

EX3DV4 Sn:3708

EX3DV4- SN:3708

November 10, 2016

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3708

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz)	Relative Permittivity ¹	Conductivity (S/m) ²	ConvF X	ConvF Y	ConvF Z	Alpha ³	Depth ⁴ (mm)	Unc (k=2)
900	41.5	0.97	9.05	9.05	9.05	0.48	0.90	± 12.0 %
1810	40.0	1.40	7.84	7.84	7.84	0.36	0.80	± 12.0 %
2000	40.0	1.40	7.85	7.85	7.85	0.31	0.80	± 12.0 %
2450	39.2	1.80	7.11	7.11	7.11	0.29	0.95	± 12.0 %
5200	36.0	4.66	5.53	5.53	5.53	0.35	1.80	± 13.1 %
5300	35.9	4.76	5.30	5.30	5.30	0.35	1.80	± 13.1 %
5500	35.6	4.96	5.00	5.00	5.00	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.81	4.81	4.81	0.40	1.80	± 13.1 %
5800	35.3	5.27	5.01	5.01	5.01	0.40	1.80	± 13.1 %

¹ Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2); else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 160 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

² At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

³ AlphaDepth are determined during calibration. SPEAC warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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November 10, 2016

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3708

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz)	Relative Permittivity ¹	Conductivity (S/m) ²	ConvF X	ConvF Y	ConvF Z	Alpha ³	Depth ⁴ (mm)	Unc (k=2)
900	55.0	1.05	9.10	9.10	9.10	0.48	0.80	± 12.0 %
1810	53.3	1.52	7.79	7.79	7.79	0.44	0.80	± 12.0 %
2000	53.3	1.52	7.71	7.71	7.71	0.43	0.80	± 12.0 %
2450	52.7	1.95	7.27	7.27	7.27	0.45	0.80	± 12.0 %
5200	49.0	5.30	4.62	4.62	4.62	0.45	1.90	± 13.1 %
5300	48.9	5.42	4.51	4.51	4.51	0.45	1.90	± 13.1 %
5500	48.6	5.65	4.07	4.07	4.07	0.50	1.90	± 13.1 %
5600	48.5	5.77	3.95	3.95	3.95	0.50	1.90	± 13.1 %
5800	48.2	6.00	4.13	4.13	4.13	0.50	1.90	± 13.1 %

¹ Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2); else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 160 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

² At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

³ AlphaDepth are determined during calibration. SPEAC warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

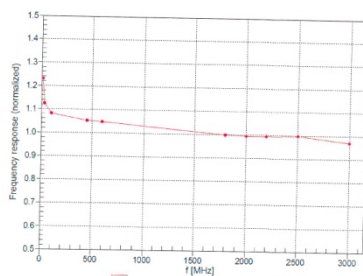
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Frequency Response of E-Field (TEM-Cell:R110 EXX, Waveguide: R22)



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

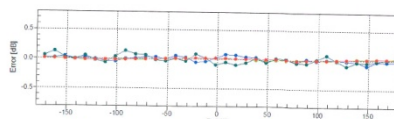
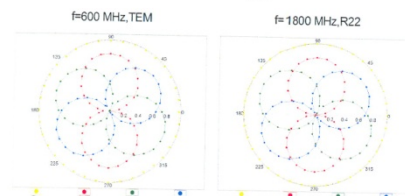
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Receiving Pattern (φ), θ = 0°



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

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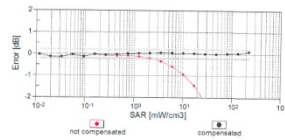
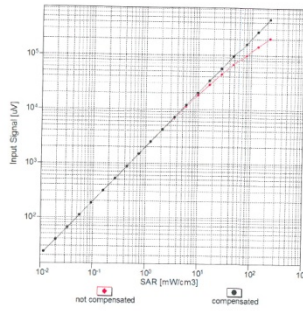
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Dynamic Range f(SAR_{head}) (TEM cell, f_{test}=1900 MHz)



Uncertainty of Linearity Assessment: $\pm 0.6\%$ (k=2)

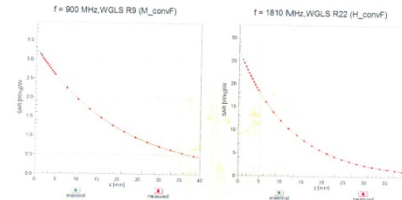
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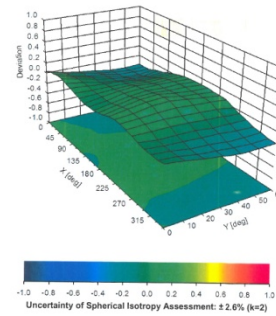
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Conversion Factor Assessment



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



Uncertainty of Spherical Isotropy Assessment: $\pm 2.6\%$ (k=2)

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DASY/EASY - Parameters of Probe: EX3DV4 - SN:3708

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-1.9
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

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D750V3 Sn:1101

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client: SRTC (Vites)

Certificate No: D750V3-1101_Oct16

CALIBRATION CERTIFICATE

Object: D750V3 - SN:1101

Calibration procedure(s): QA CAL-05_v9
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: October 24, 2016

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 (MATE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-251	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-251	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20K)	05-Apr-16 (No. 217-02290)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe ERX2V4	SN: 7349	15-Jun-16 (No. ERX-7349_Jun16)	Jun-17
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: 0837480704	07-Oct-15 (in house check Oct-16)	In house check Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check Oct-18
Power sensor HP 8481A	SN: MY1089317	07-Oct-15 (in house check Oct-16)	In house check Oct-18
RF generator R&S SM1-06	SN: 100972	15-Jun-16 (in house check Oct-18)	In house check Oct-18
Network Analyzer HP 8753E	SN: US37300585	18-Oct-15 (in house check Oct-18)	In house check Oct-17

Calibrated by: Laili Kiyner, Laboratory Technician, Signature: *Laili Kiyner*
Approved by: Katja Pokovic, Technical Manager, Signature: *Katja Pokovic*

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

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

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:

- 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
- 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
- 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
- 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%.

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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	41.1 ± 6 %	0.92 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.11 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	8.19 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.38 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	5.39 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	55.5	0.96 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	55.6 ± 6 %	0.97 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	---	---

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.17 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	8.62 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm³ (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	5.72 W/kg ± 18.5 % (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	55.4 Ω ± 0.2 (j)
Return Loss	- 25.9 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.8 Ω ± 2.4 (j)
Return Loss	- 32.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.034 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	July 05, 2013

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DASY5 Validation Report for Head TSL

Date: 24.10.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN:1101

Communication System: UID 0 - CW; Frequency: 750 MHz
Medium parameters used: $f = 750$ MHz; $\sigma = 0.92$ S/m; $\epsilon_r = 41.1$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(10.07, 10.07, 10.07); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

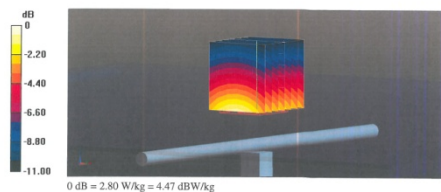
Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 58.05 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 3.14 W/kg

SAR(1 g) = 2.11 W/kg; SAR(10 g) = 1.38 W/kg

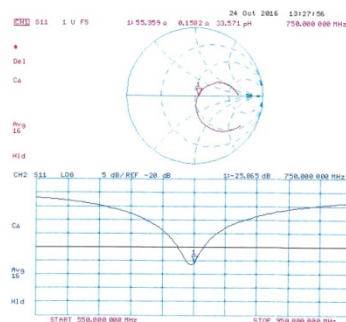
Maximum value of SAR (measured) = 2.80 W/kg



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Impedance Measurement Plot for Head TSL



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DASY5 Validation Report for Body TSL

Date: 24.10.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN:1101

Communication System: UID 0 - CW; Frequency: 750 MHz
Medium parameters used: $f = 750$ MHz; $\sigma = 0.97$ S/m; $\epsilon_r = 55.6$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.99, 9.99, 9.99); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

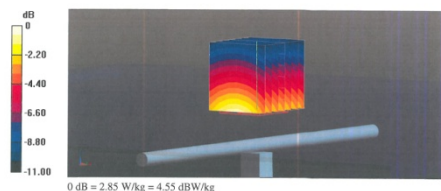
Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 56.73 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 3.19 W/kg

SAR(1 g) = 2.17 W/kg; SAR(10 g) = 1.44 W/kg

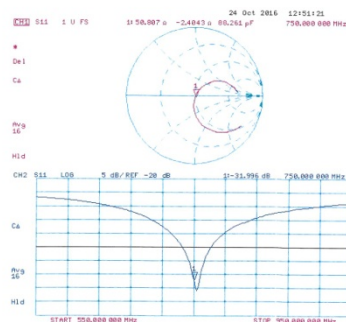
Maximum value of SAR (measured) = 2.85 W/kg



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Impedance Measurement Plot for Body TSL



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D835V2 Sn:4d023

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Accreditation No.: SCS 0108

Client: SRTC (Vitec)

Certificate No: D835V2-4d023_Oct16

CALIBRATION CERTIFICATE

Object	D835V2 - SN:4d023		
Calibration procedure(s)	QA CAL-05-V3 Calibration procedure for dipole validation kits above 700 MHz		
Calibration date:	October 24, 2016		
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 ± 0.2) °C and humidity < 70%.			
Calibration Equipment used (MATE critical for calibration)			
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02388-02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02388)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02388)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02392)	Apr-17
Type N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02396)	Apr-17
Reference Probe EX32V4	SN: 7349	15-Jun-16 (No. D32-7349_Jun16)	Jun-17
DAEA	SN: 601	30-Dec-15 (No. DAEA-601_Dec15)	Dec-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: G837480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US3792783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41082317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator RAS SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyser HP 8733E	SN: US37300585	19-Oct-15 (in house check Oct-16)	In house check: Oct-17
Calibrated by:	Name: Leif Kysner	Function: Laboratory Technician	Signature:
Approved by:	Katja Pokovic	Technical Manager	Signature:
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			Issued: October 25, 2016

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Accreditation No.: SCS 0108

Glossary:

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

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- 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
- 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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- 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: D835V2-4d023_Oct16

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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	40.8 ± 6 %	0.95 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.47 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.45 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.59 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	6.14 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	55.4 ± 6 %	0.99 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	---	---

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.44 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.82 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.60 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	6.33 W/kg ± 16.5 % (k=2)

Certificate No: D835V2-4d023_Oct16

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.4 Ω - 1.9 jΩ
Return Loss	-29.4 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.3 Ω - 5.1 jΩ
Return Loss	-25.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.389 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	December 17, 2004

Certificate No: D835V2-4d023_Oct16

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D835V2 Sn:4d023

DASY5 Validation Report for Head TSL

Date: 24.10.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d023

Communication System: UID 0 - CW; Frequency: 835 MHz
Medium parameters used: $f = 835$ MHz; $\sigma = 0.95$ S/m; $\epsilon_r = 40.8$; $\rho = 1000$ 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: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

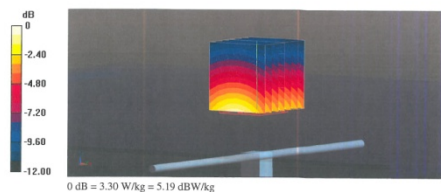
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 61.72 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 3.72 W/kg

SAR(1 g) = 2.47 W/kg; SAR(10 g) = 1.59 W/kg

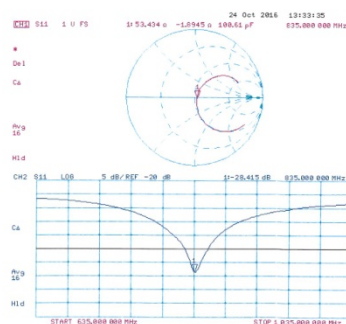
Maximum value of SAR (measured) = 3.30 W/kg



Certificate No: D835V2-4d023_Oct16

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Impedance Measurement Plot for Head TSL



Certificate No: D835V2-4d023_Oct16

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DASY5 Validation Report for Body TSL

Date: 24.10.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d023

Communication System: UID 0 - CW; Frequency: 835 MHz
Medium parameters used: $f = 835$ MHz; $\sigma = 0.99$ S/m; $\epsilon_r = 55.4$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.73, 9.73, 9.73); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

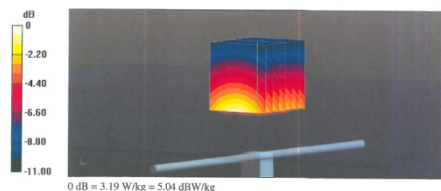
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 59.97 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 3.54 W/kg

SAR(1 g) = 2.44 W/kg; SAR(10 g) = 1.6 W/kg

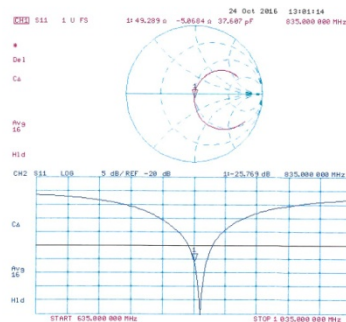
Maximum value of SAR (measured) = 3.19 W/kg



Certificate No: D835V2-4d023_Oct16

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Impedance Measurement Plot for Body TSL



Certificate No: D835V2-4d023_Oct16

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D1900V2 Sn:5d113

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Accreditation No.: SCS 0108

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Client: SRTC (Vitec)

Certificate No: D1900V2-5d113_Oct16

CALIBRATION CERTIFICATE

Object	D1900V2 - SN:5d113		
Calibration procedure(s)	QA CAL-05 v9 Calibration procedure for dipole validation kits above 700 MHz		
Calibration date:	October 31, 2016		
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 NRP	SN: 104778	06-Apr-16 (No. 217-02286/02289)	Apr-17
Power sensor NRP-Z21	SN: 103244	06-Apr-16 (No. 217-02286)	Apr-17
Power sensor NRP-Z21	SN: 103245	06-Apr-16 (No. 217-02286)	Apr-17
Reference 30 dB Attenuator	SN: 5058 (D04)	06-Apr-16 (No. 217-02286)	Apr-17
Type-A inductance combination	SN: 5047.2 / 06327	06-Apr-16 (No. 217-02286)	Apr-17
Reference Probe EXD0V4	SN: 7349	15-Jun-16 (No. 130-7349_Jun16)	Jun-17
DAEA	SN: 801	30-Dec-16 (No. DAE4-001_Dec16)	Dec-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-16 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8441A	SN: U537292763	07-Oct-16 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8441A	SN: M141092317	07-Oct-16 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-08	SN: 100972	15-Jun-16 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8733E	SN: U53790585	18-Oct-16 (in house check Oct-16)	In house check: Oct-17
Calibrated by:	Name: Jaton Kasrati, Function: Laboratory Technician, Signature: [Signature]		
Approved by:	Name: Kapa Pokovic, Function: Technical Manager, Signature: [Signature]		
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			
Issued: October 31, 2016			

Certificate No: D1900V2-5d113_Oct16

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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:

- 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
- 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
- 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- 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: D1900V2-5d113_Oct16

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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	49.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.6 ± 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	40.7 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.3 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	53.2 ± 6 %	1.48 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	9.80 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	39.8 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.23 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.1 W/kg ± 16.5 % (k=2)

Certificate No: D1900V2-5d113_Oct16

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.1 Ω ± 6.5 Ω
Return Loss	-23.8 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.0 Ω ± 7.2 Ω
Return Loss	-21.9 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.200 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard. No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	July 24, 2009

Certificate No: D1900V2-5d113_Oct16

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D1900V2 Sn:5d113

DASY5 Validation Report for Head TSI

Date: 31.10.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d1113

Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: $f = 1900$ MHz; $\sigma = 1.39$ S/m; $\epsilon_r = 40.6$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.99, 7.99, 7.99); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

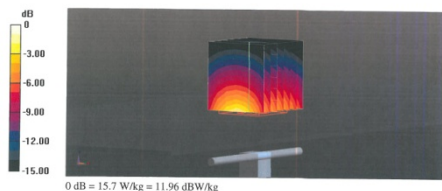
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$
Reference Value = 108.4 M/m ; Power Drift = 0.02%

Reference Value = 108.4 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 10.0 W/kg

Peak SAR (extrapolated) = 19.0 W/kg
SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.3 W/kg

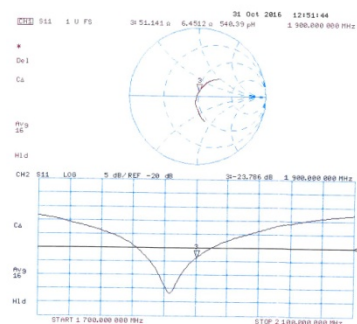
Maximum value of SAR (measured) = 15.7 W/kg



Certificate No: D1900V2-5d113_Oct16

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Impedance Measurement Plot for Head TSL



Certificate No: D1900V2-5d113_Oct16

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DASY5 Validation Report for Body TSL

Date: 31.10.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d113

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.48$ S/m; $\epsilon_r = 53.2$; $\rho = 1000$ kg/m³

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.03, 8.03, 8.03); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

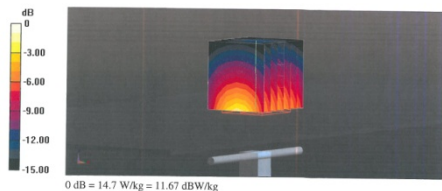
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

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

Reference Value = 104.5 V/m; Power Drift = -0.09 dB
Peak S.A.B. (extrapolated) = 17.2 W/m²

Peak SAR (extrapolated) = 17.2 W/kg
SAR(1 g) = 9.8 W/kg; SAR(10 g) = 5.23 W/kg

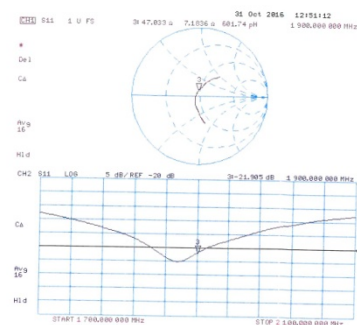
Maximum value of SAR (measured) = 14.7 W/kg



Certificate No: D1900V2-5d113_Oct16

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Impedance Measurement Plot for Body TSL



Certificate No: D1900V2-5d113_Oct16

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D2450V2 Sn:738

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Client: SRTC (Vitec)

Certificate No: D2450V2-738_Oct16

CALIBRATION CERTIFICATE

Object: D2450V2 - SN:738

Calibration procedure(s): QA CAL-05.v0
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: October 25, 2016

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 ± 2)°C and humidity < 70%.

Calibration Equipment used (MATE criteria for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-231	SN: 103844	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-231	SN: 103845	06-Apr-16 (No. 217-02288)	Apr-17
Reference 20 dB Attenuator	SN: 3068 (B04)	05-Apr-16 (No. 217-02282)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 00327	05-Apr-16 (No. 217-02286)	Apr-17
Reference Probe EX20V4	SN: 7348	15-Jun-16 (No. E30-7348_Jun16)	Jun-17
DAEA	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: G837480704	07-Oct-15 (in house check Oct-15)	In house check: Oct-16
Power sensor HP 8441A	SN: US37292703	07-Oct-15 (in house check Oct-15)	In house check: Oct-16
Power sensor HP 8441A	SN: MY41092317	07-Oct-15 (in house check Oct-15)	In house check: Oct-16
RF generator RAS SMF-06	SN: 100972	15-Jun-15 (in house check Oct-15)	In house check: Oct-16
Network Analyzer HP 8733E	SN: US37300585	18-Jun-01 (in house check Oct-15)	In house check: Oct-17

Calibrated by: Claudio Leubner, Laboratory Technician

Approved by: Kaja Piskovic, Technical Manager

Issued: October 25, 2016

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

Certificate No: D2450V2-738_Oct16

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Glossary:

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

Calibration is Performed According to the Following Standards:

- 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
- 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
- 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- 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: D2450V2-738_Oct16

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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	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied:

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.5) °C	38.2 ± 6 %	1.87 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	51.2 W/kg ± 17.5 % (k=2)
SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.07 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.9 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	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.3 ± 6 %	2.02 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	---	---

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.0 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	50.8 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.08 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.0 W/kg ± 16.5 % (k=2)

Certificate No: D2450V2-738_Oct16

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.6 Ω ± 2.1 Ω
Return Loss	- 27.8 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.7 Ω ± 5.9 Ω
Return Loss	- 24.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.157 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	SPEAD
Manufactured on	August 26, 2003

Certificate No: D2450V2-738_Oct16

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D2450V2 Sn:738

DASY5 Validation Report for Head TSL

Date: 25.10.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:738

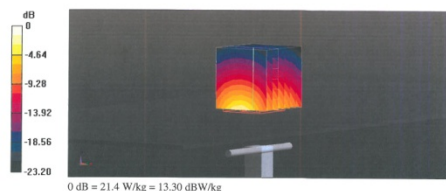
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: $f = 2450$ MHz; $\sigma = 1.87$ S/m; $\epsilon_r = 38.2$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.72, 7.72, 7.72); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

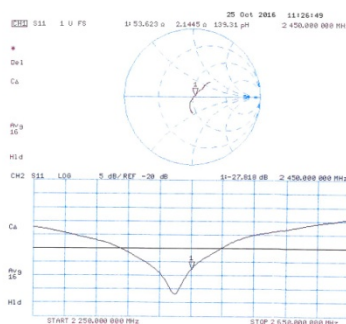
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 111.7 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 26.4 W/kg
SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.07 W/kg
Maximum value of SAR (measured) = 21.4 W/kg



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Impedance Measurement Plot for Head TSL



Certificate No: D2450V2-738_Oct16

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DASY5 Validation Report for Body TSL

Date: 25.10.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:738

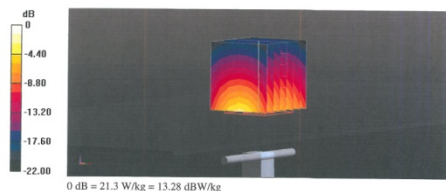
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: $f = 2450$ MHz; $\sigma = 2.02$ S/m; $\epsilon_r = 51.3$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.79, 7.79, 7.79); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

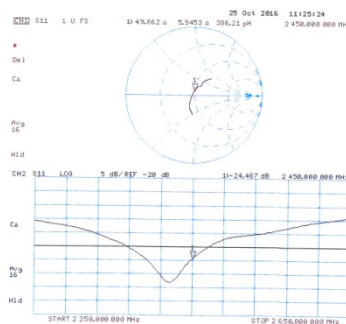
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 107.3 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 26.0 W/kg
SAR(1 g) = 13 W/kg; SAR(10 g) = 6.08 W/kg
Maximum value of SAR (measured) = 21.3 W/kg



Certificate No: D2450V2-738_Oct16

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Impedance Measurement Plot for Body TSL



Certificate No: D2450V2-738_Oct16

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D2600V2 Sn:1089

Calibration Laboratory of
Schindler & Partner
Engineering AG
Zürcherstrasse 43, 8034 Zurich, Switzerland



S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Swiss Institute of Metrology
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: Sony Mobile CH (Vitec)

Certificate No. D2600V2-1089_Jul16

CALIBRATION CERTIFICATE

Object: D2600V2 - SN: 1089

Calibration procedure(s):

QA CAL-05-V9

Calibration procedure for dipole validation kits above 700 MHz

Calibration date:

July 13, 2016

This calibration certificate documents the traceability to national standards, which ensure the physical units of measurement (SI).
The measurement 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 stated laboratory facility and under ambient temperature (22 ± 0.5 °C) and humidity < 75%.

Calibration Equipment used (EMTE output for calibration):

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104776	06-Apr-16 (No. 217-02089-02089)	Apr-17
Power sensor NRP-Z91	SN: 100044	06-Apr-16 (No. 217-02089)	Apr-17
Power sensor NRP-Z91	SN: 100045	06-Apr-16 (No. 217-02089)	Apr-17
Reference 20 dB Attenuator	SN: 0558 (20k)	06-Apr-16 (No. 217-02089)	Apr-17
Feed Point Impedance Calibration	SN: 104772 (NRP-Z)	16-Apr-16 (No. 217-02089)	Apr-17
Reference Power Loss Coefficient	SN: 104773	16-Apr-16 (No. 217-02089)	Apr-17
Secondary Standards	ID #	Check Date (Certificate No.)	Scheduled Check
Power meter EPR-403	SN: 1001180104	17-Oct-15 (No. 217-02089)	16-Nov-16 Check Oct-16
Power sensor HP-3481A	SN: 1001180103	17-Oct-15 (No. 217-02089)	16-Nov-16 Check Oct-16
Power sensor HP-3481A	SN: 1001180102	17-Oct-15 (No. 217-02089)	16-Nov-16 Check Oct-16
IE Generator 16S-5011 (G)	SN: 110217	15-Jun-15 (No. 100-000-0000) (No. 110)	16-Nov-16 Check Feb-16
Antenna Impedance 17-1875V	SN: 1001180105	16-Oct-15 (No. 100-000-0000) (No. 110)	16-Nov-16 Check Feb-16

Calibrated by:

John Kottus

Laboratory Technician

Approved by:

Kolja Pokorski

Technical Manager

This certificate should read only be reissued under the strictest conditions and only after agreement of the authority.

Certificate No. D2600V2-1089_Jul16

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Calibration Laboratory of
Schindler & Partner
Engineering AG
Zürcherstrasse 43, 8034 Zurich, Switzerland



S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Swiss Institute of Metrology
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

Glossary:

TSL: Issue simulating liquid
ConF: sensitivity in TSL / IORR x y z
N/A: not applicable or not measured

Calibration is Performed According to the Following Standards:

- 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
- 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
- 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
- KDB 855664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- 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

(SAR system configuration, as described on page 1)

DASY Version	DAW1.0	avg. SAR
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	off-Resonance
Zoom Scan Resolution	(x, y, z) = 5 mm	
Frequency	2700 MHz ± 1.5 MHz	

Head TSL parameters

The following parameters and calculations were applied:

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	79.0	1.66 mS/m
Measured Head TSL parameters	22.0 ± 0.2 °C	77.5 ± 6 %	2.02 mS/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL

SAR averaged over 1 cm ² (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	14.6 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	57.1 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ² (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	6.46 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.5 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	52.5	2.16 mS/m
Measured Body TSL parameters	22.0 ± 0.2 °C	51.4 ± 6 %	2.20 mS/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	---	---

SAR result with Body TSL

SAR averaged over 1 cm ² (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.6 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	53.7 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ² (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	6.06 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.1 W/kg ± 16.5 % (k=2)

Certificate No. D2600V2-1089_Jul16

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	48.5 Ω ± 6.8 Ω
Return Loss	> 20.0 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	55.8 Ω ± 6.0 Ω
Return Loss	> 22.9 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.148 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 device is made of standard serrated metal cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is flexible and short-circuited to 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 15, 2014

Certificate No. D2600V2-1089_Jul16

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D2600V2 Sn:1089

DASY5 Validation Report for Head TSL

Date: 15/07/2016

Test Laboratory: SP/AGL Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1089

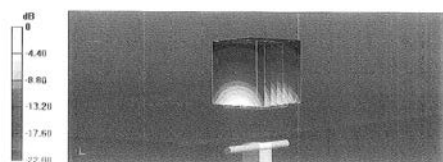
Communication System: UTD 0 - CW; Frequency: 2600 MHz
Medium parameters used: $f = 2600$ MHz; $n = 2.02$ S/m; $\epsilon_r = 37.5$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/ECANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF:7.56, 7.56, 7.56; Calibrated: 15.06.2016
- Sensor Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

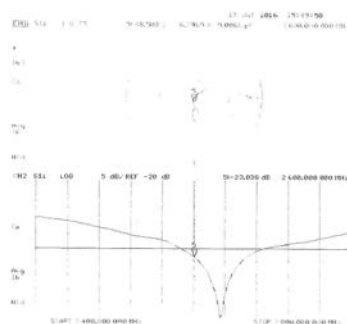
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value ≈ 17.2 V/m; Power Drift ≈ 0.01 dB
Peak SAR (extrapolated) ≈ 11.2 W/kg
NAR(1 g) ≈ 14.6 W/kg; SAR(10 g) ≈ 6.46 W/kg
Maximum value of SAR (measured) ≈ 25.0 W/kg



Cartesian (dx: 1000/100/100) - Jul 16

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Impedance Measurement Plot for Head TSL



Cartesian (dx: 1000/100/100) - Jul 16

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DASY5 Validation Report for Body TSL

Date: 07/07/2016

Test Laboratory: SP/AGL Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1089

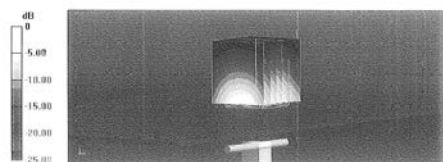
Communication System: UTD 0 - CW; Frequency: 2600 MHz
Medium parameters used: $f = 2600$ MHz; $n = 2.2$ S/m; $\epsilon_r = 51.4$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/ECANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF:7.48, 7.48, 7.48; Calibrated: 15.06.2016
- Sensor Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

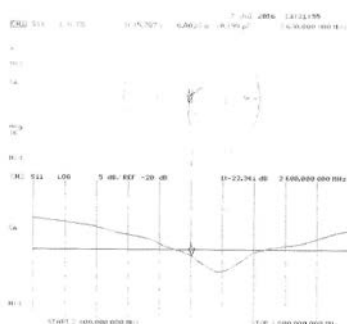
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value ≈ 105.3 V/m; Power Drift ≈ -0.07 dB
Peak SAR (extrapolated) ≈ 27.8 W/kg
NAR(1 g) ≈ 13.6 W/kg; SAR(10 g) ≈ 6.06 W/kg
Maximum value of SAR (measured) ≈ 21.9 W/kg



Cartesian (dx: 1000/100/100) - Jul 16

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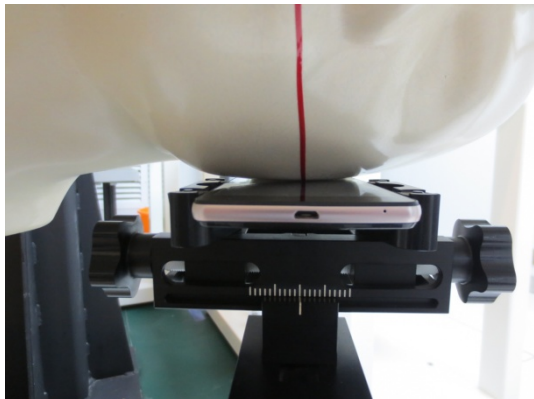
Impedance Measurement Plot for Body TSL



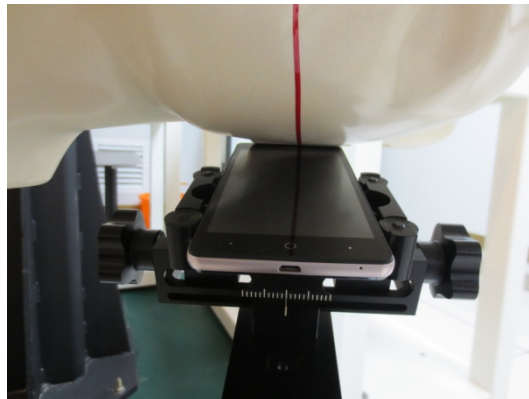
Cartesian (dx: 1000/100/100) - Jul 16

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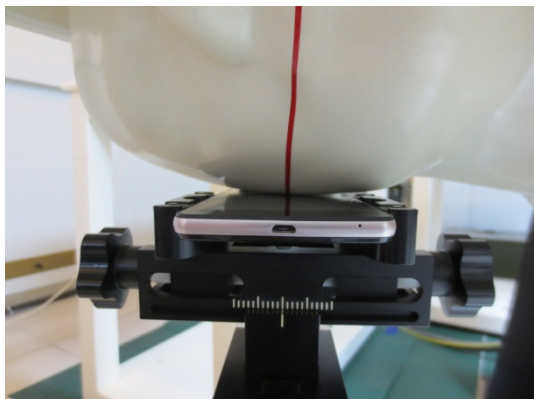
ANNEX C - PHOTOGRAPH



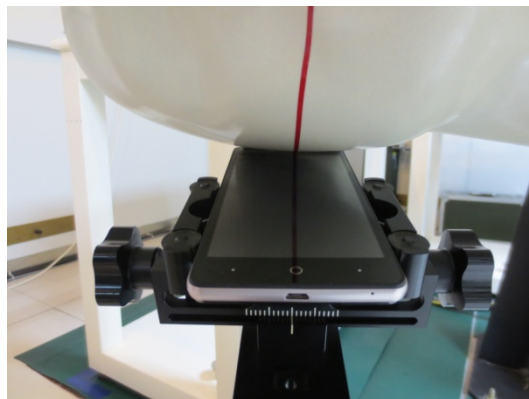
Cheek position, left side



Tilt position, left side



Cheek position, Right side



Tilt position, Right side



FLAT position, Towards phantom



FLAT position, Towards ground

	
FLAT position, EDGE1	FLAT position, EDGE2
	
FLAT position, EDGE3	FLAT position, EDGE4
	
10mm Spacer	

---End of Test Report---