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



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Auden Client

Certificate No: EX3-3820\_Dec12

Object	EX3DV4 - SN:382	20	
Calibration procedure(s)		A CAL-14.v3, QA CAL-23.v4, QA dure for dosimetric E-field probes	CAL-25.v4
Calibration date:	December 10, 20	12	Sector Sector
The measurements and the unc	ertainties with confidence pr ucted in the closed laborator	onal standards, which realize the physical units obability are given on the following pages and a y facility: environment temperature $(22 \pm 3)^{\circ}$ C a	are part of the certificate.
Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	29-Mar-12 (No. 217-01508)	Apr-13
Power sensor E4412A	MY41498087	29-Mar-12 (No. 217-01508)	Apr-13
		07 14- 40 (1) 017 04504)	
Reference 3 dB Attenuator	SN: S5054 (3c)	27-Mar-12 (No. 217-01531)	Apr-13
	SN: S5054 (3c) SN: S5086 (20b)	27-Mar-12 (No. 217-01531) 27-Mar-12 (No. 217-01529)	Apr-13 Apr-13
Reference 20 dB Attenuator			
Reference 20 dB Attenuator Reference 30 dB Attenuator	SN: S5086 (20b)	27-Mar-12 (No. 217-01529)	Apr-13
Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2	SN: S5086 (20b) SN: S5129 (30b)	27-Mar-12 (No. 217-01529) 27-Mar-12 (No. 217-01532)	Apr-13 Apr-13
Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4	SN: S5086 (20b) SN: S5129 (30b) SN: 3013	27-Mar-12 (No. 217-01529) 27-Mar-12 (No. 217-01532) 29-Dec-11 (No. ES3-3013_Dec11)	Apr-13 Apr-13 Dec-12
Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards	SN: S5086 (20b) SN: S5129 (30b) SN: 3013 SN: 660	27-Mar-12 (No. 217-01529) 27-Mar-12 (No. 217-01532) 29-Dec-11 (No. ES3-3013_Dec11) 20-Jun-12 (No. DAE4-660_Jun12)	Apr-13 Apr-13 Dec-12 Jun-13
Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C	SN: S5086 (20b)           SN: S5129 (30b)           SN: 3013           SN: 660           ID	27-Mar-12 (No. 217-01529) 27-Mar-12 (No. 217-01532) 29-Dec-11 (No. ES3-3013_Dec11) 20-Jun-12 (No. DAE4-660_Jun12) Check Date (in house)	Apr-13 Apr-13 Dec-12 Jun-13 Scheduled Check
Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C	SN: S5086 (20b)           SN: S5129 (30b)           SN: 3013           SN: 660           ID           US3642U01700	27-Mar-12 (No. 217-01529) 27-Mar-12 (No. 217-01532) 29-Dec-11 (No. ES3-3013_Dec11) 20-Jun-12 (No. DAE4-660_Jun12) Check Date (in house) 4-Aug-99 (in house check Apr-11)	Apr-13 Apr-13 Dec-12 Jun-13 Scheduled Check In house check: Apr-13
Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E Calibrated by:	SN: S5086 (20b)           SN: S5129 (30b)           SN: 3013           SN: 660           ID           US3642U01700           US37390585	27-Mar-12 (No. 217-01529) 27-Mar-12 (No. 217-01532) 29-Dec-11 (No. ES3-3013_Dec11) 20-Jun-12 (No. DAE4-660_Jun12) Check Date (in house) 4-Aug-99 (in house check Apr-11) 18-Oct-01 (in house check Oct-12)	Apr-13 Apr-13 Dec-12 Jun-13 Scheduled Check In house check: Apr-13 In house check: Oct-13
Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E	SN: S5086 (20b)           SN: S5129 (30b)           SN: 3013           SN: 660           ID           US3642U01700           US37390585           Name	27-Mar-12 (No. 217-01529) 27-Mar-12 (No. 217-01532) 29-Dec-11 (No. ES3-3013_Dec11) 20-Jun-12 (No. DAE4-660_Jun12) Check Date (in house) 4-Aug-99 (in house check Apr-11) 18-Oct-01 (in house check Oct-12) Function	Apr-13 Apr-13 Dec-12 Jun-13 Scheduled Check In house check: Apr-13 In house check: Oct-13

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#### Glossary:

Glossary.	
TSL	tissue simulating liquid
NORMX, y, z	sensitivity in free space
ConvF	sensitivity in TSL / NORMX, y, z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C	modulation dependent linearization parameters
Polarization ()	lo rotation around probe axis
Polarization 9	9 rotation around an axis that is in the plane normal to probe axis (at measurement center). i.e., 9 = 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
- 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:

- NORMx,y,z: Assessed for E-field polarization 9 = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz; R22 waveguide), NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- NORM(!)x,y,z = NORMx,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
- Ax,y,z; Bx,y,z; Cx,y,z, VRx,y,z; A, B, C are numerical linearization parameters assessed based on the data of
  power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the
  maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for f < 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to Improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORMx.y,z \* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy): in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

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EX3DV4 - SN:3820

December 10, 2012

# Probe EX3DV4

## SN:3820

Manufactured: Calibrated: September 2, 2011 December 10, 2012

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

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EX3DV4- SN 3820

December 10, 2012

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3820

#### **Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (µV/(V/m) <sup>2</sup> ) <sup>A</sup>	0.44	0.35	0.44	± 10.1 %
DCP (mV) <sup>0</sup>	99.1	100.3	99.4	

#### **Modulation Calibration Parameters**

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc <sup>L</sup> (k=2)
0	CW	0.00	X	0.0	0.0	1.0	149.3	±3.0 %
×	11	1 2 2 3	Y	0.0	0.0	1.0	179.2	
			Z	0.0	0.0	1.0	147.4	

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%.

The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 6). Numerical linearization parameter uncertainty not required Uncertainty is determined using the max, deviation from linear response applying rectangular distribution and is expressed for the square of the field value

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December 10, 2012

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3820

f (MHz) <sup>c</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
835	41.5	0.90	9.19	9,19	9.19	0.80	0.66	± 12.0 %
1750	40.1	1.37	7.81	7.81	7.81	0.49	0.77	± 12.0 %
1900	40.0	1.40	7.51	7.51	7.51	0.46	0.78	± 12.0 %
2100	39.8	1.49	7.64	7.64	7.64	0.42	0.81	± 12.0 %
2450	39.2	1.80	6.74	6.74	6.74	0.37	0.89	± 12.0 %
5200	36.0	4.66	5.01	5.01	5.01	0.45	1.80	± 13.1 %
5300	35.9	4.76	4.76	4.76	4.76	0.45	1.80	± 13.1 %
5500	35.6	4.96	4.58	4.58	4.58	0.45	1.80	± 13.1 9
5600	35.5	5.07	4.31	4.31	4.31	0.50	1.80	± 13.1 %
5800	35.3	5.27	4.52	4.52	4.52	0.45	1.80	± 13.1 %

#### Calibration Parameter Determined in Head Tissue Simulating Media

<sup>6</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>6</sup> At frequencies below 3 GHz, the validity of tissue parameters (r and o) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies below 3 GHz, the validity of tissue parameters (i and o) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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December 10, 2012

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3820

f (MHz) <sup>c</sup>	Relative Permittivity*	Conductivity (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
835	55.2	0.97	9,07	9.07	9.07	0.32	1.10	± 12.0 %
1750	53.4	1.49	7.60	7.60	7.60	0.37	0.91	± 12.0 %
1900	53.3	1.52	7.30	7.30	7.30	0.26	1.19	± 12.0 %
2100	53.2	1.62	7.56	7.56	7.56	0.25	1.17	± 12.0 %
2450	52.7	1.95	6.84	6.84	6.84	0.80	0.61	± 12.0 %
5200	49.0	5.30	4.23	4.23	4.23	0.50	1,90	± 13.1 %
5300	48.9	5.42	3.95	3.95	3 95	0.55	1.90	± 13.1 %
5500	48.6	5.65	3.63	3.63	3,63	0.60	1.90	± 13.1 %
5600	48.5	5.77	3.39	3.39	3.39	0.65	1,90	± 13.1 %
5800	48.2	6.00	3.83	3.83	3.83	0.60	1.90	± 13.1 %

#### Calibration Parameter Determined in Body Tissue Simulating Media

<sup>6</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>6</sup> All requencies balow 3 GHz, the validity of tissue parameters (a and a) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At the quencies above 3 GHz, the validity of tissue parameters (a and a) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At the quencies above 3 GHz, the validity of tissue parameters (a and a) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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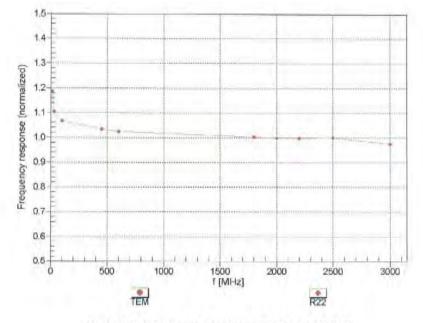
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December 10, 2012

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



Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

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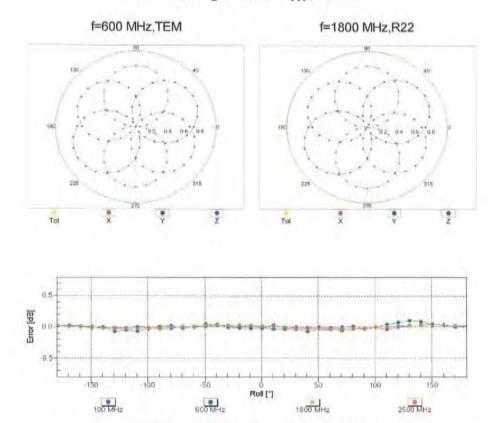
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EX3DV4- SN:3820

December 10, 2012



## Receiving Pattern ( $\phi$ ), $\vartheta = 0^{\circ}$

Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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台灣檢驗科技股份有限公司 t (886-2) 2299-3279

f (886-2) 2298-0488

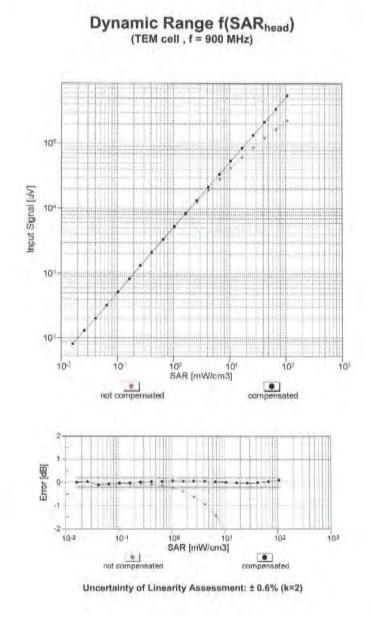
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EX3DV4- SN:3820

December 10, 2012



Certificate No: EX3-3820\_Dec12

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December 10, 2012 **Conversion Factor Assessment** f = 835 MHz,WGLS R9 (H\_convF) f = 1900 MHz,WGLS R22 (H\_convF) 40 an. 26 28 Stription into 2,0 10 0.5 0.0 a Immi .87 Deviation from Isotropy in Liquid Error (0, 9), f = 900 MHz 1,0 0.8 0.6 uoteiva0 0.2 -0.2 0.4 -0.4 -0.6 -0.8 -1.0 0 45 90 135 +10001 180 225 60 50 270 40 30 20 Y [deg] 315 10 0 -1.0 -0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8 1.0 Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

Certificate No: EX3-3820\_Dec12

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December 10, 2012

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3820

#### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (*)	-69,3
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Longth	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

Certificate No: EX3-3820\_Dec12

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## 8. Uncertainty Budget

Measurement Uncertainty evaluation

62209-2 : 2010			-	-					
A	с	D	e = f(d,k)		f	g	h=c * f / e	i=c * g / e	k
Source of	Tolerance	Probabilit					Standard	Standard	vi, or
Uncertainty	1	у	Div.	Div Value	ci (1g)	ci (10g)	uncertainty	uncertainty	Vi, oi Veff
oncertainty	Uncertaint	Distributi					+ %. (1 a)	+ %. (10 a)	VCII
Measurement									
system									
Probe calibration	6.55%	N	1	1	1	1	6.55%	6.55%	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Isotropy	3.50%	R	√3	1.732	1	1	2.02%	2.02%	~~~
Linearity	4.70%	R	√3	1.732	1	1	2.71%	2.71%	00
Probe modulation	0.400/		<u>_</u>	4 700			1 000/	1 000/	
response	2.40%	R	√3	1.732	1	1	1.39%	1.39%	$\infty$
Detection Limits	1.00%	R	√3	1.732	1	1	0.58%	0.58%	8
Boundary effect	2.00%	R	√3	1.732	1	1	1.15%	1.15%	8
Readout Electronics	0.30%	N	1	1	1	1	0.30%	0.30%	~~~~
Response time	0.80%	R	√3	1.732	1	1	0.46%	0.46%	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Integration Time	2.60%	R	√3	1.732	1	1		1.50%	~~~
RF ambient									
condition - noise	3.00%	R	√3	1.732	1	1	1.73%	1.73%	~~
RF ambient	3.00%	R	√3	1.732	1	1	1.73%	1.73%	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
conditions -	3.00%	ĸ	√ 3	1.732	1	'	1.7370	1.7376	~
Probe positioner	0.40%	R	√3	1.732	1	1	0.23%	0.23%	~~~
mech. restrictions	0.1070		1 0			•	0.2070	0.2070	
Probe positioning	2 000/		<i>(</i> 2	1 700	1	1	1 ( 70(	1 ( 70 (	~~~
with respect to	2.90%	R	√3	1.732	1	1	1.67%	1.67%	00
phantom shell	1.00%	R	√3	1.732	1	1	0.58%	0.58%	~~~
Post-processing	1.00%	ĸ	√ 3	1.732	1		0.58%	0.58%	
Test sample									
related									
Device holder	3.60%	Ν	1	1	1	1	3.60%	3.60%	M-1
uncertainty	3.0070		•	•			3.0070	0.0070	
Test sample	2.90%	Ν	1	1	1	1	2.90%	2.90%	M-1
positionina	0.000/		<b>Ca</b>	4 700	1	1	0.000/	0.000/	
Power scaling	0.00%	R	√3	1.732	1	1	0.00%	0.00%	~~
Drift of output	5.00%	R	√3	1.732	1	1	2.89%	2.89%	~~~~
power (measured									
Phantom and									
set-up									
Phantom			60	4 700				0.010/	
Uncertainty (shape	4.00%	R	√3	1.732	1	1	2.31%	2.31%	~~
and thickness Algorithm for									
correcting SAR for									
deviations in	1.90%	Ν	1	1	1	0.84	1.90%	1.60%	~~~
permittivity and			-	-					
conductivity									
Liquid conductivity	4.71%	N	1	1	0.78	0.71	3.67%	3.34%	M-1
(meas.)	4.7170	N N	-		0.76	0.71	3.0776	5.54 %	141-1
Liquid permitivity	4.20%	N	1	1	0.23	0.26	0.97%	1.09%	М
(meas.)				-					
Liquid conductivity -	3.40%	R	√3	1.732	0.78	0.71	1.53%	1.39%	~~~
temperature uncertainty	3.40%	ĸ	v 3	1.732	0.78	0.71	1.5576	1.3970	~
Liquid permitivity -							1		
temperature	0.40%	R	$\sqrt{3}$	1.732	0.23	0.26	0.05%	0.06%	~~~
uncertainty									
Combined standard		RSS					11.19%	11.03%	
uncertainty		кээ					11.1976	11.03%	
Expant uncertainty									
(95% confidence							22.37%	22.05%	
interval).K=2	l				ļ	ļ	ļ		

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## 9. Phantom Description

Schmid & Partner Engineering AG

Zeugheusstrasse 43, 6004 Zurich, Switzer and Phone +41 1 245 9700, Pax +41 1 245 9778 m/c@apeag.com, http://www.apeag.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	
Manufacturar	SPEAG Zeughausstrasse 43 CH-8004 Zorich 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 flat and specific areas of head section	First article, Semples, TP-1314 ff.
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 almulating liquid.	< 1% typical < 0.8% if filled with 155mm of HSL900 and without DUT below	Prototypes, Sample testing

- Standards [1] CENELEC EN 50381 [2] IEEE Std 1528-2003 [3] IEC 62209 Part I
- [1] [2] [3] [4]

FCC DET Bulletin 65, Supplement C, Edition 01-01 The IT1S 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	<u>s p e a g</u>
Signature / Stamp		Belgentel 15 Poppier Engineering AC 2500 hausstonse 53, 8005 20105 Avriteriand Phone 541, 245 97005 20105 20105 Avriteriand Into Septes, com, http://www.speeg.com

Dechip MIT-OD DOD PAD C ... P

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## **10. System Validation from Original Equipment Supplier**

	ch, Switzerland	CONTRACTOR CONTRACTOR S	Servizio svizzero di taratura
Accredited by the Swiss Accredit The Swiss Accreditation Servic Aultilateral Agreement for the r	e is one of the signatorie	es to the EA	n No.: SCS 108
SGS-TW (Aude	en)	Certificate N	o: D835V2-4d063_May12
CALIBRATION O	CERTIFICATI	E	
Object	D835V2 - SN: 40	1063	
Calibration procedure(s)	QA CAL-05.v8 Calibration proce	edure for dipole validation kits ab	ove 700 MHz
Calibration date:	May 25, 2012		
The measurements and the unce	artainties with confidence p	ional standards, which realize the physical ur robability are given on the following pages ar ry facility: environment temperature $(22 \pm 3)^{\circ}$	nd are part of the certificate.
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards	ertainties with confidence p cted in the closed laborato TE critical for calibration)	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)° Cal Date (Certificate No.)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A	ertainties with confidence p cted in the closed laborato TE critical for calibration) ID # GB37480704	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)° Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-12
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A	ted in the closed laborato TE critical for calibration) ID # GB37480704 US37292783	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)° Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-12 Oct-12
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator	ertainties with confidence p cted in the closed laborato TE critical for calibration) ID # GB37480704	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)° Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-12
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3	ertainties with confidence p cted in the closed laborato TE critical for calibration) ID # GB37480704 US37292783 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205	Cal Date (Certificate No.)           05-Oct-11 (No. 217-01451)           05-Oct-11 (No. 217-01451)           27-Mar-12 (No. 217-01533)           30-Dec-11 (No. ES3-3205_Dec11)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3	artainties with confidence p cted in the closed laborato TE critical for calibration) ID # GB37480704 US37292783 SN: 5058 (20k) SN: 5057.2 / 06327	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)* <u>Cal Date (Certificate No.)</u> 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 27-Mar-12 (No. 217-01530) 27-Mar-12 (No. 217-01533)	And are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4	ertainties with confidence p cted in the closed laborato TE critical for calibration) ID # GB37480704 US37292783 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)° Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 27-Mar-12 (No. 217-01530) 27-Mar-12 (No. 217-01533) 30-Dec-11 (No. ES3-3205_Dec11) 04-Jul-11 (No. DAE4-601_Jul11) Check Date (in house)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A	inties with confidence p           cted in the closed laborato           TE critical for calibration)           ID #           GB37480704           US37292783           SN: 5058 (20k)           SN: 5058 (20k)           SN: 5058 (20k)           SN: 601           ID #           ID #	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)* <u>Cal Date (Certificate No.)</u> 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 27-Mar-12 (No. 217-01530) 27-Mar-12 (No. 217-01533) 30-Dec-11 (No. ES3-3205_Dec11) 04-Jul-11 (No. DAE4-601_Jul11) <u>Check Date (in house)</u> 18-Oct-02 (in house check Oct-11)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-12 Oct-12 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12 Scheduled Check In house check: Oct-13
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06	inties with confidence p           cted in the closed laborato           TE critical for calibration)           ID #           GB37480704           US37292783           SN: 5058 (20k)           SN: 5047.2 / 06327           SN: 601           ID #           MY41092317           100005	Cal Date (Certificate No.)           05-Oct-11 (No. 217-01451)           05-Oct-11 (No. 217-01451)           05-Oct-11 (No. 217-01451)           27-Mar-12 (No. 217-01533)           30-Dec-11 (No. ES3-3205_Dec11)           04-Jul-11 (No. DAE4-601_Jul11)           Check Date (in house)           18-Oct-02 (in house check Oct-11)           04-Aug-99 (in house check Oct-11)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06	inties with confidence p           cted in the closed laborato           TE critical for calibration)           ID #           GB37480704           US37292783           SN: 5058 (20k)           SN: 5058 (20k)           SN: 5058 (20k)           SN: 601           ID #           ID #	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)* <u>Cal Date (Certificate No.)</u> 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 27-Mar-12 (No. 217-01530) 27-Mar-12 (No. 217-01533) 30-Dec-11 (No. ES3-3205_Dec11) 04-Jul-11 (No. DAE4-601_Jul11) <u>Check Date (in house)</u> 18-Oct-02 (in house check Oct-11)	And are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-12 Oct-12 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12 Scheduled Check In house check: Oct-13
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards	inties with confidence p           cted in the closed laborato           TE critical for calibration)           ID #           GB37480704           US37292783           SN: 5058 (20k)           SN: 5047.2 / 06327           SN: 601           ID #           MY41092317           100005	Cal Date (Certificate No.)           05-Oct-11 (No. 217-01451)           05-Oct-11 (No. 217-01451)           05-Oct-11 (No. 217-01451)           27-Mar-12 (No. 217-01533)           30-Dec-11 (No. ES3-3205_Dec11)           04-Jul-11 (No. DAE4-601_Jul11)           Check Date (in house)           18-Oct-02 (in house check Oct-11)           04-Aug-99 (in house check Oct-11)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-12 Oct-12 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13
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Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland



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

Accreditation No.: SCS 108

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 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) DASY4/5 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%.

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## Report No. : EN/2013/40003 Page : 390 of 432

#### **Measurement Conditions**

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

DASY Version	DASY5	V52.8.1
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	40.6 ± 6 %	0.89 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	2.36 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	9.47 mW /g ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	1.54 mW / g

#### **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	54,3 ± 6 %	1,00 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	2.46 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	9.58 mW / g ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 250 mW input power	1.62 mW / g

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#### Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.6 Ω + 0.3 jΩ	
Return Loss	- 29.1 dB	

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.0 Ω - 2.9 jΩ
Return Loss	- 28.9 dB

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1,390 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	November 27, 2006

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#### **DASY5 Validation Report for Head TSL**

Date: 25.05.2012

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d063

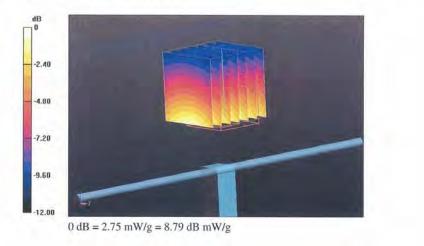
Communication System: CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz;  $\sigma$  = 0.89 mho/m;  $\epsilon_r$  = 40.6;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.07, 6.07, 6.07); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

## Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm 2/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 57.199 V/m; Power Drift = -0.01 dBPeak SAR (extrapolated) = 3.481 mW/g**SAR(1 g) = 2.36 \text{ mW/g}; SAR(10 g) = 1.54 \text{ mW/g}** Maximum value of SAR (measured) = 2.75 mW/g



Certificate No: D835V2-4d063\_May12

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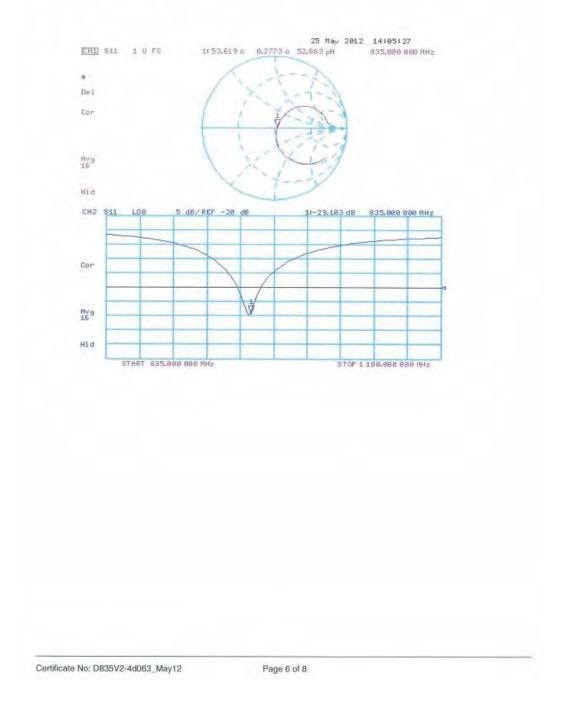
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#### Impedance Measurement Plot for Head TSL



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#### **DASY5 Validation Report for Body TSL**

Date: 25.05.2012

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d063

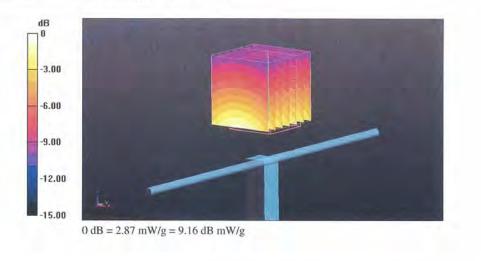
Communication System: CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz;  $\sigma$  = 1 mho/m;  $\epsilon_r$  = 54.3;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.02, 6.02, 6.02); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

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

Reference Value = 55.303 V/m; Power Drift = 0.03 dBPeak SAR (extrapolated) = 3.569 mW/gSAR(1 g) = 2.46 mW/g; SAR(10 g) = 1.62 mW/gMaximum value of SAR (measured) = 2.87 mW/g



Certificate No: D835V2-4d063\_May12

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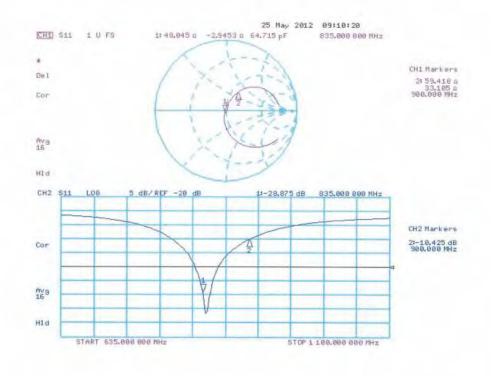
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#### Impedance Measurement Plot for Body TSL



Certificate No: D835V2-4d063\_May12

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## Report No. : EN/2013/40003 Page : 396 of 432

eughausstrasse 43, 8004 Zurio	ch, Switzerland		Service suisse d'étalonnage Servizio svízzero di taratura Swiss Calibration Service
Accredited by the Swiss Accredit The Swiss Accreditation Servic Multilateral Agreement for the r	e is one of the signatorie	s to the EA	on No.: SCS 108
Client SGS-TW (Audo	en)	Certificate N	No: D1750V2-1008_May12
CALIBRATION (	CERTIFICATE		
Object	D1750V2 - SN: 1	008	-
Calibration procedure(s)	QA CAL-05.v8 Calibration proce	dure for dipole validation kits ab	oove 700 MHz
Calibration date:	May 29, 2012		
The measurements and the unce All calibrations have been condu	ertainties with confidence p	onal standards, which realize the physical $u$ robability are given on the following pages a ry facility: environment temperature (22 $\pm$ 3)	and are part of the certificate.
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## Report No. : EN/2013/40003 Page : 397 of 432

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



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

S Swiss Calibration Service

Accreditation No.: SCS 108

SWISS

BRA

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 Glossarv:

#### TO

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) DASY4/5 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%.

Certificate No: D1750V2-1008 May12

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## Report No. : EN/2013/40003 Page : 398 of 432

#### **Measurement Conditions**

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

DASY Version	DASY5	V52.8.1
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

	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	40.5 ± 6 %	1.34 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	1111	

#### 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	8.76 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	35.6 mW /g ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	4,69 mW / g

#### **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	52.9 ± 6 %	1.46 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	9.03 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	36.5 mW / g ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 250 mW input power	4.88 mW / g

Certificate No: D1750V2-1008\_May12

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#### Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.1 Ω - 0.5 jΩ	
Return Loss	- 45.4 dB	

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.0 Ω - 0.3 JΩ
Return Loss	- 27.5 dB

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.222 ns

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

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

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

#### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	February 11, 2009

Certificate No: D1750V2-1008\_May12

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#### **DASY5 Validation Report for Head TSL**

Date: 29.05.2012

Test Laboratory: SPEAG, Zurich, Switzerland

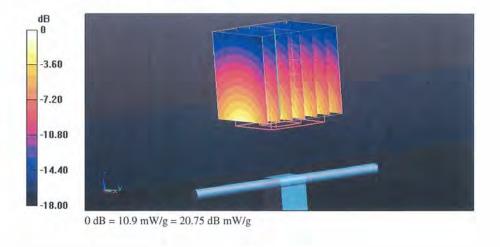
#### DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1008

Communication System: CW; Frequency: 1750 MHz Medium parameters used: f = 1750 MHz;  $\sigma$  = 1.34 mho/m;  $\epsilon_r$  = 40.5;  $\rho$  = 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(5.22, 5.22, 5.22); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- · Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

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 = 93.240 V/m; Power Drift = 0.05 dB Peak SAR (extrapolated) = 15.463 mW/g SAR(1 g) = 8.76 mW/g; SAR(10 g) = 4.69 mW/g Maximum value of SAR (measured) = 10.9 mW/g



Certificate No: D1750V2-1008 May12

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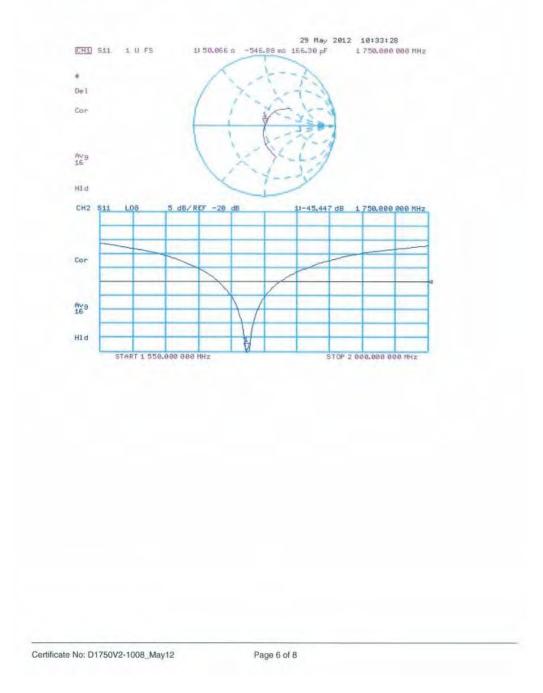
台灣檢驗科技股份有限公司 t (886-2) 2299-3279

f (886-2) 2298-0488



## Report No. : EN/2013/40003 Page : 401 of 432

#### Impedance Measurement Plot for Head TSL



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#### **DASY5 Validation Report for Body TSL**

Date: 29.05.2012

Test Laboratory: SPEAG, Zurich, Switzerland

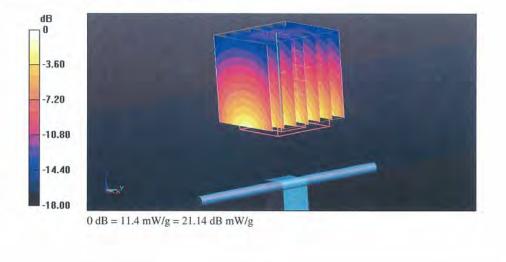
#### DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1008

Communication System: CW; Frequency: 1750 MHz Medium parameters used: f = 1750 MHz;  $\sigma = 1.46$  mho/m;  $\varepsilon_r = 52.9$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.85, 4.85, 4.85); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

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 = 92.190 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 15.359 mW/g SAR(1 g) = 9.03 mW/g; SAR(10 g) = 4.88 mW/g Maximum value of SAR (measured) = 11.4 mW/g



Certificate No: D1750V2-1008\_May12

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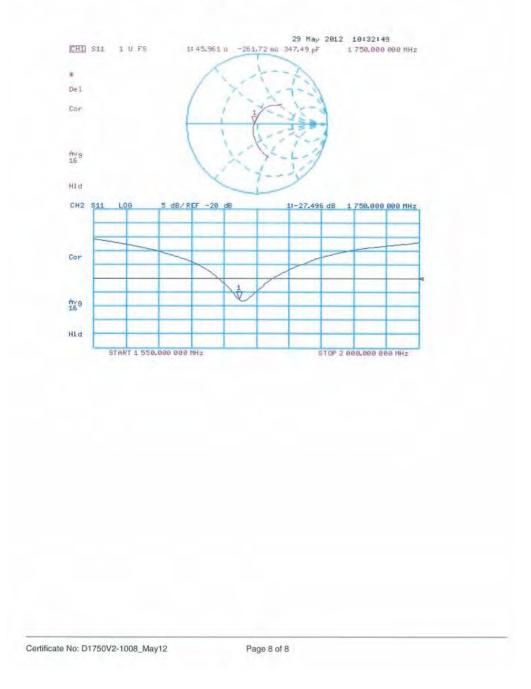
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## Report No. : EN/2013/40003 Page : 403 of 432

#### Impedance Measurement Plot for Body TSL



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## Report No. : EN/2013/40003 Page : 404 of 432

Engineering AG eughausstrasse 43, 8004 Zuricl	y of h, Switzerland	CONSCIENTA	Servizio svizzero di taratura
ccredited by the Swiss Accredita he Swiss Accreditation Service Iultilateral Agreement for the re	e is one of the signatorie	s to the EA	n No.: SCS 108
lient Auden	FRTIFICATE		o: D1900V2-5d018_Jun12
Dbject	D1900V2 - SN: 5	la.	
Calibration procedure(s)	QA CAL-05.v8 Calibration proce	dure for dipole validation kits ab	ove 700 MHz
Calibration date:	June 21, 2012		
The measurements and the unce	rtainties with confidence p	onal standards, which realize the physical u robability are given on the following pages a $\gamma$ facility: environment temperature (22 ± 3)	nd are part of the certificate.
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The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&' Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer HP 8753E	Intainties with confidence p cted in the closed laborator TE critical for calibration) ID # GB37480704 US37292783 SN: 5058 (20k) SN: 5058 (20k) SN: 5047.2 / 06327 SN: 601 ID # MY41092317 100005 US37390585 S4206 Name	robability are given on the following pages a ry facility: environment temperature (22 ± 3)' 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 27-Mar-12 (No. 217-01530) 27-Mar-12 (No. 217-01533) 30-Dec-11 (No. ES3-3205_Dec11) 04-Jul-11 (No. DAE4-601_Jul11) Check Date (in house) 18-Oct-02 (in house check Oct-11) 04-Aug-99 (in house check Oct-11) 18-Oct-01 (in house check Oct-11) Function	nd are part of the certificate. *C and humidity < 70%. *C and humidity < 70%. Oct-12 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-12

Certificate No: D1900V2-5d018\_Jun12

Page 1 of 8

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## Report No. : EN/2013/40003 Page: 405 of 432

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



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

Accreditation No.: SCS 108

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

#### **Glossary:**

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

#### 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%.

Certificate No: D1900V2-5d018 Jun12

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#### **Measurement Conditions**

DASY Version	DASY5	V52.8.1
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	40.2 ± 6 %	1.38 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	9.88 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	39.9 mW /g ± 17.0 % (k=2)
	1	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	5.23 mW / g

#### **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	52.7 ± 6 %	1.53 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	10.2 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	40.5 mW / g ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 250 mW input power	5.39 mW / g

Certificate No: D1900V2-5d018\_Jun12

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#### Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.3 Ω + 3.2 jΩ
Return Loss	- 29.4 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.9 Ω + 3.1 jΩ
Return Loss	- 27.0 dB

#### **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.196 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	June 04, 2002

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#### **DASY5 Validation Report for Head TSL**

Date: 21.06.2012

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d018

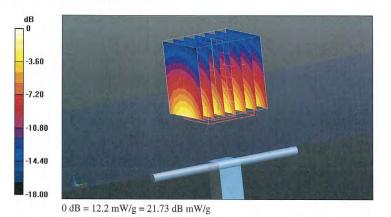
Communication System: CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.38 mho/m;  $\varepsilon_r$  = 40.2;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(5.01, 5.01, 5.01); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 97.845 V/m; Power Drift = 0.04 dB Peak SAR (extrapolated) = 17.531 mW/g SAR(1 g) = 9.88 mW/g; SAR(10 g) = 5.23 mW/g Maximum value of SAR (measured) = 12.2 mW/g



Certificate No: D1900V2-5d018\_Jun12

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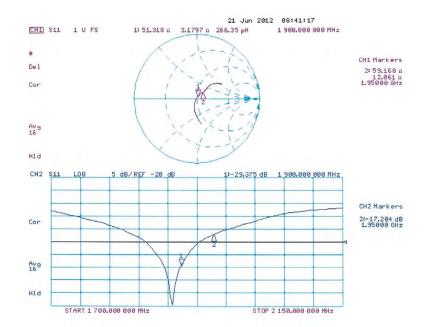
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#### Impedance Measurement Plot for Head TSL



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#### **DASY5 Validation Report for Body TSL**

Date: 21.06.2012

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d018

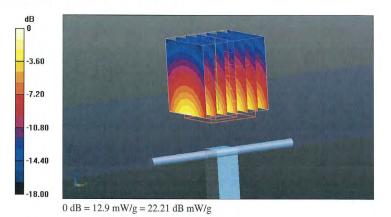
Communication System: CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.53 mho/m;  $\varepsilon_r$  = 52.7;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.62, 4.62, 4.62); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

#### 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 = 95.712 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 17.826 mW/g SAR(1 g) = 10.2 mW/g; SAR(10 g) = 5.39 mW/g Maximum value of SAR (measured) = 12.9 mW/g



Certificate No: D1900V2-5d018\_Jun12

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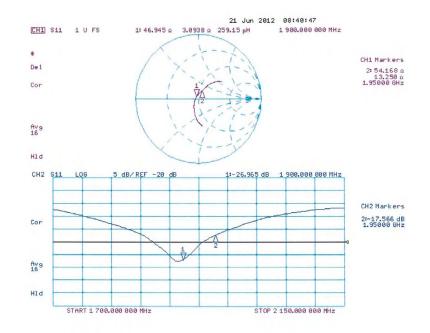
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# Impedance Measurement Plot for Body TSL

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Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zuric	y of h, Switzerland	BICARRA CRISS S CRUCK CRUCK CRISS S CRUCK CRUCK	Service suisse d'étalonnage Servizio svizzero di taratura
Accredited by the Swiss Accredita The Swiss Accreditation Service Multilateral Agreement for the re	e is one of the signatorie	s to the EA	n No.: SCS 108
Client Auden		and the second second	o: D2450V2-869_Jun12
CALIBRATION C	ERTIFICATE		
Object	D2450V2 - SN: 8	69	
Calibration procedure(s)	QA CAL-05.v8 Calibration proce	dure for dipole validation kits ab	ove 700 MHz
Calibration date:	June 15, 2012		
The measurements and the unce	ertainties with confidence p	onal standards, which realize the physical un robability are given on the following pages a ry facility: environment temperature $(22 \pm 3)^2$	nd are part of the certificate.
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Certificate No: D2450V2-869\_Jun12

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Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 6004 Zurich, Switzerland



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Accreditation No.: SCS 108

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

#### Glossary:

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

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

- a) IEEE Std 1528-2003, "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%.

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#### Measurement Conditions

DASY Version	DASY5	V52.8.1
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	$dx_1 dy_1 dz = 5 mm$	
Frequency	2450 MHz ± 1 MHz	

#### Head TSL parameters

The following parameters and calculations were applied

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) "C	38.9 ± 6 %	1.86 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	13.8 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	54.3 mW /g ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>2</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>2</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	6.41 mW / g

#### **Body TSL parameters**

The following parameters and calculations were applied

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.6 ± 6 %	2.01 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °G		

### SAR result with Body TSL

SAR averaged over 1 cm <sup>2</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.0 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	51.0 mW / g ± 17.0 % (k=2)
	second a distant in the second s	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 250 mW input power	6.06 mW / g

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#### Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.0 Ω + 6.0 jΩ	
Return Loss	- 23.7 dB	

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.0 Ω + 6,4 jΩ
Return Loss	- 23.8 dB

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.159 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

#### **Additional EUT Data**

Manufactured by	SPEAG
Manufactured on	August 18, 2010

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#### **DASY5 Validation Report for Head TSL**

Date: 15.06.2012

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 869

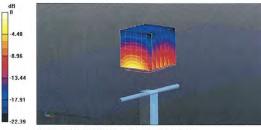
Communication System: CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma$  = 1.86 mho/m;  $\epsilon_r$  = 38.9;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.45, 4.45, 4.45); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 99.524 V/m; Power Drift = 0.08 dB Peak SAR (extrapolated) = 28.407 mW/g SAR(1 g) = 13.8 mW/g; SAR(10 g) = 6.41 mW/g Maximum value of SAR (measured) = 17.5 mW/g



0 dB = 17.5 mW/g = 24.86 dB mW/g

Certificate No: D2450V2-869\_Jun12

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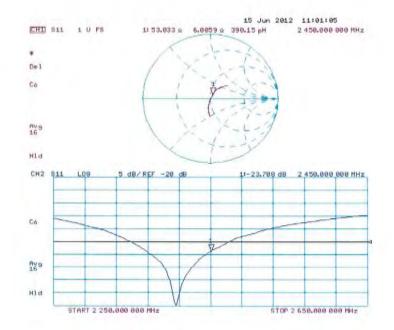
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### Impedance Measurement Plot for Head TSL

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#### **DASY5 Validation Report for Body TSL**

Date: 14.06.2012

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 869

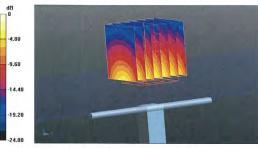
Communication System: CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma$  = 2.01 mho/m;  $\epsilon_r$  = 51.6;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.26, 4.26, 4.26); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

#### 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 = 95.289 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 26.649 mW/g SAR(1 g) = 13 mW/g; SAR(10 g) = 6.06 mW/g Maximum value of SAR (measured) = 17.0 mW/g



0 dB = 17.0 mW/g = 24.61 dB mW/g

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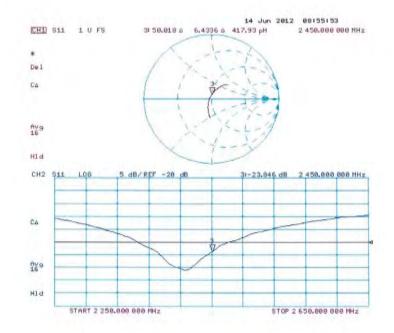
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#### Impedance Measurement Plot for Body TSL

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lient Auden			No: D5GHzV2-1040_Jun12
CALIBRATION C	CERTIFICATE		
Object	D5GHzV2 - SN:	1040	
Calibration procedure(s)	QA CAL-22.v1 Calibration proce	dure for dipole validation kits be	etween 3-6 GHz
Calibration date:	June 19, 2012		
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Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland



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

Accreditation No.: SCS 108

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

## 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) IEC 62209-2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation, and Procedures"; Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", March 2010
- b) 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:

c) 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%.

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#### **Measurement Conditions**

DASY Version	DASY5	V52.8.1
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz ± 1 MHz 5500 MHz ± 1 MHz 5800 MHz ± 1 MHz	

### Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.0 ± 6 %	4.52 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	eree.	

### SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.20 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	81.5 mW /g ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 100 mW input power	2.36 mW / g

#### Head TSL parameters at 5500 MHz

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.6 ± 6 %	4.80 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.82 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	87.5 mW / g ± 19.9 % (k=2)
	The second se Second second s Second second se	
3		
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 100 mW input power	2.52 mW / g

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#### Head TSL parameters at 5800 MHz

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.1 ± 6 %	5.11 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

### SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.23 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	81.6 mW / g ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 100 mW input power	2.35 mW / g

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#### Body TSL parameters at 5200 MHz

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.0 ± 6 %	5.37 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.37 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	73.1 mW / g ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 100 mW input power	2.07 mW / g

#### Body TSL parameters at 5500 MHz

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.6	5.65 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.5 ± 6 %	5.76 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL at 5500 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.87 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	78.1 mW / g ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 100 mW input power	2.19 mW / g

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#### Body TSL parameters at 5800 MHz

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.0 ± 6 %	6.16 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

### SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.44 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	73.8 mW / g ± 19.9 % (k=2)
		5
	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 100 mW input power	2.06 mW / g

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#### Appendix

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	49.2 Ω - 7.1 jΩ
Return Loss	- 22.8 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	51.5 Ω - 4.4 jΩ	
Return Loss	- 26.8 dB	

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	55.3 Ω - 2.7 jΩ
Return Loss	- 24.9 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	49.6 Ω - 5.5 jΩ
Return Loss	- 25.2 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	52.5 Ω - 3.2 jΩ
Return Loss	- 28.1 dB

#### Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	56.6 Ω - 1.3 jΩ	
Return Loss	- 24.0 dB	

#### **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.202 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

#### **Additional EUT Data**

Manufactured by	SPEAG
Manufactured on	December 30, 2005

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#### **DASY5 Validation Report for Head TSL**

Date: 19.06.2012

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1040

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz Medium parameters used: f = 5200 MHz;  $\sigma$  = 4.52 mho/m;  $\epsilon_r$  = 35;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5500 MHz;  $\sigma$  = 4.8 mho/m;  $\epsilon_r$  = 34.6;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5800 MHz;  $\sigma$  = 5.11 mho/m;  $\epsilon_r$  = 34.1;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(5.41, 5.41, 5.41); Calibrated: 30.12.2011, ConvF(4.91, 4.91, 4.91); Calibrated: 30.12.2011, ConvF(4.81, 4.81, 4.81); Calibrated: 30.12.2011;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 65.507 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 30.371 mW/g SAR(1 g) = 8.2 mW/g; SAR(10 g) = 2.36 mW/g Maximum value of SAR (measured) = 19.0 mW/g

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 66.096 V/m; Power Drift = 0.05 dB Peak SAR (extrapolated) = 35.013 mW/g SAR(1 g) = 8.82 mW/g; SAR(10 g) = 2.52 mW/g Maximum value of SAR (measured) = 21.2 mW/g

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 62.419 V/m; Power Drift = 0.07 dB Peak SAR (extrapolated) = 34.147 mW/g SAR(1 g) = 8.23 mW/g; SAR(10 g) = 2.35 mW/g Maximum value of SAR (measured) = 20.0 mW/g

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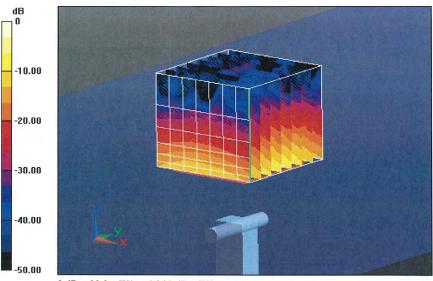
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0 dB = 20.0 mW/g = 26.02 dB mW/g

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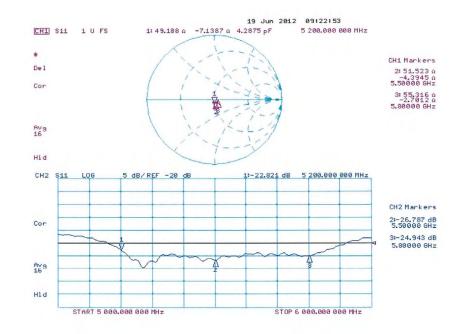
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#### Impedance Measurement Plot for Head TSL

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#### **DASY5 Validation Report for Body TSL**

Date: 18.06.2012

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1040

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz Medium parameters used: f = 5200 MHz;  $\sigma$  = 5.37 mho/m;  $\varepsilon_r$  = 47;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5500 MHz;  $\sigma$  = 5.76 mho/m;  $\varepsilon_r$  = 46.5;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5800 MHz;  $\sigma$  = 6.16 mho/m;  $\varepsilon_r$  = 46;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(4.91, 4.91, 4.91); Calibrated: 30.12.2011, ConvF(4.43, 4.43, 4.43); Calibrated: 30.12.2011, ConvF(4.38, 4.38, 4.38); Calibrated: 30.12.2011;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 58.667 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 29.022 mW/g SAR(1 g) = 7.37 mW/g; SAR(10 g) = 2.07 mW/g Maximum value of SAR (measured) = 17.2 mW/g

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 58.708 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 33.769 mW/g SAR(1 g) = 7.87 mW/g; SAR(10 g) = 2.19 mW/g Maximum value of SAR (measured) = 19.0 mW/g

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 55.529 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 34.868 mW/g SAR(1 g) = 7.44 mW/g; SAR(10 g) = 2.06 mW/g Maximum value of SAR (measured) = 18.1 mW/g

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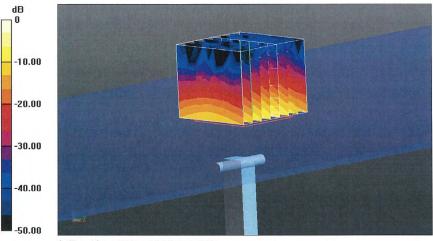
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0 dB = 18.1 mW/g = 25.15 dB mW/g

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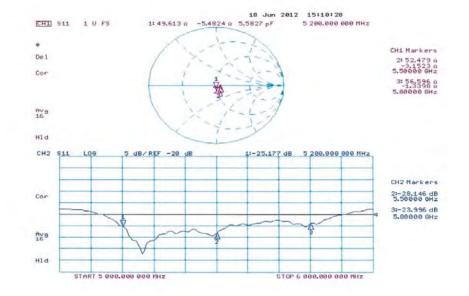
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Impedance Measurement Plot for Body TSL



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

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