



CETECOM ICT Services consulting - testing - certification >>>

Annex E



Appendix to Test Report No.: 1-3851/11-01-13

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Appendix with Calibration data, Phantom certificate and system validation information



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2 Calibration report "Probe ET3DV6"

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Clien: Cetecom			ET3-1558_Aug11
CALIBRATION	CERTIFICAT	E	
Object	ET3DV6 - SN:15	58	Section and the
Collibration procedure(s)		DA CAL-23 v4, DA CAL-25 v4 eduro for dosimetric F-field probes	
Collection date:	August 23, 2011		WHITE STATES
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Certificate No: ET3-1558_Aug11

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



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Swiss Calibration Service

Accreditation No.: SCS 108

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

Classon

tissue simulating liquid
sensitivity in free space
sensitivity in TSL / NORMx,y,z
diode compression point
creat factor (1/duty_cyclo) of the RF signal
modulation dependent linearization parameters
o rotation around probe axis
9 rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., 9 = 0 is normal to probe axis

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2003, "IFEE 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-heid devices used in cluse
- 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-coll; f > 1800 MHz R22 waveguide) NORMx, y,z are only intermediate values, i.e., the uncertainties of NORMx, y,z does not affect the E² field uncertainty inside TSL (see below ConvF).
- $NORM(l)x, y, z = NORMx, y, z * frequency_response$ (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCPx,y,z: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required) DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- Ax.y.z. Bx.y.z. Cx.y.z. VRx.y.z. A, B, C are numerical linearization parameters assassed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and incide waveguide using analytical field distributions based on power measurements for (> 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (a pha, dopth) 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 uncertaintly 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 doviation from isotropy) in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset. The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

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ET3DV0 - SN:1558

August 23, 2011

Probe ET3DV6

SN:1558

Calibrated:

Manufactured: September 16, 2003 August 23, 2011

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

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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 (uV/(V/m)2)*	2.03	1.79	1.76	± 10.1 %
DCP (mV) ⁰	96.7	97.9	97.2	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	dB B	C dB	VR mV	Unc ^L (k=2)
10000	CW	C.00	X	0.00	0.00	1.00	116.3	=2.5 %
			Y	0.C	0.00	1.00	134.7	
			Z	0.00	0.00	1.00	43.7	

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%.

⁶ The uncertainties of NormX, Y,Z do not affect the F² field uncertainty inside TSL (see Pages 5 and 6).
 ⁶ Numarical invariation parameter: uncertainty not required.
 ⁶ Uncertainty is determined using the moxil deviation from linear response exploying rectangular distribution and is expressed for the security of the secure security of the security of the securety of the securety of

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ETSDV8 SN:1558

August 23, 2011

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

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ⁼	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	6.95	5.95	5.95	0.65	1,98	± 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	10.0	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	1 12.0 %

⁴ Frequency validity of ± 100 MHz only applies for DASY v1.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvE uncertainty at collaration frequency and the uncertainty for the indicated frequency band.
⁵ At frequencies below 3 GHz, the validity of tissue commetters (c and c) can be relaxed to ± 10% if liquid companiation formula is applied to measured GAR values. At frequencies above 3 GHz, the validity of tissue parameters (s and c) is restricted to ± 5%. The uncertainty is the RSS of the ConvE uncertainty for indicates, length issue parameters.

Certificate No: ET3-1568_Aug11

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ETSDV8 SN:1558

August 23, 2011

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

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ⁼	Relative Permittivity	Conductivity (5/m)	ConvF X	ConvF Y	ConvF Z	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	3.00	3.90	3.90	D.86	1.39	± 12.0 %

⁶ Programmy validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), etse it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvE uncertainty to collocation frequency and the uncertainty for the indicated frequency band.
¹ At frequencies below 3 GHz, the validity of tissue parameters (c and c) can be relaxed to ± 10% if liquid componentiation fermula is applied to measured SAR values. At frequencies above 3 GHz, the validity of the validity of tissue parameters (c and c) is restricted to ± 5%. The uncertainty is the RSS of the ConvE uncertainty for indicated larget issue parameters.

Certificate No: ET3-1558 Aug11

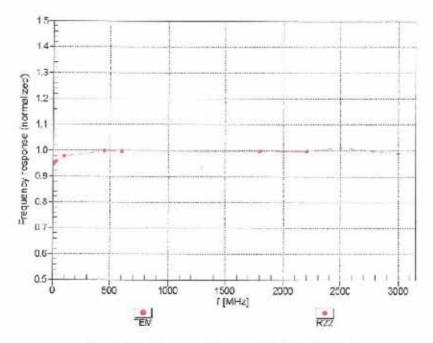
Page 6 o' 11

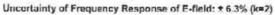


ET3DVG- SN:1558

August 23, 2011

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





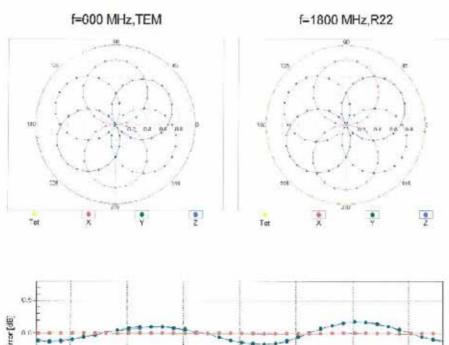
Conificate No: ET3-1550 Aug11

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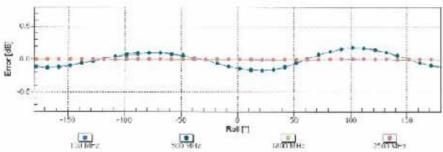


ET3DV8- SN:1558

August 23, 2011



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



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

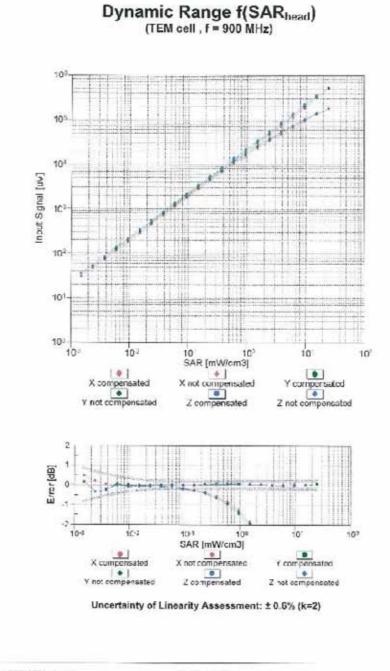
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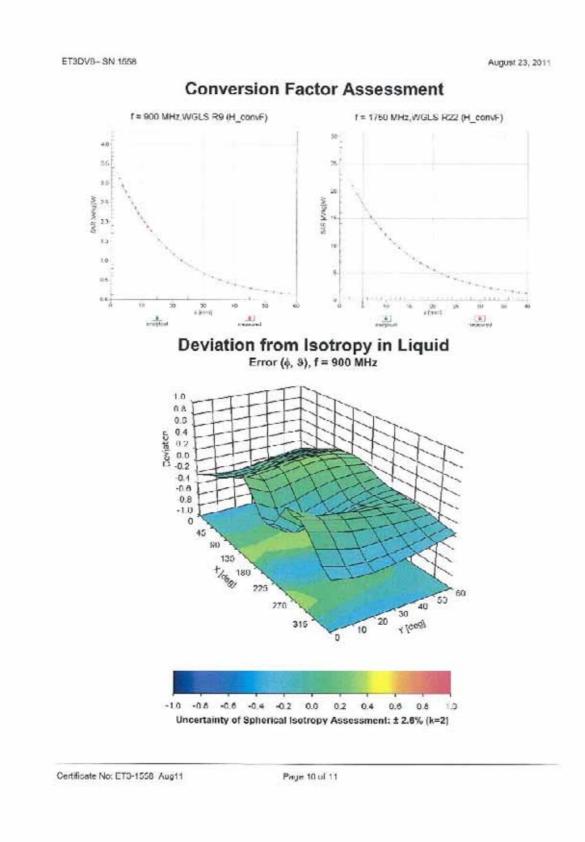
August 23, 2011



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ET3DV6-SN:1558

August 23, 20**

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

Other Probe Parameters

Sensor Anangement	Triangular
Connector Angle (*)	Not applicable
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	enabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
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

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3 Calibration report "Probe ET3DV6"

Engineering AG Zeughausstrasse 43, 8004 Zu	ory of	Hac MRA	Servizio svizzero di taratura
Accredited by the Swiss Accred The Swiss Accreditation Serv Multilateral Agreement for the	ice is one of the signator	ies to the EA	No.: SCS 108
Client Cetecom		Certificate N	o: ET3-1559_Jan11
CALIBRATION	CERTIFICAT	E	
Object	ET3DV6 - SN:1	559	
Calibration procedure(s)		QA CAL-12.v6, QA CAL-23.v4 an edure for dosimetric E-field probe	
Calibration date:	January 19, 201	1	
The measurements and the un	certainties with confidence	tional standards, which realize the physical un probability are given on the following pages an ory facility: environment temperature (22 ± 3)*C	d are part of the certificate.
The measurements and the un All calibrations have been cond Calibration Equipment used (M	certainties with confidence ucted in the closed laborat &TE critical for calibration)	probability are given on the following pages an ory facility: environment temperature $(22 \pm 3)^{\circ}C$	d are part of the certificate.
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards	certainties with confidence ucted in the closed laborat &TE critical for calibration) ID #	probability are given on the following pages an ory facility: environment temperature (22 ± 3)*C Cal Date (Certificate No.)	d are part of the certificate. C and humidity < 70%. Scheduled Calibration
The measurements and the un All calibrations have been cond Calibration Equipment used (M	certainties with confidence ucted in the closed laborat &TE critical for calibration)	probability are given on the following pages an ory facility: environment temperature (22 ± 3)*C Cal Date (Certificate No.) 1-Apr-10 (No. 217-01136)	d are part of the certificate. C and humidity < 70%. Scheduled Calibration Apr-11
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power meter E4419B	ertainties with confidence ucted in the closed laborat &TE critical for calibration) ID # GB41293874	probability are given on the following pages an ory facility: environment temperature (22 ± 3)*C Cal Date (Certificate No.)	d are part of the certificate. C and humidity < 70%. Scheduled Calibration
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power meter E44198 Power sensor E4412A Power sensor E4412A Reference 3 dB Attenuator	Certainties with confidence ucted in the closed laborat &TE critical for calibration) ID # GB41293874 MY41495277	probability are given on the following pages an ory facility: environment temperature (22 ± 3)*C Cal Date (Certificate No.) 1-Apr-10 (No. 217-01136) 1-Apr-10 (No. 217-01136)	d are part of the certificate. 2 and humidity < 70%. Scheduled Calibration Apr-11 Apr-11
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The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power sensor E4412A Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator	Certainties with confidence ucted in the closed laborat &TE critical for calibration) ID # GB41293874 MY41495277 MY41496087 SN: S5054 (3c) SN: S5056 (20b)	Cal Date (Certificate No.) 1-Apr-10 (No. 217-01136) 1-Apr-10 (No. 217-01136) 1-Apr-10 (No. 217-01136) 30-Mar-10 (No. 217-01136) 30-Mar-10 (No. 217-01159) 30-Mar-10 (No. 217-01161)	d are part of the certificate. C and humidity < 70%. Scheduled Calibration Apr-11 Apr-11 Apr-11 Mar-11 Mar-11
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power meter E44198 Power sensor E4412A Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards	Cartainties with confidence ucted in the closed laborat &TE critical for calibration) ID # GB41293874 MY41495277 MY41498087 SN: S5054 (3c) SN: S5054 (3c) SN: S5056 (20b) SN: S5129 (30b) SN: S103 SN: 660 ID #	cal Date (Certificate No.) 1.Apr-10 (No. 217-01136) 1.Apr-10 (No. 217-01136) 1.Apr-10 (No. 217-01136) 1.Apr-10 (No. 217-01136) 30-Mar-10 (No. 217-01159) 30-Mar-10 (No. 217-01161) 30-Mar-10 (No. 217-01160) 29-Dec-10 (No. 253-3013_Dec10) 20-Apr-10 (No. DAE4-660_Apr10) Check Date (in house)	d are part of the certificate. C and humidity < 70%. Scheduled Calibration Apr-11 Apr-11 Mar-11 Mar-11 Mar-11 Dec-11 Apr-11 Scheduled Check
The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power meter E44198 Power sensor E4412A Power sensor E4412A Reference 3 dB Attenuator Reference 3 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8848C	Lot the closed laborat LD # GB41293874 MY41495277 MY41498087 SN: S5054 (3c) SN: S5054 (3c) SN: S5054 (3c) SN: S5129 (30b) SN: 3013 SN: 660	cal Date (Certificate No.) 1-Apr-10 (No. 217-01136) 1-Apr-10 (No. 217-01136) 1-Apr-10 (No. 217-01136) 1-Apr-10 (No. 217-01136) 30-Mar-10 (No. 217-01159) 30-Mar-10 (No. 217-01161) 30-Mar-10 (No. 217-01160) 29-Dec-10 (No. 283-3013_Dec10) 20-Apr-10 (No. DAE4-860_Apr10)	d are part of the certificate. C and humidity < 70%. Scheduled Calibration Apr-11 Apr-11 Mar-11 Mar-11 Mar-11 Dec-11 Apr-11
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The measurements and the un All calibrations have been cond Calibration Equipment used (M Primary Standards Power meter E44198 Power sensor E4412A Power sensor E4412A Reference 3 dB Attenuator Reference 3 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8848C	ID # ID # GB41293874 MY41495277 MY41495277 MY41495277 SN: S5054 (3c) SN: S5054 (3c) SN: S5129 (30b) SN: 3013 SN: 660 ID # US3642U01700 US37390585	Cal Date (Certificate No.) 1-Apr-10 (No. 217-01136) 1-Apr-10 (No. 217-01136) 1-Apr-10 (No. 217-01136) 1-Apr-10 (No. 217-01136) 30-Mar-10 (No. 217-01136) 30-Mar-10 (No. 217-01159) 30-Mar-10 (No. 217-01161) 30-Mar-10 (No. 217-01160) 29-Dec-10 (No. ES3-3013_Dec10) 20-Apr-10 (No. DAE4-660_Apr10) Check Date (in house) 4-Aug-99 (in house check Oct-09) 18-Oct-01 (in house check Oct-10)	d are part of the certificate. C and humidity < 70%. Scheduled Calibration Apr-11 Apr-11 Mar-11 Mar-11 Mar-11 Dec-11 Apr-11 Scheduled Check In house check: Oct-11 In house check: Oct-11



Calibration Laboratory of Schmid & Partner Engineering AG Zeoghausstrasse 43, 8084 Zurich, Switzerland



Schweizerlscher Ke§brierdienst

Service suisse d'élalonnage

C Servicio svizzero di faratura S Sular Calibratica Servica

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 Agraement for the recognition of calibration cartificates

Glossary:	
TSL	Issue simulating liquid
NORM×,y,z	sensitivity in free space
ConvF	sensitivity in TSL/ NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C	modulation dependent 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 SId 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- NORMX, y, z. Assessed for E-field polarization 8 = 0 (field 900 MHz in TEM-cell; field 1800 MHz; R22 waveguide).
 NORMX, y, z are only infermediate values, i.e., the uncertainties of NORMX, y, z does not effect the E²-field uncertainty inside FSL (see below *Convil*).
- NORM(f)x y, z = NORMx, y, z * Trequency_response (see Frequency Response Charl). This Incarization 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 døde.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical 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 NORMs, yz * ConvF whereby the uncertainty cartesponds 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



January 19, 2011

Probe ET3DV6

SN:1559

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

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

Cert Scale No. ET3-1559_Jan 11

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ET30V6 SN:1559

January 19, 2011

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

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Une (k=2)
Norm (uV/(V/m) ²) ⁴	1.79	- 59	1.64	± 10.1%
DCP (mV) [#]	<u>96</u> .9	97.6	96.3	

Modulation Calibration Parameters

luio L	Communication System Name	PAR		A dB	B d⊟uV	С	VR m¥	Unc" (k=2)
10000	CW:	0.00	х	0.00	0.00	1.00	132.1	t29%
			Y	0.00	0.00	1.00	137.8	
			Z	i <u>0.00</u>	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%.

 * The uncertainlies of NormX,Y,Z oo not affect the D^{2} -field uncertainly inside TSL (see Pages 5 and 6).

^a Numerical Incanzation parameter luncensibly not required.

⁶ Uncertainty is determined using the inverteent environment in the investigation of the second state of the square of the field value.

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DASY/EASY - Parameters of Probe: ET3DV6 \$N:1559

Calibration Parameter Determined in Head Tissue Simulating Media

I [MHz]	Validity_[KHz] ⁶	Permittivity	Conductivity	CONVEX CO	RWE Y Cor	IVF Z	Alpha	Depth Unc (k=Z)
450	± 50 / ± 100	43.5 ± 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 ¢%
900	± 50 / ± 100	415±5%	0.97 ± 5%	6.20	6.20	6 20	0.26	3.00 ± 11.0%
1750	$\pm 50 / \pm 100$	40.1±5%	1.37 ± 5%	5.28	5.28	5.28	0.79	1.69 ± 11.0%
1900	\pm 50 / \pm 100	$40.0\pm5\%$	1.40 ± 5%	5 02	5.02	5.02	0.79	1.60 ± 11.0%
2450	± 50 / ± 100	39.2 ± 5%	1.8D ± 5%	4.38	4.38	4.3B	0.79	2.02 ± 11.0%

³ The validity of ± 100 MHz dwy appres for DASY v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF ancertainty at calibration (recency) and the uncertainty for the indicated frequency sand.

Certificate No: ET3-1559_Jan11

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

Calibration Parameter Determined in Body Tissue Simulating Media

f [MHz]	Validity (MHz) ^C	Permittivity	Conductivity	ConvFX Ca	пуЕУ Сол	nvF Z	Aipha	Depth Unc (k=2)
450	± 50 / ± 100	56.7 ± 5%	0 94 + 5%	7,73	7.73	7,73	0.12	2.07 ± 13.3%
835	± 50 / ± 100	552±5%	0.97 ± 5%	6.22	6.22	6.22	0.25	2.98 ±11.0%
900	\pm 50 / \pm 100	55.0 ± 5%	1.05 ± 5%	6.10	6 10	6.10	0 29	287 ±11.0%
1750	± 50 / ± 100	53.4 ± 5%	$1.49\pm5\%$	4.68	4 66	4.68	0.79	2.39 ±11.0%
1900	± 50 / ± 100	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%

⁵ The validity of ± 100 MHz only applies for DASY will 4 and higher (son Page 2). The uncertainty is the RSS of the ConvE uncertainty at calibrative frequency and the uncertainty for the indicated frequency band.

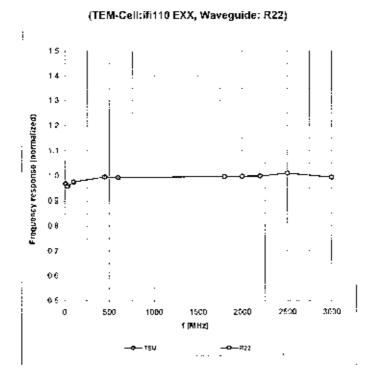
Certificate Nor EY3-1659_Jan11

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Frequency Response of E-Field



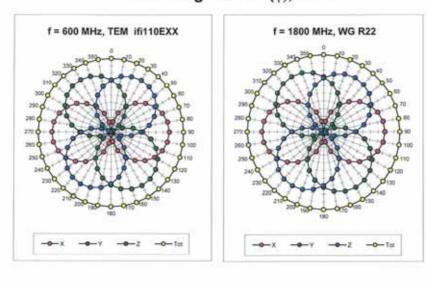


Certificate No: E13-1555, Jan11

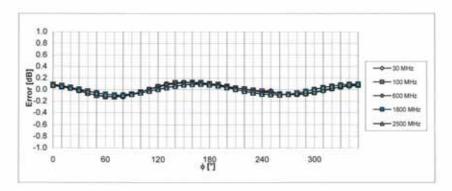
Page 7 cf 15



January 19, 2011



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



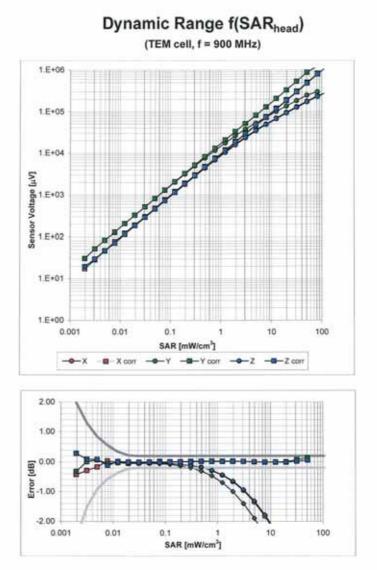
Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Certificate No: ET3-1559_Jan11

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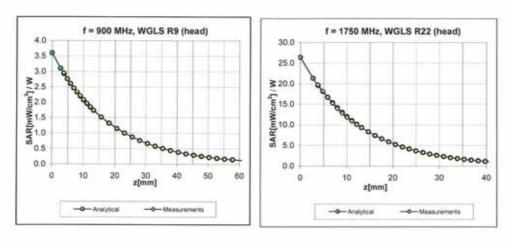
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Certificate No: ET3-1559_Jan11

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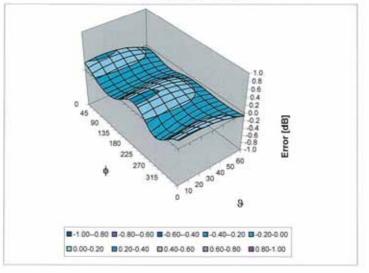
January 19, 2011



Conversion Factor Assessment

Deviation from Isotropy in HSL

Error (¢, ୬), f = 900 MHz



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

Certificate No: ET3-1559_Jan11

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January 19, 2011

Other Probe Parameters

Sensor Atrangement	Triangular
Connector Angle (*)	Not applicable
Mechanical Surface Dotection Mode	enablec
Optical Surface Detection Mode	enabled
Probe Overail Length	337 mm
Probe Body Diameter	:0 mm
Tip Length	10 m·m
Tip Diameter	6.8 m m
Probe Tip to Sensor X Calibration Point	2.7 com
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	סזוני 3.7

Certificate No: ET3-1559_Jan%1

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4 Calibration report "900 MHz System validation dipole"

Zeughausstrasse 43, 8004 Zurk	ch, Switzerland	Hac MRA (2 () & C	Servicio Svizzelo di Israilira
		"dolable"	
Accredited by the Swiss Accredit The Swiss Accreditation Servic Multilataral Agreement for the r	e is one of the signatorie	to the EA	n Nn.: SCS 108
Client Cetecom		parately and a second second	o: D900V2-102_Aug11
CALIBRATION (CERTIFICATI		
Object	D900V2 + SN: 10	12	
Galibration procedure(s)	QA CAL-05.v8 Calibration proce	dure for dipole validation kits ab	ove 700 MH∠
Calibration date:	August 15, 2011		
The measurements and the unco	ertainties with confidence p eted in the closed laborate	coal standards, which realize the physical un mbshility are given on the following pages or ry facility: environment temporature $(22\pm3)^2$	nd are part of the certificate.
The measurements and the unco All calibrations have been condu Calibration Eculpment used (M&)	intainties with confidence p ated in the closed laborate TE critical (or calibration)	mbability are given on the following pages all ry facility: environment temporature $(22\pm3)^2$	nd are part of the certificate. °C and humidity < 70%,
The measurements and the unco	International second se	mbability are given on the following pages all ry facility: environment temperature $(22\pm3)^2$ Call Date (Certificate No.)	nd are part of the certificate. C and humidity < 70%, Scheduled Calibration
The measurements and the unco All calibrations have been condu Calibration Eculipment used (M&) Primary Standards	intainties with confidence p ated in the closed laborate TE critical (or calibration)	mbability are given on the following pages all ry facility: environment temporature $(22\pm3)^2$	nd are part of the certificate. °C and humidity < 70%,
The measurements and the unco All calibrations have been condu Calibration Eru Ipment used (M&) Primary Standards Power meter EPV-442A	etainties with confidence p eted in the closed laborate TE critical 'or calibration) ID # GB37460704	mbability are given on the following pages a ry facility: environment temperature (22 ± 3) ¹ Call Date (Certificate No.) 08-Oct-10 (No. 217-01286)	nd are part of the certificate. C and humidity < 70%, Scheduled Calibration Oct-11
The measurements and the unce All collibrations have been condu- Calibration Eru ipment used (M&) Primary Standards Power meter CPV-442A Power sensor HP 8431A Reference 22 dB Attenuator Type-N Internation constitutation	International States and States a	mbability are given on the following pages at ry facility: environment temperature (22 ± 3) ² Cal Date (Certificate No.) 09-Oct: 10 (No. 217-01266) 03-Oct: 10 (No. 217-01266) 20 Mar 11 (No. 217-01377) 29-Mar-11 (No. 217-01371)	nd are part of the certificate. C and humidity < 70%, Scheduled Calibration Ott-11 Oct-11 Apr-12 Apr-12
The measurements and the unce All calibrations have been condu- Calibration Eru Ipment used (M&) Primary Standards Power meter EPV-442A Power sensor HP 8431A Reference 22 dB Attenuator	etainties with confidence p eted in the closed laborate TE critical for calibration) ID # GB37460704 U637292763 SN: S508E (20b)	mbability are given on the following pages al ry facility: environment temperature (22 ± 3) ² Call Date (Certificate No.) 08-Oct: 10 (No. 217-01266) 03-Oct: 10 (No. 217-01266) 20 Mar 11 (No. 217 01037)	nd are part of the certificate. C and humidity < 70%, Scheduled Calibration Oct-11 Oct-11 Apr-12
The measurements and the unce All calibrations have been condu- Calibration Fra Ipment used (M& Primary Standards Power meter EPV-442A Power sensor HP 8431A Reference 20 dB Attenuator Type-N hismatch contribution Belerence Probe FS3DV3 DAE4	etainties with confidence p etain the closed laborate TE critical for calibration) ID II GB37460704 US37202763 SN: S5086 (20b) SN: S5047.2 / 06527 SN: 3205 SN: 301	mbability are given on the following pages a ry facility: environment temporature (22 ± 3)* Cal Date (Certificate No.) 09-Oct: 10 (No. 217-01266) 09-Oct: 10 (No. 217-01266) 20 Mor 11 (No. 217-0137) 29-Mar-11 (No. E53-3205_Apr11) 34-Ju-11 (No. DAE4-001_Jul11)	nd are part of the certificate. C and humidity < 70%, Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Apr-12 Jul-12
The measurements and the unco All collibrations have been condu- Calibration Erg Ipment used (M&) Primary Standards Power sonsor HP 841A Power sonsor HP 841A Reference 22 dB Attenuator Type-N Internation contribution Reference Probe FS3DV3	In the closed laborate TE critical for calibration) ID # GB37460704 U637202763 SN: 55086 (20b) SN: 55047.2 / 06327 SN: 3205	mbability are given on the following pages a ry facility: environment temperature (22 ± 3)* Cal Date (Certificate No.) 08-Oct-10 (No. 217-01266) 09-Oct-10 (No. 217-01266) 09-Oct-10 (No. 217-01266) 29-Mar-11 (No. 217-01371) 29-Apr-11 (No. 253-3205_Apr11) 34-Ju-11 (No. DAE4-001_Jul11) Chook Date (in house)	nd are part of the certificate. C and humidity < 70%, Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Jul-12 Scheduled Check
The measurements and the unce All calibrations have been condu- Calibration Era Ipment used (M& Primary Standards Power meter EPV-442A Power sensor PV-442A Power sensor PV-442A Power sensor PV-442A Power sensor PV-442A Power sensor PV-442A Power sensor PV-442A Power sensor PV-442A Reference 20 dB Attenuator Type-N Tribmatch combination Reference Probe FS3DV3 DAE4 Secondary Standards	etainties with confidence p etain the closed laborate TE critical for calibration) ID # GB37480704 US37222763 SN: S5086 (20b) SN: S647.2 / 06527 SN: 5047.2 / 06527 SN: 3205 SN: 601 ID #	mbability are given on the following pages a ry facility: environment temporature (22 ± 3)* Cal Date (Certificate No.) 09-Oct: 10 (No. 217-01266) 09-Oct: 10 (No. 217-01266) 20 Mor 11 (No. 217-0137) 29-Mar-11 (No. E53-3205_Apr11) 34-Ju-11 (No. DAE4-001_Jul11)	nd are part of the certificate. C and humidity < 70%, Scheduled Calibration Oct-11 Oct-11 Apr-12 Apr-12 Apr-12 Apr-12 Jul-12
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Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland



- SNISC S C S
 - Schweizerlscher Kalibrierdienst Service auisse c'étalonnage Servizio avizzero di taratura
 - Swice Calibration Service

Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS)

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

Glossary: TSL

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

Certificate No: D900V2-102_Aug11

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Measurement Conditions

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

DASY Version	DASY5	V52.6.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	16 mm	with Spacar
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 mho/m = 6 %
Head TSL temperature change during test	< 0.5 *C		++++0

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAF 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 cm ² (10 g) of Head TSL	cond tion	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 253 mW input power	1.73 mW / g

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.0	1.05 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.0 ± 6 %	1.05 mbo/m ± 6 %
Body TSL temperature change during test	<0.5 °C		

SAR result with Body TSL

SAR averaged over 1 cm ³ (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 ² (10 g) of Body TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Body TSL SAR measured	condition 250 mW input power	1.82 mW / g

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Appendix

Antenna Parameters with Head TSL

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

Antenna Parameters with Body TSL

Impedance, transformed to food point	45.8 Ω - 6.4 jΩ	
Roturn Loos	- 22.0 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.407 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

Contificate No: D900V2-102 Aug11

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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

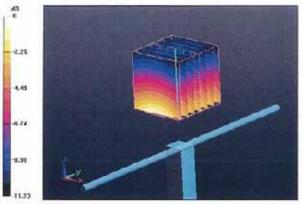
Communication System: CW; Frequency: 900 MHz Medium parameters used: f = 900 MHz; $\sigma = 0.95$ mho/m; $\epsilon_r = 40.3$; $\rho = 1000$ kg/m² Phantom section: Plat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

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 = -0.04 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



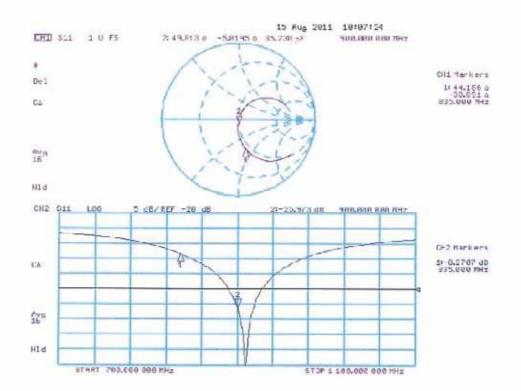


Certificate No: D900V2-102 Aug I

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Impedance Measurement Plot for Head TSL



Certificate No: D300V2-102_Aug11

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DASY5 Validation Report for Body TSL

Date: 15.08.2011

Test Laboratory: SPEAG, Zurich, Switzerland

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

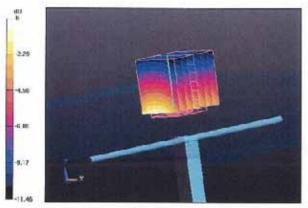
Communication System: CW: Frequency: 900 MHz Medium parameters used: f = 900 MHz; $\sigma = 1.05$ mho/m; $v_r = 52.8$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

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



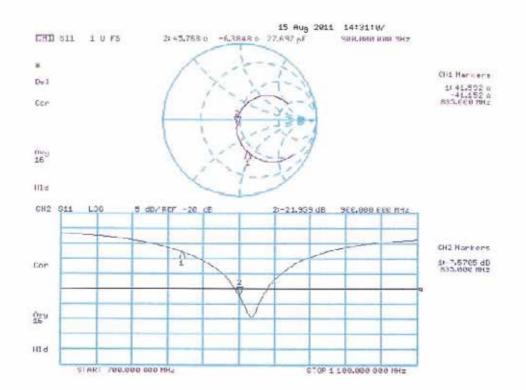
0 dB = 3.320 mW/g

Certilicate No. D90CV2-102_Aug11

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Impedance Measurement Plot for Body TSL



Certificate No: D900V2-102_Aug11

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5 Calibration report "1900 MHz System validation dipole"

Accredited by the Swiss Accredit The Swiss Accreditation Servi Multilateral Agreement for the	ce is one of the signatorio	s to the EA	n No.: SCS 108
client Cetecom		Certificate N	n: D1900V2-5d009_Au
CALIBRATION	CERTIFICATI		
Object	D1900V2 - SN: 5	d009	
Calibration procedure(s)	QA CAL-05.v8 Calibration proce	dure for dipole validation kits ab	ove 700 MHz
Calibration date:	August 17, 2011		
		ional standards, which realize the physical u robability are given on the following pages a	
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Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstraceo 43, 8004 Zurich, Switzerland



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S Schweizerlacher Kalibrierdienst

- C Service suisco d'ótalonnago
- Servizio evizzero di taratura Si 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-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:

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 of the certificate. All figures stated in the certificate are valid at the frequency indicated.
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 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
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 measurement at the SMA connector to the feed point. The Return Loss ensures low
 reflected power. No uncertainty regulred.
- 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.
- 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

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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 Phantom	
Distance Dipole Center TEL	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 ³ (1 g) of Head TSL	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 ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 250 mW input power	5.2/ mW / g

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mbo/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	1	

SAR result with Body TSL

SAR averaged over 1 cm ³ (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 ³ (10 g) of Body TSL	concition	
SAR measured	250 mW input power	5.43 mW / a

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

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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 (2 + 2.8 J ^c)	
Return Loss	- 26.8 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.188 ns

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

The dipole is made of standard cominigid coaxial cable. The center conductor of the toosing 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
Manufacturee on	February 22, 2002

Certificate No: D1900V2-50009_Aug11

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DASY5 Validation Report for Head TSL

Date: 16.08.2011

Test Laboratory: SPEAG, Zurich, Switzerland

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

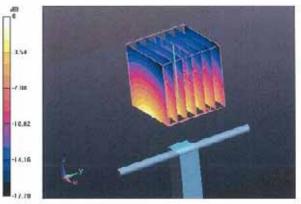
Communication System: CW; Frequency: 1900 MHz Medium parameters used: $\Gamma = 1900 \text{ MHz}$; $\sigma = 1.42 \text{ mho/m}$; $\epsilon = 39.5$; $\rho = 1000 \text{ kg/m}^3$ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

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



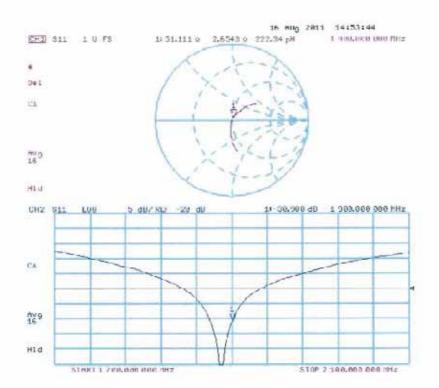
 $0 \, dB = 12.500 \, mW/g$

Certificate No: D (900V2-5cl009, Aug I 1

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Impedance Measurement Plot for Head TSL



Certificate No: D1900V2 5d009_Aug11

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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

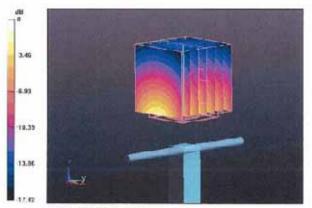
Communication System: CW; Frequency: 1900 MHz Medium parameters used: t = 1900 MHz; σ = 1.57 mho/m; c_t = 53.9; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

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 Drilt = 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



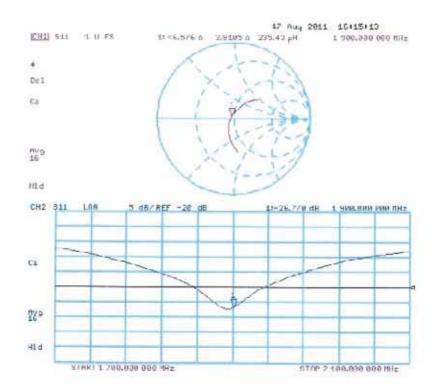
0 dB = 13.110 mW/g

Certilicate No: D1900V2 5d009_Aug11

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Impedance Measurement Plot for Body TSL



Certificate No: D1900V2-5dC09_Aug11

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6 Calibration report "2450 MHz System validation dipole"

Engineering AG Zoughausstrasso 43, 8004 Zurio	h, Switzerland	Hac-MRA (0 C Z Z	Servizio svizzero di taraturo
Accredited by the Swies Accredite The Swies Accreditation Service Multilateral Agreement for the r	e is one of the signatoric	s to the EA	in No.: SCS 108
Client Celecom	11000	Certificate N	to: D2450V2-710_Aug11
CALIBRATION O	CERTIFICATE		and the second
Object	D2450V2 - SN: 7	10	1000000000
Col bration procedure(s)	QA CAL-05.v8 Calibration proce	dure for dipole validation kits ab	ovo 700 MHz
Calibration data:	August 19, 2011		SULES X STOR
The measurements and the unse All calibrations have been conduc	rtainties with confidence p sted in the clused faturator	onal standards, which realize the physical u robebility are given on the following pages a ty facility: emotionment temperature (22 + 3)	ind are part of the certificate.
The measurements and the unce All calibrations have been conduc Calibration Equipment used (MB1	ntainties with confidence p ated in the closed faborator ("E critical for calibration)	robebility are given on the following pages a ny facility, environment temperature (22 + 3)	nd are part of the certificate. "C and humidity < 70%
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The measurements and the under All calibrations have been conduct Galibration Equipment used (M&T Primary Standards Power moter EPM-4/2A Power sensor HP 6401A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4	tainties with confidence p ted in the closed faborator ID / GB37/80704 US37/292783 SN: 55066 (200) SN: 6047.2 / 06527 SN: 8205 SN: 601	Cal Data (Dertificate No.) Cal Data (Dertificate No.) 06 Oct 10 (No. 217-31268) 06-Oct-10 (No. 217-31268) 06-Oct-10 (No. 217-31268) 29-Mar-11 (No. 217-01371) 29-Mar-11 (No. 217-01371) 20 Apr 11 (No. E83-3205 Apr11) 04 Jul 11 (No. DAE4 601_Jul 11)	Incluse pair of the certificate. TC and humidity < 70% Scheculed Calibration Cot 11 Cot 11 Ann-12 Aar 12 Aar-12 Jul-12
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The measurements and the under All calibrations have been conclud Galibration Equipment used (M&T Primary Standards Power sensor HP 9491A Roterance 20 dB Atternation Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 0491A RF generator R&S SMT-06 Network Analyzer HP 8753E	Ital infex with confidence p Ital in the closed faborator ID 7 GB37/80704 US37/252783 SN: 55066 (200) SN: 55066 (200) SN: 5506 (200) SN: 5506 SN: 501 ID # MM41092317 100005 US37390586 S4206 Name	Cul Dula (Certificate No.) Cul Dula (Certificate No.) 06 Oct 10 (No. 217-01266) 06-Oct 10 (No. 217-01266) 06-Oct 10 (No. 217-01266) 29-Mar-11 (No. 217-01371) 29-Mar-11 (No. 217-01371) 29-Apr 11 (No. E83-3205 Apr11) 04-Jul 11 (No. E83-3205 Apr11) 04-Jul 11 (No. DAE4-901_Jul 11) Chack Date (in house) 18 Oct 02 (in house check Oct-09) 04 Aug 99 (in house check Oct-09) 18 Oct 01 (in house check Oct-09) 18 Oct 01 (in house check Oct-00) 18 Oct 01 (in house check Oct-00) 18 Oct 01 (in house check Oct-10) Function	C and humidity < 70% C and humidity < 70% Scheduled Calibration Oot 11 Ool:11 Am:12 Aur:12 Aur:12 Jul-12 Scheduled Cneck In house check: Oct-11 In house check: Oct-11

Certificate No: D2450V2-710_Aug11

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



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Schweizerischer Köllbrierdionat Service suisse d'étalennage C Servizio svizzero di taratura Swiss Calibration Service

Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS)

The Swies 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 Rale (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

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Measurement Conditions

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

DASY Vorsion	DASYS	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	2450 MHz + 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Mossurod Hoad TSL parameters	(22.0 ± 0.2) °C	38.4 ± 6 %	1.65 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 "C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (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 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 250 mW input power	6.42 mW / g

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mbo/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	100	

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Concition	
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 cm ³ (10 g) of Body TSL	condition	
	The second states and states of the second states o	KAR MED IN DRAMAS INC

normalized to 1W

24.2 mW / g ± 16.5 % (k=2)

Certificate No: D2450V2 710_Aug11

SAR for nominal Body TSL parameters



Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.2 (1 + 1.3 j(t)	
Return Loss	- 29.6 dB	

Antenna Parameters with Body TSL

Impedance, 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 conformation of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC eignals.

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	July 05. 2002

Certificate No: D2450V2-710_Aug11

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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

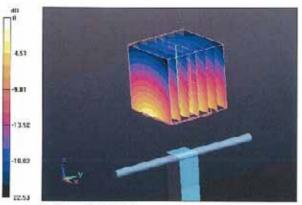
Communication System: CW: Frequency: 2450 MHz Medium parameters used: f = 2450 MHz; $\sigma = 1.85$ mho/m; $c_r = 38.4$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19 2007)

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; 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 = 101.9 V/m; Power Drift = 0.06 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



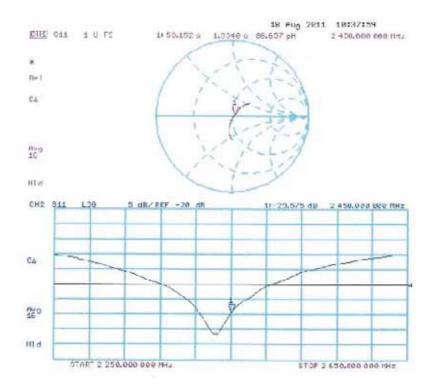
 $0 \, dB = 17.760 \, mW/g$

Certificate No: D2450V2-710_Aug11

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Impedance Measurement Plot for Head TSL



Certificate No: D2450V2-710_Aug11

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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

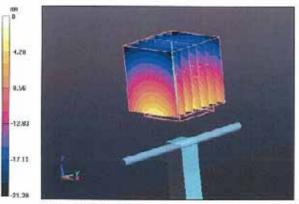
Communication System: CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz; $\sigma = 2.02$ mho/m; $c_r = 51.8$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

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 Tissue/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



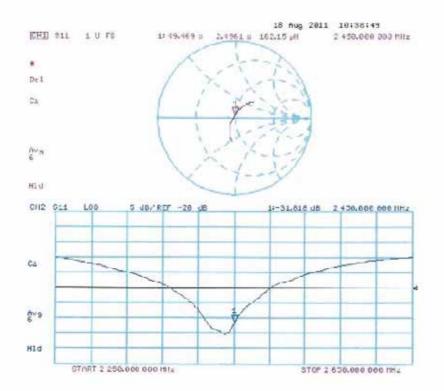
0 dB = 17.250 mW/g

Contificate No: D2450V2-710_Aug11

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Impedance Measurement Plot for Body TSL



Certificate No: D2450V2-710_Aug11

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7 Calibration certificate of Data Acquisition Unit (DAE)

eughausstrasse 43, 8004 Zuric	h, Switzerland	TORATE TORATE	S Swiss Calibration Service
Accredited by the Swiss Accredita The Swiss Accreditation Servic Multilateral Agreement for the r	e is one of the signatories	s to the EA	tation No.: SCS 108
Client Cetecom		Certific	ste No: DAE3-413_Jan11
CALIBRATION	CERTIFICATE	REAL PROPERTY AND INCOME.	
Object	DAE3 - SD 000 D	03 AA - SN: 413	or other of the little in
Calibration procedure(s)	QA CAL-06.v22 Calibration proces	dure for the data acquisition	electronics (DAE)
Calibration date:	January 13, 2011		N
The measurements and the unce	ertainties with confidence pro	nal standards, which realize the physic bability are given on the following pag facility: environment temperature (22	es and are part of the certificate.
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&1	rtainties with confidence protocol of the closed laboratory TE critical for calibration)	obability are given on the following page facility: environment temperature (22	es and are part of the certificate. ± 3)*C and humidity < 70%.
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&1 Primary Standards	ertainties with confidence pro	obability are given on the following pag	es and are part of the certificate.
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M& Primary Standards Keithley Multimeter Type 2001	ertainties with confidence pro- cted in the closed laboratory TE critical for calibration) ID # SN: 0810278	bability are given on the following page facility: environment temperature (22 Cal Date (Certificate No.) 28-Sep-10 (No:10376)	es and are part of the certificate. ± 3)*C and humidity < 70%. Scheduled Calibration Sep-11
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&1 Primary Standards	ertainties with confidence pro- cted in the closed laboratory TE critical for calibration)	obability are given on the following page facility: environment temperature (22 Cal Date (Certificate No.)	es and are part of the certificate. ± 3)*C and humidity < 70%. Scheduled Calibration
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M& Primary Standards Keithley Multimeter Type 2001 Secondary Standards	ertainties with confidence pro- cted in the closed laboratory TE critical for calibration) ID # SN: 0810278 ID #	bability are given on the following pages facility: environment temperature (22 Cal Date (Certificate No.) 28-Sep-10 (No:10376) Check Date (in house)	tes and are part of the certificate. ± 3)°C and humidity < 70%. Scheduled Calibration Sep-11 Scheduled Check
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Certificate No: DAE3-413_Jan11

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Annex E to	o Test report no.: 1-3851/11-0	1-13
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8 Calibration certificate of Data Acquisition Unit (DAE)

	ch, Switzerland	Tank Frank	S Swiss Calibration Service			
Accredited by the Swiss Accredit The Swiss Accreditation Service			reditation No.: SCS 108			
Multilateral Agreement for the	recognition of calibration					
Client Cetecom		Cert	tificate No: DAE3-477_May11			
CALIBRATION	CERTIFICATE					
Object	DAE3 - SD 000 D	03 AA - SN: 477				
Calibration procedure(s)	QA CAL-06.v22 Calibration proces	dure for the data acquisiti	ion electronics (DAE)			
Calibration date:	May 4, 2011					
This calibration certificate docum The measurements and the unc	nents the traceability to natio entainties with confidence pr		hysical units of measurements (SI). pages and are part of the certificate. (22 ± 3)°C and humidity < 70%.			
This calibration certificate docum The measurements and the uncl All calibrations have been condu Calibration Equipment used (M&	nents the traceability to natio entainties with confidence pr incted in the closed laboratory TE critical for calibration)	obability are given on the following facility: environment temperature	pages and are part of the certificate. (22 ± 3)°C and humidity < 70%.			
This calibration certificate docurr The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards	nents the traceability to natio entainties with confidence pr incted in the closed laboratory	cal Date (Certificate No.)	(22 ± 3)°C and humidity < 70%. Scheduled Calibration			
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This calibration certificate docurr The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards	nents the traceability to natio entainties with confidence pr cted in the closed laboratory TE critical for calibration) ID # SN: 0810278 ID #	cal Date (Certificate No.)	(22 ± 3)°C and humidity < 70%. Scheduled Calibration			
This calibration certificate docurr The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Keithley Multimeter Type 2001 Secondary Standards	nents the traceability to natio entainties with confidence pr cted in the closed laboratory TE critical for calibration) ID # SN: 0810278 ID #	Cal Date (Certificate No.) 28-Sep-10 (No:10376) Check Date (in house)	pages and are part of the certificate. (22 ± 3)°C and humidity < 70%. Scheduled Calibration Sep-11 Scheduled Check			
This calibration certificate docum The measurements and the uncl All calibrations have been condu Calibration Equipment used (M& Primary Standards Keithley Multimeter Type 2001 Secondary Standards Calibrator Box V1.1	nents the traceability to natio entainties with confidence pro- incred in the closed laboratory TE critical for calibration) ID # SN: 0810278 ID # SE UMS 006 AB 1004	cal Date (Certificate No.) 28-Sep-10 (No:10376) Check Date (in house) 07-Jun-10 (in house check)	pages and are part of the certificate. (22 ± 3)°C and humidity < 70%. Scheduled Calibration Sep-11 Scheduled Check			
This calibration certificate docurr The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Keithley Multimeter Type 2001 Secondary Standards	nents the traceability to natio entainties with confidence pro- incred in the closed laboratory TE critical for calibration) ID # SN: 0810278 ID # SE UMS 006 AB 1004	cal Date (Certificate No.) 28-Sep-10 (No:10376) Check Date (in house) 07-Jun-10 (in house check)	pages and are part of the certificate. (22 ± 3)°C and humidity < 70%. Scheduled Calibration Sep-11 Scheduled Check In house check: Jun-11			

Certificate No: DAE3-477_May11

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9 Certificate of "SAM Twin Phantom V4.0/V4.0C"

Schmid & Partner Engineering AG

Zeugheusstresse 43, 8004 Zurich, Switzerland, Phone +41 1 245 97 00, Fex +41 1 245 97 79

Certificate of conformity / First Article Inspection

ltem	SAM Twin Phantom V4.0
Туре No	QD 000 P40 BA
Series No	TP-1002 and higher
Manufacturer / Origin	Untersee Composites
i i	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, Serial No. TP-1006. Certain parameters have been retested using further series units (called samples).

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

Standards

- [1] CENELEC EN 50361
- [2] IEEE P1528-200x 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].

18.11.2001 Date Schmid & Partner Fra Brutelt : lat Signature / Stamp Engineering AG Zeughsusstrate 43, CH-BD04 Zurich Tel. 441 1 245 97 00, Féx +41 1 245 97 79

Doc No 881 - QD 000 P40 BA - B

Page 1 (1)



10 Application Note System Performance Check

10.1 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.

10.2 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.

10.3 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 _i 1g	c _i 10g	Standard Uncertainty 1g	Standard Uncertainty 10g	v _i ² or v _{eff}
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%	∞
Probe positioner	± 0.4%	Rectangular	√3	1	1	± 0.2%	± 0.2%	∞
Probe positioning	± 2.9%	Rectangular	√3	1	1	± 1.7%	± 1.7%	∞
Max. SAR evaluation	± 1.0%	Rectangular	√3	1	1	± 0.6%	± 0.6%	∞
Test Sample Related								
Dipole axis to liquid distance	± 2.0%	Normal	1	1	1	± 1.2%	± 1.2%	∞
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:

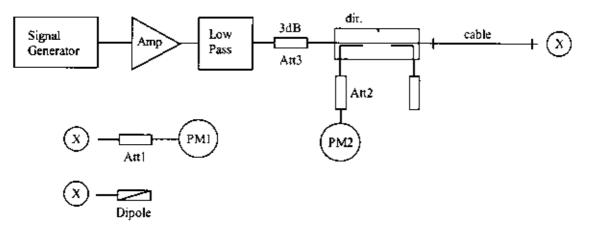
Error Sources	Uncertainty Value	Probability Distribution	Divi- sor	c _i 1g	c _i 10g	Standard Uncertainty 1g	Standard Uncertainty 10g	v _i ² or v _{eff}
						.9	log	·en
Measurement System								
Probe calibration	± 4.8%	Normal	1	1	1	0	0	8
Axial isotropy	± 4.7%	Rectangular	√3	0.7	0.7	0	0	8
Hemispherical isotropy	± 0.0%	Rectangular	√3	0.7	0.7	0	0	8
Boundary effects	± 1.0%	Rectangular	√3	1	1	0	0	8
Probe linearity	± 4.7%	Rectangular	√3	1	1	0	0	8
System detection limits	± 1.0%	Rectangular	√3	1	1	0	0	8
Readout electronics	± 1.0%	Normal	1	1	1	0	0	8
Response time	± 0.0%	Rectangular	√3	1	1	0	0	8
Integration time	± 0.0%	Rectangular	√3	1	1	0	0	8
RF ambient conditions	± 3.0%	Rectangular	√3	1	1	0	0	8
Probe positioner	± 0.4%	Rectangular	√3	1	1	0	0	8
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	± 2.0%	Normal	1	1	1	± 1.2%	± 1.2%	8
distance								
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%	8
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%	8
Liquid permittivity (meas.)	± 2.5%	Normal	1	0.6	0.49	± 1.5%	± 1.2%	8
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.



10.4 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 ³ 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.

10.5 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.

10.6 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.