

## Appendix

### 1. Photographs of Test Setup

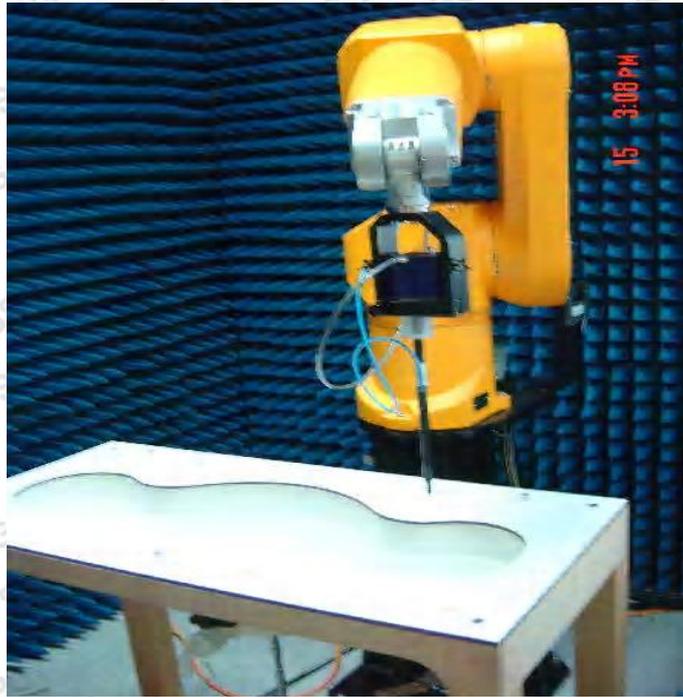


Fig.1 Photograph of the SAR measurement System



Fig.2 Photograph of the Tissue Simulant Fluid Liquid depth 15cm for Body Worn

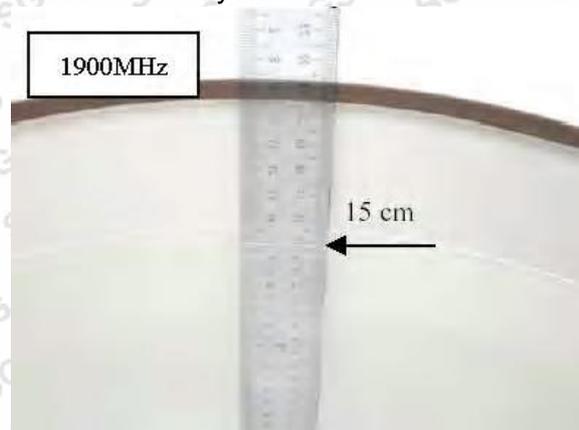
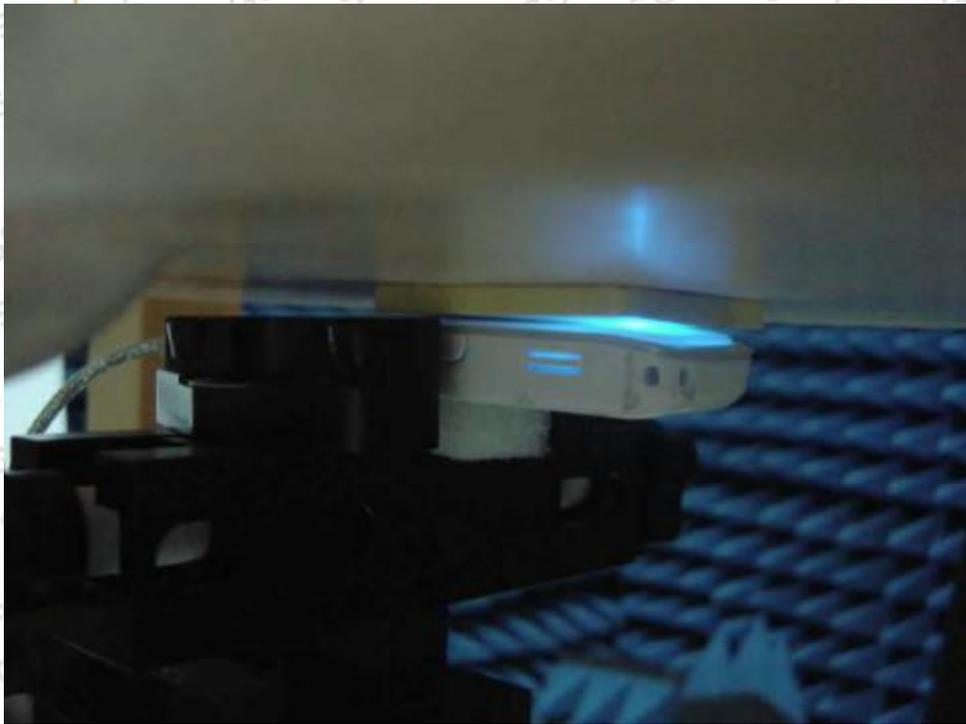
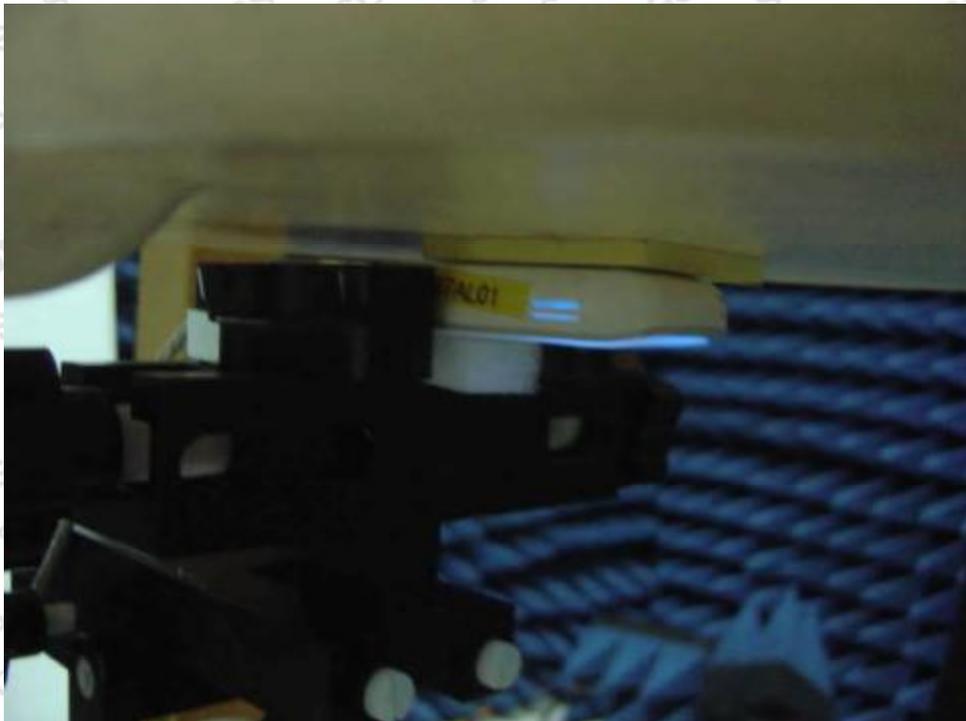


Fig.3 Photograph of the Tissue Simulant Fluid Liquid depth 15cm for Body Worn

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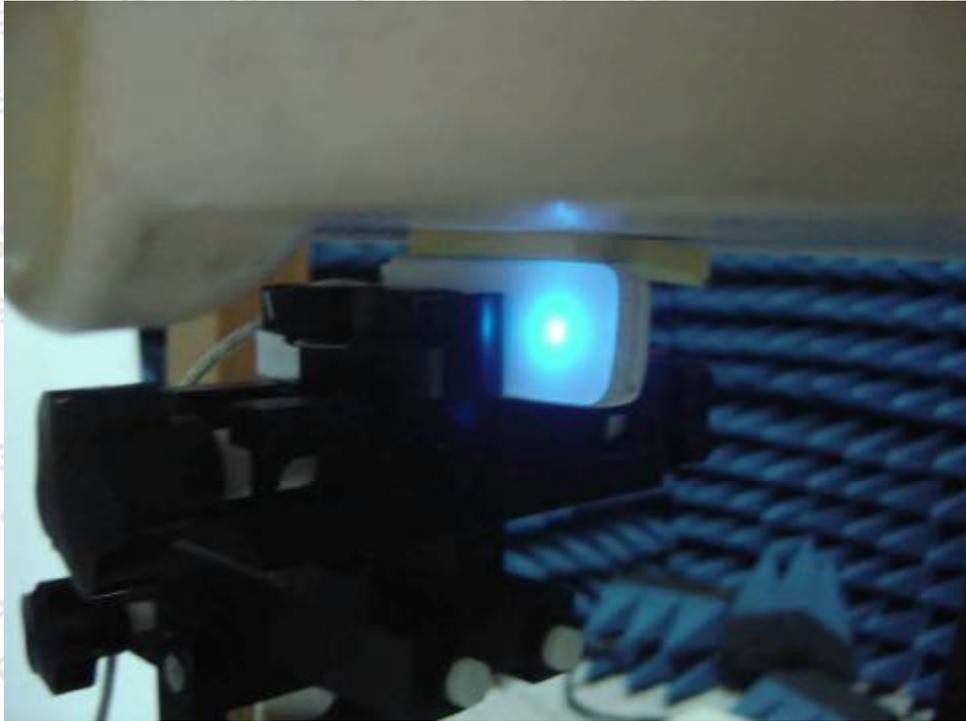


P1



P2

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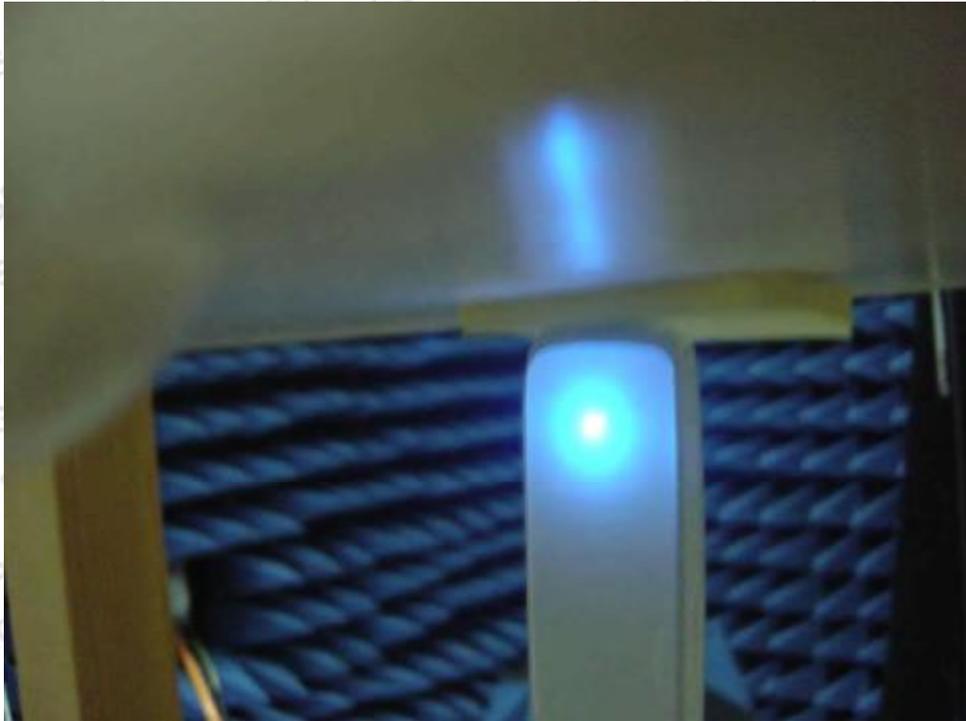


P3



P4

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P5

Fig.4 Photograph of the BodyWorn status(P1~P5)  
 (The separator was removed when performing all the tests)

## 2. Photographs of the EUT



Fig.5 Photograph of the EUT

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### 3. Probe Calibration certificate

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



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 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 China (Auden)**

Certificate No: **ES3-3088\_Jan08**

#### CALIBRATION CERTIFICATE

Object: **ES3DV3 - SN:3088**

Calibration procedure(s): **QA CAL 01.06  
 Calibration procedure for dosimetric E-field probes**

Calibration date: **January 18, 2008**

Condition of the calibrated item: **In Tolerance**

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&E critical for calibration):

Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter E4415B	GB41293874	28-Mar-07 (METAS, No. 217-00570)	Mar-08
Power sensor E4412A	MY41495277	28-Mar-07 (METAS, No. 217-00570)	Mar-08
Power sensor E4412A	MY41493087	28-Mar-07 (METAS, No. 217-00570)	Mar-08
Reference 3 dB Attenuator	SN: S5054 (3c)	8-Aug-07 (METAS, No. 217-00719)	Aug-08
Reference 20 dB Attenuator	SN: S5056 (20a)	28-Mar-07 (METAS, No. 217-00571)	Mar-08
Reference 30 dB Attenuator	SN: E5129 (30a)	8-Aug-07 (METAS, No. 217-00720)	Aug-08
Reference Probe ES3DV2	SN: 3073	2-Jan-08 (SPEAG, No. ES3-3013_Jan08)	Jan-08
DAE4	SN: 854	20-Apr-07 (SPEAG, No. DAE4-054_Apr07)	Apr-08

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator HP 8649C	US3642U01703	4-Aug-08 (SPEAG, in house check Oct-07)	In house check: Oct-08
Network Analyzer HP 8753E	US37390585	18-Oct-01 (SPEAG, in house check Oct-07)	In house check: Oct-08

Created by: **Kolja Pokovic** (Name), **Technical Manager** (Function), [Signature]

Approved by: **Maria Kusler** (Name), **Quality Manager** (Function), [Signature]

Issued: January 18, 2008

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Certificate No: ES3-3088\_Jan08

Page 1 of 9

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SHGSM

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 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

**Glossary:**

TSL tissue simulating liquid  
 NORM<sub>x,y,z</sub> sensitivity in free space  
 Conf sensitivity in TSL / NORM<sub>x,y,z</sub>  
 DCP diode compression point  
 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:**

- 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

**Methods Applied and Interpretation of Parameters:**

- **NORM<sub>x,y,z</sub>:** Assessed for E-field polarization  $\theta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not effect the E<sup>2</sup>-field uncertainty inside TSL (see below *ConfF*).
- **NORM(f)<sub>x,y,z</sub> = NORM<sub>x,y,z</sub> \* frequency\_response** (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConfF*.
- **DCP<sub>x,y,z</sub>:** DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- **ConfF and Boundary Effect Parameters:** Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800$  MHz) and inside waveguide using analytical field distributions based on power measurements for  $f > 800$  MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to **NORM<sub>x,y,z</sub> \* ConfF** whereby the uncertainty corresponds to that given for *ConfF*. A frequency dependent *ConfF* 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.

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**SHGSM**

ES3DV3 SN:3088

January 18, 2008

# Probe ES3DV3

## SN:3088

Manufactured:	July 20, 2005
Last calibrated:	December 12, 2006
Recalibrated:	January 18, 2008

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

Certificate No: ES3-0088\_Jan08

Page 3 of 3

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ES3DV3 SN:3088

January 18, 2008

**DASY - Parameters of Probe: ES3DV3 SN:3088**

Sensitivity in Free Space<sup>A</sup>

NormX	1.31 ± 10.1%	$\mu\text{V}/(\text{V}/\text{m})^2$
NormY	1.26 ± 10.1%	$\mu\text{V}/(\text{V}/\text{m})^2$
NormZ	1.24 ± 10.1%	$\mu\text{V}/(\text{V}/\text{m})^2$

Diode Compression<sup>B</sup>

DCP X	92 mV
DCP Y	93 mV
DCP Z	93 mV

Sensitivity in Tissue Simulating Liquid (Conversion Factors)

Please see Page 3.

Boundary Effect

TSL	900 MHz	Typical SAR gradient: 5 % per mm
Sensor Center to Phantom Surface Distance	3.0 mm	4.0 mm
SAR <sub>90</sub> [%]	Without Correction Algorithm	11.0 6.8
SAR <sub>90</sub> [%]	With Correction Algorithm	0.9 0.4

TSL	1750 MHz	Typical SAR gradient: 10 % per mm
Sensor Center to Phantom Surface Distance	3.0 mm	4.0 mm
SAR <sub>90</sub> [%]	Without Correction Algorithm	9.6 5.1
SAR <sub>90</sub> [%]	With Correction Algorithm	0.7 0.3

Sensor Offset

Probe Tip to Sensor Center	2.0 mm
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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 NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Page 8)

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

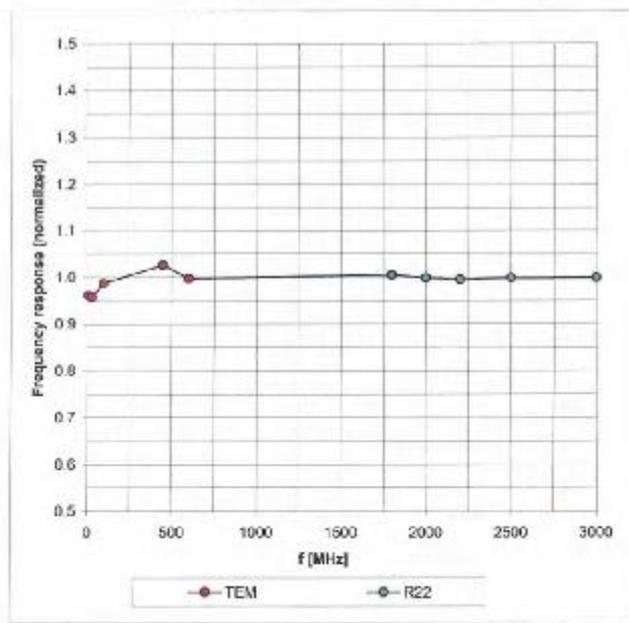
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ES3DV3 SN:3088

January 18, 2008

### Frequency Response of E-Field

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



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

Certificate No: ES3-3088\_Jan08

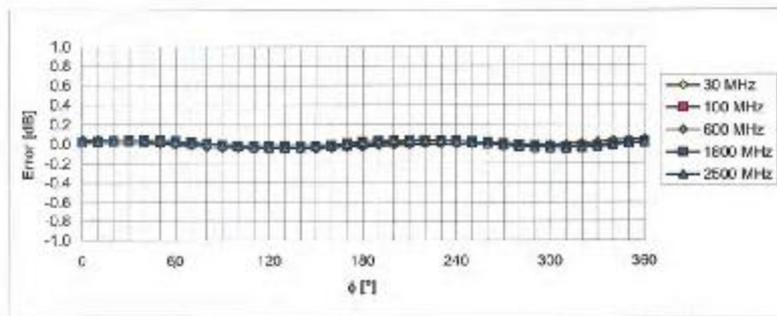
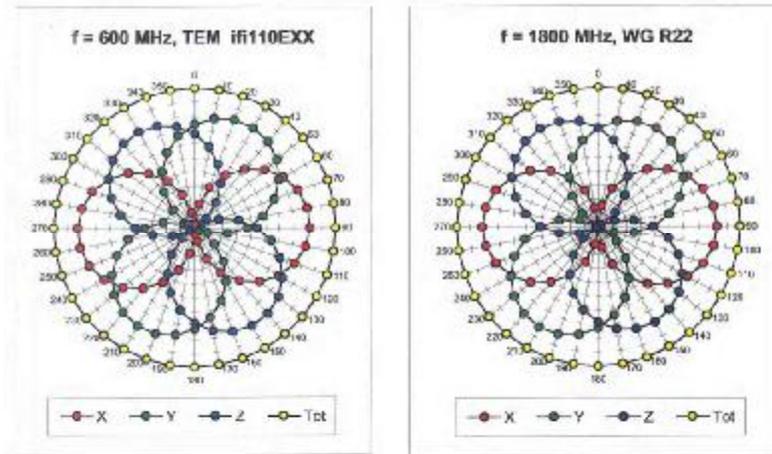
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ES3DV3 SN:3088

January 18, 2008

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



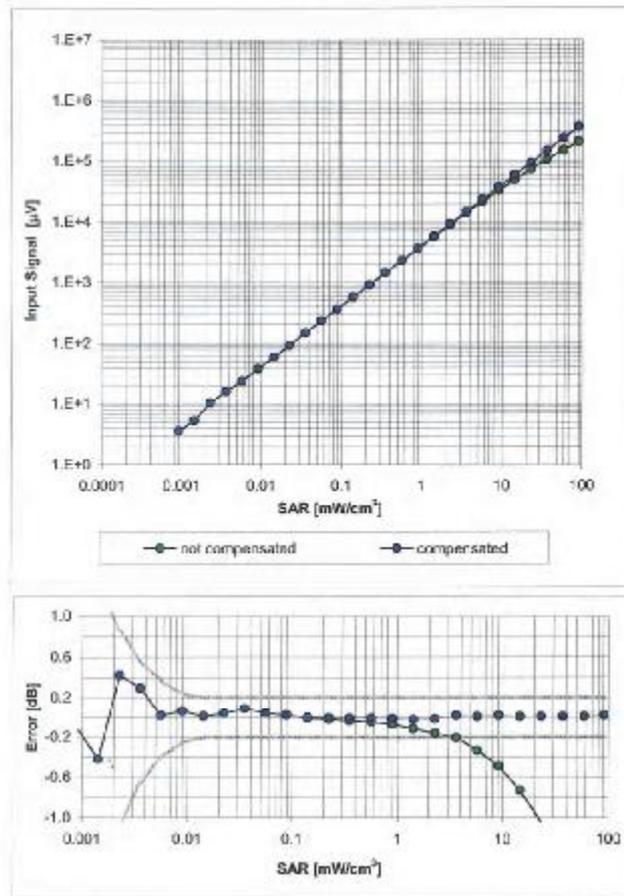
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)

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January 18, 2008

## Dynamic Range f(SAR<sub>head</sub>) (Waveguide R22, f = 1800 MHz)



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

Certificate No: ES3-3C88\_Jan08

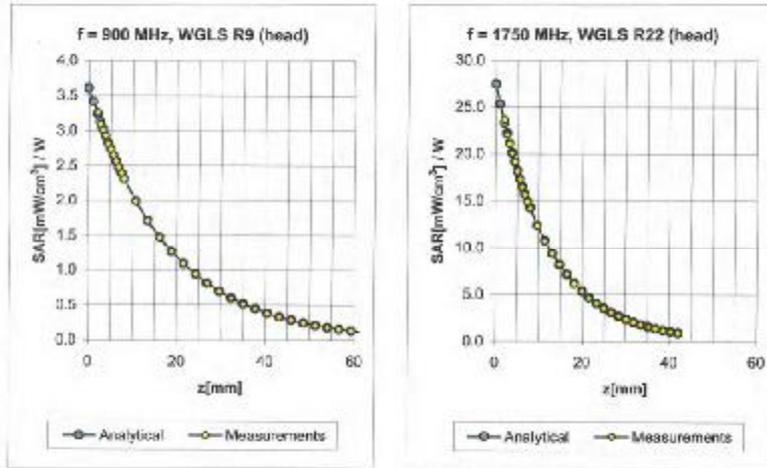
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ES3DV3 SN:3088

January 18, 2008

### Conversion Factor Assessment



f [MHz]	Validity [MHz] <sup>c</sup>	TSL	Permittivity	Conductivity	Alpha	Depth	ConvF Uncertainty
900	± 50 / ± 100	Head	41.5 ± 5%	0.97 ± 5%	0.90	1.23	6.15 ± 11.0% (k=2)
1750	± 50 / ± 100	Head	40.1 ± 5%	1.37 ± 5%	0.93	1.18	5.04 ± 11.0% (k=2)
1950	± 50 / ± 100	Head	40.0 ± 5%	1.40 ± 5%	0.73	1.35	4.84 ± 11.0% (k=2)
2450	± 50 / ± 100	Head	39.2 ± 5%	1.80 ± 5%	0.70	1.39	4.53 ± 11.8% (k=2)
900	± 50 / ± 100	Body	55.0 ± 5%	1.05 ± 5%	0.95	1.14	5.81 ± 11.0% (k=2)
1750	± 50 / ± 100	Body	53.4 ± 5%	1.49 ± 5%	0.90	1.17	4.92 ± 11.0% (k=2)
1950	± 50 / ± 100	Body	53.3 ± 5%	1.52 ± 5%	0.84	1.23	4.60 ± 11.0% (k=2)
2450	± 50 / ± 100	Body	52.7 ± 5%	1.95 ± 5%	0.84	1.17	4.13 ± 11.8% (k=2)

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

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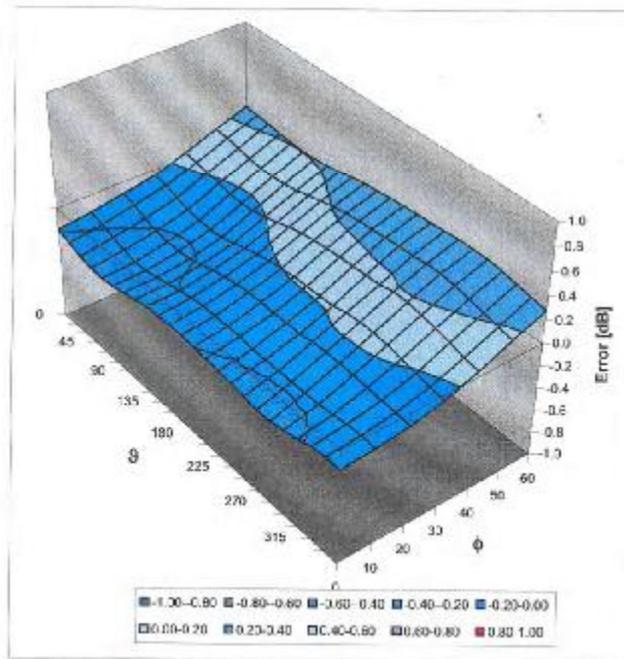
**SHGSM**

ES3DV3 SN:3088

January 18, 2008

## Deviation from Isotropy in HSL\*\*

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



Uncertainty of Spherical Isotropy Assessment:  $\pm 2.6\%$  ( $k=2$ )

Certificate No. ES3-3088\_Jan08

Page 9 of 9

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Accreditation No.: SCS 108

Client **SGS - CSTC (MTT)**

Certificate No: **DAE3-569\_Nov07**

### CALIBRATION CERTIFICATE

Object: **DAE3 - SD 000 D03 AA - SN: 569**

Calibration procedure(s): **QA CAL-06 v12  
 Calibration procedure for the data acquisition electronics (DAE)**

Calibration date: **November 19, 2007**

Condition of the calibrated item: **In Tolerance**

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 (Calibrated by, Certificate No.)	Scheduled Calibration
Fluke Process Calibrator Type 702	SN: 6258303	04-Oct-07 (Eikal AG, No: 6467)	Oct-08
Kathley Multimeter Type 2001	SN: 0310278	03-Oct-07 (Eikal AG, No: 6465)	Oct-08
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Calibrator Box V1.1	SE UMS 006 AB 1004	25-Jun-07 (SPEAG, in house check)	In house check Jun-08

Calibrated by:	Name: Dominique Steffen	Function: Technicien	Signature: 
Approved by:	Name: Fin Bornholdt	Function: R&D Director	Signature: 

Issued: November 19, 2007

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Certificate No: DAE3-569\_Nov07

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 Shanghai Branch GSM Laboratory

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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 +10% and -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:** 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.

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**DC Voltage Measurement**

A/D - Converter Resolution nominal  
 High Range: 1LSB = 6.1 $\mu$ V, full range = -100...+300 mV  
 Low Range: 1LSB = 61nV, full range = -1.....+3mV  
 DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	404.776 $\pm$ 0.1% (k=2)	404.362 $\pm$ 0.1% (k=2)	404.137 $\pm$ 0.1% (k=2)
Low Range	3.94862 $\pm$ 0.7% (k=2)	3.94274 $\pm$ 0.7% (k=2)	3.94290 $\pm$ 0.7% (k=2)

**Connector Angle**

Connector Angle to be used in DASY system	265 $\pm$ 1 $^\circ$
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**Appendix**

**1. DC Voltage Linearity**

High Range	Input ( $\mu\text{V}$ )	Reading ( $\mu\text{V}$ )	Error (%)
Channel X + Input	20000	19999.4	0.00
Channel X + Input	20000	20003.10	0.02
Channel X - Input	20000	-19996.40	-0.01
Channel Y + Input	20000	19999.8	0.00
Channel Y + Input	20000	20000.56	0.00
Channel Y - Input	20000	-20003.76	0.02
Channel Z + Input	20000	19999.7	0.00
Channel Z + Input	20000	19999.91	0.00
Channel Z - Input	20000	-20001.93	0.01

Low Range	Input ( $\mu\text{V}$ )	Reading ( $\mu\text{V}$ )	Error (%)
Channel X + Input	2000	2000	0.00
Channel X + Input	200	199.91	-0.05
Channel X - Input	200	-200.13	0.06
Channel Y + Input	2000	2000	0.00
Channel Y + Input	200	198.90	-0.55
Channel Y - Input	200	-200.33	0.17
Channel Z + Input	2000	2000	0.00
Channel Z + Input	200	198.87	-0.56
Channel Z - Input	200	-200.97	0.48

**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 ( $\mu\text{V}$ )	Low Range Average Reading ( $\mu\text{V}$ )
Channel X	200	-5.51	-5.11
	-200	9.14	5.16
Channel Y	200	7.38	7.24
	-200	-8.13	-8.74
Channel Z	200	-5.41	-5.65
	-200	4.60	4.15

**3. Channel separation**

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

	Input Voltage (mV)	Channel X ( $\mu\text{V}$ )	Channel Y ( $\mu\text{V}$ )	Channel Z ( $\mu\text{V}$ )
Channel X	200	-	1.82	0.97
Channel Y	200	0.44	-	3.38
Channel Z	200	-0.57	-0.43	-

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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	16396	15475
Channel Y	15747	16647
Channel Z	16314	16212

**5. Input Offset Measurement**

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

Input 10M $\Omega$

	Average ( $\mu$ V)	min. Offset ( $\mu$ V)	max. Offset ( $\mu$ V)	Std. Deviation ( $\mu$ V)
Channel X	-0.02	-0.85	1.22	0.32
Channel Y	-0.62	-1.53	0.45	0.30
Channel Z	-0.95	-2.89	-0.14	0.35

**6. Input Offset Current**

Nominal Input circuitry offset current on all channels: <25fA

**7. Input Resistance**

	Zeroing (M $\Omega$ )	Measuring (M $\Omega$ )
Channel X	0.2000	199.3
Channel Y	0.2000	203.2
Channel Z	0.2001	204.8

**8. Low Battery Alarm Voltage** (verified during pre test)

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

**9. Power Consumption** (verified during pre test)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.0	+6	+14
Supply (- Vcc)	-0.01	-8	-9

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## 7. Dipole Calibration certification

**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 China (Auden)**

Certificate No. **D900V2-184\_Dec07**

CALIBRATION CERTIFICATE			
Object	D900V2 - SN: 184		
Calibration procedure(s)	QA CAL-05 v7 Calibration procedure for dipole validation kits		
Calibration date:	December 21, 2007		
Condition of the calibrated item	In Tolerance		
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)			
<b>Primary Standards</b>	<b>ID #</b>	<b>Cal Date (Calibrated by, Certificate No.)</b>	<b>Scheduled Calibration</b>
Power meter EPM-442A	GB37460704	04-Oct-07 (METAS, No. 217-00735)	Oct-08
Power sensor HP 8481A	US37292733	04-Oct-07 (METAS, No. 217-00735)	Oct-08
Reference 20 dB Attenuator	SN: 5098 (20g)	07-Aug-07 (METAS, No. 217-00718)	Aug-08
Reference 10 dB Attenuator	SN: 5047.2 (10r)	07-Aug-07 (METAS, No. 217-00718)	Aug-08
Reference Probe ET3DVB (HF)	SN 1307	23-Oct-07 (SPEAG, No. ET3-1007_Oct07)	Oct-08
DVE4	SN 601	30-Jan-07 (SPEAG, No. DVE4-601_Jan07)	Jan-08
<b>Secondary Standards</b>	<b>ID #</b>	<b>Check Date (in house)</b>	<b>Scheduled Check</b>
Power sensor HP 8481A	MY410E2317	18-Oct-02 (SPEAG, in house check Oct-07)	In house check: Oct-09
RF generator R&S SMT-05	100005	4-Aug-99 (SPEAG, in house check Oct-07)	In house check: Oct-09
Network Analyzer HP 8753E	US3739C635 S4206	18-Oct-01 (SPEAG, in house check Oct-07)	In house check: Oct-06
Calibrated by:	Name: <b>Miro Nef</b>	Function: <b>Laboratory Technician</b>	Signature:
Approved by:	Name: <b>Katja Pokovic</b>	Function: <b>Technical Manager</b>	Signature:
			issued: December 21, 2007
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

Certificate No: D900V2-184\_Dec07

Page 1 of 9

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**SHGSM**

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

Accreditation No.: SCS 108

**Glossary:**

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

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

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

**Additional Documentation:**

- d) DASY4 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.

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**Measurement Conditions**

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

DASY Version	DASY4	V4.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V4.9	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	900 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	0.97 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	42.5 ± 6 %	0.98 mho/m ± 6 %
Head TSL temperature during test	(22.1 ± 0.2) °C	----	----

**SAR result with Head TSL**

SAR averaged over 1 cm <sup>2</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.73 mW / g
SAR normalized	normalized to 1W	10.9 mW / g
SAR for nominal Head TSL parameters <sup>†</sup>	normalized to 1W	11.0 mW / g ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>2</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.75 mW / g
SAR normalized	normalized to 1W	7.00 mW / g
SAR for nominal Head TSL parameters <sup>†</sup>	normalized to 1W	7.05 mW / g ± 16.5 % (k=2)

<sup>†</sup> Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities"

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**Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.0	1.05 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	54.2 ± 6 %	1.06 mho/m ± 6 %
Body TSL temperature during test	(22.6 ± 0.2) °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	2.90 mW / g
SAR normalized	normalized to 1W	11.6 mW / g
SAR for nominal Body TSL parameters <sup>2</sup>	normalized to 1W	11.4 mW / g ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.87 mW / g
SAR normalized	normalized to 1W	7.48 mW / g
SAR for nominal Body TSL parameters <sup>2</sup>	normalized to 1W	7.40 mW / g ± 16.5 % (k=2)

<sup>2</sup> Correction to nominal TSL parameters according to 2), chapter "SAR Sensitivities"

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**Appendix**

**Antenna Parameters with Head TSL**

Impedance, transformed to feed point	40.8 Ω - 7.5 jΩ
Return Loss	- 22.3 dB

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	45.3 Ω - 9.4 jΩ
Return Loss	- 19.1 dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.411 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.

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	April 1, 2003

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**DASY4 Validation Report for Head TSL**

Date/Time: 21.12.2007 14:51:24

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN:184**

Communication System: CW; Frequency: 900 MHz; Duty Cycle: 1:1

Medium: HSL 900 MHz;

Medium parameters used:  $f = 900 \text{ MHz}$ ;  $\sigma = 0.98 \text{ mho/m}$ ;  $\epsilon_r = 42.5$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

**DASY4 Configuration:**

- Probe: ET3DV6 - SN1507 (HF); ConvF(5.93, 5.93, 5.93); Calibrated: 26.10.2007
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.01.2007
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA
- Measurement SW: DASY4, V4.7 Build 55; Postprocessing SW: SEMCAD, V1.8 Build 172

**Pin = 250 mW; d = 15 mm/Zoom Scan (7x7x7)/Cube 0:**

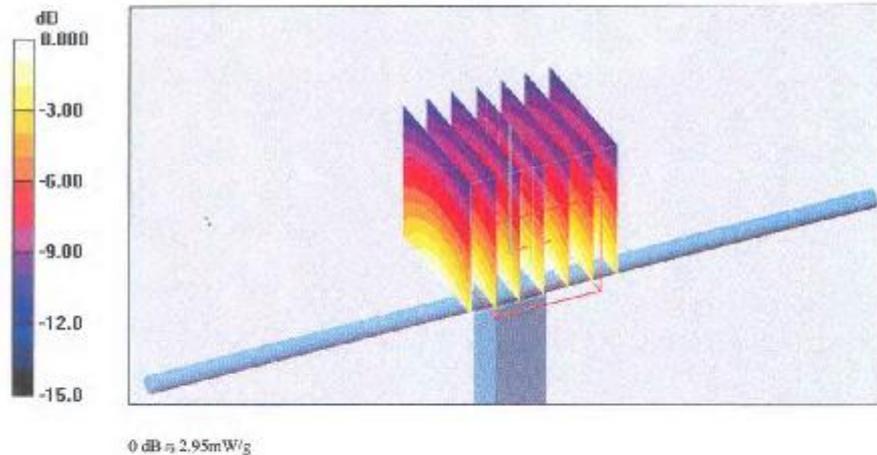
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 56.9 V/m; Power Drift = -0.012 dB

Peak SAR (extrapolated) = 4.06 W/kg

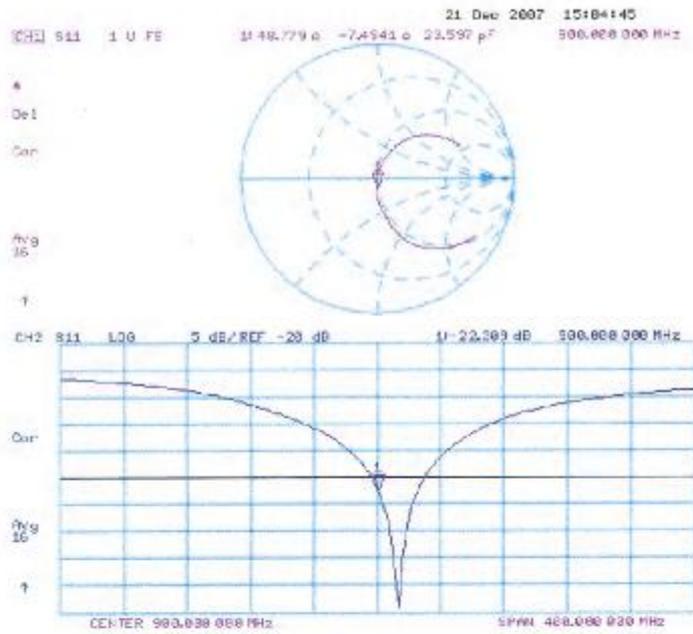
**SAR(1 g) = 2.73 mW/g; SAR(10 g) = 1.75 mW/g**

Maximum value of SAR (measured) = 2.95 mW/g



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### Impedance Measurement Plot for Head TSL



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**DASY4 Validation Report for Body TSL**

Date/Time: 21.12.2007 15:46:31

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN:184**

Communication System: CW; Frequency: 900 MHz; Duty Cycle: 1:1

Medium: MSL900;

Medium parameters used:  $f = 900$  MHz;  $\sigma = 1.06$  mho/m;  $\epsilon_r = 54.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

**DASY4 Configuration:**

- Probe: ET3DV6 - SN1507 (HF); ConvP(3.57, 5.57, 5.57); Calibrated: 26.10.2007
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 S8601; Calibrated: 30.01.2007
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA
- Measurement SW: DASY4, V4.7 Build 55; Postprocessing SW: SEMCAD, V1.8 Build 172

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

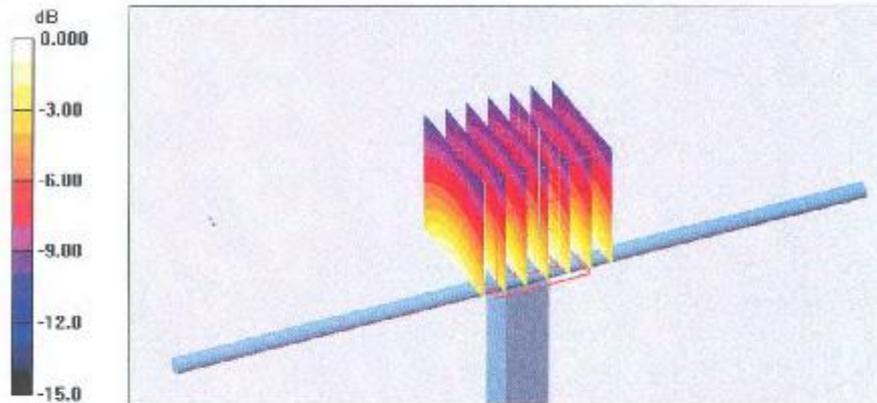
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 56.9 V/m; Power Drift = 0.008 dB

Peak SAR (extrapolated) = 4.23 W/kg

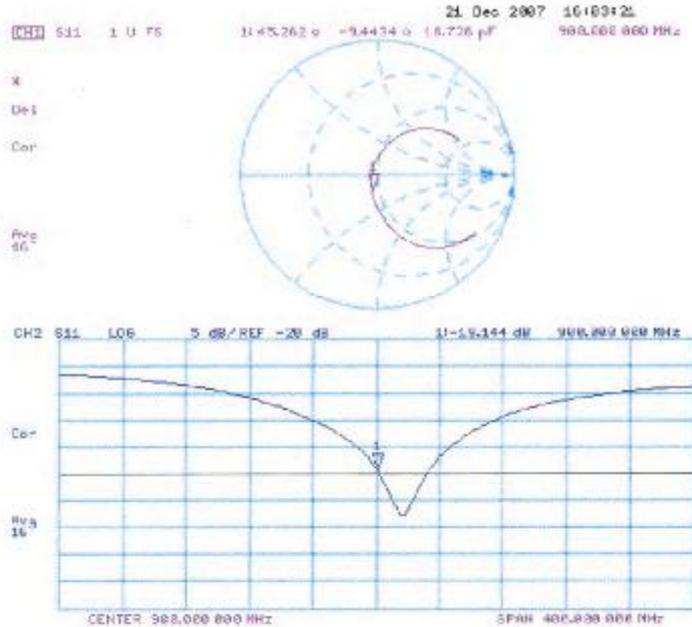
SAR(1 g) = 2.9 mW/g; SAR(10 g) = 1.87 mW/g

Maximum value of SAR (measured) = 3.16 mW/g



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### Impedance Measurement Plot for Body TSL



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 Zeughausstrasse 43, 8004 Zurich, Switzerland



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 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 Chins (Audent)**

Certificate No: **D1900V2-5d028\_Dec07**

## CALIBRATION CERTIFICATE

Object: **D1900V2 - SN: 5d028**

Calibration procedure(s): **QA\_CAL-05.v7  
 Calibration procedure for dipole validation kits**

Calibration date: **December 21, 2007**

Condition of the calibrated item: **In Tolerance**

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 (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GG37460704	04-Oct-07 (METAS, No. 217-00736)	Oct-08
Power sensor HP 8481A	US37292733	04-Oct-07 (METAS, No. 217-00736)	Oct-08
Reference 20 dB Attenuator	SN: 5096 (20g)	07-Aug-07 (METAS, No. 217-00718)	Aug-08
Reference 10 dB Attenuator	SN: 5047.2 (10r)	07-Aug-07 (METAS, No. 217-00718)	Aug-08
Reference Probe ET3DVB (HF)	SN: 1537	28-Oct-07 (SPEAG, No. ET3-1507_Grd07)	Oct-08
DAE4	SN 631	30-Jan-07 (SPEAG, No. DAE4-601_Jan07)	Jan-08
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41069317	18-Oct-02 (SPEAG, in house check Oct-07)	In house check: Oct-08
RF generator R&S SMT-06	100035	4-Aug-98 (SPEAG, in house check Oct-07)	In house check: Oct-09
Network Analyzer HP 8753E	US37390595 S4206	18-Oct-01 (SPEAG, in house check Oct-07)	In house check: Oct-08

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

Issued: December 31, 2007

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

Certificate No: D1900V2-5d028\_Dec07

Page 1 of 9

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**SHGSM**

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Accreditation No.: SCS 108

**Glossary:**

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

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

- 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 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.

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**SHGSM**

**Measurement Conditions**

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

DASY Version	DASY4	V4.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
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	39.0 ± 6 %	1.46 mho/m ± 6 %
Head TSL temperature during test	(21.5 ± 0.2) °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	9.82 mW / g
SAR normalized	normalized to 1W	39.3 mW / g
SAR for nominal Head TSL parameters <sup>1</sup>	normalized to 1W	37.9 mW / g ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	5.14 mW / g
SAR normalized	normalized to 1W	20.6 mW / g
SAR for nominal Head TSL parameters <sup>1</sup>	normalized to 1W	20.2 mW / g ± 16.5 % (k=2)

<sup>1</sup> Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities"

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**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	53.5 ± 6 %	1.54 mho/m ± 6 %
Body TSL temperature during test	(21.5 ± 0.2) °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	9.34 mW / g
SAR normalized	normalized to 1W	37.4 mW / g
SAR for nominal Body TSL parameters <sup>2</sup>	normalized to 1W	<b>37.2 mW / g ± 17.0 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	4.97 mW / g
SAR normalized	normalized to 1W	19.9 mW / g
SAR for nominal Body TSL parameters <sup>2</sup>	normalized to 1W	<b>19.8 mW / g ± 16.5 % (k=2)</b>

<sup>2</sup> Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities"

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**Appendix**

**Antenna Parameters with Head TSL**

Impedance, transformed to feed point	53.7 Ω + 5.2 jΩ
Return Loss	- 24.3 dB

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	49.5 Ω + 3.4 jΩ
Return Loss	- 29.1 dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.198 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.  
 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 17, 2002

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**DASY4 Validation Report for Head TSL**

Date/Time: 21.12.2007 09:54:50

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d028**

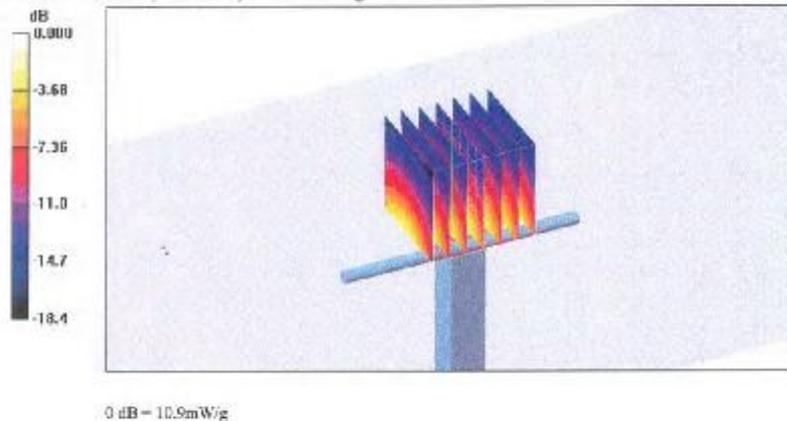
Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1  
 Medium: HSL U10 BB;  
 Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.46$  mho/m;  $\epsilon_r = 39$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section  
 Measurement Standard: DASY4 (High Precision Assessment)

**DASY4 Configuration:**

- Probe: ET3DV6 - SN1507 (HF); ConvF(4.86, 4.86, 4.86); Calibrated: 26.10.2007
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sx601; Calibrated: 30.01.2007
- Phantom: Flat Phantom 5.0 (front); Type: QD000F50AA; ;
- Measurement SW: DASY4, V4.7 Build 55; Postprocessing SW: SEMCAD, V1.8 Build 172

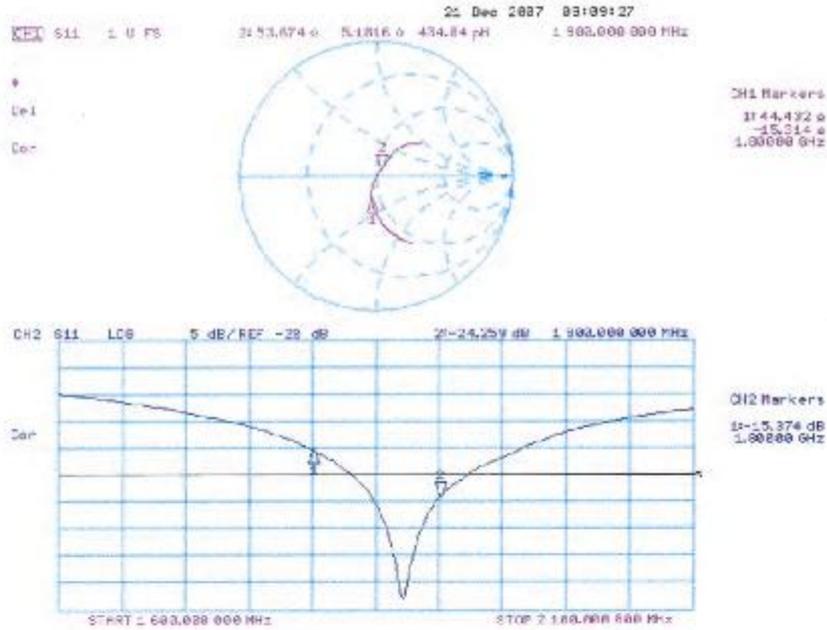
**Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0:**

Measurement grid: dx=5mm, dy=5mm, dz=5mm  
 Reference Value = 89.9 V/m; Power Drift = 0.010 dB  
 Peak SAR (extrapolated) = 17.2 W/kg  
**SAR(1 g) = 9.82 mW/g; SAR(10 g) = 5.14 mW/g**  
 Maximum value of SAR (measured) = 10.9 mW/g



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### Impedance Measurement Plot for Head TSL



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**DASY4 Validation Report for Body TSL**

Date/Time: 21.12.2007 11:05:06

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d028**

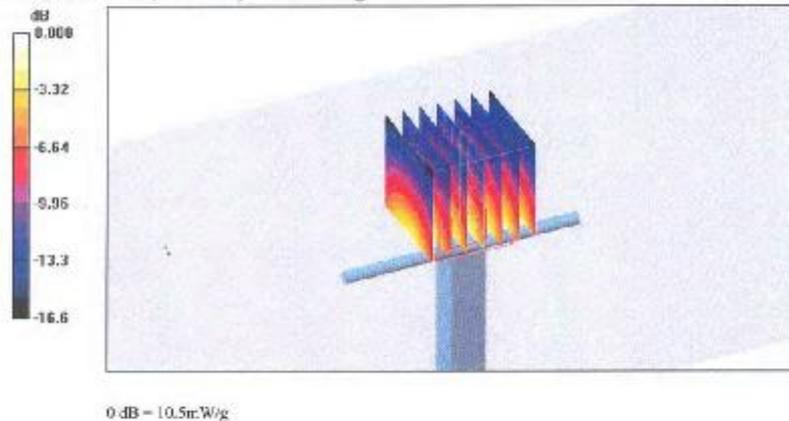
Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1  
 Medium: MSL U10 BB;  
 Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.54$  mho/m;  $\epsilon_r = 53.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section  
 Measurement Standard: DASY4 (High Precision Assessment)

**DASY4 Configuration:**

- Probe: ET3DV6 - SN1507 (HF); ConvF(4.48, 4.48, 4.48); Calibrated: 26.10.2007
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.01.2007
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA;
- Measurement SW: DASY4, V4.7 Build 55; Postprocessing SW: SEMCAD, V1.8 Build 172

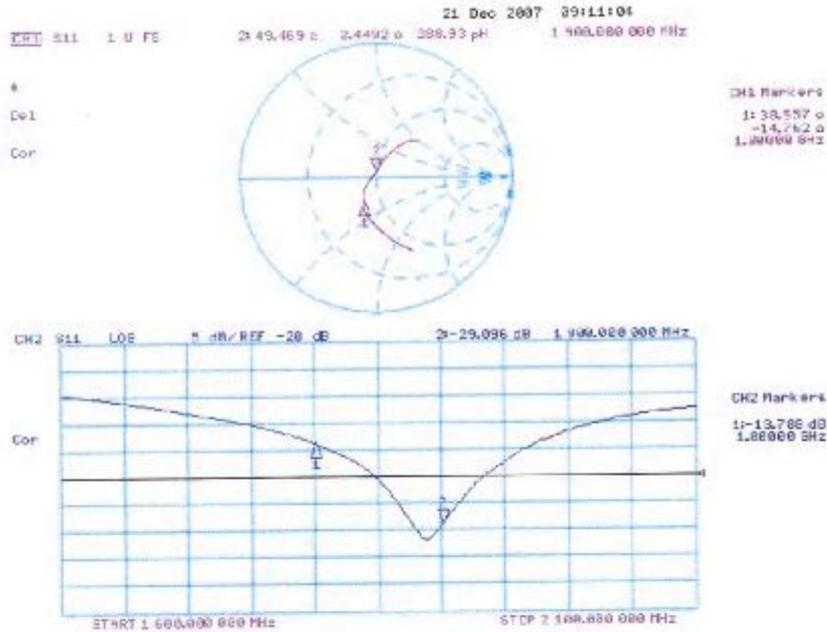
**Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0:**

Measurement grid: dx=5mm, dy=5mm, dz=5mm  
 Reference Value = 89.3 V/m; Power Drift = -0.044 dB  
 Peak SAR (extrapolated) = 16.0 W/kg  
**SAR(1 g) = 9.34 mW/g; SAR(10 g) = 4.97 mW/g**  
 Maximum value of SAR (measured) = 10.5 mW/g



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## Impedance Measurement Plot for Body TSL



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## 8. Uncertainty analysis

### Measurement uncertainty

a	b	c	d	e = f(d,k)	f	g	h = cxf/e	i = cxg/e	k
Uncertainty Component	Clause	(%)	Prob. Dist.	Div.	Ci (1g)	Ci (10g)	1g ui (%)	10g ui (%)	Vi (Veff)
Probe calibration	E.2.1	6.3	N	1	1	1	6.3	6.3	∞
Axial isotropy	E.2.2	0.5	R	2	$(1-C)^{1/2}$	$(1-C)^{1/2}$	0.18	0.18	∞
hemispherical isotropy	E.2.2	2.6	R	2	$\frac{1-C}{\sqrt{C}}$	$\frac{1-C}{\sqrt{C}}$	0.92	0.92	∞
Boundary effect	E.2.3	0.8	R	$\sqrt{3}$	1	1	0.46	0.46	∞
Linearity	E.2.4	0.6	R	2	1	1	0.3	0.3	∞
System detection limit	E.2.5	1.0	R	$\sqrt{3}$	1	1	0.58	0.58	∞
Readout electronics	E.2.6	0.3	N	1	1	1	0.3	0.3	∞
Response time	E.2.7	0	R	$\sqrt{3}$	1	1	0.00	0.00	∞
Integration time	E.2.8	2.6	R	$\sqrt{3}$	1	1	1.50	1.50	∞
RF ambient Condition -Noise	E.6.1	3.0	R	$\sqrt{3}$	1	1	1.73	1.73	∞
RF ambient Condition - reflections	E.6.1	3.0	R	$\sqrt{3}$	1	1	1.73	1.73	∞
Probe positioning mechanical tolerance	E.6.2	0.4	R	$\sqrt{3}$	1	1	0.23	0.23	∞
Probe positioning with respect to phantom	E.6.3	2.9	R	$\sqrt{3}$	1	1	1.67	1.67	∞
Max. SAR evaluation	E.5	1.0	R	$\sqrt{3}$	1	1	0.58	0.58	∞
Test sample positioning	E.4.2	4.2	N	1	1	1	4.2	4.2	9
Device holder uncertainty	E.4.1	3.6	N	1	1	1	3.6	3.6	5
Output power variation -SAR drift measurement	6.6.3	5.0	R	$\sqrt{3}$	1	1	2.89	2.89	∞
Phantom uncertainty (shape and thickness tolerances)	E.3.1	4.0	R	$\sqrt{3}$	1	1	2.31	2.31	∞
Liquid conductivity - deviation from target values	E.3.2	5.0	R	$\sqrt{3}$	0.64	0.43	1.85	1.24	∞
Liquid conductivity - measurement uncertainty	E.3.3	0.6	N	1.00	0.64	0.43	0.37	0.25	5
Liquid permittivity - deviation from target values	E.3.2	5.0	R	$\sqrt{3}$	0.6	0.49	1.73	1.41	∞
Liquid permittivity - measurement uncertainty	E.3.3	0.8	N	1.00	0.64	0.49	0.54	0.42	5

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SHGSM

Combined standard uncertainty				RSS			10.21	10.06	147
Expanded uncertainty (95% CONFIDENCE INTERVAL)				K=2			20.4	20.1	

Note 1:  $C_p = 0.5$

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9. CNAS Certificate



## End of Report

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