

# Attachment 2. Dipole calibration data

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





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

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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

Multilateral Agreement for the recognition of calibration certificates

Client

VITEC

Certificate No: D835V2-4d104\_May15

Calibration procedure(s)  Calibration procedure for dipole validation kits above 700 MHz  Calibration procedure for dipole validation kits above 700 MHz  This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.  Calibration Equipment used (M&TE critical for calibration)  Primary Standards  D# Cal Date (Certificate No.) Scheduled Calibration  Power meter EPM-442A GB37480704 07-Oct-14 (No. 217-02020) Oct-15  Power sensor HP 8481A US37282783 07-Oct-14 (No. 217-02020) Oct-15  Power sensor HP 8481A MY41092317 07-Oct-14 (No. 217-02021) Oct-15  Type-N mismatch combination SN: 5084 (20k) 01-Apr-15 (No. 217-02131) Mar-16  Type-N mismatch combination SN: 5047.2 / 06327 01-Apr-15 (No. 217-02134) Mar-16  SN: 5047.2 / 06327 01-Apr-15 (No. 217-02134) Mar-16  SN: 5047.2 / 06327 01-Apr-16 (No. 217-02134) Mar-16  Secondary Standards  D# Check Date (in house) Scheduled Check  Scheduled Check  Network Analyzer HP 8753E US37390585 S4206 18-Oct-01 (in house check Oct-13) In house check: Oct-15  Name Function Signature  Laboratory Technician		DOOENIO ON A		
Calibration procedure for dipole validation kits above 700 MHz  Calibration date:  May 28, 2015  This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.  Calibration Equipment used (M&TE critical for calibration)  Primary Standards  ID # Cal Date (Certificate No.) Scheduled Calibration Power meter EPM-442A GB37480704 07-Oct-14 (No. 217-02020) Oct-15 Power sensor HP 8481A US37292783 07-Oct-14 (No. 217-02020) Oct-15 Power sensor HP 8481A MY41092317 07-Oct-14 (No. 217-02020) Oct-15 Reference 20 dB Attenuator SN: 5047.2 / 06327 01-Apr-15 (No. 217-02131) Mar-16 Reference Probe ES3DV3 SN: 5047.2 / 06327 01-Apr-15 (No. 217-02134) Mar-16 SR-6rence Probe ES3DV3 SN: 5047.2 / 06327 01-Apr-15 (No. 217-02134) Dec-15 SN: 504.2 / 06327 01-Apr-15 (No. 217-02134) Dec-15 SN: 504.2 / 06327 01-Apr-15 (No. 217-02134) Mar-16 Secondary Standards ID # Check Date (in house) Scheduled Check SR-F generator R&S SMT-06 100005 04-Aug-99 (in house check Oct-13) In house check: Oct-16 Network Analyzer HP 8753E US37390585 S4206 18-Oct-01 (in house check Oct-14) In house check: Oct-15 Name Function Jeton Kastrati Laboratory Technician	Object	D835V2 - SN: 40	1104	
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Power meter EPM-442A	All calibrations have been conduc		,	- The second of
Power meter EPM-442A			,,	
Power sensor HP 8481A Reference 20 dB Attenuator SN: 5058 (20k) SN: 5058 (20k) SN: 5058 (20k) Power sensor HP 8481A Reference 20 dB Attenuator SN: 5058 (20k) SN: 504.25 (N. 20k) SN: 504.25 (N.	Calibration Equipment used (M&T	TE critical for calibration)		
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SN: 3205   30-Dec-14 (No. ES3-3205_Dec14)   Dec-15     SN: 601   18-Aug-14 (No. DAE4-601_Aug14)   Aug-15     Secondary Standards   ID #   Check Date (in house)   Scheduled Check     RF generator R&S SMT-06   100005   04-Aug-99 (in house check Oct-13)   In house check: Oct-16     In house check: Oct-15   In house check: Oct-15     In house check: Oct-15     Signature   Signature   Signature     Secondary Standards   ID #   Check Date (in house)   Scheduled Check     Scheduled Check   In house check Oct-13   In house check: Oct-15     Secondary Standards   ID #   Check Date (in house)   Scheduled Check     In house check: Oct-15   In house check: Oct-15     Secondary Standards   ID #   Check Date (in house)   Scheduled Check     In house check: Oct-15   In house check: Oct-15     Secondary Standards   ID #   Check Date (in house)   Scheduled Check     In house check: Oct-16   In house check: Oct-16     In house check: Oct-17   In house check: Oct-17     Signature   In house check: Oct-18   In house check: Oct-19     Secondary Standards   ID #   Check Date (in house)   In house check: Oct-16     Secondary Standards   ID #   Check Date (in house)   Scheduled Check     In house check: Oct-16   In house check: Oct-17     Secondary Standards   ID #   Check Date (in house)   Scheduled Check     In house check: Oct-16   In house check: Oct-16     In house check: Oct-16   In house check: Oct-17     In house check: Oct-17   In house check: Oct-18     In house check: Oct-19   In house check: Oct-19     In house check: Oct-19   In house check: Oct-19   In house check: Oct-19     In house check: Oct-19   In house check: Oct-19   In house check: Oct-19     In house check: Oct-19   In house check: Oct-19   In house check: Oct-19   In house check: Oct-19   In house check: Oct-19   In house check: Oct-19   In house check: Oct-19   In house check: Oct-19   In house check: Oc	Calibration Equipment used (M&T Primary Standards Power meter EPM-442A Power sensor HP 8481A	ID # GB37480704 US37292783	Cal Date (Certificate No.) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020)	Scheduled Calibration Oct-15 Oct-15
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Approved by:  Katja Pokovic  Technical Manager	Calibration Equipment used (M&T Primary Standards Power meter EPM-442A 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	ID #  GB37480704  US37292783  MY41092317  SN: 5058 (20k)  SN: 5047.2 / 06327  SN: 3205  SN: 601  ID #  100005  US37390585 S4206  Name	Cal Date (Certificate No.)  07-Oct-14 (No. 217-02020)  07-Oct-14 (No. 217-02020)  07-Oct-14 (No. 217-02021)  01-Apr-15 (No. 217-02131)  01-Apr-15 (No. 217-02134)  30-Dec-14 (No. ES3-3205_Dec14)  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-14)	Scheduled Calibration Oct-15 Oct-15 Oct-15 Mar-16 Mar-16 Dec-15 Aug-15 Scheduled Check In house check: Oct-16 In house check: Oct-15
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Calibration Laboratory of Schmid & Partner Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland





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

Accreditation No.: SCS 0108

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 N/A sensitivity in TSL / NORM x,y,z 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	42.1 ± 6 %	0.92 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	2.35 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.28 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.54 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	6.09 W/kg ± 16.5 % (k=2)

**Body TSL parameters**The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	55.2 ± 6 %	0.99 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	2.36 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.30 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	1.55 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	6.13 W/kg ± 16.5 % (k=2)

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# Appendix (Additional assessments outside the scope of SCS 0108)

#### **Antenna Parameters with Head TSL**

Impedance, transformed to feed point	52.1 Ω - 2.9 jΩ	
Return Loss	- 29.2 dB	

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

Impedance, transformed to feed point	47.7 Ω - 4.1 jΩ
Return Loss	- 26.4 dB

# **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.399 ns
The second of a second contract to the second	

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	May 26, 2010

Certificate No: D835V2-4d104\_May15

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

Date: 27.05.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d104

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used: f = 835 MHz;  $\sigma = 0.92 \text{ S/m}$ ;  $\varepsilon_r = 42.1$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

#### DASY52 Configuration:

• Probe: ES3DV3 - SN3205; ConvF(6.2, 6.2, 6.2); Calibrated: 30.12.2014;

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

Electronics: DAE4 Sn601; Calibrated: 18.08.2014

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

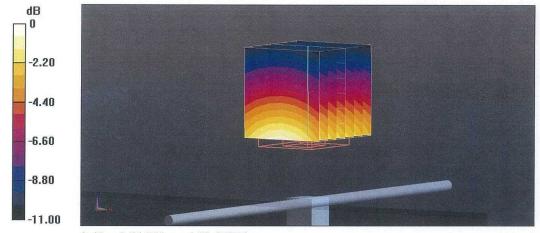
DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

#### 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 = 56.42 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 3.48 W/kg

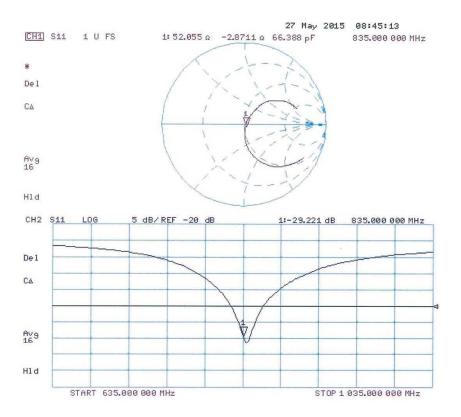
SAR(1 g) = 2.35 W/kg; SAR(10 g) = 1.54 W/kgMaximum value of SAR (measured) = 2.75 W/kg



0 dB = 2.75 W/kg = 4.39 dBW/kg



# Impedance Measurement Plot for Head TSL





# **DASY5 Validation Report for Body TSL**

Date: 28.05.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d104

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used: f = 835 MHz;  $\sigma = 0.99$  S/m;  $\varepsilon_r = 55.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

#### DASY52 Configuration:

• Probe: ES3DV3 - SN3205; ConvF(6.17, 6.17, 6.17); Calibrated: 30.12.2014;

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

Electronics: DAE4 Sn601; Calibrated: 18.08.2014

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

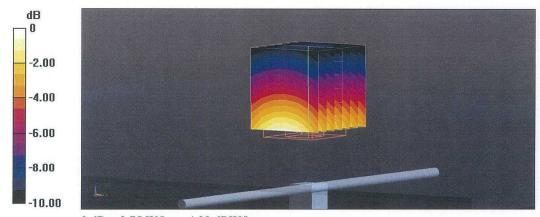
• DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

### 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 = 54.53 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 3.47 W/kg

SAR(1 g) = 2.36 W/kg; SAR(10 g) = 1.55 W/kgMaximum value of SAR (measured) = 2.75 W/kg



0 dB = 2.75 W/kg = 4.39 dBW/kg

Certificate No: D835V2-4d104\_May15



# Impedance Measurement Plot for Body TSL

