



# **TEST REPORT**

Test Report No.: 1-1954-07-03/10-A



#### **Testing Laboratory**

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

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#### **Accredited Test Laboratory:**

The test laboratory (area of testing) is accredited

according to DIN ÉN ISO/IEC 17025

DAR registration number: DAT-P-176/94-D1

Appendix with Calibration data, Phantom certificate and system validation information

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#### Calibration report "Probe ET3DV6" 2

Calibration Laboratory of Schmid & Partner Engineering AG Zeoghwisstrasse 43, 8684 Zurich, Switzerland

Client Cetecom





S Schweizenscher Kalibnerdienst Service suisse d'étalonnage C Servizio svizzaro 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

Certificate No: ET3-1558 Aug09

Accreditation No.: SCS 108

Calibration procedure(s)			
Calibration procedure(s)	Description of the last of the		
	A TOTAL CONTRACTOR OF THE PROPERTY OF THE PARTY OF THE PA	QA CAL-23.V3 and QA CAL-25.V2	
	Calibration proc	cedure for dosimetric E-field probe	3
	A	×	ENERGIC MONTHS WANT
Calibration data:	August 21, 2008		
Condition of the calibrated Hem	In Tolerence		
		stionel standards, which realize the physical un procedify are given on the following pages an	
HIS THE SECURIT WITE STILL SHE WITE	manues with confidence	producing are given on the rollowing pages an	diane part of the contribute.
al castrations have been condu	cted in the closed laborat	tory facility: environment temperature (22 ± 3)*C	and numbery < 70%.
Saltration Equipment used (MS	He entical for calibration)		
Primary Standarda	10#	Cal Date (Certificate No.)	Schoduled Calibration
lower meter E4419B	G941203874	1-Apr 08 (No. 217-01030)	Apr-10
ower sensor E4412A	MY41495277	1-Apr 09 (No. 217 01030)	Apr-10
ower eensor E4412A	MY41498087	1-Apr-09 (No. 217-01030)	Apr-10
afgrency 3 dB Attenuator	SN: S5054 (3c)	31-Mar-09 (No. 217-01026)	Mar-11
eference 20 dB Attenuator	SNE SBUBB (200)	31-Mar-09 (No. 217-01028)	Mar-10
elerance 30 dB Attenuator	SN: S5129 (30b)	31-Mar-09 (No. 217-01027)	Mar-10
nimena Prote E530V2 AE4	5N: 3013	2-Jan-09 (No. E53-3013_Jan09)	Jan-10
SE4	SN: 660	8-Sep-88 (No. DAE4-880_Sep08)	Sep-0f1
econdary Standards	ID#	Check Date (in house)	Scheduled Check
Figenerator IIP 86480	UB3042U01700	4-Aug-99 (in house obeuk Out-37)	In house check: Oct-09
twork Analyzer HP 8753F	U837393585	15-Oct-01 (in house check Oct-08)	In house check. Oct-09
a bar we	Name	Function	Signature
alibrated by:	Ketis Poliovic	Technical Menager	246 183
	Miels Kuster	1	11
approved by:	Necis PCLISTOT	Quality Manager	- CRIN-
			1

Certificate No: E13-1558\_AugUB

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Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 0004 Zurich, Switzerland





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Swiss Calibration Service
Accreditation No.: SGS 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
NORMx,y,z sensitivity in free space
ConvF sensitivity in TSL / NORMx,y,z
DCP diode compression point
Polarization φ rotation around probe axis

Polarization 9 9 rotation around an axis that is in the plane normal to probe axis (at

measurement center), i.e., 9 = 0 is normal to probe axis

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

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

#### Methods Applied and Interpretation of Parameters:

- NORMx,y,z: Assessed for E-field polarization 9 = 0 (f < 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide) NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not effect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- NORM(f)x,y,z = NORMx,y,z \* frequency\_response (see Frequency Response Chart). This
  linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of
  the frequency response is included in the stated uncertainty of ConvF.
- DCPx,y,z: DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORMx,y,z \* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy): in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

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ET3DV6 3N:1558

August 21, 2009

# Probe ET3DV6

SN:1558

Manufactured: Last calibrated: Recalibrated: September 16, 2003 August 15, 2008 August 21, 2009

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

Confidere No: E13-1558\_Aug09

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ET3DV6 SN:1558 August 21, 2009

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

Sensitivity in Fro	c Space <sup>A</sup>		Diode C	compression <sup>6</sup>
NormX	1.97 ± 10.1%	$\mu V/(V/m)^2$	DCP X	93 mV
NormY	1.94 ± 10.1%	μV/(V/m) <sup>2</sup>	DCP Y	94 mV
NormZ	1.73 ± 10.1%	$\mu V/(V/m)^2$	DCP Z	95 mV

Sensitivity in Tissue Simulating Liquid (Conversion Factors)

Please see Page 8.

#### Boundary Effect

TSL	DOG WELL	Timelant CAR	margin and a first of the same trainer
ISL	900 MHz	LVDICAL SAR O	radient: 6 % per mm

Sensor Cente	er to Phantom Surface Distance	3.7 mm	4.7 mm	
SAR [%]	Without Correction Algorithm	10.1	5.8	
SAR [%]	With Correction Algorithm	0.9	0.7	

#### TBL 1750 MHz Typical SAR gradient: 10 % per mm

Sensor Cente	r to Phantom Surface Distance	3.7 mm	4.7 mm
SAR [%]	Without Correction Algorithm	9.7	5.8
SAR to [%]	With Correction Algorithm	0.8	0.6

#### Sensor Offset

Probe Tip to Sensor Center 2.7 mm

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

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 $<sup>^{6}</sup>$  The uncontainties of NormX,Y Z do not affect the  $\mathbb{C}^{2}$ -field uncertainty inside TSL (see Page 8).

<sup>&</sup>lt;sup>6</sup> Numerical inearization parameter uncombinly not required.

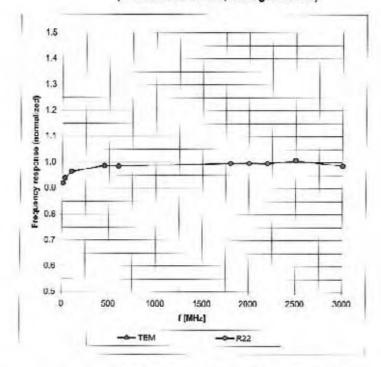


ET3DV6 SN:1558

August 21, 2009

# Frequency Response of E-Field

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



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

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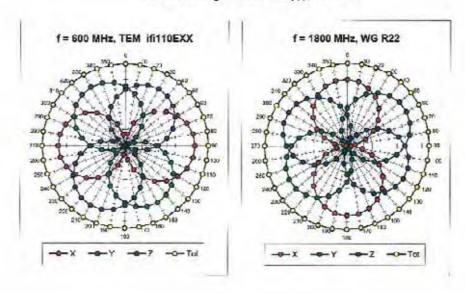
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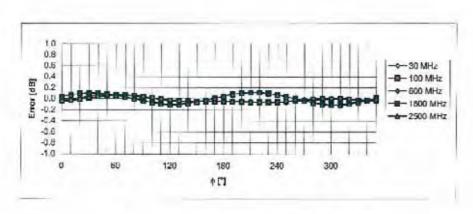


#### ET3DV6 SN:1558

August 21, 2009

# Receiving Pattern (6), 9 = 0°





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

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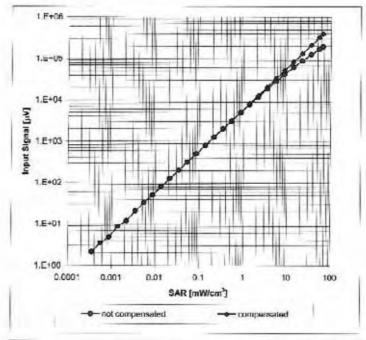


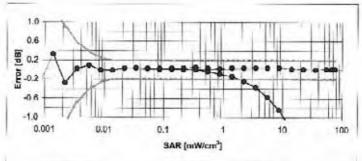
ET3DV6 SN:1558

August 21, 2009

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

(Waveguide R22, f = 1800 MHz)





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

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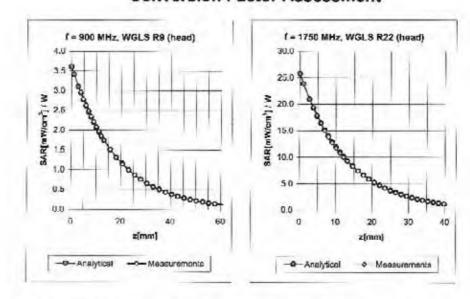
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ET3DV6 SN:1558

August 21, 2009

## Conversion Factor Assessment



f [MHz]	Validity [MHz] <sup>C</sup>	TSL	Permittivity	Conductivity	Alpha	Depth	ConvF Uncertainty
836	±50/±100	Head	41.5 ± 5%	0.90 1 5%	0.59	1.94	6.02 + 11.0% (k-2)
900	± 50 / ± 100	Head	415+5%	0.97 ± 5%	0.55	1.96	5.84 ± 11.0% (k=2)
1750	± 50 / ± 100	Hoad	40.1 ± 6%	1.37 ± 5%	0.52	2.56	5.00 ± 11.0% (k=2)
1900	±50/±100	Head	40.0 ± 5%	1.40 ± 5%	0.70	2.12	4.75 ± 11.0% (k=2)
2450	± 50 / ± 100	Head	39.2 ± 5%	1.80 ± 5%	0.99	1.64	4.16 ± 11.0% (k=2)
835	± 50 /± 100	Body	55.2 ± 5%	0.97 ± 5%	0.38	2.51	5.78 ± 11.0% (k=2)
900	= 50 / 1 100	Dody	55.0 1 5%	1.05 ± 5%	0.33	2.80	5.63 ± 11.0% (k=2)
1750	± 50 / ± 100	Body	53.4 ± 5%	1.49 ± 5%	0.62	3.28	4.53 ± 11.0% (k=2)
1900	± 50 / ± 100	Body	53.3 ± 5%	1.52 ± 5%	0.84	2.63	4.31 ± 11.0% (k=2)
2450	± 50 / ± 100	Body	52.7 ± 5%	1.95 + 5%	0.99	1.80	3.96 ± 11.0% (k=2)

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

Certificate No: ET3-1558\_Aug09

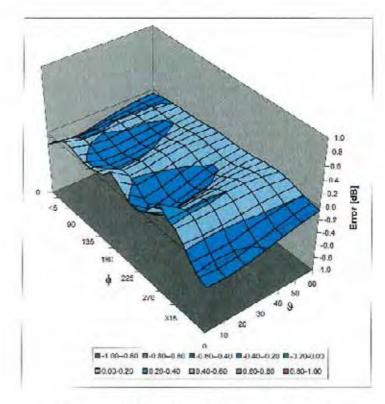
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ET3DV6 SN:1558 August 21, 2009

# Deviation from Isotropy in HSL Error (6, 0), f = 900 MHz



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

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# 3 Calibration report "900 MHz System validation dipole"

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





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Accreditation No SCS 108

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Certificate Nor D900V2-102 Aug09

CALIBRATION (	ERTIFICATI	*	
Ubject	D900V2 - SN: 10	12	
Chilbration procedure(s)	QA CAL-05:v7 Calibration proce	edure for dipole validation kils	
Calibration data:	August 17, 2009		
Condition of the calibrated Item	In Tolerance		
The measurements and the unce	rtaintes with confidence o	ional standards, which real ite the physical un rubublify are given on the following pages ar by facility: sendomment temperature (22 ± 3)?	nd are part of the certificate.
Primary Standards	10#	Cal Dala (Certificate No.)	Scheduled Californian
Power moter EPM-442A	CID37460704	08 Oct-08 (No. 217-00838)	Oct-08
	US37202783		and the same
ower sensor HP 8481A	0837232733	00-Oct-00 (No. 217-00898)	DOM NO
COLD CO-SCHOOL GURSTIN	A 2 C LO CO 1 2 CO 1	00-Oct-00 (No. 217-00898) 31-Mar-09 (No. 217-01025)	Oct-08 Mar-10
teference 20 cB Attenuator	SN: 5000 (20g) SN: 5047.2 / 06327	08-Oct-00 (No. 217-00896) 31-Mar-09 (No. 217-01025) 31-Mar-09 (No. 217 01029)	Mar-10 Mar-10
reference 20 eB Attenuator ype-N mismatch combination	SN: 5000 (20g)	31-Mar-09 (No. 217-01025) 31-Mar-09 (No. 217-01029)	Mar-10
Reference 20 dB Attenuator ype-N mismalch combination Reference ⊐robe ES3DV3	SN: 5000 (20g) SN: 5047.2 / 06327	31-Mar-09 (No. 217-01025)	Mar+10 Mas-10
Reference 20 cB Attornuator Type N mismatch cambination Reference Probe ES3DV3 DAE4	SN: 5000 (20g) SN: 5047.2 / 06327 SN: 3206 SN: 601	31-Mar-09 (No. 217-01025) 31-Mar-09 (No. 217-01029) 26-Jun-09 (No. E33-3205, Jun-39)	Mar+10 Mar+10 Jun-10
Reference 20 c8 Attornuator Type N mismatch cambination Reference Probe ES3DV3 DAE4 Secondary Standards	SN: 5000 (20g) SN: 5047.2 / 06327 SN: 3200 SN: 601	01-Mar-08 (No. 217-01025) 01-Mar-09 (No. 217-01029) 26-Jun-00 (No. E63-0205, Jun-09) 07-Mar-09 (No. DAE4-601_Mar-09) Check Date (in house) 18-Ost-02 (in house shock Oct-07)	Mar-10 Mer-10 Jun-10 Mer-10 Mer-10 Scheduled Chack In toxics-chart Cot-09
Reference 20 c8 Attornuator type N mismalich cambination teterence Probe ES3DV3 DAE4 secondary Stancards Power surrisor HP 8481A IF generator R&S SMT-C8	SN: 5000 (20g) SN: 5047.2 / 06327 SN: 3200 SN: 601 1D # MY41022317 100005	01-Mar-08 (No. 217-01025) 01-Mar-09 (No. 217-01029) 26-Jun-00 (No. E63-0205, Jun-09) 07-Mar-09 (No. DAE4-601_Mar-09) Check Date (in house) 18-Ost-02 (in house shock Oct-07) 4-Aug-98 (in house sheek Oct-07)	Mar-10 Mar-10 Jun-10 Mar-10 Mar-10 Soliestated Clasck In transporter Oct-09 in transporter Oct-09
Reference 20 cB Attornuator lype N mismatch combination Reterence Probe ES3DV3 DAE4 Secondary Stancards Power surrisor HP 8481A RF penerotor R&S SMT-08	SN: 5000 (20g) SN: 5047.2 / 06327 SN: 3200 SN: 601	01-Mar-08 (No. 217-01025) 01-Mar-09 (No. 217-01029) 26-Jun-00 (No. E63-0205, Jun-09) 07-Mar-09 (No. DAE4-601_Mar-09) Check Date (in house) 18-Ost-02 (in house shock Oct-07)	Mar-10 Mer-10 Jun-10 Mer-10 Mer-10 Scheduled Chack In toxics-chart Cot-09
Reference 20 c8 Attornuator Type-N mismatch cambination Reference Probe ES3DV3 DAE4 Secondary Stancards Power sursor HP 8481A RF penerotor R&S SVIT-08	SN: 5000 (20g) SN: 5047.2 / 06327 SN: 3200 SN: 601 1D # MY41022317 100005	01-Mar-08 (No. 217-01025) 01-Mar-09 (No. 217-01029) 26-Jun-00 (No. E63-0205, Jun-09) 07-Mar-09 (No. DAE4-601_Mar-09) Check Date (in house) 18-Ost-02 (in house shock Oct-07) 4-Aug-98 (in house sheek Oct-07)	Mar-10 Mar-10 Jun-10 Mar-10 Mar-10 Soliestated Clasck In transporter Oct-09 in transporter Oct-09
Abwer sanser HP 8481A Reference 20 e8 Attonuator Type N mismalich cambination Reference Probe ES3DV3 DAE4 Secondary Stancards Power surror HP 8481A RE penerator R&S SVT-08 Notwork Analyzer HP 8753E Calibrated by:	SN: 5000 (20g) SN: 5047.2 / 06327 SN: 3206 SN: 601  1D# MY41022317 100005 U\$37330885 54206	01-Mar-08 (No. 217-01025) 31-Mar-09 (No. 217-01029) 26-Jun-00 (No. 253-9205_uun09) 07-Mar-06 (No. DAE4-601_Mar-08)  Check Date (in house) 18-Ost-02 (in house shock Oct-07) 4-Aug-98 (in house shock Oct-07) 10-Ost-01 (in house shock Oct-08)	Mar-10 Mer-10 Jun-10 Mer-10 Mer-10 Scheduled Clasck In house check: Oct-08 In house check: Oct-08
Reference 20 c8 Attenuator Type N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Stancards Power sursor HP 8481A RF generator R&S SMT-08 Natwork Analyzer HP 8753E	SN: 5000 (20g) SN: 5047.2 / 06327 SN: 3206 SN: 601  1D # MY41022317 100005 US37330585 54206 Nanie	01-Mar-08 (No. 217-01025) 01-Mar-09 (No. 217-01029) 26-Jun-00 (No. 253-3205_dun09) 07-Mar-06 (No. DAE4-601_Mar-08)  Check Date (in house) 18-Ost-02 (in house shock Oct-07) 4-Aug-98 (in house shock Oct-07) 10-Ost-01 (in house shock Oct-08)  Function	Mar-10 Mer-10 Jun-10 Mer-10 Mer-10 Scheduled Clasck In house check: Oct-08 In house check: Oct-08
Reference 20 c8 Attenuator Type-N mismalich combination Reference Probe ES3DV3  DAE4  Secondary Stancards  Power surror HP 8481A  RF generator R&S SVIT-08  Network Analyzer HP 8753E  Calibrated by:	SN: 5000 (20g) SN: 5047.2 / 06327 SN: 3206 SN: 601  1D #  MY41022317 100805 US3/330685 34206 Name	01-Mar-08 (No. 217-01025) 01-Mar-09 (No. 217-01029) 26-Jun-09 (No. 263-0205 Jun-09) 07-Mar-06 (No. DAE4-601_Mar-08) Check Date (in house) 18-Oct-02 (in house shock Oct-07) 4-Aug-98 (in house shock Oct-07) 18-Oct-01 (in house shock Oct-08) Function Laboratory (Exhinisien)	Mar-10 Mar-10 Jun-10 Mar-10 Solveduled Chards In house check: Oct-08 In house check: Oct-08

Certificate No: D900V2-102\_Aug09

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#### Calibration Laboratory of Schmid & Partner

Engineering AG
Zoughausstrasse 43, 2004 Zurich, Switzerland





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S Swiss Calibration Service

Accreditation No. SCS 108

Accredited by the Swiss Accreditation Service (GAS)

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

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:

- i) 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 Lechniques", 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 (ECC OET), "Evaluating Compliance with ECC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with ECC 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 phentom. The impedance stated is transformed from the
  measurement at the SMA connector to the feed point. The Return Loss ensures low
  reflected power. No uncertainty required.
- Electrical Delay: One-way delay between the SMA connector and the antenna feed point.
   No uncertainty required.
- SAR measured. SAR measured at the stated antenna input power.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

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#### Measurement Conditions

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

DASY Version	DASY5	V5 0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V4.9	
Distance Dipote Center - TSL	16 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	900 MHz ± 1 MHz	

#### Head TSL parameters

The following carameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22,0 °C	41.5	0.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40 4 ± 6 %	0.98 inho/m ± 6 %
Head TSL temperature during test	(22.0 ± 0.2) °C		

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 n/W input power	2.81 mW / g
SAR normalized	normalized to 1W	11,2 mW / g
SAR for nominal Head TSL parameters	normalized to IW	11.3 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	1.00 mW /g
SAR normalized	normalized to 1W.	7.20 mW / g
SAR for nominal Hope TSL parameters	normalized to 1W	7.21 mW /g + 16.5 % (k=2)

Correction to nominal (SL parameters according to d), chapter "SAR Sensitivities".

Contribate No: D900V2-102 Aug08

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Body TSL parameters
The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22,0 °C	55.0	1:05 mno/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.7 ± 8 %	1:06 min/m + 6 %
Body TSL temperature during test	(22.0 ± 0.2) °C	-	

#### SAR result with Body TSL

SAR everaged over 1 cm2 (1 g) of Body TSL	Condition	
SAR measured	250 mW Input power	2.88 mW / g
SAR hormalized	normalized to 1W	11.5 mW / g
SAR for nominal Body TSL parameters 2	normalized to 1W	11.3 mW/g ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.85 mW / g
SAR normalized	normalized to 1W	7.40 mW/g
SAR for nominal Body TSL parameters	normalized to 1W	7.32 mW / g ± 16.5 % (k=2)

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Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities".



#### Appendix

#### Antenna Parameters with Head TSL.

Impedance, transformed to feed point	49.8 Ω - 4.2 JΩ
Return Loss	27,5 dB

#### Antenna Parameters with Body TSL

Impedance transformed to feed point	45.9 Ω - 5.8 JΩ		
Rotum Loss	-22.8 dB		

#### General Antenna Parameters and Design

5
2

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 semiring discovarial cable. The center conductor of the feeding like is rilically 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 hend or the suidered connections resulting feedpoint may be demaged.

#### Additional EUT Data

Manutactured by	SPEAG
Manufactured on	January 24, 2001

Certificate No D900V2-102\_Augit9

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#### DASY5 Validation Report for Head TSL

Date/Time: 10.08.2009 12:21:29

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

Medium: HS1, 900 MHz

Medium parameters used: f = 900 MHz;  $\sigma = 0.96 \text{ mhg/m}$ ;  $\varepsilon_i = 40.4$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Plat Section

Measurement Standard: DASY5 (IEEE/IEC)

#### DASY5 Configuration:

Probc: ES3DV3 - \$N3205; ConvF(5.88, 5.88, 5.88); Calibrated: 26.06.2009

- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics, DAE4 So601, Caliborest 07 03 2009
- Phantom: Flat Phantom 4.91.; Type: QD000P49AA: Serial 1001
- Measurement SW: DASY5, V5.0 Boild 120; SEMCAD X Version 13.4 Build 45

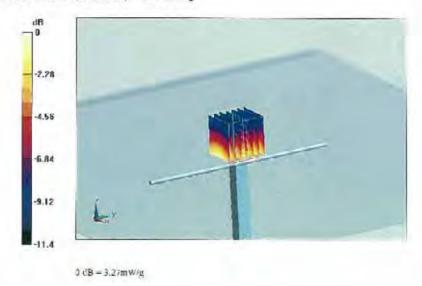
# Pin=250mW; dip=15mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid; dx=5mm, dy=5mm, dz=5mm

Reference Value = 59.9 V/m; Power Drift = 0.038 dB

Peak SAR (extrapolated) - 4.28 W/kg

SAR(1 g) = 2.81 mW/g; SAR(10 g) = 1.8 mW/g.

Maximum value of SAR (measured) = 3.27 mW/g



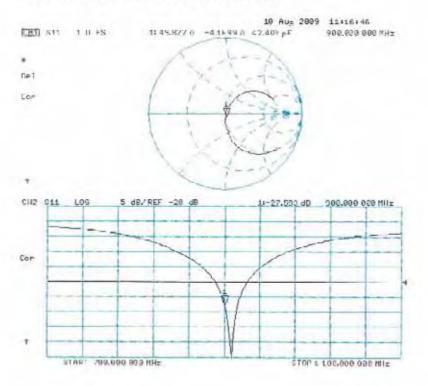
Certificate No. D900V2-102\_Aug09

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#### Impedance Measurement Plot for Head TSL



Certificate No. D900V2-102\_Aug09

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#### DASY5 Validation Report for Body

Date/Fime: 17.08.2009 10:47.05

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

Medium: MSI.900

Medium parameters used: f = 900 MHz;  $\alpha = 1.06 \text{ mho/m}$ ;  $\epsilon_r = 52.7$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC)

#### DASY5 Configuration:

Probe: FS3DV3 - SN3205; ConvF(5.81, 5.81, 5.81); Callbrated: 26.06,2009

Sensor-Surface; 3mm (Mechanical Sorface Detection)

Electronics: DATA Sn601; Calibrated: 07.03.2009

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

Measurement SW: DASY5, V5.0 Build 120, SEMCAD X Version 13.4 Build 45

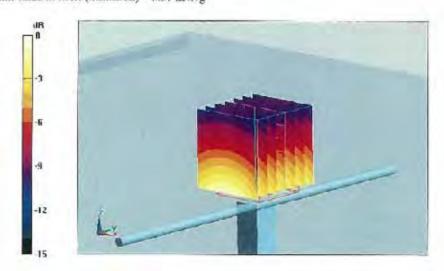
#### Pin=250mW; dip=15mm; dist=3.0mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid-

dx-5mm, dy 5mm, dz-5mm

Reference Value = 58.3 V/m; Power Drift = 0.00443 dB

Peak SAR (extrapolated) = 4.3 W/kg

SAR(1 g) = 2.88 mW/g; SAR(10 g) = 1.85 mW/gMaximum value of SAR (measured) = 3.37 mW/g



0 dB = 3,37mW/g

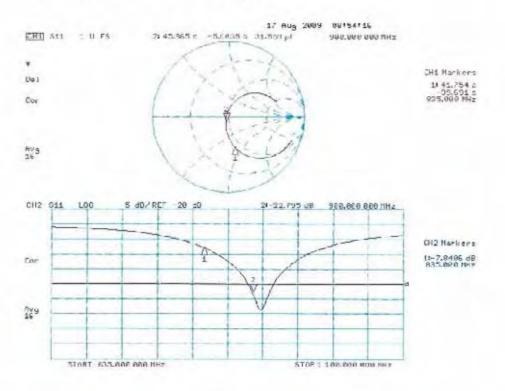
Certificate No: D900V2-102\_Aug09

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#### Impedance Measurement Plot for Body TSL



Certificate No: D900V2-102\_Aug09

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# 4 Calibration report "1900 MHz System validation dipole"

Calibration Laboratory of Schmid & Pariner Engineering AG Zeuglinussirasse 43, A104 Zurich, Switzerland





Senwegerischer Kalibriordienst Service suisse d'étalennege Bervizie evizzere 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.

Client Catacon

Gertificate No: D1900V2-5d009-Aug09

Accreditation No.: SCS 108

Object	D1900V2 - SN: 5d009		
Calibration procedure(s)	QA CAI -05 v7 Calibration procedure for dipole validation kits		
Calcination date.	August 18, 2009		
Condition of the calibrated from	In Tolerance		
		minishiry are given on the following pages and by Bucilly west minimum temporature (22.4.3)**	
Calibration Equipment used (M8)	TE critical for contration)		
		Co Data (Cultivated by Conflict) At 1	
Primary Standards	10 =	Co. Date (Calibrated by, Contricate No.)	Schoduled Calibration
Primery Standards		08-Oct-08 (No. 217-00898)	Oct-06
Printery Standards Power malor EPM 442A Power sensor HP 849* A	(D = CB37480704	08-Out-08 (No. 217-00898) 08-Out-08 (No. 217-00898)	Oct-08
Primary Standards Power motor EPM 442A Power sensor HP 640° A Haforence 20 dB Attenuation	IU # CB37460704 US37292783	08-Oct-08 (No. 217-00898)	Oct-06
Primery Standards Power motor EPM 442A Power sensor HP 840° A (aforence 20 dB Attenuation y, e- N mission on condition	IU = CB37460704 US37292783 SN: 5086 (20g)	08-Out-08 (Nn. 217-00898) 08-Out-08 (Nn. 217-00898) 31-Maz-09 (No. 217-01)(25)	Oct-09 Oct-09 Mar 10
Simply Standards Power motor EPM 442A Invertisensor HP 848* A Inforence 20 dB Attenuation y, in N mismon on combination toforoncy Proba ESSOV3	(U = CB37460704 US37292783 (N) 5086 (20g) SN: 5047:21 US327	08-Out-08 (No. 217-00899) 08-Out-08 (No. 217-00898) 31-Mar-09 (No. 217-01)(25) 31-Mar-08 (No. 217-01029)	Oct-09 Oct-08 Mar 10 Mar-10
Primary Standards Power seasor HP 949-A fower seasor HP 949-A forence 20 dB Attenuation fycie-N mismocian combination fycionous Probe ESSDV3 JAE4 incondary Standards	ID # CB37480704 US37292785 SN: 5086 (20g) SN: 5087 (2 ) US327 SN: 3334 SN: 601	08-Out-08 (No. 217-00899) 08-Out-08 (No. 217-00898) 31-Mar-09 (No. 217-01025) 31-Mar-09 (No. 217-01029) 26-Jun-09 (No. CSO-0206 Jun/88)	Oct-08 Oct-08 Mar 10 Mar-10 Jun-10
Pointery Standards Power sensor HP 840*A Fower sensor HP 840*A Forence 20 dB Attenuation Type-N mismorph combination Reference Probe ESSDV3 JAE4 Gecondary Standards Power sensor HP 8481A	ID # CB37480704 US37292785 SN: 6086 (20g) SN: 5047.2   065227 SN: 3334; SN: 601 ID # MY41052317	08-Oci-08 (Nr. 217-0089N) 08-Oci-08 (Nr. 217-0089N) 31-Mar-09 (Nr. 217-01025) 31-Mar-09 (Nr. 217-01025) 25-Jun-09 (Nr. C50-0206 Junus) 07-Mar-09 (Nr. DAE4-001_Mar/9) Check Date (In linear)	Oct-08 Oct-08 Mar 10 Mar-10 Jan-10 Mar-10 Mar-10 Solvaduled Check lis house conck: Oct-09
Pointery Standards Power sensor HP 849 A Power sensor HP 850V3 DAE4 Power sensor HP 848 IA RE generator P&S SMT-06	ID # CB37480704 US37232785 SN: 6086 (20g) SN: 5097.2 / 065227 SN: 238: EN: 601 ID // MY41052317 100005	08-Oci-08 (Nr. 217-0089N) 08-Oci-08 (Nr. 217-0089N) 31-Mar-09 (Nr. 217-01025) 31-Mar-09 (Nr. 217-01026) 26-Jun-09 (Nr. CS0-0206 Junus) 07-Mar-09 (Nr. DAE4-001_Mar(9)) Check Date (In flouse) 18-Oct-02 (In house check Oct 07) 4-Aug-99 (in house check Oct-07)	Oct-08 Oct-08 Mar 10 Mar-10 Jan-10 Mar-10 Solkeduled Check lis house check: Oct-09 In house check: Oct-09
Primary Standards Power sensor HP 849 A Power sensor HP 849 IA	ID # CB37480704 US37292785 SN: 6086 (20g) SN: 5047.2   065227 SN: 3334; SN: 601 ID # MY41052317	08-Oci-08 (Nr. 217-0089N) 08-Oci-08 (Nr. 217-0089N) 31-Mar-09 (Nr. 217-01025) 31-Mar-09 (Nr. 217-01025) 25-Jun-09 (Nr. C50-0206 Junus) 07-Mar-09 (Nr. DAE4-001_Mar/9) Check Date (In linear)	Oct-08 Oct-08 Mar 10 Mar-10 Jan-10 Mar-10 Mar-10 Solvaduled Check lis house conck: Oct-09
Calibration Equipment used (MS: Pairmany Standards Power sensor HP 840 A Haferance 20 dB Attenuation Type-N misman on combination Reference Probe ESSDV3 JAE4 Gecondary Standards Power sensor HP 848 JA HE generator PSS SM1-06 Notwork Analyzer HP 8763E	ID # CB37480704 US37232785 SN: 6086 (20g) SN: 5097.2 / 065227 SN: 238: EN: 601 ID // MY41052317 100005	08-Oci-08 (Nr. 217-0089N) 08-Oci-08 (Nr. 217-0089N) 31-Mar-09 (Nr. 217-01025) 31-Mar-09 (Nr. 217-01026) 26-Jun-09 (Nr. CS0-0206 Junus) 07-Mar-09 (Nr. DAE4-001_Mar(9)) Check Date (In flouse) 18-Oct-02 (In house check Oct 07) 4-Aug-99 (in house check Oct-07)	Oct-08 Oct-08 Mar 10 Mar-10 Jan-10 Mar-10 Solvaduled Check let house check: Oct-08 in house check: Oct-08 in house check: Oct-08
Pointery Standards Power sensor HP 849 A Power sensor HP 849 A Laforance 20 dB Attenuation Type-N mismonian combination Referency Probe ESSDVS JAE4  Gecondary Standards Power sensor HP 8481A RF generator P&S SMT-06	ID # CB37460704 US37292785 SN: 6086 (20g) SN: 5047.2 / U632/ SN: 3304. EN: 601 ID # MY4105231/ 100005 UB37090565 S4806	08-Oci-08 (No. 217-00899) 08-Oci-09 (No. 217-00898) 31-Mar-09 (No. 217-01029) 25-Jun-09 (No. C50-0205 Junu9) 07-Mar-09 (No. DAEA-001_Mar(9)) Check Date (In flouse) 18-Oct-02 (in house oheck Oct-07) 1-Aug-99 (in house oheck Oct-07) 10-Oct-01 (in house nheck Oct-07)	Oct-08 Oct-08 Mar 10 Mar-10 Jan-10 Mar-10 Solkeduled Check lis house check: Oct-09 In house check: Oct-09
Primary Standards Power sensor HP 640*A Power sensor HP 640*A Power sensor HP 640*A Autorance 20 dB Attenuation Tytle N mismouth combination Reference Probe ES3DV3 JAE4 Secondary Standards Power sensor HP 8461A RF generator PSS SMJ-06 Network Analyzer HP 8763E	ID # CB37460704 US37292733 SN: 5096 (20g) SN: 5097 (2 ) US32 / SN: 5304 EN: 601 ID # MY4105231 / 100005 U837000566 54806	08-Oci-08 (No. 217-00899) 08-Oci-09 (No. 217-00898) 31-Mar-09 (No. 217-01029) 25-Jun-09 (No. C50-0205 Junu9) 07-Mar-09 (No. DAEA-001_Mar(9)) Check Date (In flouse) 18-Oct-02 (in house otheck Oct-07) 1-0-Oct-01 (in house otheck Oct-07) 10-Oct-01 (in house otheck Oct-08)	Oct-08 Oct-08 Mar 10 Mar-10 Jan-10 Mar-10 Solvaduled Check let house check: Oct-08 in house check: Oct-08 in house check: Oct-08

Certificate No: D1900V2-fidons Augos

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Calibration Laboratory of Schmid & Partner Engineering AG Zoughausstresse 43, 6004 Zurich, Switzwland





Schweizeriocher Kalibrierdienat Service suissa d'etalonhage Servizio aviczuro di taratura

S Swiss Calibration Service

Accreditation No.: SCS 108

Americana by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signaturus to the FA

Multilateral Agreement for the recognition of celibration 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) IFFF 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) CENELEC EN 50361, "Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz - 3 GHz), July 2001

c) Federal Communications Commission Office of Engineering & Technology (FCC OFT), "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.
- Anterma 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.
- Flectrical Delay. One-way delay between the SMA connector and the antenna feed point.
   No uncertainty required.
- SAH 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: D1900V2-5d009\_A:g09 Page 2 of 9

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#### Measurement Conditions

DASY Version	DASYS	V9.0
Extrapolation	Advanced Extrapolation	
Phanlom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz - 5 mm	
Frequency	1000 MHz ± 1 MHz	

Head TSL parameters
The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Numinal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.8 ± 6 %	1.45 mho/m ± 6 %
Head TSL temperature during test	(22.0 ± 0.2) °C		-

#### SAR result with Head TSL

SAR averaged over 1 cm3 (1 g) of Head TSL	condition	
SAR measured	250 mW input power	in i mW/g
SAR normalized	normalized to 1W	40.4 mW / g
SAR for nominal Head TSL parameters.	normalized to TW	39.7 mW / g = 17.0 % (k=2)

SAR averaged over 10 cm² (10 g) of Head TSL	Condition	
SAR measured	250 mW Input power	5.28 mW / g
SAR normalized	normalized to TW	21.1 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	21.0 mW/g = 16.5 % (k=2)

Certificate No. 01900V2-50009\_Avg09

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<sup>\*</sup>Correction to nominal TSL parameters according to d), chapter "SAR Gensitivities"



#### Body TSL parameters

The following parameters and calculations were applied.

	Temporature	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 ± 8 %	1.57 mho/m + 6 %
Body ISL temperature during test	(22.0 ± 0.2) "G	****	ree

# SAR result with Body TSL

SAR averaged over 1 cm2 (1 g) of Hody ISL	Condition	
SAR measured	250 mW input power	10.2 mW / g
SAR normalized	normalized to 1W	40.8 mW / g
SAR for nominal Body TSL parameters 2	normalized to 1W	40.1 mW/g ± 17.0 % (k=2)

SAR averaged over 10 cm* (10 g) of Body TSL	condition	
SAR moasured	260 mW input power	5,38 mW / g
SAH normalized	normalized to 1W	21.3 mW / q
SAH for nominal Body TSL parameters*	normalized to TW	21.1 mW/g ± 16.5 % (k=2)

Carrificate No: D1900Vz-5d009\_Aug09

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<sup>\*</sup>Committee to committee TSI parameters according to di, chacter SAR Sensitivities\*



#### Appendix

#### Antenna Parameters with Hoad TSL.

Impedance, transformed to feed point	50.2 Ω + 1.5 JΩ
Return Loss	- 37.4 dB

#### Antenna Parameters with Body TSL

Impodance, transformed to food point	40.1 Ω + 2.2 jΩ	
Return Loss	-26.7 dB	

#### 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 dipole near the feerfpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center constructor of the feeding line is directly connected to the account arm of the dipole. The antanna is therefore structure site of DC-signals.

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

#### Additional EUT Data

Manufactured by	SPEAG	
Manufactured on	February 22, 2002	

Camilicate No: D1900V2-5d009\_Aug09

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#### DASY5 Validation Report for Head TSL

Date/Time 05 08 2009 13:43:12

Test Laboratory: SPEAG, Zurich, Switzerland

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

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: HSL U11 BB

Medium parameters used: f = 1900 MHz;  $\sigma = 1.45 \text{ mho/m}$ ;  $\varepsilon_r = 40.8$ ,  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC)

#### DASY5 Configuration:

Probe: ES3DV3 - SN3205; ConvF(5.09, 5.09, 5.09). Calibrated: 26.06 2009

- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Flootronics; DAE4 Sn601; Calibrated: 07.03.2009
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Senal: 1001
- Measurement SW: DASY5, V5.0 Build 120; SI/MCAD X Version 13.4 Build 45

#### Pin = 250 mW; dip = 10 mm, scan at 3.0 mm/Zoom Scan (dist=3.0 mm, probe 0deg)

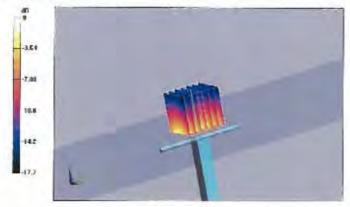
(7x7x7)/Cube 0: Measurement grid: dx-5mm, dy-5mm, dz=5mm

Reference Value = 95.6 V/m; Power Drift = 0.056 dB

Peak SAR (extrapolated) = 18.5 W/kg

SAR(1 g) = 10.1 mW/g; SAR(10 g) = 5.28 mW/g

Maximum value of SAR (measured) = 12.3 mW/g



0 dB = 12.3mW/g

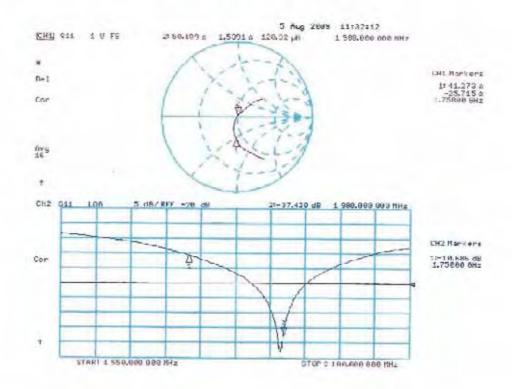
Certificata No: D1900V2-5d009 Aug09

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#### Impedance Measurement Plot for Head TSL



Certificate No. D1900V2-5d009\_Aug09

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#### DASY5 Validation Report for Body TSL

Date/Time: 18.08.2009 13:30:35

Test Laboratory: SPEAG, Zurich, Switzerland

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

Communication System: CW, Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: MSL U10 BB

Medium parameters used: f = 1900 MHz;  $\sigma = 1.57 \text{ mho/m}$ ;  $\varepsilon_r = 53.9$ ;  $\rho = 1000 \text{ kg/m}^2$ 

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IFC)

#### DASY5 Configuration:

Probe: F83DV3 SN3205: ConvF(4.59, 4.59, 4.59); Calibrated: 26.06.2009

Sensor Surface: 3mm (Mechanical Surface Defection)

Electronics, DAE4 Sn601; Calibraced; 07.03.2009

Pliantom: Fiat Phantom 5.0 (back): Type: QD0000P50AA, Scrial 1002

Measurement SW: DASY5, V5.0 Build 120; SEMCAD X Version 13.4 Build 45

#### Pin = 250 mW; dip = 10 mm, scan at 3.0mm/Zoom Scan (dist=3.0mm, probe 0dcg)

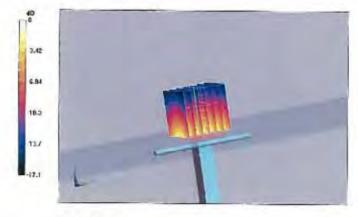
(7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96 V/m; Power Drift = -0.00504 dB

Peak SAR (extrapolated) = 17.3 W/kg

SAR(1 g) = 10.2 mW/g; SAR(10 g) = 5.33 mW/g.

Maximum value of SAR (measured) = 12.9 mW/g



0 dB = 12.9 mW/g

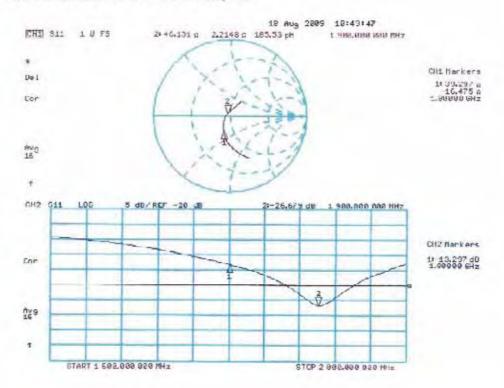
Certificate No: D1900V2-5d009\_Aug09

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#### Impedance Measurement Plot for Body TSL



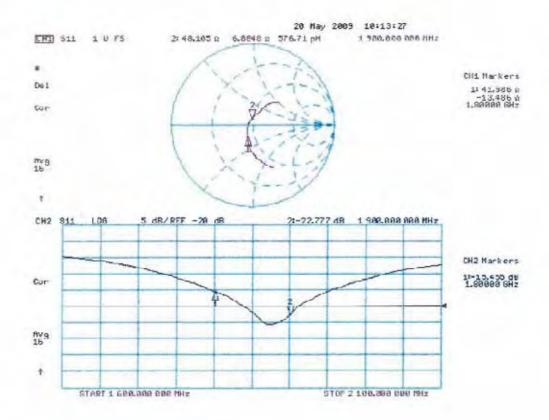
Certificate No: D1900V2-5d009\_Aug09

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#### Impedance Measurement Plot for Body TSL



Certificate No: D1900V2-531\_May09

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# Calibration report "2450 MHz System validation dipole"

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

Cetecom

Calurason date:





- Schweizerischer Kaltbrierdienst Service suisse d'étalonnage
- C Servizio svizzero di taretura S Swiss Calibration Service

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

Accreditation No SCS 108

Certificate No: D2450V2-710\_Aug09 CALIBRATION CERTIFICATE Object D2450V2 - SN: 710 QA CAL 05.V7 Calibration procedure(s) Calibration procedure for dipole validation kits

This collimation certificate occurrents the traceability to national standards, which reside the physical units of measurements (SI). The moseurements and the uncertainties with confidence probability are given unlike full away pages and are part of the certainties.

All transferes have been conducted in the closed laboratory facility; environment languageless (22 ± 1)°C and humility < 70%.

Addust 17, 2009

Calibration Equipment used (M&TE critical for calibration)

Condition of the collected item. In Taleranco

10.1	Cal Flare (Collbrated by, Centricate No.)	Schedilled Calibratori
GR37480704	08-Oct-08 (No. 217 00809)	Dct-03
US37202783	00-Oct-00 (No. 217-00699)	Dends
SN: 5086 (20c)	31-Mar-09 (No. 217 U1025)	Mar-10
GN, 5047.27 06327	31-Mar-09 (No. 217-01029)	Mar-10
SN: 320b	76-Jun-09 (No. ESS 3205 Jun09)	Jun 10.
SN: 601	07-Mar 03 (No. DAE4-601_Mar03)	Mar 10
10 -	Check Date (in humser)	Schodulad Check
MY41092317		in house shook: Opt 00
100005		In house check, Out-09
USS/380585 \$4208	18 Oct 01 (in house check Oct-00)	In house clieck, Oct-09
Name	Function	Signifium:
Characterist	Leberatory Technician	(blu
Kalla Follovio	Technical Manager	3000
	GR37480704 US37202783 SN: 5086 (20c) GN: 5047.27 (30327 SN: 500 SN: 601 ID # MY41092317 100005 US57390686 54206 Name: CRUDIO GGL/B/OF	Character   Char

Certificate No: D2450V2-710 Aug0S

Project 14.9.

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





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Senwergerracher Kellbrierdienel Sorvice suices d'élatennage Servizio svizzero di laratura Swiss Collbration Service

Accreditation Nu.: SCS 108

Accredited by the Swine According on Renviru (SAS) The Swiss Accordination Service is one of the signatories to the EA. Multilateral Agreement for the recognition of calibration certificates.

Glossary:

ISL lissue 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:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial. Averaged Specific Absorption Flate (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 Lields; 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 food point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss. These parameters are measured with the dipole. positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay: One-way delay between the SMA connector and the antenna feed point; No uncertainty required:
- SAR measured: SAR measured at the stated antenna input power.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters. The measured TSL parameters are used to calculate the nominal SAR result.

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#### Measurement Conditions

DASY Version	DASY5	V5.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantem V5.0	
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 TSI, parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) "G	40 1 + A %	1 80 mbq/m = 6 %
Head TSL temperature during test	(22.0 ± 0.2) °C	_	

#### SAR result with Head TSL

SAR averaged over 1 cm² (1 g) of Head TSL	Condition	
SAR measured	.250 mW input power	13,1 mW / g
SAR nomislized	normalized to 1W	52.4 mW / g
SAR for nominal Hoad TSL parameters 1	WI of pestiamon	52.7 mW /g ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head ISL	nombnba	
SAR measured	250 mW input power	6.16 mW/g
SAR normalized	normalized to 1W	74.8 mW/ / g
SAR for nominal Hosa TSL paramotors "	normalized to TW	24.7 mW /g ± 16.5 % (k=2)

\* Correction to nominal TSL paramoters according to d), chapter \*GAR Sensitivities\*

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#### **Body TSL parameters**

no following parameters and calculations were applied

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	29.0 °C	52.7	1,95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	59.2 - 6 %	2 01 mbg/m±6 %
Body TSL temperature during test	(22.5 ± 0.2) °C		

#### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 nW Input powor	13.0 mW (g
SAH normalized	normalized to 1W	52.0 mW / g
SAR for nominal Body TSL parameters *	- normalized to TW	51.4 mW /g = 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR neasured	250 mW Input power	5.99 mW / g
SAR normalized	normalized to 1W	24.0 mW / g
SAR for cominal Body TSL parameters. <sup>2</sup>	normalized to 1W	23.9 mW /g = 16.5 % (k=2)

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



#### Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.9 Ω - 0.2 JΩ		
Réturn Loss	-31,1 dB		

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	49 1 O + O B JO
Relum Loss	39.2 dB

#### General Antenna Parameters and Design

A	
Elecuical Delay (one direction)	1.150 ns
The state of the s	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

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

The cipole is made of standard cominged coastal cable. The center conductor of the feeding line is directly connected to true 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 sordered connections near the feedpoint may be damaged.

#### Additional EUT Data

Manufactured by	SPEAG				
Manufactured on	July 05, 2002				

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#### DASY5 Validation Report for Head TSL

Date/Time: 17.08.2009 13:40:44

Test Laboratory; SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN710

Communication System; CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: HSL U11 BB

Medium parameters used: t = 2450 MHz;  $\alpha = 1.8 \text{ mbo/m}$ ;  $\epsilon_c = 40.1$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC)

#### DASY5 Configuration:

Probe: ES3DV3 - SN3205; ConvF(4.53, 4.53, 4.53); Calibrated: 26.06.2009

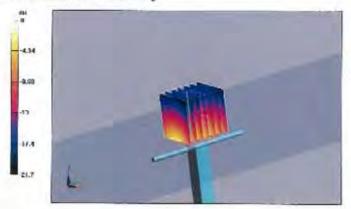
- Sensor-Surface: 3mm (Machanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 07.03.2009
- Phantom: Plat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- Measurement SW: DASY5, V5.0 Build 120; SEMCAD X Version 13.4 Build 45

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 98.7 V/m; Power Drift = 0.047 dB

Peak SAR (extrapolated) = 26.8 W/kg

SAR(1 g) = 13.1 mW/g; SAR(10 g) = 6.16 mW/g Maximum value of SAR (measured) = 16.6 mW/g



0 dB = 16.6mW/g

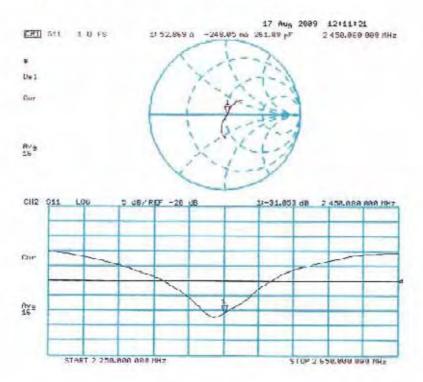
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#### Impedance Measurement Plot for Head TSL



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## DASY5 Validation Report for Body TSL

Date/Time: 17.08.2009 14:51:57

Test Laboratory: SPEAG, Zurich, Switzerland

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

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: MSL 1.10 BB

Medium parameters used: f = 2450 MHz;  $\sigma = 2.01$  mbo/m;  $\varepsilon_t = 53.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC)

#### DASY5 Configuration:

- Probe: ES3DV3 SN3205: ConvP(4.31, 4.31, 4.31); Calibrated: 26.06.2009
- Sensor Surface: 3mm (Mechanical Surface Detection)
- Iffectionies: DAF4 Sn601; Calibrated: 07.03.200)
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- Measurement SW: DASY5, V5.0 Build 120: SEMCAD X Version 13.4 Build 45

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 94.2 V/m; Power Drift = 0.020 dB Peak SAR (extrapolated) = 27.4 W/kg

SAR(1 g) = 13 mW/g; SAR(10 g) = 5.99 mW/g

Maximum value of SAR (measured) = 16.9 mW/g



0.6R = 16.9 mW/g

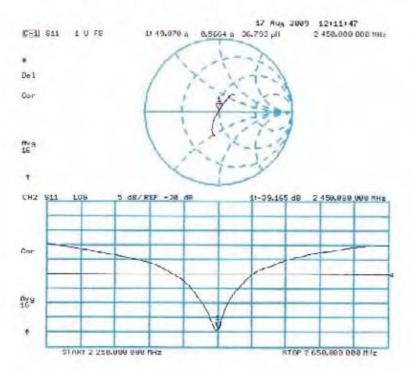
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## Impedance Measurement Plot for Body TSL



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

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

Certificate No. DAES-413\_km10





Schweizenscher Kalibrierdienst Service suisee d'étaionnage Servizio avizzero di taratura Swisa Calibration Service

Accredited by the Swiss Accreditation Service (SAS)

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

Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

S

C

Certificate No. DAE3-413\_Jnn10 cetecom CALIBRATION CERTIFICATE DAE3 - SD 000 D03 AA - SN: 413 Object QA CAL-08.v12 Calibration procedure(s) Calibration procedure for the data acquisition electronics (DAE) January 4, 2010 This calibration certificate documents the traceability to national clandards, which realize the physical units of measurements (Ei). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate, All collaborations have been conducted in the closed laboratory facility: environment temperature (22 ± 3) °C and numitity < 70%. Calibration Equipment used (M&TE critical for calibration) Cal Date (Certificate No.) Scheduled Calibration Keithley Multimeter Type 2001 SN: 08102/8 1-Oct-09 (No: 9055) Oct-10 Secondary Standards 10# Check Date (in house) Subreduled Check Calibrator Box V1 1 SE UMS 006 AS 1004 05-Jun-09 (In house check) In house check: Jun-10 Name Function Daniel Hoss. Calibrated by: Technician Approved by: Fin Bornholt R&D Director locued: January 4, 2010. This collibration conflicate shall not be reproduced except in full without written approval of the laboratory.

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

# Schmid & Partner Engineering AG

Zeughausstresse 43, 8004 Zurich, Switzerland, 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 Composites Hauptstr. 69 CH-8559 Fruthwilen Switzerland	

#### Tesis

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].

Oate

18 11.2001

Signature / Stamp

Schmid & Partner Fin Boulett

Zeughpusetraete 43, CH-8004 Zurich Tel. +41 1 243 97 00, Fax +41 1 245 97 79

Dec No 881 - QD 000 P40 9A - 8

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1 (1)



## 8 Application Note System Performance Check

#### 8.1 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.

# 8.2 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.

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#### **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.

#### 8.3 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.

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#### 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%	8
Axial isotropy	± 4.7%	Rectangular	√3	0.7	0.7	± 1.9%	± 1.9%	8
Hemispherical isotropy	± 0.0%	Rectangular	√3	0.7	0.7	± 0.0%	± 3.9%	8
Boundary effects	± 1.0%	Rectangular	√3	1	1	± 0.6%	± 0.6%	∞
Probe linearity	± 4.7%	Rectangular	√3	1	1	± 2.7%	± 2.7%	8
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%	8
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%	∞
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%	

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#### 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	∞
Probe positioner	± 0.4%	Rectangular	√3	1	1	0	0	∞
Probe positioning	± 2.9%	Rectangular	√3	1	1	0	0	∞
Max. SAR evaluation	± 1.0%	Rectangular	√3	1	1	0	0	∞
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%	∞
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%	8
Combined Uncertainty						± 5.3%	± 4.9%	
Expanded Std. Uncertainty						± 10.6%	± 9.7%	

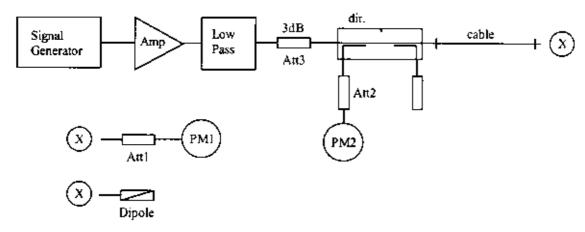
The expected repeatability deviation is low. Excessive drift (e.g., drift in liquid parameters), partial system failures or incorrect parameter settings (e.g., wrong probe or device settings) will lead to unexpectedly high repeatability deviations. The repeatability gives an indication that the system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

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#### 8.4 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.

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- 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.

#### 8.5 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.

#### 8.6 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.

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