

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





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

Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS)

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

#### Glossary:

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

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

Polarization φ 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 § = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide).
   NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)x,y,z = NORMx,y,z \* frequency\_response (see Frequency Response Chart). This linearization is
  implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included
  in the stated uncertainty of ConvF.
- DCPx,y,z: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- Ax,y,z; Bx,y,z; Cx,y,z, VRx,y,z: A, B, C are numerical linearization parameters assessed based on the data of
  power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the
  maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for 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.



ES3DV3 - SN:3149

April 24, 2012

# Probe ES3DV3

SN:3149

Manufactured: Calibrated:

June 12, 2007 April 24, 2012

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

Certificate No: ES3-3149\_Apr12

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ES3DV3-SN:3149 April 24, 2012

# DASY/EASY - Parameters of Probe: ES3DV3 - SN:3149

#### **Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (µV/(V/m) <sup>2</sup> ) <sup>A</sup>	1.21	1.24	1.24	± 10.1 %
DCP (mV) <sup>B</sup>	101.1	100.9	100.5	

**Modulation Calibration Parameters** 

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	0.00	X	0.00	0.00	1.00	112.7	±2.2 %
			Y	0.00	0.00	1.00	114.2	
			Z	0.00	0.00	1.00	118.9	

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%.

A The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 6).

B Numerical linearization parameter: uncertainty not required.

E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.



ES3DV3-SN:3149 April 24, 2012

# DASY/EASY - Parameters of Probe: ES3DV3 - SN:3149

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

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	6.50	6.50	6.50	0.24	2.36	± 12.0 %
850	41.5	0.92	6.26	6.26	6.26	0.25	2.14	± 12.0 %
900	41.5	0.97	6.17	6.17	6.17	0.21	2.55	± 12.0 %
1800	40.0	1.40	5.23	5.23	5.23	0.43	1.64	± 12.0 %
1900	40.0	1.40	5.19	5.19	5.19	0.45	1.64	± 12.0 %
2000	40.0	1.40	5.11	5.11	5,11	0.52	1.46	± 12.0 %
2100	39.8	1.49	5.12	5.12	5.12	0.49	1.52	± 12.0 %
2450	39.2	1.80	4.49	4.49	4.49	0.71	1.37	± 12.0 %
2550	39.1	1.91	4.34	4.34	4.34	0.69	1.26	± 12.0 %
2600	39.0	1.96	4.26	4.26	4.26	0.55	1.29	± 12.0 %

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



ES3DV3-SN:3149 April 24, 2012

# DASY/EASY - Parameters of Probe: ES3DV3 - SN:3149

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

f (MHz) <sup>c</sup>	Relative Permittivity F	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	6.29	6.29	6.29	0.43	1.56	± 12.0 %
850	55.2	0.99	6.14	6.14	6.14	0.41	1.63	± 12.0 %
900	55.0	1.05	6.16	6.16	6.16	0.63	1.30	± 12.0 %
1800	53.3	1.52	4.84	4.84	4.84	0.28	2.97	± 12.0 %
1900	53.3	1.52	4.64	4.64	4.64	0.34	2.25	± 12.0 %
2000	53.3	1.52	4.63	4.63	4.63	0.35	2.21	± 12.0 %
2100	53.2	1.62	4.91	4.91	4.91	0.36	2.20	± 12.0 %
2450	52.7	1.95	4.15	4.15	4.15	0.80	0.61	± 12.0 %
2550	52.6	2.09	4.07	4.07	4.07	0.80	0.50	± 12.0 %
2600	52.5	2.16	3.99	3.99	3.99	0.80	0.51	± 12.0 %

 $<sup>^{</sup>c}$  Frequency validity of  $\pm$  100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to  $\pm$  50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

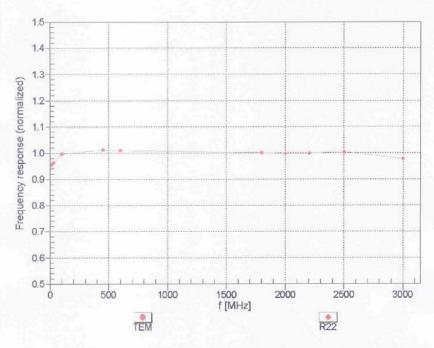
F At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to  $\pm$  10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to  $\pm$  5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.



ES3DV3-SN:3149

April 24, 2012

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



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



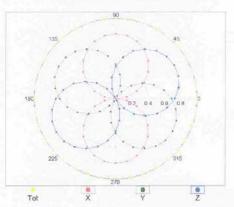


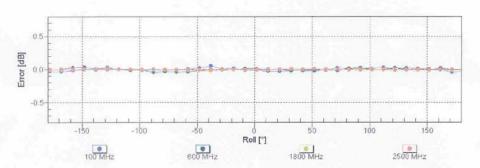
# Receiving Pattern ( $\phi$ ), $9 = 0^{\circ}$

# f=600 MHz,TEM



# f=1800 MHz,R22



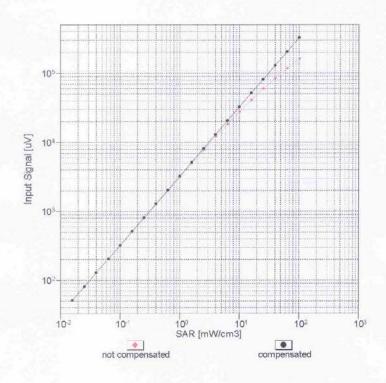


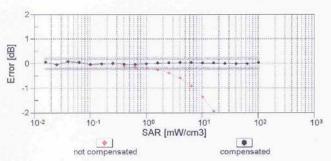
Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)



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

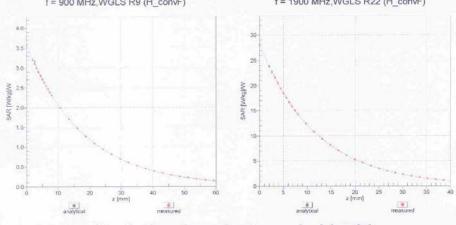




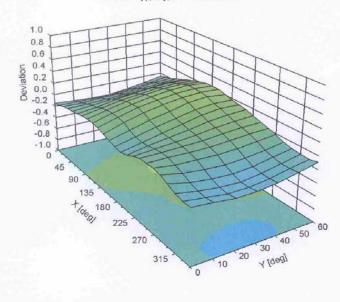
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

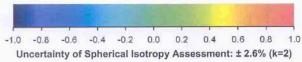






# Deviation from Isotropy in Liquid Error (φ, θ), f = 900 MHz







ES3DV3- SN:3149 April 24, 2012

# DASY/EASY - Parameters of Probe: ES3DV3 - SN:3149

#### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	51.8
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm



# **ANNEX H** Dipole Calibration Certificate

# 835 MHz Dipole Calibration Certificate

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





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ALIBRATION	CERTIFICATE		
Object	D835V2 - SN: 44	3	
Calibration procedure(s)	QA CAL-05.v8 Calibration proce	dure for dipole validation kits abo	ove 700 MHz
Calibration date:	May 03, 2012		
This calibration certificate docu	ments the traceability to nati	orial standards, which reduze the physical di	
The measurements and the unitary calibrations have been conducted Calibration Equipment used (M. Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3	certainties with confidence putted in the closed laborator  LD #  GB37480704  US37292783  SN: 5058 (20k)  SN: 5047.2 / 06327  SN: 3205	robability are given on the following pages arry facility: environment temperature (22 ± 3)°  Cal Date (Certificate No.)  05-Oct-11 (No. 217-01451)  05-Oct-11 (No. 217-01451)  27-Mar-12 (No. 217-01530)  27-Mar-12 (No. 217-01533)  30-Dec-11 (No. ES3-3205_Dec11)	Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12
The measurements and the unital calibrations have been conducted Calibration Equipment used (Measurements) Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4	certainties with confidence putted in the closed laborator  BTE critical for calibration)  ID #  GB37480704  US37292783  SN: 5058 (20k)  SN: 5047.2 / 06327  SN: 3205  SN: 601	robability are given on the following pages are ry facility: environment temperature (22 ± 3)°  Cal Date (Certificate No.)  05-Oct-11 (No. 217-01451)  05-Oct-11 (No. 217-01451)  27-Mar-12 (No. 217-01530)  27-Mar-12 (No. 217-01533)  30-Dec-11 (No. ES3-3205_Dec11)  04-Jul-11 (No. DAE4-601_Jul11)	Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12
The measurements and the unitary calibrations have been conducted Calibration Equipment used (M. Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3	certainties with confidence putted in the closed laborator  LD #  GB37480704  US37292783  SN: 5058 (20k)  SN: 5047.2 / 06327  SN: 3205	robability are given on the following pages arry facility: environment temperature (22 ± 3)°  Cal Date (Certificate No.)  05-Oct-11 (No. 217-01451)  05-Oct-11 (No. 217-01451)  27-Mar-12 (No. 217-01530)  27-Mar-12 (No. 217-01533)  30-Dec-11 (No. ES3-3205_Dec11)	Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12
All calibrations have been cond Calibration Equipment used (M. Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06	certainties with confidence poucted in the closed laborator  BTE critical for calibration)  ID #  GB37480704  US37292783  SN: 5058 (20k)  SN: 5047.2 / 06327  SN: 3205  SN: 601  ID #  MY41092317  100005	robability are given on the following pages are ry facility: environment temperature (22 ± 3)°  Cal Date (Certificate No.)  05-Oct-11 (No. 217-01451)  05-Oct-11 (No. 217-01451)  27-Mar-12 (No. 217-01530)  27-Mar-12 (No. 217-01533)  30-Dec-11 (No. ES3-3205_Dec11)  04-Jul-11 (No. DAE4-601_Jul11)  Check Date (in house)  18-Oct-02 (in house check Oct-11)  04-Aug-99 (in house check Oct-11)	Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13
All calibrations have been cond Calibration Equipment used (M. Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06	retrainties with confidence poucted in the closed laborator  RTE critical for calibration)    ID #   GB37480704   US37292783   SN: 5058 (20k)   SN: 5047.2 / 06327   SN: 3205   SN: 601    ID #   MY41092317   100005   US37390585 S4206	robability are given on the following pages are ry facility: environment temperature (22 ± 3)°  Cal Date (Certificate No.)  05-Oct-11 (No. 217-01451)  05-Oct-11 (No. 217-01451)  27-Mar-12 (No. 217-01530)  27-Mar-12 (No. 217-01530)  20-Dec-11 (No. ES3-3205_Dec11)  04-Jul-11 (No. DAE4-601_Jul11)  Check Date (in house)  18-Oct-02 (in house check Oct-11)  04-Aug-99 (in house check Oct-11)  18-Oct-01 (in house check Oct-11)	Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-13



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Glossary:

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

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

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

#### **Additional Documentation:**

d) DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

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

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



#### **Measurement Conditions**

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

DASY Version	DASY5	V52.8.1
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, $dy$ , $dz = 5 mm$	
Frequency	835 MHz ± 1 MHz	

**Head TSL parameters** 

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	41.1 ± 6 %	0.90 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	***	****

#### SAR result with Head TSL

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.33 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	9.30 mW /g ± 17.0 % (k=2)

SAR averaged over 10 cm3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.52 mW / g
SAB for nominal Head TSL parameters	normalized to 1W	6.07 mW /g ± 16.5 % (k=2)

# **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	54.5 ± 6 %	1.01 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	700	****

### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.42 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	9.36 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	1.59 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	6.20 mW / g ± 16.5 % (k=2)

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#### **Appendix**

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.8 Ω - 6.7 jΩ	
Return Loss	- 23.5 dB	

#### **Antenna Parameters with Body TSL**

Impedance, transformed to feed point	46.8 Ω - 7.8 jΩ
Return Loss	- 21.2 dB

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

Electrical Delay (one direction)	1.387 ns

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

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

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

#### **Additional EUT Data**

Manufactured by	SPEAG
Manufactured on	July 26, 2001



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

Date: 03.05.2012

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 443

Communication System: CW; Frequency: 835 MHz

Medium parameters used: f = 835 MHz;  $\sigma = 0.9$  mho/m;  $\varepsilon_r = 41.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

#### DASY52 Configuration:

Probe: ES3DV3 - SN3205; ConvF(6.07, 6.07, 6.07); Calibrated: 30.12.2011;

· Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn601; Calibrated: 04.07.2011

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

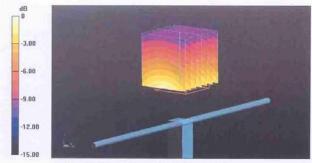
DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 56.826 V/m; Power Drift = -0.01 dB

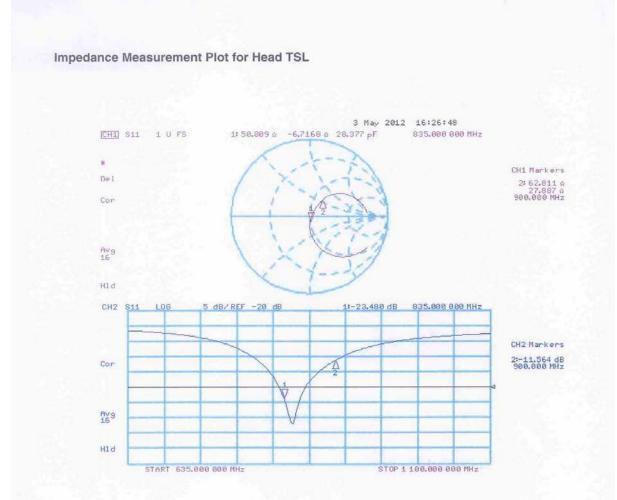
Peak SAR (extrapolated) = 3.423 mW/g

SAR(1 g) = 2.33 mW/g; SAR(10 g) = 1.52 mW/gMaximum value of SAR (measured) = 2.71 mW/g



0 dB = 2.71 mW/g = 8.66 dB mW/g







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

Date: 03.05.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 443

Communication System: CW; Frequency: 835 MHz

Medium parameters used: f = 835 MHz;  $\sigma = 1.01$  mho/m;  $\varepsilon_r = 54.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

#### DASY52 Configuration:

Probe: ES3DV3 - SN3205; ConvF(6.02, 6.02, 6.02); Calibrated: 30.12.2011;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn601; Calibrated: 04.07.2011

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

DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

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

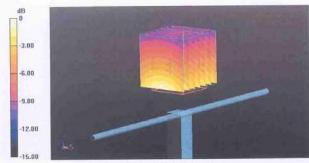
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 54.758 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 3.514 mW/g

SAR(1 g) = 2.42 mW/g; SAR(10 g) = 1.59 mW/g

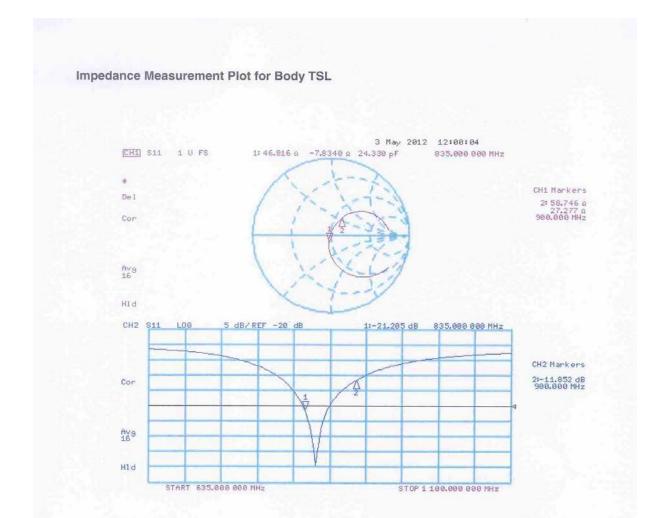
Maximum value of SAR (measured) = 2.82 mW/g



0 dB = 2.82 mW/g = 9.00 dB mW/g

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# 1900 MHz Dipole Calibration Certificate

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





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

Accredited by the Swiss Accreditation Service (SAS)

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

0-46-4- No. D1900V2-541 May12

Dispect D1900V2 - SN: 541  Calibration procedure(s)  Calibration procedure for dipole validation kits above 700 MHz  Calibration procedure for dipole validation kits above 700 MHz  Calibration date:  May 09, 2012  Chis calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI), the measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.  All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.  Calibration Equipment used (M&TE critical for calibration)  Primary Standards  Diff Cal Date (Certificate No.) Scheduled Calibration  Primary Standards  Dower meter EPM-442A  GB37480704  GB37480704  GB-0-0-11 (No. 217-01451)  Oct-12  Oct-12  SN: 508 (20k)  ZP-Mar-12 (No. 217-01530)  Apr-13  SN: 5047.2 / 06327  ZP-Mar-12 (No. 217-01530)  Apr-13  SN: 5047.2 / 06327  ZP-Mar-12 (No. 217-01530)  Apr-13  SN: 5047.2 / 06327  ZP-Mar-12 (No. DAE4-601_Jul11)  Jul-12  Secondary Standards  Diff Check Date (in house)  Scheduled Check  Prover sensor HP 8481A  MY41092317  18-Oct-02 (in house check Oct-11)  In house check: Oct-13  Name  Function  Signature  Calibrated by:  Katja Pokovic  Technical Manager				
Calibration procedure for dipole validation kits above 700 MHz  Calibration date:  May 09, 2012  Chis calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.  All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.  Calibration Equipment used (M&TE critical for calibration)  Primary Standards  ID # Cal Date (Certificate No.) Scheduled Calibration  Prover meter EPM-422A GB37480704 05-Oct-11 (No. 217-01451) Oct-12  Prover sensor HP 8481A US37292783 05-Oct-11 (No. 217-01451) Oct-12  Reference 20 dB Attenuator SN: 5058 (20k) 27-Mar-12 (No. 217-01530) Apr-13  Reference 20 dB Attenuator SN: 5058 (20k) 27-Mar-12 (No. 217-01530) Apr-13  Reference Probe ES3DV3 SN: 3205 30-Dec-11 (No. ES3-3205_Dec11) Dec-12  SN: 601 04-Jul-11 (No. DAE4-601_Jul11) Jul-12  Secondary Standards  ID # Check Date (in house) Scheduled Check  Power sensor HP 8481A MY41092317 18-Oct-02 (in house check Oct-11) In house check: Oct-13  Reference Res SMT-06 100005 04-Aug-99 (in house check Oct-11) In house check: Oct-13  Name Function Signature	Object	D1900V2 - SN: 5	41	THE PROPERTY OF STREET
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Calibration Equipment used (M&TE critical for calibration)  Primary Standards  ID # Cal Date (Certificate No.) Scheduled Calibration  Prower meter EPM-442A  GB37480704  O5-Oct-11 (No. 217-01451)  Oct-12  Prower sensor HP 8481A  US37292783  O5-Oct-11 (No. 217-01451)  Oct-12  Reference 20 dB Attenuator  SN: 5058 (20k)  SN: 5058 (20k)  SN: 5047.2 / 06327  SN: 400-217-01530)  Apr-13  Apr-13  Reference Probe ES3DV3  SN: 3205  SN: 300-Dec-11 (No. ES3-3205_Dec11)  Dec-12  SN: 601  O4-Jul-11 (No. DAE4-601_Jul11)  Jul-12  Secondary Standards  ID # Check Date (in house)  Scheduled Check  Prower sensor HP 8481A  MY41092317  MY41092317  MS-Oct-02 (in house check Oct-11)  In house check: Oct-13  Reference R&S SMT-06  100005  O4-Aug-99 (in house check Oct-11)  In house check: Oct-13  Reference R&S SMT-06  In house check: Oct-12  Name  Function  Signature	ne measurements and the unce	ertainties with confidence p	robability are given on the following pages ar	no are part of the certificate.
Calibration Equipment used (M&TE critical for calibration)  Primary Standards  ID # Cal Date (Certificate No.) Scheduled Calibration  Prower meter EPM-442A  GB37480704  O5-Oct-11 (No. 217-01451)  Oct-12  Prower sensor HP 8481A  US37292783  O5-Oct-11 (No. 217-01451)  Oct-12  Reference 20 dB Attenuator  SN: 5058 (20k)  SN: 5058 (20k)  SN: 5047.2 / 06327  SN: 400-217-01530)  Apr-13  Apr-13  Reference Probe ES3DV3  SN: 3205  SN: 300-Dec-11 (No. ES3-3205_Dec11)  Dec-12  SN: 601  O4-Jul-11 (No. DAE4-601_Jul11)  Jul-12  Secondary Standards  ID # Check Date (in house)  Scheduled Check  Prower sensor HP 8481A  MY41092317  MY41092317  MS-Oct-02 (in house check Oct-11)  In house check: Oct-13  Reference R&S SMT-06  100005  O4-Aug-99 (in house check Oct-11)  In house check: Oct-13  Reference R&S SMT-06  In house check: Oct-12  Name  Function  Signature				
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Primary Standards ID # Cal Date (Certificate No.) Scheduled Calibration  Prower meter EPM-442A GB37480704 05-Oct-11 (No. 217-01451) Oct-12  Prower sensor HP 8481A US37292783 05-Oct-11 (No. 217-01451) Oct-12  Reference 20 dB Attenuator SN: 5058 (20k) 27-Mar-12 (No. 217-01530) Apr-13  Prower sensor HP 8481A SN: 5047.2 / 06327 27-Mar-12 (No. 217-01533) Apr-13  Reference Probe ES3DV3 SN: 3205 30-Dec-11 (No. ES3-3205_Dec11) Dec-12  SN: 601 04-Jul-11 (No. DAE4-601_Jul11) Jul-12  Recondary Standards ID # Check Date (in house) Scheduled Check  Prower sensor HP 8481A MY41092317 18-Oct-02 (in house check Oct-11) In house check: Oct-13  Reference R&S SMT-06 100005 04-Aug-99 (in house check Oct-11) In house check: Oct-13  Reference R&S SMT-06 100005 18-Oct-01 (in house check Oct-11) In house check: Oct-12  Name Function Signature	all calibrations have been condu	cted in the closed laborator	ry facility: environment temperature (22 ± 3)°	C and humidity < 70%.
Oct-12			ry facility: environment temperature (22 $\pm$ 3) $^{\circ}$	C and humidity < 70%.
Vower sensor HP 8481A			ry facility: environment temperature $(22 \pm 3)^{\circ}$	C and humidity < 70%.
SN: 5058 (20k)   27-Mar-12 (No. 217-01530)   Apr-13	Calibration Equipment used (M&	TE critical for calibration)		
Type-N mismatch combination         SN: 5047.2 / 06327         27-Mar-12 (No. 217-01533)         Apr-13           Reference Probe ES3DV3         SN: 3205         30-Dec-11 (No. ES3-3205_Dec11)         Dec-12           DAE4         SN: 601         04-Jul-11 (No. DAE4-601_Jul11)         Jul-12           Secondary Standards         ID #         Check Date (in house)         Scheduled Check           Power sensor HP 8481A         MY41092317         18-Oct-02 (in house check Oct-11)         In house check: Oct-13           RF generator R&S SMT-06         100005         04-Aug-99 (in house check Oct-11)         In house check: Oct-13           Network Analyzer HP 8753E         US37390585 S4206         18-Oct-01 (in house check Oct-11)         In house check: Oct-12           Name         Function         Signature	Calibration Equipment used (M&	TE critical for calibration)	Cal Date (Certificate No.)	Scheduled Calibration
SN: 3205   30-Dec-11 (No. ES3-3205_Dec-11)   Dec-12	Calibration Equipment used (M& Primary Standards Power meter EPM-442A	TE critical for calibration)  ID #  GB37480704	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451)	Scheduled Calibration Oct-12
SN: 601   O4-Jul-11 (No. DAE4-601_Jul11)   Jul-12	Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A	TE critical for calibration)  ID #  GB37480704  US37292783	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451)	Scheduled Calibration Oct-12 Oct-12
Secondary Standards ID # Check Date (in house) Scheduled Check Power sensor HP 8481A MY41092317 18-Oct-02 (in house check Oct-11) In house check: Oct-13 RF generator R&S SMT-06 100005 04-Aug-99 (in house check Oct-11) In house check: Oct-13 Network Analyzer HP 8753E US37390585 S4206 18-Oct-01 (in house check Oct-11) In house check: Oct-12  Name Function Signature	Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator	TE critical for calibration)  ID #  GB37480704  US37292783  SN: 5058 (20k)	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 27-Mar-12 (No. 217-01530)	Scheduled Calibration Oct-12 Oct-12 Apr-13
MY41092317   18-Oct-02 (in house check Oct-11)   In house check: Oct-13	Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination	TE critical for calibration)  ID #  GB37480704  US37292783  SN: 5058 (20k)  SN: 5047.2 / 06327	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 27-Mar-12 (No. 217-01530) 27-Mar-12 (No. 217-01533)	Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13
RF generator R&S SMT-06 100005 04-Aug-99 (in house check Oct-11) In house check: Oct-13 In house check: Oct-12 US37390585 S4206 18-Oct-01 (in house check Oct-11) In house check: Oct-12 Name Function Signature	Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3	TE critical for calibration)  ID #  GB37480704  US37292783  SN: 5058 (20k)  SN: 5047.2 / 06327  SN: 3205	Cal Date (Certificate No.)  05-Oct-11 (No. 217-01451)  05-Oct-11 (No. 217-01451)  27-Mar-12 (No. 217-01530)  27-Mar-12 (No. 217-01533)  30-Dec-11 (No. ES3-3205_Dec11)	Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12
Network Analyzer HP 8753E US37390585 S4206 18-Oct-01 (in house check Oct-11) In house check: Oct-12  Name Function Signature	Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3	TE critical for calibration)  ID #  GB37480704  US37292783  SN: 5058 (20k)  SN: 5047.2 / 06327  SN: 3205  SN: 601	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 27-Mar-12 (No. 217-01530) 27-Mar-12 (No. 217-01533) 30-Dec-11 (No. ES3-3205_Dec11) 04-Jul-11 (No. DAE4-601_Jul11)	Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12
Name Function Signature	Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4	TE critical for calibration)  ID #  GB37480704  US37292783  SN: 5058 (20k)  SN: 5047.2 / 06327  SN: 3205  SN: 601	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 27-Mar-12 (No. 217-01530) 27-Mar-12 (No. 217-01533) 30-Dec-11 (No. ES3-3205_Dec11) 04-Jul-11 (No. DAE4-601_Jul11) Check Date (in house)	Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12 Scheduled Check
	Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4	TE critical for calibration)  ID #  GB37480704  US37292783  SN: 5058 (20k)  SN: 5047.2 / 06327  SN: 3205  SN: 601  ID #  MY41092317	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 27-Mar-12 (No. 217-01530) 27-Mar-12 (No. 217-01533) 30-Dec-11 (No. ES3-3205_Dec11) 04-Jul-11 (No. DAE4-601_Jul11) Check Date (in house) 18-Oct-02 (in house check Oct-11)	Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12 Scheduled Check In house check: Oct-13
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Calibrated by: Israe El-Naouq Laboratory Technician  Approved by: Katia Pokovic Technical Manager	Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Recondary Standards Power sensor HP 8481A RF generator R&S SMT-06	TE critical for calibration)  ID #  GB37480704  US37292783  SN: 5058 (20k)  SN: 5047.2 / 06327  SN: 3205  SN: 601  ID #  MY41092317  100005	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 27-Mar-12 (No. 217-01530) 27-Mar-12 (No. 217-01530) 30-Dec-11 (No. ES3-3205_Dec11) 04-Jul-11 (No. DAE4-601_Jul11) Check Date (in house) 18-Oct-02 (in house check Oct-11) 04-Aug-99 (in house check Oct-11)	Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13
Norroved by: Katia Pokovic Technical Manager	Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Recondary Standards Power sensor HP 8481A RF generator R&S SMT-06	TE critical for calibration)    ID #   GB37480704   US37292783   SN: 5058 (20k)   SN: 5047.2 / 06327   SN: 3205   SN: 601   ID #   MY41092317   100005   US37390585 S4206	Cal Date (Certificate No.)  05-Oct-11 (No. 217-01451)  05-Oct-11 (No. 217-01451)  27-Mar-12 (No. 217-01530)  27-Mar-12 (No. 217-01530)  30-Dec-11 (No. ES3-3205_Dec11)  04-Jul-11 (No. DAE4-601_Jul11)  Check Date (in house)  18-Oct-02 (in house check Oct-11)  04-Aug-99 (in house check Oct-11)  18-Oct-01 (in house check Oct-11)	Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-12
Approved by: Katia Pokovic Technical Manager	Calibration Equipment used (M&Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06 Retwork Analyzer HP 8753E	TE critical for calibration)    ID #   GB37480704   US37292783   SN: 5058 (20k)   SN: 5047.2 / 06327   SN: 3205   SN: 601   ID #   MY41092317   100005   US37390585 S4206   Name	Cal Date (Certificate No.)  05-Oct-11 (No. 217-01451)  05-Oct-11 (No. 217-01451)  27-Mar-12 (No. 217-01530)  27-Mar-12 (No. 217-01530)  30-Dec-11 (No. ES3-3205_Dec11)  04-Jul-11 (No. DAE4-601_Jul11)  Check Date (in house)  18-Oct-02 (in house check Oct-11)  04-Aug-99 (in house check Oct-11)  18-Oct-01 (in house check Oct-11)	Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-12
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#### Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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

Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS)

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

Multilateral Agreement for the recognition of calibration certificates

#### Glossary:

TSL

tissue simulating liquid

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

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

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

#### **Additional Documentation:**

d) DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

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

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



#### **Measurement Conditions**

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

DASY Version	DASY5	V52.8.1
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz ± 1 MHz	

#### **Head TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.5 ± 6 %	1.37 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.62 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	39.1 mW /g ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.11 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	20.6 mW /g ± 16.5 % (k=2)

# **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.9 ± 6 %	1.52 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.0 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	39.9 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	5.33 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	21.3 mW / g ± 16.5 % (k=2)



#### **Appendix**

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	$52.6 \Omega + 6.2 j\Omega$
Return Loss	- 23.7 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	$48.6 \Omega + 6.9 j\Omega$	
Return Loss	- 23.0 dB	

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.197 ns
----------------------------------	----------

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

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

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

#### **Additional EUT Data**

Manufactured by	SPEAG
Manufactured on	July 26, 2001



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

Date: 09.05.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 541

Communication System: CW; Frequency: 1900 MHz

Medium parameters used: f = 1900 MHz;  $\sigma = 1.37 \text{ mho/m}$ ;  $\varepsilon_r = 40.5$ ;  $\rho = 1000 \text{ kg/m}^3$ 

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: 30.12.2011;

· Sensor-Surface: 3mm (Mechanical Surface Detection)

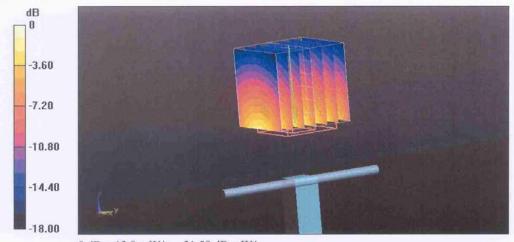
Electronics: DAE4 Sn601; Calibrated: 04.07.2011

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

DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

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

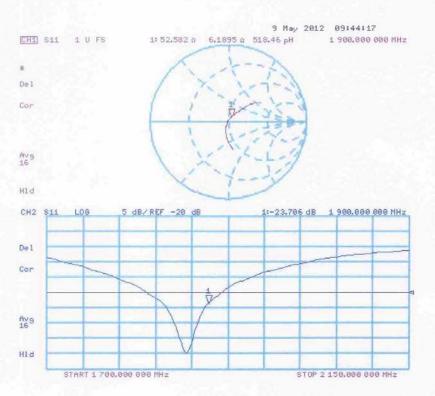
Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 96.763 V/m; Power Drift = 0.06 dB Peak SAR (extrapolated) = 17.071 mW/g SAR(1 g) = 9.62 mW/g; SAR(10 g) = 5.11 mW/g Maximum value of SAR (measured) = 12.0 mW/g



0 dB = 12.0 mW/g = 21.58 dB mW/g



# Impedance Measurement Plot for Head TSL





# **DASY5 Validation Report for Body TSL**

Date: 04.05.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 541

Communication System: CW; Frequency: 1900 MHz

Medium parameters used: f = 1900 MHz;  $\sigma = 1.52 \text{ mho/m}$ ;  $\varepsilon_r = 52.9$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

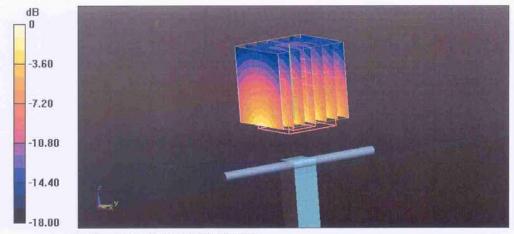
#### DASY52 Configuration:

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

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 95.165 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 17.442 mW/g SAR(1 g) = 10 mW/g; SAR(10 g) = 5.33 mW/g

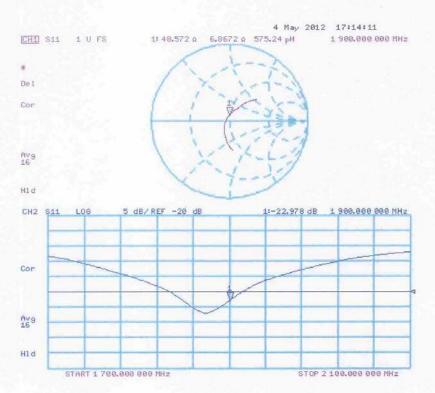
Maximum value of SAR (measured) = 12.7 mW/g



0 dB = 12.7 mW/g = 22.08 dB mW/g



# Impedance Measurement Plot for Body TSL





# 2450 MHz Dipole Calibration Certificate

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





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

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CALIBRATION C	ERTIFICATE		
Dbject	D2450V2 - SN: 8	53	
Calibration procedure(s)	QA CAL-05.v8 Calibration proce	dure for dipole validation kits abo	ove 700 MHz
Calibration date:	May 02, 2012		
	7	ional standards, which realize the physical un	
he measurements and the unce	idainties with confidence n		
		robability are given on the following pages are ry facility; environment temperature $(22 \pm 3)^\circ$	
The measurements and the unce	cted in the closed laborator		
All calibrations have been conducted that the calibration Equipment used (M&	cted in the closed laborator	ry facility: environment temperature (22 $\pm$ 3) $^\circ$ (	C and humidity < 70%.
All calibrations have been conducted to the conducted calibration Equipment used (M& Primary Standards	cted in the closed laborator TE critical for calibration)	ry facility; environment temperature (22 $\pm$ 3)°( Cal Date (Certificate No.)	C and humidity < 70%.  Scheduled Calibration
all calibrations have been conducted that calibration Equipment used (M& rimary Standards	cted in the closed laborator TE critical for calibration)    ID #   GB37480704	ry facility; environment temperature (22 ± 3)°(  Cal Date (Certificate No.)  05-Oct-11 (No. 217-01451)	C and humidity < 70%.  Scheduled Calibration Oct-12
all calibrations have been conducted to the conducted to	TE critical for calibration)  ID #  GB37480704  US37292783	ry facility: environment temperature (22 ± 3)°(  Cal Date (Certificate No.)  05-Oct-11 (No. 217-01451)  05-Oct-11 (No. 217-01451)	C and humidity < 70%.  Scheduled Calibration  Oct-12  Oct-12
calibrations have been conducted to the	TE critical for calibration)  ID #  GB37480704  US37292783  SN: 5058 (20k)	ry facility: environment temperature (22 ± 3)°(  Cal Date (Certificate No.)  05-Oct-11 (No. 217-01451)  05-Oct-11 (No. 217-01451)  27-Mar-12 (No. 217-01530)	Scheduled Calibration Oct-12 Oct-12 Apr-13
alibrations have been conducted in the c	ted in the closed laborator  TE critical for calibration)  ID #  GB37480704  US37292783  SN: 5058 (20k)  SN: 5047.2 / 06327	Cal Date (Certificate No.)  05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 27-Mar-12 (No. 217-01530) 27-Mar-12 (No. 217-01533)	Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13
all calibrations have been conducted that calibration Equipment used (M&	TE critical for calibration)  ID #  GB37480704  US37292783  SN: 5058 (20k)	ry facility: environment temperature (22 ± 3)°(  Cal Date (Certificate No.)  05-Oct-11 (No. 217-01451)  05-Oct-11 (No. 217-01451)  27-Mar-12 (No. 217-01530)	Scheduled Calibration Oct-12 Oct-12 Apr-13
calibrations have been conducted in the calibration Equipment used (M& calibration Equipment	ted in the closed laborator  TE critical for calibration)  ID #  GB37480704  US37292783  SN: 5058 (20k)  SN: 5047.2 / 06327  SN: 3205	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 27-Mar-12 (No. 217-01530) 27-Mar-12 (No. 217-01533) 30-Dec-11 (No. ES3-3205_Dec11) 04-Jul-11 (No. DAE4-601_Jul11)	Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12
all calibrations have been conducted in the calibration Equipment used (M& calibration Equipm	cted in the closed laborator TE critical for calibration)  ID # GB37480704 US37292783 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601	Cal Date (Certificate No.)  05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 27-Mar-12 (No. 217-01530) 27-Mar-12 (No. 217-01533) 30-Dec-11 (No. ES3-3205_Dec11)	Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12
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Il calibrations have been conductable cond	Cited in the closed laborator  TE critical for calibration)  ID #  GB37480704  US37292783  SN: 5058 (20k)  SN: 5047.2 / 06327  SN: 3205  SN: 601  ID #  MY41092317  100005  US37390585 S4206	Cal Date (Certificate No.)  05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 27-Mar-12 (No. 217-01530) 27-Mar-12 (No. 217-01530) 20-Dec-11 (No. ES3-3205_Dec11) 04-Jul-11 (No. DAE4-601_Jul11)  Check Date (in house)  18-Oct-02 (in house check Oct-11) 04-Aug-99 (in house check Oct-11) 18-Oct-01 (in house check Oct-11)	Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-12

Certificate No: D2450V2-853\_May12

Page 1 of 8

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Accreditation No.: SCS 108

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#### Glossary:

TSL tissue simulating liquid

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

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

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

#### **Additional Documentation:**

d) DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

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

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



#### **Measurement Conditions**

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

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

#### **Head TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.6 ± 6 %	1.81 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.1 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	52.4 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	6.09 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	24.4 mW /g ± 16.5 % (k=2)

#### **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.4 ± 6 %	1.98 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

# SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.7 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	50.4 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	5.92 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	23.6 mW / g ± 16.5 % (k=2)



#### **Appendix**

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.7 Ω + 3.2 jΩ	
Return Loss	- 26.4 dB	

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	$49.9 \Omega + 4.8 j\Omega$	
Return Loss	- 26.4 dB	

#### General Antenna Parameters and Design

	Tay and another the second
Electrical Delay (one direction)	1.163 ns

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

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

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

#### **Additional EUT Data**

Manufactured by	SPEAG	
Manufactured on	November 10, 2009	



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

Date: 02.05.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 853

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: f = 2450 MHz;  $\sigma = 1.81 \text{ mho/m}$ ;  $\varepsilon_r = 39.6$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

#### DASY52 Configuration:

Probe: ES3DV3 - SN3205; ConvF(4.45, 4.45, 4.45); Calibrated: 30.12.2011;

· Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn601; Calibrated: 04.07.2011

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

DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 100.0 V/m; Power Drift = 0.05 dB Peak SAR (extrapolated) = 26.785 mW/g SAR(1 g) = 13.1 mW/g; SAR(10 g) = 6.09 mW/g

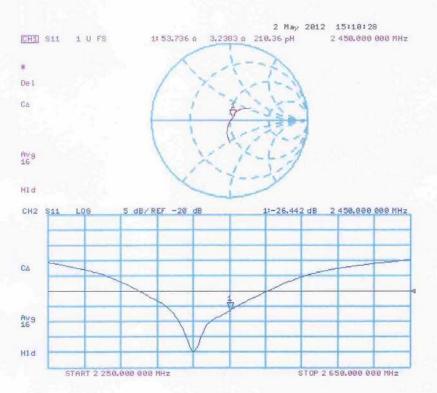
Maximum value of SAR (measured) = 16.7 mW/g

-5.20 -10.40 -15.60 -20.80

0 dB = 16.7 mW/g = 24.45 dB mW/g



#### Impedance Measurement Plot for Head TSL





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

Date: 02.05.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 853

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: f = 2450 MHz;  $\sigma = 1.98 \text{ mho/m}$ ;  $\varepsilon_r = 52.4$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

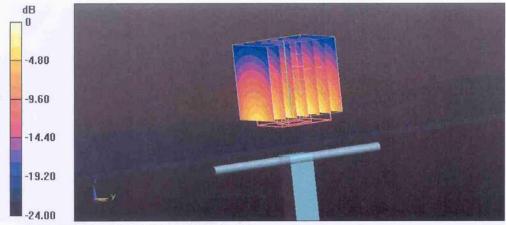
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

#### DASY52 Configuration:

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

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 95.306 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 26.029 mW/g SAR(1 g) = 12.7 mW/g; SAR(10 g) = 5.92 mW/g Maximum value of SAR (measured) = 16.8 mW/g



0 dB = 16.8 mW/g = 24.51 dB mW/g



# Impedance Measurement Plot for Body TSL

