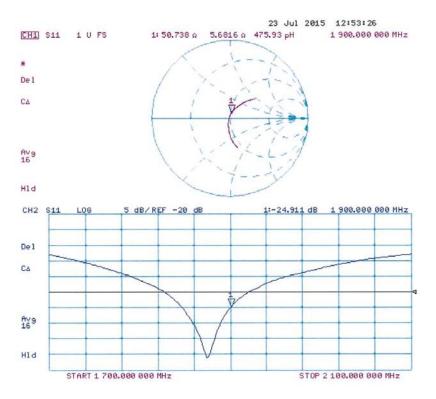


## Impedance Measurement Plot for Head TSL



Certificate No: D1900V2-5d101\_Jul15 Page 6 of 8



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

Date: 23.07.2015

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;  $\sigma = 1.54 \text{ S/m}$ ;  $\varepsilon_r = 52.7$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

#### DASY52 Configuration:

Probe: ES3DV3 - SN3205; ConvF(4.65, 4.65, 4.65); Calibrated: 30.12.2014;

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

Electronics: DAE4 Sn601; Calibrated: 18.08.2014

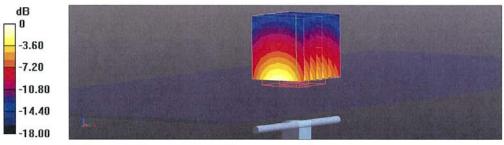
Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002

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 = 95.76 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 17.1 W/kg SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.47 W/kg

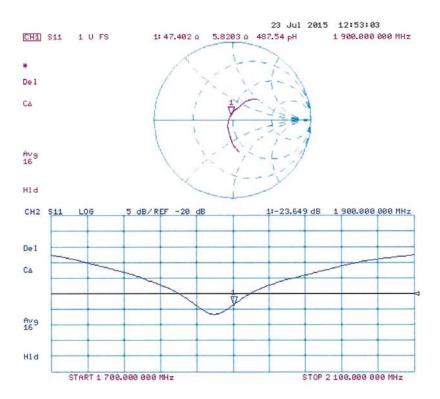
Maximum value of SAR (measured) = 12.7 W/kg



0 dB = 12.7 W/kg = 11.04 dBW/kg



## Impedance Measurement Plot for Body TSL





## 2450 MHz Dipole Calibration Certificate for 2015

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





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C Service suisse d'étalonnage
Servizio svizzero di taratura
S 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 CTTL (Auden)

Certificate No: D2450V2-853\_Jul15

#### CALIBRATION CERTIFICATE Object D2450V2 - SN:853 QA CAL-05.v9 Calibration procedure(s) Calibration procedure for dipole validation kits above 700 MHz July 24, 2015 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 Cal Date (Certificate No.) Primary Standards ID# Power meter EPM-442A GB37480704 07-Oct-14 (No. 217-02020) Oct-15 US37292783 07-Oct-14 (No. 217-02020) Oct-15 Power sensor HP 8481A 07-Oct-14 (No. 217-02021) Oct-15 Power sensor HP 8481A MY41092317 Mar-16 Reference 20 dB Attenuator SN: 5058 (20k) 01-Apr-15 (No. 217-02131) SN: 5047.2 / 06327 01-Apr-15 (No. 217-02134) Mar-16 Type-N mismatch combination Reference Probe ES3DV3 SN: 3205 30-Dec-14 (No. ES3-3205\_Dec14) 18-Aug-14 (No. DAE4-601\_Aug14) Aug-15 DAE4 SN: 601 Scheduled Check ID# Check Date (in house) Secondary Standards 04-Aug-99 (in house check Oct-13) In house check: Oct-16 RF generator R&S SMT-06 100005 US37390585 S4206 18-Oct-01 (in house check Oct-14) In house check: Oct-15 Network Analyzer HP 8753E Signature Name Function Calibrated by: Jeton Kastrati Laboratory Technician Katja Pokovic Technical Manager Approved by: Issued: July 24, 2015 This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: D2450V2-853\_Jul15



#### Calibration Laboratory of

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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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) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### **Additional Documentation:**

e) 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\_Jul15



## **Measurement Conditions**

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

DAST system conliguration, as fair 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	2450 MHz ± 1 MHz	

## **Head TSL parameters**

g 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	37.9 ± 6 %	1.88 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.5 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.5 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	6.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.5 W/kg ± 16.5 % (k=2)

Body TSL parameters
The following parameters and calculations were applied.

The following parameters and calculations were applied	u.		
	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.4 ± 6 %	2.03 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	13.3 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	52.1 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	6.16 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.4 W/kg ± 16.5 % (k=2)



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

# Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.8 Ω + 4.4 jΩ
Return Loss	- 27.2 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	$52.3 \Omega + 1.5 j\Omega$
Return Loss	- 31.4 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



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

Date: 24.07.2015

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;  $\sigma = 1.88$  S/m;  $\varepsilon_r = 37.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

#### DASY52 Configuration:

Probe: ES3DV3 - SN3205; ConvF(4.54, 4.54, 4.54); Calibrated: 30.12.2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

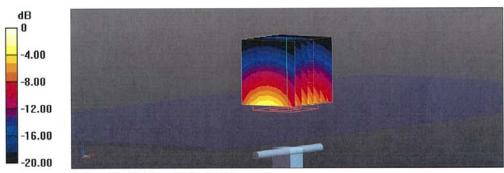
Electronics: DAE4 Sn601; Calibrated: 18.08.2014

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:

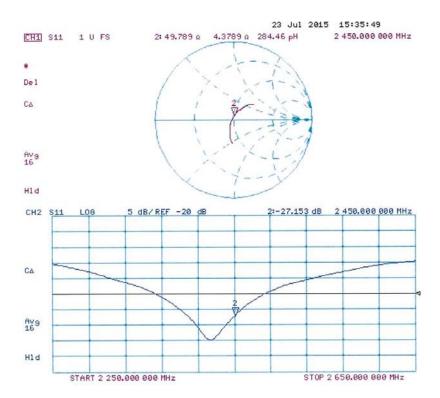
Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 100.4 V/m; Power Drift = 0.04 dB Peak SAR (extrapolated) = 27.9 W/kg SAR(1 g) = 13.5 W/kg; SAR(10 g) = 6.24 W/kg Maximum value of SAR (measured) = 17.7 W/kg



0 dB = 17.7 W/kg = 12.48 dBW/kg



## Impedance Measurement Plot for Head TSL





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

Date: 24.07.2015

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;  $\varepsilon_r = 52.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

#### DASY52 Configuration:

Probe: ES3DV3 - SN3205; ConvF(4.32, 4.32, 4.32); Calibrated: 30.12.2014;

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

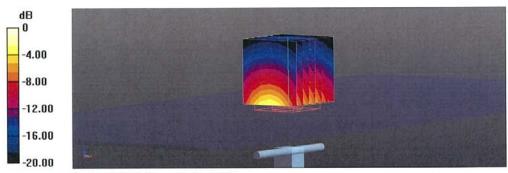
Electronics: DAE4 Sn601; Calibrated: 18.08.2014

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:

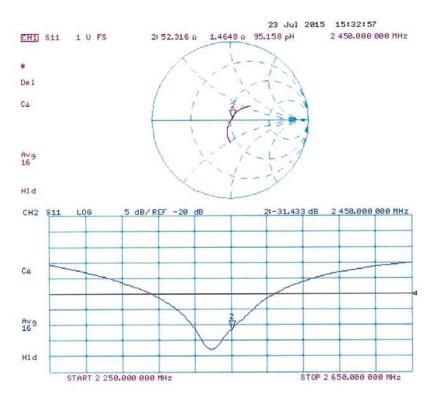
Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 95.79 V/m; Power Drift = 0.03 dB Peak SAR (extrapolated) = 27.5 W/kg SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.16 W/kg Maximum value of SAR (measured) = 17.6 W/kg



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



## Impedance Measurement Plot for Body TSL





# **ANNEX I** Accreditation Certificate

