



### **Annex E**

Appendix to Test Report No.: 1-3851/11-01-31



### **Testing Laboratory**

#### **CETECOM ICT Services GmbH**

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### **Accredited Test Laboratory:**

The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2005) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)

The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12076-01-01

Appendix with Calibration data, Phantom certificate and system validation information



### Table of contents

1	Table of contents
2	Calibration report "Probe ET3DV6"3
3	Calibration report "Probe ET3DV6"14
4	Calibration report "900 MHz System validation dipole"25
5	Calibration report "1800 MHz System validation dipole"33
6	Calibration report "1900 MHz System validation dipole"41
7	Calibration report "2450 MHz System validation dipole"49
8	Calibration certificate of Data Acquisition Unit (DAE)57
9	Calibration certificate of Data Acquisition Unit (DAE)58
10	Certificate of "SAM Twin Phantom V4.0/V4.0C"59
11	Application Note System Performance Check60
	11.1 Purpose of system performance check60
	11.2 System Performance check procedure60
	11.3 Uncertainty Budget61
	11.4 Power set-up for validation64
	11.5 Laboratory reflection65
	11.6 Additional system checks65



#### Calibration report "Probe ET3DV6" 2

Calibration Laboratory of Schmid & Partner Engineering AG





S Schweizerischer Kallibrierdienst Service suisse d'étalonnage C Servizio svizzero di taratura Ewise Calibration Service

Zeughausstrasse 43, 8904 Zurich, Switzerland

Accordited 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

Cetecom

Certificate No: ET3-1558\_Aug11

### CALIBRATION CERTIFICATE

ET3DV6 - SN:1558

Calibration procedure(s)

QA CAL-01.vB, QA CAI -23 v4, QA CAI -25 v4 Calibration procedure for dosimetric F-field probes

Collibration date:

August 23, 2011

This calibration certificate Jocuments the biacoability to national standards, which restize the physical in its of measurements (SI). The measurements and the uncertainties with contridence probability are given unithe following pages and are part of the curtificats.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 + 3)°C and hum dity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	105	Cal Date (Certificate No.)	Scheduled Calibration
Power meta: E4419E	GB41263874	31-Mar-11 (No. 217-01372)	Apr-12
Power sensor E4412A	MY41450007	31-Mar-11 (No. 217-01372)	Apr-12
Reference 3 d5 Attenueror	SN: S5054 (3c)	29-Mar-11 (No. 217-01369)	Apr-12
Reference 20 dB Attenuator	SN: S6086 (20b)	29-Mar-11 (No. 217-01307)	Apr-12
Reference 30 dB Abenuator	SN: S5129 (30b)	29 Mor-11 (No. 217-01370)	Apr-12
Reference Probe ES30V2	SN: 3013	29 Ope 10 (No. ES3 3013 Dec10)	Dog 11
DAE4	SN: 654	3-May-11 (No. DAE4-654_May11)	Msy-12
Secondary Standards	ID	Check Date (in house)	Scheduler Check
RF generator HP 8648C	U53842U01700	4-Aug-99 (in house check Oct-09)	In house check: Oct-11
Notwork Analyzer HP 8753F	11837300585	16-Oct-01 (in house check Oct-10)	In house dreck: Cut-11

Name Function Collibrated by: Katja Pokovic **Technical Manager** Approved by: Niels Kuster Quality Manager Issued: August 23, 2011 This calibration cortificate shull not be reproduced except in full without written approval of the laboratory.

Certificate No: ET3-1558\_Aug11

Page 1 of 11



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





S Schweizeriecher Kalibrierdionst
C Service suisse d'étalonnage
Servizio svizzero di taratura
Swise Calibration Servico

Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAO)

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#### Glossary:

TSL NORMx,y,z ConvF

DCP

tissue simulating liquid sensitivity in free space sensitivity in TSL / NORMx,y,z diode compression point

CF A. B. C

creet factor (1/duty\_cycle) of the RF signal modulation dependent linearization parameters

Polarization φ

o 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., 3 = 0 is normal to probe axis

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

- IEEE Std 1528-2000, "IFFE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Messurement Techniques", December 2003
- iEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)". February 2005

#### Methods Applied and Interpretation of Parameters:

- NORMx,y,z: Assessed for E-field polarization 9 = 0 (f ≤ 900 MHz in TEM-call; f > 1800 MHz R22 waveguirle) 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 CorwF).
- 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 signs
  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 diedo.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and incide 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 suffwere 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 toterance required.

Certificate No: ET3-1558, Aug 11 Page 2 of 11



ET0DY6 - SN:1558 August 23, 2011

# Probe ET3DV6

SN:1558

Manufactured: September 16, 2003 Calibrated:

August 23, 2011

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

Certificate No: ET3-1558 Aug 11

Page 3 of 11



ET3DV6-- SN:1558 August 23, 2011

### DASY/EASY - Parameters of Probe: ET3DV6 - SN:1558

#### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (µV/(V/m) <sup>2</sup> ) <sup>4</sup>	2.03	1.79	1.76	± 10.1 %
DCP (mV) <sup>0</sup>	96.7	97.9	97.2	

#### **Modulation Calibration Parameters**

UID	Communication System Name	PAR		Λ dB	qB B	C dB	VR mV	Uno <sup>L</sup> (k=2)
10000	CW	C.00	00.C X 00.C	0.00	0.00	1.00	116.3	±2.5 %
			Y	20.C	0.00	1.00	134.7	
			7	0.00	0.00	1.00	143.7	

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. ET3-1558\_Aug11

<sup>&</sup>lt;sup>5</sup> The uncertainties of NormX,Y,Z do not affect the F<sup>2</sup> field uncertainty inside TS\_ (see Pages 5 and 6).
<sup>5</sup> Numerical invarianties parameter: uncertainty not required.
<sup>6</sup> Uncertainty is determined using the mox, deviation from linear response applying rectangular distribution and is expressed for the square of the field value.



ETSDV8 SN:1558 August 23, 2011

### DASY/EASY - Parameters of Probe: ET3DV6 - SN:1558

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

f (MHz) <sup>=</sup>	Relative Permittivity	Conductivity (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	6.22	6.22	6,22	0.71	1.89	± 12.0 %
835	41.5	0.90	5.95	5.95	5.95	0.65	1,08	± 12.0 %
900	41,5	0.97	5.87	5.87	5.87	0.68	1.90	± 12.0 %
1750	40.1	1.37	5.09	5.09	5.09	0.49	2.51	± 12.0 %
1900	40.0	1.40	4.86	4.86	4.86	0.51	2.36	1 12.0 %
2450	39.2	1.80	4.15	4.15	4.15	0.70	1.79	± 12.0 %

Certificate No: ET3-1558\_Aug11

Page 5 of 11

Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncortainty is the RSS of the ConvE uncortainty at collection frequency and the uncertainty for the indicated frequency band.

At frequencies below 3 GHz, the validity of tissue parameters (clond o) can be retained to ± 10% if liquid companisation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (sland o) is restricted to ± 5%. The uncertainty is the RSS of the ConvE uncertainty for indicates, larger issue parameters.



ETSDV8 SN:1558 August 23, 2011

### DASY/EASY - Parameters of Probe: ET3DV6- SN:1558

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

f (MHz) <sup>=</sup>	Relative Permittivity	Conductivity (5/m)	ConvF X	ConvF Y	ConvFZ	Alpha	Depth (mm)	Unct. (k≃2)
750	55.5	0.96	5.97	5.97	5.97	0.76	1.84	1 12.0 %
835	55.2	0.97	5.85	5.85	5.85	0.66	1.98	± 12.0 %
900	55.0	1.05	5.77	5.77	5.77	0.67	1.99	+ 12.0 %
1750	53.4	1,49	4.52	4.52	4.52	0.53	2.78	± 12.0 %
1900	53.3	1.62	4.30	4.30	4.30	0.56	2.61	± 12.0 %
2450	52.7	1.05	3.90	3,90	3.90	D.86	1,39	± 12.0 %

Certificate No: ET3-1558 Aug11

file requency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), also it is restricted to ± 50 MHz. The uncertainty is the HSS of the ConvFilence of the ConvFile

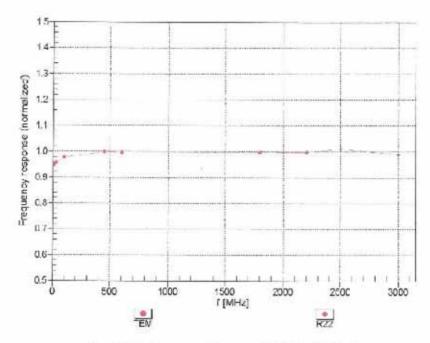


ET3DVG-3N:1558

August 23, 2011

### Frequency Response of E-Field

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



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

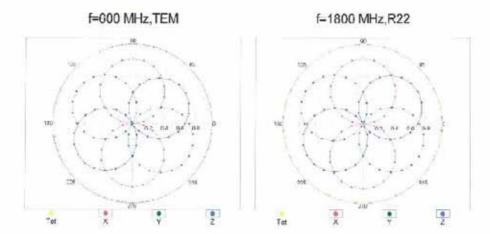
Conificate No: ET3-1550 Aug11

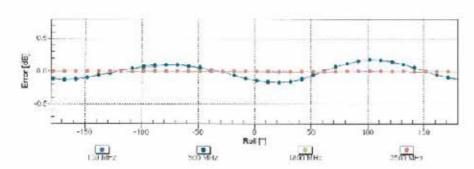
Page 7 of 11



ET3DV6- SN:1558 August 23, 2311

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





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

Certificate No: ET3-1550 Aug11

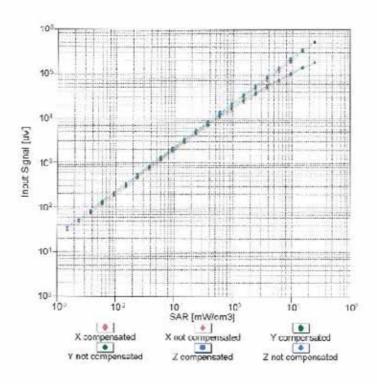
Page 5 of 11

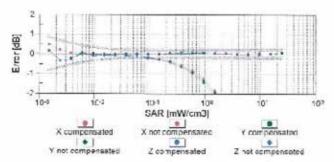


ET3DV6-SN:1558

August 23, 2011

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



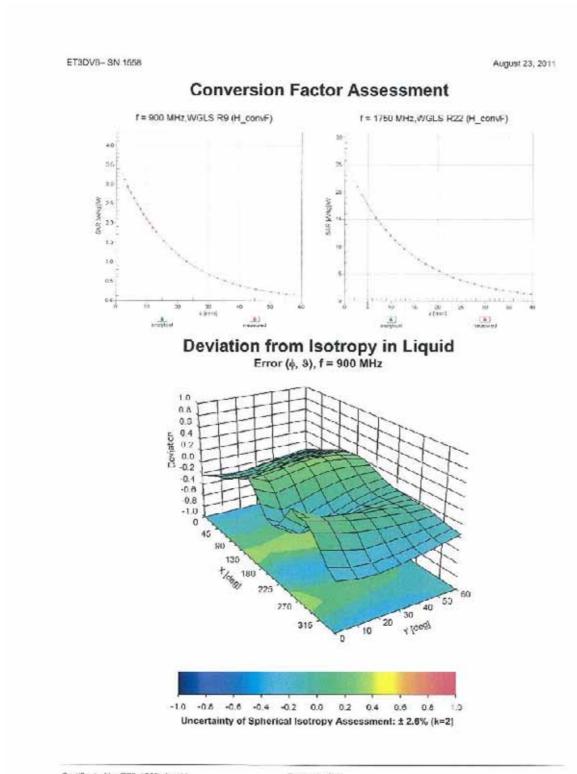


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conificate No: ET3 1558 Aug11

Page 9 of 11







ET3DV5-SN:1558

August 23, 20\*\*

### DASY/EASY - Parameters of Probe: ET3DV6 - SN:1558

### Other Probe Parameters

Sensor Arrangement	Triangular		
Connector Angle (*)	Not applicable		
Mechanical Surface Detection Vode	onabled		
Optical Surface Detection Mode	enabled		
Probe Overall Length	337 mm		
Probe Body Diameter	10 m		
Tip Length	10 mm		
Tip Diameter	6.8 mm		
Probe Tip to Sensor X Calibration Point	2.7 mm		
Probe Tip to Sensor Y Calibration Point	2.7 mm		
Probe Tip to Sensor Z Calibration Point	2.7 mm		
Recommended Measurement Distance from Surface	4 mm		

Certificate No. ET3-1558\_Aug11

Page 11 of 11



### 3 Calibration report "Probe ET3DV6"

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Client Cetecom Certificate No: ET3-1559\_Jan11

#### CALIBRATION CERTIFICATE ET3DV6 - SN:1559 QA CAL-01.v7, QA CAL-12.v6, QA CAL-23.v4 and QA CAL-25.v3 Calibration procedure(s) Calibration procedure for dosimetric E-field probes Calibration date January 19, 2011 This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) Primary Standards ID# Cal Date (Certificate No.) Scheduled Calibration Power meter E4419B 1-Apr-10 (No. 217-01136) GB41293874 Apr-11 Power sensor E4412A MY41495277 1-Apr-10 (No. 217-01136) Apr-11 Power sensor E4412A MY41498087 1-Apr-10 (No. 217-01136) Apr-11 Reference 3 dB Attenuator SN: S5054 (3c) 30-Mar-10 (No. 217-01159) Mar-11 Reference 20 dB Attenuator SN: S5086 (20b) 30-Mar-10 (No. 217-01161) Mar-11 Reference 30 dB Attenuator SN: S5129 (30b) 30-Mar-10 (No. 217-01160) Mar-11 Reference Probe ES3DV2 SN: 3013 29-Dec-10 (No. ES3-3013\_Dec10) Dec-11 DAE4 SN: 660 20-Apr-10 (No. DAE4-660\_Apr10) Apr-11 Secondary Standards ID# Check Date (in house) Scheduled Check RF generator HP 8648C US3642U01700 4-Aug-99 (in house check Oct-09) In house check: Oct-11 Network Analyzer HP 8753E US37390585 18-Oct-01 (in house check Oct-10) In house check: Oct-11 Calibrated by: Jeton Kastrati Laboratory Technician Approved by: Katja Pokovic Technical Manager Issued: January 20, 2011 This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: ET3-1559\_Jan11

Page 1 of 11



#### Calibration Laboratory of

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Servicie svizzere du taratura
S Swiss Catibration Service

Accreditation No.: SCS 108

Aggred set by the Swiss Aggreditation Service (SAS).
The Swiss Addreditation Service is one of the signatories to the EA fluttilateral Agreement for the recognition of calibration contificates.

#### Glossary:

TSL I sque simulating liquid NORMx,y,z sonsitivity in free space ConvF sensitivity in TSL / NORMx,y,z DCP diode compression point

CF crest factor (1/cutly\_cycle) of the RF signal A, B, C modulation dependent linear zation parameters

Polarization o o rotation around probe axis

Polarization 3 3 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
- EC 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 effect the E<sup>2</sup>-f e d uncertainty inside FSL (see below Convt.).
- MORM(f)x y, z = NORMx, y, z \* Trequency\_response (see Frequency Response Chart). This Indextization 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.
- 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 dode.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for fis 800 MHz) and inside waveguide using analytical field distributions based on power measurements for fis 800 MHz. The same selups are used for assessment of the parameters applied for boundary companisation (alpha, depth) of which typical uncortainty 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 phentom
  exposed by a patch antenna
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probeit p
  (on probe axis). No tolerance required.

Certificate No: ET3-1559\_Jan11



ET3DV6 SN:1559 January 19, 2011

## Probe ET3DV6

SN:1559

Manufactured: December 1, 2000 Last calibrated: January 20, 2010 Recalibrated: January 19, 2011

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

Certificate No. ET3-1559\_Jan11

Page 3 of 11



ET3DV6 SN:1559 January 19, 2011

### DASY/EASY - Parameters of Probe: ET3DV6 SN:1559

### Basic Calibration Parameters

	Sensor X	SensorY	Sensor Z	Unc (k=2)
Norm (uV/(V/m)²) <sup>A</sup>	1.79	- 59	1.64	± 10.1%
DCP (mV) <sup>II</sup>	96.9	97.6	96.3	,

### **Modulation Calibration Parameters**

luib L	Communication System Name	PAR		A dB	B d⊜bV	С	VR mV	Unc <sup>e</sup> {k=2)
10000	cw	0.00	×	0.00	0.00	1.00	132.1	t29%
			Y	0.00	0.00	1.00	137.8	
			Z	0.00	0.00	1.00	128.3	

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. ET3-1559 [Jan11]

Page 4 of 11

<sup>^</sup> The uncontaintee of NormX,Y,Z opinot affect the  $\hat{E}^2$ -field uncertainty inside TSL (see Pages 5 and 6).

<sup>&</sup>lt;sup>6</sup> Numerical (reanzation parameter, unconsinty not required

<sup>\*</sup> Uncertainty is determined using the initial mumidewation from those response applying recalling like of slobycon and is expressed for the square of the field value.



ET3DV6 \$N:1559 January 19, 2011

### DASY/EASY - Parameters of Probe: ET3DV6 SN:1559

### Calibration Parameter Determined in Head Tissue Simulating Media

[sHM] <u>1</u>	Validity_[MHz] <sup>©</sup>	Permittivity	Conductivity	ComF X Co	rwF <b>Y</b> Cor	NF Z	Alpha	Depth Und (k=Z)
450	± 507 ± 100	$43.5 \pm 5\%$	0.87 ± 5%	7.39	7.39	7.39	0.18	2.07 ± 13.3%
835	±50/±100	41 S ± 5%	0 90 ± 5%	5 33	6 33	6 33	0.25	3.00 ± 11 0%
900	±50/±100	41 5 ± 5%	0.97 ± 5%	6.20	6.20	5 20	0.26	3 00 ± 11.0%
1750	$\pm 50 / \pm 100$	$40.1 \pm 5\%$	$1.37 \pm 5\%$	5.28	5.28	5.28	0.79	1.69 ± 11.0%
1900	±507±100	$40.0 \pm 5\%$	1.40 ± 5%	5 02	5.02	5.02	0.79	1.60 ± 11.0%
2450	± 50 / ± 100	$39.2 \pm 5\%$	1.8D ± 5%	4.38	4.38	4.3B	0.79	2.02 ± 11.0%

The validity of ± 100 MHz day applies for DASY v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF ancestainty at calibration frequency and the uncertainty for the indicated frequency pand.

Cestificate No: ET3-1559\_Jan11 Page 5 of 11



### DASY/EASY - Parameters of Probe: ET3DV6 SN:1559

### Calibration Parameter Determined in Body Tissue Simulating Media

f [MHz]	Validily [MHz] <sup>C</sup>	Permittivity	Conductivity	ConvFX Ca	nvFY Co	nvF Z	Alpha	Depth Unc (k=2)
450	± 50 / ± 100	$56.7 \pm 5\%$	0 94 + 5%	7.73	7.73	7,73	0.12	2.07 ± 13.3%
835	± 50 / ± 100	55.2 ± 5%	$0.97 \pm 5\%$	6.22	6.22	6.22	0.25	2.98 ±11.0%
900	≥ 50 / ± 100	$55.0 \pm 5\%$	1.05 ± 5%	6.10	6 10	6.10	0.29	287 ±11.0%
1750	± 50 / ± 100	53.4 ± 5%	1 49 ± 5%	4,68	4 68	4.68	0.79	2.39 ± 11.0%
190C	± 50 / ± <b>10</b> 0	533 (5%	1.52 ± 5%	4.40	4.40	4.40	0.79	2.32 ± 11.0%
2450	± 60 / ± 100	52.7 ± 5%	$1.95\pm5\%$	3,91	3 91	3.91	0.70	3.00 ± 11.0%

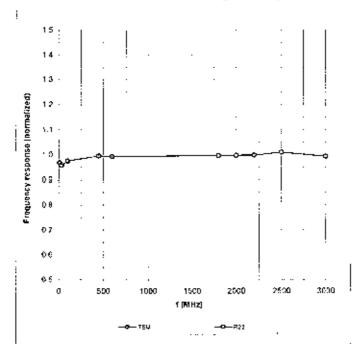
The validity of \$100 MHz only applies for DASY will also higher (son Page 2). The uncertainty is the RSS of the ConvE uncertainty at collapses frequency and the uncertainty for the indicated frequency band.

Certificate Not EY3-1659\_Jan11



### Frequency Response of E-Field

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



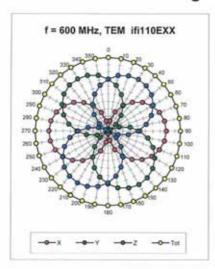
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

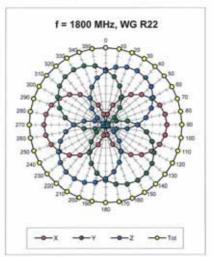
Certificate No: £13-1559, Jan11

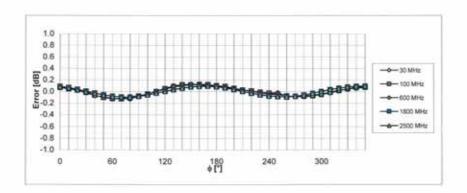
Page 7 of 15



### Receiving Pattern ( $\phi$ ), $\vartheta$ = 0°







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

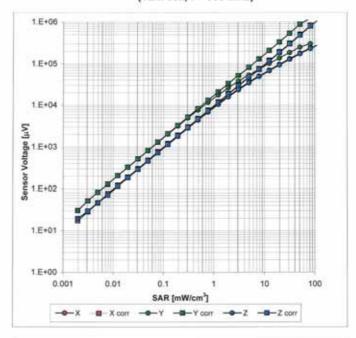
Certificate No: ET3-1559\_Jan11

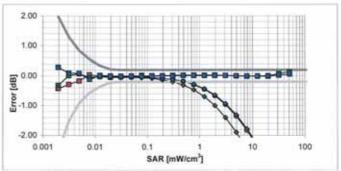
Page 8 of 11



## Dynamic Range f(SAR<sub>head</sub>)

(TEM cell, f = 900 MHz)





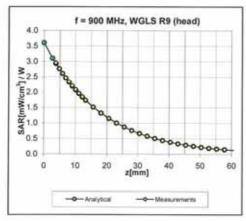
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

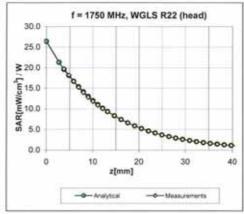
Certificate No: ET3-1559\_Jan11

Page 9 of 11



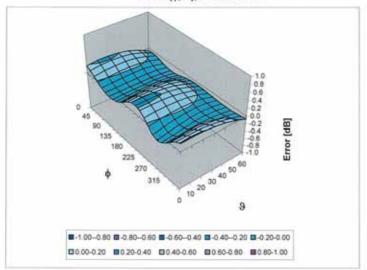
### Conversion Factor Assessment





### Deviation from Isotropy in HSL

Error (φ, θ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

Certificate No: ET3-1559\_Jan11

Page 10 of 11



ET3DV6 SN:1559 January 19, 2011

### **Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	Not applicable
Mechanical Surface Detection Mode	enablec
Optical Surface Detection Mode	enabled
Probe Overall Length	337 mm
Probe Body Diameter	:0 mm
Tip Length	10 nm
Tip Diameter	6.8 <b>m</b> m
Probe Tip to Sensor X Calibration Point	2.7 cm
Probe Tip to Sensor Y Calibration Point	27 mm
Probe Tip to Sensor Z Calibration Point	2.7 mm
Recommended Measurement Distance from Surface	3.7 mm

Certificate Not ET3-1559\_Jan/11 Page 11 of 11



### 4 Calibration report "900 MHz System validation dipole"

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





S Schweizerischer Kalibrierdienst
C Service suisse d'étalennage
Servizie svizzere di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)

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

Multilateral Agreement for the recognition of calibration pertificates

Accreditation No.: SCS 108

Client Ce

Certificate No: D900V2-102 Aug11

			o: D900V2-102_Aug1
CALIBRATION O	CERTIFICATI		
Object	D900V2 - SN: 10	02	
Calibration procedure(s)	QA CAL-05.v8 Calibration proce	edure for dipole validation kits ab	ove 700 MHz
Calitration date.	August 15, 2011		
All collections to a book conduc	eted in the closed laborate	ry facility: environment temporature $(22 \pm 3)^3$	C and humidity < 70%.
			and the second of the second o
Calitzalinn Eru ipment used (M&)		Cal Date (Certificate No.)	Scheduled Calibration
Califixation Fru ipment used (M&* Primary Standards Power meter ETV-442A	TE critical for calibration)		
Califixation Fru Ipment used (M&* Primury Standards Power meter ETV-442A Power sensor HP 8481A	ID # GB37480704 U637292763	Cal Date (Certificate No.) 08-Oct-10 (No. 217-01266) 03-Oct-10 (No. 217-01266)	Scheduled Calibration Oct-11 Oct-11
calitizatirin Fru ipment used (M&* rimany Standards Cower meter ETV-442A Cower sensor HP 8481A leference 20 dB Attenuator	ID #  GB37480704 U637292763 SN: S6086 (20b)	Cal Data (Certificate No.) 08-Oct-10 (No. 217-01266) 03-Oct-10 (No. 217-01266) 20-Mar 11 (No. 217-01037)	Scheduled Calibration Oct-11 Oct-11 Apr-12
calitization Fru ipment used (M&* frimary Standards fower meter EPV-442A fower sensor HP 8481A leference 20 dB Attenuator ype-N mismalich conditination	ID #  GB37480704  U637292763  SN: S5086 (20b)  SN: 5047.2708527	Cal Data (Certificate No.) 08-Out-10 (No. 217-01266) 03-Oet-10 (No. 217-01266) 20-Mar 11 (No. 217-01037) 29-Mar-11 (No. 217-01371)	Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12
calitization Equipment used (M&* rimary Standards Cover meter EPV-442A Cover sensor HP 8481A teleforede 20 dB Attenuator ype-N mismatch contribuation teleforede Probe ES3DV3	ID #  GB37480704 U637292763 SN: S6086 (20b)	Cal Data (Certificate No.) 08-Oct-10 (No. 217-01266) 03-Oct-10 (No. 217-01266) 20-Mar 11 (No. 217-01037)	Scheduled Calibration Oct-11 Oct-11 Apr-12
Calibration Era ipment used (M8.* Primary Standards Power meter E.*V-442A Power consor HP 8431A Heterance 20 dB Attenuator Type-N internation continuation Reference Probe FS3DV3 DAE4	ID #  GB37480704 U637202763 SN: S6086 (20b) SN: 5047.2 / 06527 SN: 3206	Cali Date (Certificate No.)  08-Oct-10 (No. 217-01266)  03-Oct-10 (No. 217-01266)  20-Mer 11 (No. 217-01037)  29-Mar-11 (No. 217-01037)  29-Apr-11 (No. E53-3205_Apr11)  04-Ju-11 (No. DAE4-001_Jul11)	Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Jul-12
Calibration Erg Ipment used (M8.*  Primary Standards  Power meter E.*V-442A  Power sensor HP 8481A  Heference 20 dB Attenuator  Type-N internation contribution  Belletence Probe ES3DV3  DAE4  Secondary Standards	ID # GB37460704 U637202763 SN: S508E (20b) SN: 5047.2706527 SN: 5047.2706527 SN: 601	Cal Date (Certificate No.) 09-Out-10 (No. 217-01266) 03-Oet-10 (No. 217-01266) 20-Mar 11 (No. 217-01337) 29-Mar-11 (No. 217-01371) 29-Apr-11 (No. E53-3305_Apr11)	Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12
Calibration Era ipment used (M8.* Primary Standards Power meter E.*V-442A Power sensor HP 8481A Heference 20 dB Attenuator Type-N internation Entertheatter DAE4 Secondary Standards Power sensor HP 8481A	ID # GB37480704 U697202763 SN: S508E (20b) SN: 5047.2 / 06527 SN: 3208 SN: 001	Cali Date (Certificate No.)  08-Oct-10 (No. 217-01266)  03-Oct-10 (No. 217-01266)  20-Mar 11 (No. 217-0137)  29-Mar-11 (No. 217-01371)  29-Apr-11 (No. E53-3205_Apr11)  04-Ju-11 (No. DAE4-001_Jul11)  Chock Date (in house)	Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Jul-12 Scheduled Check In house check Oct-11
Calibration Era Ipment used (M8.* Primary Standards Power meter E.*V-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N internation contributation Reference Probe FS30V3 DAE4 Secondary Standards Power sensor HP 8481 A RF generator R&S SMT-06	ID # GB37480704 U697222793 SN: S5086 (20b) SN: 5047.2 / 06527 SN: 3205 GN: 001 ID # MY41092317	Cni Date (Certificate No.)  08-Oct-10 (No. 217-01266)  03-Oct-10 (No. 217-01266)  20-Mar-11 (No. 217-01237)  29-Mar-11 (No. 217-0137)  29-Apr-11 (No. E53-3205_Apr11)  04-Ju-11 (No. DAE4-001_Jul11)  Chock Date (in house)  18-Oct-02 (in house check Oct-09)	Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Jul-12 Scheduled Check In house check Oct-11 In house check Oct-11
Calibration Eq. Ipment used (M8.* Primary Standards Power meter E.*V-442A Power sensor HP 8481A Heteronce 20 dB Attenuator Type-N internation contributation Belevence Probe FS30V3 DAE4 Secondary Standards Power sensor HP 8481 A HF generator R&S SMT-06	ID #  GB37480704 U697292793 SN: S508E (20b) SN: 5047.2 / 06527 SN: 3205 GN: 601 ID #  MY41092317 100005 U697090505 S4200	Cai Date (Certificase No.)  08-Oct-10 (No. 217-01266)  03-Oct-10 (No. 217-01266)  20 Mar 11 (No. 217-0137)  29-Mar-11 (No. 217-0137)  29-Apr-11 (No. E53-3205_Apr11)  04-Ju-11 (No. DAE4-001_Jul11)  Chock Date (in house)  18-Oct-02 (in house check Oct-09)  04-Aug-92 (in house check Oct-09)  10-Oct-01 (in house check Oct-10)	Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Jul-12 Scheduled Check In house check Oct-11 In house check: Oct-11
Calibration Eru Ipment used (M&* Primary Standards Power meter EPV-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N internation contributation Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A HF generator R&S SMT-08 Network Analyzer HP 0755E	ID #  GB37480704 U697292793 SN: S5086 (20b) SN: 5047.2 / 06327 SN: 3205 GN: 601 ID #  MY41092317 100005 UG97090505 S4200 Name	Cai Date (Certificate No.)  08-Oct-10 (No. 217-01266)  03-Oct-10 (No. 217-01266)  20 Mar 11 (No. 217-0137)  29-Mar-11 (No. 217-0137)  29-Apr-11 (No. E53-3205_Apr11)  04-Ju-11 (No. DAE4-001_Jul11)  Chock Date (in house)  18-Oct-02 (in house check Oct-09)  04-Aug-98 (in house check Oct-09)  18-Oct-01 (in house check Oct-09)	Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Jul-12 Scheduled Check In house check Oct-11 In house check Oct-11
Calibration Eq. ipment used (M8) Primary Standards Power meter ETV-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismalch contribution Reference Probe FS3DV3 DAE4 Secondary Standards Power sensor HP 8481A HF generator R&S SMT-06 Network Analyzer HP 0755E	ID #  GB37480704 U697292793 SN: S508E (20b) SN: 5047.2 / 06527 SN: 3205 GN: 601 ID #  MY41092317 100005 U697090505 S4200	Cai Date (Certificase No.)  08-Oct-10 (No. 217-01266)  03-Oct-10 (No. 217-01266)  20 Mar 11 (No. 217-0137)  29-Mar-11 (No. 217-0137)  29-Apr-11 (No. E53-3205_Apr11)  04-Ju-11 (No. DAE4-001_Jul11)  Chock Date (in house)  18-Oct-02 (in house check Oct-09)  04-Aug-92 (in house check Oct-09)  10-Oct-01 (in house check Oct-10)	Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Jul-12 Scheduled Check In house check Oct-11 In house check: Oct-11
Calibration For ipment used (M&) Primary Standards Power meter ENV-442A Power sensor HP 8481A	ID #  GB37480704 U697292793 SN: S5086 (20b) SN: 5047.2 / 06327 SN: 3205 GN: 601 ID #  MY41092317 100005 UG97090505 S4200 Name	Cai Date (Certificate No.)  08-Oct-10 (No. 217-01266)  03-Oct-10 (No. 217-01266)  20 Mar 11 (No. 217-0137)  29-Mar-11 (No. 217-0137)  29-Apr-11 (No. E53-3205_Apr11)  04-Ju-11 (No. DAE4-001_Jul11)  Chock Date (in house)  18-Oct-02 (in house check Oct-09)  04-Aug-98 (in house check Oct-09)  18-Oct-01 (in house check Oct-09)	Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Jul-12 Scheduled Check In house check Oct-11 In house check Oct-11

Certificate No: D900V2-102, Aug 11

Page 1 of 8



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





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Swiss Calibration Service

Accreditation No.: SCS 108

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According by the Swiss Accordination Service (SAS)

The Swiss Accordination 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 TSI\_parameters: The measured TSL parameters are used to calculate the nominal SAR result.

Certificate No: D900V2-102\_Aug11 Page 2 of 6



### Measurement Conditions

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

DASY Version	DASY5	V52.6.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantoni	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx. dy. dz = 5 mm	
Frequency	900 MHz ± 1 MHz	

### Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.6	0.97 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) "C	40.3 ± 6 %	0.95 mha/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	2.69 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	10.9 mW/g ± 17.0 % (k=2)

SAR averaged over 10 cm3 (10 g) of Head TSL	condition	
SAN measured	250 mW input power	1.73 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	6.97 mW /g ± 16.5 % (k=2)

### **Body TSL parameters**

The to lowing parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.0	1.05 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.0 ± 6 %	1.05 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	260 mW input power	2.83 mW / g
SAR for nominal Body TSL parameters	normal zed to 1W	11.2 mW / g ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>2</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.82 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	7.24 mW / g ± 16.5 % (k=2)

Confroate No: D900V2-102\_Aug11



### Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.8 Ω - 5.0 ]Ω
Return Loss	- 26.0 dB

### Antenna Parameters with Body TSL

Impedance, transformed to food point	45.8 Ω - 6.4 jΩ
Hoturn Loca	- 22.0 dD

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.407 na

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-croulted for DC-signals.

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

### **Additional EUT Data**

Manufactured by	SPEAG
Manufactured on	January 24, 2001

Cortificate No: D900VZ-102 Aug11



#### DASY5 Validation Report for Head TSL

Date: 15.08.2011

Test Laboratory: SPEAG, Zurich, Switzerland

### DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN: 102

Communication System: CW; Frequency: 900 MHz

Medium parameters used: f = 900 MHz;  $\sigma = 0.95 \text{ mho/m}$ ;  $\varepsilon_r = 40.3$ ;  $\rho = 1000 \text{ kg/m}^2$ 

Phantom section: Flat Section

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

#### DASY52 Configuration:

Probe: ES3DV3 - SN3205; ConvF(5.97, 5.97, 5.97); Calibrated: 29.04.2011

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn601; Calibrated: 04.07.2011

Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001

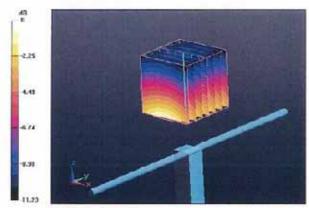
DASY52 52.6.2(482); SEMCAD X 14.4.5(3634)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 59.842 V/m; Power Drift = 40.04 dB

Peak SAR (extrapolated) - 4.018 W/kg

SAR(1 g) = 2.69 mW/g; SAR(10 g) = 1.73 mW/g Maximum value of SAR (measured) = 3.146 mW/g



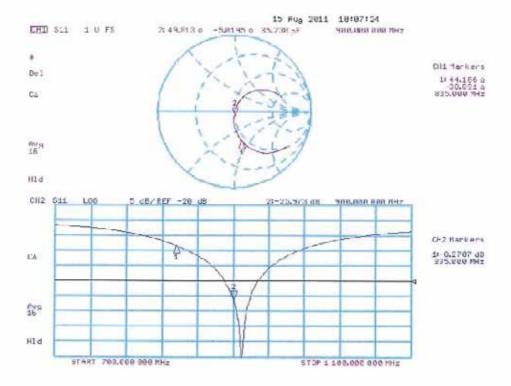
0 dB = 3.150 mW/g

Certificate No: D900V2-102 Aug I

Page 5 of 8



### Impedance Measurement Plot for Head TSL



Certificate No: D300V2-102\_Aug11

Page 6 of 6



#### DASY5 Validation Report for Body TSL

Date: 15.08.2011

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN: 102

Communication System: CW; Frequency: 900 MHz

Medium parameters used: f = 900 MHz;  $\alpha = 1.05 \text{ mho/m}$ ;  $\epsilon_r = 52.8$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

#### DASY52 Configuration:

Probe: ES3DV3 - SN3205; ConvF(5.94, 5.94, 5.94); Calibrated: 29.04.2011

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn601; Calibrated: 04.07.2011

Phantom: Flat Phantom 4.91.; Type: QD000P49AA; Serial: 1001

DASY52 52.6.2(482); SEMCAD X 14.4.5(3634)

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

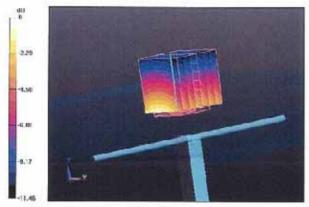
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 56.479 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 4.331 W/kg

SAR(1 g) = 2.83 mW/g; SAR(10 g) = 1.82 mW/g

Maximum value of SAR (measured) = 3.319 mW/g

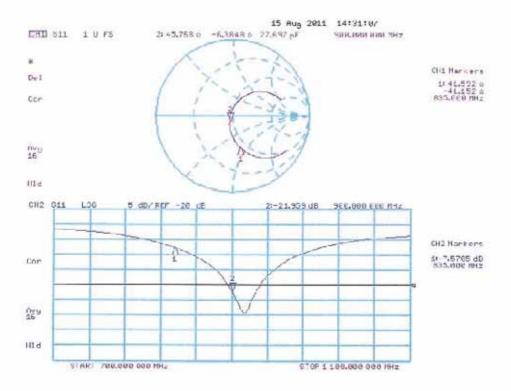


0 dB = 3.320 mW/g

Certificate No. DS0CV2-102\_Aug11



### Impedance Measurement Plot for Body TSL



Certificate No: D900V2-102\_Aug11

Page 6 of 6



### Calibration report "1800 MHz System validation dipole"

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





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C Servizio svizzero di taratura S Swiss Calibration Service

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

Accreditation No.: SCS 108

CALIBRATION (	CERTIFICATE		
Object	D1800V2 - SN: 2	87	200 100 40
Calibration procedure(s)	QA CAL-05.v8 Calibration proce	dure for dipole validation kits abo	ove 700 MHz
Calibration date:	August 17, 2011		
The measurements and the unce	rtainties with confidence p	ional standards, which realize the physical un robability are given on the following pages on by facility unninorment temperature: (22 ± 3)°C	ed are part of the contificate.
	TE critical for calibration)	***************************************	nni odko odki i odko i odki
Calibration Equipment used (IAS	TE critical for calibration)	Cal Date (Certificate No.)	Scheduled Calibration
Calibration Equipment used (MS: Primary Standards	50		
Calibration Equipment used (MS: Primary Standards Powor motor EPM-4424	ID a	Cal Date (Certificate No.)	Scheduled Galibration
Calibration Equipment used (IAS Primary Standards Power motor EPM-442A Power sansor HP 3481A Pedecence 20 dB Attenueror	ID # GB37480704 US37292783 SN: 35088 (20b)	Cai Date (Certificate No.) 06-Oct-10 (No. 217-01266) 06-Oct-10 (No. 217-01266) 29-Mer-11 (No. 217-01367)	Scheduled Calibration Oct-1 Oct-1 Apr-12
Calibration Equipment used (IAS: Primary Standards Power motor EPIA-442A Power sansor HP 3481A Peference 20 JB Attenueror Typo N. mismatch combination	ID # GB37480704 US37292783 SN: S5086 (20b) SN: 5047.2 / 06827	Cai Date (Certificate No.) 06-Oct-10 (No. 217-01266) 06-Oct-10 (No. 217-01266) 29-Mer-11 (No. 217-01367) 29 Mor 11 (No. 217-01371)	Scheduled Calibration Oct-1 Oct-1 Apr-12 Apr-12
Calibration Equipment used (MS: Primary Standards Power motor EP\$4.4424 Power sensor HP 3481A Pelecence 20 dB Attenueror Typo N mismatch combination Reference Probe ES3DV3	ID II GB37480704 US37292783 SN: S5086 (2016) SN: 5047.2 / 06527 SN: 3205	Cai Date (Certificate No.) 06-Oct-10 (No. 217-01266) 06-Oct-10 (No. 217-01266) 29-Mar-11 (No. 217-01367) 29 Mor 11 (No. 217-01371) 29-Apr-11 (No. ES3-3205 Apr-11)	Scheduled Calibration Oct-1 Oct-11 Apr-12 Apr-12 Apr-12
Calibration Equipment used (MS: Primary Standards Power motor EPM-4424 Power sansor HP 3481A Peterence 20 dB Attenueror Typo N mismatch combination Reference Probe ES3DV3	ID # GB37480704 US37292783 SN: S5086 (20b) SN: 5047.2 / 06827	Cai Date (Certificate No.) 06-Oct-10 (No. 217-01266) 06-Oct-10 (No. 217-01266) 29-Mer-11 (No. 217-01367) 29 Mor 11 (No. 217-01371)	Scheduled Calibration Oct-1 Oct-1 Apr-12 Apr-12
Calibration Equipment used (IAS) Primary Standards Power Sensor HP 3481A Pederation 20 dB Attenuation Type N mismatch combination Reference Probe ES3DV3 DAE4	ID II GB37480704 US37292783 SN: S5086 (2016) SN: 5047.2 / 06527 SN: 3205	Cai Date (Certificate No.) 06-Oct-10 (No. 217-01266) 06-Oct-10 (No. 217-01266) 29-Mar-11 (No. 217-01367) 29 Mor 11 (No. 217-01371) 29-Apr-11 (No. ES3-3205 Apr-11)	Scheduled Calibration Oct-1 Oct-11 Apr-12 Apr-12 Apr-12
Calibration Equipment used (IAS: Primary Standards Power motor EPM-4424 Power sansor HP 3481A Perference 20 dB Attenuation Type N mismatch combination Reference Probe ES3DV3 DAE4 Socondary Standards	ID # GB37480704 UG37292783 SN: S5086 (20b) SN: 5047.2 / 06527 SN: 2205 SN: 601	Cal Date (Certificate No.) 06-Oct-10 (No. 2:7-01266) 06-Oct-10 (No. 2:7-01266) 29-Mer-11 (No. 217-01367) 29 Mor 11 (No. 217-01371) 29-Apr-11 (No. ESS-3205, Aurt1) 04-Jul-11 (No. DAE4-901_Jul11)	Scheduled Galibration Oct-1 Oct-11 Apr-12 Apr-12 Apr-12 Jul-12
Calibration Equipment used (IAS: Primary Standards Power motor EP\$44424 Power sensor HP 34814 Peterstop 20 tills Attenuation Typo N mismatch combination Peterstop Probe ES3DV3 DAE4 Socondary Standards Power consor HP 34814	ID # GB37480704 UG37292783 SN: S5086 (20b) SN: 5047.2 / 06527 SN: 2205 SN: 601	Cal Date (Certificate No.) 06-Oct-10 (No. 217-01266) 06-Oct-10 (No. 217-01266) 29-Mar-11 (No. 217-01367) 29-Mar-11 (No. 217-01371) 29-Apr-11 (No. EG3-3205 Apr11) 04-Jul-11 (No. DAE4-831_Jul11) Check Date (in house)	Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Apr-12 Jul-12 Scheduled Check
Calibration Equipment used (IAS: Primary Standards Power motor EPM-4424 Power sensor HP 3481A Petinence 20 dB Attenueur Type N mismatch combination Reference Probe ES3DY3 DAE4 Socondary Standards Power concer HP 3481A HF generator R&S SMT-06	ID 8 GB37480704 US37292783 SN: 35088 (2010) SN: 5047.2 / 06527 SN: 3205 SN: 601 ID 8 MY41092317	Cal Date (Certificate No.) 06-Oct-10 (No. 2:7-01266) 06-Oct-10 (No. 2:7-01266) 29-Mar-11 (No. 2:7-01266) 29-Mar-11 (No. 2:7-01367) 29-Apr-11 (No. 2:50-3205 Apr-11) 04-Jul-11 (No. DAE4-801_Jul11) Check Date (in house) 18-Oct-02 (in house check Oct-09)	Scheduled Calibration Oct-1 Oct-11 Apr-12 Apr-12 Apr-12 Jul-12 Jul-12 Scheduled Chack In house check: Oct-11
Calibration Equipment used (IAS: Primary Standards Power motor EPM-4424 Power sensor HP 3481A Petinence 20 dB Attenueur Type N mismatch combination Reference Probe ES3DY3 DAE4 Socondary Standards Power concer HP 3481A HF generator R&S SMT-06	ID # GB37480704 US37292783 SN: S5C86 (2010) SN: 5047.2 / 06527 SN: 2005 SN: 601 ID # MY41092317 100005	Cai Date (Certificate No.)  06-Oct-10 (No. 2 '7-01266)  06-Oct-10 (No. 2 '7-01266)  29-Mar-11 (No. 217-01367)  29-Mar-11 (No. 217-01367)  29-Apr-11 (No. EG3-3205 Apr11)  04-Jul-11 (No. DAE4-901_Jul11)  Check Date (in house)  19-Oct-32 (in house check Oct-09)  04-Aug-99 (in house check Oct-09)	Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Jul-12 Scheduled Chack In house check: Oct-11 In house check: Oct-11
Calibration Equipment used (IAS: Primary Standards Power motor EPIA-4424 Power sensor HP 8481A Peterence 20 dB Anexusor Typo N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power concer HP 8481A HF generator H&S STAT-06 Notwork Analyzor HP 8753E	ID #  GB37480704 US37292783 SN: S5686 (201) SN: 5647.2 / 06527 SN: 3205 SN: 601  ID #  MY41092317 100308 US37390585 \$4206	Cai Date (Certificate No.)  06-Oct-10 (No. 2:7-01266)  06-Oct-10 (No. 2:7-01266)  29-Mar-11 (No. 2:7-01367)  29 Mor 11 (No. 2:17-01371)  29-Apr-11 (No. ES3-3205, Apr-11)  04-Jul-11 (No. DAE4-801_Jul11)  Check Date (in house)  18-Oct-32 (in house check Oct-09)  04-Aug-99 (in house check Oct-09)  18-Oct-31 (in house check Oct-10)	Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Jul-12 Jul-12 Scheduled Chack In house check: Oct-11 In house check: Oct-11 In house check: Oct-11
Calibration Equipment used (IAS) Primary Standards Power Sentor EPM-4424 Power sentor EPM-481A Power sentor HP 3481A Type N mismatch combination Reference Probe ES3DV3 CAE4	ID #  GB37480704 US37292783 SN: S5686 (201) SN: 5647.2 / 06527 SN: 3205 SN: 601  ID #  MY41092317 100308 US37390585 \$4206  Name	Cai Date (Certificate No.)  06-Oct-10 (No. 2: 7-01266)  06-Oct-10 (No. 2: 7-01266)  29-Mar-11 (No. 2: 7-01266)  29-Mar-11 (No. 2: 7-01367)  29-Apr-11 (No. E53-3205, Aurill)  04-Jul-11 (No. E53-3205, Aurill)  Check Date (In house)  18-Oct-32 (In house check Oct-09)  04-Aug-99 (In house check Oct-09)  18-Oct-31 (In house check Oct-10)  Function	Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Jul-12 Jul-12 Scheduled Chack In house check: Oct-11 In house check: Oct-11 In house check: Oct-11

Certificate No: D1800V2-287\_Aug11

Page 1 of 8



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





S Schwelzerlecher Katibrierdienst
C Service suisse d'étalonnage
Scrvizio svizzero di taratura
S Swiss Calibration Service

Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS)

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

Multilateral Agreement for the recognition of calibration certificates

Glossary:

TSL tissue simulating liquid

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

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

- a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- EC 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) Foderal 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.

Cortificate No: D1800V2-287 Aug1\*

Page 2 of 8



#### Measurement Conditions

DASY Version	DASY5	V52.6.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1800 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	39.7 ± 6 %	1.37 mno/m ± 6 %
Head TSI, temperature change during test	< 0.5 °C	****	****

### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.28 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	37.5 mW /g ± 17.0 % (K=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSI.	condition	
SAR measured	250 mW input power	4.90 mW / g
SAB for nominal Head TSL parameters	normalized to 1W	19.7 mW /g ± 16.5 % (k=2)

### **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	51.0 ± 6 %	1.50 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	eset.	4444

### 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	9.58 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	38.7 mW / g ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>2</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.06 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	20.4 mW / g ± 16.5 % (km2)

Certificate No: D1600V2-207\_Aug11

Page 3 of 8



### Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.4 Ω - 5.4 Ω	
Return Loss	- 25.3 dB	

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.3 Ω - 4.8 μΩ
Return Loss	- 23.0 dB

### General Antenna Parameters and Design

Commence of the commence of th	
Electrical De ay (one direction)	1.205 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 antonna is therefore short-circuited for DC-signals.

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

#### Additional EUT Data

Manufactured by	SPEAG	
Manufactured on	January 24, 2001	

Certificate No: E1800V2-287\_Aug11

Page 4 of 8



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

Date: 16.08.2011

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN: 287

Communication System: CW; Frequency: 1800 MHz.

Medium parameters used: f = 1800 MHz;  $\sigma = 1.37$  mho/m;  $\epsilon_r = 39.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

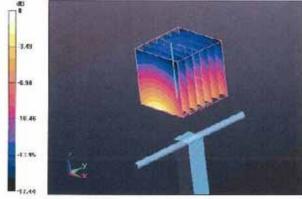
#### DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(5.07, 5.07, 5.07); Calibrated: 29.04.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.6.2(482); SEMCAD X 14.4.5(3634)

#### 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 = 93.567 V/m; Power Drift = 0.06 dB Peak SAR (extrapolated) = 16.557 W/kg SAR(1 g) = 9.28 mW/m; SAR(10 g) = 4.0 mW/m

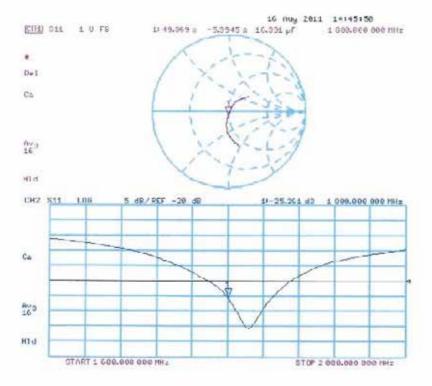
SAR(1 g) = 9.28 mW/g; SAR(10 g) = 4.9 mW/gMaximum value of SAR (measured) = 11.541 mW/g



0 dB = 11.540 mW/g



## Impedance Measurement Plot for Head TSL



Certificate No: D1800V2-287\_Aug I I



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

Date: 17.08.2011

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN: 287

Communication System; CW, Frequency; 1800 MHz

Medium parameters used: f = 1800 MHz;  $\sigma = 1.5 \text{ mho/m}$ ;  $\epsilon_r = 54$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

#### DASY52 Configuration:

Probe: ES3DV3 - SN3205; ConvF(4.74, 4.74, 4.74); Calibrated: 29.04.2011

Sensor-Surface: 3mm (Mechanical Surface Detection)

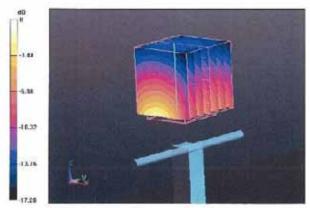
Electronics: DAE4 Sn601; Calibrated: 04.07.2011

Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002

DASY52 52.6.2(482); SEMCAD X 14.4.5(3634)

## 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 = 90.491 V/m; Power Drift = 0.05 dB Peak SAR (extrapolated) = 16.947 W/kg SAR(1 g) = 9.58 mW/g; SAR(10 g) = 5.06 mW/g Maximum value of SAR (measured) = 11.829 mW/g

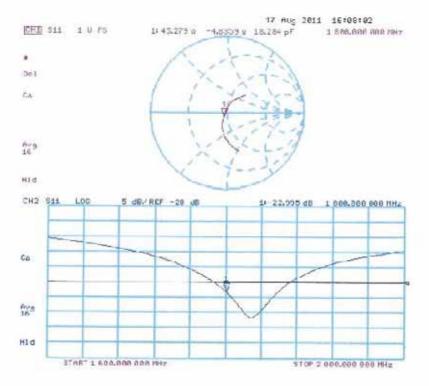


0 dB = 11.830 mW/g

Certificate No: D1800V2-287\_Aug11



## Impedance Measurement Plot for Body TSL



Certificate No: D1800V2-287\_Aug11



# 6 Calibration report "1900 MHz System validation dipole"

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





S Schweizerischer Kalibrierdienst
C Service sulsse d'étalonnage
Servizio svizzero di laratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)

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

Accreditation No.: SCS 108

Client Cetecom

Certificate No: D1900V2-5d009\_Aug11

Object	D1900V2 - SN: 5	d009	1111 878 1170
Calibration procadure(a)	QA CAL-05.v8 Calibration proce	dure for dipole validation kits abo	ove 700 MHz
Calibration date:	August 17, 2011		
		robability are given on the following pages ar	- Paris and Marini Annie
		ry facility: environment temperature (22 ± 3)*(	C and humidity < 70%.
al bration Equipment used (M&		ry facility: environment temperature (22 ± 3)*\ Cal Date (Certificate No.)	C and humidity < 70%. Scheduled Galibration
al bration Equipment used (M& innery Standards ower meter EPM-442A	TE critical for calibration)		
niibration Equipment used (M& imary Standards over meter EPM-442A over sensor HP 8481A	TE critical for calibration)  ID †  GB3/480/04  US37292783	Ccl Date (Certificate No.) 06-Oct-10 (No. 217-01288) 06-Oct-10 (No. 217-01268)	Scheduled Celibration Oct-11 Oct 11
al bration Equipment used (M& imary Standards ower meter EPM-442A ower sensor HP 8481A oference 20 dD Attenuator	TE critical for calibration)  ID * GB3/480/04 US37292783 SN: 85086 (20b)	Cal Date (Certificate No.) 06-Oct-10 (No. 217-01266) 06-Oct-10 (No. 217-01266) 29 Mar-11 (No. 217-01267)	Scheduled Galibration Oct-11 Oct 11 Apr-12
infloration Equipment used (M& innery Standards ower meter EPM-442A ower sensor HP 8481A oterence 20 dD Attenuator ype-61 mismarch combination	TE critical for calibration)  ID * GB3/490/04 US37292703 SN: 85086 (20b) SN: 5047.2706327	Cal Date (Certificate No.) C6-Oct-10 (No. 217-01266) C6-Oct-10 (No. 217-01266) 29 Mar-11 (No. 217-01267) 29 Mar-11 (No. 217-01271)	Scheduled Grillmation Oct-11 Oct 11 Apr-12 Apr-12
ni bration Equipment used (M& imary Standards ower meter EPM-442A ower sensor HP 8481A oference 20 dD Attenuator ope-N mismarch combination oference Probe ES3DV3	TE critical for calibration)  ID * GB3/490/04 US37292703 SN: 85086 (20b) SN: 5047.27 06327 SN: 3205	Cal Date (Certificate No.) C6-Oct-10 (No. 217-01266) C6-Oct-10 (No. 217-01266) 29 Mar-11 (No. 217-01267) 29 Mar-11 (No. 217-01271) 29-Apr-11 (No. ES2-3205 Apr-11)	Scheduled Gelibration Oct-11 Oct 11 Apr-12 Apr-12 Apr-12
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Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Idelerence 20 dB Attanuator ype-N mismarch combination tectorence Probe ES3DV3 IAF4	TE critical for calibration)  ID #  GB9/480704  US97292700  SN: 85086 (20b)  SN: 5047.27 (06327  SN: 3208  SN: 601	Col Date (Certificate No.)  CB-Oct-10 (No. 217-01268)  CB-Oct-10 (No. 217-01268)  29 Mor-11 (No. 217-01271)  29-Apr-11 (No. 217-01271)  29-Apr-11 (No. DAE4-601_Jul11)  Check Date (Introsee)	Scheduled Celibration Oct-11 Oct 11 Apr-12 Apr-12 Apr-12 Ju-12 Scheduled Check
Calibration Equipment used (M& Primery Standards Power meter EPM-442A Power sensor HP 8481A Helerence 20 dd Attonuator Type-N mismarch combination Reference Probe ES3DV3 hAE4 Secondary Standards Power sensor HP 8481A	TE critical for calibration)  ID #  GD9/480704  US37292703  SN: 85086 (20b)  SN: 5047.2706927  SN: 3206  SN: 601  ID #  MY41092317	Col Date (Certificate No.)  C6-Oct-10 (No. 217-D1266)  C6-Oct-10 (No. 217-D1266)  20 Mor-11 (No. 217-D127)  29 Mor-11 (No. 217-D127)  29-Apr-11 (No. ES2-3205 Apr-11)  O4-Jul-11 (No. D464-601 Juli11)  Check Date (Entropse)	Scheduled Celibration Oct-11 Oct 11 Apr-12 Apr-12 Apr-12 Ju-12 Scheduled Check In house check: Oct-11
Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dD Attenuator ype-N mismarch combination Reference Probe ES3DV3 pAF4 Recordary Standards Power sensor HP 8481A RF generator R&S 3MT 06	TE critical for calibration)  ID 1 GB3/480704 US37292703 SN: 85086 (20b) SN: 85086 (20b) SN: 9208 SN: 601  ID 4 MY41092317 100006	Ccl Date (Certificate No.)  C6-Oct-10 (No. 217-D1266)  C6-Oct-10 (No. 217-D1266)  20 Mar 11 (No. 217-D1267)  20 Mar 11 (No. 217-D1271)  29-Apr-11 (No. ES3-3205 Apr11)  O4-Jul-11 (No. DAE4-601_Jul11)  Check Date (Erticuse)  18-Oct-02 (in busies check Oct-09)  04-Aug-99 (in busies check Oct-09)	Scheduled Celibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Ju-12 Scheduled Check In house check: Oct-11 In house check: Oct-11
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inimary Standards ower meter EPM-442A ower acnsor HP 8481A toterence 20 dD Attanuator type-N mismarch combination eforence Probe ES3DV3 AE4 econdary Standards ower sensor HP 8481A Figenerator P&S 3MT 06	TE critical for calibration)  ID 1 GB3/480/U4 US37292700 SN: 85086 (20b) SN: 5047.2 / 08327 SN: 3205 SN: 601 ID # MY41092317 100005 US37390585 S4206	Ccl Date (Certificate No.)  C6-Oct-10 (No. 217-01266)  C6-Oct-10 (No. 217-01266)  29 Mor-11 (No. 217-01267)  29 Mor-11 (No. 217-01271)  29-Apr-11 (No. ES3-3205 Apr11)  C4-Jul-11 (No. DAE4-601_Jul11)  Check Oxte (Introduct  18-Oct-02 (in bouse check Oct-09)  18-Oct-01 (in house check Oct-09)	Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Ju-12 Scheduled Check In house check: Oct-11 In house check: Oct-11 In house check: Oct-11
Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attanuator (ype-8 mismarch combination Reference Probe ES3DV3 bAE4 Recordary Standards Power sensor HP 8481A RE generator R&S 3MT 00 Retwork Analyzer HP 3753E	TE difficel for cellibration)  ID # GB07480704 US37292703 SN: 85086 (20b) SN: 5047.27 08327 SN: 3205 SN: 601  IC # MY41092317 100005 US37390505 \$4206	Ccl Date (Certificate No.)  C6-Oct-10 (No. 217-01266)  C6-Oct-10 (No. 217-01266)  29 Mor-11 (No. 217-01367)  29 Mor-11 (No. 217-01371)  29-Apr-11 (No. ES3-3205 Apr11)  O4-Jul-11 (No. DAE4-601_Jul11)  Check Oxte (Introduct  18-Oct-02 (in house check Oct-09)  18-Oct-01 (in house check Oct-09)  18-Oct-01 (in house check Oct-16)	Scheduled Celibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Ju-12 Scheduled Check In house check: Oct-11 In house check: Oct-11
calibration Equipment used (M& Inmary Standards fower meter EPM-442A lower sensor HP 8481A loterence 20 dB Attanuator ype-6 mismarch combination teterence Probe ES3DV3 iAE4 econdary Standards ower sensor HP 8481A IF generator R&S 3MT 00 letwork Analyzer HP 3753E	TE critical for calibration)  ID 1 GB3/480/U4 US37292700 SN: 85086 (20b) SN: 5047.2 / 08327 SN: 3205 SN: 601 ID # MY41092317 100005 US37390585 S4206	Ccl Date (Certificate No.)  C6-Oct-10 (No. 217-01266)  C6-Oct-10 (No. 217-01266)  29 Mor-11 (No. 217-01267)  29 Mor-11 (No. 217-01271)  29-Apr-11 (No. ES3-3205 Apr11)  C4-Jul-11 (No. DAE4-601_Jul11)  Check Oxte (Introduct  18-Oct-02 (in bouse check Oct-09)  18-Oct-01 (in house check Oct-09)	Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Ju-12 Scheduled Check In house check: Oct-11 In house check: Oct-11 In house check: Oct-11
Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Helerence 20 dD Attanuator Type-N mismarch combination Reference Probe ES3DV3 DAE4	TE difficel for cellibration)  ID # GB07480704 US37292703 SN: 85086 (20b) SN: 5047.27 08327 SN: 3205 SN: 601  IC # MY41092317 100005 US37390505 \$4206	Ccl Date (Certificate No.)  C6-Oct-10 (No. 217-01266)  C6-Oct-10 (No. 217-01266)  29 Mor-11 (No. 217-01367)  29 Mor-11 (No. 217-01371)  29-Apr-11 (No. ES3-3205 Apr11)  O4-Jul-11 (No. DAE4-601_Jul11)  Check Oxte (Introduct  18-Oct-02 (in house check Oct-09)  18-Oct-01 (in house check Oct-09)  18-Oct-01 (in house check Oct-16)	Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Ju-12 Scheduled Check In house check: Oct-11 In house check: Oct-11 In house check: Oct-11

Certificate No: D1900V2-5d009\_Aug11

Page 1 ol 8



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





S Schweizerlacher Kalibrierdienst
C Service quisco d'étalonnage
Servizio evizzero 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 Multilatoral 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-hold 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 Dolay: One-way dolay between the SMA connector and the antenna feed point.
   No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power.
- SAH normalized: SAH 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.

Certificate No: D1900V2-5d009\_Aug11 Page 2 of 8



#### Measurement Conditions

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

DASY Version	DASY5	V52.6.2
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	39.5 ± 6 %	1.42 mho/m ± 8 %
Hoad 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 TSI.	Condition	
SAR measured	250 mW input power	10.1 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	40.0 mW/g ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.27 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	20.9 mW /g ± 16.5 % (k=2)

## **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	53.9 - 6 %	1.57 mho/m + 6 %
Body TSL temperature change during test	< 0.5 °C	1111	

## SAR result with Body TSL

SAR averaged over 1 cm3 (1 g) of Body TSL	Condition	
SAR measured	250 mW riput power	10.4 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	40.9 mW / g ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	candition	
SAR measured	250 mW input power	5.43 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	21.5 mW/g ± 16.5 % (k=2)

Certificate No: D1900V2-5d009\_Aug11

Page 3 of 8



## Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.1 Ω + 2.7 jΩ	
Return Loss	- 30.9 dB	

## Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.6 Ω + 2.8 JΩ	
Return Less	- 26.8 dG	

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.188 ns

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

The dipole is made of standard comingid coaxial cable. The center conductor of the faceting line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.

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

#### **Additional EUT Data**

Manufacturec by	SPEAG
Manufactured on	Fobruary 22, 2002

Certificate No: D1900V2-50009\_Aug11



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

Date: 16.08.2011

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d009

Communication System: CW; Frequency: 1900 MHz

Medium parameters used:  $\Gamma = 1900 \text{ MHz}$ ;  $\sigma = 1.42 \text{ mho/m}$ ;  $\epsilon = 39.5$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

#### DASY52 Configuration:

Probe: ES3DV3 - SN3205; ConvF(5.01, 5.01, 5.01); Calibrated: 29.04.2011

· Sensor Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn601; Calibrated: 04.07.2011

Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001

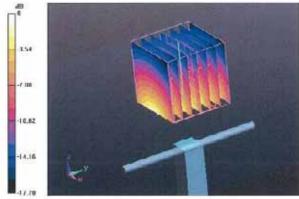
DASY52 52.6.2(482); SEMCAD X 14.4.5(3634)

## 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 = 97,320 V/m; Power Drift = 0.04 dB Peak SAR (extrapolated) = 18,403 W/kg

SAR(1 g) = 10.1 mW/g; SAR(10 g) = 5.27 mW/g

Maximum value of SAR (measured) = 12.504 mW/g



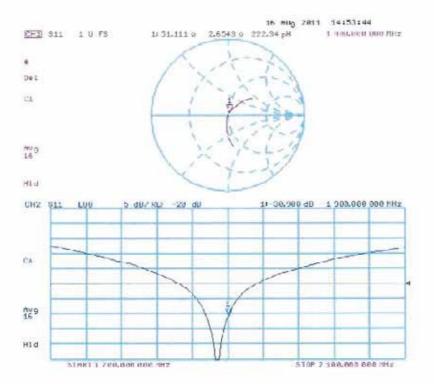
0 dB = 12.500 mW/g

Certificate No: D (900V2-5d009, Aug III)

Page 5 of 8



## Impedance Measurement Plot for Head TSL



Certificate No: D1900V2 5d009\_Aug11

Page 6 of 8



#### DASY5 Validation Report for Body TSL

Date: 17.08.2011

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 1900 MHz; Type: D1900V2; Scrial: D1900V2 - SN: 5d009

Communication System: CW; Frequency: 1900 MHz.

Medium parameters used: t = 1900 MHz;  $\sigma = 1.57 \text{ mho/m}$ ;  $\varepsilon_t = 53.9$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

#### DASY52 Configuration:

Probe: ES3DV3 - SN3205; ConvF(4.62, 4.62, 4.62); Calibrated; 29.04.2011

Sensor-Surface: 3mm (Mechanical Surface Detection)

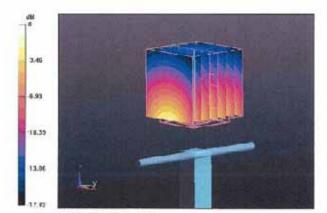
Electronics: DAE4 Sn601; Calibrated: 04.07.2011

Phantom: Flat Phantom 5.0 (back): Type: QD000P50AA; Serial: 1002

DASY52 52.6.2(482); SEMCAD X 14.4.5(3634)

## 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 = 95.260 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 18.457 W/kg SAR(1 g) = 10.4 mW/g; SAR(10 g) = 5.43 mW/g Maximum value of SAR (measured) = 13.111 mW/g

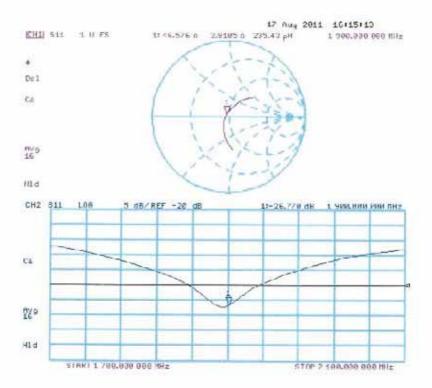


0 dB = 13.110 mW/g

Certificate No: D1900V2 5d009\_Aug11



## Impedance Measurement Plot for Body TSL



Certificate No: D1900V2-5d009, Aug11

Page 8 of 8



## 7 Calibration report "2450 MHz System validation dipole"

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





S Schweizerischer Kalibrierdienst
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Servizie svizzere di tarature
S Swiss Calibration Service

Accreditation No.: SCS 108

Accredited by the SWes Accreditation Service (SAS)

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

Cetecom Certificate No: D2450V2-710\_Aug11 CALIBRATION CERTIFICATE Object D2450V2 - SN: 710 Cal bration procedure(a) QA CAL-05.v8 Calibration procedure for dipole validation kits above 700 MHz Calibration date: August 19, 2011 This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility, environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) Primary Standards 10 % Oal Date (Certificate No.) Scheduled Calibration Power meter EPM-4/2A GB37480704 06 Oct 10 (No. 217-31266) Oat 11 Fower sensor HP 848: A U\$37292783 06-Oct-10 (No. 217-01266) Oct-11 Reference 20 dB Attenuator SN: \$5066 (20b) 29-M2F-11 (NO. 217-01367) Anr-12 Type-N mismatch combination 3N: 5047.2 / 06327 29-Mar-11 (No. 217-01371) Aur 12 Peference Probe ES3DV3 SN: 8205 29-Apr-11 (No. E83-3205 Apr11) Aur-12 DAE4 SN: 601 04 Jul 11 (No. DAE4-901\_Jul 11) Jul-12 Secondary Standards ID A Check Date (in house) Scheduled Check MY41092317 Power sensor HP 9481A 18 Oct-02 (in house check Oct-09) In house check: Oct-11 RF generator R&S SMT-06 100005 04 Aug 99 (in house check Oct-09) In house check: Oct-11 Network Analyzer HP 8753E US37390586 S4236 18 Oct-01 (in house check Oct-10) In house check: Oct-11 On ibrared by: Claudio Leubler Laboratory Technician Katja Pokovic Approved by: Technical Manager Issued: August 22, 2011 This as ibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: D2450V2-710\_Aug11 Page 1 of 8



## Calibration Laboratory of

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, 8witzerland





S Sohweizerlocher Kallbrierdionat
C Service suisse d'étatennage
Servizio svizzero di taratura
S Swiss Calibration Service

Accreditation No.: SCS 108

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

#### Glossary:

TSI. 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.

Certificate No: D2450V2-710\_Aug11 Page 2 of 8



#### **Measurement Conditions**

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

DASY Vorsion	DASYS	V52.6.2
Extrapolation	Advanced Extrapolation	
Phanton	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.

2 Mari and Calabert and English (1000 and 1000 a	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Mossurod Hoad TSL parameters	(22.0 ± 0.2) °C	38.4 ± 6 %	1.85 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

## SAR result with Head TSL

SAR averaged over 1 cm3 (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	54.2 mW /g ± 17.0 % (k=2)

SAR averaged over 10 cm3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.42 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	25.5 mW/g ± 16.5 % (k=2)

## **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mba/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.8 ± 6 %	2.02 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	
SAH measured	250 mW input power	13.2 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	51.7 mW / g ± 17.0 % (k=2)

SAR averaged over 10 cm3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.10 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	24.2 mW / g ± 16.5 % (k=2)

Certificate No: D2450V2 710\_Aug11



## Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.2 \( \Omega + 1.0 \) \( \Omega \)
Return Loss	+ 29.6 dB

## Antenna Parameters with Body TSL

Impodance, transformed to feed point	49.5 Ω + 2.5 jΩ
Return Loss	31.8 dB

## General Antenna Parameters and Design

Electrical Delay (one direction)	1.156 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 comingid 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 cignals.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feed-point may be demaged.

## Additional EUT Data

Manufactured by	SPEAG
Manufactured on	July 05, 2002

Certificate No: D2450V2-710\_Aug11



#### DASY5 Validation Report for Head TSL

Date: 18.08.2011

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 710

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: f = 2450 MHz;  $\sigma = 1.85$  mho/m;  $\varepsilon_r = 38.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

#### DASY52 Configuration:

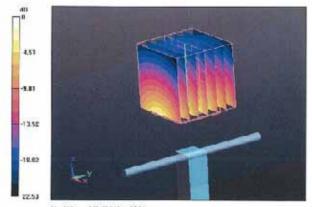
- Probe: ES3DV3 SN3205; ConvF(4.45, 4.45, 4.45); Calibrated: 29.04.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Scrial: 1001
- DASY52 52.6.2(482); SEMCAD X 14.4.5(3634)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 101.9 V/m; Power Drift = 0.00; dB Peak SAR (extrapolated) = 28.588 W/kg

SAR(1 g) = 13.8 mW/g; SAR(10 g) = 6.42 mW/g

Maximum value of SAR (measured) = 17.763 mW/g

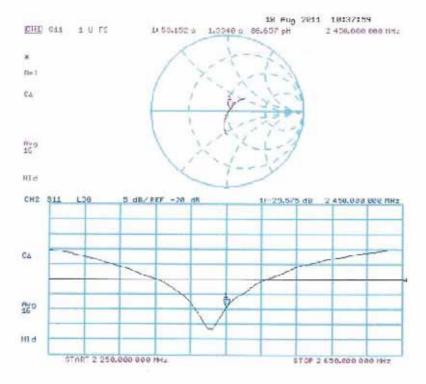


0 dB = 17.760 mW/g

Certificate No: D2450V2-710\_Aug11



## Impedance Measurement Plot for Head TSL



Certificate No: D2450V2-710\_Aug11

Page 6 of 8



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

Date: 19.08.2011

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 710

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: f = 2450 MHz;  $\sigma = 2.02 \text{ mho/m}$ ;  $c_r = 51.8$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

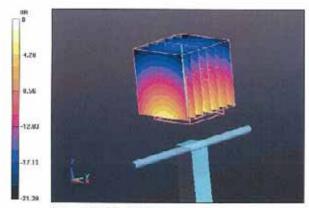
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

#### DASY52 Configuration:

- Probe; ES3DV3 SN3205; ConvF(4.26, 4.26, 4.26); Calibrated: 29.04.2011
- Senser-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.6.2(482); SEMCAD X 14.4.5(3634)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 95.772 V/m; Power Drift = -0.03 dB Peak SAR (extrapolated) = 26.990 W/kg SAR(1 g) = 13.2 mW/g; SAR(10 g) = 6.1 mW/g Maximum value of SAR (measured) = 17.251 mW/g

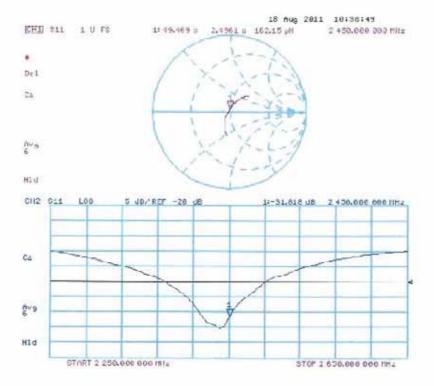


0 dB = 17.250 mW/g

Cortificate No: D2450V2-710\_Aug11



## Impedance Measurement Plot for Body TSL



Certificate No: D2456V2-710\_Aug 11



# Calibration certificate of Data Acquisition Unit (DAE)

Calibration Laboratory of Schmid & Partner Engineering AG





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

Zeughausstrasse 43, 8004 Zurich, Switzerland

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates Accreditation No.: SCS 108

Certificate No: DAE3-413\_Jan11 Cetecom

Object	DAE3 - SD 000 D	03 AA - SN: 413	Carlos Carlos III
Calibration procedure(s)	QA CAL-06.v22 Calibration process	dure for the data acquisition e	electronics (DAE)
alibration date:	January 13, 2011		
he measurements and the unce	ertainties with confidence pro	nal standards, which realize the physical obability are given on the following page $\tau$ facility: environment temperature (22 $\pm$	s and are part of the certificate.
alibration Equipment used (M&	TE critical for calibration)		
	TE critical for calibration)	Cal Date (Certificate No.)	Scheduled Calibration
imary Standards		Cal Date (Certificate No.) 28-Sep-10 (No:10376)	Scheduled Calibration Sep-11
imary Standards sithley Multimeter Type 2001 scondary Standards	ID # SN: 0810278	28-Sep-10 (No:10376) Check Date (in house)	Sep-11 Scheduled Check
Calibration Equipment used (M& Primary Standards Ceithley Multimeter Type 2001 Secondary Standards Calibrator Box V1.1	ID# SN: 0810278	28-Sep-10 (No:10376) Check Date (in house)	Sep-11
Primary Standards Ceithley Multimeter Type 2001 Secondary Standards	ID # SN: 0810278 ID # SE UMS 006 AB 1004	28-Sep-10 (No:10376)  Check Date (in house)  07-Jun-10 (in house check)	Sep-11  Scheduled Check In house check: Jun-11  Signature
eithley Multimeter Type 2001 econdary Standards alibrator Box V1.1	ID # SN: 0810278	28-Sep-10 (No:10376) Check Date (in house)	Sep-11 Scheduled Check
Primary Standards Ceithley Multimeter Type 2001 Secondary Standards	ID # SN: 0810278 ID # SE UMS 006 AB 1004 Name	28-Sep-10 (No:10376)  Check Date (in house)  07-Jun-10 (in house check)	Sep-11  Scheduled Check In house check: Jun-11  Signature

Certificate No: DAE3-413\_Jan11 Page 1 of 5



#### 9 Calibration certificate of Data Acquisition Unit (DAE)

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





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

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

Cetecom Client

Accreditation No.: SCS 108

Certificate No: DAE3-477\_May11 CALIBRATION CERTIFICATE DAE3 - SD 000 D03 AA - SN: 477 Object Calibration procedure(s) QA CAL-06.v22 Calibration procedure for the data acquisition electronics (DAE) May 4, 2011 Calibration date: This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) Primary Standards ID# Cal Date (Certificate No.) Scheduled Calibration Keithley Multimeter Type 2001 SN: 0810278 28-Sep-10 (No:10376) Sep-11 Secondary Standards Check Date (in house) Scheduled Check Calibrator Box V1.1 SE UMS 006 AB 1004 07-Jun-10 (in house check) In house check: Jun-11 Name Function Calibrated by: Dominique Steffen Technician Approved by: Fin Bornholt **R&D Director** Issued: May 4, 2011 This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: DAE3-477\_May11

Page 1 of 5



#### Certificate of "SAM Twin Phantom V4.0/V4.0C" 10

# Schmid & Partner Engineering AG

Zeugheusstrassa 43, 8004 Zurich, Switzarland, Phone +41 1 245 97 00, Fax +41 1 245 97 79

#### Certificate of conformity / First Article Inspection

Item	SAM Twin Phantom V4.0
Type No	QD 000 P40 BA
Series No	TP-1002 and higher
Manufacturer / Origin	Untersee Composités
· -	Hauptstr. 69
	CH-8559 Fruthwilen
	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 8A, Seriat No. TP-1006. Certain parameters have been retested using further series units (called samples).

Test	Requirement	Details	Units tested
Shape	Compliance with the geometry	IT'IS CAD File (*)	First article,
	according to the CAD model.		Samples
Material thickness	Compliant with the requirements	2mm +/- 0.2mm in	First article.
	according to the standards	specific areas	Samples
Material	Dielectric parameters for required	200 MHz = 3 GHz	Material
parameters	frequencies	Relative permittivity < 5	sample
<b>FF F</b> · · · · · · · · · · · · · · · · · · ·		Loss tangent < 0.05.	TP 104-5
Material resistivity	The material has been tested to be	Liquid type HSL 1800	Pre-series,
	compatible with the liquids defined in	and others according to	First article
	the standards	the standard.	

#### Standards

- [1] CENELEC EN 50361 [2] IEEE P1526-200x draft 6.5
- [3] IEC PT 62209 draft 0.9
- The iT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of [1] and [3].

#### Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of SAR measurements specified in standard [1] and draft standards [2] and [3].

Date

18.11.2001

Schmid & Partner For Smilett Engineering AG

Zeughpusstrage 43, CH-8004 Zurich Tel. +41 1 245 97 00, Fex +41 1 245 97 79

Doc No 881 - QD 000 P40 BA - B

Page

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# 11 Application Note System Performance Check

## 11.1 Purpose of system performance check

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check is performed prior to any usage of the system in order to guarantee reproducible results.

The measurement of the Specific Absorption Rate (SAR) is a complicated task and the result depends on the proper functioning of many components and the correct settings of many parameters. Faulty results due to drift, failures or incorrect parameters might not be recognized, since they often look similar in distribution to the correct ones. The Dosimetric Assessment System DASY4 incorporates a system performance check procedure to test the proper functioning of the system. The system performance check uses normal SAR measurements in a simplified setup (the flat section of the SAM Twin Phantom) with a well characterized source (a matched dipole at a specified distance). This setup was selected to give a high sensitivity to all parameters that might fail or vary over time (e.g., probe, liquid parameters, and software settings) and a low sensitivity to external effects inherent in the system (e.g., positioning uncertainty of the device holder). The system performance check does not replace the calibration of the components. The accuracy of the system performance check is not sufficient for calibration purposes. It is possible to calculate the field quite accurately in this simple setup; however, due to the open field situation some factors (e.g., laboratory reflections) cannot be accounted for. Calibrations in the flat phantom are possible with transfer calibration methods, using either temperature probes or calibrated E-field probes. The system performance check also does not test the system performance for arbitrary field situations encountered during real measurements of mobile phones. These checks are performed at SPEAG by testing the components under various conditions (e.g., spherical isotropy measurements in liquid, linearity measurements, temperature variations, etc.), the results of which are used for an error estimation of the system. The system performance check will indicate situations where the system uncertainty is exceeded due to drift or failure.

# 11.2 System Performance check procedure

#### Preparation

The conductivity should be measured before the validation and the measured liquid parameters must be entered in the software. If the measured values differ from targeted values in the dipole document, the liquid composition should be adjusted. If the validation is performed with slightly different (measured) liquid parameters, the expected SAR will also be different. See the application note about SAR sensitivities for an estimate of possible SAR deviations. Note that the liquid parameters are temperature dependent with approximately - 0.5% decrease in permittivity and + 1% increase in conductivity for a temperature decrease of 1° C. The dipole must be placed beneath the flat phantom section of the Generic Twin Phantom with the correct distance holder in place. The distance holder should touch the phantom surface with a light pressure at the reference marking (little hole) and be oriented parallel to the long side of the phantom. Accurate positioning is not necessary, since the system will search for the peak SAR location, except that the dipole arms should be parallel to the surface. The device holder for mobile phones can be left in place but should be rotated away from the dipole. The forward power into the dipole at the dipole SMA connector should be determined as accurately as possible. See section 4 for a description of the recommended setup to measure the dipole input power. The actual dipole input power level can be between 20mW and several watts. The result can later be normalized to any power level. It is strongly recommended to note the actually used power level in the "comment"-window of the measurement file; otherwise you loose this crucial information for later reference.



#### **System Performance Check**

The DASY4 installation includes predefined files with recommended procedures for measurements and validation. They are read-only document files and destined as fully defined but unmeasured masks, so you must save the finished validation under a different name. The validation document requires the Generic Twin Phantom, so this phantom must be properly installed in your system. (You can create your own measurement procedures by opening a new document or editing an existing document file). Before you start the validation, you just have to tell the system with which components (probe, medium, and device) you are performing the validation; the system will take care of all parameters. After the validation, which will take about 20 minutes, the results of each task are displayed in the document window. Selecting all measured tasks and opening the predefined "validation" graphic format displays all necessary information for validation. A description of the different measurement tasks in the predefined document is given below, together with the information that can be deduced from their results:

- The "reference" and "drift" measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the amplifier output power. If it is too high (above ± 0.1dB) the validation should be repeated; some amplifiers have very high drift during warm-up. A stable amplifier gives drift results in the DASY4 system below ± 0.02 dB.
- The "surface check" measurement tests the optical surface detection system of the DASY4 system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above ± 0.1mm). In that case it is better to abort the validation and stir the liquid. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe. (It does not depend on the surface reflectivity or the probe angle to the surface within ± 30°.) However, varying breaking indices of different liquid compositions might also influence the distance. If the indicated difference varies from the actual setting, the probe parameter "optical surface distance" should be changed in the probe settings (see manual). For more information see the application note about SAR evaluation.
- The "area scan" measures the SAR above the dipole on a parallel plane to the surface. It is used to
  locate the approximate location of the peak SAR with 2D spline interpolation. The proposed scan uses
  large grid spacing for faster measurement; due to the symmetric field the peak detection is reliable. If a
  finer graphic is desired, the grid spacing can be reduced. Grid spacing and orientation have no influence
  on the SAR result.
- The zoom scan job measures the field in a volume around the peak SAR value assessed in the previous "area" scan (for more information see the application note on SAR evaluation).

If the validation measurements give reasonable results, the peak 1g and 10g spatial SAR values averaged between the two cubes and normalized to 1W dipole input power give the reference data for comparisons. The next section analyzes the expected uncertainties of these values. Section 6 describes some additional checks for further information or troubleshooting.

#### 11.3 Uncertainty Budget

Please note that in the following Tables, the tolerance of the following uncertainty components depends on the actual equipment and setup at the user location and need to be either assessed or verified on-site by the end user of the DASY4 system:

- · RF ambient conditions
- Dipole Axis to Liquid Distance
- Input power and SAR drift measurement
- Liquid permittivity measurement uncertainty
- Liquid conductivity measurement uncertainty

Note: All errors are given in percent of SAR, so 0.1 dB corresponds to 2.3%. The field error would be half of that. The liquid parameter assessment give the targeted values from the dipole document. All errors are given in percent of SAR, so 0.1dB corresponds to 2.3%. The field error would be half of that.



## **System validation**

In the table below, the system validation uncertainty with respect to the analytically assessed SAR value of a dipole source as given in the P1528 standard is given. This uncertainty is smaller than the expected uncertainty for mobile phone measurements due to the simplified setup and the symmetric field distribution.

Error Sources	Uncertainty Value	Probability Distribution	Divi- sor	c <sub>i</sub> 1g	c <sub>i</sub> 10g	Standard Uncertainty 1g	Standard Uncertainty 10g	V <sub>i</sub> <sup>2</sup> or V <sub>eff</sub>
Measurement System								
Probe calibration	± 4.8%	Normal	1	1	1	± 4.8%	± 4.8%	∞
Axial isotropy	± 4.7%	Rectangular	√3	0.7	0.7	± 1.9%	± 1.9%	∞
Hemispherical isotropy	± 0.0%	Rectangular	√3	0.7	0.7	± 0.0%	± 3.9%	∞
Boundary effects	± 1.0%	Rectangular	√3	1	1	± 0.6%	± 0.6%	∞
Probe linearity	± 4.7%	Rectangular	√3	1	1	± 2.7%	± 2.7%	∞
System detection limits	± 1.0%	Rectangular	√3	1	1	± 0.6%	± 0.6%	∞
Readout electronics	± 1.0%	Normal	1	1	1	± 1.0%	± 1.0%	∞
Response time	± 0.0%	Rectangular	√3	1	1	± 0.0%	± 0.0%	∞
Integration time	± 0.0%	Rectangular	√3	1	1	± 0.0%	± 0.0%	∞
RF ambient conditions	± 3.0%	Rectangular	√3	1	1	± 1.7%	± 1.7%	8
Probe positioner	± 0.4%	Rectangular	√3	1	1	± 0.2%	± 0.2%	8
Probe positioning	± 2.9%	Rectangular	√3	1	1	± 1.7%	± 1.7%	8
Max. SAR evaluation	± 1.0%	Rectangular	√3	1	1	± 0.6%	± 0.6%	8
Test Sample Related								
Dipole axis to liquid distance	± 2.0%	Normal	1	1	1	± 1.2%	± 1.2%	8
Power drift	± 4.7%	Rectangular	√3	1	1	± 2.7%	± 2.7%	∞
Phantom and Set-up								
Phantom uncertainty	± 4.0%	Rectangular	√3	1	1	± 2.3%	± 2.3%	∞
Liquid conductivity (target)	± 5.0%	Rectangular	√3	0.64	0.43	± 1.8%	± 1.2%	∞
Liquid conductivity (meas.)	± 2.5%	Normal	1	0.64	0.43	± 1.6%	± 1.1%	∞
Liquid permittivity (target)	± 5.0%	Rectangular	√3	0.6	0.49	± 1.7%	± 1.4%	∞
Liquid permittivity (meas.)	± 2.5%	Normal	1	0.6	0.49	± 1.5%	± 1.2%	∞
Combined Uncertainty						± 8.4%	± 8.1%	
Expanded Std. Uncertainty				_		± 16.8%	± 16.2%	



## Performance check repeatability

The repeatability check of the validation is insensitive to external effects and gives an indication of the variations in the DASY4 measurement system, provided that the same power reading setup is used for all validations. The repeatability estimate is given in the following table:

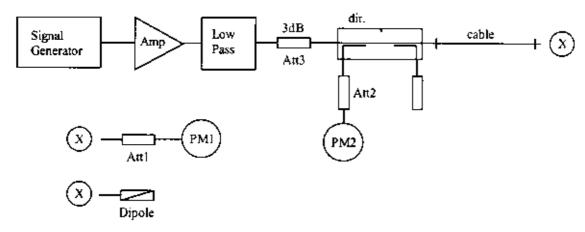
Error Sources	Uncertainty Value	Probability Distribution	Divi- sor	c <sub>i</sub> 1g	c <sub>i</sub> 10g	Standard Uncertainty 1g	Standard Uncertainty 10g	V <sub>i</sub> <sup>2</sup> or V <sub>eff</sub>
Measurement System								
Probe calibration	± 4.8%	Normal	1	1	1	0	0	∞
Axial isotropy	± 4.7%	Rectangular	√3	0.7	0.7	0	0	∞
Hemispherical isotropy	± 0.0%	Rectangular	√3	0.7	0.7	0	0	∞
Boundary effects	± 1.0%	Rectangular	√3	1	1	0	0	∞
Probe linearity	± 4.7%	Rectangular	√3	1	1	0	0	∞
System detection limits	± 1.0%	Rectangular	√3	1	1	0	0	∞
Readout electronics	± 1.0%	Normal	1	1	1	0	0	∞
Response time	± 0.0%	Rectangular	√3	1	1	0	0	∞
Integration time	± 0.0%	Rectangular	√3	1	1	0	0	∞
RF ambient conditions	± 3.0%	Rectangular	√3	1	1	0	0	8
Probe positioner	± 0.4%	Rectangular	√3	1	1	0	0	∞
Probe positioning	± 2.9%	Rectangular	√3	1	1	0	0	8
Max. SAR evaluation	± 1.0%	Rectangular	√3	1	1	0	0	8
Test Sample Related								
Dipole axis to liquid distance	± 2.0%	Normal	1	1	1	± 1.2%	± 1.2%	8
Power drift	± 4.7%	Rectangular	√3	1	1	± 2.7%	± 2.7%	8
Phantom and Set-up		_						
Phantom uncertainty	± 4.0%	Rectangular	√3	1	1	± 2.3%	± 2.3%	∞
Liquid conductivity (target)	± 5.0%	Rectangular	√3	0.64	0.43	± 1.8%	± 1.2%	8
Liquid conductivity (meas.)	± 2.5%	Normal	1	0.64	0.43	± 1.6%	± 1.1%	8
Liquid permittivity (target)	± 5.0%	Rectangular	√3	0.6	0.49	± 1.7%	± 1.4%	∞
Liquid permittivity (meas.)	± 2.5%	Normal	1	0.6	0.49	± 1.5%	± 1.2%	∞
Combined Uncertainty						± 5.3%	± 4.9%	
Expanded Std.						± 10.6%	± 9.7%	
Uncertainty								

The expected repeatability deviation is low. Excessive drift (e.g., drift in liquid parameters), partial system failures or incorrect parameter settings (e.g., wrong probe or device settings) will lead to unexpectedly high repeatability deviations. The repeatability gives an indication that the system operates within its initial specifications. Excessive drift, system failure and operator errors are easily detected.



## 11.4 Power set-up for validation

The uncertainty of the dipole input power is a significant contribution to the absolute uncertainty and the expected deviation in interlaboratory comparisons. The values in Section 2 for a typical and a sophisticated setup are just average values. Refer to the manual of the power meter and the detector head for the evaluation of the uncertainty in your system. The uncertainty also depends on the source matching and the general setup. Below follows the description of a recommended setup and procedures to increase the accuracy of the power reading:



The figure shows the recommended setup. The PM1 (incl. Att1) measures the forward power at the location of the validation dipole connector. The signal generator is adjusted for the desired forward power at the dipole connector and the power meter PM2 is read at that level. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at power meter PM2. If the signal generator does not allow a setting in 0.01dB steps, the remaining difference at PM2 must be noted and considered in the normalization of the validation results. The requirements for the components are:

- The signal generator and amplifier should be stable (after warm-up). The forward power to the dipole should be above 10mW to avoid the influence of measurement noise. If the signal generator can deliver 15dBm or more, an amplifier is not necessary. Some high power amplifiers should not be operated at a level far below their maximum output power level (e.g. a 100W power amplifier operated at 250mW output can be quite noisy). An attenuator between the signal generator and amplifier is recommended to protect the amplifier input.
- The low pass filter after the amplifier reduces the effect of harmonics and noise from the amplifier. For most amplifiers in normal operation the filter is not necessary.
- The attenuator after the amplifier improves the source matching and the accuracy of the power head. (See power meter manual.) It can also be used also to make the amplifier operate at its optimal output level for noise and stability. In a setup without directional coupler, this attenuator should be at least 10dB.
- The directional coupler (recommended <sup>3</sup> 20dB) is used to monitor the forward power and adjust the signal generator output for constant forward power. A medium quality coupler is sufficient because the loads (dipole and power head) are well matched. (If the setup is used for reflective loads, a high quality coupler with respect to directivity and output matching is necessary to avoid additional errors.)
- The power meter PM2 should have a low drift and a resolution of 0.01dBm, but otherwise its accuracy has no impact on the power setting. Calibration is not required.
- The cable between the coupler and dipole must be of high quality, without large attenuation and phase changes when it is moved. Otherwise, the power meter head PM1 should be brought to the location of the dipole for measuring.
- The power meter PM1 and attenuator Att1 must be high quality components. They should be calibrated, preferably together. The attenuator (310dB) improves the accuracy of the power reading. (Some higher power heads come with a built-in calibrated attenuator.) The exact attenuation of the attenuator at the frequency used must be known; many attenuators are up to 0.2dB off from the specified value.



- Use the same power level for the power setup with power meter PM1 as for the actual measurement to avoid linearity and range switching errors in the power meter PM2. If the validation is performed at various power levels, do the power setting procedure at each level.
- The dipole must be connected directly to the cable at location "X". If the power meter has a different connector system, use high quality couplers. Preferably, use the couplers at the attenuator Att1 and calibrate the attenuator with the coupler.
- Always remember: We are measuring power, so 1% is equivalent to 0.04dB.

## 11.5 Laboratory reflection

In near-field situations, the absorption is predominantly caused by induction effects from the magnetic nearfield. The absorption from reflected fields in the laboratory is negligible. On the other hand, the magnetic field around the dipole depends on the currents and therefore on the feed point impedance. The feed point impedance of the dipole is mainly determined from the proximity of the absorbing phantom, but reflections in the laboratory can change the impedance slightly. A 1% increase in the real part of the feed point impedance will produce approximately a 1% decrease in the SAR for the same forward power. The possible influence of laboratory reflections should be investigated during installation. The validation setup is suitable for this check, since the validation is sensitive to laboratory reflections. The same tests can be performed with a mobile phone, but most phones are less sensitive to reflections due to the shorter distance to the phantom. The fastest way to check for reflection effects is to position the probe in the phantom above the feed point and start a continuous field measurement in the DASY4 multi-meter window. Placing absorbers in front of possible reflectors (e.g. on the ground near the dipole or in front of a metallic robot socket) will reveal their influence immediately. A 10dB absorber (e.g. ferrite tiles or flat absorber mats) is probably sufficient, as the influence of the reflections is small anyway. If you place the absorber too near the dipole, the absorber itself will interact with the reactive near-field. Instead of measuring the SAR, it is also possible to monitor the dipole impedance with a network analyzer for reflection effects. The network analyzer must be calibrated at the SMA connector and the electrical delay (two times the forward delay in the dipole document) must be set in the NWA for comparisons with the reflection data in the dipole document. If the absorber has a significant influence on the results, the absorber should be left in place for validation or measurements. The reference data in the dipole document are produced in a low reflection environment.

#### 11.6 Additional system checks

While the validation gives a good check of the DASY4 system components, it does not include all parameters necessary for real phone measurements (e.g. device modulation or device positioning). For system validation (repeatability) or comparisons between laboratories a reference device can be useful. This can be any mobile phone with a stable output power (preferably a device whose output power can be set through the keyboard). For comparisons, the same device should be sent around, since the SAR variations between samples can be large. Several measurement possibilities in the DASY software allow additional tests of the performance of the DASY system and components. These tests can be useful to localize component failures:

- The validation can be performed at different power levels to check the noise level or the correct compensation of the diode compression in the probe.
- If a pulsed signal with high peak power levels is fed to the dipole, the performance of the diode compression compensation can be tested. The correct crest factor parameter in the DASY software must be set (see manual). The system should give the same SAR output for the same averaged input power.
- The probe isotropy can be checked with a 1D-probe rotation scan above the feed point. The automatic
  probe alignment procedure must be passed through for accurate probe rotation movements (optional
  DASY4 feature with a robot-mounted light beam unit). Otherwise the probe tip might move on a small
  circle during rotation, producing some additional isotropy errors in gradient fields.