

September 24, 2014

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3846

#### **Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm $(\mu V/(V/m)^2)^A$	0.39	0.42	0.49	± 10.1 %
DCP (mV) <sup>8</sup>	103.8	100.3	98.5	

### **Modulation Calibration Parameters**

UID	Communication System Name		A dB	B dBõV	С	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	141.2	±3.8 %
		Y	0.0	0.0	1.0		146.9	
		Z	0.0	0.0	1.0		139.6	

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>&</sup>lt;sup>A</sup> The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 6).
 <sup>B</sup> Numerical linearization parameter: uncertainty not required.
 <sup>E</sup> Uncertainty is determined using the max, deviation from linear response applying rectangular distribution and is expressed for the square of the Statemeter. field value.



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f (MHz) <sup>c</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct. (k=2)
750	41.9	0.89	9.53	9.53	9.53	0.80	0.62	± 12.0 %
835	41.5	0.90	9.18	9.18	9.18	0.39	0.87	± 12.0 %
900	41.5	0.97	9.00	9.00	9.00	0.38	0.91	± 12.0 %
1450	40.5	1.20	7.90	7.90	7.90	0.60	0.75	± 12.0 %
1640	40.3	1.29	7.57	7.57	7.57	0.62	0.74	± 12.0 %
1750	40.1	1.37	7.64	7.64	7.64	0.46	0.91	± 12.0 %
1810	40.0	1.40	7.40	7.40	7.40	0.56	0.80	± 12.0 %
1900	40.0	1.40	7.26	7.26	7.26	0.39	0.98	± 12.0 %
2000	40.0	1.40	7.24	7.24	7.24	0.57	0.79	± 12.0 %
2100	39.8	1.49	7.33	7.33	7.33	0.40	0.93	± 12.0 %
2300	39.5	1.67	6.94	6.94	6.94	0.32	1.16	± 12.0 %
2450	39.2	1.80	6.56	6.56	6.56	0.31	1.18	± 12.0 %
2600	39.0	1.96	6.50	6.50	6.50	0.30	1.30	± 12.0 %
3500	37.9	2.91	6.75	6.75	6.75	0.81	0.65	± 13.1 %
3700	37.7	3.12	6.32	6.32	6.32	0.23	1.60	± 13.1 %
5200	36.0	4.66	5.00	5.00	5.00	0.40	1.80	± 13.1 %
5300	35.9	4.76	4.79	4.79	4.79	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.64	4.64	4.64	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.25	4.25	4.25	0.50	1.80	± 13.1 %
5800	35.3	5.27	4.44	4.44	4.44	0.40	1.80	± 13.1 %

### Calibration Parameter Determined in Head Tissue Simulating Media

<sup>C</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to respect to the SAP values. (A provide the SAP value of the section of the section.

measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (s and o) can be index to 1 for indicated the uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters. <sup>6</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3846

f (MHz) <sup>c</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct. (k=2)
750	55.5	0.96	9.18	9.18	9.18	0.52	0.82	± 12.0 %
835	55.2	0.97	9.09	9.09	9.09	0.80	0.64	± 12.0 %
900	55.0	1.05	8.93	8.93	8.93	0.65	0.72	± 12.0 %
1450	54.0	1.30	7.79	7.79	7.79	0.60	0.70	± 12.0 %
1640	53.8	1.40	7.93	7.93	7.93	0.35	0.91	± 12.0 %
1750	53.4	1.49	7.43	7.43	7.43	0.63	0.69	± 12.0 %
1810	53.3	1.52	7.27	7.27	7.27	0.30	0.98	± 12.0 %
1900	53.3	1.52	7.15	7.15	7.15	0.38	0.87	± 12.0 %
2000	53.3	1.52	7.31	7.31	7.31	0.50	0.76	± 12.0 %
2100	53.2	1.62	7.42	7.42	7.42	0.31	0.94	± 12.0 %
2300	52.9	1.81	7.07	7.07	7.07	0.43	0.82	± 12.0 %
2450	52.7	1.95	6.90	6.90	6.90	0.80	0.50	± 12.0 %
2600	52.5	2.16	6.68	6.68	6.68	0.80	0.50	± 12.0 %
3500	51.3	3.31	6.25	6.25	6.25	0.41	1.04	± 13.1 %
3700	51.0	3.55	6.12	6.12	6.12	0.46	0.98	± 13.1 %
5200	49.0	5.30	4.32	4.32	4.32	0.40	1.90	± 13.1 %
5300	48.9	5.42	4.18	4.18	4.18	0.40	1.90	± 13.1 %
5500	48.6	5.65	3.80	3.80	3.80	0.45	1.90	± 13.1 %
5600	48.5	5.77	3.76	3.76	3.76	0.40	1.90	± 13.1 %
5800	48.2	6.00	3.86	3.86	3.86	0.50	1.90	± 13.1 9

### Calibration Parameter Determined in Body Tissue Simulating Media

<sup>C</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity validity can be extended to ± 110 MHz.
<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters (s and σ) can be relaxed to ± 10% if liquid compensation formula is applied to present the validity of validi

At requencies below 3 GHz, the validity of itssue parameters (s and  $\sigma$ ) can be relaxed to  $\pm 10\%$  in induid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (s and  $\sigma$ ) is restricted to  $\pm 5\%$ . The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters. <sup>6</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than  $\pm 1\%$  for frequencies below 3 GHz and below  $\pm 2\%$  for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

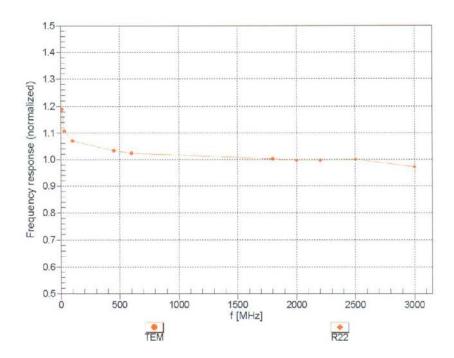
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# Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



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

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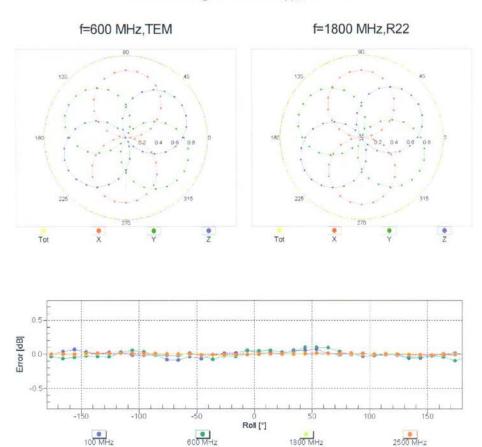
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# Receiving Pattern ( $\phi$ ), $\vartheta = 0^{\circ}$

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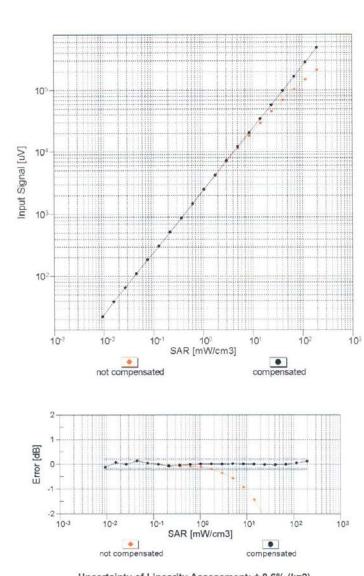
Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)



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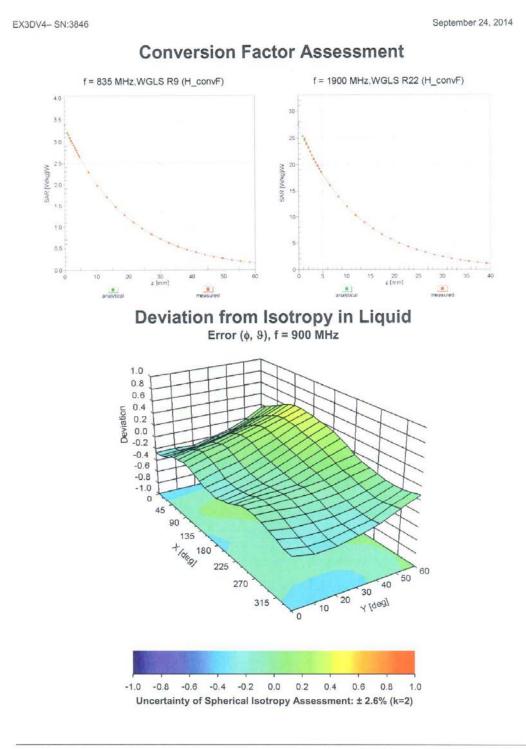
Dynamic Range f(SAR<sub>head</sub>) (TEM cell , f<sub>eval</sub>= 1900 MHz)

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

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# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3846

### **Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	4
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

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# ANNEX H Dipole Calibration Certificate

# 835 MHz Dipole Calibration Certificate

ccredited by the Swiss Accredited by the Swiss Accreditation Servultilateral Agreement for the item. CTTL (Auden	ice is one of the signatories recognition of calibration	s to the EA	No.: SCS 108
ultilateral Agreement for the	recognition of calibration		
ient CTTL (Auden			
the second se	)	Certificate No	D835V2-4d069_Aug14
CALIBRATION	CERTIFICATE		
Dbject	D835V2 - SN: 4d	069	
Calibration procedure(s)	QA CAL-05.v9		
	Calibration proce	dure for dipole validation kits abo	ve 700 MHz
Calibration date:	August 28, 2014		
The measurements and the un All calibrations have been con	ncertainties with confidence p ducted in the closed laborato	onal standards, which realize the physical un robability are given on the following pages an y facility: environment temperature $(22 \pm 3)^{\circ}$	d are part of the certificate.
The measurements and the un All calibrations have been con	ncertainties with confidence p ducted in the closed laborato	robability are given on the following pages an	d are part of the certificate.
The measurements and the un All calibrations have been con Calibration Equipment used (f	ncertainties with confidence p ducted in the closed laborato	robability are given on the following pages an	d are part of the certificate.
The measurements and the un All calibrations have been con Calibration Equipment used (M Primary Standards	ducted in the closed laborato	robability are given on the following pages an y facility: environment temperature (22 $\pm$ 3)°(	d are part of the certificate. C and humidity < 70%.
The measurements and the un All calibrations have been con Calibration Equipment used (M Primary Standards Power meter EPM-442A Power sensor HP 8481A	Accretainties with confidence p ducted in the closed laborator M&TE critical for calibration) ID # GB37480704 US37292783	Cal Date (Certificate No.) 09-Oct-13 (No. 217-01827)	d are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14
The measurements and the un All calibrations have been con Calibration Equipment used (N Primary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A	Accretainties with confidence p ducted in the closed laborator M&TE critical for calibration) ID # GB37480704 US37292783 MY41092317	Cal Date (Certificate No.) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01827)	d are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14
The measurements and the un All calibrations have been con Calibration Equipment used (N Primary Standards Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator	Acertainties with confidence p ducted in the closed laborator A&TE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k)	Cal Date (Certificate No.) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01828) 03-Apr-14 (No. 217-01918)	d are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Oct-14 Apr-15
The measurements and the un All calibrations have been con Calibration Equipment used (M Primary Standards Power Sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination	Acertainties with confidence p ducted in the closed laborator A&TE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5058 (20k) SN: 5047.2 / 06327	Cal Date (Certificate No.)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01827)         09-Oct-14 (No. 217-01827)         09-Oct-13 (No. 217-01827)         09-Oct-14 (No. 217-01828)         03-Apr-14 (No. 217-01921)	d are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Apr-15 Apr-15
The measurements and the un All calibrations have been con Calibration Equipment used (N Primary Standards Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3	Acertainties with confidence p ducted in the closed laborator A&TE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k)	Cal Date (Certificate No.) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01828) 03-Apr-14 (No. 217-01918)	d are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Oct-14 Apr-15
The measurements and the un All calibrations have been con Calibration Equipment used (M Primary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4	Acertainties with confidence p ducted in the closed laborato M&TE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5058 (20k) SN: 5058 (20k) SN: 3205 SN: 3205	Cal Date (Certificate No.)           09-Oct-13 (No. 217-01827)           09-Oct-13 (No. 217-01827)           09-Oct-13 (No. 217-01827)           09-Oct-13 (No. 217-01828)           03-Apr-14 (No. 217-01918)           03-Apr-14 (No. ES3-3205_Dec13)           18-Aug-14 (No. DAE4-601_Aug14)	d are part of the certificate. C and humidity < 70%. <u>Scheduled Calibration</u> Oct-14 Oct-14 Oct-14 Oct-14 Apr-15 Apr-15 Dec-14 Aug-15
The measurements and the ui All calibrations have been con Calibration Equipment used (f Primary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards	Acertainties with confidence p ducted in the closed laborato M&TE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5058 (20k) SN: 5058 (20k) SN: 3205 SN: 3205 SN: 601 ID #	Cal Date (Certificate No.)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01828)         03-Apr-14 (No. 217-01918)         03-Apr-14 (No. ES3-3205_Dec13)         18-Aug-14 (No. DAE4-601_Aug14)         Check Date (in house)	d are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Oct-14 Apr-15 Apr-15 Dec-14 Aug-15 Scheduled Check
The measurements and the un All calibrations have been con Calibration Equipment used (M Primary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards RF generator R&S SMT-06	Acertainties with confidence p ducted in the closed laborato M&TE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5058 (20k) SN: 5058 (20k) SN: 3205 SN: 3205	Cal Date (Certificate No.)           09-Oct-13 (No. 217-01827)           09-Oct-13 (No. 217-01827)           09-Oct-13 (No. 217-01827)           09-Oct-13 (No. 217-01828)           03-Apr-14 (No. 217-01918)           03-Apr-14 (No. ES3-3205_Dec13)           18-Aug-14 (No. DAE4-601_Aug14)	d are part of the certificate. C and humidity < 70%. <u>Scheduled Calibration</u> Oct-14 Oct-14 Oct-14 Oct-14 Apr-15 Apr-15 Dec-14 Aug-15
The measurements and the u	Acertainties with confidence p ducted in the closed laborator A&TE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # 100005 US37390585 S4206	Cal Date (Certificate No.)           09-Oct-13 (No. 217-01827)           09-Oct-13 (No. 217-01921)           03-Apr-14 (No. 217-01918)           03-Apr-14 (No. 217-01921)           30-Dec-13 (No. ES3-3205_Dec13)           18-Aug-14 (No. DAE4-601_Aug14)           Check Date (in house)           04-Aug-99 (in house check Oct-13)           18-Oct-01 (in house check Oct-13)	d are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Apr-15 Apr-15 Dec-14 Aug-15 Scheduled Check In house check: Oct-16 In house check: Oct-14
The measurements and the un All calibrations have been con Calibration Equipment used (N Primary Standards Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards RF generator R&S SMT-06 Network Analyzer HP 8753E	Acertainties with confidence p ducted in the closed laborator A&TE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5058 (20k) SN: 5058 (20k) SN: 5058 (20k) SN: 5058 (20k) ID # 100005 US37390585 S4206 Name	Cal Date (Certificate No.)           09-Oct-13 (No. 217-01827)           09-Oct-13 (No. 217-01921)           03-Apr-14 (No. 217-01918)           03-Apr-14 (No. 217-01921)           30-Dec-13 (No. ES3-3205_Dec13)           18-Aug-14 (No. DAE4-601_Aug14)           Check Date (in house)           04-Aug-99 (in house check Oct-13)           18-Oct-01 (in house check Oct-13)           Function	d are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Apr-15 Apr-15 Dec-14 Aug-15 Scheduled Check In house check: Oct-16
The measurements and the un All calibrations have been con Calibration Equipment used (M Primary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards RF generator R&S SMT-06	Acertainties with confidence p ducted in the closed laborator A&TE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # 100005 US37390585 S4206	Cal Date (Certificate No.)           09-Oct-13 (No. 217-01827)           09-Oct-13 (No. 217-01921)           03-Apr-14 (No. 217-01918)           03-Apr-14 (No. 217-01921)           30-Dec-13 (No. ES3-3205_Dec13)           18-Aug-14 (No. DAE4-601_Aug14)           Check Date (in house)           04-Aug-99 (in house check Oct-13)           18-Oct-01 (in house check Oct-13)	d are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Apr-15 Apr-15 Dec-14 Aug-15 Scheduled Check In house check: Oct-16 In house check: Oct-14



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





S

Schweizerischer Kalibrierdienst

- C Service suisse d'étalonnage
- Servizio svizzero di taratura Suvise Calibration Service
- 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 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### 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%.

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### **Measurement Conditions**

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

DASY Version	DASY5	V52.8.8
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	42.0 ± 6 %	0.94 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.43 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.43 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	1.58 W/kg

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	55.2 ± 6 %	1.01 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	1000	-1112

### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.46 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.55 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.62 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	6.33 W/kg ± 16.5 % (k=2)

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### Appendix (Additional assessments outside the scope of SCS108)

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.3 Ω + 0.8 jΩ		
Return Loss	- 29.7 dB		

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.8 Ω - 1.4 jΩ	
Return Loss	- 34.5 dB	

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.393 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 09, 2007	

Certificate No: D835V2-4d069\_Aug14

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

Date: 28.08.2014

Test Laboratory: SPEAG, Zurich, Switzerland

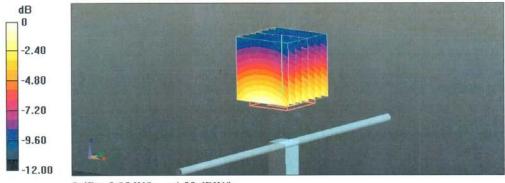
### DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d069

Communication System: UID 0 - CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz;  $\sigma = 0.94$  S/m;  $\epsilon_r = 42$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.22, 6.22, 6.22); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 56.74 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 3.61 W/kg SAR(1 g) = 2.43 W/kg; SAR(10 g) = 1.58 W/kg Maximum value of SAR (measured) = 2.85 W/kg



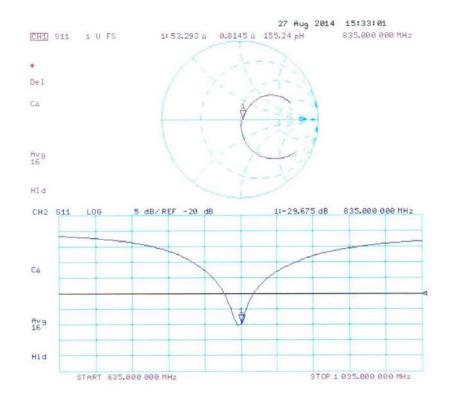
0 dB = 2.85 W/kg = 4.55 dBW/kg

Certificate No: D835V2-4d069\_Aug14

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### Impedance Measurement Plot for Head TSL



Certificate No: D835V2-4d069\_Aug14

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# No. I14Z47754-SEM01 Page 157 of 206

### DASY5 Validation Report for Body TSL

Date: 27.08.2014

Test Laboratory: SPEAG, Zurich, Switzerland

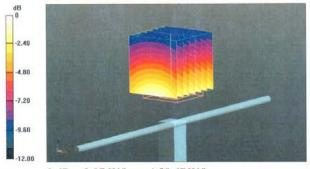
### DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d069

Communication System: UID 0 - CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz;  $\sigma = 1.01$  S/m;  $\epsilon_r = 55.2$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.09, 6.09, 6.09); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 54.97 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 3.60 W/kg SAR(1 g) = 2.46 W/kg; SAR(10 g) = 1.62 W/kg Maximum value of SAR (measured) = 2.87 W/kg



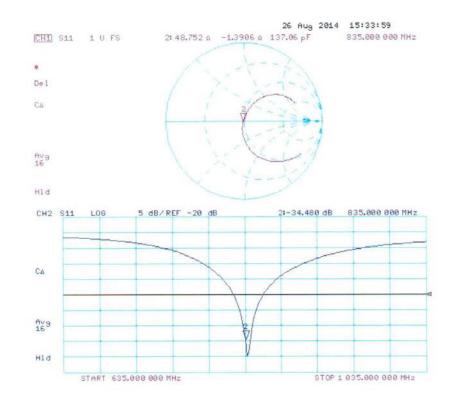
0 dB = 2.87 W/kg = 4.58 dBW/kg

Certificate No: D835V2-4d069\_Aug14

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### Impedance Measurement Plot for Body TSL



Certificate No: D835V2-4d069\_Aug14

Page 8 of 8



# 1750 MHz Dipole Calibration Certificate

			No.: SCS 108
ccredited by the Swiss Accredita the Swiss Accreditation Service		Contraction of the second s	No.: 303 100
ultilateral Agreement for the re			
ient CTTL (Auden)		Certificate No	. D1750V2-1003_Aug14
CITE (Adden)		or and the	
CALIBRATION C	ERTIFICATE		
Dbject	D1750V2 - SN: 10	003	
Calibration procedure(s)	QA CAL-05.v9	duna dan dinaka salidakina kika aka	700 MU
	Galibration proce	dure for dipole validation kits abo	
Calibration date:	August 18, 2014		
This calibration certificate docum	ents the traceability to nation	onal standards, which realize the physical ur	nits of measurements (SI).
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The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards	ertainties with confidence proceed in the closed laborator TE critical for calibration)	robability are given on the following pages as y facility: environment temperature $(22\pm3)^\circ$	nd are part of the certificate. C and humidity < 70%.
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# No. I14Z47754-SEM01 Page 160 of 206

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





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Schweizerischer Kalibrierdienst

- C Service suisse d'étalonnage
- Servizio svizzero di taratura Suiss Calibration Service

Accreditation No.: SCS 108

• 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

# 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 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Additional Documentation:

d) DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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

Certificate No: D1750V2-1003\_Aug14

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### **Measurement Conditions**

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1750 MHz ± 1 MHz	

### Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.1	1.37 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.2 ± 6 %	1.37 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	9.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	36.9 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	4.93 W/kg

### **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.4	1.49 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.0 ± 6 %	1.49 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	9.49 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	37.7 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.09 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.3 W/kg ± 16.5 % (k=2)

Certificate No: D1750V2-1003\_Aug14

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### Appendix (Additional assessments outside the scope of SCS108)

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.4 Ω + 1.2 jΩ	
Return Loss	- 34.8 dB	

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.7 Ω + 1.4 jΩ	
Return Loss	- 28.6 dB	

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

Electrical Delay (one direction)	1.213 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	July 30, 2008

Certificate No: D1750V2-1003\_Aug14

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# No. I14Z47754-SEM01 Page 163 of 206

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

Date: 18.08.2014

Test Laboratory: SPEAG, Zurich, Switzerland

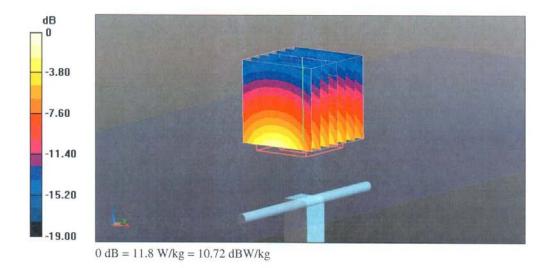
### DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1003

Communication System: UID 0 - CW; Frequency: 1750 MHz Medium parameters used: f = 1750 MHz;  $\sigma = 1.37$  S/m;  $\epsilon_r = 39.2$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(5.23, 5.23, 5.23); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 96.38 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 16.7 W/kg SAR(1 g) = 9.27 W/kg; SAR(10 g) = 4.93 W/kg Maximum value of SAR (measured) = 11.8 W/kg

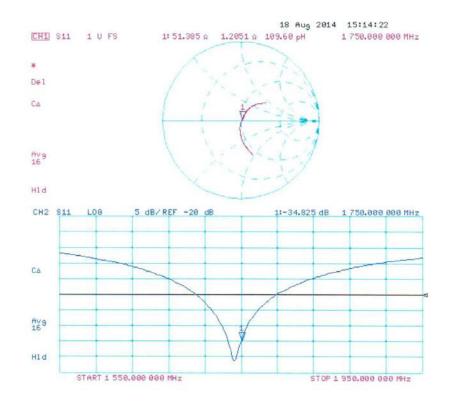


Certificate No: D1750V2-1003\_Aug14

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### Impedance Measurement Plot for Head TSL



Certificate No: D1750V2-1003\_Aug14

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# No. I14Z47754-SEM01 Page 165 of 206

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

Date: 18.08.2014

Test Laboratory: SPEAG, Zurich, Switzerland

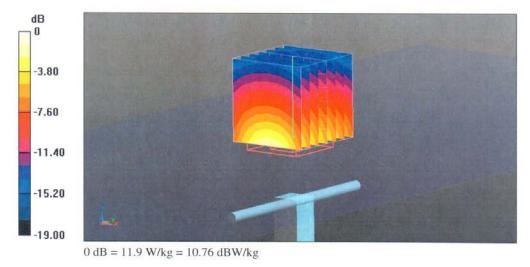
### DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1003

Communication System: UID 0 - CW; Frequency: 1750 MHz Medium parameters used: f = 1750 MHz;  $\sigma = 1.49$  S/m;  $\epsilon_r = 52$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.89, 4.89, 4.89); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 93.50 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 16.3 W/kg SAR(1 g) = 9.49 W/kg; SAR(10 g) = 5.09 W/kg Maximum value of SAR (measured) = 11.9 W/kg

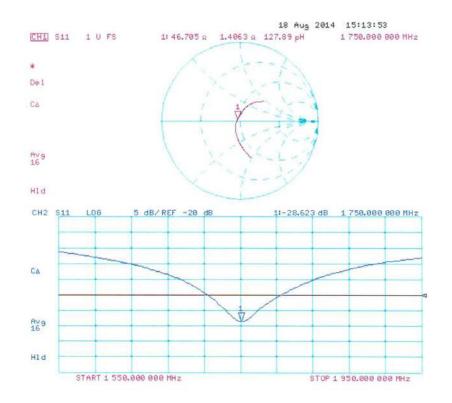


Certificate No: D1750V2-1003\_Aug14

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## Impedance Measurement Plot for Body TSL



Certificate No: D1750V2-1003\_Aug14

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# No. I14Z47754-SEM01 Page 167 of 206

# 1900 MHz Dipole Calibration Certificate

Engineering AG eughausstrasse 43, 8004 Zuric	h, Switzerland	CONTRACTOR S	Service suisse d'étalonnage Servizio svizzero di taratura
occredited by the Swiss Accredite The Swiss Accreditation Servic			n No.: SCS 108
Iultilateral Agreement for the r	ecognition of calibration		o: D1900V2-5d101 Jul14
			o: D1900V2-50101_50114
CALIBRATION (	ERIFICATE		
Object	D1900V2 - SN: 5	d101	
Calibration procedure(s)	QA CAL-05.v9 Calibration proce	dure for dipole validation kits abo	ove 700 MHz
Calibration date:	July 23, 2014		
The measurements and the unce	ertainties with confidence p	ional standards, which realize the physical ur robability are given on the following pages ar	nd are part of the certificate.
The measurements and the unce	artainties with confidence p		nd are part of the certificate.
The measurements and the unce All calibrations have been condu	artainties with confidence p	robability are given on the following pages ar	nd are part of the certificate.
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards	ertainties with confidence p cted in the closed laborato TE critical for calibration)	robability are given on the following pages arry facility: environment temperature $(22\pm3)^\circ$	nd are part of the certificate. C and humidity < 70%.
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A	ertainties with confidence p cted in the closed laborato TE critical for calibration)	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)° Cal Date (Certificate No.)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A	ertainties with confidence p cted in the closed laborato TE critical for calibration) ID # GB37480704	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)° Cal Date (Certificate No.) 09-Oct-13 (No. 217-01827)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A	ertainties with confidence p cted in the closed laborato TE critical for calibration) ID # GB37480704 US37292783	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)° <u>Cal Date (Certificate No.)</u> 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01827)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination	ertainties with confidence p cted in the closed laborato TE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5057.2 / 06327	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)° Cal Date (Certificate No.) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01828) 03-Apr-14 (No. 217-01921)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Apr-15 Apr-15
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Fype-N mismatch combination Reference Probe ES3DV3	ertainties with confidence p cted in the closed laborato TE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5057.2 / 06327 SN: 3205	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)° Cal Date (Certificate No.) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01828) 03-Apr-14 (No. 217-01918) 03-Apr-14 (No. 217-01921) 30-Dec-13 (No. ES3-3205_Dec13)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Oct-14 Apr-15 Apr-15 Dec-14
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3	ertainties with confidence p cted in the closed laborato TE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5057.2 / 06327	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)° Cal Date (Certificate No.) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01828) 03-Apr-14 (No. 217-01921)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Apr-15 Apr-15
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Yype-N mismatch combination Reference Probe ES3DV3 DAE4	ertainties with confidence p cted in the closed laborato TE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)° <u>Cal Date (Certificate No.)</u> 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01828) 03-Apr-14 (No. 217-01921) 30-Dec-13 (No. ES3-3205_Dec13) 30-Apr-14 (No. DAE4-601_Apr14)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Oct-14 Apr-15 Apr-15 Dec-14 Apr-15
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Fype-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards	artainties with confidence p           cted in the closed laborato           TE critical for calibration)           ID #           GB37480704           US37292783           MY41092317           SN: 5058 (20k)           SN: 5047.2 / 06327           SN: 601           ID #	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)° <u>Cal Date (Certificate No.)</u> 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01828) 03-Apr-14 (No. 217-01918) 03-Apr-14 (No. 217-01921) 30-Dec-13 (No. ES3-3205_Dec13) 30-Apr-14 (No. DAE4-601_Apr14) Check Date (in house)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Oct-14 Apr-15 Dec-14 Apr-15 Dec-14 Apr-15 Scheduled Check
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Fype-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards RF generator R&S SMT-06	ertainties with confidence p cted in the closed laborato TE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)° <u>Cal Date (Certificate No.)</u> 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01828) 03-Apr-14 (No. 217-01921) 30-Dec-13 (No. ES3-3205_Dec13) 30-Apr-14 (No. DAE4-601_Apr14)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Oct-14 Apr-15 Apr-15 Dec-14 Apr-15
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Fype-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards RF generator R&S SMT-06	artainties with confidence p           cted in the closed laborato           TE critical for calibration)           ID #           GB37480704           US37292783           MY41092317           SN: 5058 (20k)           SN: 5047.2 / 06327           SN: 3205           SN: 601           ID #           100005	Cal Date (Certificate No.)           09-Oct-13 (No. 217-01827)           09-Oct-13 (No. 217-01828)           03-Apr-14 (No. 217-01918)           03-Apr-14 (No. 217-01912)           30-Dec-13 (No. ES3-3205_Dec13)           30-Apr-14 (No. DAE4-601_Apr14)           Check Date (in house)           04-Aug-99 (in house check Oct-13)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Oct-14 Apr-15 Dec-14 Apr-15 Dec-14 Apr-15 Scheduled Check In house check: Oct-16
The measurements and the unce All calibrations have been condu Calibration Equipment used (M& Primary Standards Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards RF generator R&S SMT-06 Network Analyzer HP 8753E	ertainties with confidence p cted in the closed laborato TE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 50547.2 / 06327 SN: 3205 SN: 601 ID # 100005 US37390585 S4206	Cal Date (Certificate No.)           09-Oct-13 (No. 217-01827)           09-Oct-13 (No. 217-01921)           03-Apr-14 (No. 217-01921)           30-Dec-13 (No. ES3-3205_Dec13)           30-Apr-14 (No. DAE4-601_Apr14)           Check Date (in house)           04-Aug-99 (in house check Oct-13)           18-Oct-01 (in house check Oct-13)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Apr-15 Apr-15 Dec-14 Apr-15 Scheduled Check In house check: Oct-16 In house check: Oct-14
The measurements and the unce All calibrations have been condu Calibration Equipment used (M&	ertainties with confidence p cted in the closed laborato TE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 50547.2 / 06327 SN: 3205 SN: 601 ID # 100005 US37390585 S4206 Name	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)° Cal Date (Certificate No.) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01827) 09-Oct-13 (No. 217-01828) 03-Apr-14 (No. 217-01921) 30-Dec-13 (No. ES3-3205_Dec13) 30-Apr-14 (No. DAE4-601_Apr14) Check Date (in house) 04-Aug-99 (in house check Oct-13) 18-Oct-01 (in house check Oct-13) Function	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Apr-15 Apr-15 Dec-14 Apr-15 Scheduled Check In house check: Oct-16 In house check: Oct-14



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# Calibration Laboratory of Schmid & Partner

Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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

Accreditation No.: SCS 108

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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 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Additional Documentation:

d) DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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

Certificate No: D1900V2-5d101 Jul14

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### **Measurement Conditions**

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz ± 1 MHz	

Head TSL parameters The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.5 ± 6 %	1.38 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	10.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	40.6 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	5.25 W/kg

### **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	52.5 ± 6 %	1.51 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.1 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	40.4 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 250 mW input power	5.35 W/kg

Certificate No: D1900V2-5d101\_Jul14



### Appendix (Additional assessments outside the scope of SCS108)

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.7 Ω + 6.3 jΩ	
Return Loss	- 24.1 dB	

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.6 Ω + 6.5 jΩ	
Return Loss	- 22.4 dB	

### General Antenna Parameters and Design

1.203 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	March 28, 2008

Certificate No: D1900V2-5d101\_Jul14



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

Date: 23.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

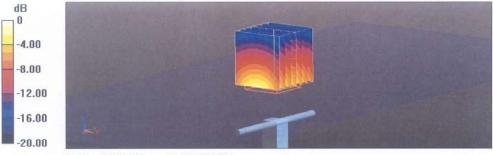
### DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d101

Communication System: UID 0 - CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.38 S/m;  $\epsilon_r$  = 39.5;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(5.06, 5.06, 5.06); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 99.04 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 18.5 W/kg SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.25 W/kg Maximum value of SAR (measured) = 12.8 W/kg



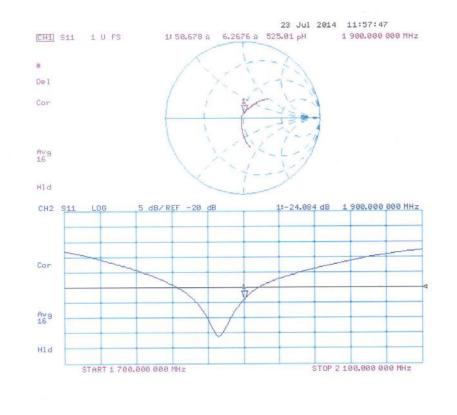
0 dB = 12.8 W/kg = 11.07 dBW/kg

Certificate No: D1900V2-5d101\_Jul14

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# Impedance Measurement Plot for Head TSL



Certificate No: D1900V2-5d101\_Jul14

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# No. I14Z47754-SEM01 Page 173 of 206

### DASY5 Validation Report for Body TSL

Date: 23.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

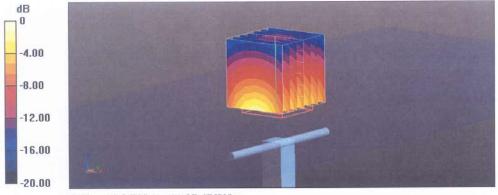
### DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d101

Communication System: UID 0 - CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.51 S/m;  $\epsilon_r$  = 52.5;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.76, 4.76, 4.76); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm Reference Value = 95.79 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 17.7 W/kg SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.35 W/kg Maximum value of SAR (measured) = 12.8 W/kg



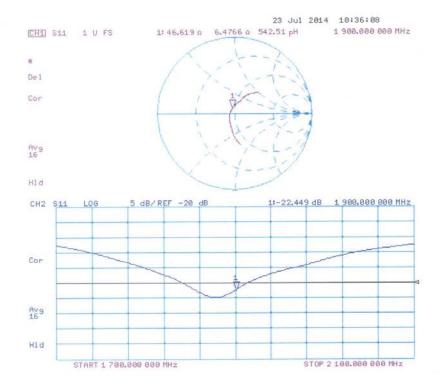
0 dB = 12.8 W/kg = 11.07 dBW/kg

Certificate No: D1900V2-5d101\_Jul14

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### Impedance Measurement Plot for Body TSL



Certificate No: D1900V2-5d101\_Jul14

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### 2450 MHz Dipole Calibration Certificate

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



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

Accreditation No.: SCS 108

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

Certificate No: D2450V2-853\_Jul14 CTTL (Auden) Client CALIBRATION CERTIFICATE D2450V2 - SN: 853 Object QA CAL-05.v9 Calibration procedure(s) Calibration procedure for dipole validation kits above 700 MHz July 24, 2014 Calibration date: This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) Scheduled Calibration 1D # Cal Date (Certificate No.) Primary Standards 09-Oct-13 (No. 217-01827) Oct-14 GB37480704 Power meter EPM-442A Oct-14 09-Oct-13 (No. 217-01827) Power sensor HP 8481A US37292783 Oct-14 MY41092317 09-Oct-13 (No. 217-01828) Power sensor HP 8481A Apr-15 SN: 5058 (20k) 03-Apr-14 (No. 217-01918) Reference 20 dB Attenuator Apr-15 03-Apr-14 (No. 217-01921) SN: 5047.2 / 06327 Type-N mismatch combination 30-Dec-13 (No. ES3-3205\_Dec13) Dec-14 SN: 3205 Reference Probe ES3DV3 Apr-15 30-Apr-14 (No. DAE4-601\_Apr14) DAE4 SN: 601 Scheduled Check Check Date (in house) 1D # Secondary Standards In house check: Oct-16 04-Aug-99 (in house check Oct-13) RF generator R&S SMT-06 100005 18-Oct-01 (in house check Oct-13) In house check: Oct-14 Network Analyzer HP 8753E US37390585 S4206 Name Function Laboratory Technician Claudio Leuber Calibrated by: Technical Manager Katja Pokovic Approved by: Issued: July 24, 2014 This calibration certificate shall not be reproduced except in full without written approval of the laboratory. Page 1 of 8 Certificate No: D2450V2-853\_Jul14



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





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

Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS)

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

### Glossary:

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 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Additional Documentation:

d) DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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

Certificate No: D2450V2-853\_Jul14

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### **Measurement Conditions**

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

DASY5	V52.8.8
Advanced Extrapolation	
Modular Flat Phantom	
10 mm	with Spacer
dx, dy, dz = 5 mm	
2450 MHz ± 1 MHz	
	Advanced Extrapolation Modular Flat Phantom 10 mm dx, dy, dz = 5 mm

### Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.8 ± 6 %	1.85 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		ionen.

# 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	13.6 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.2 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition 250 mW input power	6.26 W/kg

### **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	50.6 ± 6 %	2.03 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	7777	

### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	51.3 W/kg ± 17.0 % (k=2)
0.4D and the second a	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition 250 mW input power	6.08 W/kg

Certificate No: D2450V2-853\_Jul14



# Appendix (Additional assessments outside the scope of SCS108)

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.9 Ω + 3.3 jΩ	
Return Loss	- 27.3 dB	

### Antenna Parameters with Body TSL

1	
Impedance, transformed to feed point	50.4 Ω + 5.0 jΩ
Return Loss	- 26.0 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.162 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

Certificate No: D2450V2-853\_Jul14

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# DASY5 Validation Report for Head TSL

Date: 24.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

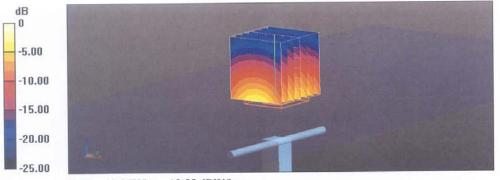
#### DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 853

Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma$  = 1.85 S/m;  $\varepsilon_r$  = 37.8;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.53, 4.53, 4.53); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

### 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 = 102.2 V/m; Power Drift = 0.03 dB Peak SAR (extrapolated) = 28.2 W/kg SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.26 W/kg Maximum value of SAR (measured) = 18.0 W/kg



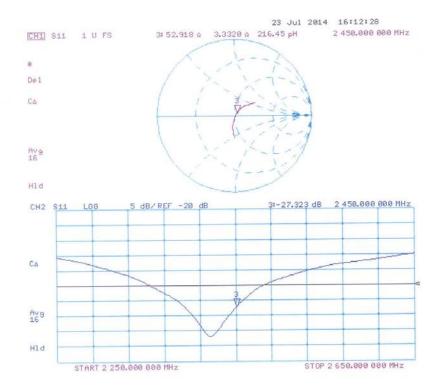
0 dB = 18.0 W/kg = 12.55 dBW/kg

Certificate No: D2450V2-853\_Jul14

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# Impedance Measurement Plot for Head TSL



Certificate No: D2450V2-853\_Jul14

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# No. I14Z47754-SEM01 Page 181 of 206

# DASY5 Validation Report for Body TSL

Date: 16.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

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

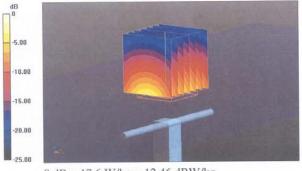
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma$  = 2.03 S/m;  $\epsilon_r$  = 50.6;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.35, 4.35, 4.35); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

# 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 = 96.00 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 27.9 W/kg SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.08 W/kg

Maximum value of SAR (measured) = 17.6 W/kg



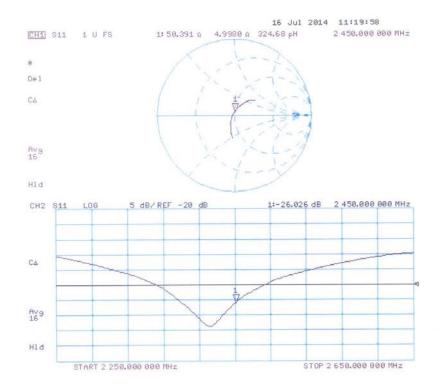
0 dB = 17.6 W/kg = 12.46 dBW/kg

Certificate No: D2450V2-853\_Jul14

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# Impedance Measurement Plot for Body TSL



Certificate No: D2450V2-853\_Jul14

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# 2600 MHz Dipole Calibration Certificate

chmid & Partner Engineering AG ughausstrasse 43, 8004 Zurich	, Switzerland	BC MRA C C C C C C C C C C C C C C C C C C C	Service suisse d'étalonnage Servizio svizzero di taratura
credited by the Swiss Accreditation Service	is one of the signatories	s to the EA	n No.: SCS 108
Itilateral Agreement for the re-	cognition of calibration of		No: D2600V2-1012_Jul14
ALIBRATION C	ERTIFICATE		
bject	D2600V2 - SN: 10	012	
alibration procedure(s)	QA CAL-05.v9 Calibration proce	dure for dipole validation kits ab	pove 700 MHz
alibration date:	July 16, 2014		
The measurements and the uncer	rtainties with confidence p	onal standards, which realize the physical uncertainty are given on the following pages any facility: environment temperature ( $22 \pm 3$ )	and are part of the certificate.
The measurements and the uncer All calibrations have been conduc Calibration Equipment used (M&T	rtainties with confidence p ted in the closed laborator 'E critical for calibration)	robability are given on the following pages a y facility: environment temperature ( $22 \pm 3$ )	and are part of the certificate. )°C and humidity < 70%.
he measurements and the uncer Il calibrations have been conduc calibration Equipment used (M&T Primary Standards	rtainties with confidence protection of the closed laborator (E critical for calibration)	robability are given on the following pages a y facility: environment temperature (22 ± 3) Cal Date (Certificate No.)	and are part of the certificate. )°C and humidity < 70%. Scheduled Calibration
he measurements and the uncer Il calibrations have been conduc alibration Equipment used (M&T rimary Standards ower meter EPM-442A	rtainties with confidence p ted in the closed laborator 'E critical for calibration)	robability are given on the following pages a y facility: environment temperature ( $22 \pm 3$ )	and are part of the certificate. )°C and humidity < 70%.
he measurements and the uncer Il calibrations have been conduc alibration Equipment used (M&T rimary Standards ower meter EPM-442A ower sensor HP 8481A	tainties with confidence providence of the closed laborator (E critical for calibration)	robability are given on the following pages a y facility: environment temperature (22 ± 3) Cal Date (Certificate No.) 09-Oct-13 (No. 217-01827)	and are part of the certificate. )°C and humidity < 70%. <u>Scheduled Calibration</u> Oct-14
he measurements and the uncer Il calibrations have been conduc calibration Equipment used (M&T rimary Standards cover meter EPM-442A cover sensor HP 8481A cover sensor HP 8481A	tainties with confidence p ted in the closed laborator "E critical for calibration) ID # GB37480704 US37292783	Cal Date (Certificate No.)         09-Oct-13 (No. 217-01827)	and are part of the certificate. y°C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Oct-14 Apr-15
he measurements and the uncer Il calibrations have been conduc alibration Equipment used (M&T rimary Standards 'ower meter EPM-442A 'ower sensor HP 8481A teference 20 dB Attenuator ype-N mismatch combination	tainties with confidence provided in the closed laborator (E critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 50547.2 / 06327	Cal Date (Certificate No.)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01827)         09-Oct-14 (No. 217-01827)         09-Oct-13 (No. 217-01827)         09-Oct-14 (No. 217-01828)         03-Apr-14 (No. 217-01921)	and are part of the certificate. y°C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Oct-14 Apr-15 Apr-15
he measurements and the uncer alibrations have been conduct alibration Equipment used (M&T trimary Standards tower meter EPM-442A tower sensor HP 8481A tower sensor HP 8481A teference 20 dB Attenuator type-N mismatch combination Reference Probe ES3DV3	tainties with confidence provided in the closed laborator (E critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k)	Cal Date (Certificate No.)         09-Oct-13 (No. 217-01827)	and are part of the certificate. y°C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Oct-14 Apr-15
he measurements and the uncer all calibrations have been conduct calibration Equipment used (M&T Primary Standards Prower sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4	tainties with confidence provided in the closed laborator (E critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205	cal Date (Certificate No.)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01921)         03-Apr-14 (No. 217-01921)         30-Apr-14 (No. DAE4-601_Apr14)         Check Date (in house)	and are part of the certificate. y°C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Oct-14 Apr-15 Dec-14 Apr-15 Dec-14 Apr-15 Scheduled Check
he measurements and the uncer alibrations have been conduct calibration Equipment used (M&T trimary Standards rower meter EPM-442A rower sensor HP 8481A Reference 20 dB Attenuator type-N mismatch combination Reference Probe ES3DV3 JAE4 Secondary Standards RF generator R&S SMT-06	tainties with confidence pr ted in the closed laborator "E critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601	Cal Date (Certificate No.)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01828)         03-Apr-14 (No. 217-01918)         03-Apr-14 (No. 217-01921)         30-Dec-13 (No. ES3-3205_Dec13)         30-Apr-14 (No. DAE4-601_Apr14)	and are part of the certificate. y°C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Apr-15 Apr-15 Dec-14 Apr-15
he measurements and the uncer all calibrations have been conduc calibration Equipment used (M&T Primary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards RF generator R&S SMT-06	tainties with confidence pr ted in the closed laborator (E critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # 100005 US37390585 S4206	Cal Date (Certificate No.)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01927)         09-Oct-13 (No. 217-01928)         03-Apr-14 (No. 217-01918)         03-Apr-14 (No. 217-01921)         30-Dec-13 (No. ES3-3205_Dec13)         30-Apr-14 (No. DAE4-601_Apr14)         Check Date (in house)         04-Aug-99 (in house check Oct-13)         18-Oct-01 (in house check Oct-13)	and are part of the certificate. y°C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Apr-15 Dec-14 Apr-15 Dec-14 Apr-15 Scheduled Check In house check: Oct-16 In house check: Oct-14
he measurements and the uncer all calibrations have been conduct alibration Equipment used (M&T trimary Standards tower meter EPM-442A tower sensor HP 8481A Reference 20 dB Attenuator type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards RF generator R&S SMT-06 Retwork Analyzer HP 8753E	tainties with confidence pr ted in the closed laborator (E critical for calibration) (D # (B37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601 (D # 100005	Cal Date (Certificate No.)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01921)         03-Apr-14 (No. 217-01918)         03-Apr-14 (No. 217-01921)         30-Apr-14 (No. DAE4-601_Apr14)         Check Date (in house)         04-Aug-99 (in house check Oct-13)	and are part of the certificate. y°C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Apr-15 Dec-14 Apr-15 Dec-14 Apr-15 Scheduled Check In house check: Oct-16 In house check: Oct-14
The measurements and the uncer All calibrations have been conduct Calibration Equipment used (M&T Primary Standards Power meter EPM-442A Power sensor HP 8481A Power Secondary Combination Reference Probe ES3DV3 DAE4 Secondary Standards RF generator R&S SMT-06 Network Analyzer HP 8753E Calibrated by:	tainties with confidence pr ted in the closed laborator (E critical for calibration) (D # (B37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601 (D # 100005 US37390585 S4206 Name	Cal Date (Certificate No.)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01828)         03-Apr-14 (No. 217-01918)         03-Apr-14 (No. 217-01921)         30-Dec-13 (No. ES3-3205_Dec13)         30-Apr-14 (No. DAE4-601_Apr14)         Check Date (in house)         04-Aug-99 (in house check Oct-13)         18-Oct-01 (in house check Oct-13)         Function	and are part of the certificate. y°C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Apr-15 Dec-14 Apr-15 Dec-14 Apr-15 Scheduled Check In house check: Oct-16 In house check: Oct-14
The measurements and the uncer All calibrations have been conduct Calibration Equipment used (M&T Primary Standards Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards RF generator R&S SMT-06 Network Analyzer HP 8753E Calibrated by: Approved by:	tainties with confidence protected in the closed laborator (E critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # 100005 US37390585 S4206 Name Michael Weber Katja Pokovic	Cal Date (Certificate No.)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01827)         09-Oct-13 (No. 217-01828)         03-Apr-14 (No. 217-01918)         03-Apr-14 (No. 217-01921)         30-Dec-13 (No. ES3-3205_Dec13)         30-Apr-14 (No. DAE4-601_Apr14)         Check Date (in house)         04-Aug-99 (in house check Oct-13)         18-Oct-01 (in house check Oct-13)         Function         Laboratory Technician	and are part of the certificate. y°C and humidity < 70%. Scheduled Calibration Oct-14 Oct-14 Oct-14 Apr-15 Apr-15 Dec-14 Apr-15 Scheduled Check In house check: Oct-16 In house check: Oct-14 Signature MilbSes MilbSes MilbSes



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



SWISS BRD

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

S Swiss Calibration Service

Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration 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 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

d) DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

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

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

Certificate No: D2600V2-1012\_Jul14

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### **Measurement Conditions**

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2600 MHz ± 1 MHz	

# Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.0	1.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.3 ± 6 %	2.02 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	14.8 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	57.8 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	6.58 W/kg

# Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.5	2.16 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	50.1 ± 6 %	2.21 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	14.6 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	57.2 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 250 mW input power	6.43 W/kg

Certificate No: D2600V2-1012\_Jul14



# Appendix (Additional assessments outside the scope of SCS108)

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	48.7 Ω - 5.0 jΩ	_
Return Loss	- 25.6 dB	

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	44.9 Ω - 3.8 jΩ	
Return Loss	- 23.6 dB	

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.152 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	October 30, 2007

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### DASY5 Validation Report for Head TSL

Date: 16.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1012

 $\begin{array}{l} \mbox{Communication System: UID 0 - CW; Frequency: 2600 MHz} \\ \mbox{Medium parameters used: } f = 2600 MHz; \mbox{$\sigma$} = 2.02 \mbox{ S/m; $\epsilon_r$} = 37.3; \mbox{$\rho$} = 1000 \mbox{$kg/m^3$} \\ \mbox{Phantom section: Flat Section} \\ \mbox{Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)} \end{array}$ 

#### DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.46, 4.46, 4.46); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 101.5 V/m; Power Drift = 0.07 dB Peak SAR (extrapolated) = 31.9 W/kg SAR(1 g) = 14.8 W/kg; SAR(10 g) = 6.58 W/kg Maximum value of SAR (measured) = 19.5 W/kg



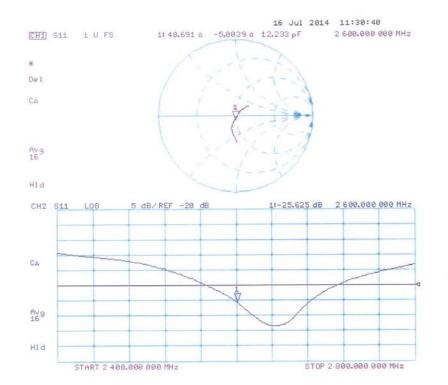
0 dB = 19.5 W/kg = 12.90 dBW/kg

Certificate No: D2600V2-1012\_Jul14

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# Impedance Measurement Plot for Head TSL



Certificate No: D2600V2-1012\_Jul14

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#### DASY5 Validation Report for Body TSL

Date: 16.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

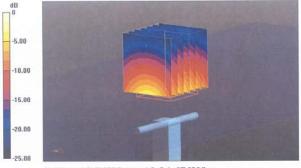
#### DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1012

Communication System: UID 0 - CW; Frequency: 2600 MHz Medium parameters used: f = 2600 MHz;  $\sigma$  = 2.21 S/m;  $\epsilon_r$  = 50.1;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.24, 4.24, 4.24); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 97.59 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 31.9 W/kg SAR(1 g) = 14.6 W/kg; SAR(10 g) = 6.43 W/kg Maximum value of SAR (measured) = 19.7 W/kg



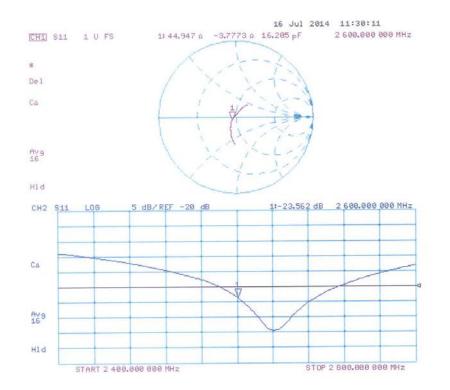
0 dB = 19.7 W/kg = 12.94 dBW/kg

Certificate No: D2600V2-1012\_Jul14

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# Impedance Measurement Plot for Body TSL



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# **5GHz Dipole Calibration Certificate**

ccredited by the Swiss Accreditation S he Swiss Accreditation Service is o ultilateral Agreement for the recognitient CTTL (Auden) CALIBRATION CEI	ne of the signatories nition of calibration	s to the EA certificates Certificate N	n No.: SCS 108
CTTL (Auden)	RTIFICATE	Certificate N	Io: D5GHzV2-1060_Jul14
ALIBRATION CEI			0. Doci1242 1000_00114
Dbject D	FOUL NO. 011		and the second s
	5GHzV2 - SN: 1	1060	
	A CAL-22.v2 alibration proce	dure for dipole validation kits be	tween 3-6 GHz
Calibration date: Ju	uly 22, 2014		
All calibrations have been conducted i Calibration Equipment used (M&TE cr		ry facility: environment temperature (22 ± 3)	°C and humidity < 70%.
Primary Standards	D #	Cal Date (Certificate No.)	Scheduled Calibration
	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Contraction and an and a strategy of the	JS37292783	09-Oct-13 (No. 217-01827)	Oct-14
	VY41092317	09-Oct-13 (No. 217-01828)	Oct-14
	SN: 5058 (20k) SN: 5047.2 / 06327	03-Apr-14 (No. 217-01918)	Apr-15 Apr-15
	SN: 3503	03-Apr-14 (No. 217-01921) 30-Dec-13 (No. EX3-3503_Dec13)	Dec-14
	SN: 601	30-Apr-14 (No. DAE4-601_Apr14)	Apr-15
Secondary Standards	D #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06 1	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	JS37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14
	Name	Function	Signature
	srae El-Naouq	Laboratory Technician	Vereen Et Door
			<i>p i i i i i i i i i i</i>
Approved by: K	Katja Pokovic	Technical Manager	& llty



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



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

Accreditation No.: SCS 108

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

# Glossary

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

# Calibration is Performed According to the Following Standards:

- a) IEC 62209-2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation, and Procedures"; Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", March 2010
- b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"
- c) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013

#### 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%.

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# **Measurement Conditions**

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz ± 1 MHz 5300 MHz ± 1 MHz 5500 MHz ± 1 MHz 5600 MHz ± 1 MHz 5800 MHz ± 1 MHz	

#### Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.6 ± 6 %	4.46 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

# SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.15 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.7 W/kg ± 19.9 % (k=2)
SAB averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 100 mW input power	2.34 W/kg

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### Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.4 ± 6 %	4.56 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	(	

### SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	82.5 W / kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 100 mW input power	2.39 W/kg

# Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.2 ± 6 %	4.74 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

### SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.50 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	84.1 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.43 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.0 W/kg ± 19.5 % (k=2)

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#### Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.0 ± 6 %	4.84 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

# SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.63 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	85.3 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 100 mW input power	2.46 W/kg

# Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	33.8 ± 6 %	5.04 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

# SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.14 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.5 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.8 W/kg ± 19.5 % (k=2)

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# Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.7 ± 6 %	5.38 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

# SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.79 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	77.5 W/kg ± 19.9 % (k=2)
04D	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 100 mW input power	2.18 W/kg

# Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.42 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.6 ± 6 %	5.51 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

# SAR result with Body TSL at 5300 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.91 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	78.7 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.22 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	22.1 W/kg ± 19.5 % (k=2)

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# Body TSL parameters at 5500 MHz

-										
	The	following	parameters	and	calcula	ations	were	applied.		 _
								000	Temperature	1

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.6	5.65 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.2 ± 6 %	5.77 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

# SAR result with Body TSL at 5500 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.32 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	82.8 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 100 mW input power	2.31 W/kg

# Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.1 ± 6 %	5.91 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

# SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.38 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	83.4 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.33 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.1 W/kg ± 19.5 % (k=2)

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# Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.7 ± 6 %	6.18 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

# SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.80 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	77.6 W/kg ± 19.9 % (k=2)
	condition	
	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 100 mW input power	2.16 W/kg

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# Appendix (Additional assessments outside the scope of SCS108)

#### Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	48.2 Ω - 7.0 jΩ	
Return Loss	- 22.7 dB	

#### Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	47.6 Ω - 3.8 jΩ
Return Loss	- 26.8 dB

### Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	50.8 Ω - 3.3 jΩ
Return Loss	- 29.6 dB

# Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	53.6 Ω - 0.8 jΩ	
Return Loss	- 28.9 dB	

# Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	52.0 Ω - 3.1 jΩ	
Return Loss	- 28.7 dB	

#### Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	48.0 Ω - 5.4 jΩ	
Return Loss	- 24.6 dB	

# Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	47.8 Ω - 2.5 jΩ
Return Loss	- 29.2 dB

# Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	51.0 Ω - 2.4 jΩ	
Return Loss	- 31.9 dB	

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# Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	54.4 Ω + 0.2 jΩ	
Return Loss	- 27.5 dB	

# Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	52.6 Ω - 1.7 jΩ
Return Loss	- 30.3 dB

#### General Antenna Parameters and Design

Electrical Delay (one direction) 1.203 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 27, 2006

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#### DASY5 Validation Report for Head TSL

Date: 21.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1060

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz Medium parameters used: f = 5200 MHz;  $\sigma = 4.46$  S/m;  $\epsilon_r = 34.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters

used: f = 5300 MHz;  $\sigma$  = 4.56 S/m;  $\varepsilon_r$  = 34.4;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5500 MHz;  $\sigma$  = 4.74 S/m;  $\varepsilon_r$  = 34.2;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5600 MHz;  $\sigma$  = 4.84 S/m;  $\varepsilon_r$  = 34;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5800 MHz;  $\sigma$  = 5.04 S/m;  $\varepsilon_r$  = 33.8;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

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

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(5.52, 5.52, 5.52); Calibrated: 30.12.2013, ConvF(5.2, 5.2, 5.2); Calibrated: 30.12.2013, ConvF(5.01, 5.01, 5.01); Calibrated: 30.12.2013, ConvF(4.86, 4.86, 4.86); Calibrated: 30.12.2013, ConvF(4.91, 4.91, 4.91); Calibrated: 30.12.2013;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 65.83 V/m; Power Drift = 0.03 dB Peak SAR (extrapolated) = 29.6 W/kg SAR(1 g) = 8.15 W/kg; SAR(10 g) = 2.34 W/kg Maximum value of SAR (measured) = 18.9 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 65.73 V/m; Power Drift = 0.04 dB Peak SAR (extrapolated) = 31.6 W/kg SAR(1 g) = 8.33 W/kg; SAR(10 g) = 2.39 W/kg Maximum value of SAR (measured) = 19.8 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 65.29 V/m; Power Drift = 0.04 dB Peak SAR (extrapolated) = 33.3 W/kg SAR(1 g) = 8.5 W/kg; SAR(10 g) = 2.43 W/kg Maximum value of SAR (measured) = 20.3 W/kg

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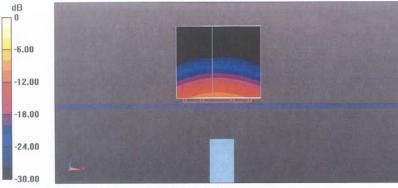
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Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 65.59 V/m; Power Drift = 0.04 dB Peak SAR (extrapolated) = 34.1 W/kg SAR(1 g) = 8.63 W/kg; SAR(10 g) = 2.46 W/kg Maximum value of SAR (measured) = 20.8 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 62.76 V/m; Power Drift = 0.03 dB Peak SAR (extrapolated) = 33.4 W/kg SAR(1 g) = 8.14 W/kg; SAR(10 g) = 2.31 W/kg



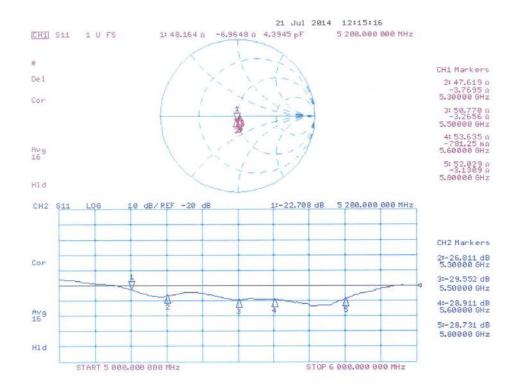
0 dB = 19.8 W/kg = 12.97 dBW/kg

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# Impedance Measurement Plot for Head TSL



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#### DASY5 Validation Report for Body TSL

Date: 22.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1060

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz Medium parameters used: f = 5200 MHz;  $\sigma = 5.38$  S/m;  $\varepsilon_r = 47.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used: f = 5500 MHz;  $\sigma = 5.51$  S/m;  $\varepsilon_r = 47.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used: f = 5500 MHz;  $\sigma = 5.77$  S/m;  $\varepsilon_r = 47.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used: f = 5600 MHz;  $\sigma = 5.91$  S/m;  $\varepsilon_r = 47.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used: f = 5600 MHz;  $\sigma = 5.91$  S/m;  $\varepsilon_r = 47.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used: f = 5800 MHz;  $\sigma = 6.18$  S/m;  $\varepsilon_r = 46.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(5.01, 5.01, 5.01); Calibrated: 30.12.2013, ConvF(4.76, 4.76, 4.76); Calibrated: 30.12.2013, ConvF(4.52, 4.52, 4.52); Calibrated: 30.12.2013, ConvF(4.3, 4.3, 4.3); Calibrated: 30.12.2013, ConvF(4.47, 4.47, 4.47); Calibrated: 30.12.2013;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- · Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 59.84 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 30.3 W/kg SAR(1 g) = 7.79 W/kg; SAR(10 g) = 2.18 W/kg Maximum value of SAR (measured) = 18.2 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 59.91 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 31.7 W/kg SAR(1 g) = 7.91 W/kg; SAR(10 g) = 2.22 W/kg Maximum value of SAR (measured) = 18.7 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 60.28 V/m; Power Drift = -0.00 dB Peak SAR (extrapolated) = 35.2 W/kg SAR(1 g) = 8.32 W/kg; SAR(10 g) = 2.31 W/kg Maximum value of SAR (measured) = 20.0 W/kg

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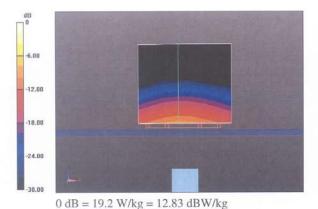
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Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 59.85 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 36.4 W/kg SAR(1 g) = 8.38 W/kg; SAR(10 g) = 2.33 W/kg Maximum value of SAR (measured) = 20.3 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 56.52 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 35.8 W/kg SAR(1 g) = 7.8 W/kg; SAR(10 g) = 2.16 W/kg Maximum value of SAR (measured) = 19.2 W/kg

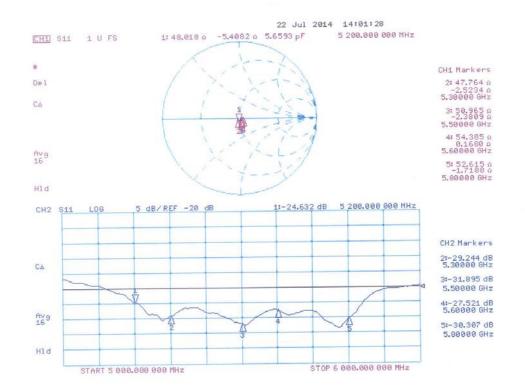


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# Impedance Measurement Plot for Body TSL



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