

3. System Validation Dipole (D1800V2,S/N: 2d04)

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



S Schweizerischer Kalibrierdienst
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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client **UL Japan (PTT)**

Certificate No: **D1800V2-2d040_Dec10**

CALIBRATION CERTIFICATE																																															
Object	D1800V2 - SN: 2d040																																														
Calibration procedure(s)	QA CAL-05.v7 Calibration procedure for dipole validation kits																																														
Calibration date:	December 09, 2010																																														
<p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.</p> <p>Calibration Equipment used (M&TE critical for calibration)</p> <table border="1"> <thead> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date (Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Power meter EPM-442A</td> <td>GB37480704</td> <td>06-Oct-10 (No. 217-01266)</td> <td>Oct-11</td> </tr> <tr> <td>Power sensor HP 8481A</td> <td>US37292783</td> <td>06-Oct-10 (No. 217-01266)</td> <td>Oct-11</td> </tr> <tr> <td>Reference 20 dB Attenuator</td> <td>SN: 5086 (20g)</td> <td>30-Mar-10 (No. 217-01158)</td> <td>Mar-11</td> </tr> <tr> <td>Type-N mismatch combination</td> <td>SN: 5047.2 / 06327</td> <td>30-Mar-10 (No. 217-01162)</td> <td>Mar-11</td> </tr> <tr> <td>Reference Probe ES3DV3</td> <td>SN: 3205</td> <td>30-Apr-10 (No. ES3-3205_Apr10)</td> <td>Apr-11</td> </tr> <tr> <td>DAE4</td> <td>SN: 601</td> <td>10-Jun-10 (No. DAE4-601_Jun10)</td> <td>Jun-11</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th>Secondary Standards</th> <th>ID #</th> <th>Check Date (in house)</th> <th>Scheduled Check</th> </tr> </thead> <tbody> <tr> <td>Power sensor HP 8481A</td> <td>MY41092317</td> <td>18-Oct-02 (in house check Oct-09)</td> <td>In house check: Oct-11</td> </tr> <tr> <td>RF generator R&S SMT-06</td> <td>100005</td> <td>4-Aug-99 (in house check Oct-09)</td> <td>In house check: Oct-11</td> </tr> <tr> <td>Network Analyzer HP 8753E</td> <td>US37390585 S4206</td> <td>18-Oct-01 (in house check Oct-10)</td> <td>In house check: Oct-11</td> </tr> </tbody> </table>				Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration	Power meter EPM-442A	GB37480704	06-Oct-10 (No. 217-01266)	Oct-11	Power sensor HP 8481A	US37292783	06-Oct-10 (No. 217-01266)	Oct-11	Reference 20 dB Attenuator	SN: 5086 (20g)	30-Mar-10 (No. 217-01158)	Mar-11	Type-N mismatch combination	SN: 5047.2 / 06327	30-Mar-10 (No. 217-01162)	Mar-11	Reference Probe ES3DV3	SN: 3205	30-Apr-10 (No. ES3-3205_Apr10)	Apr-11	DAE4	SN: 601	10-Jun-10 (No. DAE4-601_Jun10)	Jun-11	Secondary Standards	ID #	Check Date (in house)	Scheduled Check	Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-09)	In house check: Oct-11	RF generator R&S SMT-06	100005	4-Aug-99 (in house check Oct-09)	In house check: Oct-11	Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-10)	In house check: Oct-11
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Calibrated by:	Name Dimce Iliev	Function Laboratory Technician	Signature 																																												
Approved by:	Katja Pokovic	Technical Manager																																													
Issued: December 14, 2010																																															
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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 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- 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) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

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.

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Measurement Conditions

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

DASY Version	DASY5	V52.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
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	39.6 ± 6 %	1.35 mho/m ± 6 %
Head TSL temperature during test	(21.0 ± 0.2) °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.60 mW / g
SAR normalized	normalized to 1W	38.4 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	39.3 mW /g ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.04 mW / g
SAR normalized	normalized to 1W	20.2 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	20.4 mW /g ± 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	(21.2 ± 0.2) °C	52.9 ± 6 %	1.45 mho/m ± 6 %
Body TSL temperature during test	(21.0 ± 0.2) °C	---	---

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	9.34 mW / g
SAR normalized	normalized to 1W	37.4 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	38.4 mW / g ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	4.98 mW / g
SAR normalized	normalized to 1W	19.9 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	20.2 mW / g ± 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	48.8 Ω - 1.9 j Ω
Return Loss	- 33.1 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	44.4 Ω - 2.2 j Ω
Return Loss	- 24.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.205 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.

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

DASY5 Validation Report for Head TSL

Date/Time: 07.12.2010 12:17:06

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN:2d040

Communication System: CW; Frequency: 1800 MHz; Duty Cycle: 1:1

Medium: HSL U12 BB

Medium parameters used: $f = 1800$ MHz; $\sigma = 1.34$ mho/m; $\epsilon_r = 39.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.05, 5.05, 5.05); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- Measurement SW: DASY52, V52.2 Build 0, Version 52.2.0 (163)
- Postprocessing SW: SEMCAD X, V14.2 Build 2, Version 14.2.2 (1685)

Pin=250 mW /d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0: Measurement

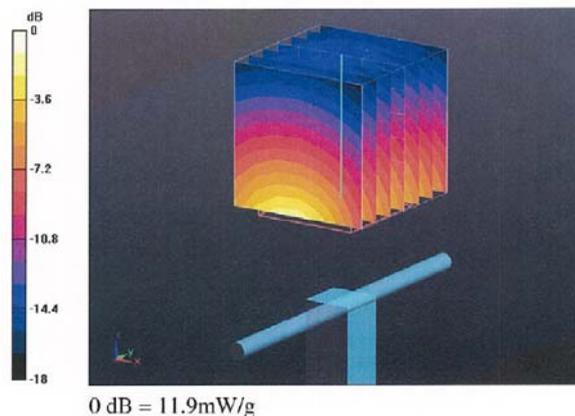
grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 97.8 V/m; Power Drift = 0.039 dB

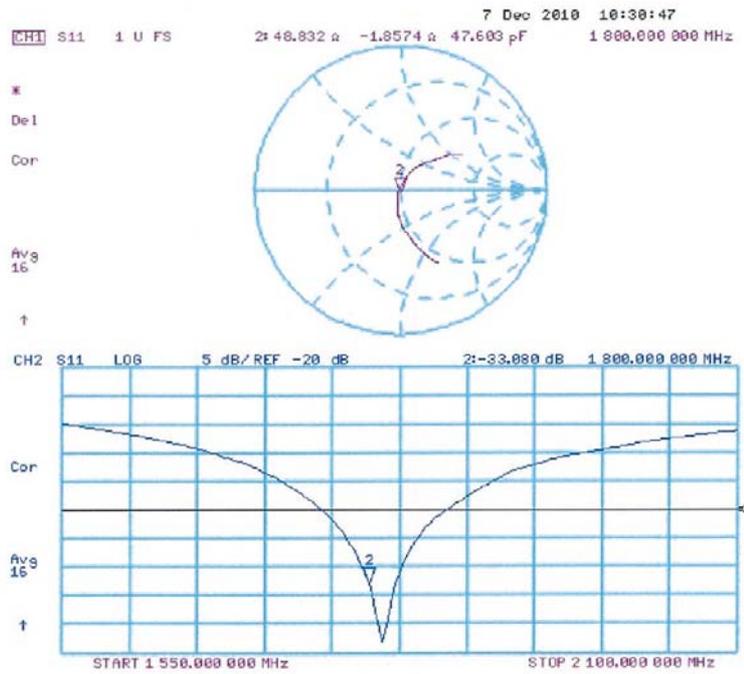
Peak SAR (extrapolated) = 17.5 W/kg

SAR(1 g) = 9.6 mW/g; SAR(10 g) = 5.04 mW/g

Maximum value of SAR (measured) = 11.9 mW/g



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date/Time: 09.12.2010 11:14:21

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN:2d040

Communication System: CW; Frequency: 1800 MHz; Duty Cycle: 1:1

Medium: MSL U12 BB

Medium parameters used: $f = 1800$ MHz; $\sigma = 1.45$ mho/m; $\epsilon_r = 53.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.74, 4.74, 4.74); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- Measurement SW: DASY52, V52.2 Build 0, Version 52.2.0 (163)
- Postprocessing SW: SEMCAD X, V14.2 Build 2, Version 14.2.2 (1685)

Pin=250 mW /d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0: Measurement

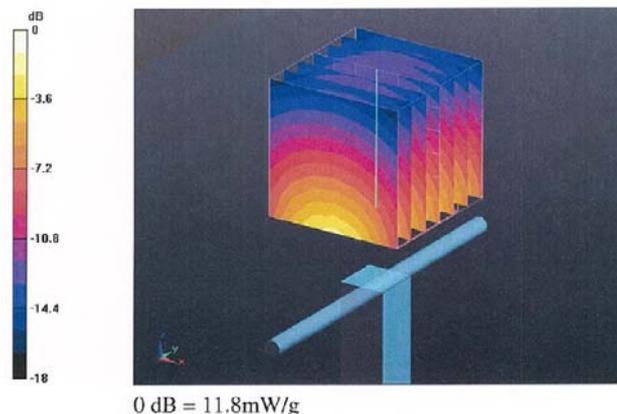
grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.6 V/m; Power Drift = -0.025 dB

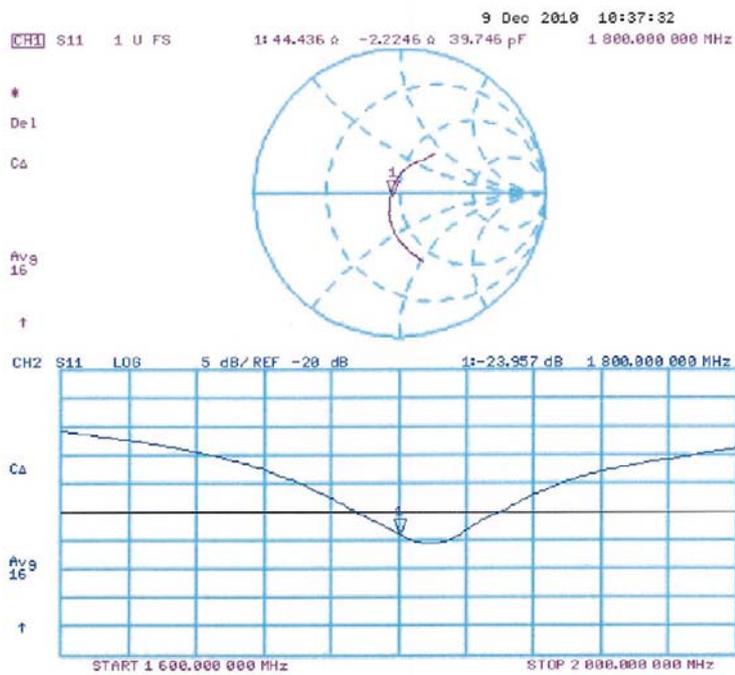
Peak SAR (extrapolated) = 16 W/kg

SAR(1 g) = 9.34 mW/g; SAR(10 g) = 4.98 mW/g

Maximum value of SAR (measured) = 11.8 mW/g



Impedance Measurement Plot for Body TSL



D1800V2 Calibration for Impedance and Return-loss

1. Test environment

Date	November 23, 2011		
Ambient Temperature	24.0 deg.C	Relative humidity	45%RH

2. Equipment used

Control No.	Instrument	Manufacturer	Model No	Serial No	Calibration Date * Interval(month)
MNA-01	Network Analyzer	Agilent/HP	E8358A	US41080381	2011/08/22 * 12
MNCK-01	Type N Calibration Kit	Agilent	85032F	MY41495257	2011/08/12 * 12
EST-46	3.5mm Calibration Kit	Agilent	85052D	MY43252869	2011/06/13 * 12
MDA-06	Dipole Antenna	Schmid&Partner Engineering AG	D1800V2	2d040	2010/12/09 * 36
MPF-01	Flat Phantom	Schmid&Partner Engineering AG	2.0mm Flat Phantom V4.3L	1005	2011/04/01 * 12
MOS-24	Thermo-Hygrometer	Custom	CTH-201	0005	2011/02/23 * 12
HSL1800					Daily check
MSL1800					Daily check
SAR room					Daily check

3. Test Result

Impedance, Transformed to feed point	Head	Deviation	Tolerance	Result
Calibration (SPEAG) 2010/12/09	48.8 Ω -1.9j Ω	-	-	-
Calibration(ULJ)2011/11/23	46.56 Ω +1.518j Ω	0.38 Ω -0.65j Ω	+/-5 Ω +/-5j Ω	Complied

Return loss	Head	Deviation	Tolerance	Result
Calibration (SPEAG) 2010/12/09	-33.1dB	-	-	-
Calibration(ULJ)2011/11/23	-28.18dB	4.92dB	33.1 *+/-20%	Complied

Impedance, Transformed to feed point	Body	Deviation	Tolerance	Result
Calibration (SPEAG) 2010/12/09	44.4 Ω -2.2j Ω	-	-	-
Calibration(ULJ)2011/11/23	43.22 Ω +0.895j Ω	-1.18 Ω +3.095j Ω	+/-5 Ω +/-5j Ω	Complied

Return loss	Body	Deviation	Tolerance	Result
Calibration (SPEAG) 2010/12/09	-24.0dB	-	-	-
Calibration(ULJ)2011/11/23	-22.69dB	1.31dB	24*+/-20%	Complied

*Tolerance : According to the KDB450824D02

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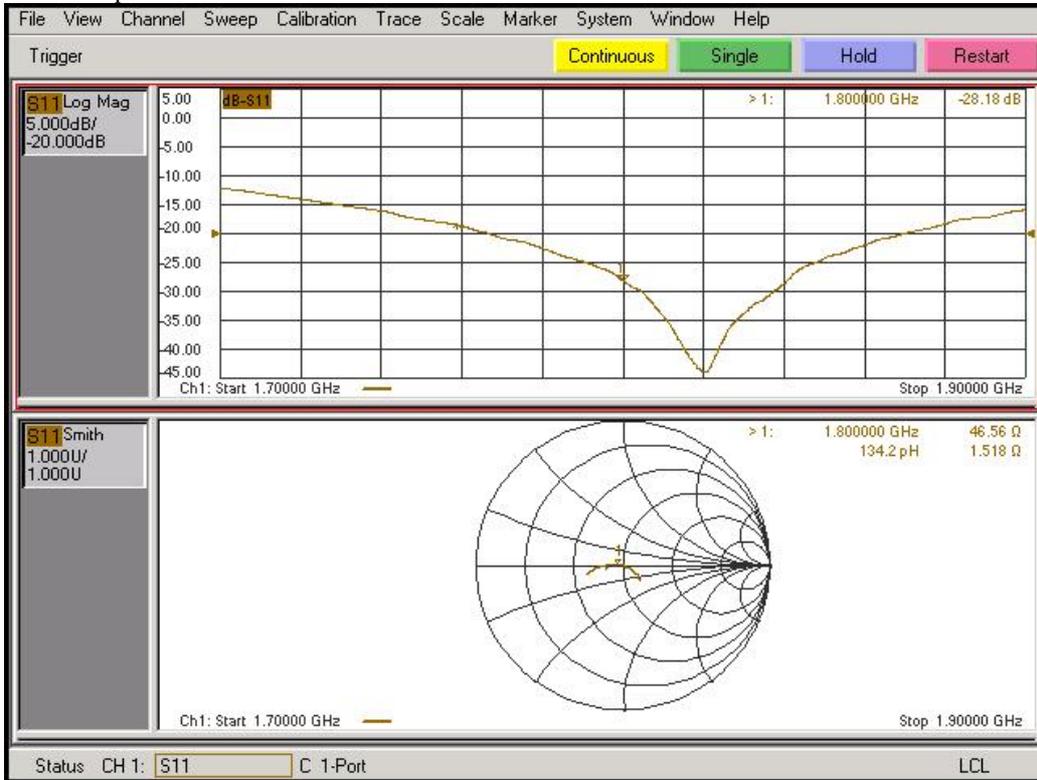
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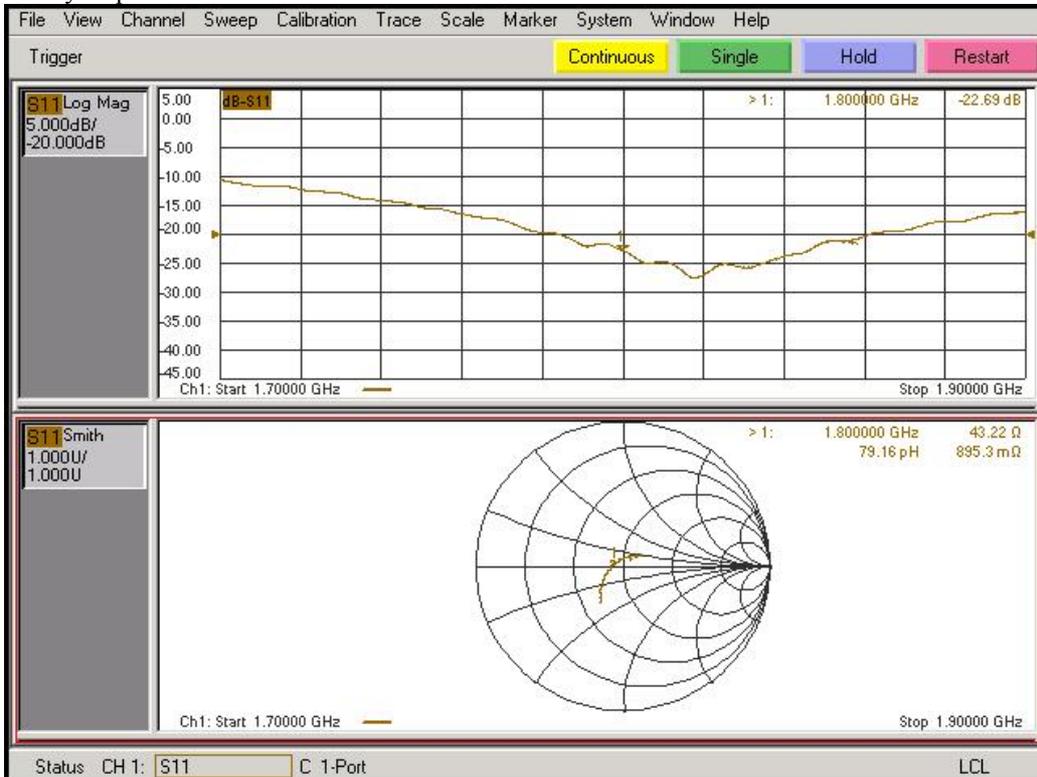
Facsimile: +81 596 24 8124

Measurement Plots

<Head Liquid>



<Body Liquid>



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4. System Validation Dipole (D2450V2,S/N:822)

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 Zeughausstrasse 43, 8004 Zurich, Switzerland



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C Service suisse d'étalonnage
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Accreditation No.: **SCS 108**

Client

UL Japan (PIT)

Certificate No: **D2450V2-822_Jan12**

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 822																																														
Calibration procedure(s)	QA CAL-05.v8 Calibration procedure for dipole validation kits above 700 MHz																																														
Calibration date:	January 10, 2012																																														
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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 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- 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) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

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.

UL Japan, Inc.

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Measurement Conditions

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

DASY Version	DASY5	V52.8.0
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 \pm 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 \pm 0.2) °C	39.2 \pm 6 %	1.85 mho/m \pm 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	13.2 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	52.1 mW / g \pm 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.12 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	24.3 mW / g \pm 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 \pm 0.2) °C	50.6 \pm 6 %	2.01 mho/m \pm 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	13.2 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	51.6 mW / g \pm 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.10 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	24.1 mW / g \pm 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.9 Ω + 4.1 j Ω
Return Loss	- 25.3 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	51.1 Ω + 5.3 j Ω
Return Loss	- 25.4 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.159 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 11, 2008

DASY5 Validation Report for Head TSL

Date: 10.01.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 822

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.85$ mho/m; $\epsilon_r = 39.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.45, 4.45, 4.45); Calibrated: 30.12.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

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

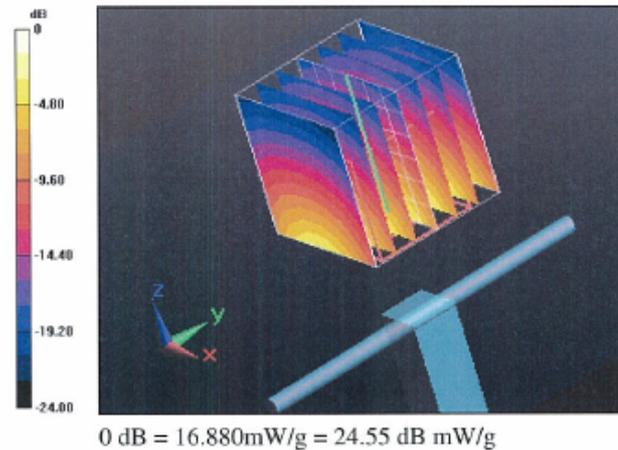
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 99.405 V/m; Power Drift = 0.04 dB

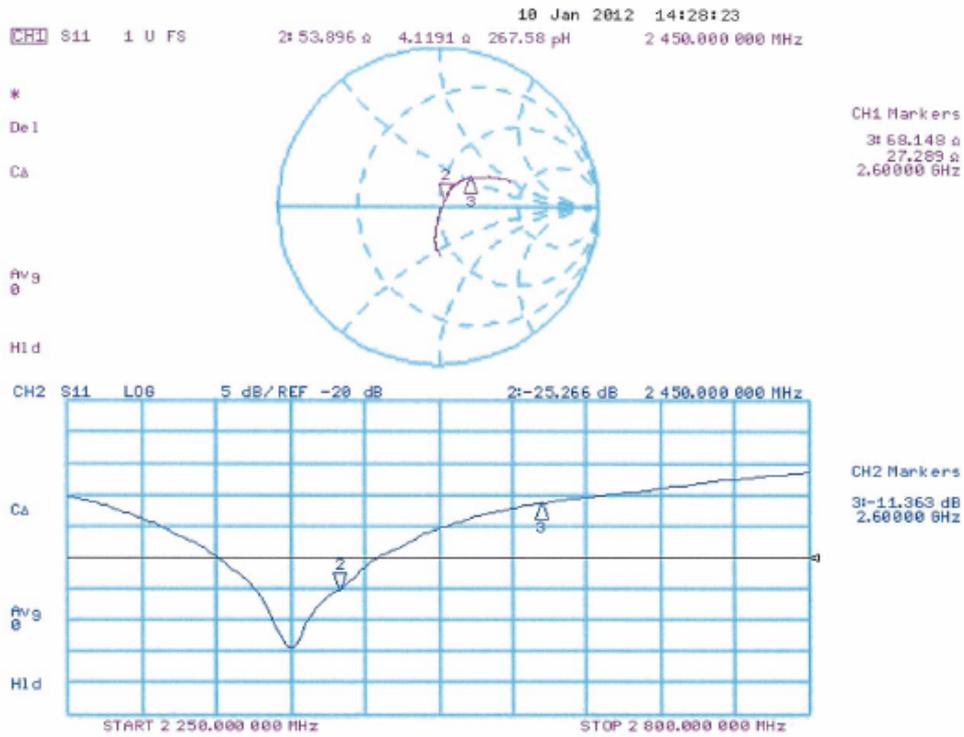
Peak SAR (extrapolated) = 27.1020

SAR(1 g) = 13.2 mW/g; SAR(10 g) = 6.12 mW/g

Maximum value of SAR (measured) = 16.876 mW/g



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 06.01.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 822

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.01$ mho/m; $\epsilon_r = 50.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.26, 4.26, 4.26); Calibrated: 30.12.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

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

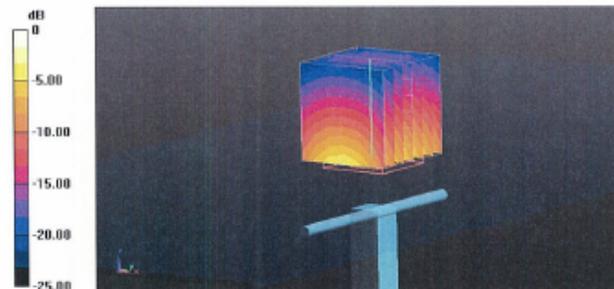
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.185 V/m; Power Drift = -0.0031 dB

Peak SAR (extrapolated) = 27.0610

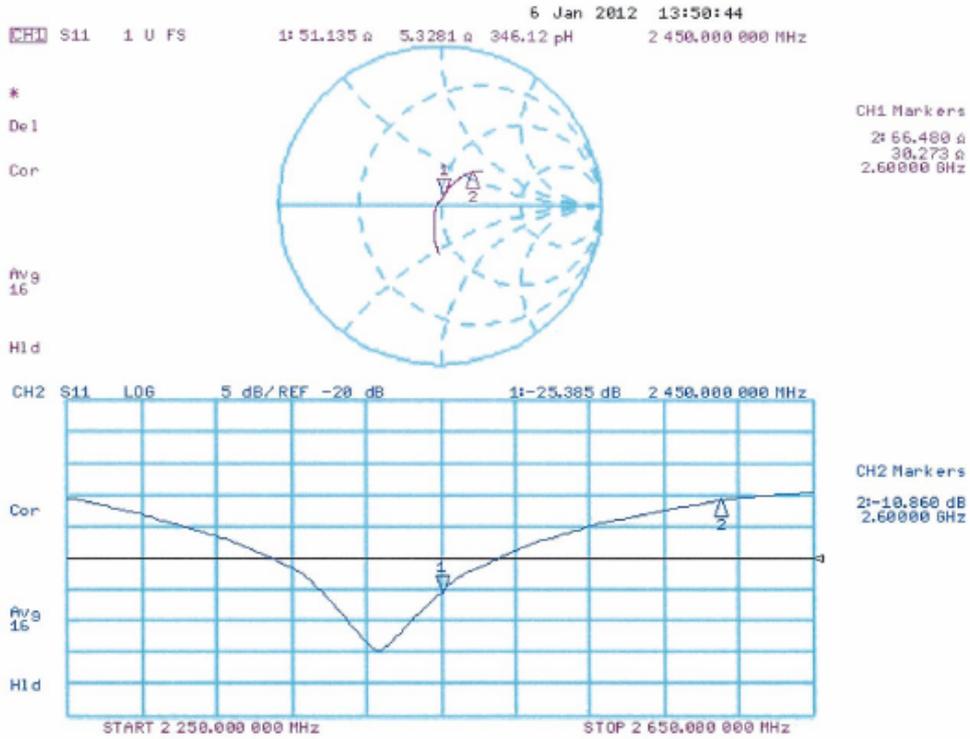
SAR(1 g) = 13.2 mW/g; SAR(10 g) = 6.1 mW/g

Maximum value of SAR (measured) = 17.340 mW/g



0 dB = 17.340mW/g = 24.78 dB mW/g

Impedance Measurement Plot for Body TSL



5. System Validation Dipole (D5GHzV2,S/N:1070)

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



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

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

Accreditation No.: SCS 108

Client **UL Japan (PTI)**

Certificate No: **D5GHzV2-1070_Feb12/2**

CALIBRATION CERTIFICATE (Replacement of No:D5GHzV2-1070_Feb12)

Object	D5GHzV2 - SN: 1070		
Calibration procedure(s)	QA CAL-22.v1 Calibration procedure for dipole validation kits between 3-6 GHz		
Calibration date:	February 16, 2012		
<p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.</p> <p>Calibration Equipment used (M&TE critical for calibration)</p>			
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	05-Oct-11 (No. 217-01451)	Oct-12
Power sensor HP 8481A	US37292783	05-Oct-11 (No. 217-01451)	Oct-12
Reference 20 dB Attenuator	SN: 5086 (20g)	29-Mar-11 (No. 217-01368)	Apr-12
Type-N mismatch combination	SN: 5047.2 / 05327	29-Mar-11 (No. 217-01371)	Apr-12
Reference Probe EX3DV4	SN: 3503	30-Dec-11 (No. EX3-3503_Dec11)	Dec-12
DAE4	SN: 601	04-Jul-11 (No. DAE4-601_Jul11)	Jul-12
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-11)	In house check: Oct-12
Calibrated by:	Name Israël El-Naouq	Function Laboratory Technician	Signature
Approved by:	Katja Pokovic	Technical Manager	
			Issued: March 2, 2012
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

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



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

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

Accreditation No.: **SCS 108**

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 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- 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) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.8.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Speag Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz \pm 1 MHz 5500 MHz \pm 1 MHz 5800 MHz \pm 1 MHz	

Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 \pm 0.2) °C	35.3 \pm 6 %	4.60 mho/m \pm 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.03 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	80.0 mW / g \pm 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.3 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	22.9 mW / g \pm 16.5 % (k=2)

Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 \pm 0.2) °C	34.9 \pm 6 %	4.89 mho/m \pm 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.57 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	85.3 mW / g \pm 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.44 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	24.3 mW / g \pm 16.5 % (k=2)

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.4 ± 6 %	5.19 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.08 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	80.3 mW / g ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.30 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	22.8 mW / g ± 16.5 % (k=2)

Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.6 ± 6 %	5.48 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.42 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	74.1 mW / g ± 18.1 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.08 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	20.8 mW / g ± 17.6 % (k=2)

Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.6	5.65 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.1 ± 6 %	5.87 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5500 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.0 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	80.0 mW / g ± 18.1 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.22 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	22.2 mW / g ± 17.6 % (k=2)

Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.5 ± 6 %	6.29 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.55 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	75.4 mW / g ± 18.1 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.09 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	20.9 mW / g ± 17.6 % (k=2)

Appendix**Antenna Parameters with Head TSL at 5200 MHz**

Impedance, transformed to feed point	51.8 Ω - 13.8 j Ω
Return Loss	- 17.3 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	49.5 Ω - 8.0 j Ω
Return Loss	- 21.9 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	53.6 Ω - 3.3 j Ω
Return Loss	- 26.5 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	51.9 Ω - 10.7 j Ω
Return Loss	- 19.5 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	51.0 Ω - 5.4 j Ω
Return Loss	- 25.2 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	55.4 Ω - 2.4 j Ω
Return Loss	- 25.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.202 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	September 26, 2008

DASY5 Validation Report for Head TSL

Date: 16.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1070

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz
Medium parameters used: $f = 5200$ MHz; $\sigma = 4.6$ mho/m; $\epsilon_r = 35.3$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5500$ MHz; $\sigma = 4.89$ mho/m; $\epsilon_r = 34.9$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 5.19$ mho/m; $\epsilon_r = 34.4$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

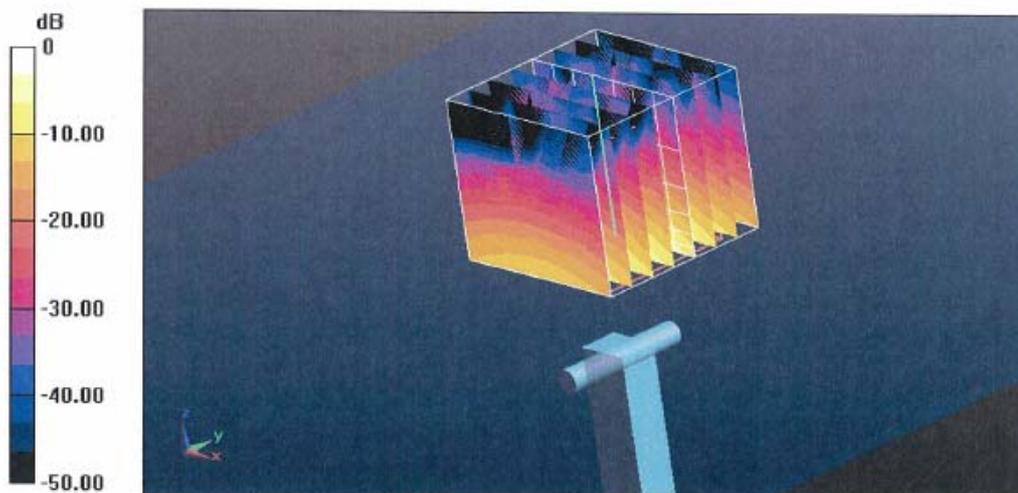
DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.41, 5.41, 5.41), ConvF(4.91, 4.91, 4.91), ConvF(4.81, 4.81, 4.81); Calibrated: 30.12.2011
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

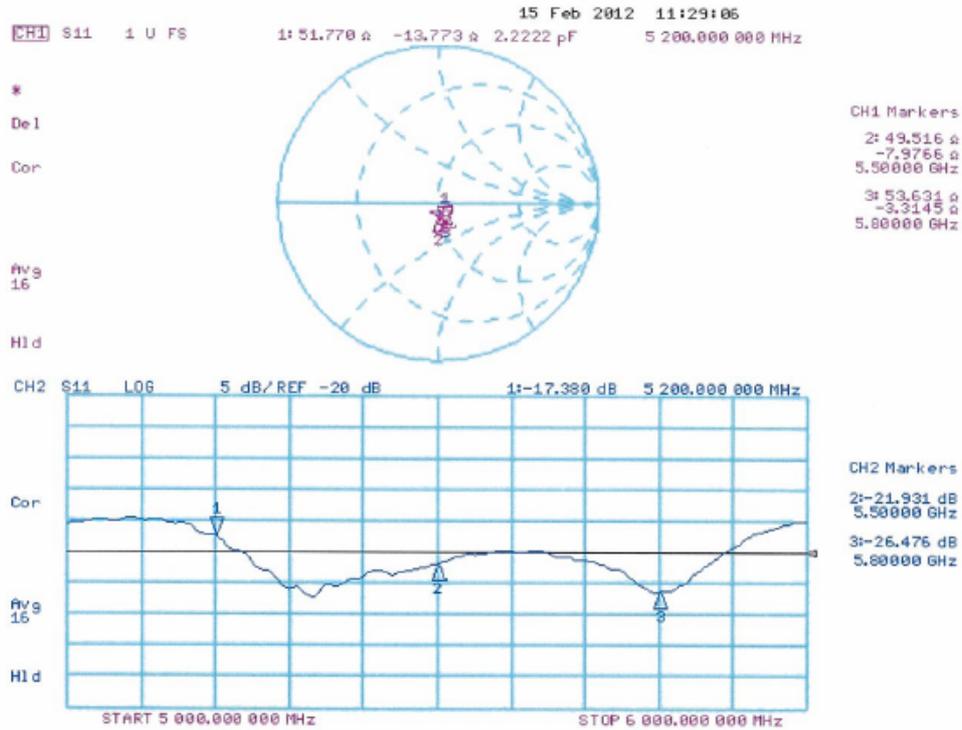
Dipole Calibration for Head Tissue - Spacer SPEAG/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 64.235 V/m; Power Drift = -0.0022 dB
Peak SAR (extrapolated) = 30.1280
SAR(1 g) = 8.03 mW/g; SAR(10 g) = 2.3 mW/g
Maximum value of SAR (measured) = 18.715 mW/g

Dipole Calibration for Head Tissue - Spacer SPEAG/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 64.915 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 34.1720
SAR(1 g) = 8.57 mW/g; SAR(10 g) = 2.44 mW/g
Maximum value of SAR (measured) = 20.497 mW/g

Dipole Calibration for Head Tissue - Spacer SPEAG/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 61.666 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 33.9990
SAR(1 g) = 8.08 mW/g; SAR(10 g) = 2.3 mW/g
Maximum value of SAR (measured) = 19.547 mW/g



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 15.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1070

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz
Medium parameters used: $f = 5200$ MHz; $\sigma = 5.48$ mho/m; $\epsilon_r = 48.6$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5500$ MHz; $\sigma = 5.87$ mho/m; $\epsilon_r = 48.1$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 6.29$ mho/m; $\epsilon_r = 47.5$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

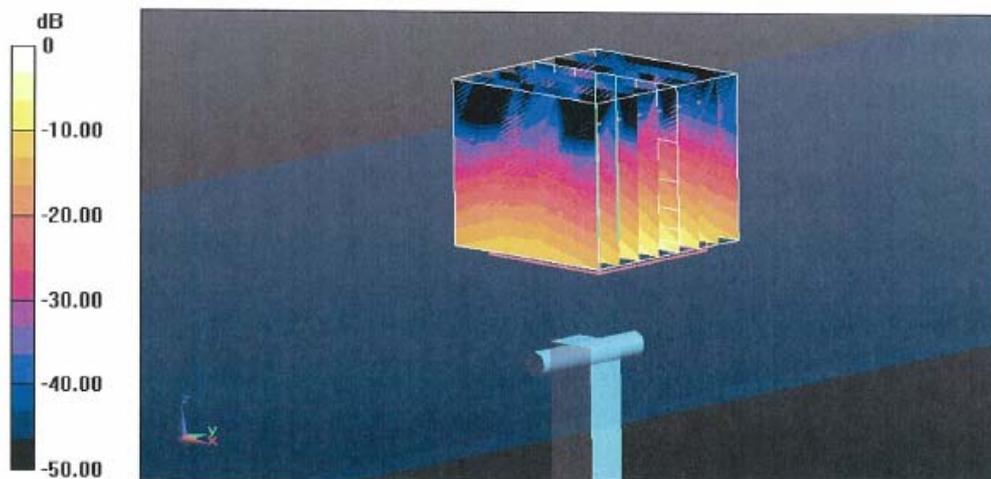
DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.91, 4.91, 4.91), ConvF(4.43, 4.43, 4.43), ConvF(4.38, 4.38, 4.38); Calibrated: 30.12.2011
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

Dipole Calibration for Body Tissue - Spacer SPEAG/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 58.023 V/m; Power Drift = -0.0003 dB
Peak SAR (extrapolated) = 29.0440
SAR(1 g) = 7.42 mW/g; SAR(10 g) = 2.08 mW/g
Maximum value of SAR (measured) = 17.104 mW/g

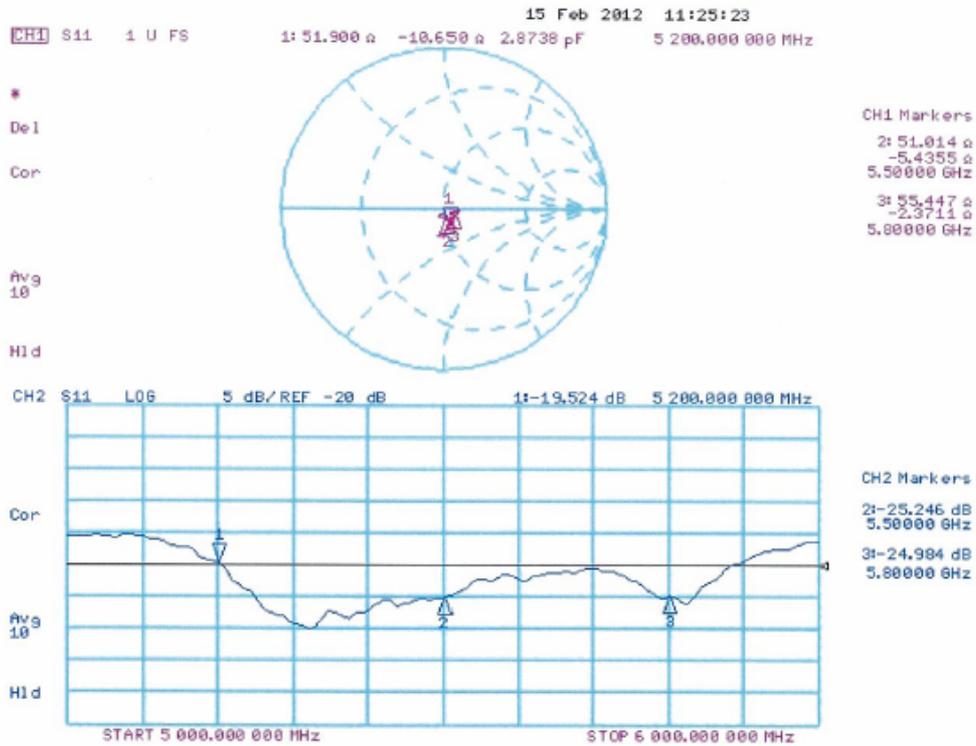
Dipole Calibration for Body Tissue - Spacer SPEAG/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 58.498 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 34.2230
SAR(1 g) = 8 mW/g; SAR(10 g) = 2.22 mW/g
Maximum value of SAR (measured) = 18.964 mW/g

Dipole Calibration for Body Tissue - Spacer SPEAG/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 55.286 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 35.0830
SAR(1 g) = 7.55 mW/g; SAR(10 g) = 2.09 mW/g
Maximum value of SAR (measured) = 18.335 mW/g



0 dB = 18.340mW/g = 25.27 dB mW/g

Impedance Measurement Plot for Body TSL



Appendix B: Additional Measurements

Upon customer request, additional measurements were done using customized Zoom Scan settings and with customer spacer, for Head and Body conditions. Results are summarized on the following pages.

Alternations to Measurement Conditions

DASY system configuration, as far as not given on pages 1 and 3.

Distance Dipole Center - TSL	10 mm	with UL Spacer #1
Zoom Scan Resolution (UL)	dx, dy = 4.0 mm, dz = 2.0 mm	Graded Ratio = 1.5 (Z direction)
Frequency	See page 3	
Head TSL parameters	See pages 3 and 4	
Body TSL parameters	See pages 5 and 6	

SAR result with Head TSL at 5200 MHz

SAR results normalized to 1W input power and for nominal TSL parameters.

SAR averaged over 1 cm ³ (1 g) of Head TSL	Dipole Spacer	
SPEAG Zoom Scan setting (page 3)	SPEAG	80.0 mW/g ± 17.0 % (k=2)
SPEAG Zoom Scan setting (page 3)	UL #1	80.1 mW/g ± 17.0 % (k=2)
UL Zoom Scan settings (page 14)	UL #1	80.6 mW/g ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	Dipole Spacer	
SPEAG Zoom Scan setting (page 3)	SPEAG	22.9 mW/g ± 16.5 % (k=2)
SPEAG Zoom Scan setting (page 3)	UL #1	23.0 mW/g ± 16.5 % (k=2)
UL Zoom Scan settings (page 14)	UL #1	23.1 mW/g ± 16.5 % (k=2)

SAR result with Head TSL at 5500 MHz

SAR results normalized to 1W input power and for nominal TSL parameters.

SAR averaged over 1 cm ³ (1 g) of Head TSL	Dipole Spacer	
SPEAG Zoom Scan setting (page 3)	SPEAG	85.3 mW/g ± 17.0 % (k=2)
SPEAG Zoom Scan setting (page 3)	UL #1	85.9 mW/g ± 17.0 % (k=2)
UL Zoom Scan settings (page 14)	UL #1	86.4 mW/g ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	Dipole Spacer	
SPEAG Zoom Scan setting (page 3)	SPEAG	24.3 mW/g ± 16.5 % (k=2)
SPEAG Zoom Scan setting (page 3)	UL #1	24.5 mW/g ± 16.5 % (k=2)
UL Zoom Scan settings (page 14)	UL #1	24.6 mW/g ± 16.5 % (k=2)

SAR result with Head TSL at 5800 MHz

SAR results normalized to 1W input power and for nominal TSL parameters.

SAR averaged over 1 cm ³ (1 g) of Head TSL	Dipole Spacer	
SPEAG Zoom Scan setting (page 3)	SPEAG	80.3 mW/g ±17.0 % (k=2)
SPEAG Zoom Scan setting (page 3)	UL #1	80.9 mW/g ±17.0 % (k=2)
UL Zoom Scan settings (page 14)	UL #1	80.8 mW/g ±17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	Dipole Spacer	
SPEAG Zoom Scan setting (page 3)	SPEAG	22.8 mW/g ±16.5 % (k=2)
SPEAG Zoom Scan setting (page 3)	UL #1	22.9 mW/g ±16.5 % (k=2)
UL Zoom Scan settings (page 14)	UL #1	22.9 mW/g ±16.5 % (k=2)

SAR result with Body TSL at 5200 MHz

SAR results normalized to 1W input power and for nominal TSL parameters.

SAR averaged over 1 cm ³ (1 g) of Body TSL	Dipole Spacer	
SPEAG Zoom Scan setting (page 3)	SPEAG	74.1 mW/g ± 18.1 % (k=2)
SPEAG Zoom Scan setting (page 3)	UL #1	74.5 mW/g ± 18.1 % (k=2)
UL Zoom Scan settings (page 14)	UL #1	74.8 mW/g ± 18.1 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	Dipole Spacer	
SPEAG Zoom Scan setting (page 3)	SPEAG	20.8 mW/g ± 17.6 % (k=2)
SPEAG Zoom Scan setting (page 3)	UL #1	21.0 mW/g ± 17.6 % (k=2)
UL Zoom Scan settings (page 14)	UL #1	21.0 mW/g ± 17.6 % (k=2)

SAR result with Body TSL at 5500 MHz

SAR results normalized to 1W input power and for nominal TSL parameters.

SAR averaged over 1 cm ³ (1 g) of Body TSL	Dipole Spacer	
SPEAG Zoom Scan setting (page 3)	SPEAG	80.0 mW/g ± 18.1 % (k=2)
SPEAG Zoom Scan setting (page 3)	UL #1	80.8 mW/g ± 18.1 % (k=2)
UL Zoom Scan settings (page 14)	UL #1	81.0 mW/g ± 18.1 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	Dipole Spacer	
SPEAG Zoom Scan setting (page 3)	SPEAG	22.2 mW/g ± 17.6 % (k=2)
SPEAG Zoom Scan setting (page 3)	UL #1	22.5 mW/g ± 17.6 % (k=2)
UL Zoom Scan settings (page 14)	UL #1	22.5 mW/g ± 17.6 % (k=2)

SAR result with Body TSL at 5800 MHz

SAR results normalized to 1W input power and for nominal TSL parameters.

SAR averaged over 1 cm ³ (1 g) of Body TSL	Dipole Spacer	
SPEAG Zoom Scan setting (page 3)	SPEAG	75.4 mW/g ± 18.1 % (k=2)
SPEAG Zoom Scan setting (page 3)	UL #1	76.4 mW/g ± 18.1 % (k=2)
UL Zoom Scan settings (page 14)	UL #1	75.7 mW/g ± 18.1 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	Dipole Spacer	
SPEAG Zoom Scan setting (page 3)	SPEAG	20.9 mW/g ± 17.6 % (k=2)
SPEAG Zoom Scan setting (page 3)	UL #1	21.2 mW/g ± 17.6 % (k=2)
UL Zoom Scan settings (page 14)	UL #1	21.0 mW/g ± 17.6 % (k=2)

Antenna Parameters with Head TSL at 5200 MHz

SPEAG reference spacer	51.8 Ω - 13.8 j Ω	- 17.3 dB
UL spacer #1	51.7 Ω - 13.9 j Ω	- 17.3 dB
UL spacer #2	51.4 Ω - 14.2 j Ω	- 17.1 dB

Antenna Parameters with Head TSL at 5500 MHz

SPEAG reference spacer	49.5 Ω - 8.0 j Ω	- 21.9 dB
UL spacer #1	49.3 Ω - 8.1 j Ω	- 21.8 dB
UL spacer #2	49.0 Ω - 8.7 j Ω	- 21.1 dB

Antenna Parameters with Head TSL at 5800 MHz

SPEAG reference spacer	53.6 Ω - 3.3 j Ω	- 26.5 dB
UL spacer #1	53.8 Ω - 3.2 j Ω	- 26.5 dB
UL spacer #2	53.4 Ω - 3.7 j Ω	- 26.3 dB

Antenna Parameters with Body TSL at 5200 MHz

SPEAG reference spacer	51.9 Ω - 10.7 j Ω	- 19.5 dB
UL spacer #1	51.8 Ω - 12.4 j Ω	- 18.3 dB
UL spacer #2	52.0 Ω - 12.0 j Ω	- 18.6 dB

Antenna Parameters with Body TSL at 5500 MHz

SPEAG reference spacer	51.0 Ω - 5.4 j Ω	- 25.2 dB
UL spacer #1	49.6 Ω - 6.5 j Ω	- 23.7 dB
UL spacer #2	49.9 Ω - 6.1 j Ω	- 24.3 dB

Antenna Parameters with Body TSL at 5800 MHz

SPEAG reference spacer	55.4 Ω - 2.4 j Ω	- 25.0 dB
UL spacer #1	54.3 Ω - 1.7 j Ω	- 27.1 dB
UL spacer #2	54.6 Ω - 1.2 j Ω	- 27.0 dB

DASY5 Validation Report for Head TSL

Date: 16.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1070

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz
Medium parameters used: $f = 5200$ MHz; $\sigma = 4.6$ mho/m; $\epsilon_r = 35.3$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5500$ MHz; $\sigma = 4.89$ mho/m; $\epsilon_r = 34.9$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 5.19$ mho/m; $\epsilon_r = 34.4$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.41, 5.41, 5.41), ConvF(4.91, 4.91, 4.91), ConvF(4.81, 4.81, 4.81); Calibrated: 30.12.2011
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

Dipole Calibration for Head Tissue - Spacer #1/Pin=100mW, dist=10mm, f=5200

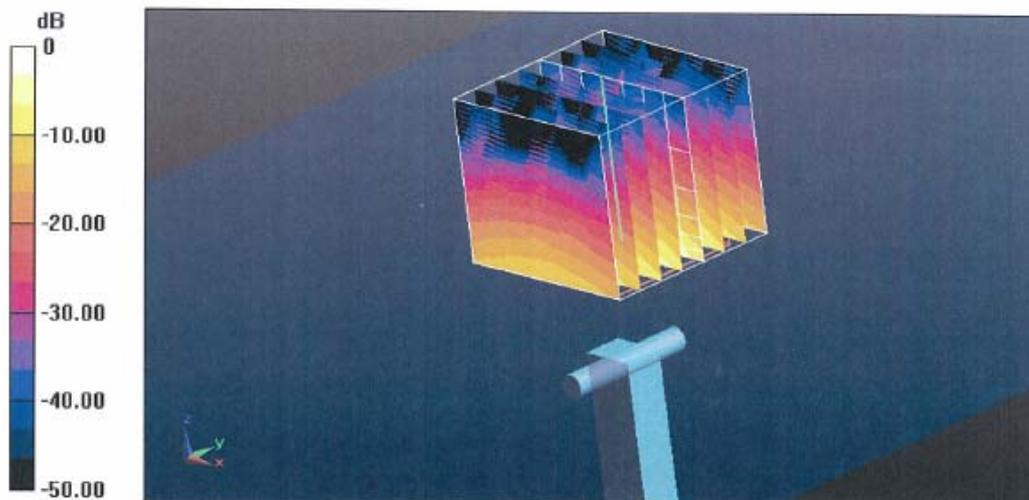
MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.699 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 30.0420
SAR(1 g) = 8.04 mW/g; SAR(10 g) = 2.31 mW/g
Maximum value of SAR (measured) = 18.830 mW/g

Dipole Calibration for Head Tissue - Spacer #1/Pin=100mW, dist=10mm, f=5500

MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 23.994 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 34.3130
SAR(1 g) = 8.63 mW/g; SAR(10 g) = 2.46 mW/g
Maximum value of SAR (measured) = 20.553 mW/g

Dipole Calibration for Head Tissue - Spacer #1/Pin=100mW, dist=10mm, f=5800

MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 23.451 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 34.3360
SAR(1 g) = 8.14 mW/g; SAR(10 g) = 2.31 mW/g
Maximum value of SAR (measured) = 19.852 mW/g



DASY5 Validation Report for Head TSL

Date: 16.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1070

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz
Medium parameters used: $f = 5200$ MHz; $\sigma = 4.6$ mho/m; $\epsilon_r = 35.3$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5500$ MHz; $\sigma = 4.89$ mho/m; $\epsilon_r = 34.9$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 5.19$ mho/m; $\epsilon_r = 34.4$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.41, 5.41, 5.41), ConvF(4.91, 4.91, 4.91), ConvF(4.81, 4.81, 4.81); Calibrated: 30.12.2011
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

Dipole Calibration for Head Tissue - Spacer #1/Pin=100mW, dist=10mm, f=5200

MHz/Zoom Scan, dist=2mm custom (8x8x6)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 63.699 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 30.6260

SAR(1 g) = 8.1 mW/g; SAR(10 g) = 2.32 mW/g

Maximum value of SAR (measured) = 15.779 mW/g

Dipole Calibration for Head Tissue - Spacer #1/Pin=100mW, dist=10mm, f=5500

MHz/Zoom Scan, dist=2mm custom (8x8x6)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 23.994 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 34.7080

SAR(1 g) = 8.68 mW/g; SAR(10 g) = 2.47 mW/g

Maximum value of SAR (measured) = 17.013 mW/g

Dipole Calibration for Head Tissue - Spacer #1/Pin=100mW, dist=10mm, f=5800

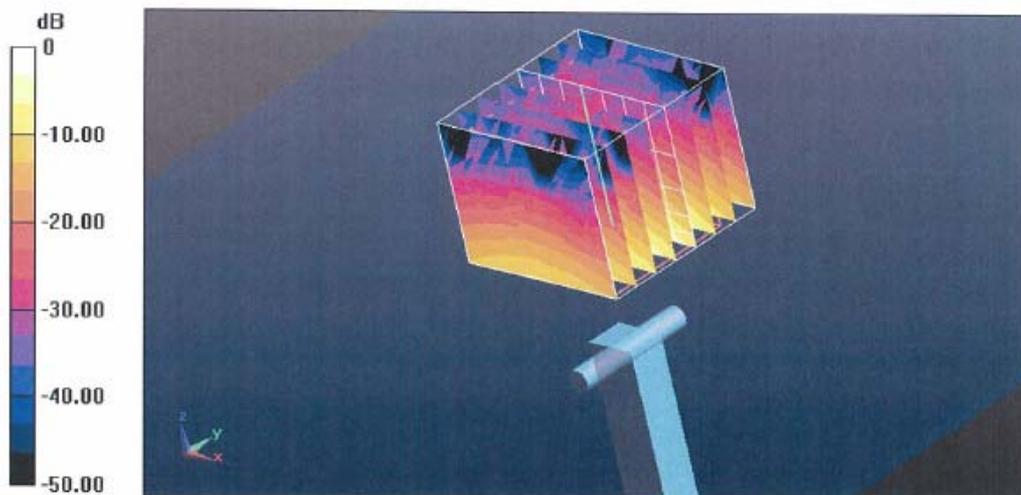
MHz/Zoom Scan, dist=2mm custom (8x8x6)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 23.451 V/m; Power Drift = -0.09 dB

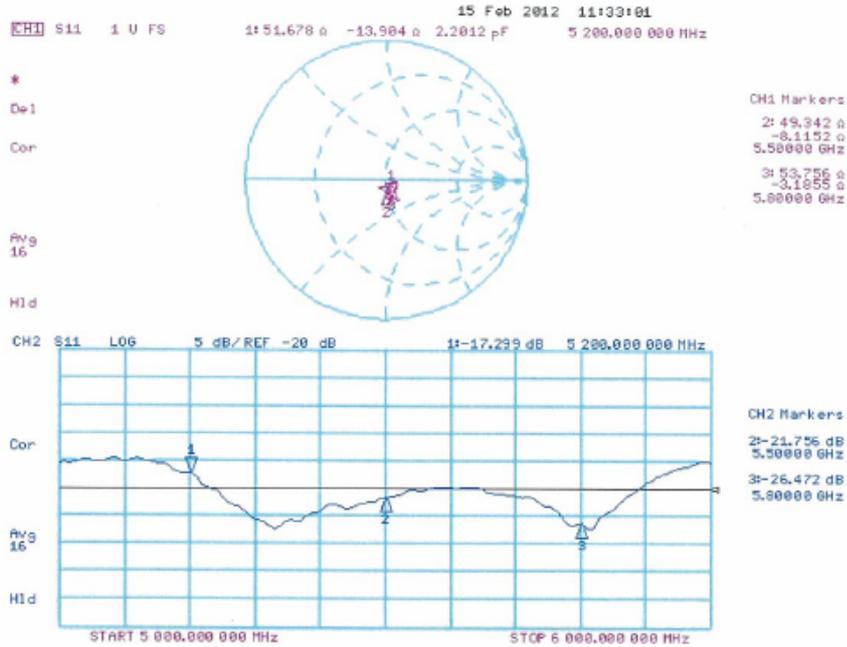
Peak SAR (extrapolated) = 34.4850

SAR(1 g) = 8.13 mW/g; SAR(10 g) = 2.31 mW/g

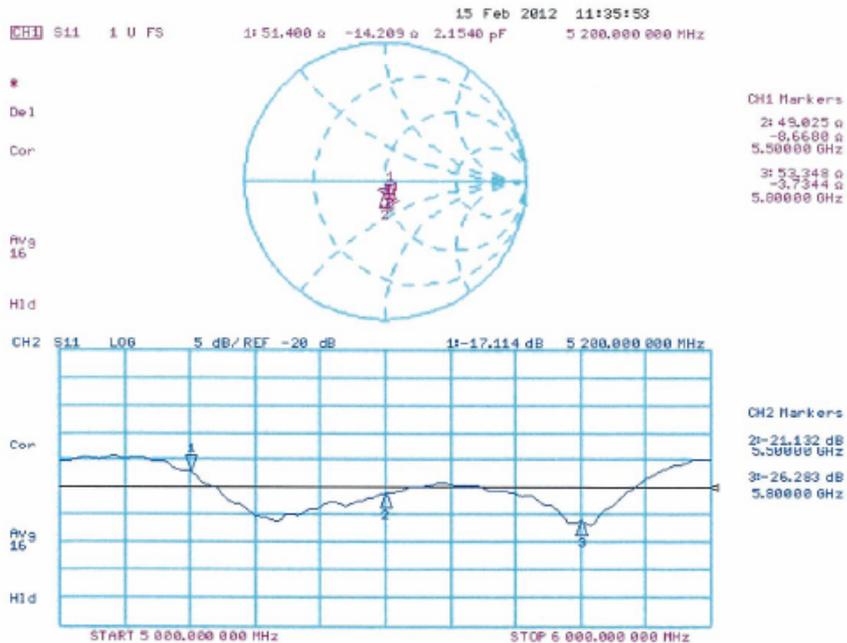
Maximum value of SAR (measured) = 16.326 mW/g



Impedance Measurement Plot for Head TSL (UL Spacer #1)



Impedance Measurement Plot for Head TSL (UL Spacer #2)



DASY5 Validation Report for Body TSL

Date: 15.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1070

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz
Medium parameters used: $f = 5200$ MHz; $\sigma = 5.48$ mho/m; $\epsilon_r = 48.6$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5500$ MHz; $\sigma = 5.87$ mho/m; $\epsilon_r = 48.1$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 6.29$ mho/m; $\epsilon_r = 47.5$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.91, 4.91, 4.91), ConvF(4.43, 4.43, 4.43), ConvF(4.38, 4.38, 4.38); Calibrated: 30.12.2011
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

Dipole Calibration for Body Tissue - Spacer #1/Pin=100mW, dist=10mm, f=5200

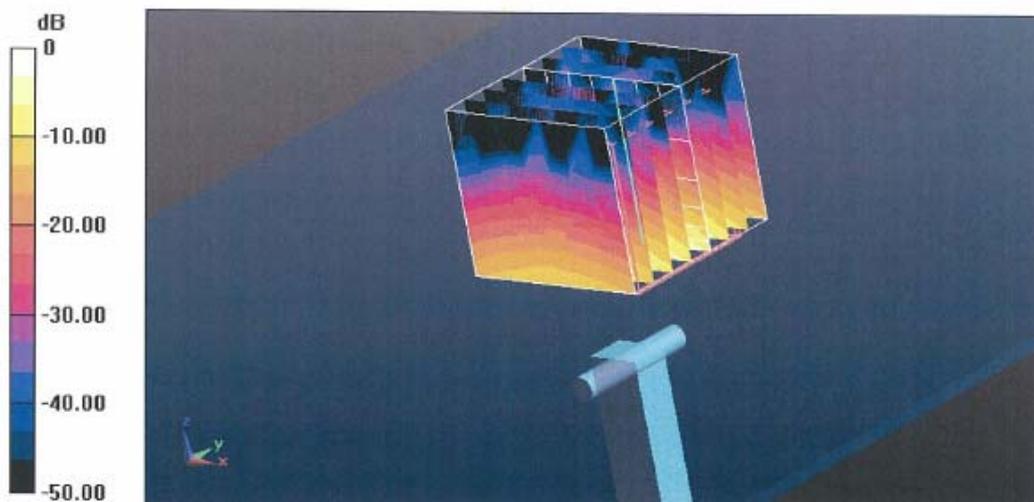
MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 57.949 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 29.4580
SAR(1 g) = 7.46 mW/g; SAR(10 g) = 2.1 mW/g
Maximum value of SAR (measured) = 17.691 mW/g

Dipole Calibration for Body Tissue - Spacer #1/Pin=100mW, dist=10mm, f=5500

MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 58.644 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 34.9420
SAR(1 g) = 8.08 mW/g; SAR(10 g) = 2.25 mW/g
Maximum value of SAR (measured) = 19.688 mW/g

Dipole Calibration for Body Tissue - Spacer #1/Pin=100mW, dist=10mm, f=5800

MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 55.296 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 35.9150
SAR(1 g) = 7.65 mW/g; SAR(10 g) = 2.12 mW/g
Maximum value of SAR (measured) = 19.112 mW/g



0 dB = 19.110mW/g = 25.63 dB mW/g

DASY5 Validation Report for Body TSL

Date: 15.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1070

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz
Medium parameters used: $f = 5200$ MHz; $\sigma = 5.48$ mho/m; $\epsilon_r = 48.6$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5500$ MHz; $\sigma = 5.87$ mho/m; $\epsilon_r = 48.1$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 6.29$ mho/m; $\epsilon_r = 47.5$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.91, 4.91, 4.91), ConvF(4.43, 4.43, 4.43), ConvF(4.38, 4.38, 4.38); Calibrated: 30.12.2011
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

Dipole Calibration for Body Tissue - Spacer #1/Pin=100mW, dist=10mm, f=5200

MHz/Zoom Scan, dist=2mm custom (8x8x6)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 57.949 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 29.6900

SAR(1 g) = 7.49 mW/g; SAR(10 g) = 2.1 mW/g

Maximum value of SAR (measured) = 14.830 mW/g

Dipole Calibration for Body Tissue - Spacer #1/Pin=100mW, dist=10mm, f=5500

MHz/Zoom Scan, dist=2mm custom (8x8x6)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 58.644 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 34.4440

SAR(1 g) = 8.1 mW/g; SAR(10 g) = 2.25 mW/g

Maximum value of SAR (measured) = 16.373 mW/g

Dipole Calibration for Body Tissue - Spacer #1/Pin=100mW, dist=10mm, f=5800

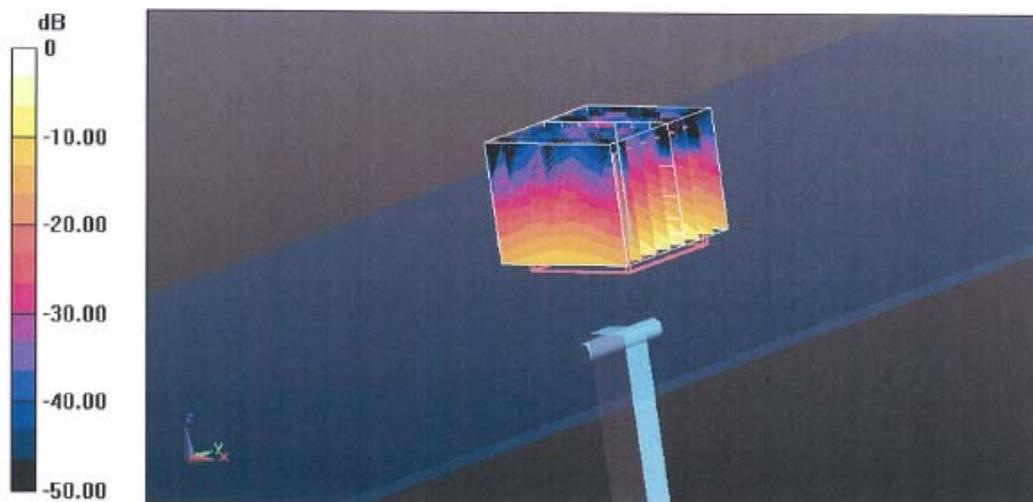
MHz/Zoom Scan, dist=2mm custom (8x8x6)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 55.296 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 34.0500

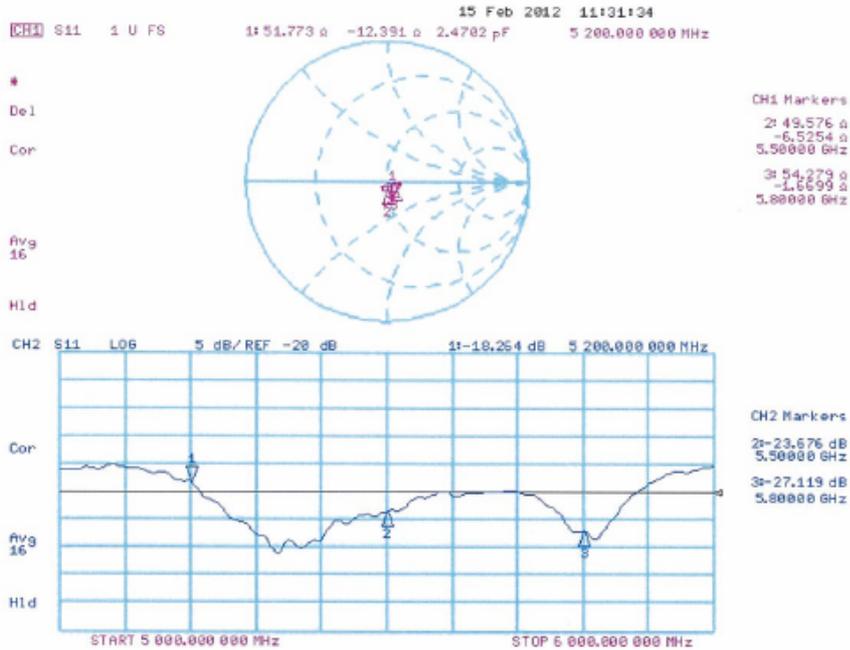
SAR(1 g) = 7.58 mW/g; SAR(10 g) = 2.1 mW/g

Maximum value of SAR (measured) = 15.404 mW/g

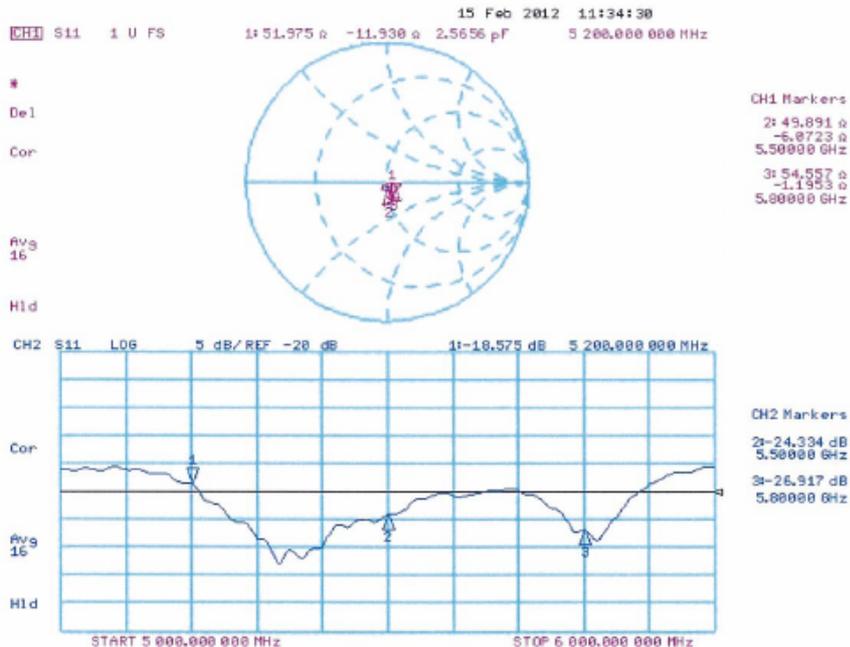


0 dB = 15.400mW/g = 23.75 dB mW/g

Impedance Measurement Plot for Body TSL (UL Spacer #1)



Impedance Measurement Plot for Body TSL (UL Spacer #2)



6. Validation uncertainty

The uncertainty budget has been determined for the DASY5 measurement system according to the SPEAG documents[2] and is given in the following Table.

Error Description	Uncertainty value \pm %	Probability distribution	divisor	(ci) 1g	Standard Uncertainty (1g)	vi or veff
Measurement System						
Probe calibration	± 6.55	Normal	1	1	± 6.55	∞
Axial isotropy of the probe	± 4.7	Rectangular	$\sqrt{3}$	1	± 2.7	∞
Spherical isotropy of the probe	± 9.6	Rectangular	0	0	0	∞
Boundary effects	± 1.0	Rectangular	$\sqrt{3}$	1	± 1.2	∞
Probe linearity	± 4.7	Rectangular	$\sqrt{3}$	1	± 2.7	∞
Detection limit	± 1.0	Rectangular	$\sqrt{3}$	1	± 0.6	∞
Readout electronics	± 0.3	Normal	1	1	± 0.3	∞
Response time	0	Rectangular	$\sqrt{3}$	1	0	∞
Integration time	0	Rectangular	$\sqrt{3}$	1	0	∞
RF ambient Noise	± 1.0	Rectangular	$\sqrt{3}$	1	± 1.7	∞
RF ambient Reflections	± 1.0	Rectangular	$\sqrt{3}$	1	± 1.7	∞
Probe Positioner	± 0.8	Rectangular	$\sqrt{3}$	1	± 0.5	∞
Probe positioning	± 6.7	Rectangular	$\sqrt{3}$	1	± 3.9	∞
Algorithms for Max.SAR Eval.	± 2.0	Rectangular	$\sqrt{3}$	1	± 1.2	∞
Dipole						
Deviation of exp.dipole	± 5.5	Rectangular	$\sqrt{3}$	1	± 3.2	∞
Dipole Axis to Liquid Distance	± 2.0	Rectangular	$\sqrt{3}$	1	± 1.2	∞
Input power and SAR drift meas.	± 3.4	Rectangular	$\sqrt{3}$	1	± 2.7	∞
Phantom and Setup						
Phantom uncertainty	± 4.0	Rectangular	$\sqrt{3}$	1	± 2.3	∞
SAR correction	± 1.9	Rectangular	$\sqrt{3}$	1	± 1.1	
Liquid conductivity (target)	± 5.0	Rectangular	$\sqrt{3}$	0.78	± 2.3	∞
Liquid conductivity (meas.)	± 5.0	Rectangular	1	0.26	± 1.3	∞
Liquid permittivity (target)	± 5.0	Rectangular	$\sqrt{3}$	0.78	± 2.3	∞
Liquid permittivity (meas.)	± 5.0	Rectangular	1	0.23	± 1.2	∞
Combined Standard Uncertainty						
					± 11.01	
Expanded Uncertainty (k=2)						
					± 22.02	

Note: This uncertainty budget for validation is worst-case.

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