

## SAR TEST REPORT

The following samples were submitted and identified on behalf of the client as:

<b>Equipment Under Test</b>	Offender Tracking Device (OTD)
<b>Marketing Name</b>	ReliAlert XC
<b>Model No.</b>	OTD 3.8
<b>Company Name</b>	SecureAlert, Inc
<b>Company Address</b>	150 West Civic Center Drive, Sandy, Utah 84070 USA
<b>Standards</b>	OET 65 supplement C, IEEE / ANSI C95.1, C95.3, IEEE 1528
<b>FCC ID</b>	TPO-OTD38
<b>Date of Receipt</b>	Mar. 14, 2014
<b>Date of Test(s)</b>	Apr. 09, 2014
<b>Date of Issue</b>	Apr. 10, 2014

In the configuration tested, the EUT complied with the standards specified above.

**Remarks:**

This report details the results of the testing carried out on two samples, the results contained in this test report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

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**Signed on behalf of SGS**

**Engineer**

Kevin Li

Date: Apr. 10, 2014

**Sr. Engineer**

John Yeh

John Yeh

Date: Apr. 10, 2014

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## Version

Report Number	Revision	Description	Issue Date
E5/2014/30008	00	Initial Version	Mar. 17, 2014
E5/2014/30008	01	1 <sup>st</sup> Modification	Mar. 18, 2014
E5/2014/30008	02	2 <sup>nd</sup> Modification	Mar. 18, 2014
E5/2014/30008	03	3 <sup>rd</sup> Modification	Apr. 10, 2014

**This test report contains a reference to the previous version test report that it replaces.**

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## 1. General Information

### 1.1 Testing Laboratory

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### 1.2 Details of Applicant

Company Name	SecureAlert, Inc
Company Address	150 West Civic Center Drive, Sandy, Utah 84070 USA

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### 1.3 Description of EUT

EUT Name	Offender Tracking Device (OTD)			
Marketing Name	ReliAlert XC			
Model No.	OTD 3.8			
HW Version	3.8.0			
SW Version	v1835			
IMEI Code	351581054172113			
FCC ID	TPO-OTD38			
Mode of Operation	<input checked="" type="checkbox"/> GSM	<input checked="" type="checkbox"/> GPRS	<input checked="" type="checkbox"/> EDGE	<input checked="" type="checkbox"/> WCDMA
Duty Cycle	GSM	1/8.3		
	GPRS (support multi class 10 max)	1/4.1 (1Dn2UP) 1/8.3 (1Dn1UP)		
	EDGE (support multi class 10 max)	1/4.1 (1Dn2UP) 1/8.3 (1Dn1UP)		
	WCDMA	1		
TX Frequency Range (MHz)	GSM850	824.2	—	848.8
	GSM1900	1850.2	—	1909.8
	WCDMA Band II	1852.4	—	1907.6
	WCDMA Band IV	1712.4	—	1752.6
	WCDMA Band V	826.40	—	846.60
Channel Number (ARFCN)	GSM850	128	—	251
	GSM1900	512	—	810
	WCDMA Band II	9262	—	9538
	WCDMA Band IV	1312	—	1513
	WCDMA Band V	4132	—	4233

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Max. SAR (10 g) (Unit: W/Kg)				
Mode	Band	Measured	Reported	Position / Channel
Extremity	GSM 850	0.581	0.683	<input type="checkbox"/> Front <input checked="" type="checkbox"/> Back 251 Channel
	GPRS 850 1Dn2UP	1.08	1.329	<input type="checkbox"/> Front <input checked="" type="checkbox"/> Back 251 Channel
	GSM 1900	0.275	0.331	<input type="checkbox"/> Front <input checked="" type="checkbox"/> Back 661 Channel
	GPRS 1900 1Dn2UP	0.516	0.620	<input type="checkbox"/> Front <input checked="" type="checkbox"/> Back 661 Channel
	WCDMA Band II	0.716	0.753	<input type="checkbox"/> Front <input checked="" type="checkbox"/> Back 9262 Channel
	WCDMA Band IV	1	1.059	<input type="checkbox"/> Front <input checked="" type="checkbox"/> Back 1312 Channel
	WCDMA Band V	0.492	0.601	<input type="checkbox"/> Front <input checked="" type="checkbox"/> Back 4132 Channel

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**#. GSM/GPRS/EDGE conducted power table:**

EUT mode	Frequency (MHz)	CH	Max. Rated Avg. Power + Max. Tolerance (dBm)	Burst average power	Source-based time average power
				Avg.(dBm)	Avg.(dBm)
GSM 850	824.2	128	31	29.90	20.87
	836.6	190	31	30.00	20.97
	848.8	251	31	30.30	21.27
The division factor compared to the number of TX time slot				1 TX time slot	
Division factor				-9.03	

Burst average power					
Max. Rated Avg. Power + Max. Tolerance (dBm)			31	31	
			1Dn1UP	1Dn2UP	
EUT mode	Frequency (MHz)	CH	Avg. (dBm)	Avg. (dBm)	
GPRS 850	824.2	128	29.80	29.70	
	836.6	190	29.90	29.90	
	848.8	251	30.20	30.10	
Source-based time average power					
GPRS 850	824.2	128	20.77	23.68	
	836.6	190	20.87	23.88	
	848.8	251	21.17	24.08	
The division factor compared to the number of TX time slot					
Division factor			1 TX time slot	2 TX time slot	
			-9.03	-6.02	

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Burst average power				
Max. Rated Avg. Power + Max. Tolerance (dBm)		26	26	
		1Dn1UP	1Dn2UP	
EUT mode	Frequency (MHz)	CH	Avg. (dBm)	Avg. (dBm)
EDGE 850	824.2	128	24.40	24.30
	836.6	190	24.40	24.40
	848.8	251	24.80	24.70
Source-based time average power				
EDGE 850	824.2	128	15.37	18.28
	836.6	190	15.37	18.38
	848.8	251	15.77	18.68
The division factor compared to the number of TX time slot				
Division factor		1 TX time slot	2 TX time slot	
		-9.03	-6.02	

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EUT mode	Frequency (MHz)	CH	Max. Rated Avg. Power + Max. Tolerance (dBm)	Burst average power	
				Avg.(dBm)	Source-based time average power
GSM 1900	1850.2	512	31	30.20	21.17
	1880	661	31	30.20	21.17
	1909.8	810	31	30.10	21.07
The division factor compared to the number of TX time slot					
Division factor				1 TX time slot	
				-9.03	

Burst average power					
Max. Rated Avg. Power + Max. Tolerance (dBm)			31	31	
			1Dn1UP	1Dn2UP	
EUT mode	Frequency (MHz)	CH	Avg. (dBm)	Avg. (dBm)	
GPRS 1900	1850.2	512	30.20	30.20	
	1880	661	30.10	30.20	
	1909.8	810	30.10	30.00	
Source-based time average power					
GPRS 1900	1850.2	512	21.17	24.18	
	1880	661	21.07	24.18	
	1909.8	810	21.07	23.98	
The division factor compared to the number of TX time slot					
Division factor			1 TX time slot	2 TX time slot	
			-9.03	-6.02	

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Burst average power				
Max. Rated Avg. Power + Max. Tolerance (dBm)		27	27	
		1Dn1UP	1Dn2UP	
EUT mode	Frequency (MHz)	CH	Avg. (dBm)	Avg. (dBm)
EDGE 1900	1850.2	512	26.40	26.40
	1880	661	26.40	26.40
	1909.8	810	26.30	26.30
Source-based time average power				
EDGE 1900	1850.2	512	17.37	20.38
	1880	661	17.37	20.38
	1909.8	810	17.27	20.28
The division factor compared to the number of TX time slot				
Division factor		1 TX time slot	2 TX time slot	
		-9.03	-6.02	

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**#. WCDMA Band II/ Band IV/ Band V/ HSDPA/ HSUPA conducted power table:**

Band	CH	Max. Rated Avg. Power + Max. Tolerance (dBm)	Rel99 AV(dBm)	HSDPA mode AV(dBm)				HSUPA mode AV(dBm)				
				SUB-1	SUB-2	SUB-3	SUB-4	SUB-1	SUB-2	SUB-3	SUB-4	SUB-5
WCDMA Band II	9262	24	23.78	22.32	22.29	22.25	22.27	22.76	21.85	22.76	22.71	22.78
	9400	24	23.71	22.24	22.23	22.21	22.29	22.33	22.29	22.18	22.27	22.24
	9538	24	23.31	22.32	22.27	22.28	22.35	21.81	21.87	21.79	21.93	21.85
WCDMA Band IV	1312	24	23.75	22.65	22.63	22.56	22.66	22.82	22.81	22.76	22.78	22.82
	1412	24	23.67	23.21	23.18	23.15	23.25	22.43	22.49	22.56	22.49	22.48
	1513	24	23.53	22.50	22.47	22.50	22.54	22.41	22.49	22.56	22.42	22.44
WCDMA Band V	4132	22	21.13	20.04	19.98	19.99	20.07	19.34	19.33	19.38	19.29	19.34
	4183	22	20.95	19.91	19.92	19.96	19.95	19.88	19.97	19.94	19.89	19.94
	4233	22	21.05	20.63	20.66	20.57	20.66	20.05	20.07	20.15	20.17	20.14

**HSDPA**

SUB-TEST	$\beta_c$	$\beta_d$	$\beta_d (SF)$	$\beta_c/\beta_d$	$\beta_{HS}$ (Note 1, Note 2)	CM (dB) (Note 3)	MPR (dB) (Note 3)
1	2/15	15/15	64	2/15	4/15	0.0	0.0
2	12/15	15/15	64	12/15	24/15	1.0	0.0
3	15/15	8/15	64	15/8	30/15	1.5	0.5
4	15/15	4/15	64	15/4	30/15	1.5	0.5

**HSUPA**

SUB-TEST	$\beta_c$	$\beta_d$	$\beta_d (SF)$	$\beta_c/\beta_d$	$\beta_{HS}$ (Note 1)	$\beta_{ec}$	$\beta_{ed}$ (Note 5) (Note 6)	$\beta_{ed}$ (SF)	$\beta_{ed}$ (Codes)	CM (dB) (Note 2)	MPR (dB) (Note 2)	AG Index (Note 6)	E-TFCI
1	11/15	15/15	64	11/15	22/15	209/225	1309/225	4	1	1.0	0.0	20	75
2	6/15	15/15	64	6/15	12/15	12/15	94/75	4	1	3.0	2.0	12	67
3	15/15	9/15	64	15/9	30/15	30/15	$\beta_{ed1}$ : 47/15 $\beta_{ed2}$ : 47/15	4 4	2	2.0	1.0	15	92
4	2/15	15/15	64	2/15	4/15	2/15	56/75	4	1	3.0	2.0	17	71
5	15/15	15/15	64	15/15	30/15	24/15	134/15	4	1	1.0	0.0	21	81

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## 1.4 Test Environment

Ambient Temperature :  $22 \pm 2^\circ \text{C}$

Tissue Simulating Liquid:  $22 \pm 2^\circ \text{C}$

## 1.5 Operation Description

### General:

1. The EUT is controlled by using a Radio Communication Tester (R&S CMU200), and the communication between the EUT and the tester is established by air link.
2. Measurements are performed respectively on the lowest, middle and highest channels of the operating band(s). The EUT is set to maximum power level during all tests, and at the beginning of each test the battery is fully charged.
3. During the SAR testing, the DASY 5 system checks power drift by comparing the e-field strength of one specific location measured at the beginning with that measured at the end of the SAR testing.
4. Testing SAR at the highest maximum output power channel in each band.
5. Based on the **KDB inquiry (tracking number 830139)**, the test conditions outlined in KDB 447498D01 section 6.2 of the subject publication would be applicable, and it is recommended that the periphery material adjoining the back be removed to create a flat surface.
6. SAR is evaluated with the back of the device (with curve back cover being removed) positioned in direct contact against a flat phantom filled with body tissue-equivalent medium to meet the extremity(ankle) SAR compliance.

Test configuration:

**(Test distance is 0mm)**

**Configuration 1: Back surface with curve back cover being removed.**

The test photos of this device and antenna location are shown in the chapter 10, 11 in appendix.

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Note:

#. This Offender Tracking Device (OTD) is primarily designed to monitor location and behavior of individuals under governmental supervision and their compliance to restrictive orders. Typically these individuals are under restrictive order by the Judicial &/or Parole system.

#. Capable of secured local Radio Frequency (RF) Communication.

#. Two/Three-Way Communication allows:

Instant intervention by SecureAlert's Monitoring Center via voice communication directly to the ReliAlert™ device.

Supervision Officers the ability to communicate with an offender via the device.

#. This device supports voice communication and data transmission, and GSM & GPRS can not be transmitted simultaneously.

#. GSM and WCDMA share the same antenna and there is no simultaneous transmission in this device.

#. This Offender Tracking Device (OTD) is intended to be worn on the ankle based on the client's description.

#. According to KDB865664 D01v01, SAR measurement variability must be assessed for each frequency band. When the original highest measured SAR is  $\geq 0.8$  W/kg, repeat that measurement once. Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is  $> 1.20$  or when the original or repeated measurement is  $\geq 1.45$  W/kg (~ 10% from the 1-g SAR limit)

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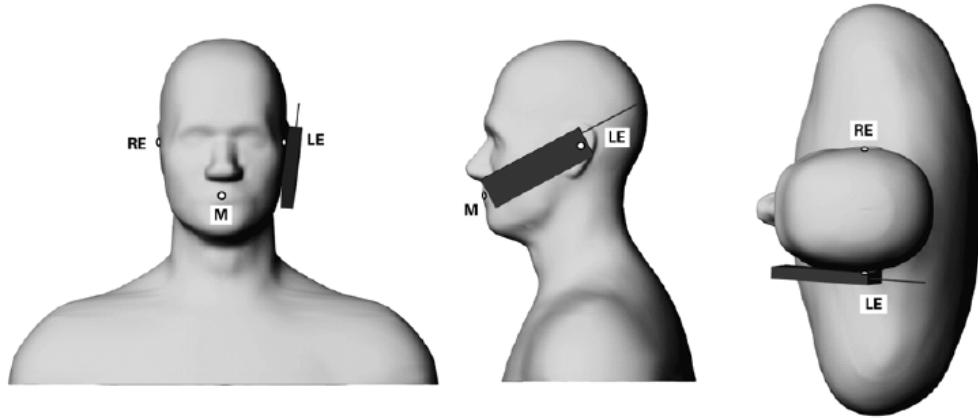
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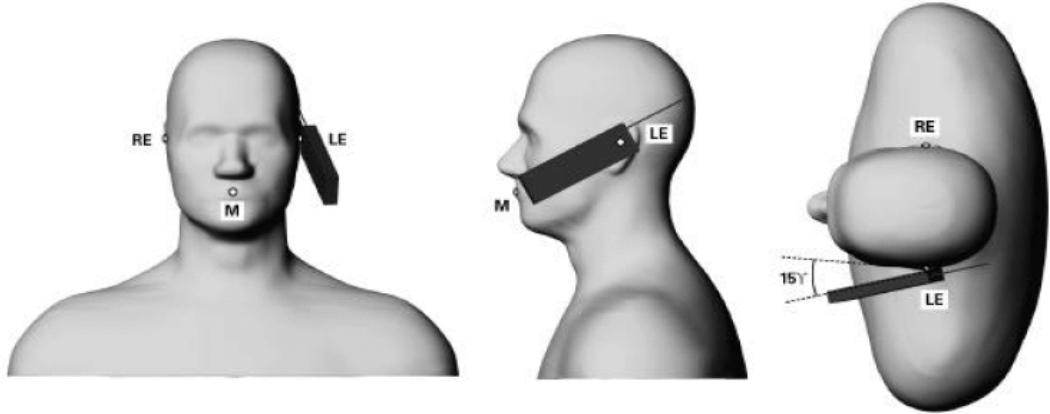
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## 1.6 Positioning Procedure



Phone position 1, "cheek" or "touch" position. The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning.



Phone position 2, "tilted position." The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning.

### Cheek/Touch Position:

The handset was brought toward the mouth of the head phantom by pivoting against the ear reference point until any point of the mouthpiece or keypad touched the phantom.

### Ear/Tilt Position:

With the phone aligned in the Cheek/Touch position, the handset was tilted away from the mouth with respect to the test device reference point by 15 degrees.

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## 1.7 Evaluation Procedures

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 1 g and 10 g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

1. The extraction of the measured data (grid and values) from the Zoom Scan.
2. The calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters).
3. The generation of a high-resolution mesh within the measured volume.
4. The interpolation of all measured values from the measurement grid to the high-resolution grid.
5. The extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface.
6. The calculation of the averaged SAR within masses of 1g and 10g.

The probe is calibrated at the center of the dipole sensors that is located 1 to 2.7mm away from the probe tip. During measurements, the probe stops shortly above the phantom surface, depending on the probe and the surface detecting system. Both distances are included as parameters in the probe configuration file. The software always knows exactly how far away the measured point is from the surface. As the probe cannot directly measure at the surface, the values between the deepest measured point and the surface must be extrapolated. The angle between the probe axis and the surface normal line is less than 30 degree.

In the Area Scan, the gradient of the interpolation function is evaluated to find all the extreme of the SAR distribution. The uncertainty on the locations of the extreme is less than 1/20 of the grid size. Only local maximum within -2 dB of the global maximum are searched and passed for the Cube Scan measurement. In the Cube Scan, the interpolation function is used to extrapolate the Peak SAR from the lowest measurement points to the inner phantom surface (the extrapolation distance). 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 5mm.

The maximum search is automatically performed after each area scan measurement. It is based on splines in two or three dimensions. The procedure can find the maximum for

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most SAR distributions even with relatively large grid spacing. After the area scanning measurement, the probe is automatically moved to a position at the interpolated maximum. The following scan can directly use this position for reference, e.g., for a finer resolution grid or the cube evaluations. The 1g and 10g peak evaluations are only available for the predefined cube 7x7x7 scans.

The routines are verified and optimized for the grid dimensions used in these cube measurements. The measured volume of 30x30x30mm contains about 30g of tissue. The first procedure is an extrapolation (incl. Boundary correction) to get the points between the lowest measured plane and the surface. The next step uses 3D interpolation to get all points within the measured volume. In the last step, a 1g cube is placed numerically into the volume and its averaged SAR is calculated. This cube is moved around until the highest averaged SAR is found.

If the highest SAR is found at the edge of the measured volume, the system will issue a warning: higher SAR values might be found outside of the measured volume. In that case the cube measurement can be repeated, using the new interpolated maximum as the center.

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## 1.8 Probe Calibration Procedures

For the calibration of E-field probes in lossy liquids, an electric field with an accurately known field strength must be produced within the measured liquid. For standardization purposes it would be desirable if all measurements which are necessary to assess the correct field strength would be traceable to standardized measurement procedures. In the following two different calibration techniques are summarized:

### 1.8.1 Transfer Calibration with Temperature Probes

In lossy liquids the specific absorption rate (SAR) is related both to the electric field ( $E$ ) and the temperature gradient ( $\delta T / \delta t$ ) in the liquid.

$$SAR = \frac{\sigma}{\rho} |E|^2 = c \frac{\delta T}{\delta t}$$

Whereby  $\sigma$  is the conductivity,  $\rho$  the density and  $c$  the heat capacity of the liquid.

Hence, the electric field in lossy liquid can be measured indirectly by measuring the temperature gradient in the liquid. Non-disturbing temperature probes (optical probes or thermistor probes with resistive lines) with high spatial resolution (<1-2 mm) and fast reaction time (<1 s) are available and can be easily calibrated with high precision [1]. The setup and the exciting source have no influence on the calibration; only the relative positioning uncertainties of the standard temperature probe and the E-field probe to be calibrated must be considered. However, several problems limit the available accuracy of probe calibrations with temperature probes:

- The temperature gradient is not directly measurable but must be evaluated from temperature measurements at different time steps. Special precaution is necessary to avoid measurement errors caused by temperature gradients due to energy equalizing effects or convection currents in the liquid. Such effects cannot be completely avoided, as the measured field itself destroys the thermal equilibrium in the liquid. With a careful setup these errors can be kept small.

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- The measured volume around the temperature probe is not well defined. It is difficult to calculate the energy transfer from a surrounding gradient temperature field into the probe. These effects must be considered, since temperature probes are calibrated in liquid with homogeneous temperatures. There is no traceable standard for temperature rise measurements.
- The calibration depends on the assessment of the specific density, the heat capacity and the conductivity of the medium. While the specific density and heat capacity can be measured accurately with standardized procedures (~ 2% for  $c$ ; much better for  $\rho$ ), there is no standard for the measurement of the conductivity. Depending on the method and liquid, the error can well exceed  $\pm 5\%$ .
- Temperature rise measurements are not very sensitive and therefore are often performed at a higher power level than the E-field measurements. The nonlinearities in the system (e.g., power measurements, different components, etc.) must be considered.

Considering these problems, the possible accuracy of the calibration of E-field probes with temperature gradient measurements in a carefully designed setup is about  $\pm 10\%$  (RSS) [2]. Recently, a setup which is a combination of the waveguide techniques and the thermal measurements was presented in [3]. The estimated uncertainty of the setup is  $\pm 5\%$  (RSS) when the same liquid is used for the calibration and for actual measurements and  $\pm 7\text{--}9\%$  (RSS) when not, which is in good agreement with the estimates given in [2].

### 1.8.2 Calibration with Analytical Fields

In this method a technical setup is used in which the field can be calculated analytically from measurements of other physical magnitudes (e.g., input power). This corresponds to the standard field method for probe calibration in air; however, there is no standard defined for fields in lossy liquids.

When using calculated fields in lossy liquids for probe calibration, several points must be considered in the assessment of the uncertainty:

- The setup must enable accurate determination of the incident power.

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- The accuracy of the calculated field strength will depend on the assessment of the dielectric parameters of the liquid.
- Due to the small wavelength in liquids with high permittivity, even small setups might be above the resonant cutoff frequencies. The field distribution in the setup must be carefully checked for conformity with the theoretical field distribution.

## References

- [1] N. Kuster, Q. Balzano, and J.C. Lin, Eds., *Mobile Communications Safety*, Chapman & Hall, London, 1997.
- [2] K. Meier, M. Burkhardt, T. Schmid, and N. Kuster, "Broadband calibration of E-field probes in lossy media", *IEEE Transactions on Microwave Theory and Techniques*, vol. 44, no. 10, pp. 1954-1962, Oct. 1996.
- [3] K. Jokela, P. Hyysalo, and L. Puranen, "Calibration of specific absorption rate (SAR) probes in waveguide at 900 MHz", *IEEE Transactions on Instrumentation and Measurements*, vol. 47, no. 2, pp. 432-438, Apr. 1998.

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## 1.9 The SAR Measurement System

A block diagram of the SAR measurement system is given in Fig. a. This SAR measurement system uses a Computer-controlled 3-D stepper motor system (SPEAG DASY 5 professional system). Model EX3DV4 field probes are used to determine the internal electric fields. The SAR can be obtained from the equation  $SAR = \sigma (|E_i|^2) / \rho$  where  $\sigma$  and  $\rho$  are the conductivity and mass density of the tissue-simulant.

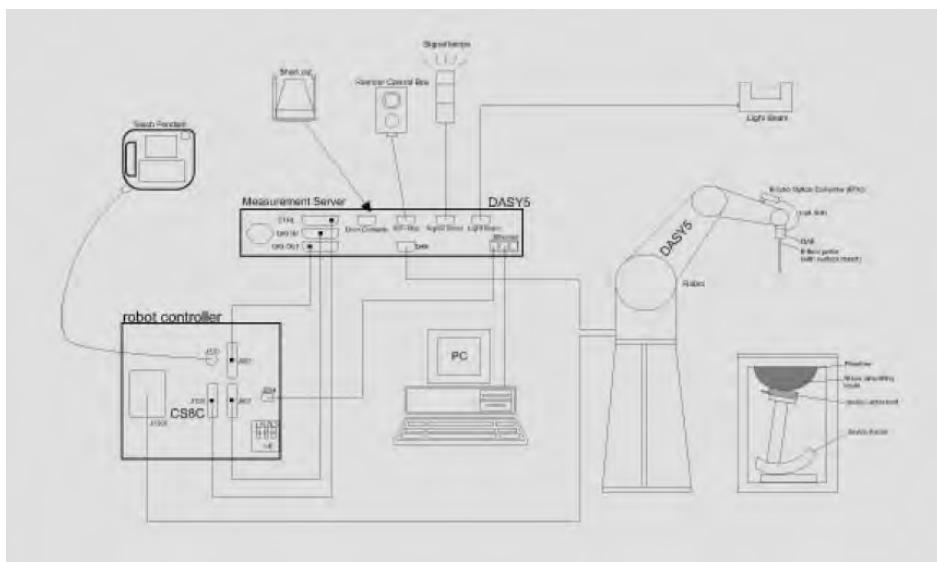


Fig. a A block diagram of the SAR measurement system

The DASY 5 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Staubli RX family) with controller, teach pendant and software. An arm extension is for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- Data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.

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- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 7
- DASY 5 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing to validate the proper functioning of the system.

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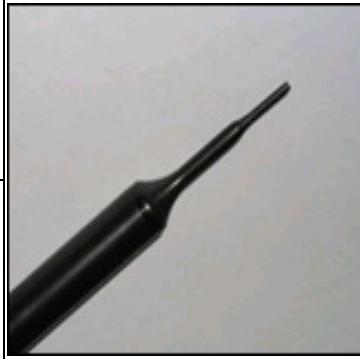
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## 1.10 System Components

### EX3DV4 E-Field Probe

Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Calibration	Basic Broad Band Calibration in air Conversion Factors (CF) for HSL835/1750/1900MHz Additional CF for other liquids and frequencies upon request	
Frequency	10 MHz to > 6 GHz, Linearity: $\pm 0.6$ dB (EX3DV4)	
Directivity	$\pm 0.3$ dB in HSL (rotation around probe axis) $\pm 0.5$ dB in tissue material (rotation normal to probe axis)	
Dynamic Range	10 $\mu$ W/g to > 100 mW/g Linearity: $\pm 0.2$ dB (noise: typically < 1 $\mu$ W/g)	
Dimensions	Tip diameter: 4 mm (ES3DV3) Tip diameter: 2.5 mm (EX3DV4)	
Application	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.	

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**SAM PHANTOM V4.0C**

Construction:	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528-200X, CENELEC 50361 and IEC 62209. 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 manually teaching three points with the robot.
Shell Thickness:	2 ± 0.2 mm
Filling Volume:	Approx. 25 liters
Dimensions:	Height: 210 mm; Length: 1000 mm; Width: 500 mm

**DEVICE HOLDER**

Construction	In combination with the Twin SAM Phantom V4.0/V4.0C or Twin SAM, the Mounting Device (made from POM) enables the rotation of the mounted transmitter in spherical coordinates, whereby the rotation point is the ear opening. The devices can be easily and accurately positioned according to IEC, IEEE, CENELEC, FCC or other specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).	 Device Holder
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## 1.11 SAR System Verification

The microwave circuit arrangement for system verification is sketched in Fig. b. The daily system accuracy verification occurs within the flat section of the SAM phantom. A SAR measurement was performed to see if the measured SAR was within +/- 10% (according to KDB865664 D01) from the target SAR values.

These tests were done at 835/1750/1900 MHz. The tests were conducted on the same days as the measurement of the DUT. The obtained results from the system accuracy verification are displayed in the table 1. During the tests, the ambient temperature of the laboratory was 21.7°C, the relative humidity was 62% and the liquid depth above the ear reference points was above 15 cm ( $\leq 3G$ ) or 10 cm ( $> 3G$ ) in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.

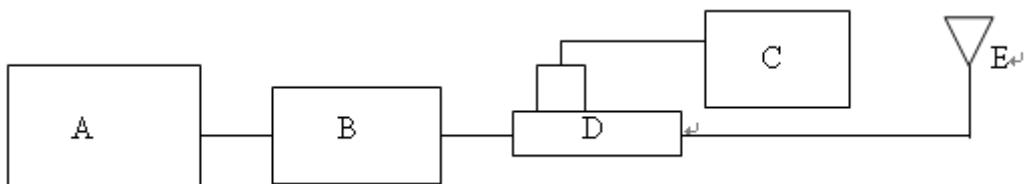


Fig. b The block diagram of system verification

- A. Signal Generator
- B. Amplifier
- C. Power Sensor
- D. Dual Directional Coupling
- E. Reference Dipole Antenna



Photograph of the Dipole Antenna

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Validation Kit	S/N	Frequency (MHz)		Target SAR (1g) (Pin=250mW) (mW/g)	Measured SAR (1g)(mW/g)	Deviation (%)	Measured Date
D835V2	4d161	835	Body	2.4	2.46	-2.50%	Apr. 09, 2014
D1750V2	1105	1750	Body	9.38	9.45	-0.75%	Apr. 09, 2014
D1900V3	5d142	1900	Body	10.1	10	0.99%	Apr. 09, 2014

Table 1. System validation (follow manufacture target value)

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## 1.12 Tissue Simulant Fluid for the Frequency Band

The dielectric properties for this Head-simulant fluid were measured by using the Agilent Model 85070E Dielectric Probe (rates frequency band 200 MHz to 20 GHz) in conjunction with Network Analyzer.

All dielectric parameters of tissue simulates were measured within 24 hours of SAR measurements. The depth of the tissue simulant in the flat section of the phantom was at least 15 cm ( $\leq 3G$ ) or 10 cm ( $> 3G$ ) during all tests. (Appendix Fig. 2)

Measured Frequency (MHz)	Tissue Type	Target Dielectric Constant, $\epsilon_r$	Target Conductivity, $\sigma$ (S/m)	Measured Dielectric Constant, $\epsilon_r$	Measured Conductivity, $\sigma$ (S/m)	% dev $\epsilon_r$	% dev $\sigma$	Measurement Date
826.4	Body	55.234	0.969	53.454	0.962	3.22%	0.72%	Apr. 09, 2014
835		55.200	0.970	53.345	0.973	3.36%	-0.31%	
848.8		55.158	0.987	53.194	0.982	3.56%	0.51%	
1712.4		53.531	1.465	53.913	1.503	-0.71%	-2.59%	
1750		53.432	1.488	53.873	1.529	-0.83%	-2.76%	
1852.4		53.300	1.520	51.897	1.51	2.63%	0.66%	
1880		53.300	1.520	51.822	1.539	2.77%	-1.25%	
1900		53.300	1.520	51.765	1.561	2.88%	-2.70%	

Table 2. Dielectric Parameters of Tissue Simulant Fluid

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The composition of the brain tissue simulating liquid:

Frequency (MHz)	Mode	Ingredient						Total amount
		DGMBE	Water	Salt	Preventol D-7	Cellulose	Sugar	
850	Body	—	631.68 g	11.72 g	1.2 g	—	600 g	1.0L(Kg)
1750	Body	300.67 g	716.56 g	4.0 g	—	—	—	1.0L(Kg)
1900	Body	300.67 g	716.56 g	4.0 g	—	—	—	1.0L(Kg)

Table 3. Recipes for tissue simulating liquid

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## 1.13 Test Standards and Limits

According to FCC 47CFR §2.1093(d) The limits to be used for evaluation are based generally on criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate ("SAR") in Section 4.2 of "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," ANSI/IEEE C95.1-1992, Copyright 1992 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017.

These criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements (NCRP) in "Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields," NCRP Report No. 86, Section 17.4.5. Copyright NCRP, 1986, Bethesda, Maryland 20814. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards. The criteria to be used are specified in paragraphs (d)(1) and (d)(2) of this section and shall apply for portable devices transmitting in the frequency range from 100 kHz to 6 GHz. Portable devices that transmit at frequencies above 6 GHz are to be evaluated in terms of the MPE limits specified in § 1.1310 of this chapter.

Measurements and calculations to demonstrate compliance with MPE field strength or power density limits for devices operating above 6 GHz should be made at a minimum distance of 5 cm from the radiating source.

(1) Limits for Occupational/Controlled exposure: 0.4 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 8 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 20 W/kg, as averaged over a 10 grams of tissue (defined as a tissue volume in the shape of a cube).

Occupational/Controlled limits apply when persons are exposed as a consequence of their employment provided these persons are fully aware of and exercise control over their exposure. Awareness of exposure can be accomplished by use of warning labels or by specific training or education through appropriate means, such as an RF safety program in a work environment.

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(2) Limits for General Population/Uncontrolled exposure: 0.08 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 1.6 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube).

Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube).

General Population/Uncontrolled limits apply when the general public may be exposed, or when persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or do not exercise control over their exposure.

Warning labels placed on consumer devices such as cellular telephones will not be sufficient reason to allow these devices to be evaluated subject to limits for occupational/controlled exposure in paragraph (d)(1) of this section.(Table .6)

Human Exposure	Uncontrolled Environment General Population	Controlled Environment Occupational
Spatial Peak SAR (Brain)	1.60 m W/g	8.00 m W/g
Spatial Average SAR (Whole Body)	0.08 m W/g	0.40 m W/g
Spatial Peak SAR (Hands/Feet/Ankle/Wrist)	4.00 m W/g	20.00 m W/g

Table 4. RF exposure limits

Notes:

1. Uncontrolled environments are defined as locations where there is potential exposure of individuals who have no knowledge or control of their potential exposure.
2. Controlled environments are defined as locations where there is potential exposure of individuals who have knowledge of their potential exposure and can exercise control over their exposure.

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## 2. Summary of Results

### GSM 850 MHz

Mode	Position	Distance (mm)	CH	Freq. (MHz)	Max. Rated Avg. Power + Max. Tolerance (dBm)	Measured Avg. Power (dBm)	Scaling	Averaged SAR over 10g (W/kg)		Plot page
								Measured	Reported	
GSM (Extremity)	Back	0 mm	251	848.8	31	30.3	17.49%	0.581	0.683	33
	Back*	0 mm	251	848.8	31	30.3	17.49%	0.579	0.680	-
GPRS (Extremity) (1Dn2UP)	Back	0 mm	251	848.8	31	30.1	23.03%	1.08	1.329	34
	Back*	0 mm	251	848.8	31	30.1	23.03%	1.07	1.316	-

- # Using KDB941225 D03v01 and KDB941225 D04v01 to exclude SAR test requirements for EDGE modes due to the source-based time-averaged output power for EDGE mode is lower than that in the GPRS mode.

### GSM 1900 MHz

Mode	Position	Distance (mm)	CH	Freq. (MHz)	Max. Rated Avg. Power + Max. Tolerance (dBm)	Measured Avg. Power (dBm)	Scaling	Averaged SAR over 10g (W/kg)		Plot page
								Measured	Reported	
GSM (Extremity)	Back	0 mm	661	1880	31	30.2	20.23%	0.275	0.331	35
GPRS (Extremity) (1Dn2UP)	Back	0 mm	661	1880	31	30.2	20.23%	0.516	0.620	36
	Back*	0 mm	661	1880	31	30.2	20.23%	0.514	0.618	-

- # Using KDB941225 D03v01 and KDB941225 D04v01 to exclude SAR test requirements for EDGE modes due to the source-based time-averaged output power for EDGE mode is lower than that in the GPRS mode.
- # According to KDB865664 D01v01, SAR measurement variability must be assessed for each frequency band. When the original highest measured SAR is  $\geq 0.8$  W/kg, repeat that measurement once. Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is  $> 1.20$  or when the original or repeated measurement is  $\geq 1.45$  W/kg ( $\sim 10\%$  from the 1-g SAR limit)

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**WCDMA Band II**

Mode	Position	Distance (mm)	CH	Freq. (MHz)	Max. Rated Avg. Power + Max. Tolerance (dBm)	Measured Avg. Power (dBm)	Scaling	Averaged SAR over 10g		Plot page
								Measured	Reported	
Extremity	Back	0 mm	9262	1852.4	24	23.78	5.20%	0.706	0.743	-
	Back*	0 mm	9262	1852.4	24	23.78	5.20%	0.716	0.753	37

**WCDMA Band IV**

Mode	Position	Distance (mm)	CH	Freq. (MHz)	Max. Rated Avg. Power + Max. Tolerance (dBm)	Measured Avg. Power (dBm)	Scaling	Averaged SAR over 10g		Plot page
								Measured	Reported	
Extremity	Back	0 mm	1312	1712.4	24	23.75	5.93%	0.984	1.042	-
	Back*	0 mm	1312	1712.4	24	23.75	5.93%	1	1.059	38

**WCDMA Band V**

Mode	Position	Distance (mm)	CH	Freq. (MHz)	Max. Rated Avg. Power + Max. Tolerance (dBm)	Measured Avg. Power (dBm)	Scaling	Averaged SAR over 10g		Plot page
								Measured	Reported	
Extremity	Back	0 mm	4132	826.4	22	21.13	22.18%	0.492	0.601	39

# Using KDB941225 D01v02 to exclude SAR test requirements for HSPA modes due to the maximum average output power of HSPA active is less than that measured without HSPA using 12.2kbps RMC.

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### 3. Instruments List

Manufacturer	Device	Type	Serial number	Date of last calibration	Date of next calibration
Schmid & Partner Engineering AG	Dosimetric E-Field Probe	EX3DV4	3938	Aug.02,2013	Aug.01,2014
Schmid & Partner Engineering AG	835/1750/1900 MHz System	D835V2	4d161	Nov.01,2013	Oct.31,2014
	Validation Dipole	D1750V2	1105	Nov.05,2013	Nov.04,2014
		D1900V2	5d142	Jun.10,2013	Jun.09,2014
Schmid & Partner Engineering AG	Data acquisition Electronics	DAE4	1374	Jun.03,2013	Jun.02,2014
Schmid & Partner Engineering AG	Software	DASY 52 V52.8	N/A	Calibration not required	Calibration not required
Schmid & Partner Engineering AG	Phantom	SAM	N/A	Calibration not required	Calibration not required
HP	Network Analyzer	8753D	3410A05547	May 07,2013	May 06,2014
Agilent	Dielectric Probe Kit	85070E	MY44300677	Calibration not required	Calibration not required
Agilent	Dual-directional coupler	772D	MY52180142	Sep.19,2013	Sep.18,2014
		778D	MY52180302	Sep.25,2013	Sep.24,2014
Agilent	RF Signal Generator	N5181A	MY50145142	Oct.03,2013	Oct.02,2014
Agilent	Power Meter	E4417A	MY52240003	May 07,2013	May.06,2014
Agilent	Power Sensor	E9301H	MY52200003	May 07,2013	May.06,2014
R&S	Radio Communication Test	CMU200	122498	Jul. 17,2013	Jul. 16,2014
TECPEL	Digital thermometer	DTM-303A	TP130077	Mar.17,2014	Mar.16,2015

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## 4. Measurements

Date: 2014/4/9

### **GSM 850\_Extremity\_Back\_CH 251\_0mm**

Communication System: GSM; Communication System Band: GSM850; Frequency: 848.8 MHz; Medium parameters used:  $f = 849$  MHz;  $\sigma = 0.982$  S/m;  $\epsilon_r = 53.194$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
DASY 5 Configuration:

- Probe: EX3DV4 - SN3938; ConvF(9.37, 9.37, 9.37); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Body;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Configuration/Body/Area Scan (81x101x1):** Interpolated grid:  $dx=15$  mm,  $dy=15$  mm

Maximum value of SAR (interpolated) = 1.36 W/kg

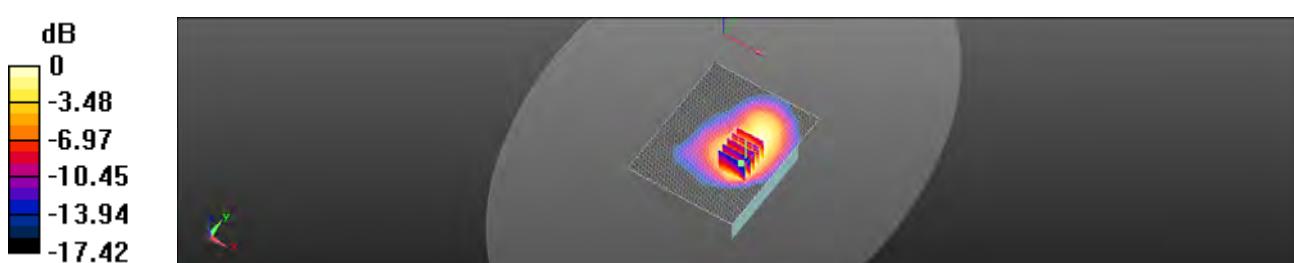
**Configuration/Body/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8$  mm,  $dy=8$  mm,  $dz=5$  mm

Reference Value = 20.767 V/m; Power Drift = -0.13 dB

Peak SAR (extrapolated) = 1.72 W/kg

**SAR(1 g) = 0.940 W/kg; SAR(10 g) = 0.581 W/kg**

Maximum value of SAR (measured) = 1.18 W/kg



0 dB = 1.18 W/kg = 0.74 dBW/kg

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Date: 2014/4/9

## GPRS 850\_Extremity\_Back\_CH 251\_0mm

Communication System: GPRS-10; Communication System Band: GPRS850; Frequency: 848.8 MHz; Medium parameters used:  $f = 849$  MHz;  $\sigma = 0.982$  S/m;  $\epsilon_r = 53.194$ ;  $\rho = 1000$  kg/m<sup>3</sup>

DASY 5 Configuration:

- Probe: EX3DV4 - SN3938; ConvF(9.37, 9.37, 9.37); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Body;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Configuration/Body/Area Scan (81x101x1):** Interpolated grid:  $dx=15$  mm,  $dy=15$  mm

Maximum value of SAR (interpolated) = 2.51 W/kg

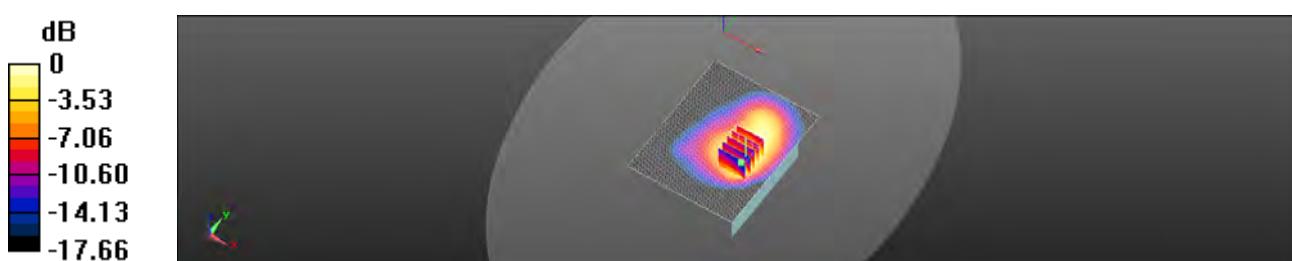
**Configuration/Body/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8$  mm,  $dy=8$  mm,  $dz=5$  mm

Reference Value = 28.715 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 3.13 W/kg

**SAR(1 g) = 1.73 W/kg; SAR(10 g) = 1.08 W/kg**

Maximum value of SAR (measured) = 2.19 W/kg



0 dB = 2.19 W/kg = 3.41 dBW/kg

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## GSM 1900\_Extremity\_Back\_CH 661\_0mm

Communication System: GSM; Communication System Band: GSM1900; Frequency: 1880 MHz; Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.539$  S/m;  $\epsilon_r = 51.822$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
DASY 5 Configuration:

- Probe: EX3DV4 - SN3938; ConvF(7.29, 7.29, 7.29); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Body;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Configuration/Body/Area Scan (81x101x1):** Interpolated grid: dx=15 mm, dy=15 mm

Maximum value of SAR (interpolated) = 0.903 W/kg

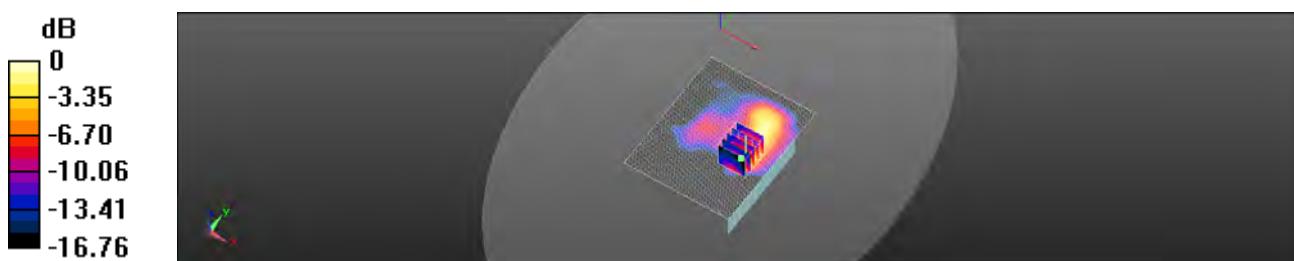
**Configuration/Body/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 7.123 V/m; Power Drift = 0.14 dB

Peak SAR (extrapolated) = 0.926 W/kg

**SAR(1 g) = 0.521 W/kg; SAR(10 g) = 0.275 W/kg**

Maximum value of SAR (measured) = 0.705 W/kg



0 dB = 0.705 W/kg = -1.52 dBW/kg

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## GPRS 1900\_Extremity\_Back\_CH 661\_0mm

Communication System: GPRS-10; Communication System Band: GPRS1900; Frequency: 1880 MHz; Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.539$  S/m;  $\epsilon_r = 51.822$ ;  $\rho = 1000$  kg/m<sup>3</sup>

DASY 5 Configuration:

- Probe: EX3DV4 - SN3938; ConvF(7.29, 7.29, 7.29); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Body;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Configuration/Body/Area Scan (81x101x1):** Interpolated grid: dx=15 mm, dy=15 mm

Maximum value of SAR (interpolated) = 1.56 W/kg

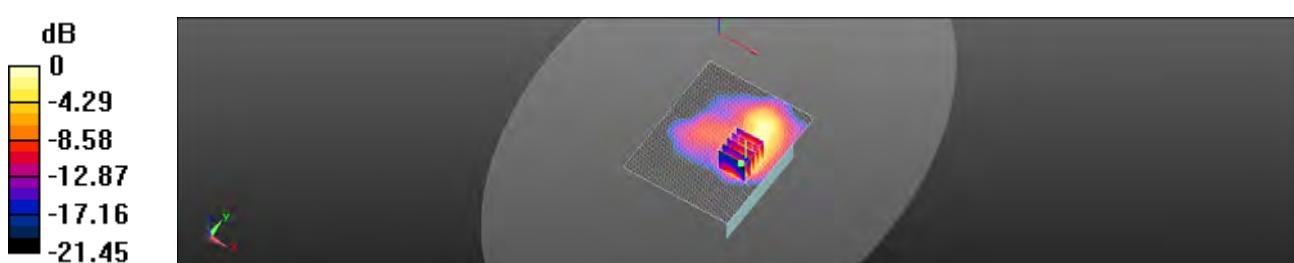
**Configuration/Body/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 9.709 V/m; Power Drift = -0.17 dB

Peak SAR (extrapolated) = 1.76 W/kg

**SAR(1 g) = 0.993 W/kg; SAR(10 g) = 0.516 W/kg**

Maximum value of SAR (measured) = 1.30 W/kg



0 dB = 1.30 W/kg = 1.15 dBW/kg

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## WCDMA Band II\_Extremity\_Back\_CH 9262\_0mm\_Repeated

Communication System: WCDMA; Communication System Band: WCDMA Band 2;  
Frequency: 1852.4 MHz; Medium parameters used (interpolated):  $f = 1852.4$  MHz;  $\sigma = 1.51$  S/m;  $\epsilon_r = 51.897$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
DASY 5 Configuration:

- Probe: EX3DV4 - SN3938; ConvF(7.29, 7.29, 7.29); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Body;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Configuration/Body/Area Scan (81x101x1):** Interpolated grid:  $dx=15$  mm,  $dy=15$  mm

Maximum value of SAR (interpolated) = 2.07 W/kg

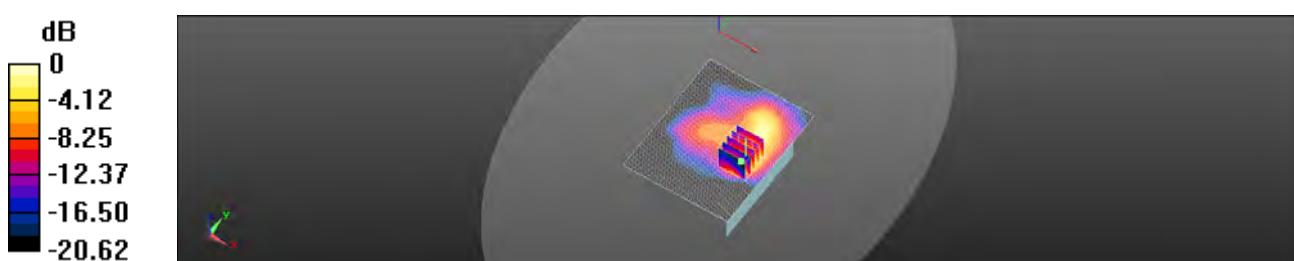
**Configuration/Body/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8$  mm,  $dy=8$  mm,  $dz=5$  mm

Reference Value = 14.324 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 2.37 W/kg

**SAR(1 g) = 1.36 W/kg; SAR(10 g) = 0.716 W/kg**

Maximum value of SAR (measured) = 1.80 W/kg



0 dB = 1.80 W/kg = 2.56 dBW/kg

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## WCDMA Band IV\_Extremity\_Back\_CH 1312\_0mm\_Repeated

Communication System: WCDMA; Communication System Band: WCDMA Band 4;  
Frequency: 1712.4 MHz; Medium parameters used (interpolated):  $f = 1712.4$  MHz;  $\sigma = 1.503$  S/m;  $\epsilon_r = 53.913$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
DASY 5 Configuration:

- Probe: EX3DV4 - SN3938; ConvF(7.6, 7.6, 7.6); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Body;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Configuration/Body/Area Scan (81x101x1):** Interpolated grid:  $dx=15$  mm,  $dy=15$  mm

Maximum value of SAR (interpolated) = 2.58 W/kg

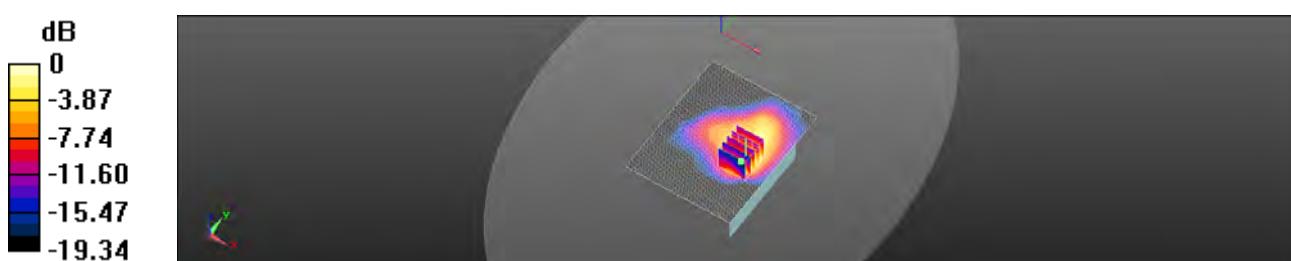
**Configuration/Body/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8$  mm,  $dy=8$  mm,  $dz=5$  mm

Reference Value = 19.887 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 2.90 W/kg

**SAR(1 g) = 1.77 W/kg; SAR(10 g) = 1 W/kg**

Maximum value of SAR (measured) = 2.41 W/kg



0 dB = 2.41 W/kg = 3.82 dBW/kg

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Date: 2014/4/9

## WCDMA Band V\_Extremity\_Back\_CH 4132\_0mm

Communication System: WCDMA; Communication System Band: WCDMA Band 5;  
Frequency: 826.4 MHz; Medium parameters used (interpolated):  $f = 826.4$  MHz;  $\sigma = 0.962$  S/m;  $\epsilon_r = 53.454$ ;  $\rho = 1000$  kg/m<sup>3</sup>

DASY 5 Configuration:

- Probe: EX3DV4 - SN3938; ConvF(9.37, 9.37, 9.37); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Body;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Configuration/Body/Area Scan (81x101x1):** Interpolated grid:  $dx=15$  mm,  $dy=15$  mm

Maximum value of SAR (interpolated) = 1.10 W/kg

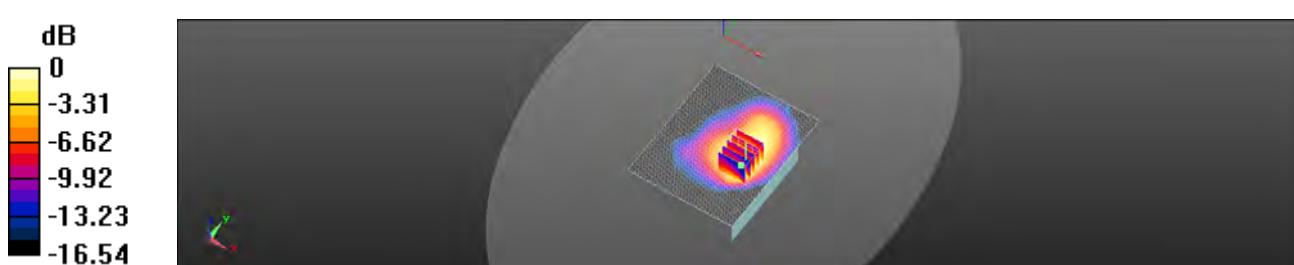
**Configuration/Body/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8$  mm,  $dy=8$  mm,  $dz=5$  mm

Reference Value = 19.837 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 1.46 W/kg

**SAR(1 g) = 0.778 W/kg; SAR(10 g) = 0.492 W/kg**

Maximum value of SAR (measured) = 0.982 W/kg



0 dB = 0.982 W/kg = -0.08 dBW/kg

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## 5. System Verification

Date: 2014/4/9

### Dipole 835 MHz\_SN: 4d161

Communication System: CW; Frequency: 835 MHz

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.973 \text{ S/m}$ ;  $\epsilon_r = 53.345$ ;  $\rho = 1000 \text{ kg/m}^3$

DASY 5 Configuration:

- Probe: EX3DV4 - SN3938; ConvF(9.37, 9.37, 9.37); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Body;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Configuration/Pin=250mW/Area Scan (61x121x1):** Interpolated grid:

$dx=15 \text{ mm}$ ,  $dy=15 \text{ mm}$

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

**Configuration/Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement

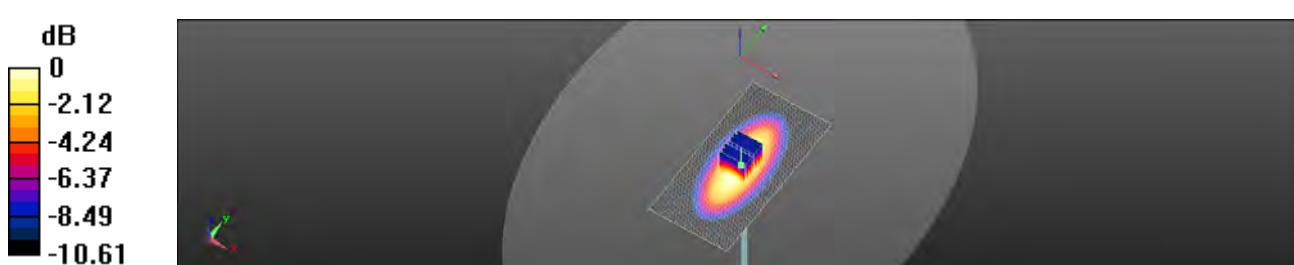
grid:  $dx=5 \text{ mm}$ ,  $dy=5 \text{ mm}$ ,  $dz=5 \text{ mm}$

Reference Value = 55.991 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 3.36 W/kg

**SAR(1 g) = 2.46 W/kg; SAR(10 g) = 1.62 W/kg**

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



0 dB = 2.90 W/kg = 4.91 dBW/kg

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Date: 2014/4/9

## Dipole 1750 MHz\_SN: 1105

Communication System: CW; Frequency: 1750 MHz

Medium parameters used:  $f = 1750$  MHz;  $\sigma = 1.529$  S/m;  $\epsilon_r = 53.873$ ;  $\rho = 1000$  kg/m<sup>3</sup>

DASY 5 Configuration:

- Probe: EX3DV4 - SN3938; ConvF(7.6, 7.6, 7.6); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Body;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Configuration/Pin=250mW/Area Scan (51x91x1):** Interpolated grid: dx=15 mm, dy=15 mm

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

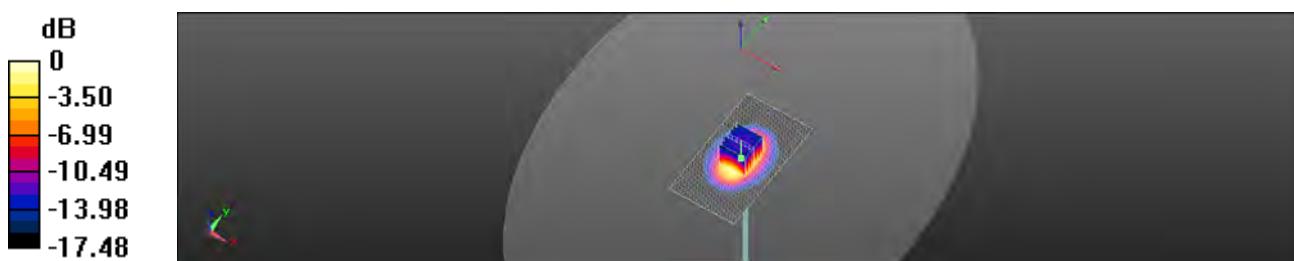
**Configuration/Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.631 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 17.7 W/kg

**SAR(1 g) = 9.45 W/kg; SAR(10 g) = 5.11 W/kg**

Maximum value of SAR (measured) = 13.4 W/kg



0 dB = 13.4 W/kg = 10.65 dBW/kg

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Date: 2014/4/9

## Dipole 1900 MHz\_SN: 5d142

Communication System: CW; Frequency: 1900 MHz

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.561$  S/m;  $\epsilon_r = 51.765$ ;  $\rho = 1000$  kg/m<sup>3</sup>

DASY 5 Configuration:

- Probe: EX3DV4 - SN3938; ConvF(7.29, 7.29, 7.29); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Body;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Configuration/Pin=250mW/Area Scan (41x101x1):** Interpolated grid:

$dx=15$  mm,  $dy=15$  mm

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

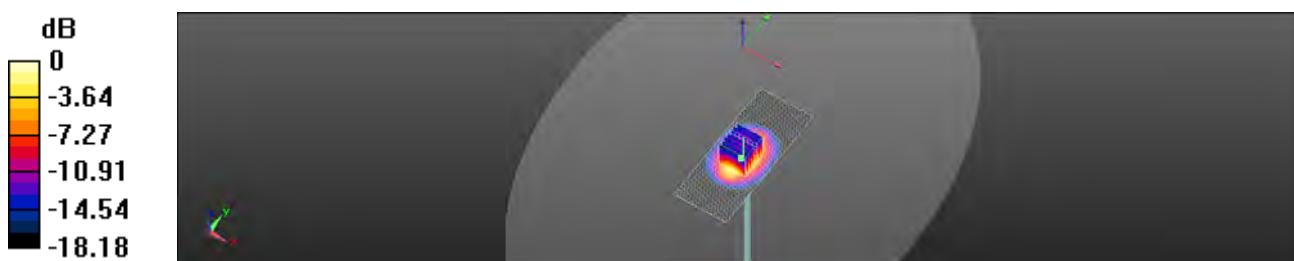
**Configuration/Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5$  mm,  $dy=5$  mm,  $dz=5$  mm

Reference Value = 97.966 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 18.4 W/kg

**SAR(1 g) = 10 W/kg; SAR(10 g) = 5.26 W/kg**

Maximum value of SAR (measured) = 14.3 W/kg



0 dB = 14.3 W/kg = 11.57 dBW/kg

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## 6. DAE & Probe Calibration Certificate

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



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

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

Accreditation No.: **SCS 108**Client **SGS-TW (Auden)**Certificate No: **DAE4-1374\_Jun13**

### CALIBRATION CERTIFICATE

Object DAE4 - SD 000 D04 BJ - SN: 1374

Calibration procedure(s) QA CAL-06.v26  
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: June 03, 2013

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	02-Oct-12 (No: 12728)	Oct-13
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit Calibrator Box V2.1	SE UWS 053 AA 1001 SE UMS 006 AA 1002	07-Jan-13 (in house check) 07-Jan-13 (in house check)	In house check: Jan-14 In house check: Jan-14

Calibrated by:	Name Eric Hainfeld	Function Technician	Signature
Approved by:	Fin Bomholt	Deputy Technical Manager	<i>J.V. Bomholt</i>

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

Issued: June 3, 2013

Certificate No: DAE4-1374\_Jun13

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Accreditation No.: SCS 108

### Glossary

DAE	data acquisition electronics
Connector angle	information used in DASY system to align probe sensor X to the robot coordinate system.

### Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement*: Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity*: Verification of the Linearity at  $\pm 10\%$  and  $\pm 10\%$  of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity*: Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation*: Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted*: Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement*: Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current*: Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance*: Typical value for information; DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage*: Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption*: Typical value for information. Supply currents in various operating modes.

**DC Voltage Measurement**

A/D - Converter Resolution nominal

High Range: 1LSB =  $6.1\mu V$ , full range =  $-100...+300 mV$   
Low Range: 1LSB =  $61\mu V$ , full range =  $-1.....+3mV$

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	$404.597 \pm 0.02\% (k=2)$	$405.252 \pm 0.02\% (k=2)$	$404.637 \pm 0.02\% (k=2)$
Low Range	$3.99874 \pm 1.50\% (k=2)$	$4.00831 \pm 1.50\% (k=2)$	$3.95007 \pm 1.50\% (k=2)$

**Connector Angle**

Connector Angle to be used in DASY system	$241.0^\circ \pm 1^\circ$
---	---------------------------

**Appendix****1. DC Voltage Linearity**

High Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	199992.07	-3.43	-0.00
Channel X + Input	20002.96	2.28	0.01
Channel X - Input	-19998.37	2.29	-0.01
Channel Y + Input	199993.84	-1.97	-0.00
Channel Y + Input	20000.33	-0.19	-0.00
Channel Y - Input	-20001.84	-1.12	0.01
Channel Z + Input	199994.33	-1.63	-0.00
Channel Z + Input	19998.59	-1.84	-0.01
Channel Z - Input	-20002.39	-1.62	0.01

Low Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	2002.45	1.56	0.08
Channel X + Input	201.83	0.44	0.22
Channel X - Input	-198.44	0.26	-0.13
Channel Y + Input	2002.11	1.27	0.06
Channel Y + Input	200.40	-0.84	-0.42
Channel Y - Input	-199.57	-0.72	0.36
Channel Z + Input	2001.68	0.77	0.04
Channel Z + Input	199.45	-1.75	-0.87
Channel Z - Input	-200.85	-2.04	1.02

**2. Common mode sensitivity**

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	-2.27	-3.74
	-200	4.97	3.23
Channel Y	200	9.68	9.30
	-200	-11.44	-11.91
Channel Z	200	6.77	6.83
	-200	-10.92	-11.26

**3. Channel separation**

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	5.60	-1.27
Channel Y	200	9.02	-	7.06
Channel Z	200	8.83	6.67	-

Certificate No: DAE4-1374\_Jun13

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**4. AD-Converter Values with inputs shorted**

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	15890	16495
Channel Y	16032	16698
Channel Z	15908	16765

**5. Input Offset Measurement**

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	1.75	0.84	3.69	0.41
Channel Y	0.08	-1.11	0.96	0.35
Channel Z	-0.02	-0.92	1.82	0.48

**6. Input Offset Current**

Nominal Input circuitry offset current on all channels: &lt;25fA

**7. Input Resistance (Typical values for information)**

	Zeroing (kOhm)	Measuring (MΩ)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

**8. Low Battery Alarm Voltage (Typical values for information)**

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

**9. Power Consumption (Typical values for information)**

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	-0.01	-8	-9

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Schmid & Partner  
Engineering AG  
Zeughausstrasse 43, 8004 Zurich, Switzerland



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Accreditation No.: SCS 108

Client SGS-TW (Auden)

Certificate No: EX3-3938\_Aug13

## CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3938		
Calibration procedure(s)	QA CAL-01.v8, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4 Calibration procedure for dosimetric E-field probes		
Calibration date:	August 2, 2013		
This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.			
All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.			
Calibration Equipment used (M&TE critical for calibration)			
Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S6054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013, Dec12)	Dec-13
DAE#	SN: 660	31-Jan-13 (No. DAE4-660, Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13
Calibrated by:	Name: Katja Pokovic	Function: Technical Manager	Signature:
Approved by:	Name: Niels Kuster	Function: Quality Manager	Signature:
Issued: August 2, 2013			
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

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#### Glossary:

TSL	tissue simulating liquid
NORM <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 $\theta$	$\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ is normal to probe axis

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

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

#### Methods Applied and Interpretation of Parameters:

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

EX3DV4 – SN:3938

August 2, 2013

# Probe EX3DV4

## SN:3938

Manufactured: May 2, 2013  
Calibrated: August 2, 2013

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

Certificate No: EX3-3938\_Aug13

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EX3DV4- SN:3938

August 2, 2013

**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3938****Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu$ V/(V/m)) <sup>A</sup>	0.52	0.58	0.34	$\pm 10.1\%$
DCP (mV) <sup>B</sup>	100.4	99.5	102.6	

**Modulation Calibration Parameters**

UID	Communication System Name	A dB	B dB/ $\mu$ V	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X 0.0	0.0	1.0	0.00	168.9	$\pm 2.5\%$
		Y 0.0	0.0	1.0		132.5	
		Z 0.0	0.0	1.0		133.2	

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<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 6).

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

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

EX3DV4- SN:3938

August 2, 2013

**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3938****Calibration Parameter Determined in Head Tissue Simulating Media**

$\bar{f}$ (MHz) <sup>c</sup>	Relative Permittivity <sup>d</sup>	Conductivity (S/m) <sup>e</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	9.49	9.49	9.49	0.57	0.75	$\pm 12.0\%$
835	41.5	0.90	9.21	9.21	9.21	0.46	0.82	$\pm 12.0\%$
900	41.5	0.97	9.06	9.06	9.06	0.68	0.68	$\pm 12.0\%$
1750	40.1	1.37	7.86	7.86	7.86	0.54	0.64	$\pm 12.0\%$
1900	40.0	1.40	7.61	7.61	7.61	0.69	0.62	$\pm 12.0\%$
2000	40.0	1.40	7.62	7.62	7.62	0.37	0.80	$\pm 12.0\%$
2300	39.5	1.87	7.35	7.35	7.35	0.67	0.59	$\pm 12.0\%$
2450	39.2	1.80	6.97	6.97	6.97	0.38	0.80	$\pm 12.0\%$
5200	36.0	4.66	5.18	5.18	5.18	0.30	1.80	$\pm 13.1\%$
5300	35.9	4.76	4.96	4.96	4.96	0.30	1.80	$\pm 13.1\%$
5500	35.6	4.96	4.86	4.86	4.86	0.30	1.80	$\pm 13.1\%$
5600	35.5	5.07	4.63	4.63	4.63	0.30	1.80	$\pm 13.1\%$
5800	35.3	5.27	4.65	4.65	4.65	0.32	1.80	$\pm 13.1\%$

<sup>c</sup> Frequency validity of  $\pm 100$  MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to  $\pm 50$  MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.<sup>d</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to  $\pm 10\%$  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  $\pm 5\%$ . The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

EX3DV4- SN:3938

August 2, 2013

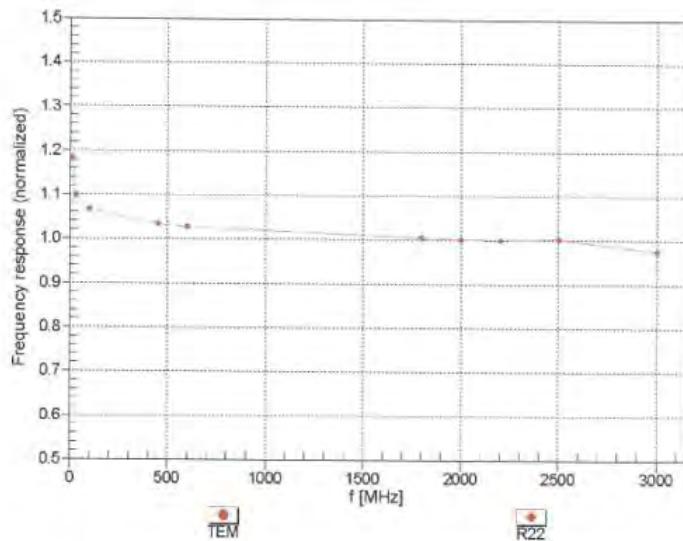
**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3938****Calibration Parameter Determined in Body Tissue Simulating Media**

f (MHz) <sup>c</sup>	Relative Permittivity <sup>d</sup>	Conductivity (S/m) <sup>e</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	9.45	9.45	9.45	0.45	0.84	± 12.0 %
835	55.2	0.97	9.37	9.37	9.37	0.74	0.66	± 12.0 %
900	55.0	1.05	9.19	9.19	9.19	0.59	0.72	± 12.0 %
1750	53.4	1.49	7.60	7.60	7.60	0.45	0.82	± 12.0 %
1900	53.3	1.52	7.29	7.29	7.29	0.48	0.74	± 12.0 %
2000	53.3	1.52	7.44	7.44	7.44	0.53	0.72	± 12.0 %
2300	52.9	1.81	7.16	7.16	7.16	0.80	0.50	± 12.0 %
2450	52.7	1.95	6.94	6.94	6.94	0.80	0.50	± 12.0 %
5200	49.0	5.30	4.44	4.44	4.44	0.36	1.90	± 13.1 %
5300	48.9	5.42	4.29	4.29	4.29	0.35	1.90	± 13.1 %
5500	48.6	5.65	4.05	4.05	4.05	0.38	1.90	± 13.1 %
5600	48.5	5.77	4.02	4.02	4.02	0.33	1.90	± 13.1 %
5800	48.2	6.00	4.17	4.17	4.17	0.40	1.90	± 13.1 %

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

EX3DV4-SN:3938

August 2, 2013

**Frequency Response of E-Field**  
(TEM-Cell:ifi110 EXX, Waveguide: R22)Uncertainty of Frequency Response of E-field:  $\pm 6.3\% (k=2)$ 

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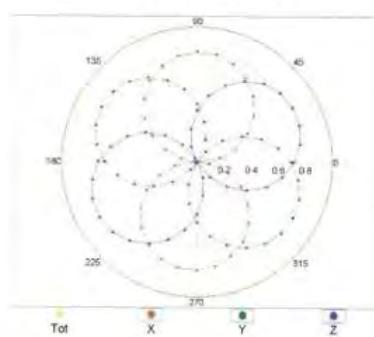
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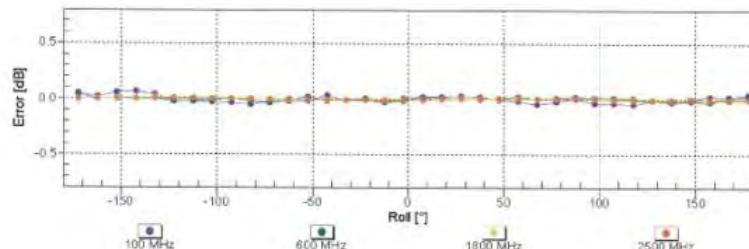
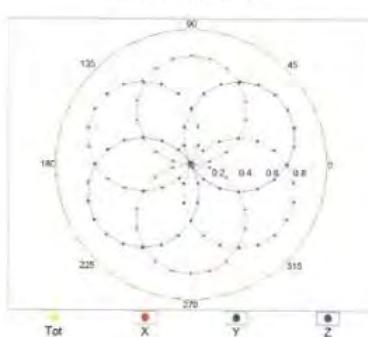
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**Receiving Pattern ( $\phi$ ),  $\theta = 0^\circ$** 

f=600 MHz, TEM



f=1800 MHz, R22



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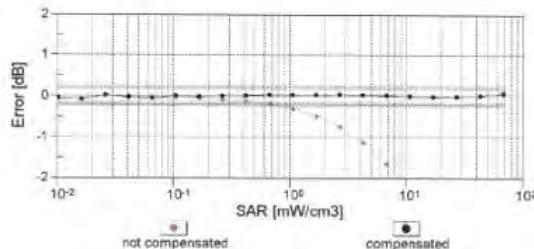
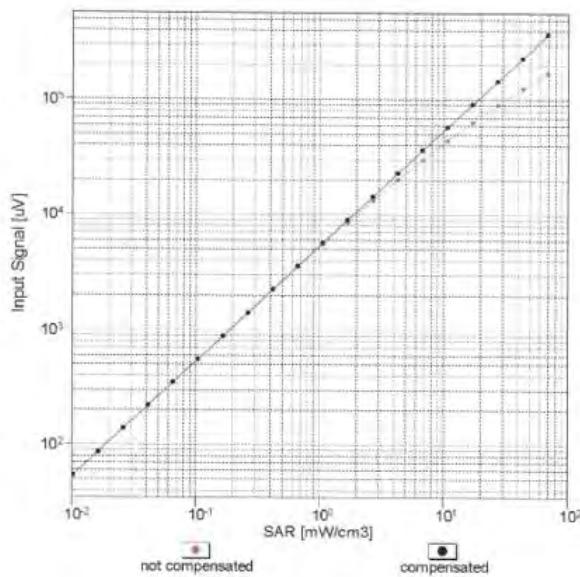
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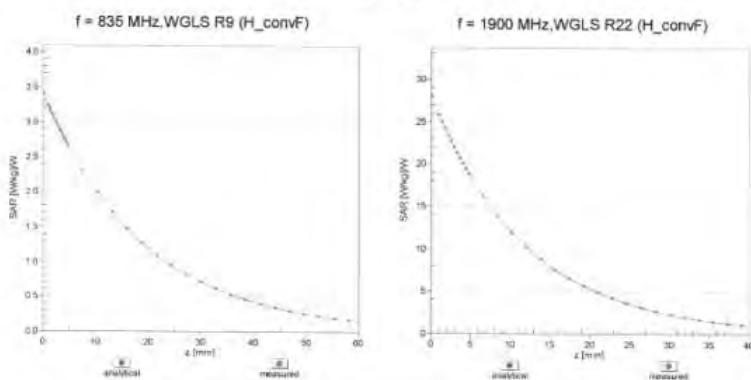
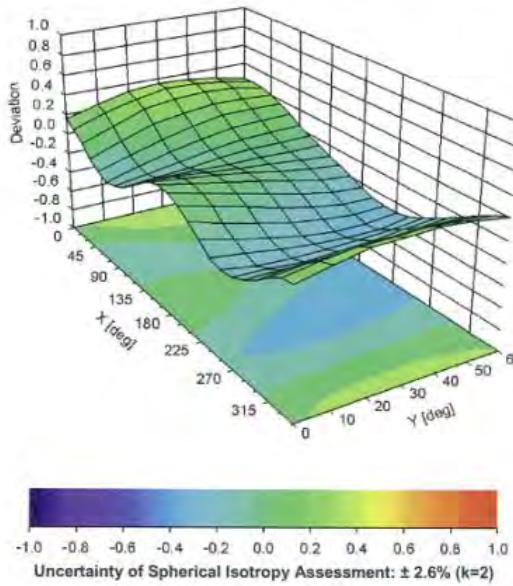
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**Dynamic Range f(SAR<sub>head</sub>)**  
(TEM cell, f = 900 MHz)Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

EX3DV4- SN:3938

August 2, 2013

**Conversion Factor Assessment****Deviation from Isotropy in Liquid**Error ( $\phi, \theta$ ),  $f = 900 \text{ MHz}$ 

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EX3DV4- SN:3938

August 2, 2013

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3938

### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (")	-32.4
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm

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## 7. Uncertainty Budget

Measurement Uncertainty evaluation template for DUT SAR test  
 IEEE 1528

A	c	D	e	f	g	h=c * f / e	i=c * g / e	k
Source of Uncertainty	Tolerance/ Uncertainty %	Probability Distributioin	Div	ci (1g)	ci (10g)	Standard uncertainty	Standard uncertainty	vi, or Veff
<b>Measurement system</b>								
Probe calibration(under 6Ghz)	6.55%	N	1	1	1	6.55%	6.55%	$\infty$
<i>Isotropy, Axial</i>	3.50%	R	$\sqrt{3}$	1	1	2.02%	2.02%	$\infty$
<i>Isotropy, Hemispherical</i>	9.60%	R	$\sqrt{3}$	1	1	5.54%	5.54%	$\infty$
Boundary Effect	1.00%	R	$\sqrt{3}$	1	1	0.58%	0.58%	$\infty$
Linearity	4.70%	R	$\sqrt{3}$	1	1	2.71%	2.71%	$\infty$
Detection Limits	1.00%	R	$\sqrt{3}$	1	1	0.58%	0.58%	$\infty$
Readout Electronics	0.30%	N	1	1	1	0.30%	0.30%	$\infty$
Response time	0.80%	R	$\sqrt{3}$	1	1	0.46%	0.46%	$\infty$
Integration Time	2.60%	R	$\sqrt{3}$	1	1	1.50%	1.50%	$\infty$
<i>Measurement drift (class A evaluation)</i>	1.75%	R	$\sqrt{3}$	1	1	1.01%	1.01%	$\infty$
RF ambient condition - noise	3.00%	R	$\sqrt{3}$	1	1	1.73%	1.73%	$\infty$
RF ambient conditions -reflections	3.00%	R	$\sqrt{3}$	1	1	1.73%	1.73%	$\infty$
Probe positioner Mechanical restrictions	0.40%	R	$\sqrt{3}$	1	1	0.23%	0.23%	$\infty$
Probe Positioning with respect to phantom	2.90%	R	$\sqrt{3}$	1	1	1.67%	1.67%	$\infty$
Post-processing	1.00%	R	$\sqrt{3}$	1	1	0.58%	0.58%	$\infty$
Max SAR Eval	1.00%	R	$\sqrt{3}$	1	1	0.58%	0.58%	$\infty$
<b>Test Sample related</b>								
Test sample	2.90%	N	1	1	1	2.90%	2.90%	M-1
Device Holder Uncertainty	3.60%	N	1	1	1	3.60%	3.60%	M-1
Drift of output power	5.00%	R	$\sqrt{3}$	1	1	2.89%	2.89%	$\infty$
<b>Phantom and Setup</b>								
Phantom Uncertainty	4.00%	R	$\sqrt{3}$	1	1	2.31%	2.31%	$\infty$
Liquid conductivity(meas.) Max at 1900 band	4.60%	N	1	0.64	0.43	2.94%	1.98%	M
Liquid permittivity(meas.) Max at 835 band	2.17%	N	1	0.6	0.49	1.30%	1.06%	M
Combined standard uncertainty		RSS				12.01%	11.79%	
Expan uncertainty (95% confidence interval), K=2						24.02%	23.57%	

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## 8. Phantom Description

Schmid &amp; Partner Engineering AG

**s p e a g**Zeughausstrasse 43, 8004 Zurich, Switzerland.  
Phone +41 1 245 9700, Fax +41 1 245 9779  
info@speag.com, http://www.speag.com**Certificate of Conformity / First Article Inspection**

Item	SAM Twin Phantom V4.0
Type No.	QD 000 P40 C
Series No.	TP-1150 and higher
Manufacturer	SPEAG Zeughausstrasse 43 CH-8004 Zurich Switzerland

**Tests**

The series production process used allows the limitation to test of first articles.  
Complete tests were made on the pre-series Type No. QD 000 P40 AA, Serial No. TP-1001 and on the series first article Type No. QD 000 P40 BA, Serial No. TP-1006. Certain parameters have been retested using further series items (called samples) or are tested at each item.

Test	Requirement	Details	Units tested
Dimensions	Compliant with the geometry according to the CAD model.	IT'IS CAD File (*)	First article, Samples
Material thickness of shell	Compliant with the requirements according to the standards.	2mm +/- 0.2mm in Bat and specific areas of head section	First article, Samples, TP-1314 fl.
Material thickness at ERP	Compliant with the requirements according to the standards.	6mm +/- 0.2mm at ERP	First article, All items
Material parameters	Dielectric parameters for required frequencies	300 MHz – 6 GHz: Relative permittivity < 5, Loss tangent < 0.05	Material samples
Material resistivity	The material has been tested to be compatible with the liquids defined in the standards if handled and cleaned according to the instructions. Observe technical Note for material compatibility.	DEGMBe based simulating liquids	Pre-series, First article, Material samples
Sagging	Compliant with the requirements according to the standards. Sagging of the flat section when filled with tissue simulating liquid.	< 1% typical < 0.8% if filled with 155mm of HSL900 and without DUT below	Prototypes, Sample testing

**Standards**

- [1] CENELEC EN 50361
- [2] IEEE Std 1528-2003
- [3] IEC 62209 Part 1
- [4] FCC OET Bulletin 65, Supplement C, Edition 01-01

(\*) The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of the other documents.

**Conformity**

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of SAR measurements specified in standards [1] to [4].

Date

07.07.2005

**s p e a g**

Signature / Stamp

Schmid & Partner Engineering AG  
Zeughausstrasse 43, 8004 Zurich, Switzerland  
Phone +41 1 245 9700, Fax +41 1 245 9779  
info@speag.com, http://www.speag.com

Doc No.: 881 - QD 000 P40 C - P

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## 9. System Validation from Original Equipment Supplier

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



S Schweizerischer Kalibrierdienst  
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S Servizio svizzero di taratura  
S Swiss Calibration Service

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

Accreditation No.: SCS 108

Client SGS-TW (Auden)

Certificate No: D835V2-4d161\_Nov13

### CALIBRATION CERTIFICATE

Object D835V2 - SN: 4d161

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

Calibration date November 01, 2013

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	08-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292793	08-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DN43	SN: 3205	28-Dec-12 (No. ES3-9205, Dec12)	Dec-13
DAE4	SN: 601	25-Apr-13 (No. DAE4-601, Apr13)	Apr-14
Secondary Standards	ID #	Check Date (In house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-15
Network Analyzer HP 8753E	US37390585: S4205	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

Calibrated by: Name: Jelena Kastrati Function: Laboratory Technician Signature:

Approved by: Name: Katica Pekovic Function: Technical Manager Signature:

Issued: November 1, 2013

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

Certificate No: D835V2-4d161\_Nov13

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Accreditation No.: **SCS 108**

**Glossary:**

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

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

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

**Additional Documentation:**

- d) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

**Measurement Conditions**

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

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz ± 1 MHz	

**Head TSL parameters**

The following parameters and calculations were applied.

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

**SAR result with Head TSL**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.46 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.49 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	1.59 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	6.18 W/kg ± 16.5 % (k=2)

**Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	54.7 ± 6 %	1.01 mho/m ± 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	2.40 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.32 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	1.57 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	6.13 W/kg ± 16.5 % (k=2)

Certificate No: D835V2-4d161\_Nov13

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## Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.9 Ω - 2.4 jΩ
Return Loss	- 27.1 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.7 Ω - 5.1 jΩ
Return Loss	- 24.8 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.425 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 28, 2012

**DASY5 Validation Report for Head TSL**

Date: 01.11.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d161**Communication System: UID 0 - CW ; Frequency: 835 MHz  
Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.94$  S/m;  $\epsilon_r = 40.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.05, 6.05, 6.05); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7)64)

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

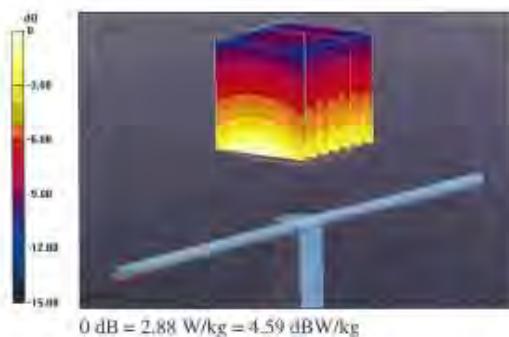
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 56.867 V/m; Power Drift = 0.02 dB

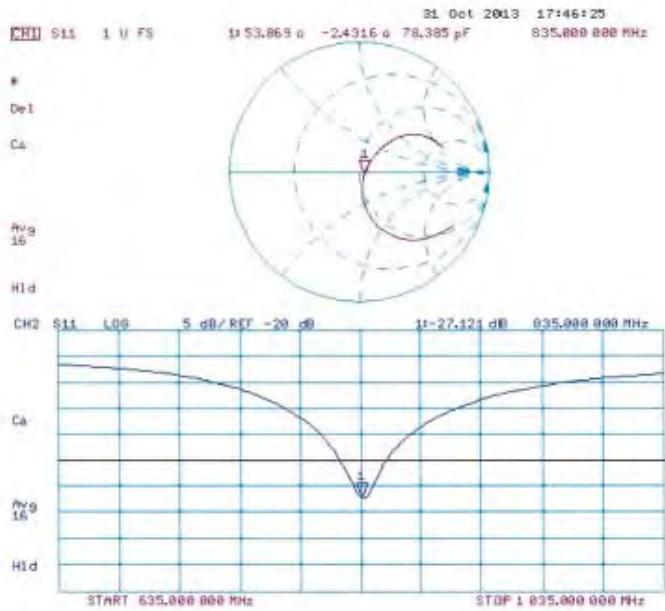
Peak SAR (extrapolated) = 3.75 W/kg

SAR(1 g) = 2.46 W/kg; SAR(10 g) = 1.59 W/kg

Maximum value of SAR (measured) = 2.88 W/kg



## Impedance Measurement Plot for Head TSL



**DASY5 Validation Report for Body TSL**

Date: 01.11.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d161**

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

Medium parameters used:  $\epsilon = 1.007 \text{ S/m}$ ;  $\epsilon_r = 54.7$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.04, 6.04, 6.04); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sa601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

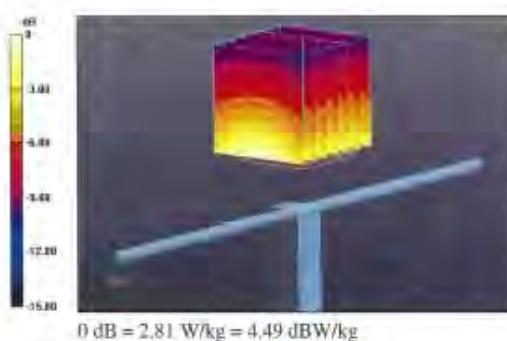
**Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:**Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$ 

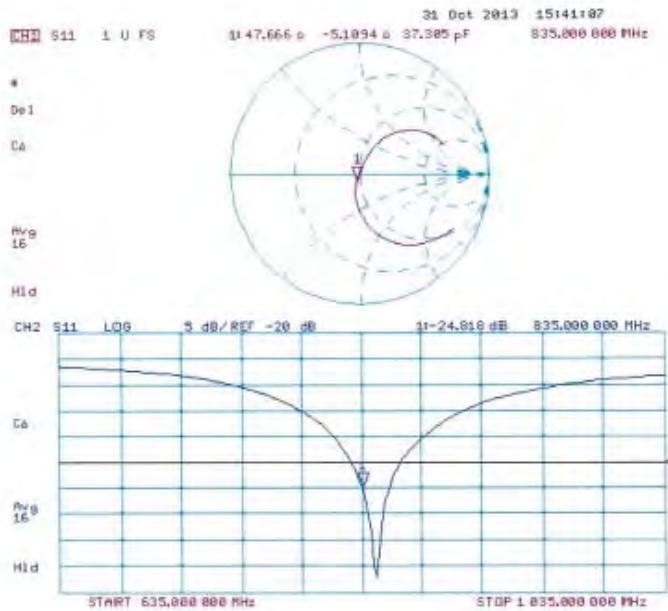
Reference Value = 55.021 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 3.55 W/kg

SAR(1 g) = 2.4 W/kg; SAR(10 g) = 1.57 W/kg

Maximum value of SAR (measured) = 2.81 W/kg



**Impedance Measurement Plot for Body TSL**

Certificate No: D835V2-4d161\_Nov13

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Accreditation No.: SCS 108

Client: SGS-TW (Auden)

Certificate No: D1750V2-1105\_Nov13

**CALIBRATION CERTIFICATE**

Object	D1750V2 - SN: 1105																																		
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz																																		
Calibration date	November 05, 2013																																		
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Calibrated by:	Name: Irena E-Nacev	Function: Laboratory Technician	Signature:																																
Approved by:	Name: Katica Pekovic	Function: Technical Manager	Signature:																																
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Certificate No: D1750V2-1105\_Nov13

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**S** Swiss Calibration Service

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

Accreditation No.: **SCS 108**

**Glossary:**

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

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

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

**Additional Documentation:**

- DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

**Measurement Conditions**

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

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1750 MHz ± 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 ± 0.2) °C	40.0 ± 6 %	1.37 mho/m ± 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	9.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	37.2 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	4.94 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	19.8 W/kg ± 16.5 % (k=2)

**Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.4	1.49 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	53.0 ± 6 %	1.48 mho/m ± 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	9.38 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	37.6 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	5.05 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.2 W/kg ± 16.5 % (k=2)

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## Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.2 Ω - 1.0 jΩ
Return Loss	- 40.3 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.9 Ω - 0.8 jΩ
Return Loss	- 27.2 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.217 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	May 16, 2013

**DASY5 Validation Report for Head TSL**

Date: 04.11.2013

Test Laboratory: SPEAG, Zurich, Switzerland

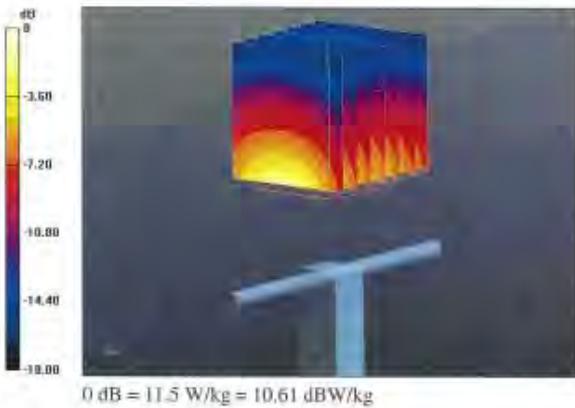
**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1105**Communication System: UID 0 - CW; Frequency: 1750 MHz  
Medium parameters used:  $f = 1750$  MHz;  $\sigma = 1.37$  S/m;  $\epsilon_r = 40$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

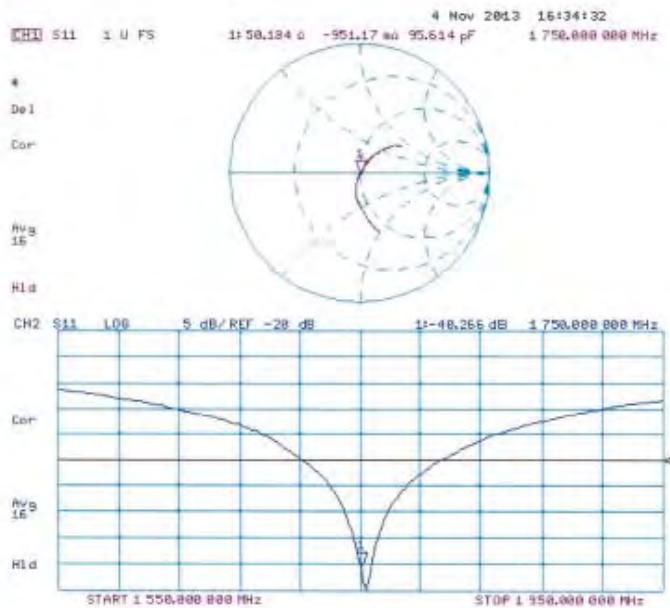
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.18, 5.18, 5.18); Calibrated: 28.12.2012
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:**Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 94.504 V/m; Power Drift = 0,03 dB  
Peak SAR (extrapolated) = 16.9 W/kg  
**SAR(1 g) = 9.31 W/kg; SAR(10 g) = 4.94 W/kg**  
Maximum value of SAR (measured) = 11.5 W/kg

## Impedance Measurement Plot for Head TSL



**DASY5 Validation Report for Body TSL**

Date: 05.11.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1105**Communication System: UID 0 - CW; Frequency: 1750 MHz  
Medium parameters used:  $f = 1750$  MHz;  $\sigma = 1.48$  S/m;  $\epsilon_r = 53$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.83, 4.83, 4.83); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

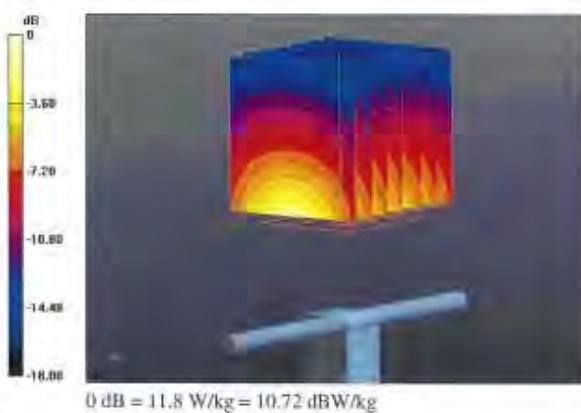
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.113 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 16.1 W/kg

SAR(1 g) = 9.38 W/kg; SAR(10 g) = 5.05 W/kg

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



Certificate No: D1750V2-1105\_Nov13

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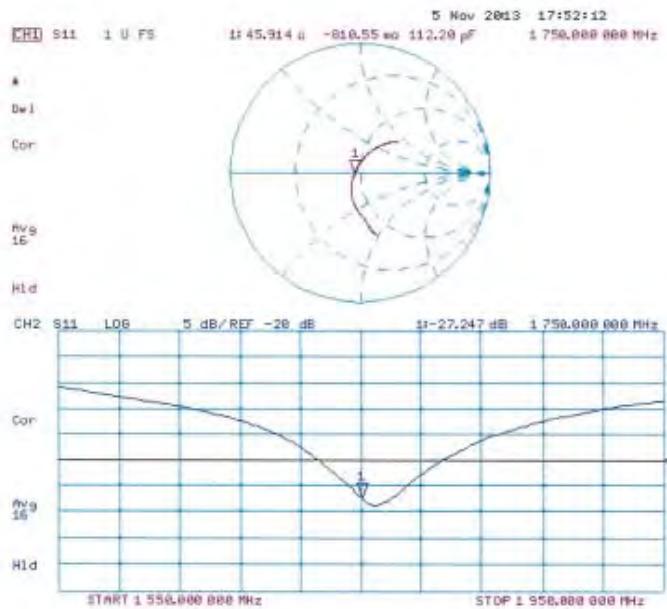
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## Impedance Measurement Plot for Body TSL



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Accreditation No.: SCS 108

Client: Auden

Certificate No: D1900V2-5d142\_Jun13

**CALIBRATION CERTIFICATE**

Object	D1900V2 - SN: 5d142																																														
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz																																														
Calibration date	June 10, 2013																																														
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Calibrated by:	Name: Jelton Kastrali	Function: Laboratory Technician	Signature:																																												
Approved by:	Name: Kaijia Pekovic	Function: Technical Manager	Signature:																																												
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Certificate No: D1900V2-5d142\_Jun13

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**Glossary:**

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

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

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

**Additional Documentation:**

- d) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

**Measurement Conditions**

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

DASY Version	DASY5	V52 E7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz ± 1 MHz	

**Head TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.3 ± 6 %	1.34 mho/m ± 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	9.85 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	40.2 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	5.16 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.0 W/kg ± 16.5 % (k=2)

**Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	53.7 ± 6 %	1.50 mho/m ± 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	10.1 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	40.8 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	5.41 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.8 W/kg ± 16.5 % (k=2)

**Appendix****Antenna Parameters with Head TSL**

Impedance, transformed to feed point	$52.6 \Omega + 5.8 j\Omega$
Return Loss	-24.0 dB

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	$48.0 \Omega + 5.2 j\Omega$
Return Loss	-23.6 dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.199 ms
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

**Additional EUT Data**

Manufactured by	SPEAG
Manufactured on	March 11, 2011

**DASY5 Validation Report for Head TSL**

Date: 10.06.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d142**

Communication System: LID 0 - CW ; Frequency: 1900 MHz  
Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.34$  S/m;  $\epsilon = 39.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

**DASY52 Configuration:**

- Probe: ES3DV3 - SN3205; ConvP(4.98, 4.98, 4.98); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

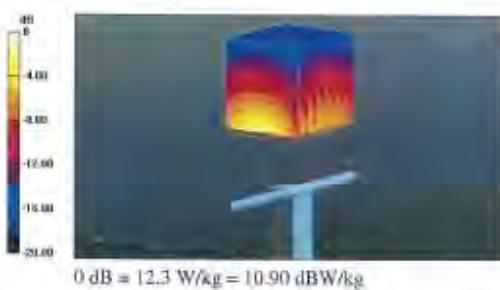
Measurement grid: dx=5mm, dy=5mm, dz=5mm

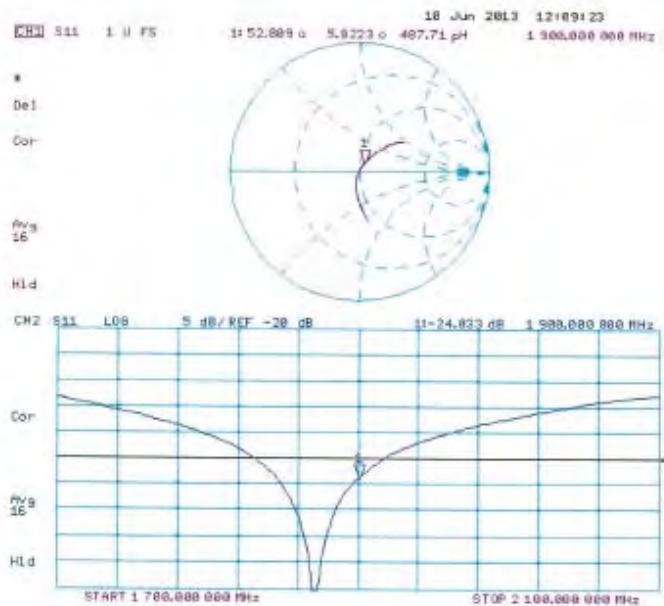
Reference Value = 95.950 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 17.8 W/kg

SAR(1 g) = 9.83 W/kg; SAR(10 g) = 5.18 W/kg

Maximum value of SAR (measured) = 12.3 W/kg



**Impedance Measurement Plot for Head TSL**

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**DASY5 Validation Report for Body TSL**

Date: 10.06.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d142.**Communication System: UID 0 - CW ; Frequency: 1900 MHz  
Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.5$  S/m;  $\epsilon_r = 53.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

**DASY52 Configuration:**

- Probe: ES3DV3 - SN3205; ConvF(4.6, 4.6, 4.6); Calibrated: 28.12.2012.
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601, Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

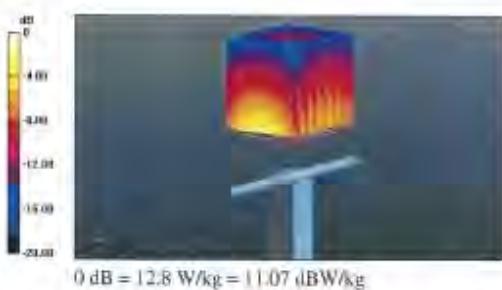
Measurement grid: dx=5mm, dy=5mm, dz=5mm

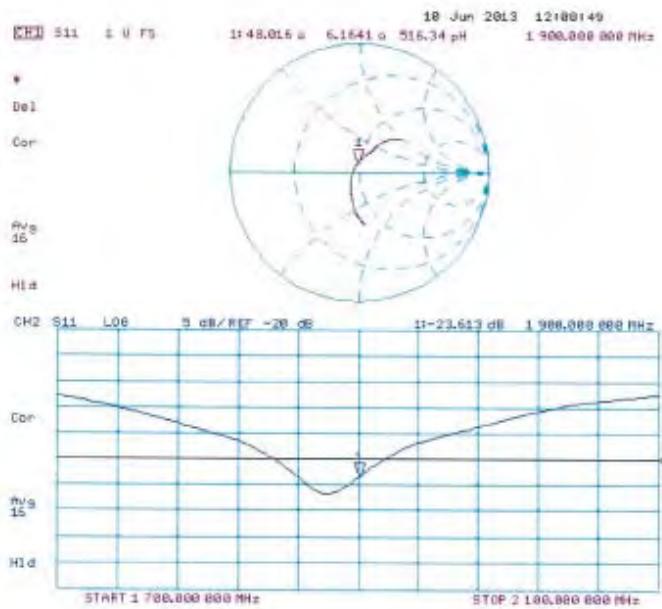
Reference Value = 95.950 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 17.4 W/kg

SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.41 W/kg

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



**Impedance Measurement Plot for Body TSL**

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**End of 1<sup>st</sup> part of report**

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