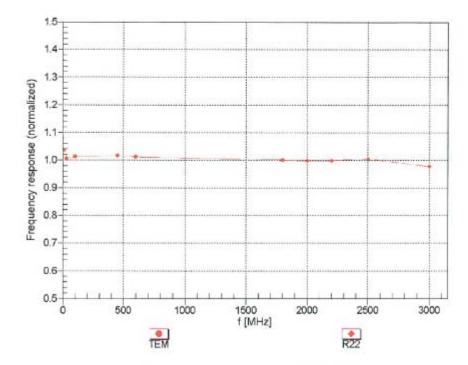


ES3DV3-SN:3327

September 2, 2015

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



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

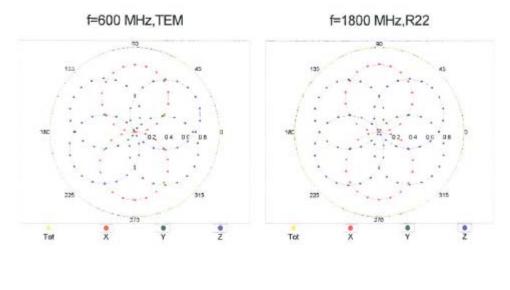
Certificate No: ES3-3327_Sep15

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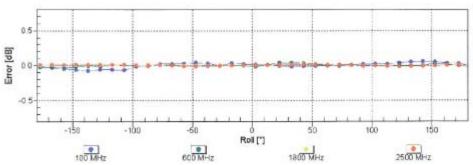


ES3DV3-SN:3327

September 2, 2015







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

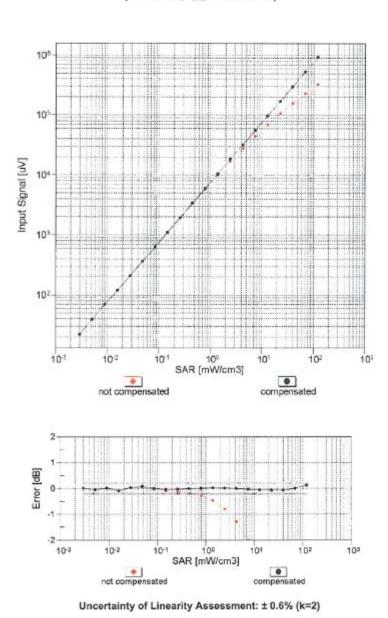
Certificate No: ES3-3327_Sep15

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ES3DV3-- SN:3327

September 2, 2015



Dynamic Range f(SAR_{head}) (TEM cell , f_{evel}= 1900 MHz)

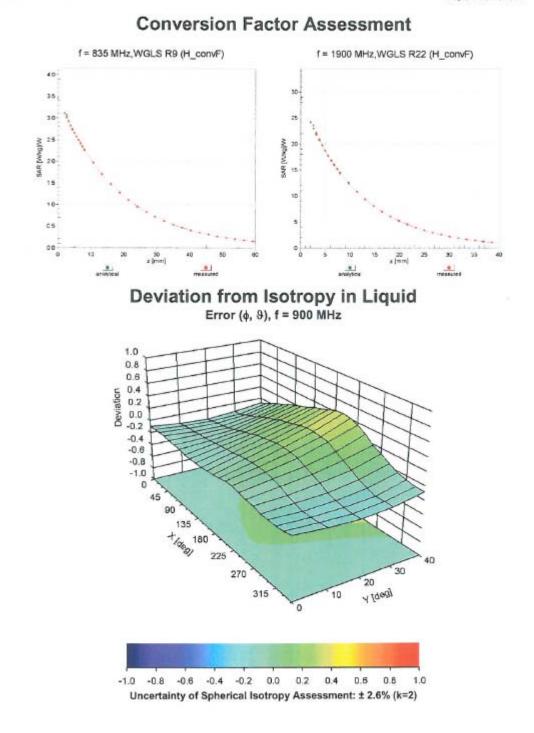
Certificate No: ES3-3327_Sep15

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ES3DV3-- SN:3327

September 2, 2015



Certificate No: ES3-3327_Sep15

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ES3DV3- SN:3327

September 2, 2015

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3327

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	102.8
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

Certificate No: ES3-3327_Sep15

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Attachment 2. – Dipole Calibration Data



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Client DT&C (Dymstec)

Certificate No: D750V3-1049_Nov14

CALIBRATION	ERTIFICATE		
Object	D750V3 - SN: 10	049	
Calibration procedure(s)	QA CAL-05.v9 Calibration proce	dure for dipole validation kits abo	ove 700 MHz
Calibration date:	November 13, 20	014	
The measurements and the unce	rtainties with confidence p	ional standards, which realize the physical un robability are given on the following pages ar ry facility: environment temperature (22 \pm 3)°(nd are part of the certificate.
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
ower sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
afaranaa 00 dD Amaayatay	SN: 5058 (20k)		
ererence 20 dB Attenuator		03-Apr-14 (No. 217-01918)	Apr-15
	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01918) 03-Apr-14 (No. 217-01921)	
ype-N mismatch combination			Apr-15
Type-N mismatch combination Reference Probe ES3DV3	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15 Apr-15
Type-N mismatch combination Reference Probe ES3DV3 DAE4	SN: 5047.2 / 06327 SN: 3205 SN: 601	03-Apr-14 (No. 217-01921) 30-Dec-13 (No. ES3-3205_Dec13) 18-Aug-14 (No. DAE4-601_Aug14)	Apr-15 Apr-15 Dec-14 Aug-15
Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards	SN: 5047.2 / 06327 SN: 3205 SN: 601	03-Apr-14 (No. 217-01921) 30-Dec-13 (No. ES3-3205_Dec13) 18-Aug-14 (No. DAE4-601_Aug14) Check Date (in house)	Apr-15 Apr-15 Dec-14 Aug-15 Scheduled Check
Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards RF generator R&S SMT-06	SN: 5047.2 / 06327 SN: 3205 SN: 601	03-Apr-14 (No. 217-01921) 30-Dec-13 (No. ES3-3205_Dec13) 18-Aug-14 (No. DAE4-601_Aug14)	Apr-15 Apr-15 Dec-14 Aug-15
Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards RF generator R&S SMT-06	SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # 100005 US37390585 S4206	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-14)	Apr-15 Apr-15 Dec-14 Aug-15 Scheduled Check In house check: Oct-16 In house check: Oct-15
Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards RF generator R&S SMT-06 Network Analyzer HP 8753E	SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # 100005 US37390585 S4206 Name	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-14) Function	Apr-15 Apr-15 Dec-14 Aug-15 Scheduled Check In house check: Oct-16
Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards RF generator R&S SMT-06 Network Analyzer HP 8753E	SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # 100005 US37390585 S4206	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-14)	Apr-15 Apr-15 Dec-14 Aug-15 Scheduled Check In house check: Oct-16 In house check: Oct-15
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:	SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # 100005 US37390585 S4206 Name	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-14) Function	Apr-15 Apr-15 Dec-14 Aug-15 Scheduled Check In house check: Oct-16 In house check: Oct-15
Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards RF generator R&S SMT-06 Network Analyzer HP 8753E Calibrated by:	SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # 100005 US37390585 S4206 Name Jeton Kastrati	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-14) Function Laboratory Technician	Apr-15 Apr-15 Dec-14 Aug-15 Scheduled Check In house check: Oct-16 In house check: Oct-15

Certificate No: D750V3-1049_Nov14

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- s Swiss Calibration Service

Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS)

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Glossary:

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

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "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	750 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.9	0.89 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	41.4 ± 6 %	0.89 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.06 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	8.22 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 250 mW input power	1.35 W/kg

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.5	0.96 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	54.7 ± 6 %	0.98 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.18 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	8.56 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.44 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	5.68 W/kg ± 16.5 % (k=2)

Certificate No: D750V3-1049_Nov14



Appendix (Additional assessments outside the scope of SCS108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.1 Ω - 2.2 jΩ	
Return Loss	- 28.6 dB	

Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.6 Ω - 4.4 jΩ	
Return Loss	- 25.8 dB	

General Antenna Parameters and Design

1.035 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 03, 2011



DASY5 Validation Report for Head TSL

Date: 13.11.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1049

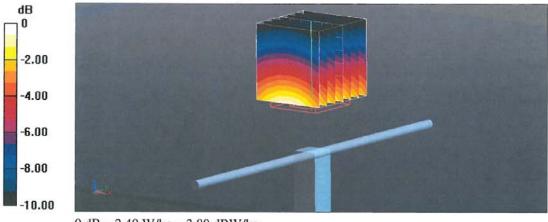
Communication System: UID 0 - CW; Frequency: 750 MHz Medium parameters used: f = 750 MHz; $\sigma = 0.89$ S/m; $\varepsilon_r = 41.4$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.37, 6.37, 6.37); 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 = 53.71 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 3.07 W/kg SAR(1 g) = 2.06 W/kg; SAR(10 g) = 1.35 W/kg Maximum value of SAR (measured) = 2.40 W/kg



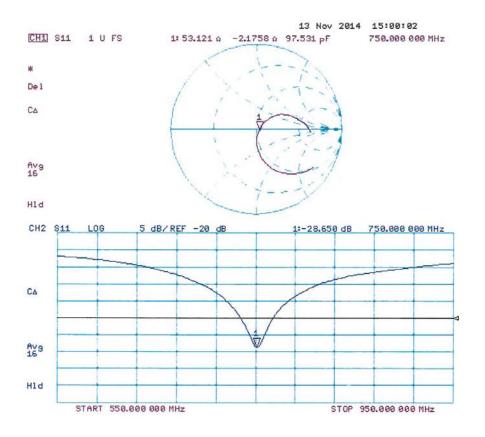
0 dB = 2.40 W/kg = 3.80 dBW/kg

Certificate No: D750V3-1049_Nov14

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Impedance Measurement Plot for Head TSL



Certificate No: D750V3-1049_Nov14

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DASY5 Validation Report for Body TSL

Date: 13.11.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1049

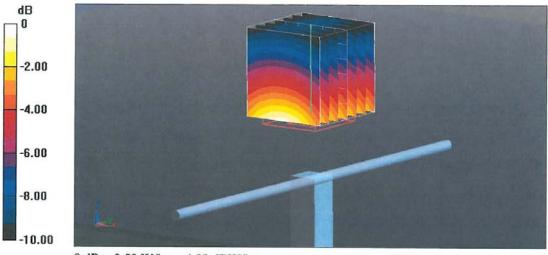
Communication System: UID 0 - CW; Frequency: 750 MHz Medium parameters used: f = 750 MHz; $\sigma = 0.98$ S/m; $\varepsilon_r = 54.7$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.13, 6.13, 6.13); 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 = 52.70 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 3.20 W/kg SAR(1 g) = 2.18 W/kg; SAR(10 g) = 1.44 W/kg Maximum value of SAR (measured) = 2.53 W/kg



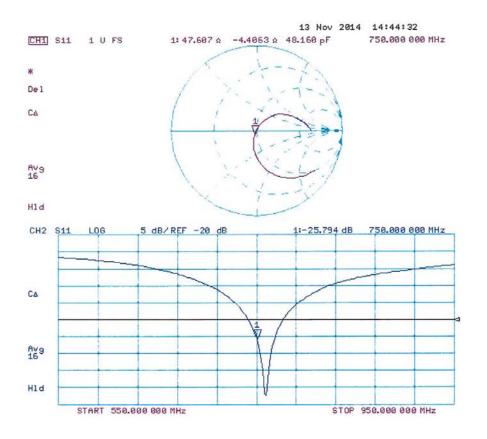
0 dB = 2.53 W/kg = 4.03 dBW/kg

Certificate No: D750V3-1049_Nov14

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Impedance Measurement Plot for Body TSL



Certificate No: D750V3-1049_Nov14

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Accreditation No.: SCS 0108

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DT&C (Dymstec) Certificate No: D835V2-464_Sep15 Client **CALIBRATION CERTIFICATE** Object D835V2 - SN: 464 Calibration procedure(s) QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz Calibration date: September 30, 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 07-Oct-14 (No. 217-02021) Power sensor HP 8481A MY41092317 Oct-15 Reference 20 dB Attenuator SN: 5058 (20k) 01-Apr-15 (No. 217-02131) Mar-16 SN: 5047.2 / 06327 Type-N mismatch combination 01-Apr-15 (No. 217-02134) Mar-16 SN: 7349 Reference Probe EX3DV4 30-Dec-14 (No. EX3-7349_Dec14) Dec-15 DAE4 SN: 601 17-Aug-15 (No. DAE4-601_Aug15) Aug-16 ID # Secondary Standards Check Date (in house) Scheduled Check RF generator R&S SMT-06 100972 15-Jun-15 (in house check Jun-15)

In house check: Jun-18 In house check: Oct-15

Signature

Issued: October 1, 2015

Certificate No: D835V2-464_Sep15

Network Analyzer HP 8753E

Calibrated by:

Approved by:

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18-Oct-01 (in house check Oct-14)

Function

Laboratory Technician

Technical Manager

US37390585 S4206

Name

Leif Klysner

Katja Pokovic

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.



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Glossary:

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

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "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: D835V2-464_Sep15

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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	41.8 ± 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 ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.31 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 250 mW input power	1.55 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	53.8 ± 6 %	1.00 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		: 2222

SAR result with Body TSL

Condition	
250 mW input power	2.45 W/kg
normalized to 1W	9.52 W/kg ± 17.0 % (k=2)
condition	
condition	
condition 250 mW input power	1.60 W/kg
	250 mW input power

Certificate No: D835V2-464_Sep15



Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.7 Ω - 1.7 jΩ	
Return Loss	- 34.7 dB	

Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.3 Ω - 4.0 jΩ	
Return Loss	- 25.0 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.382 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	March 27, 2002

Certificate No: D835V2-464_Sep15

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DASY5 Validation Report for Head TSL

Date: 30.09.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 464

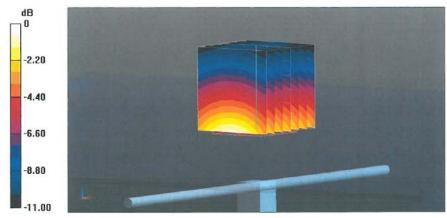
Communication System: UID 0 - CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz; σ = 0.94 S/m; ε_r = 41.8; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(9.77, 9.77, 9.77); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- 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=5mmReference Value = 61.63 V/m; Power Drift = 0.03 dB Peak SAR (extrapolated) = 3.62 W/kg SAR(1 g) = 2.4 W/kg; SAR(10 g) = 1.55 W/kg Maximum value of SAR (measured) = 3.22 W/kg



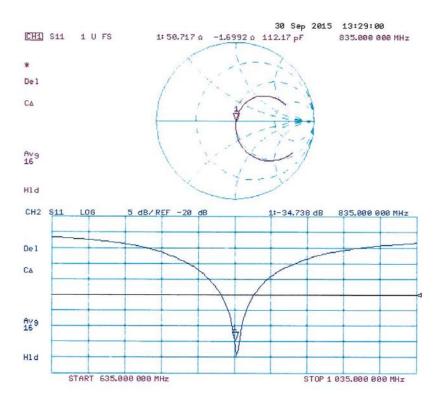
0 dB = 3.22 W/kg = 5.08 dBW/kg

Certificate No: D835V2-464_Sep15

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Impedance Measurement Plot for Head TSL



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DASY5 Validation Report for Body TSL

Date: 30.09.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 464

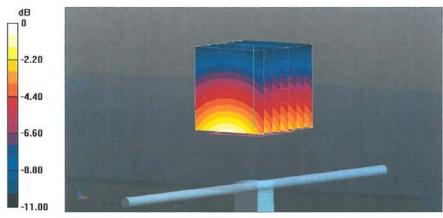
Communication System: UID 0 - CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz; $\sigma = 1$ S/m; $\epsilon_r = 53.8$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(9.72, 9.72, 9.72); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- 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 = 59.96 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 3.65 W/kg SAR(1 g) = 2.45 W/kg; SAR(10 g) = 1.6 W/kg Maximum value of SAR (measured) = 3.26 W/kg



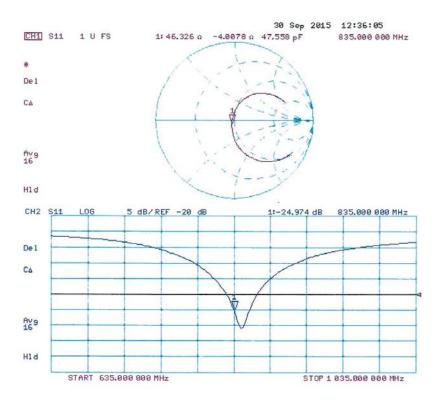
0 dB = 3.26 W/kg = 5.13 dBW/kg

Certificate No: D835V2-464_Sep15

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Impedance Measurement Plot for Body TSL



Certificate No: D835V2-464_Sep15

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



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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

DT&C (Dymstec) Client

Certificate No: D1800V2-2d047_Jul15

bject	D1800V2 - SN: 2	d047	
alibration procedure(s)	QA CAL-05.v9 Calibration proce	dure for dipole validation kits abo	ove 700 MHz
alibration date:	July 16, 2015		
		onal standards, which realize the physical un robability are given on the following pages an	
Il calibrations have been conduc		ry facility: environment temperature (22 \pm 3)*(C and humidity < 70%.
sensition reductions again funct	a contract for contentationly		
rimery Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
	ID # G837480704	Cal Date (Certificate No.) 07-Oct-14 (No. 217-02020)	Scheduled Calibration Oct-15
ower meter EPM-442A	100.0	07-Oct-14 (No. 217-02020)	
ower meter EPM-442A ower sensor HP 8481A	GB37480704	and the second se	Oct-15
ower meter EPM-442A ower sensor HP 8481A ower sensor HP 8481A	GB37480704 US37292783	07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020)	Oct-15 Oct-15
ower meter EPM-442A ower sensor HP 8481A ower sensor HP 8481A eference 20 dB Attenuator	GB37480704 US37292783 MY41092317	07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02021) 01-Apr-15 (No. 217-02131)	Oct-15 Oct-15 Oct-15
ower meter EPM-442A ower sensor HP 8481A ower sensor HP 8481A eference 20 dB Attenuator ype-N mismatch combination	GB37480704 US37292783 MY41092317 SN: 5058 (20k)	07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02021)	Oct-15 Oct-15 Oct-15 Mar-16
ower meter EPM-442A ower sensor HP 8481A ower sensor HP 8481A leference 20 dB Attenuator ype-N mismatch combination teference Probe ES3DV3	GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327	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)	Oct-15 Oct-15 Oct-15 Mar-16 Mar-16
ower meter EPM-442A ower sensor HP 8481A ower sensor HP 8481A eference 20 dB Attenuator ype-N mismatoh combination eference Probe ES3DV3 AE4	GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205	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)	Oct-15 Oct-15 Oct-15 Mar-16 Mar-16 Dec-15
ower meter EPM-442A ower sensor HP 8481A ower sensor HP 8481A eference 20 dB Attenuator ype-N mismatoh combination eference Probe ES3DV3 AE4 econdary Standards	GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601	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)	Oct-15 Oct-15 Oct-15 Mar-16 Mar-16 Dec-15 Aug-15
ower meter EPM-442A ower sensor HP 8481A ower sensor HP 8481A eference 20 dB Attenuator ype-N mismatoh combination leference Probe ES3DV3 AE4 econdary Standards F generator R&S SMT-06	GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601	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)	Oct-15 Oct-15 Oct-15 Mar-16 Mar-16 Dec-15 Aug-15 Scheduled Check
ower meter EPM-442A ower sensor HP 8481A ower sensor HP 8481A leference 20 dB Attenuator ype-N mismatoh combination teference Probe ES3DV3 IAE4 secondary Standards IF generator R&S SMT-06	GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # 100005	07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 01-Apr-15 (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)	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
ower meter EPM-442A ower sensor HP 8481A ower sensor HP 8481A leference 20 dB Attenuator ype-N mismatoh combination teference Probe ES3DV3 IAE4 secondary Standards IF generator R&S SMT-06 letwork Analyzer HP 8753E	GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # 100005 US37390585 54206	07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 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)	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
Primary Standards Prower meter EPM-442A Prower sensor HP 8481A Prower sensor HP 8481A Reference 20 dB Attenuator Proper Mismatch combination Reference Probe ES3DV3 DAE4 Recondary Standards RF generator R&S SMT-06 Retwork Analyzer HP 8753E Calibrated by:	GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # 100005 US37390585 S4206 Name	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) Function	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

Certificate No: D1800V2-2d047_Jul15

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



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S Swiss Calibration Service

Accreditation No.: SCS 0108

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Glossary:

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

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "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: D1800V2-2d047_Jul15

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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	1800 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	38.6 ± 6 %	1.42 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.78 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	38.5 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 250 mW input power	5.16 W/kg
		5.16 W/kg 20.4 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	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.0 ± 6 %	1.52 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	9.36 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	37.2 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Body TSL SAR measured	condition 250 mW input power	4.94 W/kg

Certificate No: D1800V2-2d047_Jul15



Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.1 Ω - 4.2 jΩ
Return Loss	- 27.3 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	44.3 Ω - 4.5 jΩ	
Return Loss	- 22.3 dB	

General Antenna Parameters and Design

Electrical Delay (and direction)	1.211 ns
Electrical Delay (one direction)	1.211 hs

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 16, 2002



DASY5 Validation Report for Head TSL

Date: 16.07.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN: 2d047

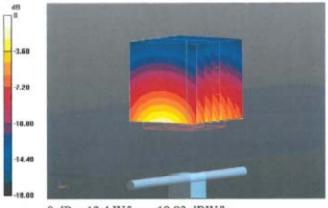
Communication System: UID 0 - CW; Frequency: 1800 MHz Medium parameters used: f = 1800 MHz; $\sigma = 1.42$ S/m; $\varepsilon_r = 38.6$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(5.06, 5.06, 5.06); Calibrated: 30.12.2014;
- 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 = 96.55 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 17.8 W/kg SAR(1 g) = 9.78 W/kg; SAR(10 g) = 5.16 W/kg Maximum value of SAR (measured) = 12.4 W/kg



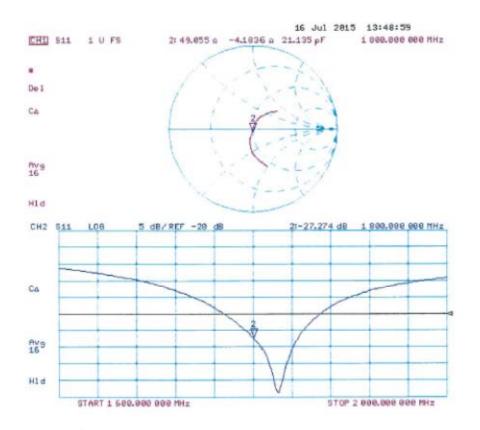
0 dB = 12.4 W/kg = 10.93 dBW/kg

Certificate No: D1800V2-2d047_Jul15

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Impedance Measurement Plot for Head TSL



Certificate No: D1800V2-2d047_Jul15

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DASY5 Validation Report for Body TSL

Date: 16.07.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN: 2d047

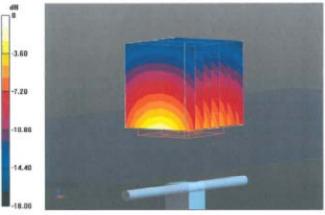
Communication System: UID 0 - CW; Frequency: 1800 MHz Medium parameters used: f = 1800 MHz; σ = 1.52 S/m; ϵ_r = 52; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.77, 4.77, 4.77); 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 = 90.97 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 16.9 W/kg SAR(1 g) = 9.36 W/kg; SAR(10 g) = 4.94 W/kg Maximum value of SAR (measured) = 11.8 W/kg



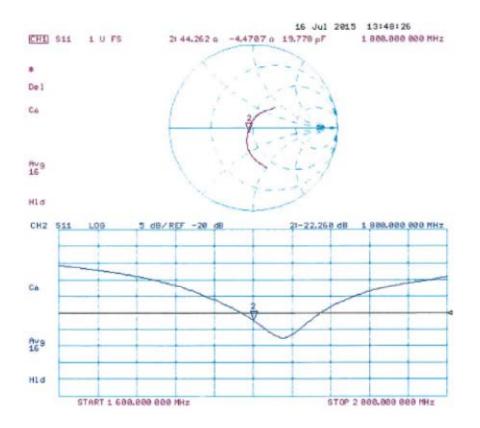
0 dB = 11.8 W/kg = 10.72 dBW/kg

Certificate No: D1800V2-2d047_Jul15

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Impedance Measurement Plot for Body TSL



Certificate No: D1800V2-2d047_Jul15

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Calibration Laboratory of	
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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 DT&C (Dymstec)

Certificate No: D1900V2-5d029_Sep15

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CALIBRATION C	ERTIFICATE	1	
Object	D1900V2 - SN:5	d029	
Calibration procedure(s)	QA CAL-05.v9 Calibration proce	dure for dipole validation kits ab	ove 700 MHz
Calibration date:	September 29, 2	015	
The measurements and the unce	rtainties with confidence p	ional standards, which realize the physical ur robability are given on the following pages arry facility: environment temperature $(22 \pm 3)^\circ$	nd are part of the certificate.
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. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (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
Reference Probe EX3DV4	SN: 7349	30-Dec-14 (No. EX3-7349_Dec14)	Dec-15
DAE4	SN: 601	17-Aug-15 (No. DAE4-601_Aug15)	Aug-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100972	15-Jun-15 (in house check Jun-15)	In house check: Jun-18
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-14)	In house check: Oct-15
	Name	Function	Signature
	Leif Klysner	Laboratory Technician	0 0 11
Calibrated by:			Sel Man
Calibrated by:			/
Calibrated by: Approved by:	Katja Pokovic	Technical Manager	Sel Man
	Katja Pokovic	Technical Manager	Issued: September 30, 2015

Certificate No: D1900V2-5d029_Sep15

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



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Accreditation No.: SCS 0108

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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: D1900V2-5d029_Sep15

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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	39.3 ± 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 ³ (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 ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 250 mW input power	5.24 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	52.6 ± 6 %	1.52 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.2 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	40.7 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.35 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.4 W/kg ± 16.5 % (k=2)

Certificate No: D1900V2-5d029_Sep15



Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.9 Ω + 4.8 jΩ	
Return Loss	- 26.0 dB	

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.3 Ω + 5.7 jΩ	
Return Loss	- 24.4 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.197 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	December 17, 2002

Certificate No: D1900V2-5d029_Sep15

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DASY5 Validation Report for Head TSL

Date: 29.09.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d029

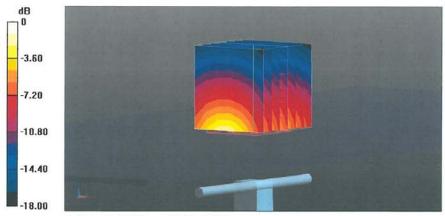
Communication System: UID 0 - CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz; σ = 1.38 S/m; ϵ_r = 39.3; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.14, 8.14, 8.14); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- 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=5mmReference Value = 109.5 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 18.9 W/kg SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.24 W/kg Maximum value of SAR (measured) = 15.5 W/kg



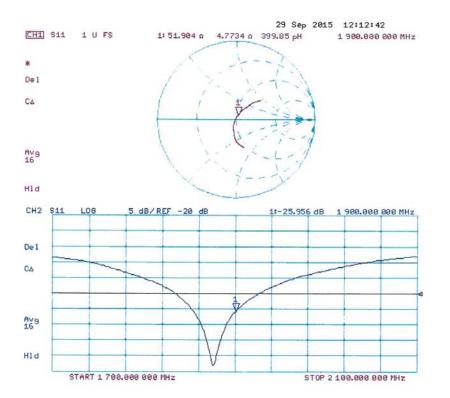
0 dB = 15.5 W/kg = 11.90 dBW/kg

Certificate No: D1900V2-5d029_Sep15

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Impedance Measurement Plot for Head TSL



Certificate No: D1900V2-5d029_Sep15

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DASY5 Validation Report for Body TSL

Date: 29.09.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d029

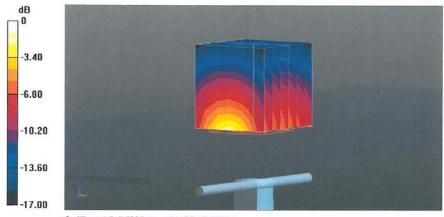
Communication System: UID 0 - CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz; σ = 1.52 S/m; ϵ_r = 52.6; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.9, 7.9, 7.9); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- 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=5mmReference Value = 104.7 V/m; Power Drift = 0.03 dB Peak SAR (extrapolated) = 18.2 W/kg SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.35 W/kg Maximum value of SAR (measured) = 15.5 W/kg



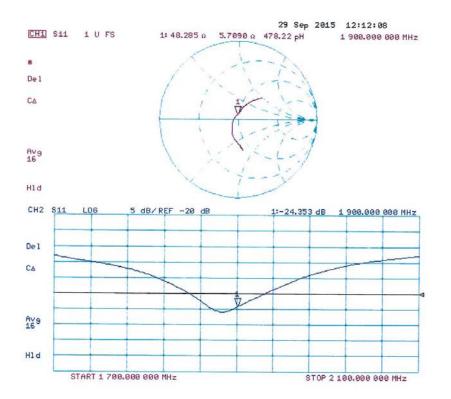
0 dB = 15.5 W/kg = 11.90 dBW/kg

Certificate No: D1900V2-5d029_Sep15

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Impedance Measurement Plot for Body TSL



Certificate No: D1900V2-5d029_Sep15

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	ation Service (SAS)		creditation No.: SCS 0108
ne Swiss Accreditation Service ultilateral Agreement for the n	12		
lient DT&C (Dymste	ec)	Certificate No	: D2450V2-726_Sep15
CALIBRATION C	CERTIFICATE		
Dbject	D2450V2 - SN: 7	26	
Calibration procedure(s)	QA CAL-05.v9 Calibration proce	dure for dipole validation kits abc	ove 700 MHz
Calibration date:	September 28, 20	015	
The measurements and the unce All calibrations have been condu	ertainties with confidence p cted in the closed laborator	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.
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The measurements and the unce All calibrations have been condu Calibration Equipment used (M& <u>Primary Standards</u> Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 <u>Secondary Standards</u> RF generator R&S SMT-06 Network Analyzer HP 8753E Calibrated by:	ertainties with confidence proceed in the closed laborator TE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # 100972 US37390585 S4206 Name	Cal Date (Certificate No.) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02131) 01-Apr-15 (No. 217-02134) 30-Dec-14 (No. EX3-7349_Dec14) 17-Aug-15 (No. DAE4-601_Aug15) Check Date (in house) 15-Jun-15 (in ouse check Jun-15) 18-Oct-01 (in house check Oct-14)	nd are part of the certificate. C and humidity < 70%. C and humidity < 70%. Oct-15 Oct-15 Oct-15 Mar-16 Mar-16 Dec-15 Aug-16 Scheduled Check In house check: Jun-18 In house check: Oct-15
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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 Suries Calibration Service
 - 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:

chio cour y .	
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: D2450V2-726_Sep15

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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	39.2 ± 6 %	1.86 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.0 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	51.2 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 250 mW input power	6.01 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	53.2 ± 6 %	2.00 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.5 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	49.5 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.84 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.2 W/kg ± 16.5 % (k=2)

Certificate No: D2450V2-726_Sep15



Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.5 Ω + 5.0 jΩ	
Return Loss	- 24.6 dB	

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.3 Ω + 6.1 jΩ	
Return Loss	- 24.2 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.160 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	January 09, 2003

Certificate No: D2450V2-726_Sep15

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DASY5 Validation Report for Head TSL

Date: 28.09.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz ; Type: D2450V2; Serial: D2450V2 - SN: 726

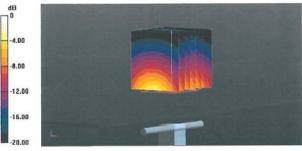
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz; σ = 1.86 S/m; ϵ_r = 39.2; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.67, 7.67, 7.67); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- 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 = 112.1 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 26.7 W/kg SAR(1 g) = 13 W/kg; SAR(10 g) = 6.01 W/kg Maximum value of SAR (measured) = 21.5 W/kg



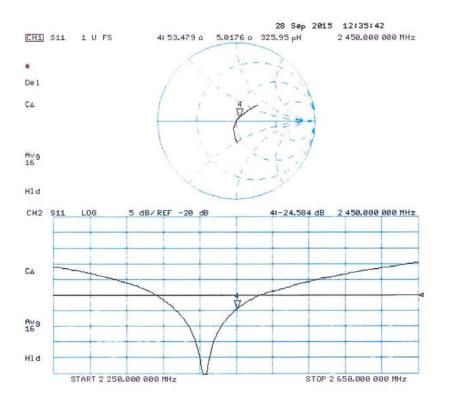
0 dB = 21.5 W/kg = 13.32 dBW/kg

Certificate No: D2450V2-726_Sep15

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Impedance Measurement Plot for Head TSL



Certificate No: D2450V2-726_Sep15

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DASY5 Validation Report for Body TSL

Date: 28.09.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz ; Type: D2450V2; Serial: D2450V2 - SN: 726

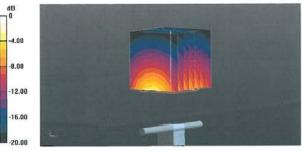
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz; σ = 2 S/m; ϵ_r = 53.2; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.53, 7.53, 7.53); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- 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 = 105.5 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 24.7 W/kg SAR(1 g) = 12.5 W/kg; SAR(10 g) = 5.84 W/kg Maximum value of SAR (measured) = 20.3 W/kg



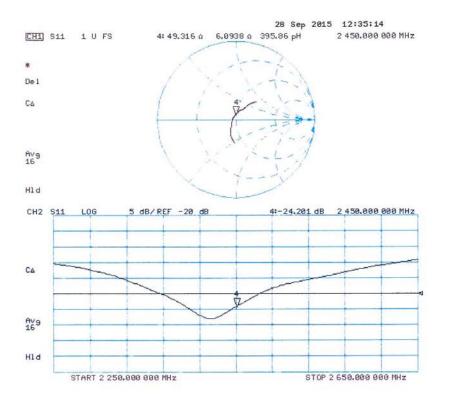
0 dB = 20.3 W/kg = 13.07 dBW/kg

Certificate No: D2450V2-726_Sep15

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Impedance Measurement Plot for Body TSL



Certificate No: D2450V2-726_Sep15

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Engineering AG eughausstrasse 43, 8004 Zuric	h, Switzerland		Service suisse d'étalonnage Servizio svizzero di taratura
Accredited by the Swiss Accredita The Swiss Accreditation Service Aultilateral Agreement for the re	e is one of the signatorie	s to the EA	ccreditation No.: SCS 0108
Client DT&C (Dymste	c)	Certificate N	o: D5GHzV2-1103_Mar15
CALIBRATION C	CERTIFICATE		
Object	D5GHzV2 - SN:	1103	
Calibration procedure(s)	QA CAL-22.v2 Calibration proce	dure for dipole validation kits be	tween 3-6 GHz
Calibration date:	March 23, 2015		
The measurements and the unce	rtainties with confidence p	ional standards, which realize the physical ur robability are given on the following pages ar ry facility: environment temperature (22 ± 3)°	nd are part of the certificate.
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&1	rtainties with confidence p cted in the closed laborato TE critical for calibration)	robability are given on the following pages an	nd are part of the certificate.
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&1 Primary Standards	rtainties with confidence p cted in the closed laborato ITE 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 conduc Calibration Equipment used (M&T Primary Standards Power meter EPM-442A	rtainties with confidence p cted in the closed laborato ITE critical for calibration) ID # GB37480704	robability are given on the following pages ar ny facility: environment temperature (22 ± 3)° Cal Date (Certificate No.) 07-Oct-14 (No. 217-02020)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-15
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&T Primary Standards Power meter EPM-442A Power sensor HP 8481A	rtainties with confidence p cted in the closed laborato TE critical for calibration) ID # GB37480704 US37292783	Cal Date (Certificate No.) 07-Oct-14 (No. 217-02020)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-15 Oct-15
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&T Primary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A	rtainties with confidence p cted in the closed laborato TE critical for calibration) ID # GB37480704 US37292783 MY41092317	Cal Date (Certificate No.) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-15 Oct-15 Oct-15 Oct-15
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&T Primary Standards Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator	rtainties with confidence p cted in the closed laborato TE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k)	Cal Date (Certificate No.) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02021) 03-Apr-14 (No. 217-01918)	And are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-15 Oct-15 Oct-15 Oct-15 Apr-15
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The measurements and the unce All calibrations have been conduct 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 EX3DV4 DAE4	International series of the se	Cal Date (Certificate No.) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02021) 03-Apr-14 (No. 217-01918) 03-Apr-14 (No. 217-01921) 30-Dec-14 (No. EX3-3503_Dec14) 18-Aug-14 (No. DAE4-601_Aug14)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-15 Oct-15 Oct-15 Apr-15 Apr-15 Dec-15 Dec-15 Aug-15
The measurements and the unce 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 EX3DV4 DAE4 Secondary Standards	Itainties with confidence p ted in the closed laborato IE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3503 SN: 601 ID #	Cal Date (Certificate No.) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02021) 03-Apr-14 (No. 217-01918) 03-Apr-14 (No. 217-01921) 30-Dec-14 (No. 217-01921) 18-Aug-14 (No. DAE4-601_Aug14) Check Date (in house)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-15 Oct-15 Oct-15 Oct-15 Apr-15 Apr-15 Dec-15 Aug-15 Scheduled Check
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The measurements and the unce 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 EX3DV4 DAE4 Secondary Standards RF generator R&S SMT-06 Network Analyzer HP 8753E	rtainties with confidence p cted in the closed laborato IE critical for calibration) ID # GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3503 SN: 601 ID # 100005	Cal Date (Certificate No.) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02021) 03-Apr-14 (No. 217-01918) 03-Apr-14 (No. 217-01921) 30-Dec-14 (No. 217-01921) 30-Dec-14 (No. 217-01921) Cal Dete (in house) 04-Aug-99 (in house check Oct-13)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-15 Oct-15 Oct-15 Apr-15 Apr-15 Dec-15 Aug-15 Scheduled Check In house check: Oct-16 In house check: Oct-15
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