

### 7. DAE & Probe Calibration Certificate

ccredited by the Swiss Accredita			tation No.: SCS 108
he Swiss Accreditation Service ultilateral Agreement for the re-			
lient SGS-TW (Aude	en)	Certific	ate No: DAE4-1336_Jun12
CALIBRATION	ERTIFICATE		
Object	DAE4 - SD 000 D	004 BJ - SN: 1336	
Calibration procedure(s)	QA CAL-06.v24		
penniamin' provideratory		dure for the data acquisition	electronics (DAE)
Calibration date:	June 05, 2012		
Sentra dell'Estate.	0010 00, 2012		
his calibration certificate docum	ents the traceability to nati	onal standards, which realize the physi	ical units of measurements (SI).
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#### Report No. : EN/2013/70006 Page: 481 of 616

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



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

Accreditation No.: SCS 108

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Multilateral Agreement for the recognition of calibration certificates

The Swiss Accreditation Service is one of the signatories to the EA

Accredited by the Swiss Accreditation Service (SAS)

#### Glossary

DAE Connector angle

data acquisition electronics 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.
  - ٠ AD Converter Values with inputs shorted: Values on the internal AD converter corresponding to zero input voltage
  - Input Offset Measurement: Output voltage and statistical results over a large number of zero voltage measurements.
  - Input Offset Current: Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - Input resistance: Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - Low Battery Alarm Voltage: Typical value for information. Below this voltage, a battery alarm signal is generated.
  - Power consumption: Typical value for information. Supply currents in various operating modes.

Certificate No: DAE4-1336 Jun12

Page 2 of 5

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#### DC Voltage Measurement

High Range:	1LSB =	6.1µV .	full range =	-100+300 mV
Low Range:	1LSB =	61nV ,	full range =	-1+3mV
DASY measurement	parameters: Au	to Zero Time: 3	sec; Measuring	time: 3 sec

Calibration Factors	х	Y	Z
High Range	403.371 ± 0.1% (k=2)	403.127 ± 0.1% (k=2)	403.194 ± 0.1% (k=2)
Low Range	3.96695 ± 0.7% (k=2)	3.96890 ± 0.7% (k=2)	3.99405 ± 0.7% (k=2)

**Connector Angle** 

Connector Angle to be used in DASY system	122.5°±1°

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Page 3 of 5

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#### Report No. : EN/2013/70006 Page : 483 of 616

#### Appendix

1.	DC	Voltage	Linearity
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High Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	199994.11	-3.29	-0.00
Channel X + Input	20001.83	0.90	0.00
Channel X - Input	-19999.76	0.45	-0.00
Channel Y + Input	199997.52	0.39	0.00
Channel Y + Input	19998.61	-2.15	-0.01
Channel Y - Input	-20001.36	-1.00	0.00
Channel Z + Input	199993.95	-3.37	-0.00
Channel Z + Input	19998.98	-1.78	-0.01
Channel Z - Input	-20001.47	-0.97	0.00

Low Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	2002.07	0.90	0.04
Channel X + Input	202.26	0.62	0.31
Channel X - Input	-197.79	0.45	-0.23
Channel Y + Input	2001.57	0.59	0.03
Channel Y + Input	201.46	-0.01	-0.01
Channel Y - Input	-198.80	-0.34	0.17
Channel Z + Input	2001.54	0.51	0.03
Channel Z + Input	200.53	-1.00	-0.50
Channel Z - Input	-199.57	-1.21	0.61

#### 2. Common mode sensitivity

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

	Common mode Input Voltage (mV)	High Range Average Reading (µV)	Low Range Average Reading (µV)
Channel X	200	5.99	4.73
	- 200	-3.24	-5.13
Channel Y	200	4.30	4.27
	- 200	-5.85	-5.85
Channel Z	200	8,94	9.05
	- 200	-12.06	-12.09

#### 3. Channel separation

	Input Voltage (mV)	Channel X (µV)	Channel Y (µV)	Channel Z (µV)
Channel X	200		6.36	-0.99
Channel Y	200	9.20		7.23
Channel Z	200	8.41	6.54	

Certificate No: DAE4-1336\_Jun12

Page 4 of 5

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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	15917	15922
Channel Y	15876	15535
Channel Z	15842	16395

#### 5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec Input  $10 M \Omega$ 

	Average (µV)	min. Offset (µV)	max. Offset ( $\mu V$ )	Std. Deviation (µV)
Channel X	1.30	-0.23	2.19	0.37
Channel Y	-0.29	-1.58	1.23	0.56
Channel Z	-2.08	-3.18	-0.96	0.49

#### 6. Input Offset Current

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

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

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

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

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

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

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

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Page 5 of 5

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#### Report No. : EN/2013/70006 Page : 485 of 616

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lient Auden		Certificate No:	ES3-3071_Jun12
CALIBRATION	CERTIFICATE	L .	
Object	ES3DV3 - SN:30	71	
Calibration procedure(s)		A CAL-23.v4, QA CAL-25.v4 dure for dosimetric E-field probes	
Calibration date:	June 22, 2012		
	ucted in the closed laborator	obability are given on the following pages and $y \text{ facility: environment temperature } (22 \pm 3)^{\circ}C \text{ a}$	
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Certificate No: ES3-3071 Jun12

Page 1 of 11

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#### Report No. : EN/2013/70006 Page: 486 of 616

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



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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:

tissue simulating liquid TSL NORMx,y,Z sensitivity in free space sensitivity in TSL / NORMx,y,z ConvF diode compression point crest factor (1/duty\_cycle) of the RF signal DCP CF A.B.C modulation dependent linearization parameters protation around probe axis Polarization w Polarization 9 B rotation around an axis that is in the plane normal to probe axis (at measurement center). i.e., 8 = 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. 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 b)

#### Methods Applied and Interpretation of Parameters:

- NORMx, y, z: Assessed for E-field polarization 3 = 0 (f  $\leq 900$  MHz in TEM-cell; ( > 1800 MHz: R22 waveguide). NORMx, y, z are only intermediate values, i.e., the uncertainties of NORMx, y, z does not affect the  $E^2$ -field uncertainty inside TSL (see below ConvF).
- NORM(f)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 measurements for 1 > 800 MHz. The same setups are used for assessment or 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.

Certificate No: ES3-3071 Jun12

Page 2 of 11

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Report No. : EN/2013/70006 Page : 487 of 616

ES3DV3-SN:3071

June 22, 2012

# Probe ES3DV3

## SN:3071

Manufactured: Calibrated: December 14, 2004 June 22, 2012

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

Certificate No: ES3-3071\_Jun12

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Page 3 of 11

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Report No. : EN/2013/70006 Page: 488 of 616

#### ES3DV3- SN:3071

June 22, 2012

#### DASY/EASY - Parameters of Probe: ES3DV3 - SN:3071

#### **Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (µV/(V/m)2) <sup>A</sup>	1.12	1.22	0.96	± 10.1 %
DCP (mV) <sup>8</sup>	101.5	99.2	99.2	

#### Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc <sup>2</sup> (k=2)
0	CW	0.00	X	0.00	0.00	1.00	107.3	±3.3 %
			Y	0.00	00.00	1.00	108.0	
			Z	0.00	0.00	1.00	99.5	

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

<sup>8</sup> The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 6).
<sup>9</sup> Numerical linearization parameter uncertainty nor required.
<sup>9</sup> Uncertainty is determined using the max, deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

Certificate No: ES3-3071 Jun12

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Page 4 of 11

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ES3DV3- SN:3071

June 22, 2012

#### DASY/EASY - Parameters of Probe: ES3DV3 - SN:3071

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) <sup>c</sup>	Relative Permittivity*	Conductivity (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (%=2)
750	41.9	0.89	5.91	5,91	5.91	0.37	1.63	± 12.0 %
835	41.5	0.90	5.68	5.68	5.68	0.77	1.14	± 12.0 %
900	41.5	0.97	5.57	5.57	5.57	0.48	1,40	± 12.0 %
1450	40,5	1.20	5.00	5.00	5,00	0.32	1.98	± 12.0 %
1750	40.1	1.37	4.89	4.89	4.89	0.80	1.25	± 12.0 %
1900	40.0	1.40	4.66	4.66	4.66	0.80	1.20	± 12.0 %
2000	40.0	1.40	4.63	4.63	4,63	0.80	1.24	± 12.0 %
2450	39.2	1.80	4.08	4.08	4.08	0.80	1.28	± 12.0 %

<sup>6</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), rise il 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 (*i* and *n*) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies below 2 GHz, the validity of tissue parameters (*i* and *n*) can be relaxed to ± 10% if liquid compensation formula is applied to the ConvF uncertainty for indicated target tasue parameters.

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Page 5 of 11

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ES3DV3- SN:3071

June 22, 2012

#### DASY/EASY - Parameters of Probe: ES3DV3 - SN:3071

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) c	Relative Permittivity	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	5.78	5.78	5.78	0,65	1.24	± 12.0 %
835	55.2	0.97	5.69	5.69	5.69	0.36	1.76	± 12.0 %
900	55.0	1.05	5.62	5.62	5.62	0.67	1.27	± 12.0 %
1450	54.0	1.30	5.04	5.04	5.04	0.66	1.31	± 12.0 %
1750	53.4	1.49	4.50	4.50	4.50	0.74	1,29	± 12.0 %
1900	53.3	1.52	4.29	4.29	4.29	0.60	1.44	± 12.0 %
2000	53.3	1.52	4.37	4.37	4.37	0.62	1.46	± 12.0 %
2450	52.7	1.95	3.87	3.87	3.87	0.80	1.08	= 12.0 %

<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else # 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>C</sup> At requencies below 3 GHz, the validity of fissue parameters (u and a) can be released to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies below 3 GHz, the validity of fissue parameters (u and a) can be released to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies below 3 GHz, the validity of fissue parameters (r and w) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tasue parameters.

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Page 6 of 11

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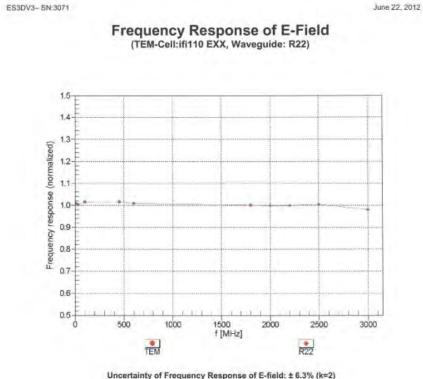
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Report No. : EN/2013/70006 Page: 491 of 616



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Page 7 of 11

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ES3DV3-SN:3071

Report No. : EN/2013/70006 Page : 492 of 616

June 22, 2012

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

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

600 MHz

Roll ["]

1800 MHz

Certificate No: ES3-3071\_Jun12

Page 8 of 11

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100 MHz

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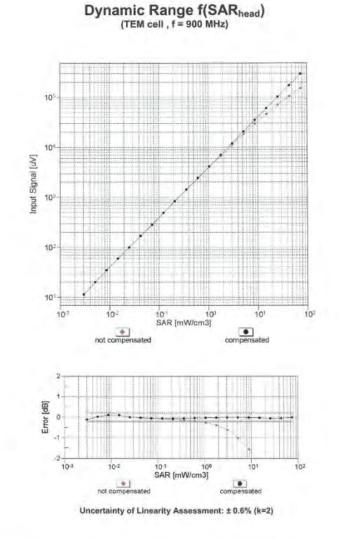
2500 MHz



Report No. : EN/2013/70006 Page : 493 of 616

ES3DV3- SN:3071

June 22, 2012



Certificate No: ES3-3071\_Jun12

Page 9 of 11

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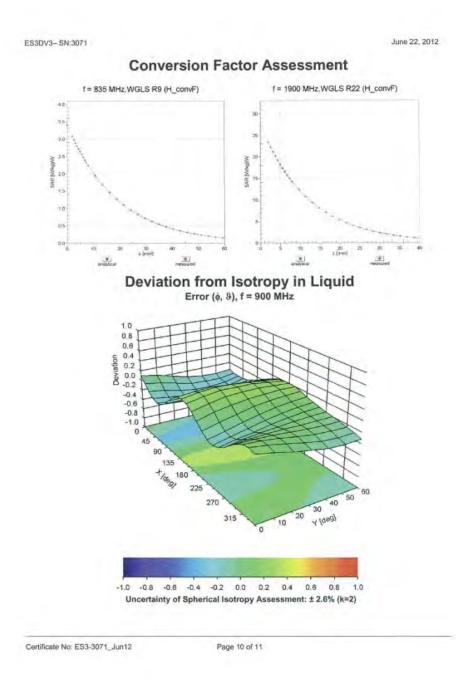
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Report No. : EN/2013/70006 Page : 494 of 616



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ES3DV3- SN:3071

June 22, 2012

#### DASY/EASY - Parameters of Probe: ES3DV3 - SN:3071

#### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (*)	64.9
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	.2 mm
Recommended Measurement Distance from Surface	3 mm

Certificate No: ES3-3071\_Jun12

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Page 11 of 11

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#### Report No. : EN/2013/70006 Page : 496 of 616

	ice is one of the signatorie		No.: SCS 108
Aultilateral Agreement for the		certificates	
Client Auden			EX3-3820_Dec12
CALIBRATION	CERTIFICATI	2	
Object	EX3DV4 - SN:38	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	
The measurements and the un	certainties with confidence p	onal standards, which realize the physical units obability are given on the following pages and	are part of the certificate.
The measurements and the un All calibrations have been cond Calibration Equipment used (M	certainties with confidence p lucted in the closed laborator		are part of the certificate.
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards	certainties with confidence p flucted in the closed laborator &TE critical for calibration)	obability are given on the following pages and y facility: environment temperature (22 ± 3)°C i Call Date (Certificate No.)	are part of the certificate. and humidity < 70%. Scheduled Calibration
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power meter E4419B	certainties with confidence p lucted in the closed laborator &TE critical for calibration) ID GB41293874	Dability are given on the following pages and y facility: environment temperature (22 ± 3)°C a Cal Date (Certificate No.) 29-Mar-12 (No. 217-01508)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power meter E4419B Power sensor E4412A	certainties with confidence p lucted in the closed laborator &TE critical for calibration) ID GB41293874 MY41498087	Dability are given on the following pages and y facility: environment temperature (22 ± 3)°C a Dal Date (Certificate No.) 29-Mar-12 (No. 217-01508) 29-Mar-12 (No. 217-01508)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power sensor E4419B Power sensor E4419A Reference 3 dB Attenuator	certainties with confidence p lucted in the closed laborator &TE critical for calibration) iD GB41293874 MY4148087 SN: 55054 (3c)	Dal Date (Certificate No.)         29-Mar-12 (No. 217-01508)         29-Mar-12 (No. 217-01508)         29-Mar-12 (No. 217-01508)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power sensor E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 3 dB Attenuator	eartainties with confidence p lucted in the closed laborator laTE critical for calibration) ID GB4 1293874 MY4 1498087 SN: \$5054 (3c) SN: \$5054 (3c) SN: \$5056 (20b)	Obability are given on the following pages and           y facility: environment temperature (22 ± 3)°C i           Cal Date (Certificate No.)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01503)           27-Mar-12 (No. 217-01503)           27-Mar-12 (No. 217-01529)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power meter E4419B Power sensor E4419A Reference 3 dB Attenuator Reference 30 dB Attenuator	eartainties with confidence p lucted in the closed laborator &TE critical for calibration) iD GB41293874 MY41498087 SN: 55054 (3c) SN: 55068 (20b) SN: 55129 (30b)	Obability are given on the following pages and           y facility: environment temperature (22 ± 3)°C a           Cal Date (Certificate No.)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01529)           27-Mar-12 (No. 217-01532)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13 Apr-13
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power sensor E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 3 dB Attenuator	certainties with confidence p lucted in the closed laborator &TE critical for calibration) ID GB41293874 MY41498087 SN: \$5056 (3c) SN: \$5066 (2bb) SN: \$5068 (2bb) SN: \$5129 (30b) SN: 3013	Dal Date (Certificate No.)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)           29-Dec-11 (No. ES3-3013, Dec11)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13 Dec-12
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 30 dB Attenuator Reference 30 dB Attenuator	eartainties with confidence p lucted in the closed laborator &TE critical for calibration) iD GB41293874 MY41498087 SN: 55054 (3c) SN: 55068 (20b) SN: 55129 (30b)	Obability are given on the following pages and           y facility: environment temperature (22 ± 3)°C a           Cal Date (Certificate No.)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01529)           27-Mar-12 (No. 217-01532)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13 Apr-13
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 30 dB Attenuator Reference 30 dB Attenuator	certainties with confidence p lucted in the closed laborator &TE critical for calibration) ID GB41293874 MY41498087 SN: \$5056 (3c) SN: \$5066 (2bb) SN: \$5068 (2bb) SN: \$5129 (30b) SN: 3013	Dal Date (Certificate No.)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)           29-Dec-11 (No. ES3-3013, Dec11)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13 Dec-12
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power meter E44198 Power sension E4412A Reference 3 dB Attenuator Reference 3 dB Attenuator Reference 3 dB Attenuator Reference 20 dB Attenuator Reference Probe ES3DV2 DAE4	eartainties with confidence p lucted in the closed laborator &TE cntical for calibration) ID GB41293874 MY41498087 SN: \$5054 (3c) SN: \$5056 (2c) SN: \$5056 (	Dabbility are given on the following pages and           y facility: environment temperature (22 ± 3)°C i           Cal Date (Certificate No.)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)           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)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13 Apr-13 Dec-12 Jun-13
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power meter E4419B Power sensor E4419A Reference 3 dB Attenuator Reference 30 dB Attenuator Reference 20 dB Attenuator	ertainties with confidence p lucted in the closed laborator &TE critical for calibration) ID GB41293874 MY41498087 SN: 55054 (3c) SN: 55058 (20b) SN: 55058 (20b) SN: 55129 (30b) SN: 3013 SN: 660 ID	Obability are given on the following pages and           y facility: environment temperature (22 ± 3)°C at           Cal Date (Certificate No.)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01531)           27-Mar-12 (No. 217-01532)           29-Dec-11 (No. ES3-3013. Dec11)           20-Jun-12 (No. DAE4-660. Jun12)           Check Date (in house)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13 Dec-12 Jun-13 Scheduled Check
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power meter E4419B Power sensor E4419A Reference 3 dB Attenuator Reference 3 dB Attenuator Reference 30 dB Attenuator Reference 30 dB Attenuator Reference S30 DB Attenuator Reference S30 DB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C	certainties with confidence p           lucted in the closed laborator           &TE cntical for calibration)           ID           GB41293874           MY41498087           SN: S5054 (3c)           SN: S5054 (3c)           SN: S5056 (20b)           SN: S5056 (20b)           SN: S5066 (20b)           SN: 660           ID           US3642U01700           US37390585	Obability are given on the following pages and           y facility: environment temperature (22 ± 3)°C at           Date (Certificate No.)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)           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 Apt-11)           18-Oct-01 (in house check Oct-12)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13 Apr-13 Dec-12 Jun-13 Scheduled Check In house check: Oct-13
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power meter E44198 Power sensor E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 3 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E	certainties with confidence p           lucted in the closed laborator           &TE critical for calibration)           ID           GB41293874           MY41498087           SN: 55096 (20b)           SN: 56096 (20b)           SN: 56090 (20b)           SN: 5609 (20b)           SN: 5609 (20b)           ID           US3642U01700	obability are given on the following pages and           y facility: environment temperature (22 ± 3)°C at           Cal Date (Certificate No.)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)           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)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13 Dec-12 Jun-13 Scheduled Check In house check: Apr-13
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power meter E44198 Power sensor E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 3 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E	certainties with confidence p           lucted in the closed laborator           &TE critical for calibration)           ID           GB41293874           MY41498087           SN: 55056 (20b)           SN: 55086 (20b)           SN: 55086 (20b)           SN: 55086 (20b)           SN: 55086 (20b)           SN: 660           ID           US3642U01700           US37390585           Name	obability are given on the following pages and           y facility: environment temperature (22 ± 3)°C at           Cal Date (Certificate No.)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)           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-Ocl-01 (in house check Oct-12)           Function	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13 Apr-13 Dec-12 Jun-13 Scheduled Check In house check: Oct-13
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power meter E4419B Power sensor E4412A Reference 3 08 Attenuator Reference 30 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference	eartainties with confidence p lucted in the closed laborator &TE cntical for calibration) ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5058 (20b) SN: S5058 (20b) SN: S5129 (30b) SN: 3013 SN: 660 ID US3642U01700 US37390585 Name Jetori Kasirati	Obability are given on the following pages and           y facility: environment temperature (22 ± 3)°C at           Cal Date (Certificate No.)           29-Mar-12 (No. 217-01508)           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 Apt-11)           18-Oct-01 (in house check Oct-12)           Function           Laboratory Technician	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13 Apr-13 Dec-12 Jun-13 Scheduled Check In house check: Oct-13
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power meter E44198 Power sensor E44198 Power sensor E44198 Reference 3 dB Attenuator Reference 3 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E	certainties with confidence p           lucted in the closed laborator           &TE critical for calibration)           ID           GB41293874           MY41498087           SN: 55056 (20b)           SN: 55086 (20b)           SN: 55086 (20b)           SN: 55086 (20b)           SN: 55086 (20b)           SN: 660           ID           US3642U01700           US37390585           Name	obability are given on the following pages and           y facility: environment temperature (22 ± 3)°C at           Cal Date (Certificate No.)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)           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-Ocl-01 (in house check Oct-12)           Function	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13 Apr-13 Dec-12 Jun-13 Scheduled Check In house check: Oct-13

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#### Report No. : EN/2013/70006 Page: 497 of 616

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



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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 cartificates

Glossary:

CF

TSL NORMX, y.z. tissue simulating liquid sensitivity in free space sensitivity in TSL / NORMx.y.z. ConvF DCP diode compression point crest factor (1/duty\_cycle) of the RF signal A.B.C modulation dependent linearization parameters Polarization @ or 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:

   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:

- NORMx,y,z: Assessed for E-field polarization  $\theta = 0$  (f  $\leq 900$  MHz in TEM-cell; f  $\geq 1800$  MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the  $E^2$ -field uncertainty inside TSL (see below ConvF).
- NORM(f)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 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 masurements 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 Mul-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 Up (on probe axis). No tolerance required.

Certificate No: EX3-3820 Dec12

Page 2 of 11

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Report No. : EN/2013/70006 Page : 498 of 616

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!)

Certificate No: EX3-3820\_Dec12

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Page 3 of 11

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December 10, 2012

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

#### **Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm $(\mu V/(V/m)^2)^A$	0.44	0.35	0.44	± 10.1 %
DCP (mV) <sup>8</sup>	99.1	100.3	99.4	

#### **Modulation Calibration Parameters**

UID	Communication System Name	PAR		A dB	B dB	Ç dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	0.00	X	0.0	0.0	1.0	149.3	±3.0 %
			Y	0.0	0.0	1.0	179,2	-
			Z	0.0	0.0	1.0	147.4	100

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

Certificate No: EX3-3820\_Dec12

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Page 4 of 11

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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) <sup>F</sup>	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 %
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  $\pm$  100 MHz only applies for DASY v4.4 and higher (see Page 2), tise it is restricted to  $\pm$  50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. <sup>6</sup> All frequencies below 3 GHz, the validity of tissue parameters (c and  $\sigma$ ) can be relaxed to  $\pm$  10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (u and  $\sigma$ ) is restricted to  $\pm$  5%. The uncertainty for the RSS of the ConvF uncertainty for indicated target tissue parameters.

Certificate No: EX3-3820\_Dec12

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Page 5 of 11

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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) <sup>F</sup>	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>b</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 a calibration frequency and the uncertainty for the indicated frequency band. <sup>c</sup> At frequencies below 3 GHz, the validity of lesue parameters (is and or) 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 (is and or) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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Page 8 of 11

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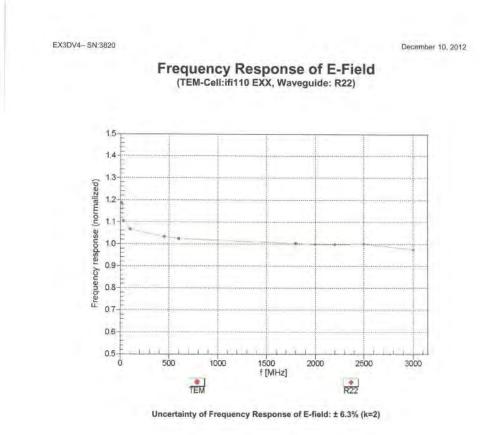
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#### Report No. : EN/2013/70006 Page : 502 of 616



Certificate No: EX3-3820\_Dec12

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Page 7 of 11

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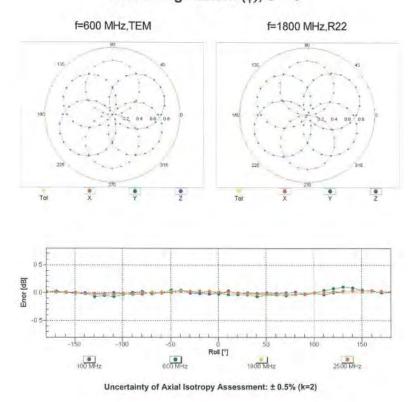
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Report No. : EN/2013/70006 Page : 503 of 616

EX3DV4- SN:3820

December 10, 2012



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

Certificate No: EX3-3820 Dec12

Page 8 of 11

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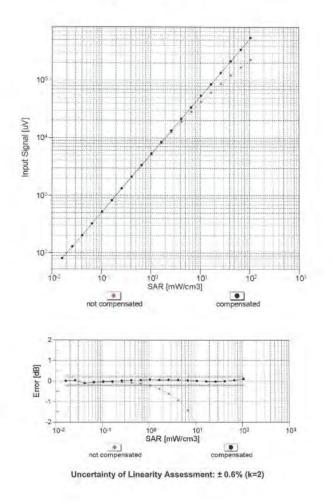


#### Report No. : EN/2013/70006 Page : 504 of 616

EX3DV4- SN:3820

December 10, 2012

Dynamic Range f(SAR<sub>head</sub>) (TEM cell , f = 900 MHz)



Certificate No: EX3-3820\_Dec12

Page 9 of 11

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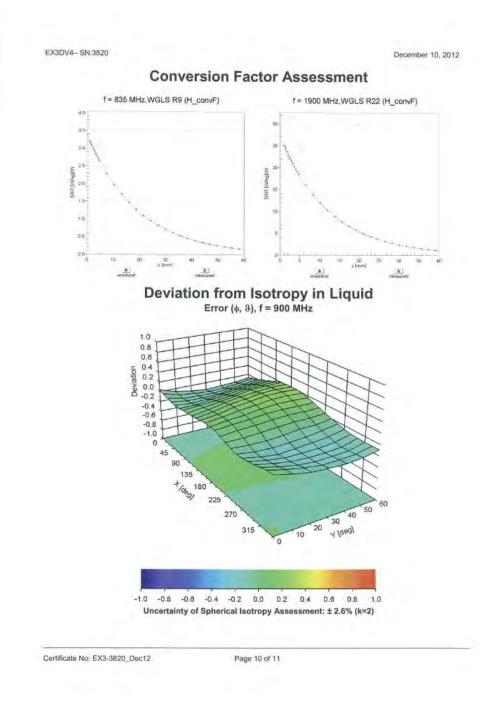
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Report No. : EN/2013/70006 Page : 505 of 616



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December 10, 2012

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

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 Length	9 mm
Tip Diameter	2,5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm

Certificate No: EX3-3820\_Dec12

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Page 11 of 11

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#### Report No. : EN/2013/70006 Page : 507 of 616

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Accredited by the Swiss Accredit The Swiss Accreditation Servic Aultilateral Agreement for the r	e is one of the signatories	s to the EA	No.: SCS 108
Silent SGS-TW (Aude	en)	Certificate No:	DAE4-1336_May13
CALIBRATION O	CERTIFICATE		
Object	DAE4 - SD 000 D	04 BM - SN: 1336	
Calibration procedure(s)	QA CAL-06.v26 Calibration procee	dure for the data acquisition elect	ronics (DAE)
Calibration date:	May 23, 2013		
The measurements and the unce All calibrations have been condu-	ertainties with confidence proceed in the closed laboratory	anal standards, which realize the physical unit obability are given on the following pages and y facility: environment temperature $(22\pm3)^{\circ}C$	are part of the certificate.
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#### Report No. : EN/2013/70006 Page : 508 of 616

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

DAE Connector angle

data acquisition electronics r 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: Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - Low Battery Alarm Voltage: Typical value for information. Below this voltage, a battery alarm signal is generated.
  - Power consumption: Typical value for information. Supply currents in various operating modes.

Certificate No: DAE4-1336\_May13

Page 2 of 5

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#### Report No. : EN/2013/70006 Page : 509 of 616

#### DC Voltage Measurement

High Range:	1LSB =	6.1µV .	full range =	-100+300 mV
Low Range:	1LSB =	61nV .	full range =	-1+3mV

Calibration Factors	x	Y	Z
High Range	403.456 ± 0.02% (k=2)	403.207 ± 0.02% (k=2)	403.280 ± 0.02% (k=2)
Low Range	3.96591 ± 1.50% (k=2)	3.96908 ± 1.50% (k=2)	3.99337 ± 1.50% (k=2)

#### **Connector Angle**

Connector Angle to be used in DASY system	122.5°±1°
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Page 3 of 5

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#### Report No. : EN/2013/70006 Page : 510 of 616

#### Appendix

#### 1. DC Voltage Linearity

High Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	199996.98	1.17	0.00
Channel X + Input	20001.78	1.50	0.01
Channel X - Input	-20000.03	0.93	-0.00
Channel Y + Input	199993.44	-2.19	-0.00
Channel Y + Input	19999.20	-0.98	-0,00
Channel Y - Input	-20002.36	-1.35	0.01
Channel Z + Input	199993.74	-1.97	-0.00
Channel Z + Input	19998.32	-1.83	-0.01
Channel Z - Input	-20002.54	-1.46	0.01

Low Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	2000.34	-0.07	-0.00
Channel X + Input	201.19	0.16	80.0
Channel X - Input	-198.81	0.01	-0.01
Channel Y + Input	2000.13	-0.33	-0.02
Channel Y + Input	200.05	-0.83	-0.41
Channel Y - Input	-200.10	-1.14	0.57
Channel Z + Input	2000.59	0.31	0.02
Channel Z + Input	200.18	-0.69	-0.34
Channel Z - Input	-199.90	-0.85	0.43

#### 2. Common mode sensitivity

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

	Common mode Input Voltage (mV)	High Range Average Reading (µV)	Low Range Average Reading (µV)
Channel X	200	6.44	4.67
	- 200	-3.73	-4.80
Channel Y	200	10.39	10.66
	- 200	-9.92	-9.79
Channel Z	200	10.68	10.35
	- 200	-11.83	-12.04

#### 3. Channel separation

	Input Voltage (mV)	Channel X (µV)	Channel Y (µV)	Channel Z (µV)
Channel X	200	1.1.1	5.56	-0.75
Channel Y	200	8.84	-	7,76
Channel Z	200	8.66	6.07	

Certificate No: DAE4-1336\_May13

Page 4 of 5

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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	15911	15227
Channel Y	15869	14671
Channel Z	15839	15960

#### 5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec Input  $10 M \Omega$ 

	Average (µV)	min. Offset (µV)	max. Offset ( $\mu V$ )	Std. Deviation (µV)
Channel X	0.96	-0.43	2.20	0.41
Channel Y	-0.95	-2.41	1.35	0.49
Channel Z	-0.65	-1.67	0.76	0.41

#### 6. Input Offset Current

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

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

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

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

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

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

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

Certificate No: DAE4-1336\_May13

Page 5 of 5

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#### Report No. : EN/2013/70006 Page : 512 of 616

Engineering AG oughausstrasse 43, 8004 Zuri	ich, Switzerland	Hac-MRA	Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service
Accredited by the Swiss Accredit The Swiss Accreditation Servi- dultilateral Agreement for the	ce is one of the signatorie	s to the EA	No.: SCS 108
-			EV2 2040 Aund 2
Client SGS-TW (Aud	len)	Certificate No:	EX3-3848_Apr13
CALIBRATION	CERTIFICATI	E	
Object	EX3DV4 - SN:38	48	
Calibration procedure(s)		DA CAL-14.v3, QA CAL-23.v4, QA edure for dosimetric E-field probes	CAL-25.v4
Calibration date:	April 30, 2013		
The measurements and the unc	pertainties with confidence p	robability are given on the following pages and	are part of the certificate.
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All calibrations have been condi	ucted in the closed laborator STE critical for calibration)	ry facility: environment temperature (22 ± 3)°C a	and humidity < 70%
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All calibrations have been condi Calibration Equipment used (M/ Primary Standards Power meter E44198 Power sensor E4412A Reference 3 dB Attenuator	ucted in the closed laborator 3TE critical for calibration) ID GB41293874 MY41498087 SN: S5054 (3c)	ry facility: environment temporature (22 ± 3)°C 4 Cal Date (Ceruficate No.) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01737)	schettuled Calibration Apr-14 Apr-14 Apr-14
All calibrations have been condi- Calibration Equipment used (M/ Primary Standards Power meter E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 30 dB Attenuator	ID GB41203874 MY41498087 SN: S5054 (3c) SN: S5277 (20x)	ry facility: environment temperature (22 ± 3)°C 4 Cal Date (Certificate No.) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01735)	Scheduled Calibration Apr-14 Apr-14 Apr-14 Apr-14 Apr-14
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All calibrations have been condi- Calibration Equipment used (MA Primary Standards Power meter E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 30 dB Attenuator Reference 30 dB Attenuator Reference Probe ES30V2	ID GB41203874 MY41498087 SN: S5054 (3c) SN: S5277 (20x)	ry facility: environment temperature (22 ± 3)°C 4 Cal Date (Certificate No.) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01735)	Scheduled Calibration Apr-14 Apr-14 Apr-14 Apr-14 Apr-14
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All calibrations have been condi Calibration Equipment used (MA Primary Standards Power meter E44198 Power sensor E4412A Reference 30 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES30V2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E	Ucled in the closed laborator STE critical for calibration) ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5054 (3c) SN: S5129 (30b) SN: 3013 SN: 660 ID US3842U01700 US37390585	ry facility: environment temperature (22 ± 3)°C 4 Cal Date (Certificate No.) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01737) 04-Apr-13 (No. 217-01737) 04-Apr-13 (No. 217-01738) 28-Dec-12 (No. ESS-3013, Dec12) 31-Jan-13 (No. DAE4-660, Jan13) Check Date (in house) 4-Aug-99 (in house check Apr-13) 18-Oct-01 (in house check Apr-13)	and humidity < 70% Schettuled Calibration Apr-14 Apr-14 Apr-14 Apr-14 Apr-14 Dec-13 Jan-14 Scheduled Check In house check: Apr-15 In house check: Oct-13
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Certificate No: EX3-3848\_Apr13

Page 1 of 11

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#### Report No. : EN/2013/70006 Page : 513 of 616

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



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Accreditation No.1 SCS 108

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#### 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, D
 modulation dependent linearization parameters

 Polarization φ
 φ rotation around probe axis

 Polarization 9
 & station 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:

- 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:

- NORMx, y, z: Assessed for E-field polarization 8 = 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(f)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; Dx, y, z; VRx, y, z; A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 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.

Certificate No: EX3-3848\_Apr13

Page 2 of 11

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Report No. : EN/2013/70006 Page: 514 of 616

EX3DV4 - SN:3848

April 30; 2013

## Probe EX3DV4

### SN:3848

Manufactured: Repaired: Calibrated:

October 25, 2011 April 22, 2013 April 30, 2013

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

Certificate No: EX3-3848 Apr13

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Page 3 of 11

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April 30, 2013

#### DASY/EASY - Parameters of Probe: EX3DV4 - SN:3848

Pacie	Calib	pration	Dars	moto	100

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm $(\mu V/(V/m)^2)^A$	0.41	0.41	0.45	± 10.1 %
DCP (mV) <sup>B</sup>	98.8	100.8	99.6	

#### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dBõV	C	D dB	VR mV	Unc <sup>e</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	145,1	±3.0 %
		Y.	0.0	0.0	1.0		150.4	
-		Z	0.0	0.0	1.0		152.4	

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>1</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 riod value.

Certificate No: EX3-3848\_Apr13

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Page 4 of 11

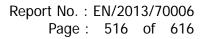
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SG:

April 30, 2013

### DASY/EASY - Parameters of Probe: EX3DV4 - SN:3848

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)
750	41.9	0.89	10.01	10.01	10.01	0.76	0.58	± 12.0 %
835	41.5	0.90	9.67	9.67	9.67	0.73	0.59	± 12.0 %
900	41.5	0.97	9.57	9.57	9.57	0.80	0.50	± 12.0 9
1750	40.1	1.37	8.41	8.41	8.41	0.48	0.78	± 12.0 9
1900	40.0	1.40	8.13	8.13	8.13	0.50	0.74	± 12.0 9
2000	40.0	1.40	8.01	8.01	8.01	0.80	0.60	± 12.0 9
2300	39.5	1.67	7.69	7.69	7.69	0.45	0.79	± 12.0 9
2450	39.2	1.80	7.15	7.15	7.15	0.29	1.06	± 12.0 %
2600	39.0	1.96	6.89	6.89	6.89	0.49	0.75	± 12.0 %
5200	36.0	4.66	5.45	5.45	5.45	0.35	1.80	± 13.1 %
5300	35.9	4.76	5.22	5.22	5.22	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.49	4.49	4.49	0.40	1.80	± 13,1 %
5800	35.3	5.27	4.88	4.88	4.88	0.40	1.80	± 13,1 9

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

<sup>5</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>7</sup> All frequencies below 3 GHz, the validity of issue parameters (*c* and *c*) can be relaxed to ± 10% if liguid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of issue parameters (*c* and *c*) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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Page 5 of 11

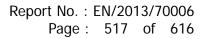
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EX3DV4- SN:3848

April 30, 2013

### DASY/EASY - Parameters of Probe: EX3DV4 - SN:3848

f (MHz) <sup>c</sup>	Relative Permittivity	Conductivity (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	9.59	9.59	9.59	0.36	0.91	± 12.0.%
835	55.2	0.97	9.43	9.43	9.43	0.27	1.14	± 12.0 %
900	55.0	1.05	9.35	9.35	9.35	0.33	0.96	± 12.0 %
1750	53.4	1.49	7.78	7.78	7.78	0.35	0.83	± 12.0 %
1900	53.3	1.52	7.41	7.41	7.41	0.45	0.80	± 12.0 9
2000	53.3	1.52	7,57	7.57	7.57	0.32	0.91	± 12.0 %
2300	52.9	1.81	7.20	7.20	7.20	0.75	0.60	± 12.0 9
2450	52.7	1.95	7.12	7.12	7,12	0.76	0.55	± 12.0 9
2600	52.5	2.16	6.98	6.98	6.98	0.80	0.50	± 12.0 9
5200	49.0	5.30	4.79	4.79	4.79	0.45	1.90	± 13.1 9
5300	48.9	5.42	4.71	4.71	4.71	0.40	1.90	± 13.1 9
5600	48.5	5.77	4.42	4.42	4.42	0.30	1.90	± 13.1 9
5800	48.2	6.00	4.42	4.42	4.42	0.50	1.90	± 13.1 %

### Calibration Parameter Determined in Body Tissue Simulating Media

<sup>5</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>7</sup> All frequencies below 3 GHz, the validity of taskie parameters (*x* and 0) can be relaxed to ± 10% if liquid compensation formula is applied to measured SRA values. At Inequencies above 3 GHz, the validity of taskie parameters (*x* and 0) can be relaxed to ± 10% if liquid compensation formula is applied to measured SRA values. At Inequencies above 3 GHz, the validity of taskie parameters (*x* and 0) is restricted to ± 55%. The uncertainty is the RSS of the ConvF uncertainty for milicated target tissue parameters.

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Page 6 of 11

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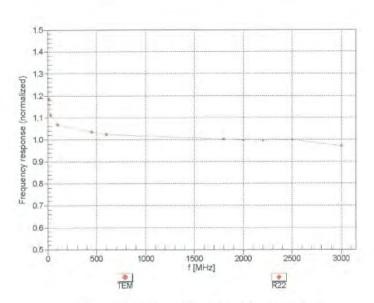
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EX3DV4- SN:3848

### Report No. : EN/2013/70006 Page : 518 of 616

April 30, 2013



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

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

Certificate No: EX3-3848\_Apr13

Page 7 of 11

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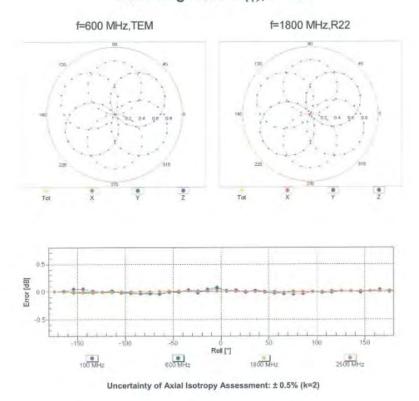
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Report No. : EN/2013/70006 Page : 519 of 616

EX3DV4-SN:3848

April 30, 2013



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

Certificate No: EX3-3848\_Apr13

Page 8 of 11

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台灣檢驗科技股份有限公司 t (886-2) 2299-3279

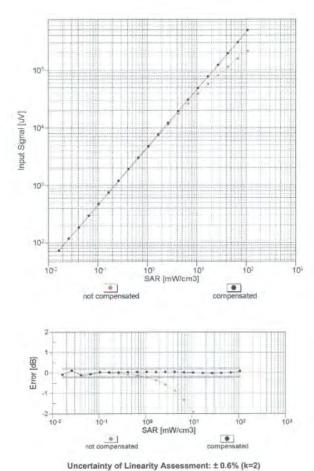
f (886-2) 2298-0488



### Report No. : EN/2013/70006 Page : 520 of 616

EX3DV4- SN:3848

April 30, 2013



Dynamic Range f(SAR<sub>head</sub>) (TEM cell , f = 900 MHz)

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Certificate No: EX3-3848\_Apr13

Page 9 of 11

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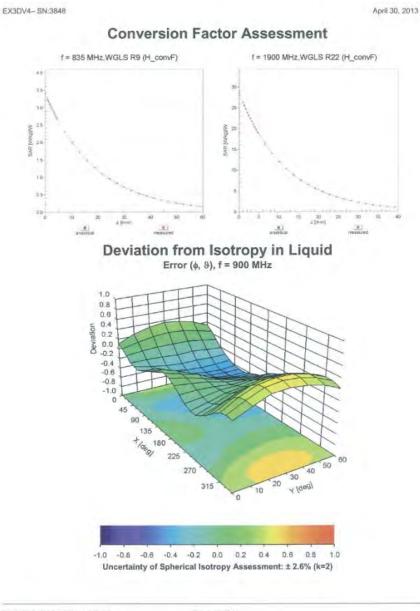
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Report No. : EN/2013/70006 Page : 521 of 616



Certificate No: EX3-3848\_Apr13

Page 10 of 11

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EX3DV4-5N:3848

April 30, 2013

### DASY/EASY - Parameters of Probe: EX3DV4 - SN:3848

#### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (")	-54.2
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm

Certificate No: EX3-3848\_Apr13

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Page 11 of 11

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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%	00
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, 8004 Zurich, Switzerand Phone +41 1 245 9700, Pax +41 1 245 9778 m/o@speeg.com, http://www.apsag.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 /f.
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		Belgentd % Paparet Engineering AG 1990 Russidense 53, 8004 2010 Switzerland Phone 941, 246 9700 Russide 7 245 9779 Info Septeg.com, http://www.sbaeg.com

Dechip MIT-OD DOD PAD C ... P

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Page

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

ccredited by the Swiss Accredit he Swiss Accreditation Serviv ultilateral Agreement for the	ce is one of the signatorie	s to the EA	m No.: SCS 108
lient SGS-TW (Aud			lo: D835V2-4d063_May12
CALIBRATION	CERTIFICATE		
Dbject	D835V2 - SN: 4d	063	
Calibration procedure(s)	QA CAL-05.v8 Calibration proce	dure for dipole validation kits ab	ove 700 MHz
Calibration date:	May 25, 2012		
The measurements and the unc	ertainties with confidence p	onal standards, which realize the physical unrobability are given on the following pages a ry facility: environment temperature $(22 \pm 3)^2$	nd are part of the certificate.
The measurements and the unc All calibrations have been condu Calibration Equipment used (M&	ertainties with confidence p acted in the closed laborator TE critical for calibration)	robability are given on the following pages a $\gamma$ facility: environment temperature (22 ± 3)	nd are part of the certificate. "C and humidity < 70%.
The measurements and the unc All calibrations have been condu Calibration Equipment used (M& Primary Standards	ertainties with confidence p acted in the closed laborator TE critical for calibration) ID #	robability are given on the following pages a $\gamma$ 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 unc All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A	ertainties with confidence p incred in the closed laboration TE critical for calibration) ID # GB37480704	robability are given on the following pages a ry facility: environment temperature (22 ± 3) Cel 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 unc All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A	ertainties with confidence p incted in the closed laboration TE critical for calibration) ID # GB37480704 US37292783	robability are given on the following pages a 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 unc All calibrations have been condu- Calibration Equipment used (M& Primary Standards Power sensor HP 8481A Reference 20 dB Attenuator	ertainties with confidence p coted in the closed laboration TE critical for calibration) ID # GB37480704 US37292783 SN: 5058 (20k)	robability are given on the following pages a 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)	nd are part of the certificate. "C and humidity < 70%. Scheduled Calibration Oct-12 Oct-12 Apr-13
The measurements and the unc All calibrations have been condu- Calibration Equipment used (M& Primary Standards Power sensor HP 8481A Feference 20 dB Attenuator Type-N mismatch combination	ertainties with confidence p incted in the closed laboration TE critical for calibration) ID # GB37480704 US37292783	robability are given on the following pages a 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 unc All calibrations have been condu- Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power meter EPM-442A Power asensor HP 8481A Reference 20 dB Attenuator Ype-N mismatch combination Reference Probe ES3DV3	ertainties with confidence p octed in the closed laboration TE ortical for calibration) ID # GB37480704 US37292783 SN: 5056 (20k) SN: 5047.2 / 06327	coability are given on the following pages a           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)	nd are part of the certificate. "C and humidity < 70%. Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13
The measurements and the unc All calibrations have been condu- Calibration Equipment used (M& Primary Standards Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards	ertainties with confidence p incted in the closed laboration TE critical for calibration) ID # GB37480704 US37292783 SN: 5068 (20k) SN: 5068 (20k) SN: 5068 (20k) SN: 5068 (20k) SN: 5068 (20k) SN: 5068 (20k) SN: 5068 (20k) ID #	robability are given on the following pages a y 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 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12 Scheduled Check
The measurements and the unc All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A	ertainties with confidence p octed in the closed laboration TE ortical for calibration) ID # GB37480704 US37292783 SN: 5058 (20k) SN: 5058 (20k) SN: 5058 (20k) SN: 5058 (20k) SN: 5058 (20k) ID # ID # MY41092317	Cal Date (Certificate No.)           OS-Oct-11 (No. 217-01451)           OS-Oct-11 (No. 217-01451)           27-Mar-12 (No. 217-01451)           27-Mar-12 (No. 217-01530)           30-Dec-11 (No. ES3-3205_Dec11)           04-Jul-11 (No. DAE4-601_Jul 11)           Check Date (in house)           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 unc 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	ertainties with confidence p incted in the closed laboration TE critical for calibration) ID # GB37480704 US37292783 SN: 5068 (20k) SN: 5068 (20k) SN: 5068 (20k) SN: 5068 (20k) SN: 5068 (20k) SN: 5068 (20k) SN: 5068 (20k) ID #	robability are given on the following pages a y 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 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12 Scheduled Check
The measurements and the unc	ertainties with confidence p code in the closed laboration TE critical for calibration) ID # GB37480704 U337292783 SN: 5058 (20k) SN: 5047.2 / 08327 SN: 501 ID # MY41092317 100005	robability are given on the following pages a ry facility: environment temperature (22 ± 3) <sup>4</sup> Cel 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. 217-01530) 27-Mar-12 (No. 253-3205_Dec11) 04-Jul-11 (No. DS3-3205_Dec11) 04-Jul-11 (No. DS3-3205_Dec11) Ot-Jul-11 (No. DS3-3205_Dec11) 04-Jul-11 (No. DS3-32	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
The measurements and the unc All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Fype N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer HP 8753E	ertainties with confidence p octed in the closed laboration TE critical for calibration) ID # GB37480704 US37292783 SN: 5058 (20k) SN: 5058 (20k) SN: 5068 (20k) SN: 5068 (20k) SN: 3205 SN: 3205 SN: 601 ID # MY41092317 100005 US37390585 S4206	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) 05-Oct-11 (No. 217-0153) 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)	nd are part of the certificate. "C and humidity < 70%. Scheduled Calibration Oct-12 Oct-12 Oct-12 Apr-13 Apr-13 Apr-13 Dec-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-12 Signature
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## Report No. : EN/2013/70006 Page: 526 of 616

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



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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

#### Glassan

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
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held b) 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: D835V2-4d063\_May12

Page 2 of 8

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## Report No. : EN/2013/70006 Page : 527 of 616

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#### **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

	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 TSI, 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

Certificate No: D835V2-4d063\_May12

Page 3 of 8

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### Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.6 £2 + 0.3 j£2
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
minute and fairs an easily	1000 110

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

Certificate No: D835V2-4d063\_May12

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Page 4 of 8

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

Date: 25.05.2012

Test Laboratory: SPEAG, Zurich, Switzerland

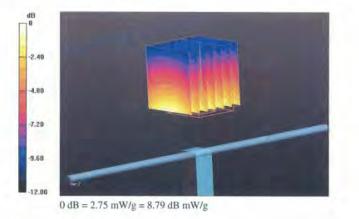
#### DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d063

Communication System: CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz;  $\sigma$  = 0.89 mho/m;  $\varepsilon_r$  = 40.6; p = 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 dB Peak SAR (extrapolated) = 3.481 mW/g SAR(1 g) = 2.36 mW/g; SAR(10 g) = 1.54 mW/g Maximum value of SAR (measured) = 2.75 mW/g



Certificate No: D835V2-4d063\_May12

Page 5 of 8

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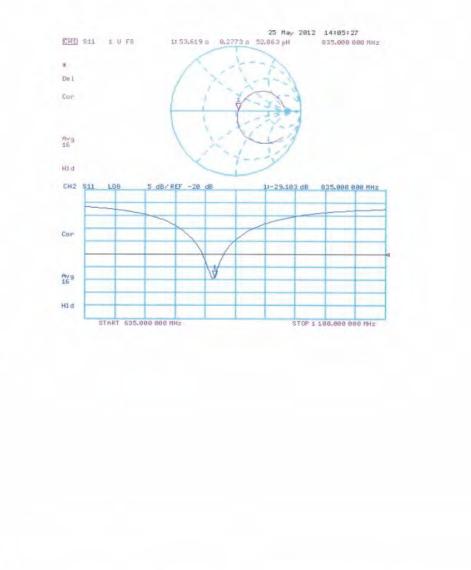
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Report No. : EN/2013/70006 Page : 530 of 616



#### Impedance Measurement Plot for Head TSL

Certificate No: D835V2-4d063\_May12

Page 6 of 8

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

Date: 25.05.2012

Test Laboratory: SPEAG, Zurich, Switzerland

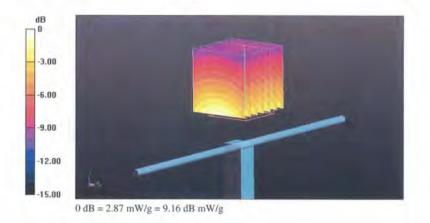
#### DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d063

Communication System: CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz;  $\sigma$  = 1 mho/m;  $\varepsilon_r$  = 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 dB Peak SAR (extrapolated) = 3.569 mW/g SAR(1 g) = 2.46 mW/g; SAR(10 g) = 1.62 mW/g Maximum value of SAR (measured) = 2.87 mW/g



Certificate No: D835V2-4d063 May12

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Page 7 of 8

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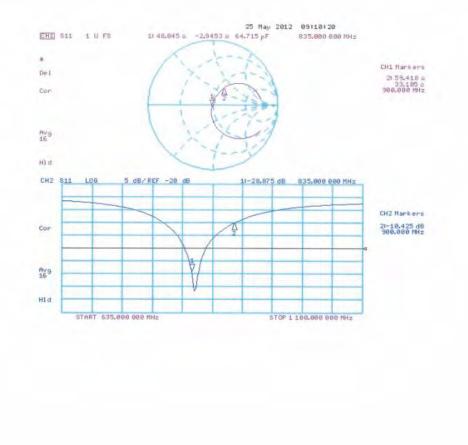
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Report No. : EN/2013/70006 Page : 532 of 616



#### Impedance Measurement Plot for Body TSL

Certificate No: D835V2-4d063\_May12

Page 8 of 8

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CALIBRATION		Concerned and	
Object	D1750V2 - SN: 1		
Calibration procedura(s)	QA CAL-05.v8 Calibration proce	dure for dipole validation kits abo	ove 700 MHz
Calibration date	May 29, 2012		
The measurements and the unce All calibrations have been condu	ertainties with confidence p cted in the closed laborato	onei standards, which realize the physical un robability are given on the following pages ar ry facility: environment temperature $(22 \pm 3)^{\circ}$	nd are part of the certificate.
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### Report No. : EN/2013/70006 Page: 534 of 616

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



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BRA

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
- 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)", b) 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

Page 2 of 8

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## Report No. : EN/2013/70006 Page : 535 of 616

#### Measurement Conditions

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

DASY Version	DASY5	V52.B.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

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.1	1.37 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.5 ± 6 %	1.34 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 "C	+98%	

#### 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**

	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

Page 3 of 8

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#### Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.1 Ω - 0.5 μΩ
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 feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

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

#### Additional EUT Data

Manufactured by	SPEAG	
Manufactured on	February 11, 2009	

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Page 4 of 8

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

Date: 29.05.2012

Test Laboratory: SPEAG, Zurich, Switzerland

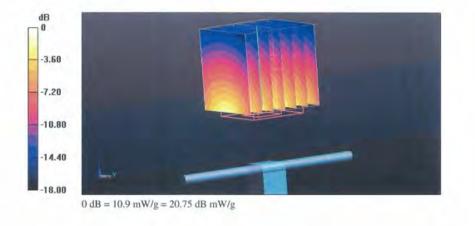
#### DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1008

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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Page 5 of 8

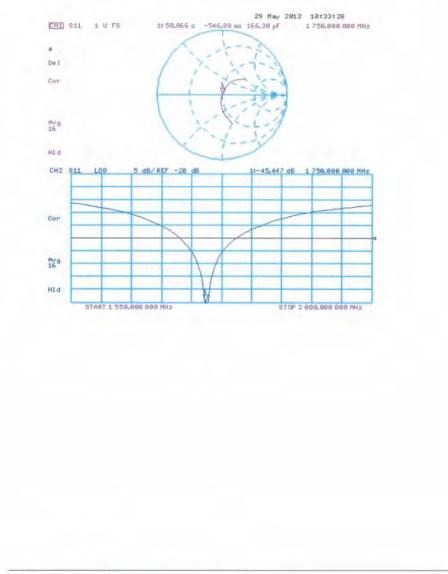
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Report No. : EN/2013/70006 Page : 538 of 616



#### Impedance Measurement Plot for Head TSL

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Page 6 of 8

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

Date: 29.05.2012

Test Laboratory: SPEAG, Zurich, Switzerland

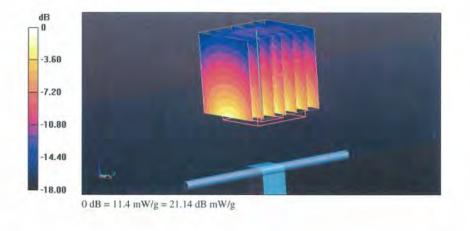
#### DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1008

Communication System: CW; Frequency: 1750 MHz Medium parameters used: f = 1750 MHz;  $\sigma = 1.46$  mho/m;  $\epsilon_r = 52.9$ ;  $\rho = 1000$  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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Page 7 of 8

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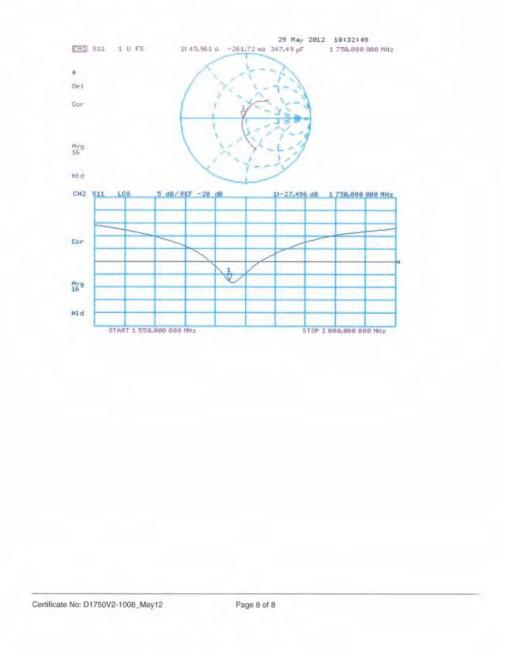
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prosecuted to the fullest extent of the law.



Report No. : EN/2013/70006 Page : 540 of 616



#### Impedance Measurement Plot for Body TSL

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### Report No. : EN/2013/70006 Page : 541 of 616

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### Report No. : EN/2013/70006 Page: 542 of 616

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



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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%

Certificate No: D1900V2-5d018\_Jun12

Page 2 nl B

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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	- mc	

#### 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)
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 cm3 (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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Page 3 of 8

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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	-
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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	June 04, 2002

Certificate No: D1900V2-5d018\_Jun12

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Page 4 of 8

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

Date: 21,06.2012

Test Laboratory: SPEAG, Zurich, Switzerland

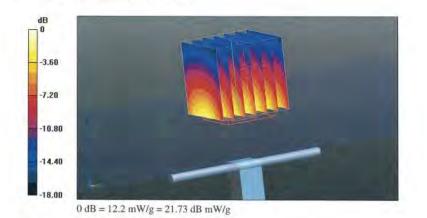
### DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d018

Communication System: CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.38 mho/m;  $\varepsilon_r$  = 40.2; p = 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=5mm Reference 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

Page 5 of 8

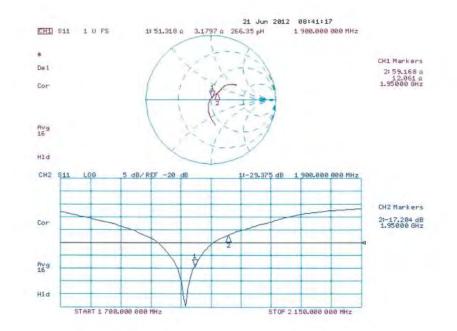
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Report No. : EN/2013/70006 Page : 546 of 616



#### Impedance Measurement Plot for Head TSL

Certificate No: D1900V2-5d018\_Jun12

Page 6 of 8

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

Date: 21.06.2012

Test Laboratory: SPEAG, Zurich, Switzerland

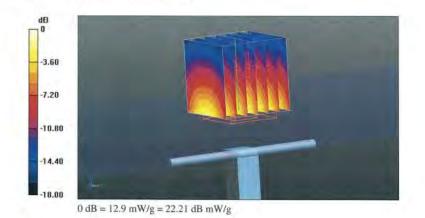
#### DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d018

Communication System: CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.53 mho/m;  $\epsilon_r$  = 52.7; p = 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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Page 7 of 8

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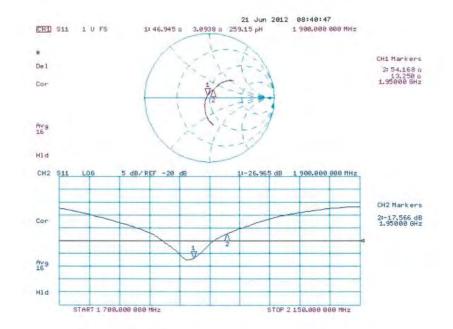
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Report No. : EN/2013/70006 Page : 548 of 616



#### Impedance Measurement Plot for Body TSL

Certificate No: D1900V2-5d018 Jun12

Page 8 of 8

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### Report No. : EN/2013/70006 Page : 549 of 616

Schmid & Partner Engineering AG eughausstrasse 43, 8004 Zuric	y of h, Switzerland	REAL CHILD S	Schweizerischer Kalibrierdiens Service suisse d'étalonnage Servizlo sylzzero di taratura Swiss Calibration Service
Accredited by the Swiss Accredits (he Swiss Accreditation Servic Aultilateral Agreement for the r	e is one of the signatorie	s to the EA	n No.: SCS 108
Client Auden		and the second	o: D2450V2-869_Jun12
CALIBRATION C	CERTIFICATE		
Object	D2450V2 - SN: 8	69	
Calibration procedure(s)	QA CAL-05.v8 Calibration proce	dure for dipole validation kits abo	ove 700 MHz
Calibration date:	June 15, 2012		
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### Report No. : EN/2013/70006 Page: 550 of 616

Calibration Laboratory of Schmid & Partner Engineering AG sstrasse 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) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held b) 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: D2450V2-869\_Jun12

Page 2 of 8

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### Report No. : EN/2013/70006 Page : 551 of 616

#### 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	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>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	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 °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	13.0 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	51.0 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	6.06 mW / g

Certificate No: D2450V2-869\_Jun12

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Page 3 of 8

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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
----------------------------------	----------

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	August 18, 2010

Certificate No: D2450V2-869\_Jun12

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Page 4 of 8

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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=5mm Reference 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

Page 5 of 8

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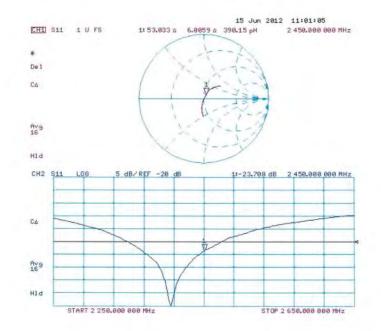
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Report No. : EN/2013/70006 Page : 554 of 616



# Impedance Measurement Plot for Head TSL

Certificate No: D2450V2-869\_Jun12

Page 6 of 8

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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; p = 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=5mmReference 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

Certificate No: D2450V2-869\_Jun12

Page 7 of 8

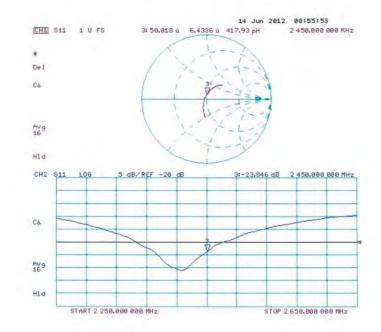
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Report No. : EN/2013/70006 Page : 556 of 616



# Impedance Measurement Plot for Body TSL

Certificate No: D2450V2-869\_Jun12

Page 8 of 8

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# Report No. : EN/2013/70006 Page: 557 of 616

Engineering AG eughausstrasse 43, 8004 Zuric	y of h, Switzerland	REAL CRUERATO	Service sulsse d'étalonnage Servizio svizzero di taratura
Accredited by the Swiss Accredite The Swiss Accreditation Servic Aultilateral Agreement for the r	e is one of the signatorie	s to the EA	on No.: SCS 108
CALIBRATION C	EDTIEICATE		No: D5GHzV2-1040_Jun12
SALIBRATION	ERTIFICATE		
Dbject	D5GHzV2 - SN:	1040	
Calibration procedure(s)	QA CAL-22.v1 Calibration proce	dure for dipole validation kits be	etween 3-6 GHz
Celibration date:	June 19, 2012		
The measurements and the unce All calibrations have been condu	ertainties with confidence p cted in the closed laborator	onal standards, which realize the physical in robability are given on the following pages $\gamma$ facility: environment temperature (22 $\pm$ 3	and are part of the certificate.
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Page 1 of 13

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# Report No. : EN/2013/70006 Page: 558 of 616

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



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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

N/A

tissue simulating liquid ConvF sensitivity in TSL / NORM x,y,z 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%.

Certificate No: D5GHzV2-1040\_Jun12

Page 2 of 13

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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

	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		

# 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)
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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Page 3 of 13

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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		1 m m m

# 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)
and a state of the second		
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	2,35 mW / g

Certificate No: D5GHzV2-1040\_Jun12

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Page 4 of 13

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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)
the second se		
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>2</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

Certificate No: D5GHzV2-1040\_Jun12

Page 5 of 13

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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)
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	2.06 mW / g
	News Configuration	2.06 mW / g 20.4 mW / g ± 19.5 % (k=2)

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Page 6 of 13

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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  Ω	
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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Page 7 of 13

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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>

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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Page 8 of 13

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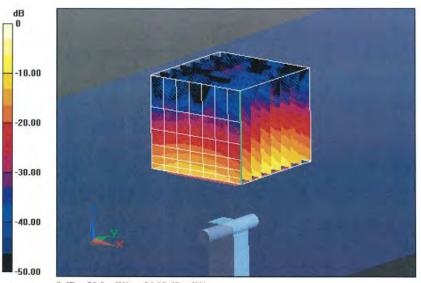
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# Report No. : EN/2013/70006 Page : 565 of 616



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

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Page 9 of 13

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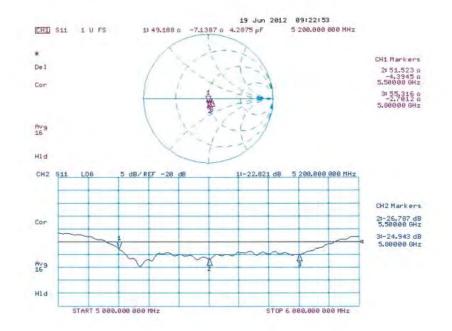
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Report No. : EN/2013/70006 Page : 566 of 616



# Impedance Measurement Plot for Head TSL

Certificate No: D5GHzV2-1040 Jun12

Page 10 of 13

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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; p = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5500 MHz;  $\sigma$  = 5.76 mho/m;  $\varepsilon_r$  = 46.5; p = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5800 MHz;  $\sigma$  = 6.16 mho/m;  $\varepsilon_r$  = 46; p = 1000 kg/m<sup>3</sup>

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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Page 11 of 13

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# Report No. : EN/2013/70006 Page : 568 of 616



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

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Page 12 of 13

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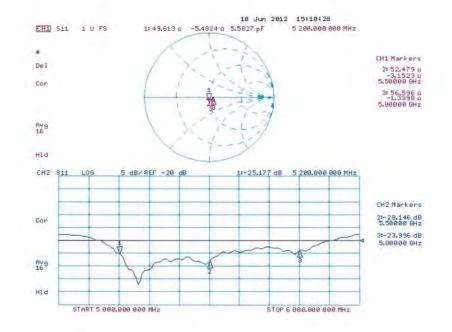
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Report No. : EN/2013/70006 Page : 569 of 616



Impedance Measurement Plot for Body TSL

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Page 13 of 13

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# Report No. : EN/2013/70006 Page : 570 of 616

he Swiss Accreditation Service is one of the signatories to the EA Iultilateral Agreement for the recognition of calibration certificates	No.: SCS 108
CALIBRATION CERTIFICATE         Dbject         DB35V2 - SN: 4d063         Calibration procedure(s)         QA CAL-05.v9	
DB35V2 - SN: 4d063 CAL-05.v9	
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# Report No. : EN/2013/70006 Page: 571 of 616

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Accreditation No.: SCS 108

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# 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%.

Certilicate No: D835V2-4d063\_May13

Page 2 of 8

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# Report No. : EN/2013/70006 Page : 572 of 616

#### Measurement Conditions

DASY Version	DASY5	V52.8.6
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	B35 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	40.4 ± 6 %	0.94 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		-

# SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.47 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.51 W/kg ± 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	1.60 W/kg

# **Body TSL parameters**

	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	54.5 ± 6 %	1.00 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	-	-

# SAR result with Body TSL

SAR averaged over 1 cm3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.41 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.40 W/kg ± 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-	1.57 W/kg

Certificate No: D835V2-4d063\_May13

Page 3 of 8

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#### Appendix

# Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.0 Ω - 3.5 jΩ	
Return Loss	- 28.9 dB	

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.7 Ω - 5.2 μΩ	
Return Loss	- 23,9 dB	

# General Antenna Parameters and Design

Electrical Delay (one direction)	1.388 ns
Electrical Delay (one direction)	1.366

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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Page 4 of 8

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# **DASY5 Validation Report for Head TSL**

Date: 28.05.2013

Test Laboratory: SPEAG, Zurich, Switzerland

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

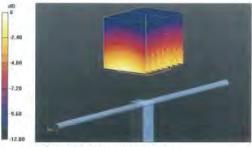
Communication System: UID 0 - CW ; Frequency: 835 MHz Medium parameters used: f = 835 MHz;  $\sigma$  = 0.94 S/m;  $\varepsilon_r$  = 40.4;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63,19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.05, 6.05, 6.05); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

#### Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x8x7)/Cube 0:

Measurement grid; dx=5mm, dy=5mm, dz=5mm Reference Value = 56.884 V/m; Power Drifi = 0.04 dB-Peak SAR (extrapolated) = 3.76 W/kg SAR(1 g) = 2.47 W/kg; SAR(10 g) = 1.6 W/kg Maximum value of SAR (measured) = 2.91 W/kg



0 dB = 2.91 W/kg = 4.64 dBW/kg

Certificate No: D835V2-4d063\_May13

Page 5 ol 8

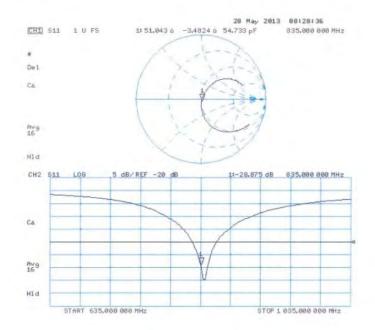
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# Report No. : EN/2013/70006 Page : 575 of 616



# Impedance Measurement Plot for Head TSL

Certificate No: D835V2-4d063\_May13

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Page 6 of 8

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# **DASY5 Validation Report for Body TSL**

Date: 27.05.2013

Test Laboratory: SPEAG, Zurich, Switzerland

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

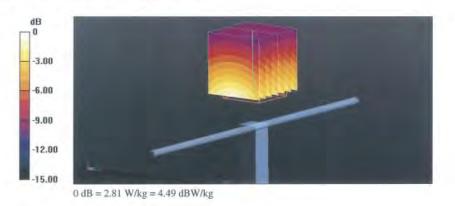
Communication System: UID 0 - CW ; Frequency: 835 MHz Medium parameters used: f = 835 MHz;  $\sigma = 1$  S/m;  $\varepsilon_r = 54.5$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.04, 6.04, 6.04); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

# 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 = 55.014 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 3.56 W/kg SAR(1 g) = 2.41 W/kg; SAR(10 g) = 1.57 W/kg Maximum value of SAR (measured) = 2.81 W/kg



Certificate No: D835V2-4d063\_May13

Page 7 of 8

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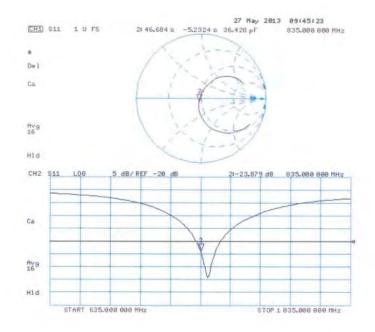
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# Report No. : EN/2013/70006 Page : 577 of 616



# Impedance Measurement Plot for Body TSL

Certificate No: D835V2-4d063\_May13

Page 8 of 8

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# Report No. : EN/2013/70006 Page : 578 of 616

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ne Swiss Accreditation Servic	e is one of the signatorie	s to the EA	
lultilateral Agreement for the r	in General Fred State		DITTOVO IDOD M. JO
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CALIBRATION O	CERTIFICATE		
Object	D1750V2 - SN: 1	008	
Calibration procedure(s)	QA CAL-05.v9		
	Calibration proce	dure for dipole validation kits ab	ove 700 MHz
Calibration date:	May 29, 2013		
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# Report No. : EN/2013/70006 Page: 579 of 616

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



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

Accreditation No.: SCS 108

S

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 certification

# 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%

Certificate No: D1750V2-1008\_May13

Page 2 of 8

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# Report No. : EN/2013/70006 Page : 580 of 616

#### Measurement Conditions

DASY Version	DASY5	V52.8.6
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1750 MHz ± 1 MHz	

# Head TSL parameters

The following parameters and calculations were applied

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.1	1.37 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.1 ± 6 %	1.32 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		1000

#### 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	9.04 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	36.8 W/kg ± 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	4.83 W/kg

# Body TSL parameters

	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	51.7±6%	1.47 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	9.46 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	37.9 W/kg ± 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	5.07 W/kg

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Page 3 of 8

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#### Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.2 Ω + 0.2 jΩ	
Return Loss	- 50,1 dB	

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.0 12 - 0.1 112	
Return Loss	- 27.6 dB	

#### General Antenna Parameters and Design

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

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

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

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

#### Additional EUT Data

Manufactured by	SPEAG	
Manufactured on	February 11, 2009	

Certificate No: D1750V2-1008\_May13

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Page 4 of 8

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

Date: 28.05.2013

Test Laboratory: SPEAG, Zurich, Switzerland

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

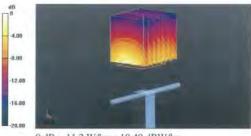
 $\begin{array}{l} \mbox{Communication System: UID 0 - CW ; Frequency: 1750 MHz} \\ \mbox{Medium parameters used: } f = 1750 MHz; \mbox{$\sigma$} = 1.32 S/m; \mbox{$\epsilon_r$} = 39.1; \mbox{$\rho$} = 1000 \mbox{$kg/m^3$} \\ \mbox{Phantom section: Flat Section} \\ \mbox{Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)} \\ \end{array}$ 

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(5.18, 5.18, 5.18); Calibrated: 28.12.2012;
- · Sensor-Surface: 3mm (Mechanical Surface Detection)
- · Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 95,241 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 16.2 W/kg SAR(1 g) = 9.04 W/kg; SAR(10 g) = 4.83 W/kg Maximum value of SAR (measured) = 11.2 W/kg



0 dB = 11.2 W/kg = 10.49 dBW/kg

Certificate No: D1750V2-1008\_May13

Page 5 of 8

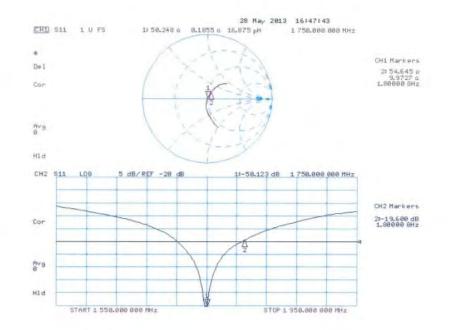
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Report No. : EN/2013/70006 Page : 583 of 616



# Impedance Measurement Plot for Head TSL

Certificate No: D1750V2-1008\_May13

Page 6 of 8

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

Date: 29.05.2013

Test Laboratory: SPEAG, Zurich, Switzerland

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

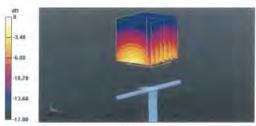
Communication System: UID 0 - CW ; Frequency: 1750 MHz Medium parameters used: f = 1750 MHz;  $\sigma$  = 1.47 S/m;  $\epsilon_r$  = 51.7;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.83, 4.83, 4.83); Calibrated: 28.12.2012;
- · Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

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

Measurement grid: dx=5min, dy=5mm, dz=5mm Reference Value = 93.817 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 16.3 W/kg SAR(1 g) = 9.46 W/kg; SAR(10 g) = 5.07 W/kg Maximum value of SAR (measured) = 11.9 W/kg



0 dB = 11.9 W/kg = 10.76 dBW/kg

Certificate No: D1750V2-1008\_May13

Page 7 of 8

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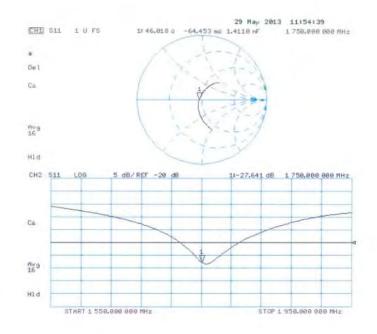
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# Impedance Measurement Plot for Body TSL

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Page 8 of 8

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# Report No. : EN/2013/70006 Page : 586 of 616

CALIBRATION CERTIFICATE         Dbject       D1900V2 - SN: 5d027         Calibration procedure(s)       QA CAL-05, v9 Calibration procedure for dipole validation kits above 700 MHz         Calibration date:       May 02, 2013         Chis calibration certificate documents the traceability to national standards, which realize the physical units of measurements (S). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.         All calibration Equipment used (M&TE critical for calibration)         Primary Standards       ID #         Oper sensor HP 8481A       US37282783         Vis 2005       24-Apr-13 (No. 217-017640)       Oct-13         Shi 5058 (200)       94-Apr-13 (No. 217-017640)       Oct-13         Parentary Standards       ID #       Cale Date (Certificate Nc.)       Scheduled Calibration         Primary Standards       ID #       Cale Date (Certificate Nc.)       Scheduled Calibration         Primary Standards       ID #       Cale Date (Certificate Nc.)       Scheduled Calibration         Prover sensor HP 8481A       US37282783       01-40v-12 (No. 217-017640)       Oct-13         Shi 5058 (200)       94-Apr-13 (No. 217-01786)       Apr-14         Steerence Probe ES3DV3       Shi 5058 (200)       94-Apr-13 (No. 217-01786)       Apr-14         Secondary Sta	iid & Partner jineering AG usstrasse 43, 8004 Zurich, S	Of Switzerland	Hac MRA	NO S	Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura Swisa Calibration Service
CALIBRATION CERTIFICATE         Object       D1900V2 - SN: 5d027         Calibration procedure(s)       QA CAL-05, v9 Calibration procedure for dipole validation kits above 700 MHz         Calibration date:       May 02, 2013         This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.         Al calibration Equipment used (M&TE critical for calibration)         Primary Standards       10 / Cal Date (Certificate Nc.)       Scheduled Calibration Proceed (No. 217-01640)         Priver sensor HP 8481A       US37292783       01-Hov-12 (No. 217-01786)       Apr-14         Prover sensor HP 8481A       US37292783       01-Hov-12 (No. 217-01786)       Apr-14         Reference 20 dB Attenuator       SN: 5058 (200)       04-Apr-13 (No. 217-01786)       Apr-14         Secondary Standards       D #       Check Date (in house)       Scheduled Check. Dete: 13         SN: 601       25-Apr-13 (No. DAE-460_Apr-13)       Apr-14         Secondary Standards       D #       Check Date (in house check Cet-11)       In house check: Cet Nate (in house check Cet-11)         Reference Probe ES3DV3       SN: 601       26-Apr-09 (in house check Cet-11)       In house check: Cet Nate (in house check Cet-11)         Second	iss Accreditation Service is	one of the signatorie	s to the EA	creditation	No.: SCS 108
Object         D1900V2 - SN: 5d027           Calibration procedure(s)         QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz           Calibration date:         May 02, 2013           This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (s). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.           All calibration Equipment used (M&TE critical for calibration)           Primary Standards         ID #         Calibration Private Private (22 ± 3)°C and humidity < 70%.           Calibration Equipment used (M&TE critical for calibration)         Scheduled Calibration           Primary Standards         ID #         Cal Date (Certificate No.)         Scheduled Calibratic Aprivation SN: 5058 (20h)           Power sensor HP 8481A         US37292783         01-Nov-12 (No. 217-01740)         Oct-13           Reference 20 dB Attenuator         SN: 5047.37 (05327         04-Apr.13 (No. 217-01739)         Apr.14           Reference Probe ES3DV3         SN: 3205         28-Dec-12 (No, ES3-3205, Dec.13)         Dec.13           DAE4         SN: 601         25-Apr.13 (No. 217-01739)         Apr.14           Secondary Standards         ID #         Check Date (in house)         Scheduled Check           Rever sensersor HP 8481A         SN: 601         25-Apr				rtificate No	: D1900V2-5d027_May13
Calibration procedure(s)       QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz         Calibration dete:       May 02, 2013         This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.         All calibration Equipment used (M&TE critical for calibration)         Primary Standards       ID #       Cal Date (Certificate Nc.)       Scheduled Calibration Dever metar EFM-442A         US37292783       01-Nov-12 (No. 217-01640)       Oct-13         Power metar EFM-442A       US37292783       01-Nov-12 (No. 217-01736)       Apr-14         Steferance 20 dB Attenuator       SN: 5047.3 / 06327       04-Apr-13 (No. 217-01739)       Apr-14         Stepence Proble ES3DV3       SN: 601       25-Apr-13 (No. DAE4-601_Apr-13)       Apr-14         Stepence Proble ES3DV3       SN: 601       25-Apr-13 (No. DAE4-601_Apr-13)       Apr-14         Stepence Proble ES3DV3       SN: 601       25-Apr-13 (No. DAE4-601_Apr-13)       Apr-14         Stepence Proble ES3DV3       SN: 601       25-Apr-13 (No. DAE4-601_Apr-13)       Apr-14         Stepence Proble ES3DV3       SN: 601       25-Apr-13 (No. DAE4-601_Apr-13)       Apr-14         Stepence Proble ES3DV3       SN: 601 <t< th=""><th>IBRATION CE</th><th>RTIFICATE</th><th></th><th></th><th></th></t<>	IBRATION CE	RTIFICATE			
Calibration: procedure for dipole validation kits above 700 MHz         Calibration date:       May 02, 2013         This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.         All calibration shave been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.         Calibration Equipment used (M&TE critical for calibration)         Primary Standards       ID #       Cal Date (Certificate Nc.)       Scheduled Calibratic Proversion on the following pages and are part of the certificate.         Primary Standards       ID #       Cal Date (Certificate Nc.)       Scheduled Calibratic Proversion on the following pages and are part of the certificate.         Primary Standards       ID #       Cal Date (Certificate Nc.)       Scheduled Calibratic Proversensor MP 2481A         Power sensor MP 2481A       US37292783       01-Nov-12 (No. 217-01740)       Oct-13         Reference 20 dB Attenuator       SN: 5058 (20k)       04-Apr-13 (No. 217-01739)       Apr-14         Type-N mismatch combination       SN: 601       25-Apr-13 (No. 217-01739)       Apr-14         Secondary Standards       ID #       Check Date (in house)       Scheduled Check         Power sensor HP 2481A       MY410022317       18-Oct-02 (in house che	1	D1900V2 - SN: 5	d027		
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%.			dure for dipole validation	kits abo	ve 700 MHz
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%.	tion date:	May 02, 2013			
Power meter EPM-442A.         GB37480704         01-Nov-12 (No. 217-01640)         Oct-13           Power sensor HP 8481A         US37292783         01-Nov-12 (No. 217-01640)         Oct-13           Reference 20 dB Attenuator         SN: 5058 (20k)         04-Apr-13 (No. 217-01736)         Apr-14           Reference Probe ES3OV3         SN: 3205         26-Dec-12 (No. 217-01739)         Apr-14           Reference Probe ES3OV3         SN: 3205         26-Dec-12 (No. 253-3205, Dec12)         Dec-13           DAE4         SN: 601         25-Apr-13 (No. DAE4-601_Apr13)         Apr-14           Secondary Standards         ID #         Check Date (in house)         Scheduled Check           Power sensor HP 8481A         MY41082317         18-Dct-02 (in house check Dct-11)         In house check: Oct           RF generator R&S SMT-06         100005         04-Aug-99 (in house check Oct-11)         In house check: Oct           Network Analyzer HP 8753E         US37390585 S4206)         18-Oct-01 (in house check Oct-12)         In house check: Oct           Name         Function         Signature         Signature	sasurements and the uncertain	nties with confidence p	robability are given on the followin	ng pages ani	d are part of the certificate.
Power sensor NP 8481A         US37292783         01-Nov-12 (No. 217-01640)         Oct-13           Reference 20 dB Attenuator         SN: 5056 (20k)         04-Apr-13 (No. 217-01736)         Apr-14           Type-N mismatch combination         SN: 5047.9 / 06327         04-Apr-13 (No. 217-01739)         Apr-14           Reference Probe ES3DV3         SN: 5047.9 / 06327         04-Apr-13 (No. 217-01739)         Apr-14           Reference Probe ES3DV3         SN: 5047.9 / 06327         25-Apr-13 (No. DAE4-601_Apr13)         Apr-14           DAE4         SN: 601         25-Apr-13 (No. DAE4-601_Apr13)         Apr-14           Secondary Standards         ID #         Check Date (in house)         Scheduled Check           Power sensor HP 8481A         MY41082317         18-Oct-02 (in house check Oct-11)         In house check: Oct           RF generator R&S SMT-06         100005         04-Aug-99 (in house check Oct-11)         In house check: Oct           Network Analyzer HP 8753E         US37390585 S4206         18-Oct-01 (in house check Oct-12)         In house check: Oct           Name         Function         \$ignature         \$ignature         \$ignature	easurements and the uncertail brations have been conducted tion Equipment used (M&TE c	nties with confidence p t in the closed laborator critical for calibration)	robability are given on the followin ny facility: environment temperatur	ng pages ani	d are part of the certificate,
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Certificate No: D1900V2-5d027\_May13

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Page 1 of 8

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# Report No. : EN/2013/70006 Page: 587 of 616

Calibration Laboratory of Schmid & Partner Engineering AG strasse 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

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# 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%.

Certificate No: D1900V2-5d027\_May13

Page 2 of 8

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# Report No. : EN/2013/70006 Page : 588 of 616

#### Measurement Conditions

DASY Version	DASY5	V52.8.6
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz ± 1 MHz	

### Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.3 ± 6 %	1.37 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 "C		111111

### 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	9,71 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	39.2 W/kg ± 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	5.09 W/kg

# **Body TSL parameters**

	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	54.0 ± 6 %	1.51 mho/m ± 6.%
Body TSL temperature change during test	< 0.5 °C		

# SAR result with Body TSL

SAR averaged over 1 cm <sup>5</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.1 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	40.7 W/kg ± 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	5.37 W/kg

Certificate No: D1900V2-5d027\_May13

Page 3 of B

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f (886-2) 2298-0488



### Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.5 Ω + 3.5 jΩ	
Return Loss	- 29.2 dB	

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	$44.7 \ \Omega + 4.8 \ j\Omega$	
Return Loss	- 22.4 dB	

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.196 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 17, 2002	

Certificate No: D1900V2-5d027\_May13

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Page 4 of 8

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# **DASY5 Validation Report for Head TSL**

Date: 02.05.2013

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d027

Communication System: UID 0 - CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.37 S/m;  $\epsilon_r$  = 39.3;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.98, 4.98, 4.98); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 95.215 V/m; Power Drift = 0.08 dB Peak SAR (extrapolated) = 17.6 W/kg SAR(1 g) = 9.71 W/kg; SAR(10 g) = 5.09 W/kg Maximum value of SAR (measured) = 12.2 W/kg



0 dB = 12.2 W/kg = 10.86 dBW/kg

Certificate No: D1900V2-5d027\_May13

Page 5 of 8

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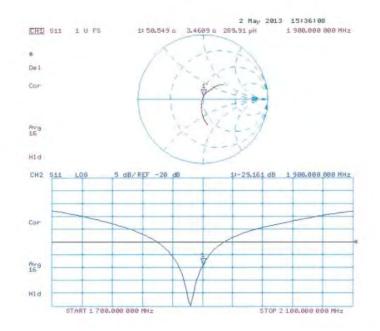
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Report No. : EN/2013/70006 Page : 591 of 616



# Impedance Measurement Plot for Head TSL

Certificate No: D1900V2-5d027\_May13

Page 6 of 8

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# **DASY5 Validation Report for Body TSL**

Date: 02.05.2013

Test Laboratory: SPEAG, Zurich, Switzerland

### DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d027

Communication System: UID 0 - CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.51 S/m;  $\varepsilon_r$  = 54;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.6, 4.6, 4.6); Calibrated: 28.12.2012;
- · Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated; 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

### 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 = 95.215 V/m; Power Drift = 0.07 dB Peak SAR (extrapolated) = 17.1 W/kg SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.37 W/kg Maximum value of SAR (measured) = 12.6 W/kg



Certificate No: D1900V2-5d027\_May13

Page 7 of 8

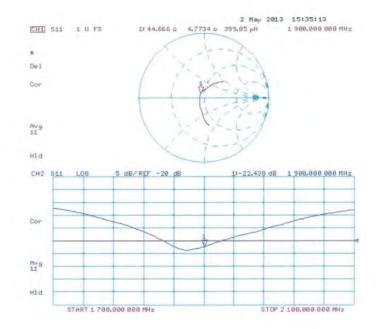
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Report No. : EN/2013/70006 Page : 593 of 616



### Impedance Measurement Plot for Body TSL

Certificate No: D1900V2-5d027\_May13

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Page 8 of 8

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lient SGS-TW (Aude			o: D2450V2-727_May13
CALIBRATION O	CERTIFICATE		
Object	D2450V2 - SN: 7	27	
Calibration procedure(s)	QA CAL-05.v9 Calibration proce	dure for dipole validation kits ab	ove 700 MHz
Calibration date:	May 02, 2013		
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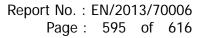
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#### Glossary:

SG

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
- Federal Communications Commission Office of Engineering & Technology (FCC OET). C) "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: D2450V2-727\_May13

Page 2 of 8

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# Report No. : EN/2013/70006 Page : 596 of 616

### Measurement Conditions

DASY system configuration, as far as not given on page

DASY Version	DASY5	V52.8.6
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 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	$37.7\pm6.\%$	1.83 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	13.7 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.9 W/kg ± 17.0 % (k=2)
	1	
SAR averaged over 10 cm° (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>a</sup> (10 g) of Head TSL SAR measured	250 mW input power	6.35 W/kg

### **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	51.2±6%	2.03 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	13.2 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	51.5 W/kg ± 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	6.09 W/kg

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Page 3 of 8

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# Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	55.6 Ω + 1.9 JΩ	
Return Loss	- 25.0 dB	

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	51.9 Ω + 4.0 jΩ	
Return Loss	- 27.2 dB	

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.150 ns
----------------------------------	----------

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

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

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

### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	January 09, 2003

Certificate No: D2450V2-727\_May13

Page 4 of 8

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# **DASY5 Validation Report for Head TSL**

Date: 02.05.2013

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 727

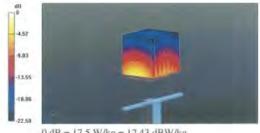
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma = 1.83 \text{ S/m}$ ;  $\varepsilon_r = 37.7$ ;  $p = 1000 \text{ kg/m}^3$ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.52, 4.52, 4.52); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection) .
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013 .
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001 .
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 95.668 V/m; Power Drift = 0.09 dB Peak SAR (extrapolated) = 28.6 W/kg SAR(1 g) = 13.7 W/kg; SAR(10 g) = 6.35 W/kg Maximum value of SAR (measured) = 17.5 W/kg



0 dB = 17.5 W/kg = 12.43 dBW/kg

Certificate No: D2450V2-727\_May13

Page 5 of 8

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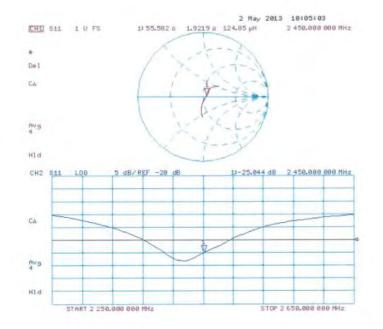
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# Report No. : EN/2013/70006 Page : 599 of 616

### Impedance Measurement Plot for Head TSL



Certificate No: D2450V2-727\_May13

Page 6 of 8

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# **DASY5 Validation Report for Body TSL**

Date: 02.05.2013

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 727

Communication System; UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma$  = 2.03 S/m;  $\epsilon_r$  = 51,2;  $\rho$  = 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(4.42, 4.42, 4.42); Calibrated: 28.12.2012;
- · Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

# 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 = 95.668 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 27.5 W/kg SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.09 W/kg Maximum value of SAR (measured) = 17.5 W/kg



0 dB = 17.5 W/kg = 12.43 dBW/kg

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Page 7 of 8

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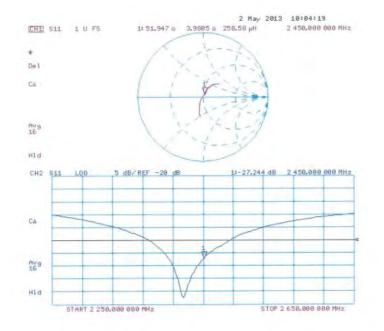
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# Report No. : EN/2013/70006 Page : 601 of 616

# Impedance Measurement Plot for Body TSL



Certificate No: D2450V2-727\_May13

Page 8 of 8

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ALIBRATION	CERTIFICATE		
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allbration procedure(s)	QA CAL-22.v2 Calibration proce	dure for dipole validation kits be	tween 3-6 GHz
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# Report No. : EN/2013/70006 Page: 603 of 616

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



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Schweizerischer Kalibrierdienst 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 certificate

# Glossary:

TSL ConvF N/A

tissue simulating liquid sensitivity in TSL / NORM x,y,z 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%

Certificate No: D5GHzV2-1104\_May13

Page 2 of 15

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# Report No. : EN/2013/70006 Page : 604 of 616

### Measurement Conditions

ASY system configuration, as far as no	t given on page 1.	
DASY Version	DASY5	V52.8.6
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 5300 MHz ± 1 MHz 5600 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	34.7 ± 6 %	4.58 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	- 1000	

#### 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	8.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	82.0 W/kg ± 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 W/kg

Certificate No: D5GHzV2-1104\_May13

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Page 3 of 15

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### Head TSL parameters at 5300 MHz

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.5 ± 6 %	4.68 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		1000

#### SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.51 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	84.4 W / kg ± 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	2.44 W/kg

### Head TSL parameters at 5600 MHz

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.1 ± 6 %	4.96 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.62 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	85.4 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>2</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.45 W/kg
SAB for nominal Head TSL parameters	normalized to 1W	24.2 W/kg ± 19.5 % (k=2)

Certificate No: D5GHzV2-1104\_May13

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Page 4 of 15

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# Report No. : EN/2013/70006 Page : 606 of 616

### 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	33.8 ± 6 %	5.17 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>2</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.09 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.1 W/kg ± 19.9 % (k=2)
	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	2.30 W/kg

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Page 5 of 15

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# Report No. : EN/2013/70006 Page : 607 of 616

### 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	46.9 ± 6 %	5.43 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	and the second sec	

# SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm <sup>2</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.64 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	75.8 W/kg ± 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	2.14 W/kg

### Body TSL parameters at 5300 MHz

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22,0 °C	48.9	5.42 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) *C	46.8 ± 6 %	5.56 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

### SAR result with Body TSL at 5300 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.77 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	77.1 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.17 W/kg
SAB for nominal Body TSL parameters	normalized to 1W	21.5 W/kg ± 19.5 % (k=2)

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Page 6 of 15

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### Body TSL parameters at 5600 MHz

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.2±6 %	5.94 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		66

# SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.25 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	81.8 W/kg ± 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	2.29 W/kg

# 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	45.9±6%	6.22 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	and a	

# SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.60 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	75.4 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>2</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.10 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.8 W/kg ± 19.5 % (k=2)

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Page 7 of 15

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# Appendix

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	52,6 Ω - 9,7 jΩ	
Return Loss	- 20.2 dB	

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	52.6 Ω - 2.8 jΩ	
Return Loss	- 28.6 dB	

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	57.2 Ω - 5.1 jΩ
Return Loss	- 21.7 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	55.5 Ω < 1.0 jΩ
Return Loss	- 25.5 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	53,1 Ω - B.0 JΩ
Return Loss	- 21.7 dB

# Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	51.9 Ω - 2.0 jΩ	
Return Loss	~ 31.4 dB	

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	58.7 Ω - 3.7 jΩ	
Return Loss	- 21.2 dB	

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	56.0 Ω + 1.5 jΩ	
Return Loss	- 24.7 dB	

Certificate No: D5GHzV2-1104\_May13

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Page 8 of 15

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# Report No. : EN/2013/70006 Page : 610 of 616

# General Antenna Parameters and Design

Electrical Delay (one direction)	1.207 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	September 24, 2010	

Certificate No: D5GHzV2-1104\_May13

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Page 9 of 15

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# **DASY5 Validation Report for Head TSL**

Date: 07.05.2013

Test Laboratory: SPEAG, Zurich, Switzerland

### DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1104

Communication System: UID 0 - CW ; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz

Medium parameters used: f = 5200 MHz;  $\sigma$  = 4.58 S/m;  $\varepsilon_r$  = 34.7;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5300 MHz;  $\sigma$  = 4.68 S/m;  $\varepsilon_r$  = 34.5;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5600 MHz;  $\sigma$  = 4.96 S/m;  $\varepsilon_r$  = 34.1;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5800 MHz;  $\sigma$  = 5.17 S/m;  $\varepsilon_r$  = 33.8;  $\rho$  = 1000 kg/m<sup>3</sup>

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

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(5.41, 5.41, 5.41); Calibrated: 28.12.2012, ConvF(5.1, 5.1, 5.1); Calibrated: 28.12.2012, ConvF(4.76, 4.76, 4.76); Calibrated: 28.12.2012, ConvF(4.81, 4.81, 4.81); Calibrated: 28.12.2012;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

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 = 65.914 V/m; Power Drift = -0.07 dB Peak SAR (extrapolated) = 31.2 W/kg SAR(1 g) = 8.27 W/kg; SAR(10 g) = 2.36 W/kg Maximum value of SAR (measured) = 19.3 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 66.338 V/m; Power Drift = 0.05 dB Peak SAR (extrapolated) = 32.5 W/kg SAR(1 g) = 8.51 W/kg; SAR(10 g) = 2.44 W/kg Maximum value of SAR (measured) = 20.0 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 65.836 V/m; Power Drift = 0.04 dB Peak SAR (extrapolated) = 34.4 W/kg SAR(1 g) = 8.62 W/kg; SAR(10 g) = 2.45 W/kg Maximum value of SAR (measured) = 20.7 W/kg

Certificate No: D5GHzV2-1104\_May13

Page 10 of 15

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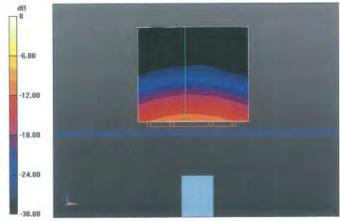
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# Report No. : EN/2013/70006 Page : 612 of 616

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz 2/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 62.381 V/m; Power Drift = 0.05 dB Peak SAR (extrapolated) = 33.9 W/kg SAR(1 g) = 8.09 W/kg; SAR(10 g) = 2.3 W/kg Maximum value of SAR (measured) = 19.8 W/kg



0 dB = 19.8 W/kg = 12.97 dBW/kg

Certificate No: D5GHzV2-1104\_May13

Page 11 of 15

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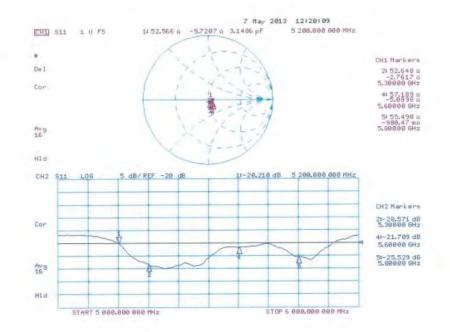
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Report No. : EN/2013/70006 Page : 613 of 616



### Impedance Measurement Plot for Head TSL

Certificate No: D5GHzV2-1104\_May13

Page 12 of 15

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# **DASY5 Validation Report for Body TSL**

Date: 06.05.2013

Test Laboratory: SPEAG, Zurich, Switzerland

### DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1104

Communication System: UID 0 - CW ; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz

Medium parameters used: f = 5200 MHz;  $\sigma$  = 5.43 S/m;  $\varepsilon_r$  = 46.9;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5300 MHz;  $\sigma$  = 5.56 S/m;  $\varepsilon_r$  = 46.8;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5600 MHz;  $\sigma$  = 5.94 S/m;  $\varepsilon_r$  = 46.2;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5800 MHz;  $\sigma$  = 6.22 S/m;  $\varepsilon_r$  = 45.9;  $\rho$  = 1000 kg/m<sup>3</sup>

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

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(4.91, 4.91, 4.91); Calibrated; 28,12,2012, ConvF(4.67, 4.67, 4.67); Calibrated; 28,12,2012, ConvF(4.22, 4.22, 4.22); Calibrated: 28,12,2012, ConvF(4.38, 4.38); Calibrated; 28,12,2012;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

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 = 59.375 V/m; Power Drift = -0.06 dB Peak SAR (extrapolated) = 30.1 W/kg SAR(1 g) = 7.64 W/kg; SAR(10 g) = 2.14 W/kg Maximum value of SAR (measured) = 18.0 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 59.419 V/m; Power Drift = -0.06 dB Peak SAR (extrapolated) = 31.4 W/kg SAR(1 g) = 7.77 W/kg; SAR(10 g) = 2.17 W/kg Maximum value of SAR (measured) = 18.5 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 59.408 V/m; Power Drift = -0.06 dB Peak SAR (extrapolated) = 36.4 W/kg SAR(1 g) = 8.25 W/kg; SAR(10 g) = 2.29 W/kg Maximum value of SAR (measured) = 20.3 W/kg

Certificate No: D5GHzV2-1104\_May13

Page 13 of 15

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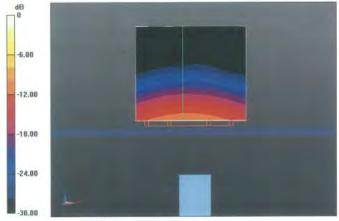
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# Report No. : EN/2013/70006 Page : 615 of 616

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 = 56.084 V/m; Power Drift = -0.06 dB Peak SAR (extrapolated) = 35.3 W/kg SAR(1 g) = 7.6 W/kg; SAR(10 g) = 2.1 W/kg Maximum value of SAR (measured) = 18.9 W/kg



0 dB = 18.9 W/kg = 12.76 dBW/kg

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Page 14 of 15

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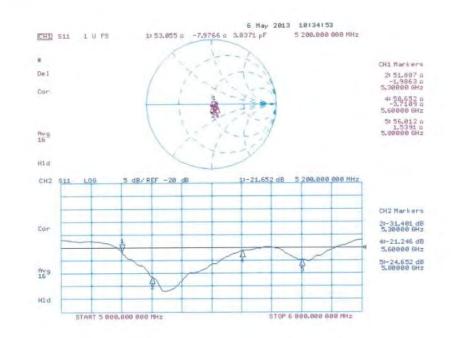
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# Impedance Measurement Plot for Body TSL

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Page 15 of 15

# - End of 2<sup>nd</sup> part of report -

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