 000 MHz

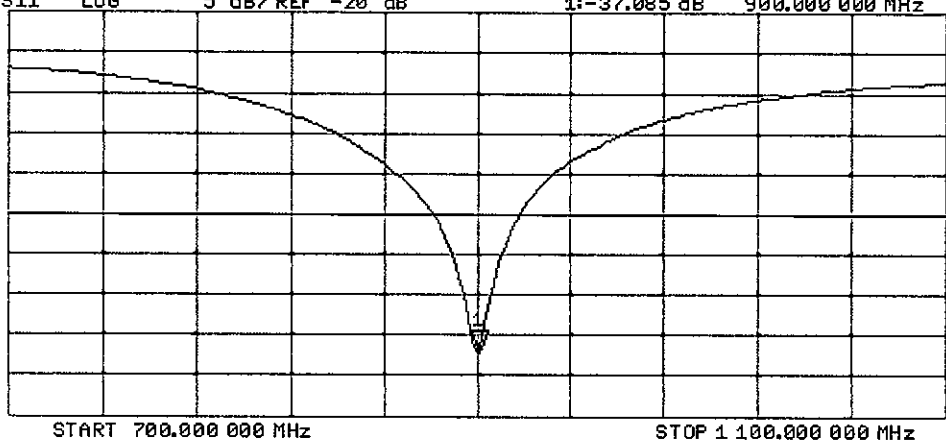
\*  
 Del  
 CA



Avg  
 16  
 H1d

CH2 S11 LOG 5 dB/REF -20 dB 1:-37.085 dB 900.000 000 MHz

CA  
 Avg  
 16  
 H1d



## DASY5 Validation Report for Body TSL

Date: 24.08.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN: 1d139**

Communication System: UID 0 - CW; Frequency: 900 MHz

Medium parameters used:  $f = 900 \text{ MHz}$ ;  $\sigma = 1.05 \text{ S/m}$ ;  $\epsilon_r = 56$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.95, 5.95, 5.95); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

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

Reference Value = 56.35 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 3.93 W/kg

**SAR(1 g) = 2.67 W/kg; SAR(10 g) = 1.74 W/kg**

Maximum value of SAR (measured) = 3.12 W/kg

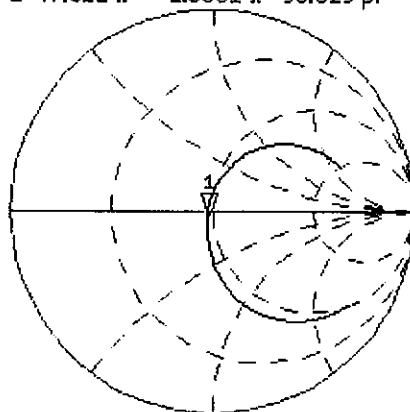


0 dB = 3.12 W/kg = 4.94 dBW/kg

# Impedance Measurement Plot for Body TSL

24 Aug 2015 12:48:17  
 CH1 S11 1 U FS 1: 47.521  $\Omega$  -1.8301  $\Omega$  96.629 pF 900.000 000 MHz

\*  
 Del  
 CA

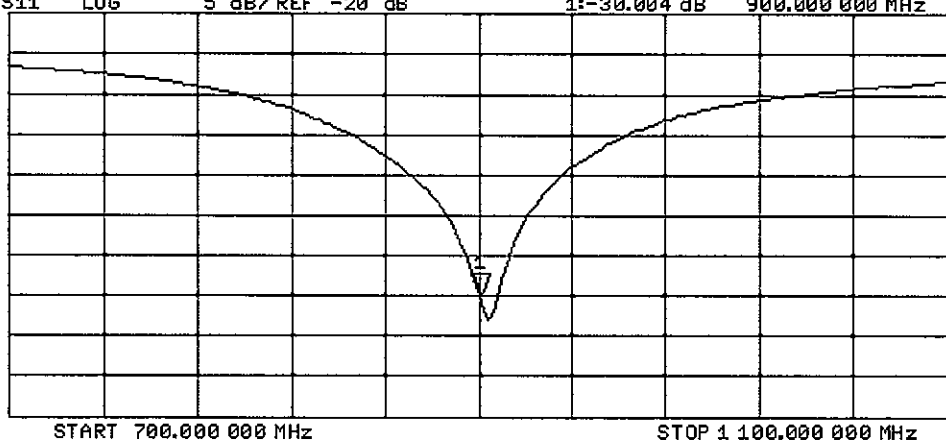


Avg  
 16  
 H1d

CH2 S11 LOG 5 dB/REF -20 dB 1:-30.004 dB 900.000 000 MHz

Del  
 CA

Avg  
 16  
 H1d





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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **BV ADT-CN (Auden)**

Certificate No: **D1750V2-1071\_Aug15**

## CALIBRATION CERTIFICATE

Object **D1750V2 - SN: 1071**

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

Calibration date: **August 20, 2015**

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 ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (20k)	01-Apr-15 (No. 217-02131)	Mar-16
Type-N mismatch combination	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02134)	Mar-16
Reference Probe ES3DV3	SN: 3205	30-Dec-14 (No. ES3-3205_Dec14)	Dec-15
DAE4	SN: 601	17-Aug-15 (No. DAE4-601_Aug15)	Aug-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

Calibrated by: **Michael Weber**      Name: **Michael Weber**      Function: **Laboratory Technician**

Approved by: **Katja Pokovic**      Technical Manager

Signature

*M. Weber*

*K. Pokovic*

Issued: August 21, 2015

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

### Glossary:

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

### Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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

## Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	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	39.8 $\pm$ 6 %	1.36 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

## SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.20 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	36.9 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	4.91 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	19.7 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	52.1 $\pm$ 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 <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	9.40 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	37.5 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.07 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.3 W/kg $\pm$ 16.5 % (k=2)

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.0 $\Omega$ - 0.5 j $\Omega$
Return Loss	- 45.4 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.6 $\Omega$ + 0.0 j $\Omega$
Return Loss	- 29.1 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.219 ns
----------------------------------	----------

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

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

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

### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	January 19, 2011

## DASY5 Validation Report for Head TSL

Date: 20.08.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1071**

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

Medium parameters used:  $f = 1750$  MHz;  $\sigma = 1.36$  S/m;  $\epsilon_r = 39.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.2, 5.2, 5.2); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

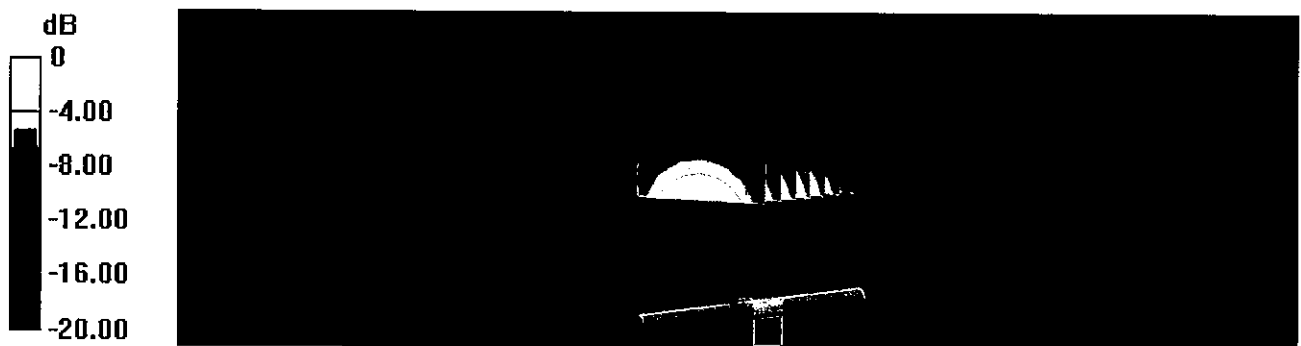
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.52 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 16.5 W/kg

**SAR(1 g) = 9.2 W/kg; SAR(10 g) = 4.91 W/kg**

Maximum value of SAR (measured) = 11.6 W/kg

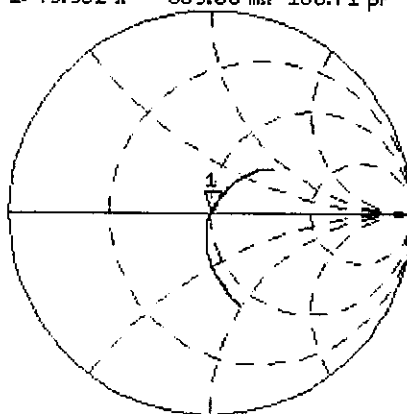


0 dB = 11.6 W/kg = 10.64 dBW/kg

# Impedance Measurement Plot for Head TSL

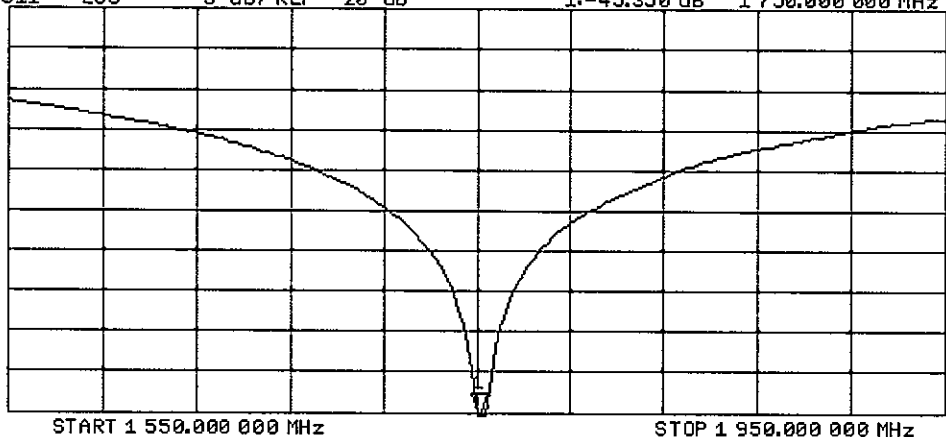
20 Aug 2015 13:11:47  
 CH1 S11 1 U FS 1: 49.982  $\Omega$  -539.06 m $\Omega$  168.71 pF 1 750.000 000 MHz

\*  
 De1  
 CA  
 Avg  
 16  
 H1d



CH2 S11 LOG 5 dB/REF -20 dB 1:-45.350 dB 1 750.000 000 MHz

De1  
 CA  
 Avg  
 16  
 H1d



## DASY5 Validation Report for Body TSL

Date: 20.08.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1071**

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

Medium parameters used:  $f = 1750$  MHz;  $\sigma = 1.48$  S/m;  $\epsilon_r = 52.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.88, 4.88, 4.88); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

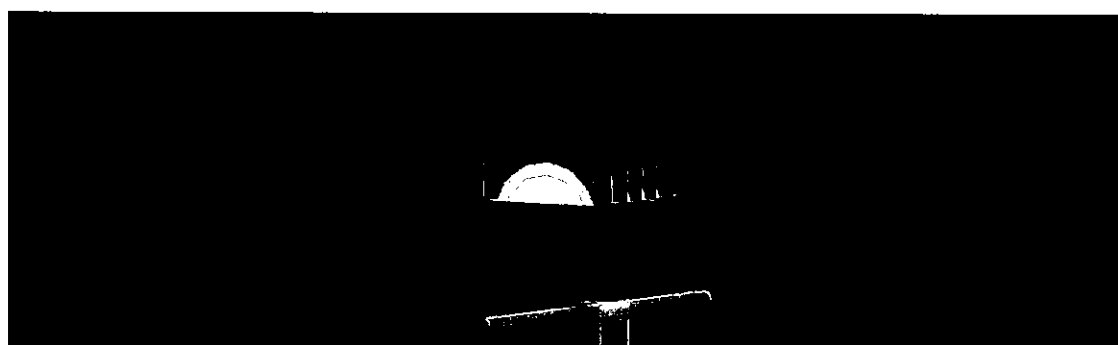
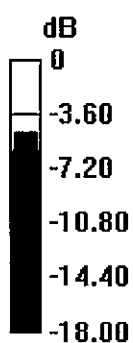
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.17 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 16.1 W/kg

**SAR(1 g) = 9.4 W/kg; SAR(10 g) = 5.07 W/kg**

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

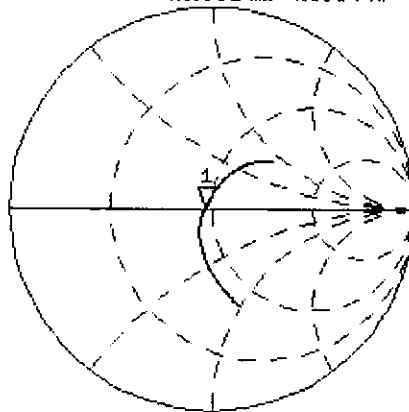


0 dB = 11.8 W/kg = 10.72 dBW/kg

# Impedance Measurement Plot for Body TSL

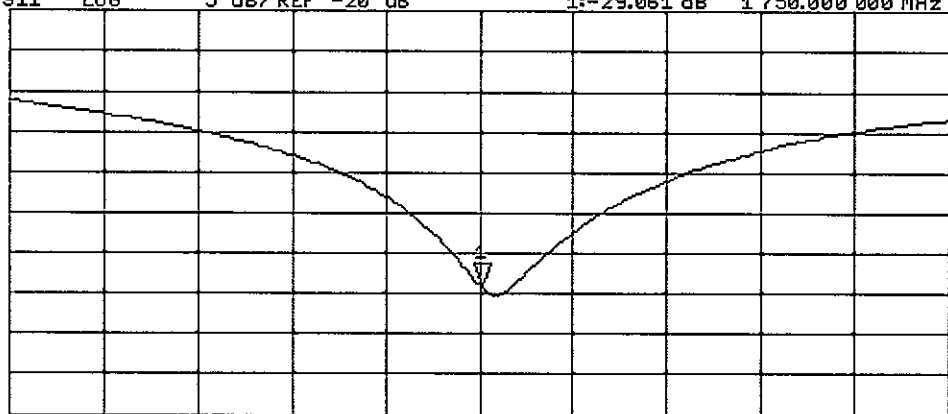
20 Aug 2015 13:11:24  
 CH1 S11 1 U FS 1: 46.611  $\Omega$  -19.531 m $\Omega$  4.6564 nF 1 750.000 000 MHz

\*  
 De1  
 CA  
 Avg  
 16  
 H1d



CH2 S11 LOG 5 dB/REF -20 dB 1:-29.061 dB 1 750.000 000 MHz

De1  
 CA  
 Avg  
 16  
 H1d



START 1 550.000 000 MHz

STOP 1 950.000 000 MHz



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Accreditation No.: **SCS 0108**

Client **BV ADT-CN (Auden)**

Certificate No: **D2450V2-893\_Aug15**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 893**

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

Calibration date: **August 20, 2015**

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 ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (20k)	01-Apr-15 (No. 217-02131)	Mar-16
Type-N mismatch combination	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02134)	Mar-16
Reference Probe ES3DV3	SN: 3205	30-Dec-14 (No. ES3-3205_Dec14)	Dec-15
DAE4	SN: 601	17-Aug-15 (No. DAE4-601_Aug15)	Aug-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

Calibrated by: Name **Michael Weber** Function **Laboratory Technician**

Approved by: **Katja Pokovic** Technical Manager

Signature

Issued: August 21, 2015

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Accreditation No.: **SCS 0108**

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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:

- 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
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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

## Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	39.2 $\pm$ 6 %	1.87 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

## SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.5 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.0 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.32 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.0 W/kg $\pm$ 16.5 % (k=2)

## Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	53.2 $\pm$ 6 %	2.00 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

## SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.9 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	51.1 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.02 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.0 W/kg $\pm$ 16.5 % (k=2)

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	$52.5 \Omega + 3.0 j\Omega$
Return Loss	- 28.4 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	$48.4 \Omega + 4.4 j\Omega$
Return Loss	- 26.4 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.162 ns
----------------------------------	----------

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

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

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

### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	October 06, 2011

## DASY5 Validation Report for Head TSL

Date: 20.08.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 893**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.87$  S/m;  $\epsilon_r = 39.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.54, 4.54, 4.54); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

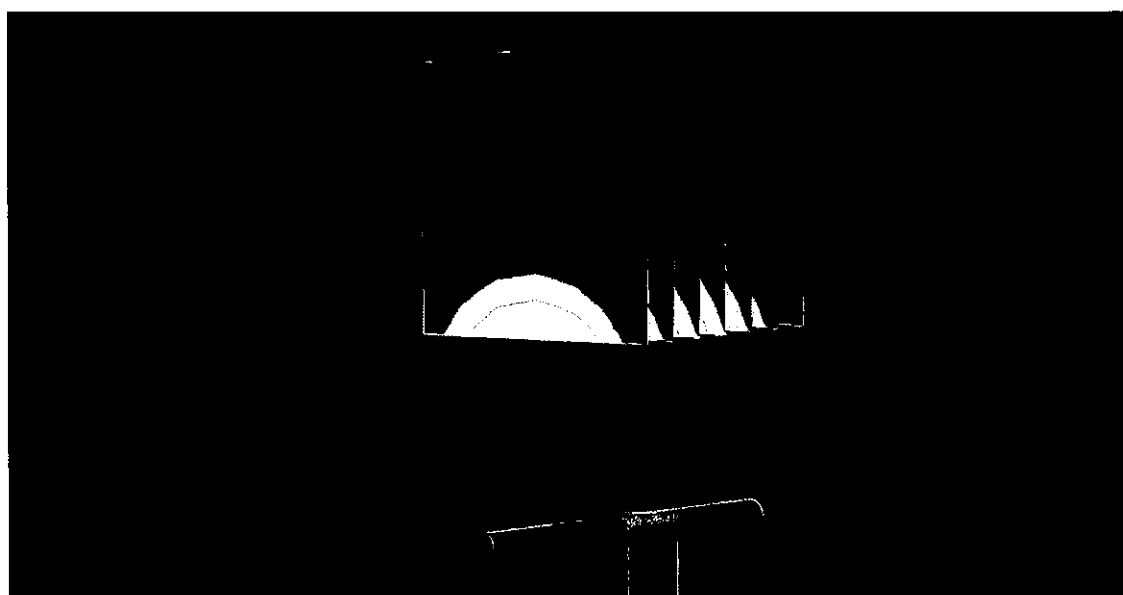
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 101.5 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 27.7 W/kg

**SAR(1 g) = 13.5 W/kg; SAR(10 g) = 6.32 W/kg**

Maximum value of SAR (measured) = 17.9 W/kg

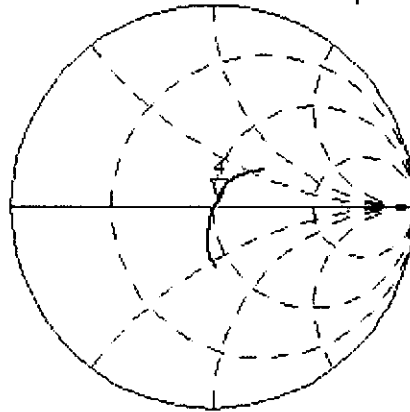


0 dB = 17.9 W/kg = 12.53 dBW/kg

## Impedance Measurement Plot for Head TSL

19 Aug 2015 12:44:16  
CH1 S11 1 U FS 4: 52.467  $\Omega$  3.0098  $\Omega$  195.52  $\mu\text{H}$  2 450.000 000 MHz

\*  
De1  
CA



Avg  
16

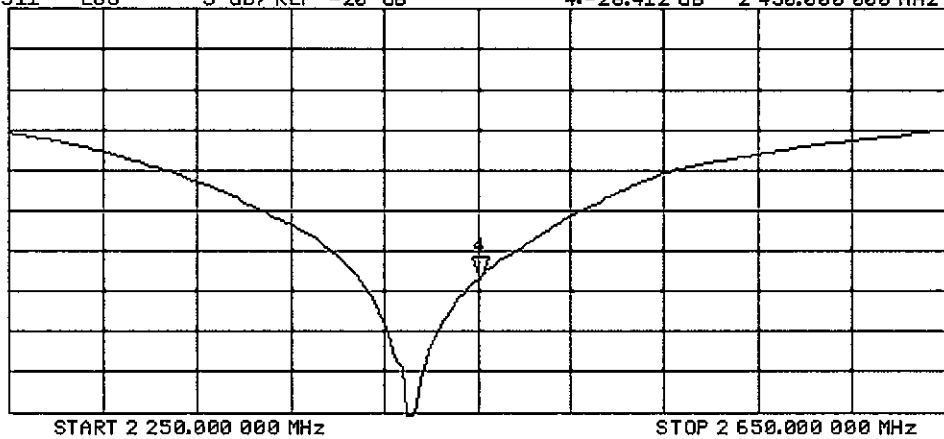
H1d

CH2 S11 LOG 5 dB/REF -20 dB 4:-28.412 dB 2 450.000 000 MHz

CA

Avg  
16

H1d



## DASY5 Validation Report for Body TSL

Date: 19.08.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 893**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2$  S/m;  $\epsilon_r = 53.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.32, 4.32, 4.32); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

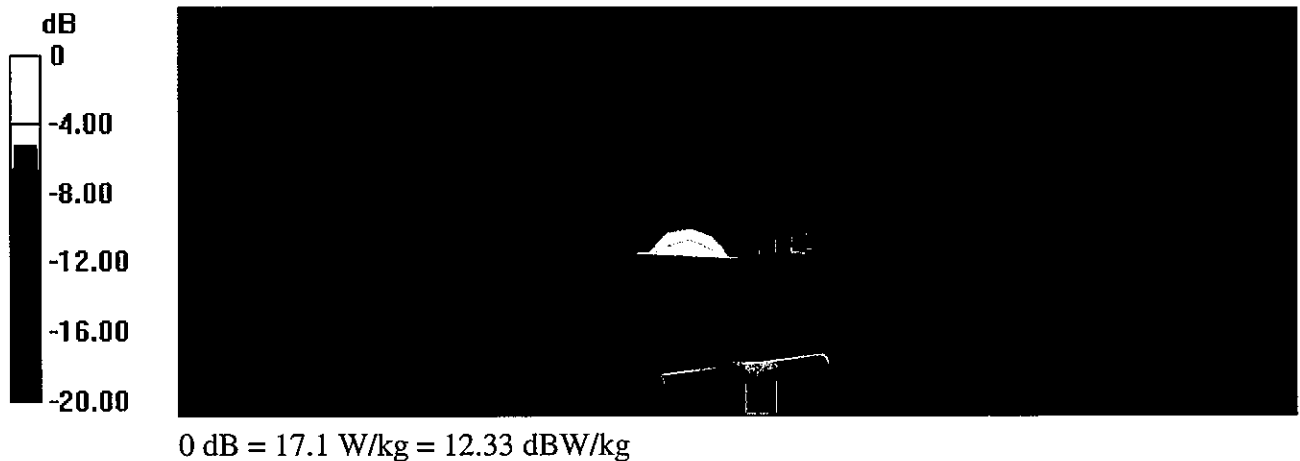
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.41 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 26.6 W/kg

**SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6.02 W/kg**

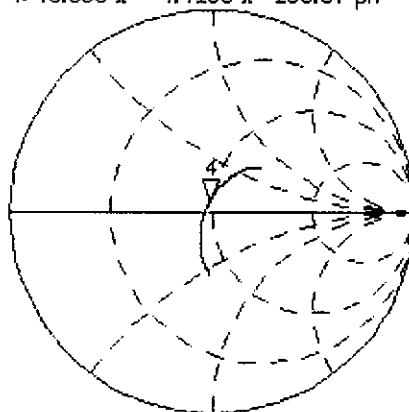
Maximum value of SAR (measured) = 17.1 W/kg



# Impedance Measurement Plot for Body TSL

19 Aug 2015 12:43:51  
 CH1 S11 1 U FS 4: 48.365  $\Omega$  4.4160  $\Omega$  286.87 pH 2 450.000 000 MHz

\*  
 Del  
 Ca



Avg  
 16

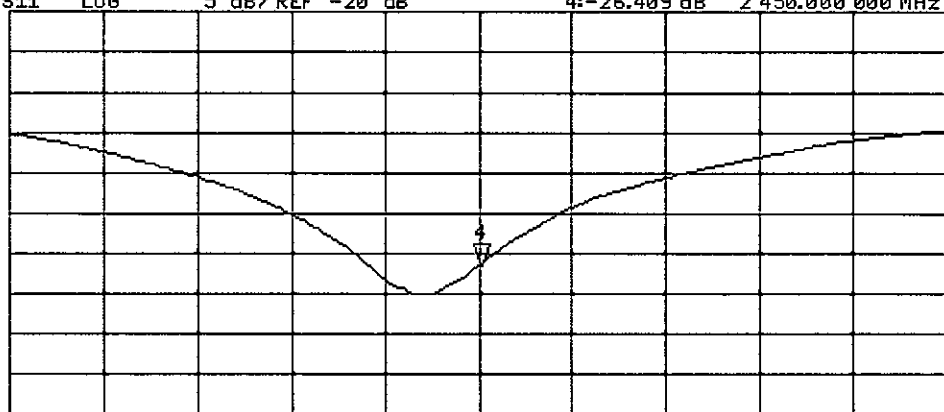
H1d

CH2 S11 LOG 5 dB/REF -20 dB 4:-26.409 dB 2 450.000 000 MHz

Ca

Avg  
 16

H1d



START 2 250.000 000 MHz

STOP 2 650.000 000 MHz



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

Client **BV ADT-CN (Auden)**

Certificate No: **EX3-3873\_Aug15**

## CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3873**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6**  
**Calibration procedure for dosimetric E-field probes**

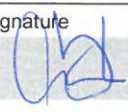

Calibration date: **August 26, 2015**

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	01-Apr-15 (No. 217-02128)	Mar-16
Power sensor E4412A	MY41498087	01-Apr-15 (No. 217-02128)	Mar-16
Reference 3 dB Attenuator	SN: S5054 (3c)	01-Apr-15 (No. 217-02129)	Mar-16
Reference 20 dB Attenuator	SN: S5277 (20x)	01-Apr-15 (No. 217-02132)	Mar-16
Reference 30 dB Attenuator	SN: S5129 (30b)	01-Apr-15 (No. 217-02133)	Mar-16
Reference Probe ES3DV2	SN: 3013	30-Dec-14 (No. ES3-3013_Dec14)	Dec-15
DAE4	SN: 660	14-Jan-15 (No. DAE4-660_Jan15)	Jan-16
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

Calibrated by:	Name <b>Claudio Leubler</b>	Function <b>Laboratory Technician</b>	Signature 
Approved by:	<b>Katja Pokovic</b>	<b>Technical Manager</b>	
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			
Issued: August 27, 2015			



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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 <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization $\varphi$	$\varphi$ rotation around probe axis
Polarization $\vartheta$	$\vartheta$ 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
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not affect the  $E^2$ -field uncertainty inside TSL (see below ConvF).
- NORM(f)<sub>x,y,z</sub> = NORM<sub>x,y,z</sub> \* frequency\_response** (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP<sub>x,y,z</sub>**: 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<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>**: 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<sub>x,y,z</sub> \* 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  $\pm 50$  MHz to  $\pm 100$  MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM<sub>x</sub> (no uncertainty required).

# Probe EX3DV4

## SN:3873

Manufactured:	March 13, 2012
Calibrated:	August 26, 2015

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

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3873

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	0.37	0.46	0.48	$\pm 10.1 \%$
DCP (mV) <sup>B</sup>	100.8	98.5	100.1	

### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	158.3	$\pm 2.2 \%$
		Y	0.0	0.0	1.0		149.1	
		Z	0.0	0.0	1.0		152.5	

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%.

<sup>A</sup> The uncertainties of Norm X,Y,Z do not affect the  $E^2$ -field uncertainty inside TSL (see Pages 5 and 6).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

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

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3873

### Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unc (k=2)
750	41.9	0.89	10.01	10.01	10.01	0.36	0.93	± 12.0 %
835	41.5	0.90	9.53	9.53	9.53	0.30	1.07	± 12.0 %
900	41.5	0.97	9.41	9.41	9.41	0.35	0.93	± 12.0 %
1750	40.1	1.37	8.21	8.21	8.21	0.36	0.80	± 12.0 %
1900	40.0	1.40	7.98	7.98	7.98	0.31	0.80	± 12.0 %
2300	39.5	1.67	7.63	7.63	7.63	0.37	0.80	± 12.0 %
2450	39.2	1.80	7.24	7.24	7.24	0.31	0.88	± 12.0 %
2600	39.0	1.96	7.05	7.05	7.05	0.35	0.80	± 12.0 %
5250	35.9	4.71	4.95	4.95	4.95	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.66	4.66	4.66	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.64	4.64	4.64	0.40	1.80	± 13.1 %

<sup>C</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) 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 ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3873

### Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unc (k=2)
750	55.5	0.96	9.77	9.77	9.77	0.46	0.80	± 12.0 %
835	55.2	0.97	9.72	9.72	9.72	0.50	0.81	± 12.0 %
900	55.0	1.05	9.41	9.41	9.41	0.42	0.86	± 12.0 %
1750	53.4	1.49	7.86	7.86	7.86	0.37	0.82	± 12.0 %
1900	53.3	1.52	7.62	7.62	7.62	0.41	0.80	± 12.0 %
2300	52.9	1.81	7.50	7.50	7.50	0.38	0.80	± 12.0 %
2450	52.7	1.95	7.30	7.30	7.30	0.31	0.80	± 12.0 %
2600	52.5	2.16	7.03	7.03	7.03	0.21	0.80	± 12.0 %
5250	48.9	5.36	4.40	4.40	4.40	0.40	1.90	± 13.1 %
5600	48.5	5.77	3.90	3.90	3.90	0.45	1.90	± 13.1 %
5800	48.2	6.00	4.02	4.02	4.02	0.50	1.90	± 13.1 %

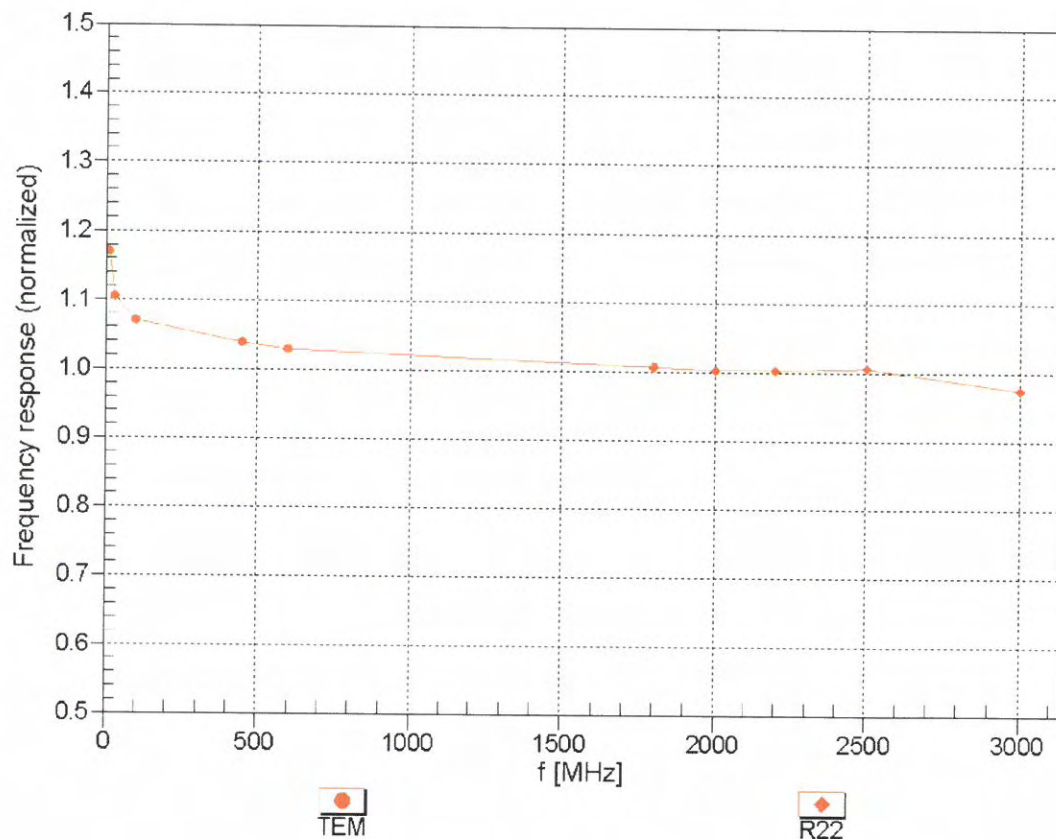
<sup>C</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) 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 ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> 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

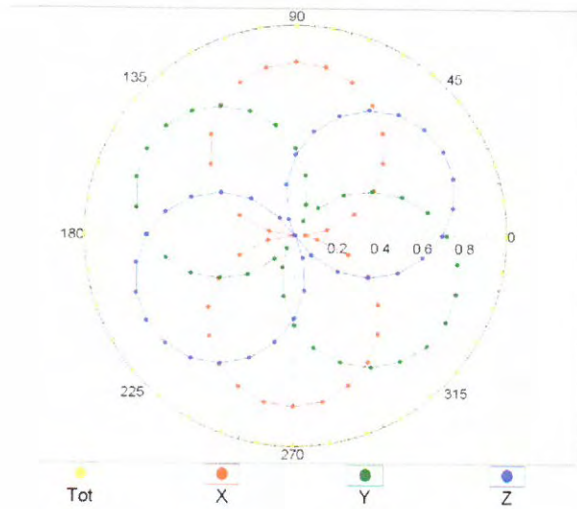
(TEM-Cell:ifi110 EXX, Waveguide: R22)



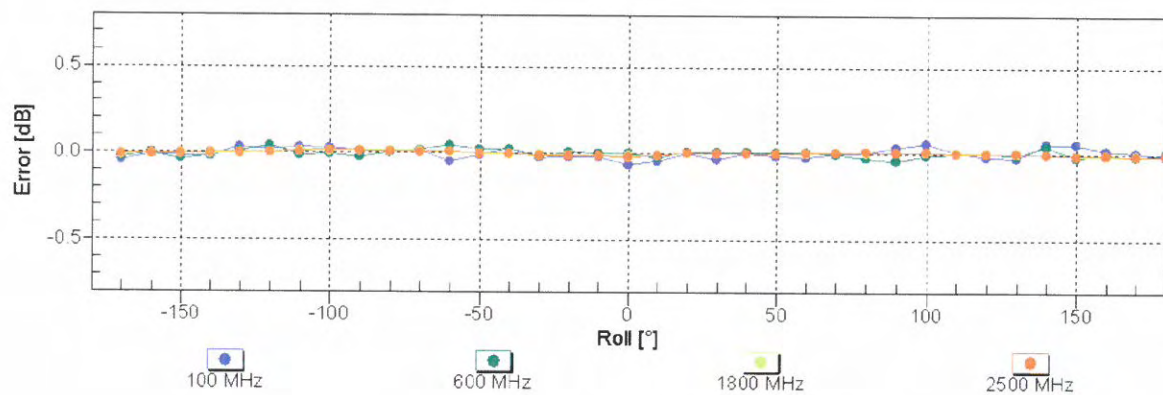
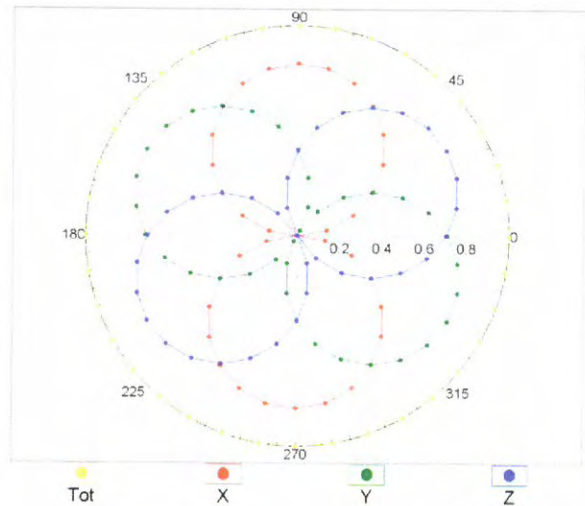
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

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

f=600 MHz,TEM

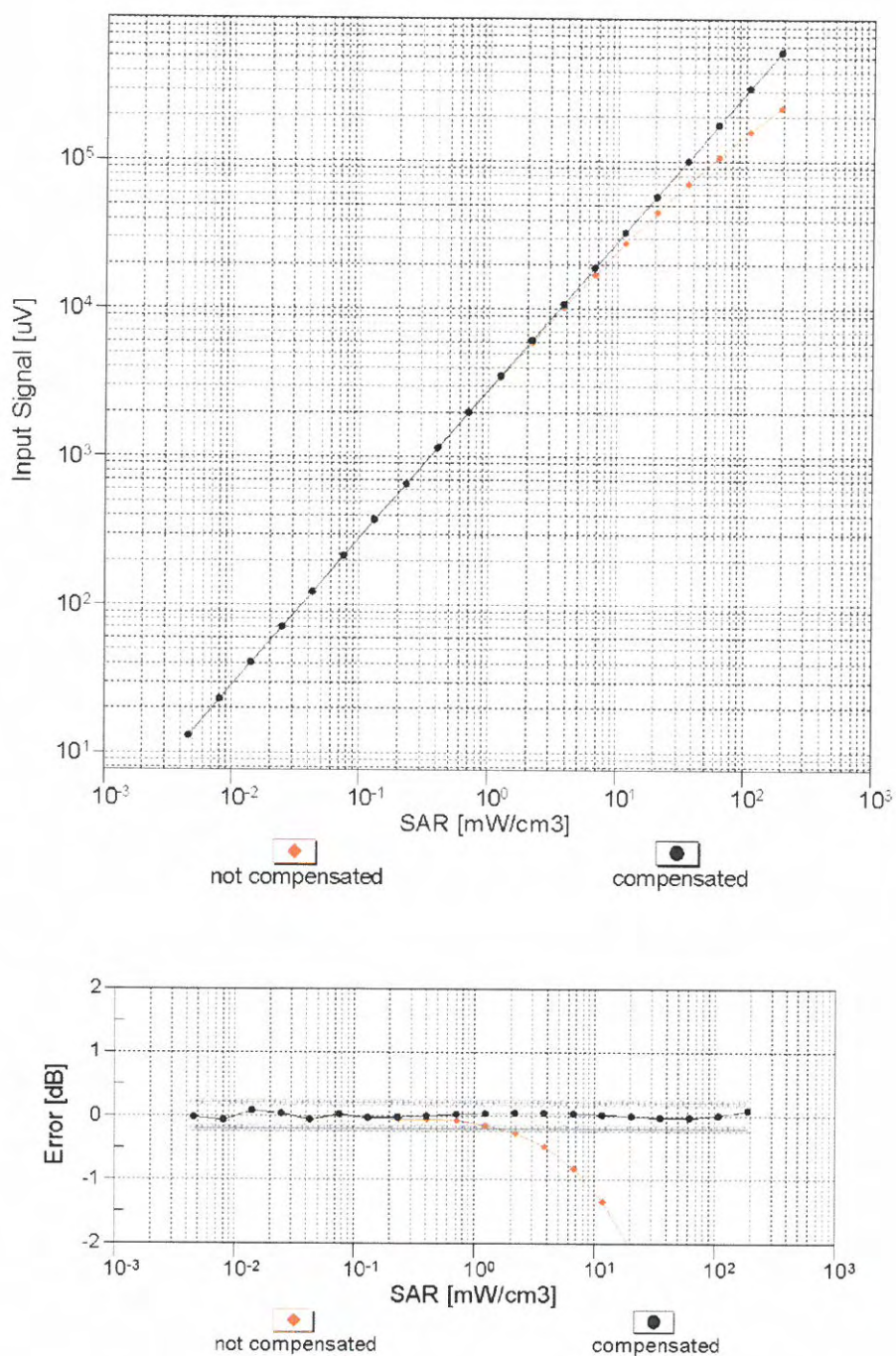


f=1800 MHz,R22



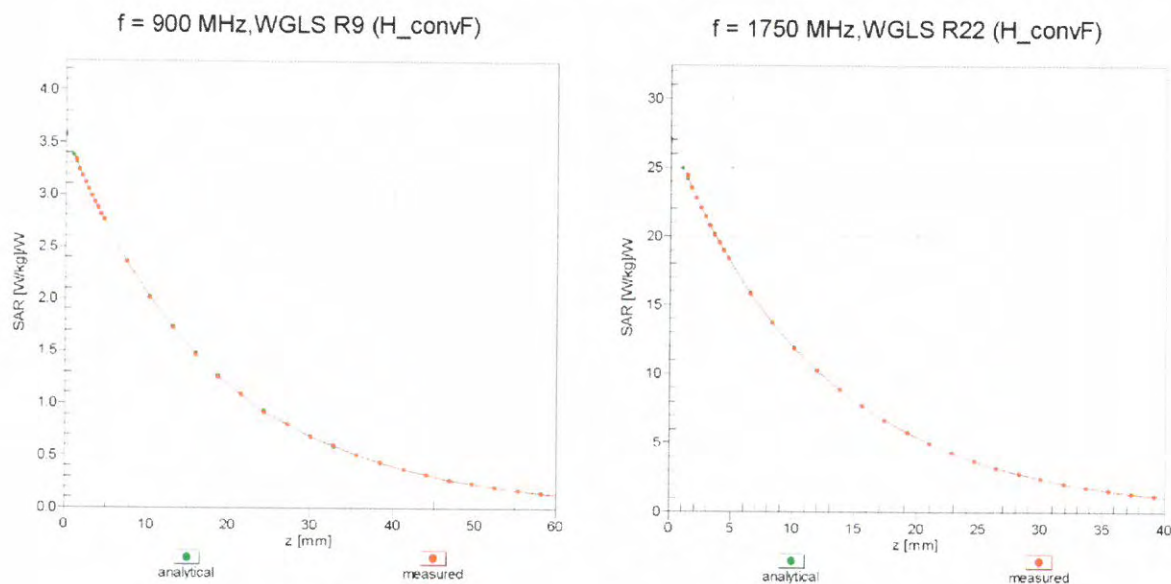
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

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



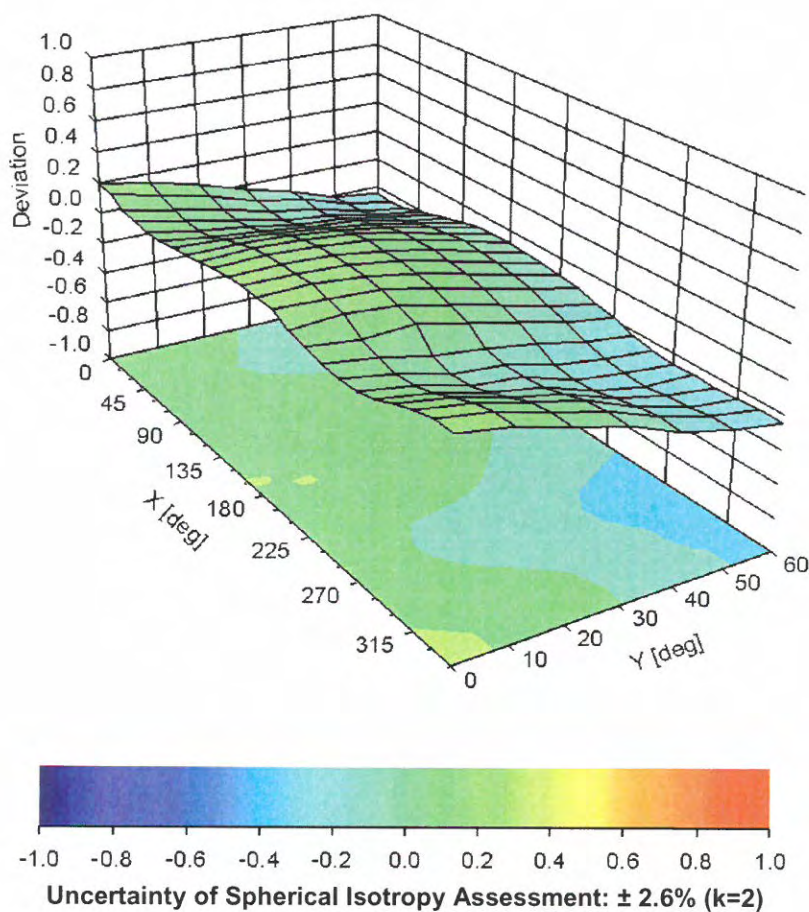
Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

## Conversion Factor Assessment



## Deviation from Isotropy in Liquid

Error ( $\phi, \theta$ ),  $f = 900 \text{ MHz}$



## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3873

### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	19.6
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm